EB-2022-0200 Technical Conference

Energy Probe Panel 4 Compendium

Table of Contents

Tab 1

EB-2012-0451 Decision, Page 47

Ontario Energy Board

Commission de l'énergie de l'Ontario

EB-2012-0433

IN THE MATTER OF AN APPLICATION BY

UNION GAS LIMITED

LEAVE TO CONSTRUCT THE PARKWAY WEST PROJECT

EB-2013-0074

IN THE MATTER OF AN APPLICATION BY

UNION GAS LIMITED

LEAVE TO CONSTRUCT THE BRANTFORD-KIRKWALL/PARKWAY D PROJECT

EB-2012-0451

IN THE MATTER OF AN APPLICATION BY

ENBRIDGE GAS DISTRIBUTION INC.

LEAVE TO CONSTRUCT THE GTA PROJECT

DECISION AND ORDER

JANUARY 30, 2014

- The role of interruptible loads in system planning
- Risk assessment in system planning, including project prioritization and option comparison
- Shareholder incentives

There will undoubtedly be other issues as well. The Board notes that this review is particularly timely given the recent provincial Long Term Energy Plan. Further information on how the Board will examine gas integrated resource planning will be released in due course.

Pending that review, the Board expects applicants to provide a more rigorous examination of demand side alternatives, including rate options, in all gas leave to construct applications.

4.2 Project Costs, Economic Evaluation, Rate Impact (including Rate 332)

Enbridge estimated the cost of the GTA Project to be $686.5 million. Segment A is estimated to cost approximately $384 million, including the Parkway West Gate Station, while Segment B is estimated to cost approximately $302 million. Enbridge conducted economic feasibility calculations for the GTA Project in accordance with both E.B.O 188 and E.B.O. 134. Based on Enbridge's analysis, the PI of the GTA Project is 1.73 and the NPV is $667 million. Enbridge also conducted sensitivity analysis scenarios: 10% higher capital costs; zero transmission revenue from shippers on Segment A; 25% and 50% lower transportation cost savings. Under these scenarios, either individually or collectively, the GTA Project is still economically feasible in Enbridge's analysis. Because the economic feasibility results are positive, the company only performed a Stage 1 analysis. However, Enbridge maintained that the evidence shows that Stage 2 benefits would be substantial for consumers using natural gas as opposed to other fuels. Enbridge also noted that the reliability benefits of GTA Project were not monetized, and are not part of the economic feasibility calculations, but are of significant value.

Tab 2

GTA Project Post Construction Financial Report[1]

[1] Photographs of construction were removed to reduce file size. The complete report with photographs is available on the OEB website at https://www.rds.oeb.ca/CMWebDrawer/Record?q=casenumber%3aEB-2012-0451&sortBy=recRegisteredOn-&pageSize=400&start=1

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Enbridge Gas Distribution
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June 30, 2017

VIA RESS, E-MAIL AND COURIER

Ms. Kirsten Walli
Ontario Energy Board
P.O. Box 2319
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Walli,

Re: Enbridge Gas Distribution Inc. ("Enbridge") – GTA Project
Ontario Energy Board ("Board") Docket No. EB-2012-0451
Conditions of Approval – Post Construction Financial Report

On January 30, 2014 the Board issued the Decision and Order for the above noted proceeding which included the Conditions of Approval.

As per paragraph 1.5 of the Conditions of Approval, Enbridge is to provide the Board with a Post Construction Financial Report within fifteen months of the in-service date.

Attached please find the Post Construction Financial Report for the GTA Project with the exception of the Ashtonbee and Buttonville Stations, which will be reported on separately as per our November 6, 2015 and June 15, 2017 letters to the Board.

Please note that Appendix K to the Post Construction Financial Report, titled "KPMG Assessment Report", contains commercially sensitive information on pages 10, 17 and 18 that has been redacted. An unredacted version of Appendix K is being filed with the Board in confidence under separate cover.

Please contact me if you have any questions.

Yours truly,

(Original Signed)

Brian Wikant
Technical Manager, Business Development

Attach.

cc: Zora Crnojacki (Chair, OPCC)
Nancy Marconi (Ontario Energy Board)
Andrew Mandyam (Enbridge)
Scott Dodd (Enbridge)

GTA PROJECT

POST CONSTRUCTION FINANCIAL REPORT

June 30, 2017

TABLE OF CONTENTS

APPENDICES

A. Enbridge Cost Modelling and Contingency Assessment Process

B. Pipeline Permits Received by Agency by Month

C. Consultation Timeline with Permitting Agencies

D. Conflicting Projects Requiring Design and/or Construction Mitigations

E. Crossings with Permit Challenges

F. Crossing Method, Length, and Depth Analysis (Estimate to Actual)

G. Shoring Schedule

H. Boring Schedule

I. Shoring and Boring Crew Ramp Up

J. Construction Pictures

K. KPMG Assessment Report

1. INTRODUCTION

Enbridge Gas Distribution Inc. ("EGD" or the "Company") applied to the Ontario Energy Board ("OEB" or the "Board") on December 21, 2012, under Section 90 of the Ontario Energy Board Act, 1998, S.O. 1998, c. 15, Schedule B, for an Order granting Leave to Construct ("LTC") to certain pipelines and facilities in the Greater Toronto Area ("GTA"). The project is referred to as the GTA Project ("Project"), and the Board assigned file number EB-2012-0451 to this application.

The GTA Project consists of approximately 26.7 kilometers ("km") of Nominal Pipe Size 42 ("NPS 42") Extra High Pressure ("XHP") steel pipeline ("Segment A"), approximately 22.9 km of NPS 36 ("Segment B") XHP steel pipeline, and associated station facilities and connecting pipes[1].

The Board issued a favorable decision on January 30, 2014[2].

On November 6, 2015, the Company informed the Board that the construction of Jonesville[3] Station and Buttonville stations would be delayed.

On April 13, 2016, the Company informed the Board that the GTA Project[4] had been energized.

On September 30, 2016, per Condition of Approval 3.1 in the decision, the Company filed the Interim Monitoring Report with the Board.

Per Condition of Approval 1.5 in the decision, this report summarizes the differences between the actual costs and the costs as outlined in the application for the GTA Project, excluding the Buttonville and Ashtonbee stations.

[1] EB-2012-0451 Exhibit A Tab 3 Schedule 6
[2] EB-2012-0451 Decision and Order dated January 30, 2014
[3] Renamed Ashtonbee Station. Please refer to EB-2016-0034 February 18, 2016 decision
[4] Excludes the Ashtonbee Station and Butttonville Station

2. SUMMARY

The estimated cost for the GTA Project was $686.5 million[5] ("MM"). After deducting the forecast costs for Buttonville and Jonesville stations[6], the forecast cost was $667.4 MM.

The actual construction costs are $847.4 MM, excluding Buttonville and Ashtonbee Stations. The difference is $180.0 MM or 27% unfavorable. The Company has discussed the potential for variance during the proceeding and kept the Board apprised of the projected difference during and after construction.

The cost estimate was Class 3 as defined by the American Association of Cost Engineers ("AACE") and the unfavorable variance is within the AACE guidelines. It is also within the range of possible outcomes defined by the cost probability distribution curve that supported the initial forecast of $667.4 MM. As well, the cost is reasonable when compared to other benchmarks. Further details can be found in Section 5.

The Company retained KPMG during the construction execution phase of the Project to independently assess the efficacy and prudency of the GTA Project's management and governance practices. In doing so, KPMG found that[7]

> *"… the GTA Project team made efforts to mitigate against cost and schedule increases and demonstrated prudency in the delivery of the project. …"*

The major cost variances are categorized as follows[8]

Reference	**CATEGORY**	Estimate	Actual	Variance
4.1	Project Management	57.2	53.4	(3.8)
4.2	Engineering	19.1	35.7	16.6
4.3	Land	85.0	72.5	(12.5)
4.4	Materials	63.1	76.4	13.3
4.5	Pipeline ("Mainline") Construction	217.3	424.5	207.2
4.6	Horizontal Direction Drilling ("HDD") Construction	68.8	56.9	(11.9)
4.7	Facilities Construction	20.1	45.7	25.6
4.8	Construction Support	26.8	51.6	24.8
4.9	Commissioning and Start Up	1.2	5.7	4.5
4.10	Interest During Construction ("IDC")	19.8	25.0	5.2
	Contingency	89.0	-	(89.0)
	TOTAL	667.4	847.4	180.0

[5] EB-2012-0451 Exhibit C Tab 2 Schedule 1 unredacted

[6] EB-2012-0451 Exhibit C Tab 2 Schedule 1 unredacted. Escalation and direct engineering costs have been apportioned to the two stations.

[7] KPMG Assessment Report, page 1 included as Appendix K

[8] Minor variances to the KPMG Assessment Report, page 13 reflect timing differences between Oct, 2016 and Apr, 2017, including reclassification of certain costs to better align actuals to estimate.

The Company attributes $191.6 MM of the variance, which is more than the total variance after applying contingency, to the following three root causes: a) bid to estimate variance; b) permit delays; and, c) construction complexity, particularly related to crossings. The latter two in turn led to a schedule delay, which increased the indirect costs associated with the duration of the Project.

Section 3 of the report is organized to explain the variances related to the three root causes mentioned above. Section 4 provides a more detailed explanation of these variances by individual cost category.

Section 6 contains some lessons learned which may be useful for future large diameter projects of similar scale and environment.

3. COST OVERAGE ROOT CAUSES

3.1. Bid Prices Relative to Estimate

Ninety five million ($95.2 MM) of the overall variance is due to the increase in bid prices relative to the estimate.

Contractor prices are generally reflective of the competitive market for their services at the time of a Request for Proposal ("RFP") and the degree of complexity and risk associated with the work. Major contracts involved RFP processes with multiple, pre-qualified parties in order to ensure a competitive process. Alternate contract structures were requested and evaluated for both the mainline and facilities RFP's in an attempt to reduce price.

With regards to process, all major contracts were supported with a Contract Development Plan ("CDP") document, detailing the specific contracting strategy to be employed. Prior to awarding the contract, a Contract Award Recommendation ("CAR") was prepared to document the successful proponent and the rationale for their selection. CDP's and CAR's were approved in accordance Enbridge's governance process.

In reviewing the mainline, HDD, and facilities contracts and contracting process, KPMG found[9]

> *"… the process of contract procurement to be competitive and well documentded. The contract terms are relatively favorable to EGD and in-line with industry practice in terms of level of security and change management."*

The cost variance breakdown by each of the three construction activity categories is as follows.

Construction Activity	Cost Estimate ($MM)	Bid Price ($MM)	Bid to Estimate Variance ($MM)	Actual Cost ($MM)	Actual to Bid Variance ($MM)	Actual to Estimate Variance ($MM)
Mainline	$217.3	$320.0	$102.6	$424.5	$104.6	$207.2
Facilities	$20.1	$34.8	$14.7	$45.7	$10.8	$25.6
HDD	$68.8	$46.6	($22.1)	$56.9	$10.2	($11.9)
Total	$306.2	$401.4	$95.2	$527.1	$125.7	$220.9

More details on the contracting strategies, processes, and results follow.

[9] KPMG Assessment Report, page 1 included as Appendix K

3.1.1. Mainline Contract

The mainline RFP was issued to four pre-qualified proponents, two of which formed a joint venture to bid. In order to eliminate the risks associated with a time and material ("T&M") contract, the form of contract was Base Lay (ie. lump sum) plus Unit Prices ("UPI") for items that could not be quantified and priced in advance without adding significant risk premium to the contract. UPI examples include shoring, boring, rock excavation, topsoil stripping, matting, and drilling mud disposal.

Due to the perceived construction risk associated with the Project, one of the three proponents refused to complete the entire job on a Base Lay basis. They indicated that they would complete either the NPS 42 or NPS 36 as Base Lay but the other half would be T&M.

A second proponent indicated that they already had two crews committed to other work in 2015 and could only commit to resource one "super-sized" crew to complete the GTA Project. Their high bid price reflected their lack of need for the work in what was expected to be a generally busy pipeline construction season in 2015/16, before the overall downturn in the energy markets was foreseen. Their ambivalence was also reflected in a low technical evaluation score, which was the result of incomplete or insufficiently detailed bid documents.

A Target Price was also requested as a possible option to reduce the bid price. One proponent refused to bid on a target price basis. For the remaining two, the target prices were higher than the lowest Base Lay + UPI price received and the limitations they placed on the cap did not justify the additional risk associated with a T&M contract structure.

The contract was awarded to the low bidder with an initial contract price of $320.0 MM, comprised of $231.2 MM in fixed costs (Base Lay, HDD support, final tie-ins and Performance Bond) and $88.8 MM in projected variable costs for UPI's. This represented a $31.3 MM reduction from the successful contractor's original RFP submission, which was achieved through bid clarifications, negotiation, and economies of scale associated with awarding the entire job to a single contractor. The second lowest proponent's price was considerably higher than the successful bidder.

The mainline bid to estimate variance of $102.6 MM can be attributed to the following items.

- The expectation of a tight labour market for pipeline construction services in 2015. This was supported by one of the contractor's ambivalent approach to the bid process as described above.
- The greater design definition provided with the 2014 Mainline RFP relative to the 2012 estimate, which was prepared without the benefit of subsurface utility engineering or agency circulation/feedback. The contractor's bid price reflected the greater number of

longer and deeper bores than originally estimated, which is explained in greater detail in Section 3.3. While some of the crossing changes were made during construction to resolve field challenges, most of the changes were included in the detailed design and crossing drawings that the contractor reviewed before finalizing its bid price. Over the entire 50 km pipeine route, the longest stretch between crossings was 1.4 km and the longest stretch installed without requiring depth of cover greater than 1.5 m (1.2 m is standard) was 0.5 km. The productivity impacts associated with these complexities resulted in higher labour hours in the bid relative to what was included in the estimate.

The following table reflects this final point. It provides a comparison of the labour hours to the mainline construction costs for each of the estimate, bid, and final actuals. On a percentage basis the increase in construction costs generally correlate with the increase in labour hours at each of these three milestones. The reasons for the actual to bid variance are explained in greater detail in Section 4.5.

	Estimate	Bid	Actual	Variance Bid to Estimate	Variance Actual to Bid
Labour Hours	978,000[10]	1,288,000	1,668,000	32%	30%
Mainline Construction Cost ($MM)	$217.3	$320.0	$424.5	47%	33%

3.1.2. HDD Contract

The HDD RFP included 14 drills, which was three less than the 17 included in the cost estimate. The variance was a result of the detailed design process that eliminated two drills, added one drill, and in two cases combined two drills into one longer drill. The cost estimate of $68.8 MM included a provision of $18.4 MM for three potential failures.

Five additional drills[11] were later added to the mainline contractor's scope of work to overcome constructability challenges and/or resolve permitting issues. The Alden Road HDD is in the mainline bid price as it was added prior to signing the mainline contract. The remaining four were added during construction as discussed in Section 4.5.

A Request for Information ("RFI") was sent to five HDD contractors in order to prequalify them for the RFP process. Of those five, four were deemed to be technically qualified to complete the work and received the RFP package, with one declining to submit a proposal. RFP submissions were received from the remaining three proponents and a decision was made to split the drills between the proponent with the highest technical evaluation and the one with the lowest cost.

[10] Contractor hours extrapolated to reflect mainline cost increase in final estimate as compared to original contractor cost model. This reflects mainline scope changes between the initial cost estimate filed December 21, 2012 and the final estimate filed July 22, 2013.
[11] Alden Road HDD, West Don HDD, Torbram Road HDD, Leslie Street Direct Pipe, Lisgar-Meadowbrook Direct Pipe.

Because the drilling program was on the critical path, the decision to split the drills was made in order to maintain maximum schedule flexibility in the event that one contractor ran into problems. By not having all rigs from a single contractor committed to the Project, the capacity to add resources was available. The decision to split the drills was rewarded as the Project required additional resources due to the addition of five HDD crossings in order to overcome constructability and permitting challenges during construction.

The combined bid price of the two successful HDD contractors was $46.6 MM, or $3.8 MM less than the $50.4 MM base estimate (ie. before failure provision). This can be attributed to the fact that a significant portion of the early engineering effort was spent progressing the HDD designs, because this is where the Project team initially perceived the greatest risk. This additional design definition, relative to the mainline and facilities, allowed for improved accuracy in the HDD cost estimate.

3.1.3. Facilities Contract

The facilities RFP was issued to two proponents, both of which are existing EGD extended alliance ("EA") partners and have experience with constructing facilities. The Project team believed that proceeding in this manner would afford competitive pricing and also reduce the contract preparation and execution time. The initial RFP was for lump sum pricing and excluded Buttonville Station.

Initial lump sum prices from both parties were just over $49 MM. These initial price submissions were thought to be too high so three additional proponents were requested to provide proposals. Of these three, one had a substantially higher price than the EA partners, one provided an incomplete proposal, and one provided competitive pricing but ranked low on the technical evaluation. The GTA Project's procurement process combined both a commercial and technical ranking when selecting contractors to ensure that a low price was not being driven by sub-standard capabilities and inferior quality.

A decision was made to re-engage the two EA partners and request revised proposals. The proponent with the highest technical score proposed a T&M Target Price of $41 MM with a sharing of overruns and underruns and an effective cap[12]. This proposal was the lowest price, represented an $8 MM savings over the initial lump sum, and was accepted.

Subsequent to contract award, Jonesville station was removed from scope which reduced the final target price from $41 MM to $34.8 MM. This represents an overage of $14.7 MM compared to the facilities construction estimate of $20.1 MM, excluding Jonesville and Buttonville . This bid to estimate variance is attributed to a combination of higher field labour

[12] 50%/50% sharing on any overage up to $2 MM and on any savings below $41 MM. Any costs over $43 MM were to the contractor's account which effectively capped the Company's cost, subject to escalation due to change orders, at $42 MM.

hours and higher average hourly labour rates required to construct the stations. The underestimate of the work effort was a result of the lack of detailed design definition at time of estimate.

3.2. Permit Delays and Additional Rquirements

The Company attributes $40.6 MM of the variance to the incremental costs associated with permit delays.

Appendix B shows the number of permits received from the respective agencies each month until the final permit was received for the Argentia Road crossing in December, 2015. As of the start of construction in January, 2015, EGD had only obtained 24 (10%) of the 236 permits and private easements required to complete the pipeline portion of the Project. Appendix C shows a timeline of discussions with five permitting agencies where the late issuance permits had an impact on the Project schedule.

Discussions with permitting agencies were initiated in early 2012. These were helpful in determining anticipated conflicts with future works and developing mitigation plans. Appendix D shows 46 such conflicts and the resulting mitigations, which typically involved either pipeline design changes or construction schedule accommodations.

Despite these meetings, most agencies did not initiate the formal permitting circulation and review process until stamped engineering crossing/alignment drawings were available. Through the review process substantive design changes were often necessary to satisfy individual agency requirements, as well as the collective requirements where multiple agencies were involved in a single crossing. In fact, of the 236 permits required, 97 had complicating issues as shown in Appendix E. Requests for design changes were often unforeseeable and driven by the following agency future constraints.

1. A desire to protect their right of way for their own use in the future and/or avoid any conflict with potential future works.
2. A requirement that the pipeline be installed in a location that ensured there would be no conflict or cost impact with maintenance work on their existing facilities in the future – often below the deepest foreign utility in the crossing.

The best example of the first point was HONI, who requested several significant last minute design changes in the fall of 2014 on both Segment A and B to protect their corridor for future buried hydro ducts and a new tower line running parallel to, and south of, Highway 407. This request caused major design re-work including the introduction of an additional HDD at Alden Road, which was the only option to maintain HONI's minimum 10 m clearance requirement to the tower footings.

The second point is best exemplified by both York and Peel Region's preference that we cross below, rather than above, their water and sewer mains. Peel also requested 2 m of clearance to their existing infrastructure rather than the municipal standard of 0.6 m and our project design criteria of 1 m. These two requirements caused many crossings to be extremely deep in order to locate the pipeline below the deepest utility within the crossing with above normal separation.

In addition, several crossings required permits from multiple agencies, sometime with disparate requests. This required close coordination amongst the parties, often prolonging the permitting timeline. The best examples of this were the crossings at German Mills Creek, West Don River, Torbram Road, and Fletchers Creek as described in Appendix E. In the case of German Mills Creek, it took 294 days from the initial permit submission until the final permit required to construct the crossing was received on August 17, 2015.

Finally, some agencies required new agreements for the GTA Project that were previously not required for permitting of projects. For example:

1. Highway 407's approval was historically done through conditions attached to the Ministry of Transportation ("MTO") agreement. However, for the GTA Project Highway 407 required a new legal agreement specific to the Project. This was first discussed on August 5, 2014 and the signed agreement was received on February 26, 2015.
2. The Company had operated under the existing Municipal Franchise Agreement in Peel Region. However, Peel Region required that a Franchise Agreement specific to the Region be in place prior to issuing any permits for the Project. The Peel Region Franchise Agreement was executed and received on December 22, 2014.

All of the above permitting complexities resulted in delays in obtaining many permits. A majority of the 24 permits that EGD had received by the end of 2014 were to enable EGD to start the HDD program on time at the start of January 2015 and complete the 4 winter drills. EGD had prioritized these permits because the HDD program, with its inherent risks, was driving the Project's critical path at that time.

The following additional actions were taken by EGD in an effort to expedite the permitting process and mitigate the negative impacts associated with the delays.

- One senior team member was assigned accountability for managing the permit acquisition process.
- Additional resources were added to EGD's permitting group to improve the turnaround time on permit submissions and re-submissions where changes were requested by the agencies.
- In addition to the detailed permit tracker, a one page dashboard was created and utilized to prioritize the permits. These priorities were reviewed through a daily team meeting, with a

focus on expediting those permits that would best mitigate the impact on the contractor's construction schedule.

- The Senior Project Director led weekly meetings with EGD's land and permitting groups, to communicate priorities and develop agency escalation strategies as necessary.
- Daily morning construction meetings were held with the mainline contractor that included discussion of which permits they required to minimize the impact on their proposed schedule as well as to adjust their work plan to reflect the permits already obtained.

These actions helped EGD to acquire 68% of the permits from March to May, 2015, at which point EGD had 89% of the required permits in hand. Unfortunately, this caused much of the winter work that the contractor had planned to be pushed into the summer/fall period, thereby driving the Project delay that was communicated to the Board on June 30, 2015.

3.3. Construction Complexity

The Company attributes $55.7 MM of the overall variance to the incremental costs associated with construction complexity. Appendix J provides construction pictures that reflect many of the challenges.

In the original estimate, crossing depth assumptions and methods were driven by typical planning requirements below ditch lines, rail tracks, creek bottoms, and foreign pipelines. However, once the subsurface utility engineering confirmed the depths of all foreign utilities, constructability assessments were completed, and agency feedback was taken into consideration, the number of bores increased by 61% compared to the estimate. In addition, the pipe depth at crossings increased significantly, from an average of 2.1 m to 3.0 m at open cut crossings (a 44% increase) and to 5.7 m at bored crossings (a 170% increase). The following table[13] summarizes the changes in crossing method, depth and length from estimate to final design.

CROSSING METHOD	Number of Crossings		Average Depth of Cover (m)		Average Length (m)		% Increase/Decrease (Actual versus Estimate)		
	Estimate	Actual	Estimate	Actual	Estimate	Actual	Number	Depth	Length
Open Cut	50	24	2.1	3.0	33.6	49.3	-52%	44%	47%
Boring	33	53	2.1	5.7	50.4	70.4	61%	170%	40%

Unfortunately, temporary work space limitations and the proximity to parallel linear facilities, such as sewers, would not allow the deep bore pit trench walls to be sufficiently sloped to meet health and safety regulations. As a result, 96% of all entry and exit bore pits, representing 102 excavations, required some form of sheet pile, slide rail and/or trench box shoring.

[13] See Appendix F for for the crossing method, length and depth analysis (actual vs estimate) by individual crossing.

On average, shoring set-up and bored installations took 19 days and 17 days respectively, or 5 weeks in total[14]. This compares to an estimated duration of 2 weeks per bore in the cost estimate and 1 week per bore in the mainline contractor's original schedule. More bores of longer duration was a significant contributor to the cost overage and schedule delay.

With the crossing work not starting until mid-June, it was July before the full schedule impact of the extended crossing durations was understood and plans were developed to mitigate the impact. The plan involved an accelerated ramp up in the number of shoring crews, followed by a significant increase in the number of boring crews once the deep excavations were safe to enter. Finding sufficient material/equipment and qualified resources to safely deliver this ramp up in such a short period of time was challenging. Local shoring and boring businesses were unable to meet the Project's demand and, as a result, additional time was required to source equipment from other jurisdictions across North America. Starting in early September, EGD and the contractor initiated weekly senior management schedule review meetings focused on the early identification and resolution of issues related to the aggressive crossing schedule.

Appendix I shows the weekly ramp up/down from the beginning of July until the final shoring removal. As shown, the number of shoring crews peaked at 17 the week of September 21, 2015 and the boring crews at 16 the week of November 9. This represents an almost doubling of resources within a two month period. Although the volume and cost of shoring was higher than estimated, this ramp up prevented an even longer schedule extension and associated incremental overhead costs.

Construction challenges were also experienced at several trenchless crossings, largely due to complex ground conditions that weren't identifiable from the geotechnical investigations. In some cases, more expensive and challenging HDD's were added as the only construction method that could resolve permitting issues. Sections 4.5 and 4.6 provide specific examples where this was the case.

[14] See Appendix G and H for the shoring and boring schedules respectively.

4. VARIANCE EXPLANATIONS BY CATEGORY

The following provides a further sub-categorization and explanation of the major variances by cost category.

4.1. Project Management

Sub-Category	Variance ($MM)	Comments
Project development	0.3	
Project execution	($7.3)	The underage of $7.3 MM is primarily attributable to labour savings in Procurement ($4.2 MM), Quality Management ($1.9 MM), Regulatory ($1.5 MM), and Commissioning ($0.5 MM) offset by $0.8 MM in added cost for the KPMG prudency assessment. Savings were identified during the development of the detailed organizational structure required to execute the Project. In addition, resources were managed effectively and came in under budget despite a five month extension in the construction schedule.
Administrative and general	2.8	The overage of $2.8 MM is primarily attributable to the resolution of First Nation issues ($1.9 MM), the addition of an EGD project integration team to ensure effective change management and operational readiness ($0.6 MM), and additional legal costs related to various Project challenges ($0.3 MM).
Insurance	0.4	
Total category	($3.8)	

4.2. Engineering

Sub-Category	Variance ($MM)	Comments
Pipeline design	6.6	Pipeline design and drawing escalation, driven primarily by the work complexity required to accommodate the varying and unique information requirements of the multiple permitting agencies. This lack of consistency required significant individual drawing customization which added to the Engineering and drafting costs. There was also increased design complexity required to accommodate the various agencies existing and future infrastructure plans as referenced in Appendix D. This required plan and profile alignment sheets for the entire 50 km length in addition to crossing drawings at roads, railroads, pipeline, and water crossings, whereas a typical pipeline has a plan drawing of the entire route and profile drawings only at the crossings. For the GTA Project, Engineering would typically involve approximately 25 plan view drawings at a scale of 1:2000 and 100 crossing drawings as compared to the 571 alignment, crossing, and environmental drawings that were actually required to permit the

		Project. This represents an over fivefold increase in the scope of engineering and drafting work. Finally, there was considerable rework required to incorporate agency feedback and permitting requests. The primary example of this was HONI's last minute request to re-route sizeable sections of the pipeline to accommodate their future infrastructure builds. On average there were five revisions for each of the 571 pipeline drawings. While a large number of these revisions were attributable to EGD's review and comment, it's fair to say that a significant portion were the result of changes requested through the agency review and permitting process.
Facilities design	1.4	Facilities design and drawing escalation, driven primarily by an increase in the work effort to complete the station designs. At Albion and Parkway West Gate Stations, the estimate provisioned for 113 and 134 drawings respectively. The actual number of drawings required to engineer these two stations were 368 and 369 respectively, or three times the number originally estimated.
Geotechnical investigation	1.8	Additional costs incurred to complete 220 boreholes at facilities, HDD's, and other major road and rail crossings. Boreholes were primarily required to; a) complete crossing feasibility assessments including selection of the most suitable construction method based on the ground conditions; b) meet the permitting requirements of the MTO and railways; and c) inform the civil design (ie. pipe supports, foundations, etc) at station locations. In addition, some boreholes were utilized to measure and monitor ground water levels prior to and during construction.
Project management	3.0	Additional engineering consultant project management costs, related to the protracted schedule, and incremental resources required to manage the additional design scope.
Specification development and procurement support	1.8	Development of 48 technical specifications, related to materials and construction, as well as Material Requisition (MR) development and technical review of vendor RFP technical documentation.
Construction support	1.6	Engineering support during the extended construction phase of the Project. This included evaluation and engineering of field changes required to execute the Project.
Miscellaneous	0.4	
Total category	16.6	

4.3. Land

Sub-Category	Variance ($MM)	Comments
Permanent easement	($16.2)	Savings are attributable to Infrastructure Ontario land costs that were 25% less than estimated.

Landowner resolutions	(2.8)	Costs incurred for property damage and business interruption were lower than estimated. This is attributable to the care and diligence taken by the contractors when working near affected businesses and homes.
Temporary work space	6.5	The overage in temporary work space (TWS) costs are due to the Project acquiring as much TWS as was reasonably possible given the constraints of the corridor(s) that the pipeline is located in. In some instances this was still insufficient and additional TWS was requested from agencies during construction. Maximizing the TWS reduced congestion on the right of way, provided more room for stockpiling spoil, and reduced the need to temporarily store it off the right-of way. While difficult to quantify, the cost to maximize the TWS was certainly offset by a reduction in the contractor's base lay price. This was a learning from the Ottawa Reinforcement Project.
Total category	($12.5)	

4.4. Materials

Sub-Category	Variance ($MM)	Comments
Currency	5.9	Pipe price variance attributable to the reduction in the Canadian vs. US dollar between the time of estimate and the time of payment for the pipe, which is in USD.
Pipe quantity	2.7	Pipe quantity increased by 3,700 m. This was necessary to provide sufficient contingency pipe, including a provision for two failed HDD's. The amount of pipe also increased due to an 88% increase (from 70 to 132) in the actual number of induction bends purchased for the final design relative to the number originally estimated.
Stockpiling and storage	4.3	Stockpiling and pipe storage costs that were not uniquely identified in the original cost estimate.
Miscellaneous	0.4	
Total category	13.3	

4.5. Mainline Construction

Sub-Category	Variance ($MM)	Comments
Bid to estimate	102.6	As discussed in Section 3.1.1.
Construction complexity	30.6	Additional shoring costs as discussed in Section 3.3
Permit delays	37.5	The contractor requested additional payment of $81.5 MM under the contract for incremental costs associated primarily with the negative impacts caused by the EGD's delay in obtaining permits. EGD recognized that its delay in obtaining permits had negatively impacted

		the schedule and the contractor's ability to execute the work in an unfettered manner. However, it argued that the contractor's underestimation of the work complexity and failure to properly plan the work were also contributing factors, neither of which are compensable events. Through negotiation, EGD agreed to compensate the contractor an amount of $30 MM, 64% less than the initial request, for its contribution to the hardship caused by the permitting delays. The Company's decision to proactively resolve the dispute in order to maintain a positive working relationship with the contractor, for the betterment of the overall Project, is consistent with expert opinion on construction disputes[15]. EGD incurred an additional $7.5 MM in costs related to the permit delays. Some of these were paid prior to the contractor's request for additional compensation and some were conditions of the compensation settlement. These costs included: • Standby payments to the contractor in the winter of 2015 due to a lack of available work ($1.4 MM) • Work acceleration in April 2015 to meet landowner commitments for work completion ($1.5 MM). This included work at the driving ranges on both the east and west sides of the Highway 404 HDD crossing, necessary to allow them to open their golf operations as soon as possible in the spring and mitigate additional loss of business claims. • Incremental costs (ie. night shift premiums, lights, direct supervision, mechanic, and paramedic costs) to implement a night shift bore crew, beginning in September, 2015, to accelerate schedule ($1.4 MM). • An incentive payment awarded to the contractor for achieving a February 15, 2016 milestone to have Segment A ready for hydrotesting ($1 MM). • Payment for the contractor's indirect costs to extend field support after February 15, 2016 solely for hydrotest support activities and final tie-ins ($2.1 MM).
Construction complexity	16.9	Construction challenges primarily related to; a) ground conditions that differed from the geotechnical evaluations, primarily at bore and HDD entry and exit locations, or; b) changes made to resolve permitting or stakeholder issues. This includes the: • Addition of the Leslie Street Direct Pipe due to flowing sand conditions that continually seized the boring augers[16] ($4.6 MM). • Addition of the Lisgar-Meadowbrook Direct Pipe due to flowing sand conditions that prevented the excavation of a stable bore pit[17] ($4.9 MM).

[15] EB-2016-0152, Exhibit M1, pages 64 and 65
[16] Pictures on page 7 of Appendix J
[17] Pictures on pages 25 and 26 of Appendix J

		• Addition of an HDD to avoid a conflict with the Torbram Road reconstruction ($2.6 MM). • Addition of an HDD as the only way to align York Region and TRCA on the West Don River crossing method ($1.4 MM). • Short water main relocation and casing installation at Argentia Road, required by Peel Region as a condition of allowing us to cross over their water main[18] ($0.9 MM). • Relocation of Airport Road alignment, crossing under the existing NPS 36 integrity main, due to post-permitting retaining wall/parking lot construction ($0.9 MM). • Procurement of special rock tooling equipment[19] required to overcome difficult ground conditions at the Highway 407 Horizontal Directional Bore ($0.5 MM). • Removal and subsequent replacement of a short section of the Don Valley line to allow for a short section of parallel pipeline construction beneath it ($0.2 MM). • Installation of an 80" steel casing under the pipeline at German Mills Creek, required by York Region to enable the easy replacement of their sewer in the future ($0.2 MM).
Scope changes	12.2	This includes situations where the contractor was requested to perform additional work that was not clearly defined in the scope of work documents. This included: • Longer and sturdier bridge structures required to meet permitting requirements[20] ($3.2 MM). • Additional costs to provide secondary isolation at several tie in points, thereby providing an additional layer of protection for worker safety ($1.3 MM) • Additional redressing costs ($1.2 MM) • Additional hydrovacing for sub-surface utilities and infrastructure either; a) not identified by the agency circulation and therefore missing from the construction drawings[21], or b) required as a condition of the permit ($0.8 MM). • Additional abrasion resistant over-coating (ARO) of incremental HDD pipe required to accommodate additional drills and added length caused by HDD field changes ($0.8 MM). • Total costs associated with a large number of small changes each under $0.3 MM ($7.5 MM). • Offsetting credits of $2.6 MM received from the mainline contractor, primarily for tie-in work transferred to the facilities contractor and avoided base lay work where the construction method was changed from open cut to bore.

[18] Pictures on pages 24 and 25 of Appendix J
[19] Picture on page 28 of Appendix J
[20] See picture of temporary bridge at Spring Creek (Page 18 of Appendix J) as an example
[21] See picture of hydrovac search for 7 unidentified HONI cables at Fletchers Creek (page 22 of Appendix J) as an example

Weather	7.4	Non-productive time due to wet weather shutdowns. Rather than having the contractor price weather risk into their Base Lay price a decision was made to include a General Contract provision to compensate the contractor for the actual weather delays that they experienced. Unfortunately, the construction period from January 1, 2015 to March 31, 2016 experienced 12% more rain days and 27% greater rainfall than average for the GTA[22]. The spring of 2015, during mainline start-up, was particularly wet with 29 more rain days and 164.6 mm (6.5 inches) more rain than average.
Total category	207.2	

4.6. Horizontal Directional Drilling

Sub-Category	Variance ($MM)	Comments
Bid to estimate	($22.1)	As discussed in Section 3.1.2. This includes $3.8 MM savings in the bid to estimate plus the $18.3 MM failed drill provision.
Construction complexity	8.2	The Project did not experience any outright drill failures, but did have to extricate 404 m of pipe installed at Bayview Avenue due to a long dent believed to be caused by a rock falling into the hole during pullback[23]. A new pull string was welded and pulled into the hole after reconditioning it to a slightly larger size. EGD did not compensate the HDD contractor for this re-work but did have to compensate the Mainline contractor for pipe preparation and support activities. Additional examples of HDD construction challenges are as follows. • The Credit River Direct Pipe[24] failed its first attempt after encountering a wood obstruction approximately 11 m into the drill. This was considered an unforeseen ground condition and the HDD contractor was compensated $1.5 MM for additional costs associated with extracting the Tunnel Boring Machine (TBM) and waiting to begin the second drill attempt, which was successful. The mainline contractor was also compensated $2.2 MM to support the recovery efforts, including excavating to remove the obstruction and backfilling the hole with unshrinkable fill. • The Finch-Claireville HDD[25] encountered two failed pullback attempts before a successful third attempt. In both cases the pipe became stuck approximately 150 m into the pullback and had to be extricated from the hole. The HDD contractor absorbed all but approximately $0.3 MM of these costs but

[22] Average monthly rainfall data from *http://www.toronto.climatemps.com/precipitation.php* and actual monthly data during construction from *https://www.worldweatheronline.com/toronto-weather-averages/ontario/ca.aspx*
[23] Picture on page 36 of Appendix J
[24] Pictures on pages 31 and 32 of Appendix J
[25] Pictures on pages 33 and 34 of Appendix J

		compensation of $1.7 MM was paid to the mainline contractor for its support activities related to the pipe extractions and three pull attempts. • The East Don HDD[26] was extended approximately 289 m to the west to include the East Don Trib 1, which was initially going to be an open cut crossing, at a cost of $1.0 MM. This eliminated environmental concerns associated with damming the tributary for an open cut crossing, but more importantly it avoided the need for the permitting and construction of a costly engineered road on Highway 407 property which was required to construct the crossing. • An aggregate amount of $0.8 MM was paid to the HDD contractors for standby time caused by various delays at five of the 14 HDD locations.
Scope changes	2.0	• Several HDD's required the use of cranes to achieve the proper entry angle for the pullback string at a total cost of $1 MM paid to the mainline contractor. • Proximity to commercial receptors required the installation of sound barriers[27] at the Pomona and Finch-Claireville HDD's at a total cost of $0.6 MM paid to the mainline contractor. • The repair of sinkholes that developed post pullback at the Mavis Road and Bathurst Street HDD's cost a total of $0.2 MM to remediate. • Due to an inadvertent return at the Pomona HDD entry, the drill profile was changed to add depth and a wash-over casing was installed. Compensation of $0.2 MM was paid to the HDD contractor to implement these measures which were effective in preventing a reoccurrence of the inadvertent return.
Total category	(11.9)	

4.7. Facilities Construction

Sub-Category	Variance ($MM)	Comments
Bid to estimate	14.7	As discussed in Section 3.1.3.
Permit delays	3.1	This extension was primarily caused by a series of events that started with the delayed completion of the Finch-Claireville HDD (which was set up in the same location required for the two CNR bores into Albion Station) from March 14 to June 10, 2015. The HDD delay was due to slower than expected production through the 1.2 km of bedrock and two failed pullback attempts. Schedule challenges were compounded by delays in obtaining

[26] Pictures on page 37 of Appendix J
[27] Picture on page 36 of Appendix J

		agreements/approvals between EGD, TCPL, City of Toronto, and CN for a temporary bridge[28] over the CN tracks on Indian Line Road. This bridge was required because the maximum allowable load for the City of Toronto's existing Indian Line Bridge was insufficient to support TCPL and EGD's movement of heavy equipment and materials to the Albion Road station site. The final approval was obtained from CN on July 3, 2015 and construction and certification of the bridge was completed on July 24. These delays pushed back the start of the extensive sheet pile shoring[29] for the NPS 42 Albion inlet and NPS 36 Albion outlet crossings of the CNR tracks, which in turn delayed the bores. Because the enormous bore receiving pits were located in conflict with a majority of the facilities to be installed at Albion Station, it was the first week of November before crews were fully mobilized to start station construction. As a result, the majority of construction work at Albion Station was completed through the winter months, resulting in the following additional costs. • Heating and hoarding, lighting, and snow removal ($0.5 MM). • Productivity impacts due to cold weather ($0.4 MM). • Civil contractor premiums - ie. mud mats, winter concrete, extra granular, Sunday work, travel allowances ($0.3 MM). • Indirect costs for contractor project management/supervision and site office trailers/facilities due to the 5 month schedule extension ($1.6 MM). In an effort to mitigate the schedule impacts caused by the bore and temporary bridge permitting delays, EGD worked with both the facilities and mainline contractors to execute the following mitigation strategies. • Built a surplus of prefabricated station sections[30] for faster installation once the site became available. • Segregated the site to avoid health and safety concerns, allowing the installation of buildings in parallel with the bore work. • Transferred ownership of the deep bore pits and shoring removal from the mainline contractor to the facilities contractor, allowing immediate access to start facilities construction once the bore pipe was installed[31]. • Added shifts and overtime to make up schedule. • Moved the NPS 42 hydrotest location to the north side of the CNR tracks and used pipe pre-tested to 100% SMYS for the crossing,

[28] Pictures on page 42 of Appendix J
[29] Pictures on pages 13-15 of Appendix J
[30] Picture on page 44 of Appendix J
[31] See page 43 of Appendix J for picture of facilities contractor tie-in of Albion Station outlet piping to end of bore pipe

		thereby decoupling the backfilling of the south bore pit within the station compound from the hydrotest schedule.
Scope changes	7.8	This includes situations where the contractor was requested to perform additional work that was not clearly defined in the scope of work documents. The primary drivers of these changes were; scope transfer from the mainline contractor to the facilities contractor to optimize work flow ($1.8 MM), design development and modifications ($2.8 MM), material quality issues ($0.9 MM), unforeseen site conditions ($0.2 MM), other miscellaneous ($2.1 MM).
Total category	25.6	

4.8. Construction Support

Sub-Category	Variance ($MM)	Comments
Third party support	8.8	Time dependent third party costs experienced an overage due to the five month schedule extension. These included: • Pipeline and facility inspection services ($3.5 MM). • Non-destructive examination (NDE) services to confirm weld integrity ($4.4 MM). • Field survey services to stake the pipe centerline and prepare as-built records of its permanent location ($0.9 MM).
Testing and drying	7.3	In September of 2015, the mainline contractor was requested to provide a cost to hydrotest and dry the pipelines. Their cost exclusive of water management, which is the greatest logistical challenge for any test, was $15.6 MM. Due to the high price, a competing quote was requested from a reputable testing company. This company's quote was $8.5 MM, with an additional $2.5 MM from the mainline contractor to provide equipment and labor for test and drying support activities. The total price of $11.0 MM was $4.6 MM less than the mainline contractor's and offered several benefits related to schedule. The testing company's plan included testing and drying the pipelines in five shorter segments, as they were completed, in order to preserve schedule. It also included a comprehensive water management plan that involved the construction of large "lake tanks" to hold the test water[32]. This had several benefits including being able to control flow rates during fill and discharge. By doing so the Project was not constrained by permit conditions related to fill rates from hydrants or discharge rates to the natural environment. This was a learning from the Ottawa Reinforcement project, which experienced delays because of restrictions on being able to discharge the test water directly from the pipeline to the environment. The tanks also allowed the same water to be used to test each half of Segment A and each half of Segment B thereby providing an environmental benefit.

[32] See page 52 of Appendix J for picture of Segment B lake tank and page 53 for Segment A lake tanks

		Final testing and drying costs of $11.3 MM were in line with the contractor(s) proposal of $11.0 MM but were above the cost estimate of $4.1 MM. The estimate included 46 days for testing and drying of all the pipelines, whereas the testing contractor's actual duration was 74 days or a 61% increase. A breakdown of the cost overage is as follows: • Mainline contractor test support ($0.9 MM) • Lake tank construction and associated civil work ($1.7 MM) • Additional testing and drying costs due to the greater number of testing/drying days as well as variances in the crew/equipment mix and rates ($3.4 MM) • Costs attributed to heating for winter test conditions ($1.3 MM)
Construction monitoring	4.4	Unanticipated costs required by agencies for monitoring of their infrastructure during construction. This included: • Settlement monitoring of highway and railway crossings, including the installation and removal of the settlement points and report preparation ($3.5 MM). • Vibration, settlement, and tilt monitoring of hydro transmission towers in proximity to the pipeline alignment ($0.5 MM). • Railway flagging at pipeline crossing and access locations ($0.4 MM).
Miscellaneous	4.3	Various costs as follows. • Rig mats purchased directly by the Project, rather than the mainline contractor, to enable HDD site preparation to begin in December, 2014 ($1.4 MM). • Indirect costs to support EGD field employees - ie. trucks, PPE, site office equipment and supplies ($0.6 MM) • Contaminated soil clean-up ($0.6 MM). • Permit acquisition costs paid to agencies ($0.6 MM) • Decommissioning and reclamation of groundwater monitoring wells ($0.4 MM) • Various additional indirect costs ($0.7 MM).
Total category	24.8	

4.9. Commissioning and Start Up

Sub-Category	Variance ($MM)	Comments
Third party support	0.5	Incremental cost to hire a third party contractor with expertise in the commissioning of large scale station facilities. The decision to utilize a dedicated, knowledgeable commissioning contractor, augmented with EGD labour, was made to compress the commissioning schedule in order to meet the already delayed in service date. These third party contractor costs were offset by a $0.5 MM savings in internal

		commission labour included in the Project Management estimate.
Segment B gas investigation	2.4	Cost incurred to investigate the source of gas detected shortly after energization of Segment B. This involved isolating and re-testing a section of the pipeline with nitrogen and helium, and performing sub-surface monitoring to test for the presence of pipeline gas. These activities ruled out Segment B as the source of the methane.
In-line inspection	1.6	Cost incurred for baseline in-line inspections of Segments A and B.
Total category	4.5	

4.10. Interest During Construction

The $5.2 MM variance in IDC is attributable to the extended Project duration and increased cost relative to the original schedule.

5. COST BENCHMARKING AND VALIDATION

The actual construction costs are $847.4 MM[33] compared to the estimated cost of $667.4 MM.

The estimate and the actual costs have been compared with various benchmarks before and after construction.

The estimate was based on a bottom up approach that was then verified using:

- a high level cost per meter estimate provided by a reputable pipeline contractor.
- a comparison to the final Portlands Energy Centre ("PEC") cost for the NPS 36 pipe installation completed in 2008. The GTA Project estimate of $12 MM per kilometer was approximately 70% higher than the $7 MM per kilometer cost for PEC.

Both of these secondary checks supported the sufficiency of the cost estimate.

The Company has discussed the potential of variance during the proceeding[34]

> *"…While the contingency and escalation models account for some portion of these risks, variability in the final cost outcome is almost a certainty. Inclusive of contingency, which is expected to be spent, there is equal probability that the final project costs will be over or under the estimate…"*

and kept the Board apprised of the projected difference during and after construction[35].

The unfavorable variance is less than the upper end of the AACE[36] expected accuracy range of +30%. It is also within the range of possible outcomes[37] defined by the cost probability distribution curve that supported the initial forecast of $667.4MM. Please refer to Appendix A.

The unfavorable variance is also less than TCPL's 37% overage for the NPS 36 Kings North Connector project, for which TCPL reported a final cost of approximately $310 MM[38] compared to their upwardly revised estimate of $227 MM[39]. Kings North is an excellent comparator of cost performance as it was constructed in a similar urban environment as the GTA Project at around the same time.

[33] Includes forecasted costs of $1.0 MM to completion
[34] EB-2012-0451 Transcript Volume 9 page 137
[35] April 1, 2015 Stakeholder day Presentation; EB-2015-0122, Exhibit D, Tab 1, Schedule 2; EB-2012-0451 June 30, 2015 letter; EB-2012-0451 November 6, 2015 letter; March 30, 2016 Stakeholder Day Presentation; EB-2016-0142, Exhibit D, Tab 1, Schedule 2; EB-2017-05-09, Exhibit D, Tab 1, Schedule 2.
[36] AACE International Recommended Practice No. 18R-97 "Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries"
[37] Enbridge's Cost Modelling and Contingency Assessment Process included as Appendix A
[38] Page 4 of TCPL Fourth Quarter and Year-End 2016 Financial Results NewsRelease dated February 16, 2017 stating "In fourth quarter 2016, we placed in service the approximate $310 million Kings North Connector …".
[39] Section 7.3 of NEB Reasons for Decision GHW-001-2014

In KPMG's performance benchmarking, the GTA Project was compared against four other projects and KPMG concluded that[40]

> *"In benchmarking the performance of the EGD GTA Project, on a cost per kilometer of pipeline the GTA Project is relatively favourable with the benchmark average, particularly when removing the costs related to the facilities."*

[40] KPMG Assessment Report, page 21 included as Appendix K

6. LESSONS LEARNED

6.1. Cost Estimating Process

The GTA Project, given its complexity, was a significant departure from typical large diameter pipeline projects that are built in much less constrained environments with minimal conflicting infrastructure. With a lack of applicable reference cost data, and limited design definition (10-40% for a Class 3 estimate), the use of standard estimating tools, assumptions, and Enbridge's experience failed to accurately quantify the incremental cost risk associated with the GTA Project's complexity.

In order to mitigate the risk of cost overages on future large scale projects with similar scope to the GTA the Company will certainly utilize the reference cost data obtained from the Project, but it will also consider the following:

i. Utilizing a higher confidence level than P50 when using an estimate with limited design definition; or,

ii. Preparing a higher class of estimate provided that time permits and there are mechanisms in place for the Company to recover the incremental development costs. A Class 2 estimate (30-75% design definition) would provide sufficient design detail to obtain reliable contractor bid estimates for purposes of establishing the contract value, which is the single largest cost component of any major pipeline project.

6.2. Resources

Based on the GTA experience, execution on future large projects could potentially be improved by:

i. Including a subject matter expert dedicated to the oversight of the contractor's boring plan and execution.

ii. Including geotechnical engineering expertise on the project team, whose key responsibility would be to interpret the results of the geo-tech program and identify areas of potential concern where additional investigation may be required. This individual would work very closely with the boring subject matter expert as referenced above.

iii. Ensuring that critical project functions, such as permitting, land, and legal, have dedicated project team members to prevent a division of priorities among several projects from negatively impacting the timely completion of project deliverables.

iv. Having a dedicated Project Scheduler for both the Company and contractor located in the field, providing pro-active real time information to the construction management team so that areas of concern can be identified and addressed in a timely manner.

v. Local or insourcing the pipeline survey and drafting functions to provide greater control and improve the turnaround time on drawing changes requested by, and re-issued to, the permitting agencies.

vi. Embedding a greater number of engineers at the Engineering Consultants office to monitor their progress and quality as well as to act as a conduit for the timely resolution of technical questions.

6.3 Scheduling and Constructability

i. Include a greater focus on the contractor's scheduling capabilities, particularly as it relates to the use of Enbridge's preferred software, in the pre-qualification process.

ii. For complex projects, require the contractor to prepare a detailed crossing plan and schedule for submission with the RFP. This would include sufficient detail to validate their cost and schedule assumptions related to shoring requirements, boring methods/techniques, and durations.

iii. Where project rationale and benefits allow, consider phasing project to mitigate constraints on construction and permiting resources, both internal and external. However, this may not reduce overall project cost due to substantial equipment and manpower mobilization and demobilization associated with large scale projects. This must be evaluated on a case by case basis.

APPENDIX A

Enbridge Cost Modelling and Contingency Assessment Process

Cost Modelling and Contingency Assessment Process

Enbridge's Major Projects Group uses a contingency model that accounts for both systemic and project specific risks. Systemic risks are quantified using a parametric model that was developed using industry research and data as per AACE[1]. This is then combined with the project specific risk analysis that uses a Monte-Carlo cost simulation. The output correlates the total project cost, excluding escalation and interest during construction (IDC), with the probability of over or under-running the estimate.

Systemic risks are those that could be experienced by any and all projects. Typical factors considered as systemic risks include the degree to which new technology is being applied, complexity of the project, level of project scope definition, and quality of the source information.

Project specific risks result from attributes, conditions, activities and characteristics that are unique to a single project. GTA project specific risks with the greatest contribution to contingency were; a) construction delays due to extenuating circumstances magnified by the highly urban construction; b) seasonal watercourses planned for isolated open cut being forced to HDD's; c) bridge access to Albion station not meeting construction requirements; d) higher drill failure ratios than expected; e) re-routing of Langstaff Road between Yonge and Bayview; and f) historical resources or archaeological findings discovered during construction. All of these project specific risks except (d) were realized.

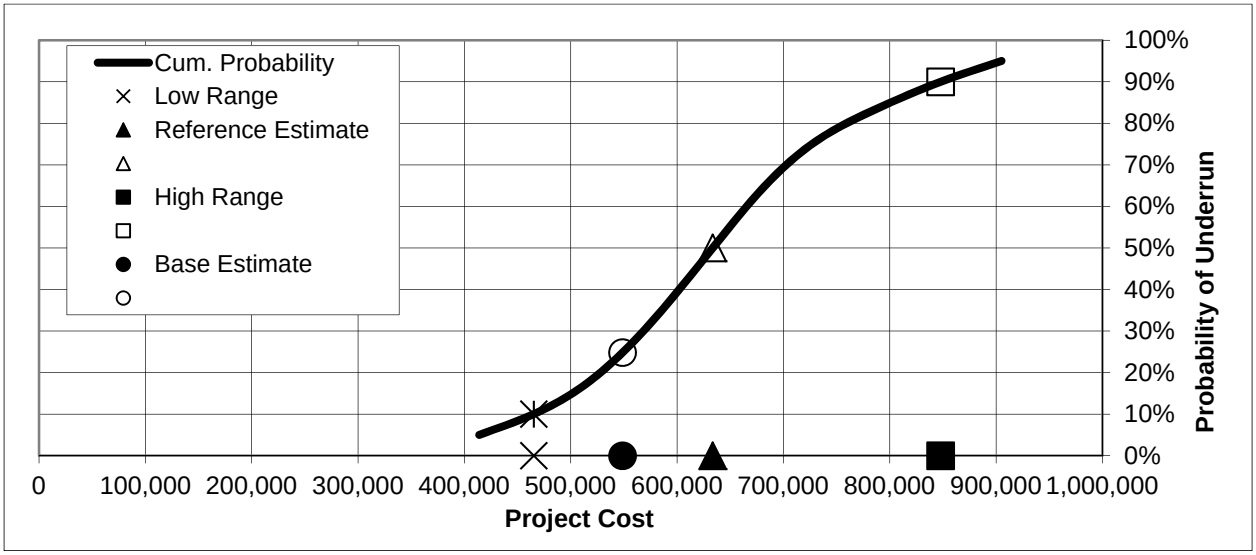
The model provides a probabilistic estimate (i.e. cost distribution curve) based on the identified project risks, their concurrence probability and potential impacts. Enbridge typically authorizes funding for projects at a P50 confidence level, which has been validated by a cost accuracy analysis of actuals to estimates for Enbridge's portfolio of completed projects. The P50 represents the amount of contingency required to produce a capital cost estimate that has an equal chance of an over or under-run. Enbridge calls this the reference estimate and the contingency is simply the difference between the reference and base estimate.

The shape of the probability curve is determined by the class of estimate[2]. As the project definition and class of estimate improves, the distribution of the curve becomes "tighter" with less variation between the minimum and maximum costs. It therefore follows that for an equivalent confidence level the contingency for a Class 2 estimate (30-75% detailed design) will be less than for a Class 3 estimate (10-40% detailed design). However, for the same class of estimate the contingency is driven by the confidence level ("P") selected and a P90 will have a larger contingency than P70, which will have a larger contingency than P50.

Normalizing the GTA Project's P90 of $847.8 MM to remove Buttonville and Ashtonbee Stations (decrease of $22.7 MM), and include IDC and escalation (increase of $51.2MM), gives a P90 value of $876.3 MM. The actual construction costs of $847.4 MM are less than this High Range predicted by the GTA cost model.

[1] AACE Recommended Practice 43R-08: Risk Analysis and Contingency Determination using Parametric Estimating
[2] AACE uses a lower value to denote a better estimate, with a Class 1 being the most mature and a Class 5 the least

GTA Project Cost Probability Curve



ESTIMATE SUMMARY			
	Estimate ($MM)	Confidence of Cost Under-run	Variance to Reference
Base Estimate	548.7		
Contingency	84.5		
Reference Estimate (P50)	633.2	50%	
Low Range (P10)	465.3	10%	-27%
High Range (P90)	847.8	90%	+34%

APPENDIX B

Pipeline Permits Received by Agency by Month

PIPELINE PERMITS RECEIVED BY AGENCY BY MONTH

Month	Regions			Cities					Railways						Government Agencies			Conservation Authorities			Foreign Pipelines				Private	Total	Percentages	
	Peel	York	Halton	Toronto	Markham	Vaughan	Brampton	Mississauga	CNR	CPR	Metrolinx	OBRY	TTC	Magna	MTO	MNR	MOE	TRCA	Credit Valley	Halton	TCPL	Enbridge	TNPL	NEB 24	Easements[1]		By Month	Cumulative
Oct-14		1																				1				2	0.8%	0.8%
Nov-14		1		1									1					1					1		1	5	2.1%	3.0%
Dec-14	1			2		1		2					1		1		4		3						2	17	7.2%	10.2%
Jan-15	1	1			2		1								4	2		1		1	1				1	15	6.4%	16.5%
Feb-15	1	1			1			1		2		1			4											11	4.7%	21.2%
Mar-15	4	2		1	1		3		2						28			16		4	1				6	68	28.8%	50.0%
Apr-15	6	1			1		2		1						21			9	1	1	10					53	22.5%	72.5%
May-15	3		1	1	1		3		5						4			8	4	2	2			1	5	40	16.9%	89.4%
Jun-15	2						1			1	2							3		1						10	4.2%	93.6%
Jul-15	2						1	1	2									3								9	3.8%	97.5%
Aug-15		1												1				2								4	1.7%	99.2%
Sep-15																		1								1	0.4%	99.6%
Oct-15																										0	0.0%	99.6%
Nov-15																										0	0.0%	99.6%
Dec-15	1																									1	0.4%	100.0%
Total	21	8	1	5	6	1	11	4	10	3	2	1	1	1	62	2	4	44	8	9	14	1	1	1	15	236	100.0%	

1. Excluding Condor (signed July, 2016) and Angus Glen (signed Nov 24, 2016) developers

APPENDIX C

Consultation Timeline with Permitting Agencies

HONI CONSULTATION TIMELINE (2011 – 2015)

2011-12

Nov 21/11
Pre-Consultation meeting at Hydro One Network Inc's (HONI) Markham office with HONI, IO and GTA Project

Apr 11/12
Pre-Consultation meeting at HONI's Markham office to discuss proposed project and route.

Apr 25
Received letter from HONI Real Estate confirming a preference for Jonesville Station to be expanded at the current station site.

May 2
Pre-consultation meeting with Town of Markham and HONI Real Estate to discuss proposed GTA Project.

May 28
Met to discuss HONI and IO land easement/TWS requirements and process.

Jun 14
Response from HONI Asset Management/Engineering ("AM") acknowledging the preferred route for the GTA Project and recommending that EGD work directly with the Real Estate group as the main point of contact.

2012

Jul 9
Met with HONI at the existing Jonesville Station site to review the proposed station expansion.

Jul 13
Met HONI and IO at HONI Markham office to follow up on action items from the May 28, 2012 meeting and discuss status of EGD access permits on HONI/IO lands to perform due diligence work in preparation for the easements.

Aug 13
Request from EGD for IBM Substation and foundation information. Response from HONI that request was sent to HONI's System Planning group to provide the information.

Sep 20
GTA Project update meeting with HONI and IO at HONI Markham office. HONI equipment loads/info provided by System Planning.

Oct 10
Met at HONI's Markham office to discuss GTA Project proposed route alignment and offsets from HONI structures.

2013

Jan 18
Met with HONI and IO at HONI Markham office.

Feb 12
Met at EGD offices with HONI and Bell to discuss the relocation of the 4 HONI conduits north of 14th Ave (3 empty conduits & 1 with Bell fibre).

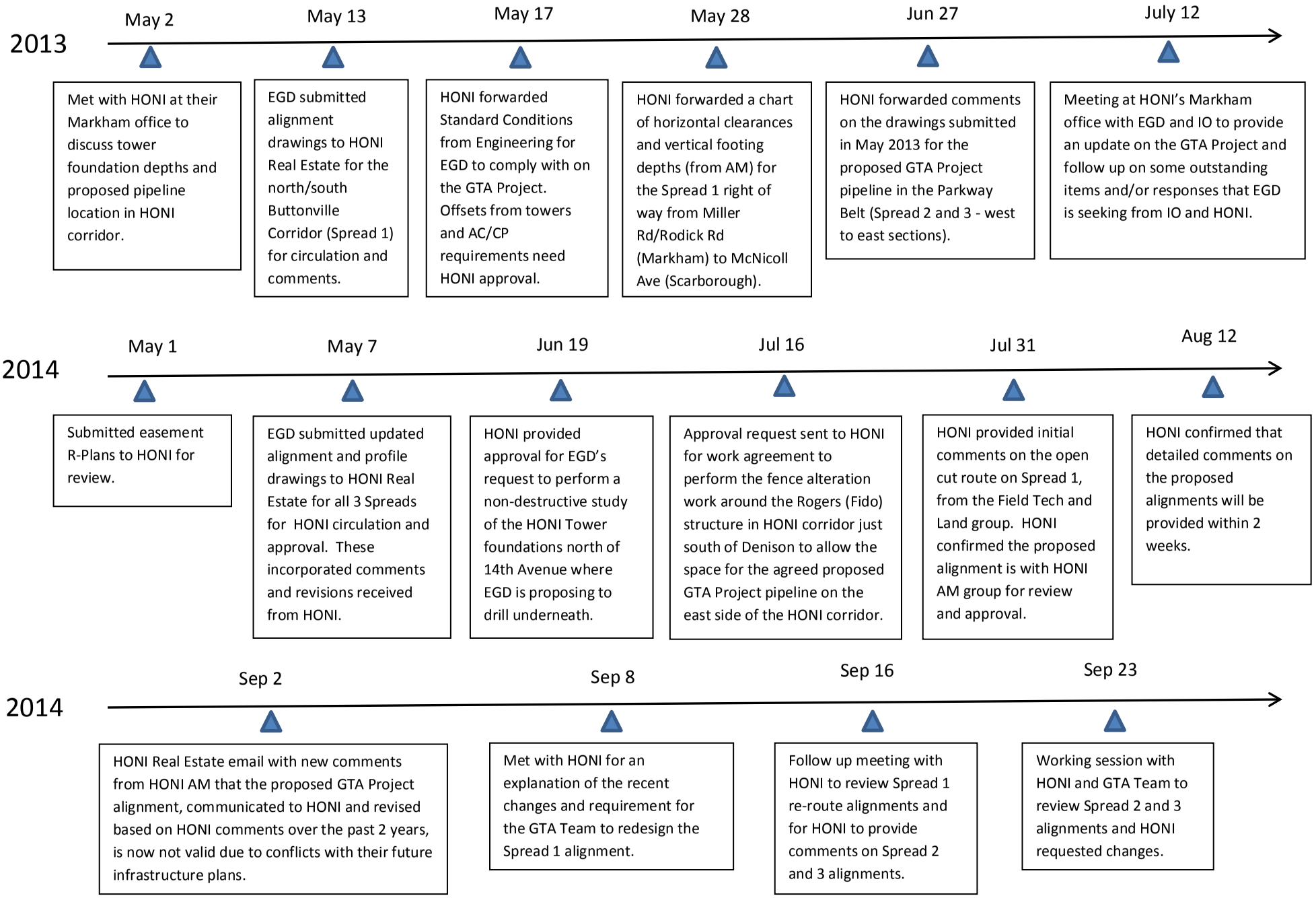
Feb 25
Met at EGD offices with HONI, IO, MTO, 407, MAH to discuss proposed route in IO and HONI corridors.

Feb 27
EGD forwarded to HONI the HDD drawings for Beaver Creek/Hydro Towers n/o 14th Ave and the Steeles Ave/IBM Sub-station. Information on roadway crossing methods between McNicoll Ave and 407 was also provided.

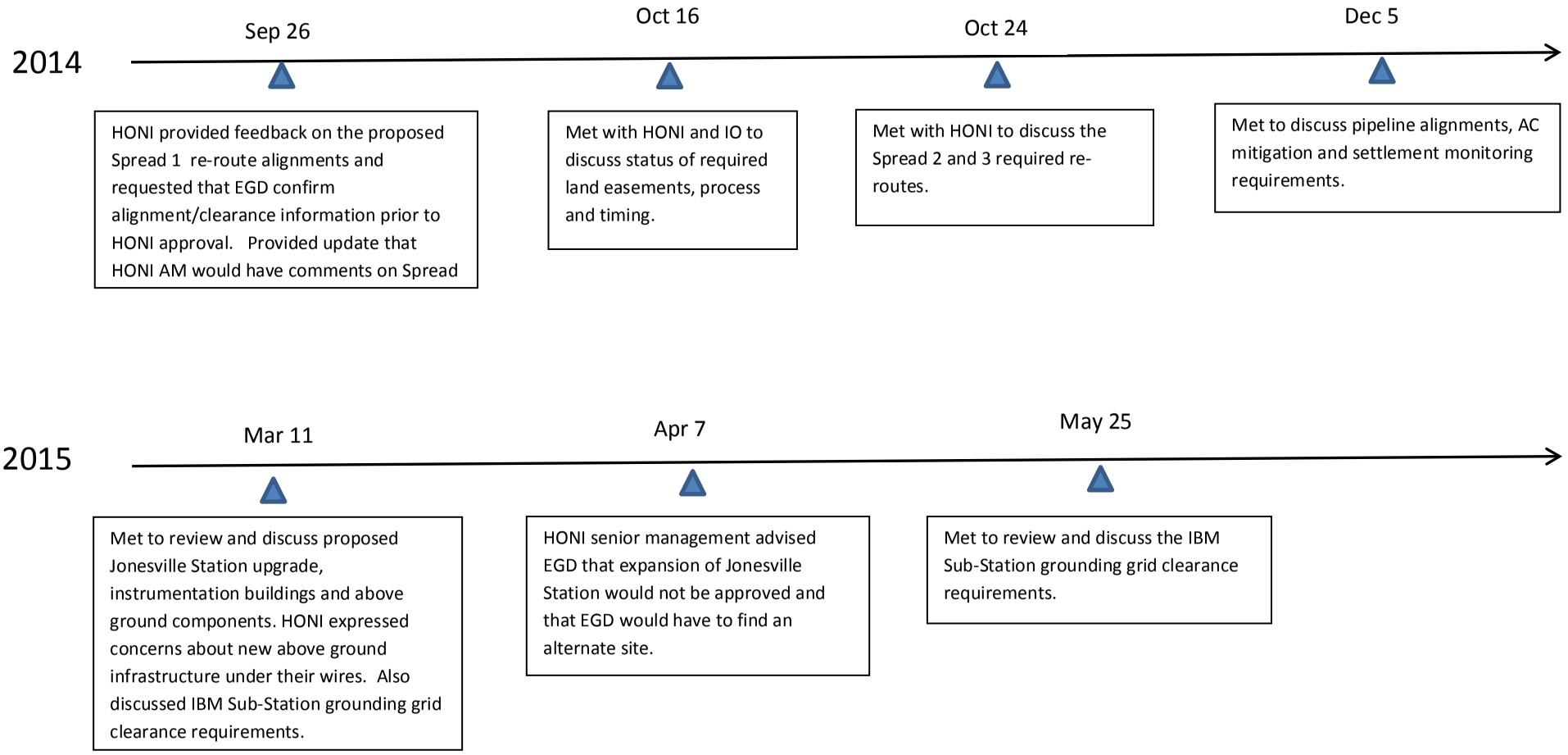
Mar 26
Comments received from HONI Real Estate on the Class III alignment drawings and proposed pipeline location in HONI corridor between Miller/Rodick and McNicoll (Spread 1).

May 1
EGD submitted alignment drawings to HONI Real Estate for the east/west pipeline sections (Spreads 2 & 3) for circulation and comments.

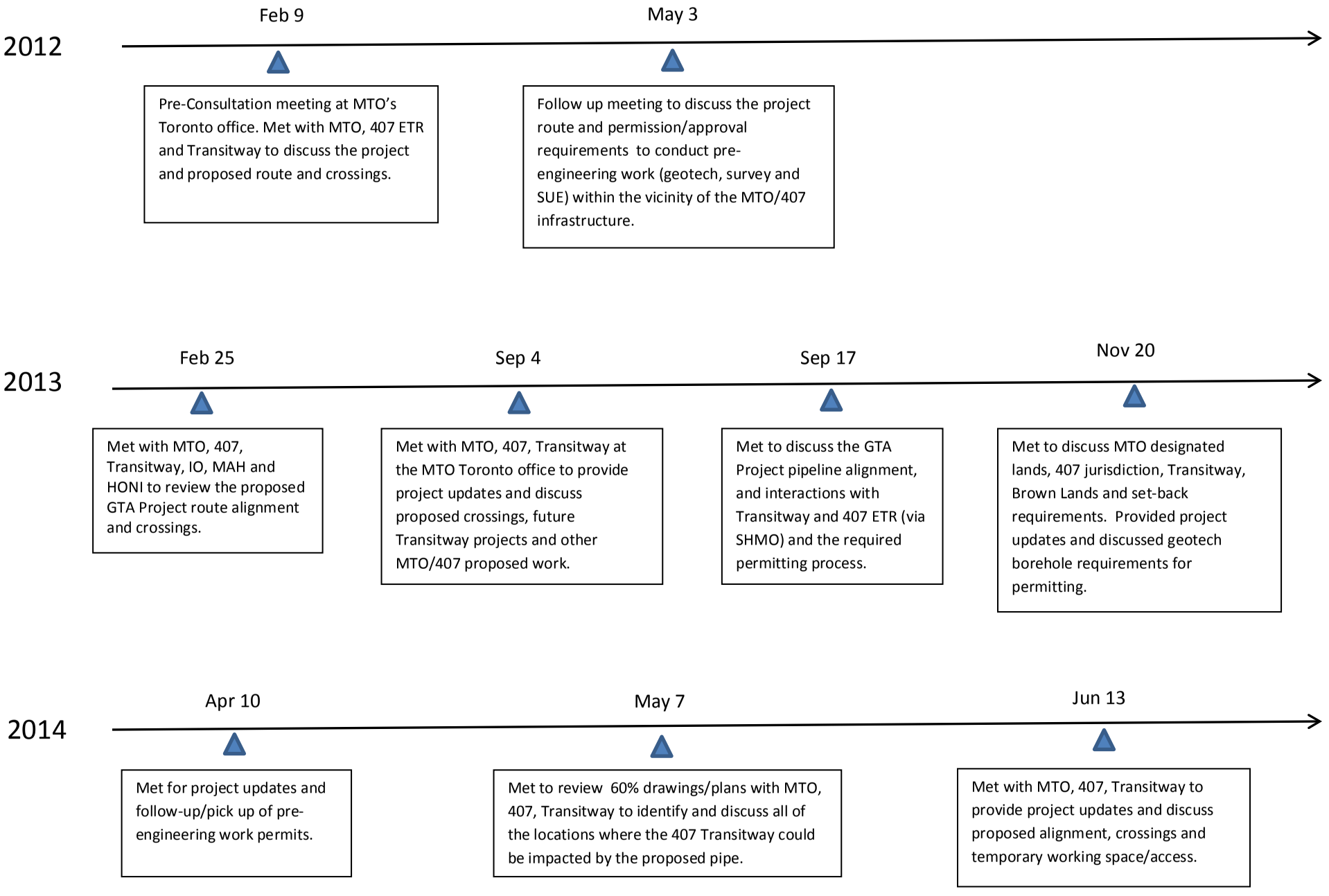
HONI CONSULTATION TIMELINE (2011 – 2015)



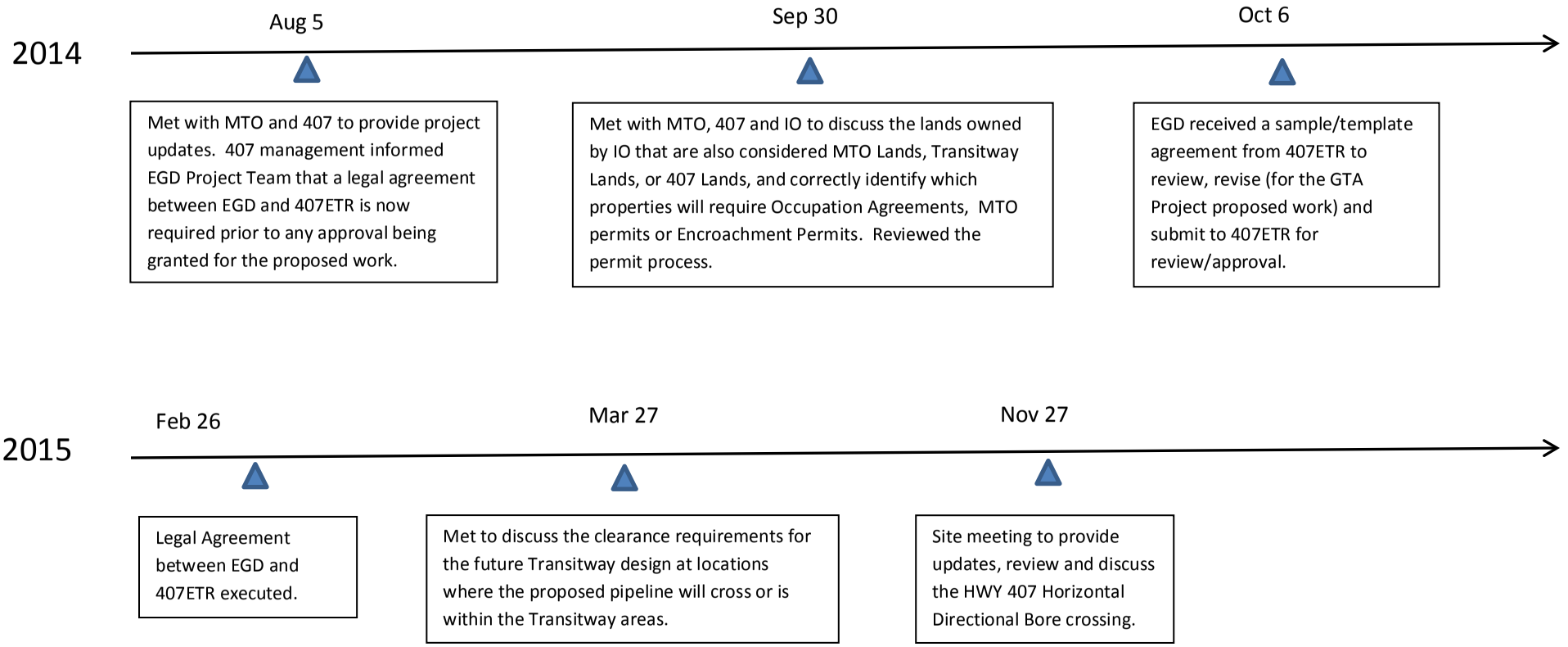
HONI CONSULTATION TIMELINE (2011 – 2015)



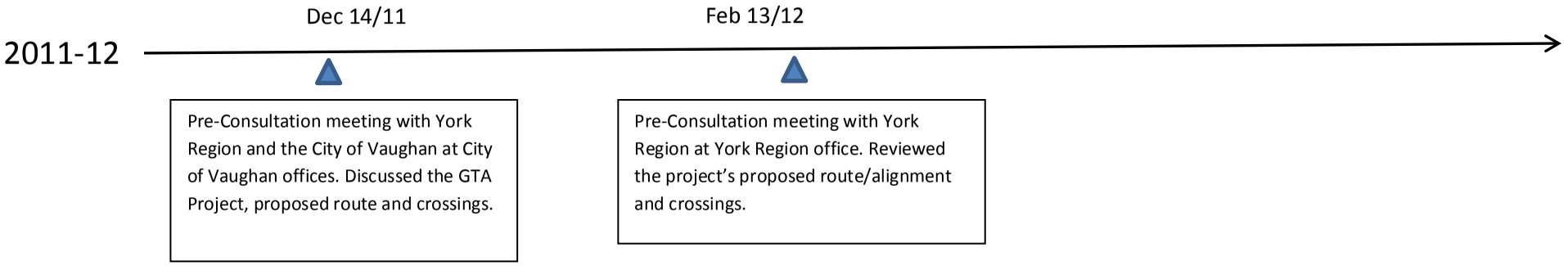
MTO/407 CONSULTATION TIMELINE (2012 – 2015)



MTO/407 CONSULTATION TIMELINE (2012 – 2015)

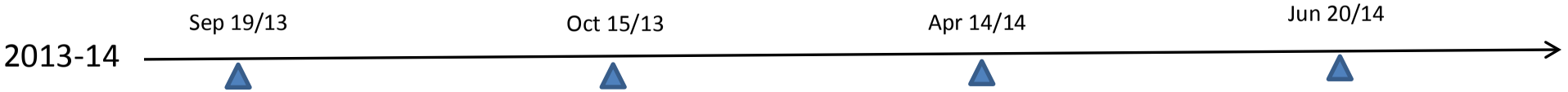


YORK REGION CONSULTATION TIMELINE (2011 – 2015)



Pre-Consultation meeting with York Region and the City of Vaughan at City of Vaughan offices. Discussed the GTA Project, proposed route and crossings.

Pre-Consultation meeting with York Region at York Region office. Reviewed the project's proposed route/alignment and crossings.

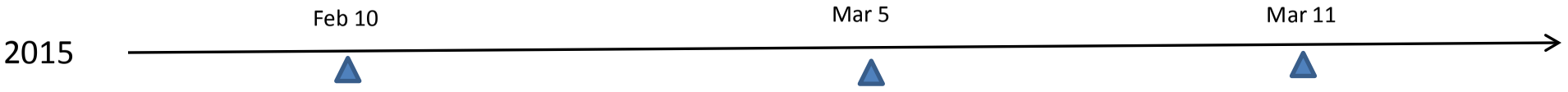


Met with York Region to discuss GTA Project proposed route and required permits.

Met with York Region to review 60% design drawings in the area of the Bathurst Street Water main Replacement Project.

Met with York Region to review the 60% design drawings and obtain feedback.

Met with York Region to provide GTA Project updates and discuss hydrotest water and disposal of test water into sanitary sewers.

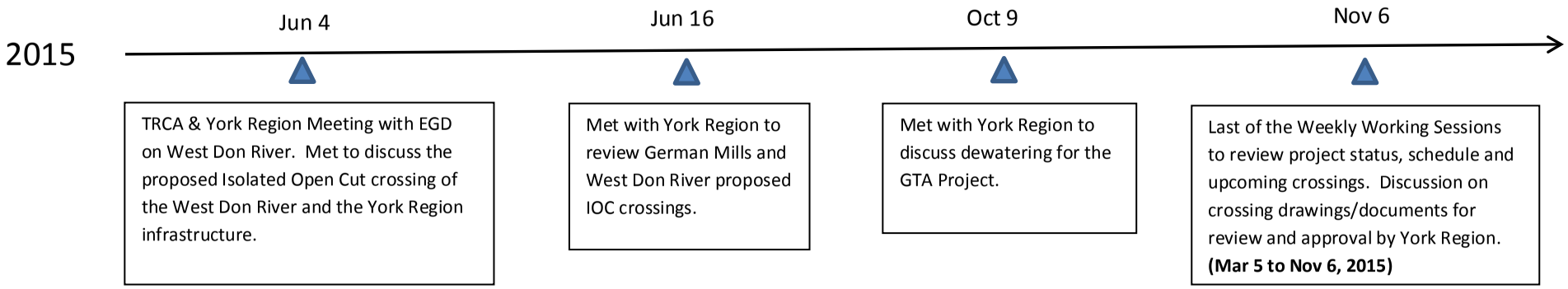


Met to discuss the set-up of the Beaver Creek HDD relative to York Region's sewer and their follow up information requests. Also discussed crossings of York Region infrastructure in general, timing/priority, and the permit approval process/requirements.

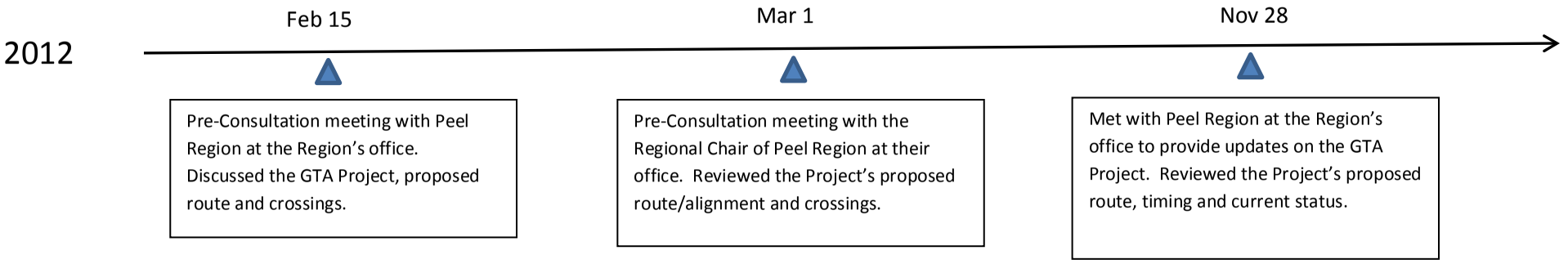
Beginning of Weekly Working Sessions to review project status, schedule and upcoming crossings. Discussion on crossing drawings/documents for review and approval by York Region. (**Ongoing Mar 5 to Nov 6, 2015)**

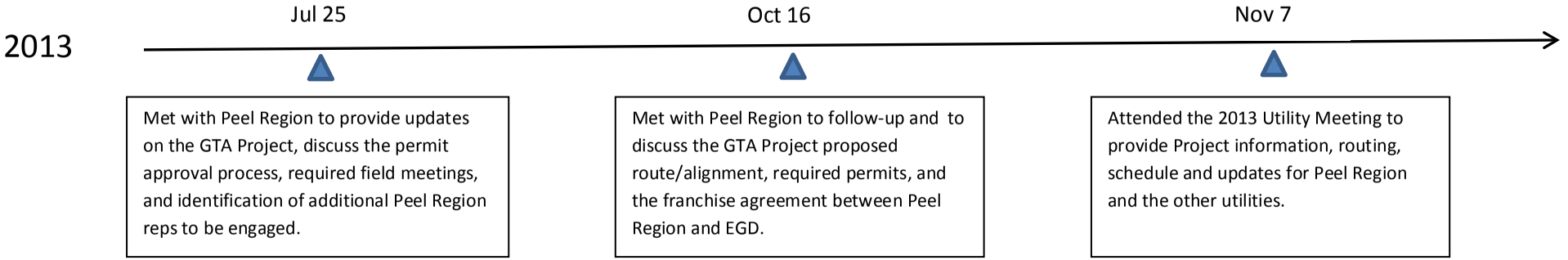
Met with York Region management to provide GTA project updates (outside of the Weekly Working Sessions).

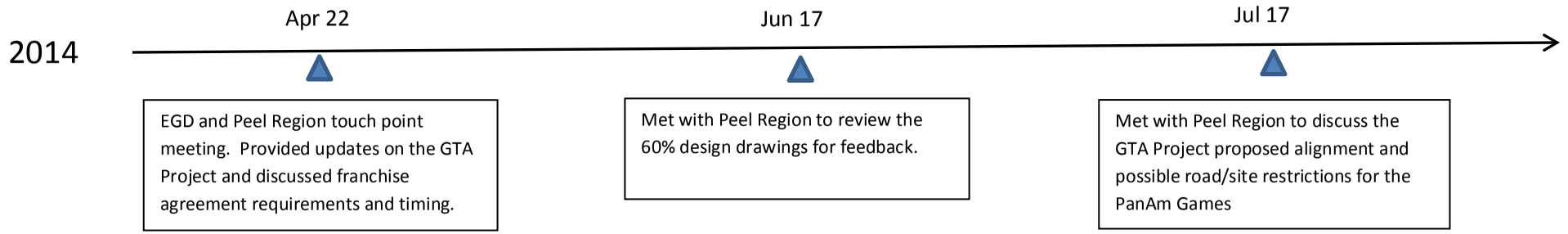
YORK REGION CONSULTATION TIMELINE (2011 – 2015)



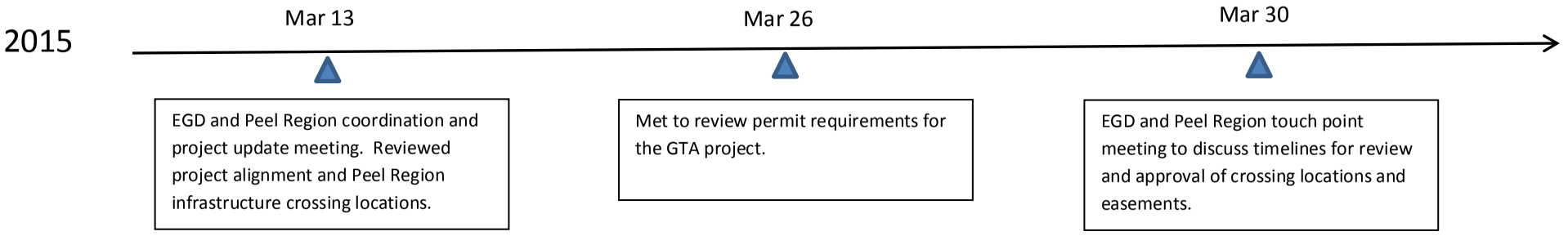
PEEL REGION CONSULTATION TIMELINE (2012 – 2016)







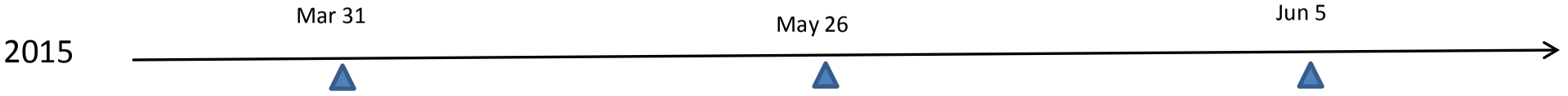
PEEL REGION CONSULTATION TIMELINE (2012 – 2016)



EGD and Peel Region coordination and project update meeting. Reviewed project alignment and Peel Region infrastructure crossing locations.

Met to review permit requirements for the GTA project.

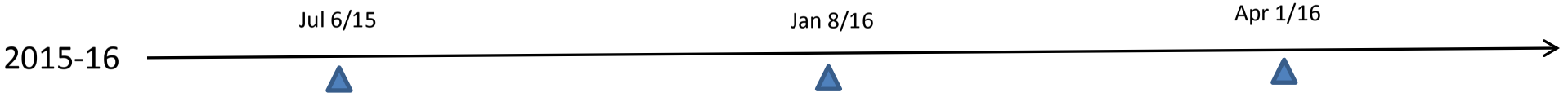
EGD and Peel Region touch point meeting to discuss timelines for review and approval of crossing locations and easements.



Beginning of Weekly Working Sessions to review project status, schedule and upcoming crossings. Discussion on crossing drawings/documents for review and approval by Peel Region. **(Ongoing Mar 31 to Jun 24, 2015)**

Working session with Peel Region to review and discuss individual locations where the 42" pipeline was crossing a Peel water main.

Met with Peel Region for follow-up discussion on proposals for the Argentia Road crossing, agreeing to extend the casing around the water main and install the pipeline over top of it using open cut construction.

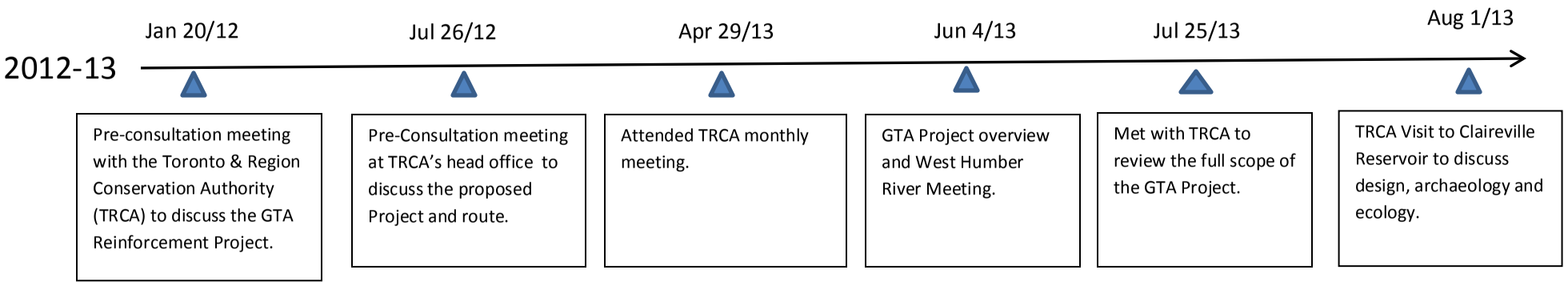


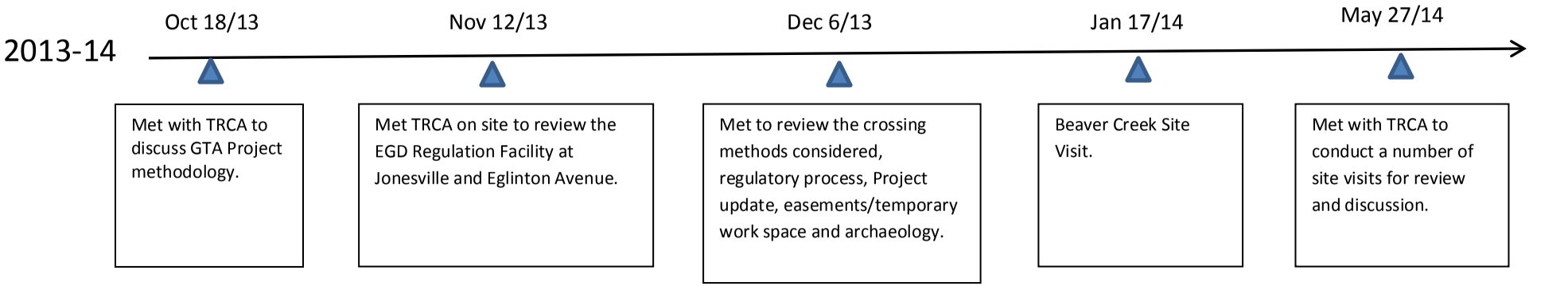
Site Meeting to review Argentia Road crossing of Peel Region water main.

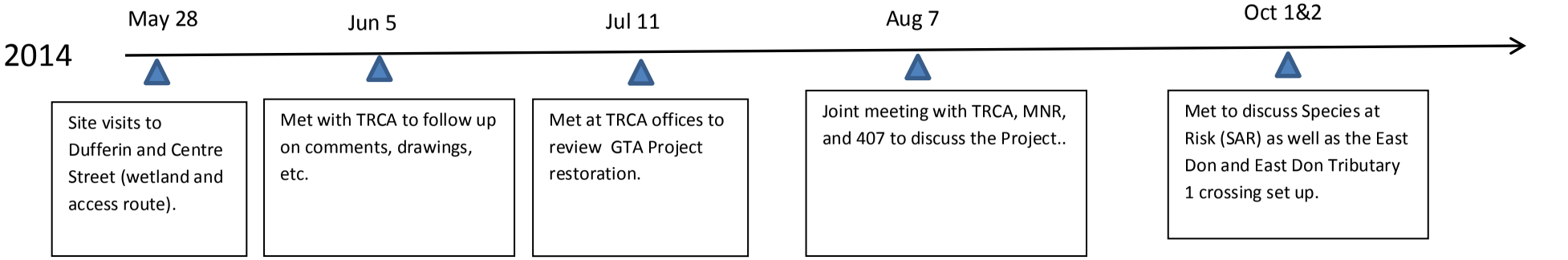
Conference call with Peel Region for follow-up and approval status on the Peel water main casing work by EGD Contractor.

Site meeting to review construction status of Argentia Road casing work for existing Peel Region water main by EGD Contractor.

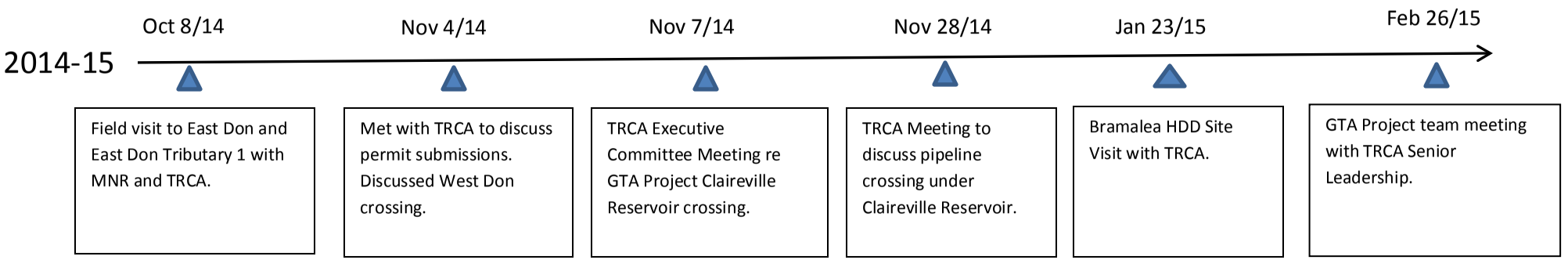
TRCA CONSULTATION TIMELINE (2012 – 2015)

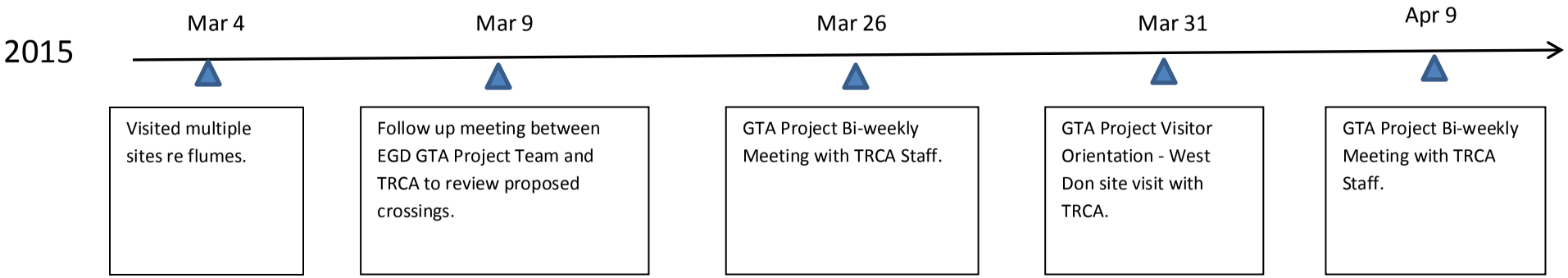


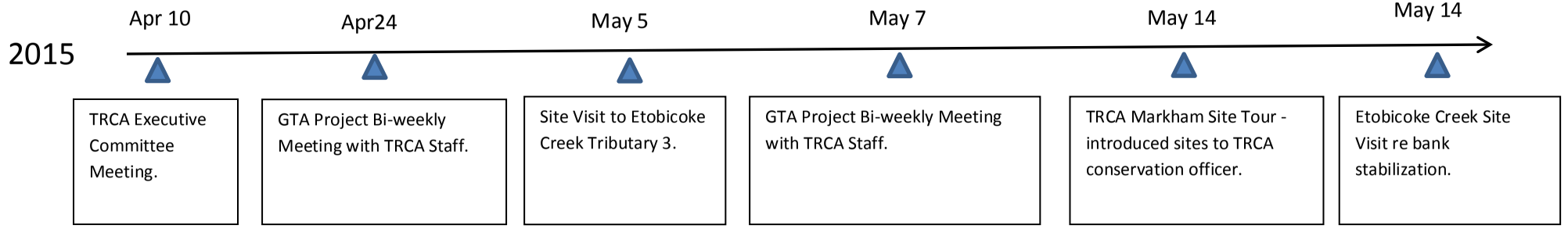




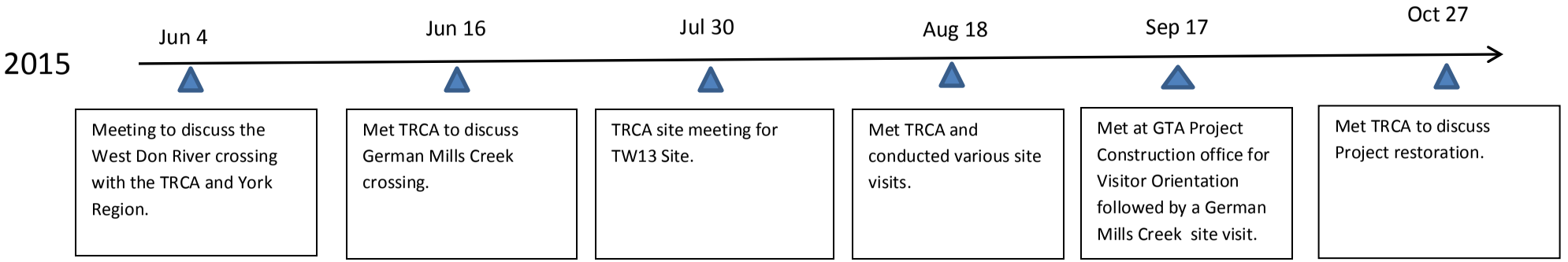
TRCA CONSULTATION TIMELINE (2012 – 2015)







TRCA CONSULTATION TIMELINE (2012 – 2015)



APPENDIX D

Conflicting Projects Requiring Design and/or Construction Mitigations

Conflicting Projects Requiring Design and/or Construction Mitigations

Item	Spread	Segment	General Location	Municipality	Owner	Description	Proposed Timing	Mitigation Result
1	1	B	Sheppard Ave	Toronto	Developer at 3220 Sheppard	New condo construction due east of Sheppard Ave tie-in and valves.	Spring 2015	Developer postponed construction until after GTA construction was complete.
2	1	B	South of Huntsmill Blvd (North leg)	Toronto	Hydro One Networks Inc	Proposed future buried 230 kva cable(s) identified after design completed and plans submitted for final approval.	TBD	The alignment and depth of the Steeles Ave HDD was revised to avoid future buried 230 kva cable(s).
3	1	B	South of Denison Rd	Markham	Hydro One Networks Inc	Proposed future buried 230 kva cable(s) identified after design completed and plans submitted for final approval.	TBD	The alignment and depth of the pipeline needed to be changed to west side of Hydro One tower line to avoid future buried 230 kva cable(s).
4	1	B	14th Avenue to Alden Rd	Markham	Hydro One Networks Inc	Proposed future buried 230 kva cable(s) identified after design completed and plans submitted for final approval.	TBD	The alignment and installation of the pipeline needed to be changed to a HDD to avoid future buried 230 kva cable(s).
5	1	B	South of Hwy 407 at Beaver Creek trib 1	Markham	Hydro One Networks Inc	Proposed future buried 230 kva cable(s) identified after design completed and plans submitted for final approval.	TBD	The alignment and depth of the Beaver Creek trib 1 HDD was revised to avoid future buried 230 kva cable(s).
6	1	B	South of Hwy 407	Markham	City of Markham	Planned reconstruction of Beaver Creek Trib 1 ditch to stop flooding on Rodick Rd.	Summer 2015	Based on additional information provided by the GTA Project the ditch reconstruction was redesigned and postponed to 2017.
7	1	B	East of Rodick Rd	Markham	City of Markham	Proposed future Miller Ave extension crosses Spread 1 south of Hwy 407.	TBD	Based on GTA input the road alignment is being reviewed and modified to account for the location and depth of GTA pipeline.
8	1	B	East of Rodick Rd	Markham	Miller Paving	Miller Paving's planned construction of a new storm water pond on the east side of Rodick Rd at Miller Ave, required as a condition of their proposed development in the area.	summer 2015	Based on GTA input the storm pond was relocated and postponed to coordinate with Item 6.
9	2	B	East of Rodick Rd	Markham	Beaver Valley Stone (8101 Woodbine Ave)	Beaver Valley Stone's site preparation for their new landscape yard - east of Rodick Rd.	2015	Beaver Valley Stone delayed site preparation/construction to eliminate conflicts with the GTA Project. This allowed Beaver Valley to refine their site proposal to match final GTA project reinstatement - completed 2016.
10	2	B	East of Woodbine Ave	Markham	Beaver Valley Stone (8101 Woodbine Ave)	Beaver Valley Stone's site preparation for their new landscape yard - east of Woodbine Ave.	2015	Beaver Valley coordinated site preparations during the GTA construction and the Woodbine bore was extended to avoid the new driveway alignment - site construction completed 2016
11	2	B	East of Woodbine Ave	Markham	MTO 407 Transitway	Proposed Woodbine/Rodick bus rapid transitway ("BRT") station.	TBD	The pipeline design was modified to accommodate the future transit station.
12	2	B	East of Woodbine Ave	Markham	Miller Paving	Miller Paving's proposed rock crushing plant sited in the utility corridor. The location would have straddled the GTA Project pipeline.	2015	Based on additional information provided by the GTA Project, Miller Paving redesigned the crusher siting to avoid the GTA pipeline and the York Region sewer - now proposed for summer 2017.
13	2	B	East of Leslie St	Markham	York Region	York Region's requirement to access their infrastructure to manage sewer flows to enable upgrades to their pumping station at Steeles Ave required overlapping work zones during the GTA Project construction.	Fall 2015	York Region and the GTA Project coordinated site access during the Leslie Street crossing.
14	2	B	West of Leslie St	Markham	MTO 407 Transitway	Proposed Leslie BRT station.	TBD	The pipeline design was modified to accommodate the future transit station.
15	2	B	West of Bayview Ave	Markham	Angus Glen Developments	Start of site clearing for the proposed high density condo development.	Fall 2015	Angus Glen delayed site preparation and clearing to 2017.
16	2	B	East and West of Essex Ave	Markham	Holy Cross Cemetery	Holy Cross Cemetery's submission to the City of Markham for a new Mausoleum. The proposed improvements required for the Mausoleum, including new drainage ditches, overlapped the GTA construction.	Summer 2015	The Cemetery delayed the start of construction until summer 2016.
17	2	B	East of Yonge St	Markham	Condor Developments	Start of site clearing for the proposed high density condo development.	2015	Condor delayed site preparation and clearing to spring 2016.
18	2	B	Yonge St	Vaughan	TTC	Proposed future Yonge Street subway with proposed station on the pipeline alignment.	TBD	TTC reviewed and coordinated our pipeline design with the preliminary subway design, to avoid future design conflicts. Subway timing has since been advanced - started in 2016.
19	2	B	Between Yonge St and Bathurst Rd	Vaughan	Hydro One Networks Inc	Proposed future high voltage transmission tower routing was identified after the pipeline design was completed and plans submitted for final approval. HONI also confirmed that the above ground valve could not be located under their existing or future power lines.	TBD	The alignment and depth of the pipeline needed to be changed to avoid the future hydro towers and move the valve to a clear location.
20	2	B	East Don River between Yonge St and Bathurst Rd	Vaughan	York Region	Planned lining and remediation of the East Don River trunk sanitary sewer.	2015	To avoid overlapping construction sites, York Region postponed their remediation work to 2016.
21	2	B	Bathurst St	Vaughan	OPP/IO	New OPP station proposed for the east side of Bathurst St south of Hwy 407.	2015	The GTA project required the OPP station site as an access point for construction. To avoid construction overlap the station construction was postponed until GTA construction was complete.
22	2	B	Bathurst St	Vaughan	York Rapid Transit	Design/construction of the new BRT at Bathurst St.	2016	The design for the BRT was coordinated with the design/installation of the GTA pipeline - construction starting 2017
23	2	B	Bathurst St	Vaughan	York Region Water	New watermain design/construction on Bathurst St.	2016	The design for the trunk watermain was coordinated with the design/installation of the GTA pipeline - construction started 2016
24	2	B	Centre St west of Dufferin St	Vaughan	York Rapid Transit	Design/construction for new BRT.	2015	The depth of the GTA pipeline was increased to avoid conflict with the BRT. Installation timing was also coordinated with BRT construction delayed to late 2016.
25	2	B	Between Keele St and Dufferin St	Vaughan	Metrolinx	Railway upgrades in preparation for all day train service on the Barrie train line.	2015	Metrolinx delayed the installation of signal improvements at this location until the GTA pipeline was completed - cable install started fall of 2015.

Conflicting Projects Requiring Design and/or Construction Mitigations

Item	Spread	Segment	General Location	Municipality	Owner	Description	Proposed Timing	Mitigation Result
26	2	B	Keele St	Vaughan	York Region	Proposed widening of the railway bridge/road on Keele Street north of Steeles Avenue.	2015	York Region revised their project schedule to delay the start of utility relocations for the road construction until 2016.
27	3	A	West of Hwy 427	Toronto	City of Toronto	Planned reconstruction of the Indian Line Road bridge in 2015.	2015	The City delayed the bridge remediation to 2017 at the earliest to accommodate the pipeline construction.
28	3	A	Goreway Rd	Brampton	City of Brampton	Design and construction of Goreway Drive/CNR overpass.	2015	The City construction schedule was revised to delay the start of utility relocations until 2016.
29	3	A	West of Airport Rd	Brampton	7900 Airport Road Development Inc	Proposed new subdivision and warehouse at 7900 Airport Rd adjacent to the pipeline alignment.	2014/2015	The landowner agreed to provide an easement and allow the pipeline construction to proceed prior to the final building construction. However, early construction of the warehouse, parking lot, and a retaining wall resulted in a field design change to realign the pipeline.
30	3	A	Torbram Rd	Brampton	Cities of Brampton and Mississauga andCNR	Torbram Road reconstruction involving a new underpass of the CNR tracks, temporary CNR track realignment, and a temporary Torbram Rd bypass.	2015 - 2020	To avoid the myriad of construction activity and coordination between multiple parties, the GTA Project changed the construction method to HDD to add depth and avoid the conflict.
31	3	A	West of Bramalea Rd	Brampton	Emerald Energy - an energy from waste owner	Emerald Energy's preliminary design for the location of a new energy from waste plant.	2016+	The GTA pipeline alignment was adjusted to enable the future EFW plant.
32	3	A	East of Tomken Rd	Brampton	TRCA	Proposed project for the naturalization of Etobicoke Creek.	2015	TRCA delayed their project until pipeline construction was complete.
33	3	A	East of Hurontario St	Brampton	Metrolinx	New LRT and maintenance facility proposed along Hurontario St.	2018	The pipeline design was modified to accommodate the future maintenance facility location and tracks in accordance with Transport Canada Order E-10.
34	3	A	East of Hurontario St	Brampton	MTO 407 Transitway	Proposed LRT station east of Hurontario St.	TBD	The pipeline design was modified to accommodate the future transit station.
35	3	A	East of Mavis Rd	Brampton	MTO 407 Transitway	Proposed LRT station east of Mavis Rd.	TBD	The pipeline design was modified to accommodate the future transit station.
36	3	A	Mavis Rd	Brampton	Bell Mobility	Bell Mobility's upgrading of the CP mitigation for their cell antenna mounted on the Hydro One tower at Mavis Rd.	2015	Bell waited until the GTA project was completed at Mavis Rd to install their deep grounding wells - completed fall 2015.
37	3	A	Financial Dr	Brampton	City of Brampton	Widening of the Hwy 407 bridge and Financial Drive south of Hwy 407.	2015	Brampton changed their construction schedule to construct north of Hwy 407 in 2015 and south of Hwy 407 in 2016 after pipeline construction was complete.
38	3	A	East of Mississauga Rd	Brampton	Hydro One Brampton (HOB)	Proposed construction of a new hydro line between Mississauga Road and 2nd Line W, south of Hwy 407, that conflicted with the GTA pipeline route.	2015	HOB avoided the GTA pipeline by realigning their proposed hydro line and changing the proposed construction timing to 2017.
39	3	A	East of Winston Churchill Rd	Brampton	City of Brampton	Proposed construction of a new Bram-West Parkway, running north-south between Heritage Rd and Winston Churchill Blvd. The alignment and design of the new road overlapped and conflicted with the GTA pipeline route.	2016	The City modified the design of the road and interchange to avoid crossing both the GTA pipeline and the existing 36" pipeline. They also delayed the start of construction to 2018.
40	3	A	East of Winston Churchill Rd	Brampton	MTO 407 Transitway	Proposed LRT station east of Winston Churchill Blvd.	TBD	The pipeline design was modified to accommodate the future transit station.
41	3	A	West of 10th Line	Mississauga	Land developer Prologis Inc	Proposed new warehouse on the west side of Lisgar Meadow Brook that overlapped the temporary construction area needed for the Lisgar Meadow Brook pipeline crossing.	2015	Prologis agreed to delay the start of the site preparation and building construction until 2016
42	3	A	East of 9th Line	Mississauga	Erin Mills Development	Design build offer for a proposed new building on the east side of 9th Line that overlapped the GTA pipeline construction area.	2015	Erin Mills delayed the start of the building construction until 2016.
43	3	A	9th Line	Mississauga	City of Mississauga	Proposed future underpass at the CP rail crossing just south of the pipeline alignment.	TBD	City of Mississauga had their consultant prepare an expected future vertical alignment for the road. The 9th Line pipeline crossing was then redesigned deeper to avoid conflicting with the future road underpass.
44	3	A	9th Line	Mississauga	Erin Mills Development/City of Mississauga	Construction of a turn lane on the east side of 9th Line, required for the Argentia Rd Subdivision - Phase 2, that overlapped the GTA pipeline construction area.	2015	Construction of the road turn lane was delayed to early 2016.
45	3	A	Hwy 407 between Hwy 401 and Derry Rd	Mississauga	MTO 407 Transitway	Proposed LRT station east of Hwy 407.	TBD	The length of the Hwy 407 pipeline bore was extended to accommodate the future transit station and tracks.
46	3	A	CP Railway between Hwy 401 and Derry Rd	Milton	Canadian Pacific Railway (CPR)	Proposed future third set of railway tracks at the CPR pipeline crossing west of Hwy 407.	TBD	The length and depth of the railway bore was increased to meet Transport Canada E-10 requirements for the third set of tracks.

APPENDIX E

Crossings with Permit Challenges

CROSSINGS WITH PERMIT CHALLENGES

Agency	# of Permits Affected
Peel Region	16
York Region	10
Toronto	2
Markham	7
Mississauga	1
Vaughan	2
Brampton	2
MTO	8
407 ETR	2
TCPL	1
CN	9
Metrolinx	3
TRCA	8
CVCA	1
CH	3
HONI	11
Private Landowner(s)	8
MEDEI	2
MNR	1
TOTAL	97

Crossings Affected by Permit Challenges		Description of Challenges	Agencies Involved		
All Spreads/Segments					
1	Multiple Crossings (MTO Encroachment/407 Legal Agreement)	MTO required an encroachment permit (18 locations) for any location where the pipeline crossed under the controlled access highway or any road or ramp within 395 m of the highway. Fourteen of these locations required Highway 407 approval. Historically, Highway 407's approval has been included as part of the MTO encroachment permit. However, for the GTA Project Highway 407 requested an entirely separate legal agreement which was without precedent and required drafting and negotiation. This resulted in delays obtaining MTO's encroachment permits, which they would not issue until the 407 legal agreement was signed.	MTO	407 ETR	
2	Multiple Crossings (CN Peer Review)	At all 8 CN railway crossings, peer review of the CN Permit Package by Golder Associates led to additional time for permitting. This was not identified as a permit requirement by CN during earlier consultation in 2014.	CN		
3	Multiple Crossings (CN Flagging)	At 7 of 8 railway crossings, the schedule was delayed by at least two weeks due to CN's failure to provide sufficient flag people to allow the installation of settlement monitoring points (4 instances) and/or execute the track bore (6 instances). Flagging requirements were also inconsistent. Once the sacrificial casing was completely installed, some crossings were allowed to proceed with the pipe installation without flagging while others were not, thereby stopping construction.	CN		
Spread 1 (Segment B)					
4	Steeles Ave/Huntsmill Blvd (N)	Due to HONI's last minute identification of future 230 kva cable requirements, the HDD drill had to be extended and the alignment had to be changed at the south end of the drill. HONI also required 3 metres of cover where we crossed their corridor. Last minute conditions for the IBM grounding grid were identified.	City of Toronto	HONI	
5	CN Alden	Crossing method changed to HDD and the alignment was shifted due to HONI's late identification of future 230 kva cable requirements, and grillage footing type on Tower 9. This required additional review by CN and HONI and extended the duration of monitoring requirements.	CN	HONI	
6	Alden Rd.	Crossing method changed to HDD and alignment was shifted due to HONI's late identification of future 230 kva cable requirements, and grillage footing type on Tower 9. This required additional review by City of Markham and HONI and extended the duration of monitoring requirements.	City of Markham	HONI	
7	Riviera Dr	Crossing method changed to HDD and alignment was shifted due to HONI's late identification of future 230 kva cable requirements, and grillage footing type on Tower 9. This required additional review by City of Markham and HONI and extended the duration of monitoring requirements.	City of Markham	HONI	
8	Beaver Creek Trib 1	Due to HONI's last minute identification of future 230 kva cable requirements, the HDD drill alignment was changed and the connection at the south end was also realigned, requiring 3 meters of cover where it crossed the HONI corridor. This required additional review by HONI and extended the duration of the monitoring requirements. York Region delayed the start of HDD to resolve issues related to the positioning of the entry rig relative to their sanitary sewer.	HONI	York Region	
Spread 2 (Segment B)					
9	Beaver Creek Trib 2	Late reclassification during permitting as a Tributary on the East side, but not on the West side, affected the planning of construction and permitting for the Rodick Valve site.	TRCA		
10	Hwy 404	MTO/407 required extended duration of settlement monitoring. York Region required camera inspection of their sewer, locating of a sewer cut off wall that was never found, and settlement monitoring. MTO required an extra 1 metre depth for the future MTO transitway clearances.	MTO	407 ETR	York Region
11	Leslie St.	MTO required 2 m of extra depth for the future MTO transitway, storm water pond and parking lot west of Leslie Street. York Region required additional clearances, settlement monitoring, and camera inspection of two sewers. The close proximity of the pipeline to one sewer and a conflict with the golf driving range access road required the crossing to be lengthened.	MTO	York Region	
12	German Mills	This crossing was changed from a deep track bore to an open cut and realigned to avoid the 407 storm ponds. Delays were caused by challenges aligning York Region and TRCA on the proposed crossing method. TRCA conditioned their approval on York Region, who agreed to an open cut on the condition that an 80" casing was installed underneath the gas pipeline to enable a future sewer replacement. They also required inspections and settlement monitoring of their infrastructure. The realigment also required the permitting of two additional York Region watermain crossings as well as HONI approval.	TRCA	York Region	
13	Bayview Avenue	City of Markham (Parks Department) permit conditions for working near the Langstaff Woods trees required a pre-inspection, which resulted in changes to the HDD drill set up and a reduction of working space.	City of Markham		
14	Langstaff Road East	The secondary plan for Markham Gateway required a revision to this crossing, adding 1.0 m of depth to avoid a future watermain connection.	City of Markham	Private Landowner(s)	
15	CN Pomona	Landowner requirements for the future CN crossing bridge (part of the Markham Gateway development) contributed to the requirement for a deep HDD crossing. The adjacent cemetary's City of Markham site plan application delayed their approval of necessary temporary work space over concerns that it could complicate the site plan application for the new mausoleum west of Langstaff Road.	Private Landowner(s)	City of Markham	CN
16	Cedar Ave	Rather than a relatively easy open cut this crossing became part of the Pomona HDD to avoid future infrastructure conflicts with the proposed Markham Gateway development. The adjacent cemetary's City of Markham site plan application delayed their approval of necessary temporary work space over concerns that it could complicate the site plan application.	Private Landowner(s)	City of Markham	
17	Ruggles Ave	Rather than a relatively easy open cut this crossing became part of the Pomona HDD to avoid future infrastructure conflicts with the proposed Markham Gateway development.	Private Landowner(s)	City of Markham	

Crossings Affected by Permit Challenges		Description of Challenges	Agencies Involved		
All Spreads/Segments					
18	Pomona Creek	The crossing became part of the Pomona HDD, which was required to avoid future infrastructure conflicts with the Markham Gateway development. Proximity to a York Region sewer and chamber at the drill entry required camera inspection and settlement monitoring. The need for temporary work space from the Cemetary in their maintenance building parking lot required negotiation and a mitigation plan to maintain access to the building during construction.	Private Landowner(s)	York Region	
19	HONI Realignment (West of Yonge Street)	HONI's last minute identification of plans for a row of future hydro towers, as well as their decision to not allow above ground infrastructure under their wires, resulted in the need to realign the pipeline and mainline valve to the south side of the IO corridor.	HONI		
20	East Don River and Tribs	Concerns over Hwy 407 permitting requirements for an engineered access road (on 407 property) required to open cut the East Don Trib 1, led to a decision to extend the HDD west to include the Trib. An HDD of the Trib, rather than open cut, was also preferable to TRCA and facilitated their permit. York Region required camera inspection of their trunk sewer along the Don River.	TRCA	York Region	
21	Bathurst Street	HONI's last minute identification of plans for a future row of hydro towers required a minor realignment, bringing the pipeline closer to the existing towers. This in turn necessitated a lengthening of the HDD to avoid the Reaman archaeological site and extended the timeline for MEDEI approval. Closer proximity to the existing towers required settlement monitoring.	HONI	MEDEI	
22	Dufferin St	Permit was delayed due to coordination of permitting and records between York Region and City of Toronto. Once the missing City of Toronto records for their water main were obtained, the design was revised to a depth of 6.9 m for permit submission in order to provide adequate clearance to the water main.	York Region	City of Toronto	
23	HONI Cable Slip Bore	Two HONI 230 kva cables located during construction, which were not previously identified by HONI during the permitting process, necessitated a 10 m long slip bore with 3.4 m of additional depth.	HONI		
24	Centre St	The design of York Region's future bus transitway improvements on Centre Street added 1.9 m of depth and 10 m of length to the crossing compared to the original permit submission. The permit was also delayed until the transitway preliminary design was completed.	York Region		
25	West Don River	Delays were caused by challenges aligning York Region and TRCA on the proposed crossing method. York Region initially requested 2 m clearance below their sanitary sewer which made the depth of a potential track bore unfeasible and unsafe. York Region was amenable to an open cut with the pipeline crossing above their sewer, but TRCA expressed concerns about the long term adverse impacts of an open cut. The crossing method was changed to an HDD as the only option to facilitate both approvals. York Region also required pre and post camera inspection of the sanitary sewer.	TRCA	York Region	
26	Metrolinx 2	The Metrolinx permit required changes to the track bore set-up methodology and extended the duration of settlement monitoring requirements. It also prevented construction during the Pan Am Games.	Metrolinx		
27	Great Gulf Drive East	City of Vaughan permit conditions required a pre-inspection. During pre-inspection Vaughan changed the crossing method from an open cut to a track bore after the contractor had already mobilized to execute the open cut.	City of Vaughan		
28	Great Gulf Drive West	City of Vaughan permit conditions required a pre-inspection. During pre-inspection Vaughan changed the crossing method from an open cut to a track bore after the contractor had already mobilized to execute the open cut.	City of Vaughan		
29	CN Keele St	The CN permit required changes to the track bore set-up methodology and extended the duration of settlement monitoring.	CN		
30	Keele St. (Tie-In)	Due to their planned widening of Keele Street at the tie-in location, York Region required extraordinary permit conditions to mitigate impacts on their design and anticipated construction requirements. They also required camera inspection of the sewer and settlement monitoring.	York Region		
Spread 3 (Segment A)					
31	Mimico Creek	Peel Region's requested 2 m of clearance to their sewer, exceeding the municipal standard of 0.6 m and the 1 m proposed by the project. The extra depth was reviewed with Peel Region and, because the additional excavation required on the storm pond berm would have caused excess damage to the berm, Peel agreed to approve the permit with the depth of cover originally submitted. They also required camera inspection of the sewer.	Peel Region		
32	Goreway Drive	Approvals for the Goreway Road crossing were delayed by the additional reviews required for Brampton's new railway overpass design. Once the overpass design was set Peel Region's requirement for additional separation to their water main added 0.8 m of depth to the crossing.	City of Brampton		
33	CN Goreway - Temporary Crossing	CN's requirement to install the level crossing themselves resulted in delays gaining access to the "rail triangle" required to complete construction.	CN		
34	CN Airport	Insufficient flag people to utilize the CN Goreway level crossing, required for access to the CN Airport track bore, caused delays in the track bore.	CN		
35	East of Airport Road (Kruger lands)	Peel had no records for two sewers, and didn't even know one existed, which delayed permitting. Time was also required to obtain agreement to cross over the sewers rather than under, which Peel did grant in this particular instance.	Peel Region		
36	Airport Rd	Peel Region's requirement to provide additional clearance to their sewer and water main added 2 m of depth and 15 m of length to the crossing. Despite previous discussions, the landowner built a retaining wall in conflict with the pipe alignment requiring us to shift the alignment to the south and re-permit.	Peel Region	Private Landowner(s)	
37	Torbram Rd[3]	Conflicts with the Torbram Road reconstruction and temporary bypass, including a CN track realignment, caused coordination problems between our design and the municipal design, which ultimately delayed the crossing until all civil work was complete. The pipeline depth required to cross underneath the very congested subsurface infrastructure was not constructable as a track bore. The crossing method was changed to an HDD to satisfy all stakeholders.	CN	City of Mississauga	
38	Mimico Trib 2	Repermitting with TRCA was required due to the change in crossing method to HDD (the creek was part of the Torbram Road HDD.	TRCA		
39	CN Torbram - Temporary Crossing	CN's requirement to install the level crossing themselves resulted in delays gaining access to the "rail triangle" required to complete construction.	CN		
40	Metrolinx 1	The Metrolinx permit required changes to the track bore set-up methodology and extended the duration of settlement monitoring requirements. It also prevented construction during the Pan Am Games.	Metrolinx		
41	East of Bramalea Road	HONI requested a last minute alignment change to go around, rather than between, their 500 kV hydro towers at this location.	HONI		
42	East of Bramalea Road	Peel Region required a camera inspection of their sewer.	Peel Region		
43	MTO Transitway - West Bramalea	MTO required 4.1 m of additional depth where the pipeline crossed under the future Transitway and a redesign at Spring Creek to avoid the future transitway bridge. Hydro One Brampton required 1 m of additional depth under their cable conduits. The landowner required a last minute realignment to avoid a newly proposed energy from waste plant.	MTO	Private Landowner(s)	
44	Spring Creek	Peel Region's permit required extra clearance beneath their sewer, but allowed a reduction in clearance in the event of bedrock (to appease TRCA who had concerns about the duration of the crossing if breaking of bedrock was required). Bedrock was realized. Peel also required camera inspection of their sewer. Brampton would not approve an easement until Peel Region gave permission to cross their sewer.	Peel Region	City of Brampton	
45	Etobicoke Creek trib 3	TRCA's delay approving the temporary bridge crossing in turn delayed construction, because equipment was uable to access the lands between Dixie and Bramalea roads. This access was also required for Spring Creek Trib 1 construction. The redesign of Etobicoke Creek Trib 3 also resulted in a depth change at Dixie Road and associated repermitting.	TRCA		
46	Etobicoke Creek	Peel Region's requirement for extra clearance to their two sewers added 2 m of depth to the crossing, which was entirely in bedrock. They also requested that both sewer crossings be combined with the creek crossing, which added 48 m of length. Peel also required camera inspection of their sewers. These additional requirements from Peel Region wastewater necessitated repermitting with TRCA.	Peel Region	TRCA	

Crossings Affected by Permit Challenges		Description of Challenges	Agencies Involved		
All Spreads/Segments					
47	Tomken Rd	Peel Region's clearance requirements for the crossing of three water mains, one of which they had no record of (but we did due to our previous NPS 36 crossing in 1986), added 1.3 m of depth (in bedrock) and 26 m of length to the crossing.	Peel Region		
48	Hwy 410	The Highway 410 crossing was delayed due to TRCA's permit delays for the temporary bridges required for the HDD pullback.	TRCA		
49	Kennedy Rd	Peel Region's clearance requirements for their water mains added 3.4 m of depth to the crossing.	Peel Region		
50	MTO Transitway - East Hurontario	MTO required 1.8 m of extra depth under their future transitway infrastructure and parking lot. Metrolinx also required 1.8 m of extra depth under their future LRT infrastructure at the same location.	MTO	Metrolinx	
51	Hurontario St.	Peel Region's clearance requirements to their water main added 1.0 m of extra depth. HONI required the mainline valve to be relocated at the last minute from under their power lines.	Peel Region	HONI	
52	Fletcher's Creek	HONI's inability to provide location information for seven buried high voltage cables on the east side of Fletchers Creek resulted in incremental time and hydrovac costs for field locating. Peel Region's request for extra vertical clearance to their sewer, and an extension of the track bore under the sewer, was reviewed with Peel Region but due to the placement of the HONI cables (referenced above) east of the sewer we could not deepen or extend the crossing. Based on this situation Peel agreed to an open cut of the sewer but required unshrinkable fill between the sewer and the pipeline and between the sewer and the bore pit shoring, as well as camera inspection of their sewer. The inability to extend the crossing, as well as Peel's request to avoid equipment set-up on top of the sewer, required additional TWS within the 30 m Species at Risk buffer, which further complicated the acquisition of the MNR permit. The multiple issues and coordination across agencies resulted in significant permitting delays.	HONI	Peel Region	MNR
53	Fletcher's Creek Trib 1	CVCA setbacks for Fletchers Creek Trib 1 required a redesign of the pipeline crossing and a relocation of the temporary bridge crossing.	CVCA		
54	MTO Transitway - East Mavis	MTO required 2 m of extra depth under the future MTO Transitway parking lot.	MTO		
55	McLaughlin Road	Peel Region's clearance requirements for their water main added 0.8 m of extra depth.	Peel Region		
56	Mavis Rd.	Easement was delayed due to extended Private Landowner negotiations. This in turn delayed access to the Mavis Road HDD entry location and the Credit River crossing sites.	Private Landowner(s)		
57	Archaelogy Site - Pengilley	Extended timelines for MEDEI approvals, related to the First Nation burial site, delayed the mainline construction and tie-in work west of the Credit River.	MEDEI		
58	Heritage Rd.	Peel Region's clearance requirements beneath two water mains (initial design had the pipe crossing over them with adequate clearance) resulted in a redesign that added 5.8 m of depth.	Peel Region		
59	Working Near TCPL Pipelines	TCPL required detailed work plans for any work within 30 m of their pipelines. A requirement to mat prior to placing topsoil above, or crossing over their lines with equipment (irrespective of depth), resulted in a substantial amount of addtional matting that otherwise would not have been required.	TCPL		
60	MTO Transitway - East Meadowpine	MTO required 2 m of extra depth under the future MTO transitway and parking lot.	MTO		
61	Winston Churchill Blvd	Peel Region required 1.6 m of added depth to minimize the pipeline relocation potential in the event of a future Winston Churchill road widening.	Peel Region		
62	10th Line	Our design was based on Peel Region's proposed facility design to supply a development on 10th line. Actual water main installation, completed subsequent to our design, was deeper than proposed (confirmed by field locating due to lack of as-built records). The actual water main depth, and Peel's new requirement for 2m of clearance beneath the water main, resulted in an additional 0.8 m of depth to the originally proposed design and a change in crossing method from open cut to track bore.	Peel Region		
63	Argentia Rd	This road did not exist at the FEED stage. The initial permit issued by the City of Mississauga was for a track bore crossing. However, Peel Region retracted their approval due to concerns with flowing sand being disturbed under the water main. Peel Region then requested and permitted the pipeline to cross above their water main on the condition that the casing around it be extended (the casing was already installed under both the existing TCPL line and EGD's Parkway North line) to facilitate easy replacement if required in the future. Incorrect as-built records (confirmed in the field after hydrovacing) necessitated the relocation of a short section of the water main before the casing could be installed.	Peel Region		
64	Lisgar Meadow Brook	The new commercial/industrial development between 9th and 10th Lines did not exist at the FEED stage. The sewer as-constructed record did not exist at the design/permitting stage so our crossing was based on the proposed design. Subsequent to the permit application, the installed sewer location had to be field verified and was found to be deeper than the proposed design. The actual sewer depth, and the new requirement for 2 m of clearance beneath the sewer, resulted in an additional 3 m of depth to the originally proposed design. This extra depth increased the required bore pit size and work space that in turn caused encroachment on the environmental setbacks required for Lisgar Meadow Brook creek. This necessitated a lengthening of the track bore by 95 m (and ultimately a Direct Pipe due flowing sand conditions in the track bore pit). As landowner, City of Mississauga conditioned their approval of the pipeline easement on the issuance of Peel Region's permit. They also required camera inspection of the sewer.	Peel Region		
65	MTO Transitway - West of Ninth Line	MTO required 2 m of extra depth under the future MTO transitway and parking lot.	MTO		
66	16 Mile Creek 1C	Delay in obtaining the temporary bridge permit from Conservation Halton resulted in contractor move arounds to complete the site preparation work.	CH		
67	16 Mile Creek 1A	Delay in obtaining the temporary bridge permit from Conservation Halton resulted in contractor move arounds to complete the site preparation work.	CH		
68	16 Mile Creek 1B	Delay in obtaining the temporary bridge permit from Conservation Halton resulted in contractor move arounds to complete the site preparation work.	CH		

APPENDIX F

Crossing Method, Length, and Depth Analysis (Estimate to Actual)

CROSSING METHOD, LENGTH AND DEPTH ANALYSIS (ESTIMATE TO ACTUAL)

CROSSING LOCATION	Spread	Segment	Crossing Method		Depth of Cover (m)		Length (m)		Shoring (Yes/No)	
			Estimate	Actual	Estimate	Actual	Estimate	Actual	West/North	East/South
Bridlewood Boulevard	1	B	OC	TB	1.2	4.3	23	35	Y	Y
Huntingwood Drive	1	B	OC	TB	1.2	4.0	27	36	Y	Y
Collingsbrook Boulevard	1	B	OC	TB	1.2	7.0	22	35	Y	Y
Pinemeadow Boulevard	1	B	OC	TB	1.2	6.7	28	36	Y	Y
Finch Avenue East	1	B	TB	TB	1.2	5.7	85	85	Y	Y
Huntingdale Drive	1	B	TB	TB	1.2	6.1	36	36	Y	Y
Beverly Glen Boulevard	1	B	OC	TB	1.2	6.6	26	47	Y	Y
McNicholl Avenue	1	B	TB	TB	1.2	7.7	60	60	Y	Y
Huntsmill Boulevard (S)	1	B	TB	TB	1.2	6.4	48	48	Y	Y
Steeles Avenue (hydro substation)	1	B	HDD	HDD			708	940	N	N
Denison Street	1	B	TB	TB	1.2	5.6	28	48	Y	Y
Alden Road	1	B	OC		1.2		34			
CNR Tracks north of Alden	1	B	TB	HDD	3.1		38	883	N	N
Riviera Drive	1	B	OC		1.2		20			
14th Avenue	1	B	TB	TB	1.5	4.5	20	44	N	Y
Beaver Creek Trib 1 (hydro towers)	1	B	HDD	HDD			367	356	N	N
Rodick Road	2	B	TB	TB	2.3	6.5	65	97	Y	Y
Beaver Creek Trib 2	2	B	OC	OC	2.5	2.2	354	354	N	N
Beaver Creek Trib 3a	2	B	OC	OC	2.5	2.5	20	20	N	N
Beaver Creek Trib 3b	2	B	OC	OC	2.5	2.5	20	20	N	N
Woodbine Avenue	2	B	TB	GB	1.5	6.1	28	130	Y	Y
Burncrest Road	2	B	OC	GB	1.2	4.4	37	105	Y	Y
Miller Parking Lot	2	B		GB		3.8		226	Y	Y
Highway 404	2	B	HDD	HDD			436	416	N	N
Leslie Street	2	B	TB	DP	1.5		51	261	Y	Y
Little German Mills Creek	2	B	OC	OC	2.5	2.7	25	25	N	N
German Mills Creek	2	B	OC	OC	2.5	3.0	33	64	N	N
Bayview Avenue	2	B	HDD	HDD			343	389	N	N
Langstaff Road East	2	B	OC	HDB	1.2	4.1	20	58	Y	Y
Essex Avenue	2	B	n/a	SB	n/a	4.1	n/a	20	Y	Y
Cedar Ave	2	B	n/a		n/a		n/a			
CNR (west of Essex)	2	B	TB	HDD	5.0		35	916	Y	N
Ruggles Road	2	B	n/a		n/a		n/a			
Pomona Creek	2	B	OC		2.5		20			
Langstaff Road (West)	2	B	OC	OC	1.2	2.6	20	20	N	N
Yonge Street	2	B	HDD	TB		5.2	383	88	Y	Y
Don River East Trib 3 (crossing A)	2	B	OC		2.5		15			
Don River East Trib 3 (crossing B)	2	B	OC		2.5		15			
Don River East	2	B	HDD	HDD			613	1006	N	N
Don River East Trib 1 (crossing A)	2	B	OC		2.5		20			
Don River East Trib 1 (crossing B)	2	B	OC		2.5		20			
Don River East Trib 1 (crossing C)	2	B	OC		2.5		20			
Bathurst Street	2	B	HDD	HDD			741	640	N	N
Dufferin Street	2	B	TB	TB	1.5	6.9	54	97	Y	Y
Power Cable	2	B	n/a	SB	n/a	4.6	n/a	9	N	N
Centre Street	2	B	TB	TB	1.5	5.6	53	73	Y	Y
Highway 7 (untravelled)	2	B	OC	SB	1.5	5.0	44	31	Y	Y
Don River West	2	B	OC	HDD	2.5		30	431	N	N
Metrolinx 2	2	B	TB	TB	3.0	4.0	70	71	Y	Y
Great Gulf Drive East	2	B	OC	TB	1.2	5.5	25	48	Y	Y
Creek B1	2	B	OC	OC	2.5	2.5	20	20	N	N
Great Gulf Drive West	2	B	OC	TB	1.2	3.5	9	35	N	N
CNR (east of Keele)	2	B	TB	HDB	7.7	9.5	90	122	Y	Y
CNR Albion (NPS 36 Outlet)	3	A	n/a	TB	n/a	6.0	n/a	58	Y	Y
CNR Albion (NPS 42 Inlet)	3	A	TB	TB	3.0	6.0	27	58	Y	Y
Claireville Reservoir	3	A	HDD	HDD			513	1144	N	N
Finch Avenue West	3	A	HDD				393		N	N
Mimico Creek Trib 5	3	A	OC	OC	2.5	4.4	25	45	N	N
Mimico Creek	3	A	OC	TB	2.5	6.0	30	63	Y	Y
Goreway Drive	3	A	TB	TB	1.2	5.8	16	63	Y	Y
CNR Goreway	3	A	TB	TB	3.1	4.2	56	44	Y	Y
CNR Airport	3	A	TB	TB	3.1	5.7	65	88	Y	Y
Airport Road	3	A	TB	HDB	1.2	7.2	80	112	Y	Y
Mimico Creek Trib 3	3	A	OC	OC	2.5	3.4	25	55	N	N
Torbram Road (and detour)	3	A	TB	HDD	2.6		20	380	N	N
Mimico Creek Trib 2	3	A	OC		2.5		45		N	N
CNR Torbram	3	A	TB	TB	3.1	6.9	40	86	Y	Y
Metrolinx 1/Mimico Trib 1	3	A	TB	TB	3.1	6.0	30	71	Y	Y
Industrial Access	3	A	OC	HDD	2.5		61	466	N	N
Bramalea Road	3	A	HDD				433		N	N
Spring Creek	3	A	OC	OC	2.5	2.9	42	71	N	N
Spring Creek Trib 1	3	A	OC	OC	2.5	2.7	29	32	N	N
Etobicoke Creek Trib 3	3	A	OC	OC	2.5	2.5	27	42	N	N
Dixie Road	3	A	TB	TB	1.2	8.2	51	98	Y	Y
Etobicoke Creek	3	A	OC	TB	2.5	8.5	40	98	Y	Y
Tomken Road	3	A	TB	TB	1.2	6.9	51	101	Y	Y
Highway 410	3	A	HDD	HDD			501	498	N	N
Etobicoke Creek Trib 2a	3	A	OC	OC	2.5	2.7	25	30	N	N
Etobicoke Creek Trib 2	3	A	OC	OC	2.5	3.4	20	20	N	N
Kennedy Road	3	A	TB	TB	1.2	8.0	35	53	Y	Y
Etobicoke Creek Trib 1A	3	A	n/a	OC	n/a	3.3	n/a	20	N	N
Etobicoke Creek Trib 1	3	A	OC	OC	2.5	3.4	25	25	N	N

CROSSING METHOD, LENGTH AND DEPTH ANALYSIS (ESTIMATE TO ACTUAL)

CROSSING LOCATION	Spread	Segment	Crossing Method		Depth of Cover (m)		Length (m)		Shoring (Yes/No)	
			Estimate	Actual	Estimate	Actual	Estimate	Actual	West/North	East/South
Hurontario Street	3	A	TB	TB	1.5	4.2	72	140	Y	Y
Fletchers Creek	3	A	HDD	TB	2.5	9.5	370	73	Y	Y
Fletchers Creek Trib 1	3	A	n/a	OC	n/a	3.4	n/a	75	N	N
McLaughlin Road	3	A	TB	TB	1.2	4.1	63	89	Y	Y
Mavis Road	3	A	HDD	HDD			525	488	N	N
Second Line West	3	A	OC	OC	1.2	1.9	21	60	N	N
Credit River Trib 1	3	A	OC	OC	2.5	3.1	20	20	N	N
Railway (Orangeville/Brampton)	3	A	HDD	DP			769	388	Y	N
Credit River	3	A								
Creditview Road	3	A	OC	OC	1.2	1.2	17	40	N	N
Financial Drive	3	A	HDD				413			
Levi's Creek	3	A		HDD				1015	N	N
Mississauga Road	3	A	HDD				408			
Mullett Creek	3	A	OC	OC	2.5	3.8	30	30	N	N
Heritage Road	3	A	TB	TB	1.2	7.0	65	95	Y	Y
Meadowpine Boulevard	3	A	TB	TB	1.2	6.9	46	72	Y	Y
Winston Churchill Boulevard	3	A	TB	TB	1.2	5.0	55	71	Y	Y
Highway 401	3	A	HDD	HDD			328	350	N	N
10th Line	3	A	OC	TB	1.2	4.2	40	69	Y	Y
Argentia Road	3	A	n/a	TB	n/a	2.8	n/a	33	N	Y
Lisgar-Meadowbrook Creek Trib 2a	3	A	OC		2.5		65			
Lisgar-Meadowbrook Creek	3	A	OC	DP	2.5		15	465	N	N
Lisgar-Meadowbrook Creek Trib 1	3	A	OC		2.5		15			
9th Line	3	A	OC	TB	1.2	5.6	20	54	Y	Y
16 Mile Creek Trib 1c	3	A	OC	OC	2.5	3.4	25	25	N	N
Highway 407	3	A	TB	HDB	1.5	6.1	108	132	Y	Y
CPR (St Lawrence & Hudson)	3	A	TB	TB	3.0	4.1	21	42	N	N
16 Mile Creek Trib 1b	3	A	OC	OC	2.5	4.3	35	35	N	N
16 Mile Creek Trib 1a	3	A	OC	OC	2.5	3.6	35	35	N	N
Derry Road	3	A	n/a	HDB	n/a	4.7	n/a	77	Y	Y
CPR HONI (Spread 3 Parkway Outlet)	3	A	n/a	TB	n/a	3.7	n/a	35	Y	Y
CPR HONI (Spread 4 Parkway Outlet)	4	A	n/a	TB	n/a	4.3	n/a	36	Y	Y

CROSSING METHOD	Estimate	Actual
Open Cut (OC)	50	24
Track Bore (TB)	33	42
Horizontal Directional Bore (HDB)	0	5
Guided Bore (GB)	0	3
Slip Bore (SB)	0	3
Horizontal Directional Drill (HDD)	17	16
Direct Pipe (DP)	0	3
Total	100	96

DEPTH/LENGTH SUMMARY BY CROSSING METHOD	Method		Average Depth of Cover (m)		Average Length (m)		% Increase/Decrease		
	Estimate	Actual	Estimate	Actual	Estimate	Actual	Method	Depth	Length
Open Cut	50	24	2.1	3.0	33.6	49.3	-52%	44%	47%
Bore Methods	33	53	2.1	5.7	50.4	70.4	61%	170%	40%
HDD/DP	17	19	n/a	n/a	484.9	601.7	12%	n/a	24%
Total	100	96							

SHORING SUMMARY	
Receiving/Entry Pits (Bore Method)	106
Number of Pits Requiring Shoring	102
Percentage of Bore Pits Shored	96%

APPENDIX G

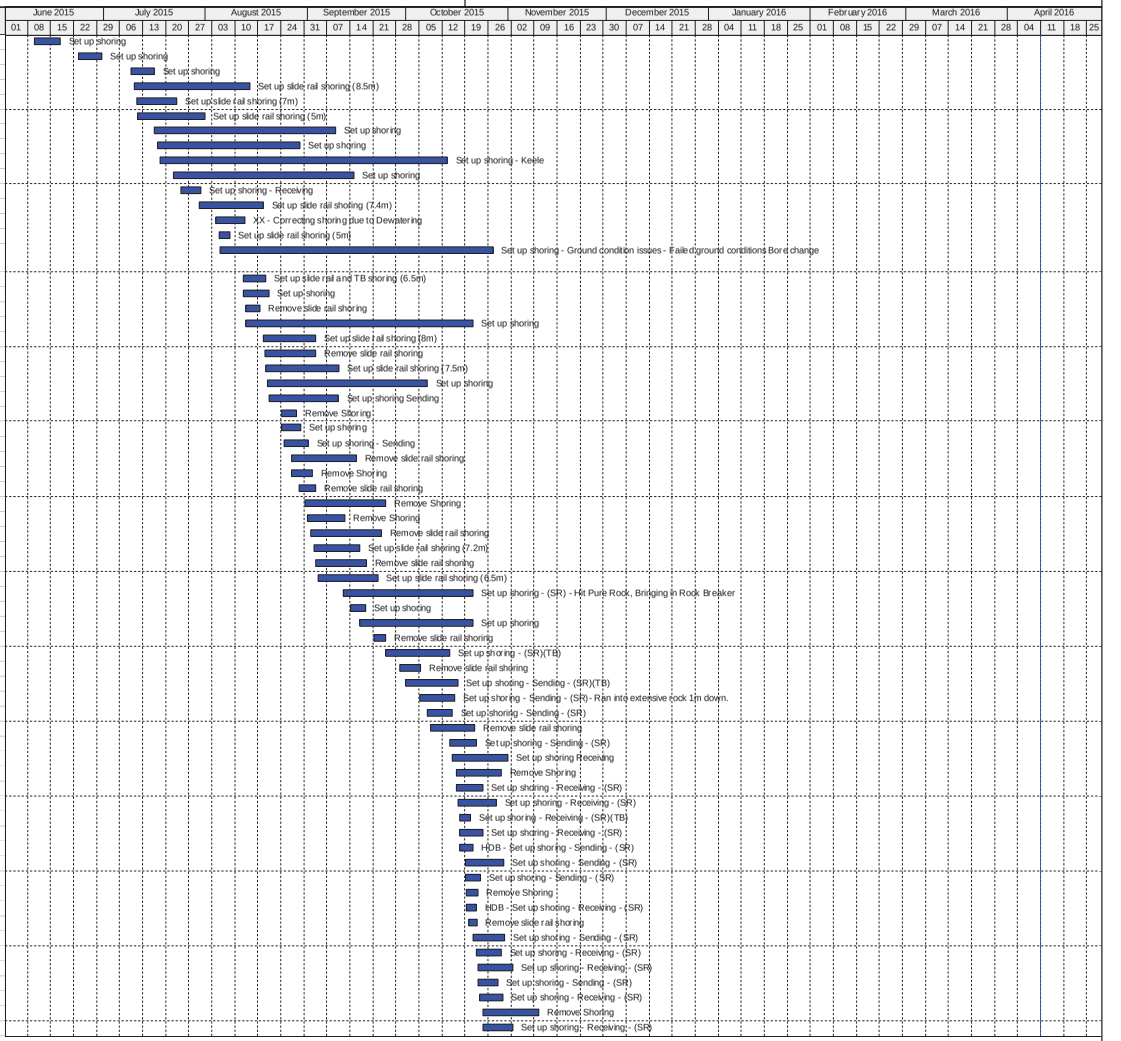
Shoring Schedule

Michels Mainline - Spread 1...

Michels GTA Schedule - Shoring Activities

20-Apr-16 09:04

Activity ID	Activity Name	WBS Name	Actual Duration	Start	Finish
A10981	Set up shoring	McLaughlin Road - 71m KP 12.18 (SR)	7d	10-Jun-15 A	18-Jun-15 A
A11601	Set up shoring	Hurontario Street - 115m KP 13.56 (SR)	6d	23-Jun-15 A	30-Jun-15 A
A10582	Set up shoring	Center Street - 68m (KP 2.68)	6d	09-Jul-15 A	16-Jul-15 A
A9972	Set up slide rail shoring (8.5m)	McNICOLL - 58m (KP 4.42)	30d	10-Jul-15 A	14-Aug-15 A
A9984	Set up slide rail shoring (7m)	HUNTSMILL - 33m (KP4.24)	10d	11-Jul-15 A	23-Jul-15 A
A10130	Set up slide rail shoring (5m)	BRIDLEWOOD BLVD - 32m (KP 7.31)	17d	11-Jul-15 A	01-Aug-15 A
A10802	Set up shoring	Miller - 204m (KP 14.30) (Wetland to Golf Net)	45d	16-Jul-15 A	09-Sep-15 A
A10742	Set up shoring	Metrolinx 2 - 59m (KP 1.3)	36d	17-Jul-15 A	29-Aug-15 A
A10692	Set up shoring - Keele	CNR Rail Road Keele - 118m (KP 0.05)	72d	18-Jul-15 A	13-Oct-15 A
A11302	Set up shoring	CNR Rail (Albion Station) - 36' - 51mKP 0 Spr	45d	22-Jul-15 A	15-Sep-15 A
A10652	Set up shoring - Receiving	Roddick Road - 108m (KP 15.16)	5d	24-Jul-15 A	30-Jul-15 A
A10090	Set up slide rail shoring (7.4m)	BEVERLY GLEN BLVD - 45m (KP 5.12)	16d	30-Jul-15 A	18-Aug-15 A
A9993	XX - Correcting shoring due to Dewatering	McNICOLL - 58m (KP 4.42)	8d	04-Aug-15 A	13-Aug-15 A
A10222	Set up slide rail shoring (5m)	HUNTINGWOOD - 33m (KP 6.90)	4d	05-Aug-15 A	08-Aug-15 A
A10952	Set up shoring - Ground condition issues - Failed ground conditions Bore change	Lisgar Meadow Brook - 240m, 42" KP 3.09 - Track Bore	69d	05-Aug-15 A	27-Oct-15 A
A9952	Set up slide rail and TB shoring (6.5m)	DENISON - 41m (KP 2.02)	6d	12-Aug-15 A	19-Aug-15 A
A11532	Set up shoring	Tomken Road - 92m KP 16.39	7d	12-Aug-15 A	20-Aug-15 A
A9991	Remove slide rail shoring	HUNTSMILL - 33m (KP4.24)	4d	13-Aug-15 A	17-Aug-15 A
A11332	Set up shoring	CNR Rail (Albion Station) - 42" - 62m KP 0 Sp	57d	13-Aug-15 A	21-Oct-15 A
A10160	Set up slide rail shoring (8m)	COLLINGSBROOK BLVD - 29m (KP 6.41)	14d	18-Aug-15 A	03-Sep-15 A
A10300	Remove slide rail shoring	BRIDLEWOOD BLVD - 32m (KP 7.31)	14d	19-Aug-15 A	03-Sep-15 A
A10182	Set up slide rail shoring (7.5m)	PINEMEADOW BLVD - 34m (KP 5.97)	19d	19-Aug-15 A	10-Sep-15 A
A10544	Set up shoring	Leslie St & Little German Mills Trib 1 - 250m (K	40d	20-Aug-15 A	07-Oct-15 A
A10853	Set up shoring Sending	Woodbine (Woodbine to Miller) - 95m	17d	20-Aug-15 A	10-Sep-15 A
A11820	Remove Shoring	Hurontario Street - 115m KP 13.56 (SR)	5d	24-Aug-15 A	28-Aug-15 A
A12090	Set up shoring	Tenth Line - 62m KP 4.19	6d	24-Aug-15 A	30-Aug-15 A
A10653	Set up shoring - Sending	Roddick Road - 108m (KP 15.16)	6d	25-Aug-15 A	01-Sep-15 A
A9955	Remove slide rail shoring	DENISON - 41m (KP 2.02)	16d	27-Aug-15 A	16-Sep-15 A
A11830	Remove Shoring	McLaughlin Road - 71m KP 12.18 (SR)	6d	27-Aug-15 A	02-Sep-15 A
A10225	Remove slide rail shoring	HUNTINGWOOD - 33m (KP 6.90)	4d	29-Aug-15 A	03-Sep-15 A
A10620	Remove Shoring	Center Street - 68m (KP 2.68)	21d	31-Aug-15 A	25-Sep-15 A
A10746	Remove Shoring	Metrolinx 2 - 59m (KP 1.3)	10d	01-Sep-15 A	12-Sep-15 A
A9975	Remove slide rail shoring	McNICOLL - 58m (KP 4.42)	18d	02-Sep-15 A	23-Sep-15 A
A10060	Set up slide rail shoring (7.2m)	HUNTINGDALE BLVD - 33m (KP 5.43)	11d	03-Sep-15 A	17-Sep-15 A
A10420	Remove slide rail shoring	BEVERLY GLEN BLVD - 45m (KP 5.12)	13d	03-Sep-15 A	19-Sep-15 A
A9962	Set up slide rail shoring (6.5m)	FINCH - 86m (KP 5.59) (7.5m) (SR)	15d	04-Sep-15 A	22-Sep-15 A
A11562	Set up shoring - (SR) - Hit Pure Rock, Bringing in Rock Breaker	Kennedy Road - 60m KP 14.97	33d	12-Sep-15 A	21-Oct-15 A
A10445	Set up shoring	Langstaff Rd (Sussex Ave) - 45m (KP 9.67) Fa	5d	14-Sep-15 A	18-Sep-15 A
A10492	Set up shoring	Yonge St - 86m (KP 8.16)	29d	17-Sep-15 A	21-Oct-15 A
A10320	Remove slide rail shoring	COLLINGSBROOK BLVD - 29m (KP 6.41)	4d	21-Sep-15 A	25-Sep-15 A
A11144	Set up shoring - (SR)(TB)	Fletchers Creek - 72m KP 12.81	15d	25-Sep-15 A	14-Oct-15 A
A10340	Remove slide rail shoring	PINEMEADOW BLVD - 34m (KP 5.97)	6d	29-Sep-15 A	05-Oct-15 A
A11084	Set up shoring - Sending - (SR)(TB)	Ninth Line - 48m KP 2.6	13d	01-Oct-15 A	17-Oct-15 A
A11502	Set up shoring - Sending - (SR) - Ran into extensive rock 1m down.	Etobicoke Creek - 104m KP 17.2	9d	05-Oct-15 A	16-Oct-15 A
A11014	Set up shoring - Sending - (SR)	Heritage Road - 91m KP 6.5	6d	07-Oct-15 A	15-Oct-15 A
A10380	Remove slide rail shoring	HUNTINGDALE BLVD - 33m (KP 5.43)	10d	08-Oct-15 A	22-Oct-15 A
A11442	Set up shoring - Sending - (SR)	Airport Road - 99m - KP 22.37	7d	14-Oct-15 A	22-Oct-15 A
A10854	Set up shoring Receiving	Woodbine (Woodbine to Miller) - 95m	15d	15-Oct-15 A	01-Nov-15 A
A10657	Remove Shoring	Roddick Road - 108m (KP 15.16)	12d	16-Oct-15 A	30-Oct-15 A
A11015	Set up shoring - Receiving - (SR)	Heritage Road - 91m KP 6.5	7d	16-Oct-15 A	24-Oct-15 A
A11503	Set up shoring - Receiving - (SR)	Etobicoke Creek - 104m KP 17.2	10d	17-Oct-15 A	28-Oct-15 A
A11085	Set up shoring - Receiving - (SR)(TB)	Ninth Line - 48m KP 2.6	3d	17-Oct-15 A	20-Oct-15 A
A12761	Set up shoring - Receiving - (SR)	Metrolinx 1 / Mimico Trib 1 - 71m KP 20.45	6d	17-Oct-15 A	24-Oct-15 A
A11114	HDB - Set up shoring - Sending - (SR)	Highway 407 Ramp - 122m KP 2.18	3d	17-Oct-15 A	21-Oct-15 A
A12760	Set up shoring - Sending - (SR)	Metrolinx 1 / Mimico Trib 1 - 71m KP 20.45	11d	19-Oct-15 A	30-Oct-15 A
A13110	Set up shoring - Sending - (SR)	Burncrest (Burncrest to Pit #2) - 127m	5d	19-Oct-15 A	23-Oct-15 A
A10806	Remove Shoring	Miller - 204m (KP 14.30) (Wetland to Golf Net)	4d	19-Oct-15 A	23-Oct-15 A
A11115	HDB - Set up shoring - Receiving - (SR)	Highway 407 Ramp - 122m KP 2.18	3d	19-Oct-15 A	22-Oct-15 A
A9965	Remove slide rail shoring	FINCH - 86m (KP 5.59) (7.5m) (SR)	3d	20-Oct-15 A	22-Oct-15 A
A11475	Set up shoring - Sending - (SR)	Dixie Road - 110m KP 17.87	9d	21-Oct-15 A	31-Oct-15 A
A11443	Set up shoring - Receiving - (SR)	Airport Road - 99m - KP 22.37	7d	22-Oct-15 A	30-Oct-15 A
A12150	Set up shoring - Receiving - (SR)	Mimico Creek - 60m - KP 23.97	9d	23-Oct-15 A	02-Nov-15 A
A12140	Set up shoring - Sending - (SR)	Mimico Creek - 60m - KP 23.97	5d	23-Oct-15 A	29-Oct-15 A
A11205	Set up shoring - Receiving - (SR)	Derry Road - 78m KP 0.61	6d	23-Oct-15 A	30-Oct-15 A
A11305	Remove Shoring	CNR Rail (Albion Station) - 36' - 51mKP 0 Spr	14d	24-Oct-15 A	10-Nov-15 A
A11476	Set up shoring - Receiving - (SR)	Dixie Road - 110m KP 17.87	7d	24-Oct-15 A	02-Nov-15 A



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

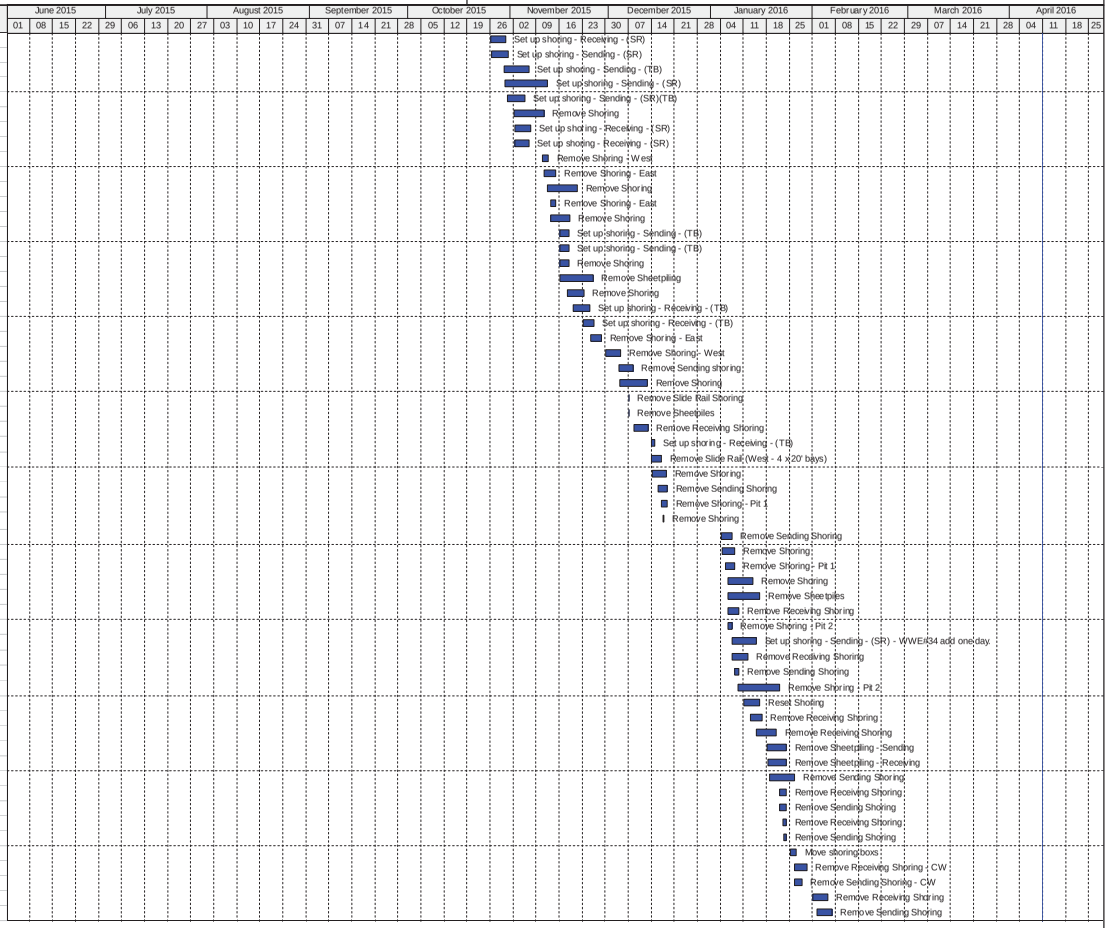
TASK filter: Mike - TEMP Code.

Michels Mainline - Spread 1...

Michels GTA Schedule - Shoring Activities

20-Apr-16 09:04

Activity ID	Activity Name	WBS Name	Actual Duration	Start	Finish
A10903	Set up shoring - Receiving - (SR)	CNR Torbram - 85m KP 20.64	5d	26-Oct-15 A	30-Oct-15 A
A11204	Set up shoring - Sending - (SR)	Derry Road - 78m KP 0.61	5d	26-Oct-15 A	31-Oct-15 A
A11415	Set up shoring - Sending - (TB)	CNR Railroad - 71m (CNR - Goreway KP 23.4	7d	30-Oct-15 A	07-Nov-15 A
A11362	Set up shoring - Sending - (SR)	Goreway Drive - 62m KP 23.78	11d	30-Oct-15 A	12-Nov-15 A
A10902	Set up shoring - Sending - (SR)(TB)	CNR Torbram - 85m KP 20.64	5d	31-Oct-15 A	05-Nov-15 A
A11790	Remove Shoring	Tomken Road - 92m KP 16.39	9d	02-Nov-15 A	11-Nov-15 A
A11363	Set up shoring - Receiving - (SR)	Goreway Drive - 62m KP 23.78	5d	02-Nov-15 A	07-Nov-15 A
A11393	Set up shoring - Receiving - (SR)	CNR Railroad - 89m (CNR - Airport KP 22.87)	4d	02-Nov-15 A	07-Nov-15 A
A10858	Remove Shoring - West	Woodbine (Woodbine to Miller) - 95m	2d	11-Nov-15 A	12-Nov-15 A
A13150	Remove Shoring - East	Burncrest (Burncrest to Pit #2) - 127m	4d	11-Nov-15 A	15-Nov-15 A
A13280	Remove Shoring	HDB Langstaff Rd (Sussex Ave) - 45m (KP 9.6	8d	12-Nov-15 A	21-Nov-15 A
A10866	Remove Shoring - East	Woodbine (Woodbine to Miller) - 95m	1d	13-Nov-15 A	15-Nov-15 A
A10497	Remove Shoring	Yonge St - 86m (KP 8.16)	4d	13-Nov-15 A	19-Nov-15 A
A11235	Set up shoring - Sending - (TB)	Hydro One Railway - 36" - 36m - KP 0.14	3d	16-Nov-15 A	19-Nov-15 A
A11265	Set up shoring - Sending - (TB)	Hydro One Railway - 42" - 36m - KP 0.14	3d	16-Nov-15 A	19-Nov-15 A
A11870	Remove Shoring	Ninth Line - 48m KP 2.6	3d	16-Nov-15 A	19-Nov-15 A
A13170	Remove Sheetpiling	Burncrest (Burncrest to Pit #2) - 127m	9d	16-Nov-15 A	26-Nov-15 A
A11810	Remove Shoring	Kennedy Road - 60m KP 14.97	4d	18-Nov-15 A	23-Nov-15 A
A11236	Set up shoring - Receiving - (TB)	Hydro One Railway - 36" - 36m - KP 0.14	4d	20-Nov-15 A	25-Nov-15 A
A11266	Set up shoring - Receiving - (TB)	Hydro One Railway - 42" - 36m - KP 0.14	4d	23-Nov-15 A	26-Nov-15 A
A11910	Remove Shoring - East	Fletchers Creek - 72m KP 12.81	4d	25-Nov-15 A	29-Nov-15 A
A11310	Remove Shoring - West	Fletchers Creek - 72m KP 12.81	5d	30-Nov-15 A	04-Dec-15 A
A12790	Remove Sending shoring	Metrolinx 1 / Mimico Trib 1 - 71m KP 20.45	5d	04-Dec-15 A	08-Dec-15 A
A12179	Remove Shoring	Mimico Creek - 60m - KP 23.97	8d	04-Dec-15 A	12-Dec-15 A
A13470	Remove Slide Rail Shoring	Leslie St & Little German Mills Trib 1 - 250m (K	0d	07-Dec-15 A	07-Dec-15 A
A13490	Remove Sheetpiles	Leslie St & Little German Mills Trib 1 - 250m (K	0d	07-Dec-15 A	07-Dec-15 A
A12800	Remove Receiving Shoring	Metrolinx 1 / Mimico Trib 1 - 71m KP 20.45	4d	08-Dec-15 A	13-Dec-15 A
A11416	Set up shoring - Receiving - (TB)	CNR Railroad - 71m (CNR - Goreway KP 23.4	1d	14-Dec-15 A	15-Dec-15 A
A13610	Remove Slide Rail (West - 4 x 20' bays)	Leslie St & Little German Mills Trib 1 - 250m (K	3d	14-Dec-15 A	17-Dec-15 A
A11950	Remove Shoring	Derry Road - 78m KP 0.61	5d	14-Dec-15 A	18-Dec-15 A
A11850	Remove Sending Shoring	Heritage Road - 91m KP 6.5	3d	16-Dec-15 A	19-Dec-15 A
A11970	Remove Shoring - Pit 1	Hydro One Railway - 36" - 36m - KP 0.14	2d	17-Dec-15 A	19-Dec-15 A
A11890	Remove Shoring	Highway 407 Ramp - 122m KP 2.18	1d	17-Dec-15 A	18-Dec-15 A
A11367	Remove Sending Shoring	Goreway Drive - 62m KP 23.78	4d	04-Jan-16 A	07-Jan-16 A
A10760	Remove Shoring	CNR Rail Road Keele - 11.8m (KP 0.05)	4d	04-Jan-16 A	08-Jan-16 A
A11350	Remove Shoring - Pit 1	Hydro One Railway - 42" - 36m - KP 0.14	3d	05-Jan-16 A	08-Jan-16 A
A12120	Remove Shoring	Tenth Line - 62m KP 4.19	8d	06-Jan-16 A	14-Jan-16 A
A13630	Remove Sheetpiles	Leslie St & Little German Mills Trib 1 - 250m (K	10d	06-Jan-16 A	16-Jan-16 A
A11860	Remove Receiving Shoring	Heritage Road - 91m KP 6.5	4d	06-Jan-16 A	09-Jan-16 A
A11980	Remove Shoring - Pit 2	Hydro One Railway - 36" - 36m - KP 0.14	2d	06-Jan-16 A	07-Jan-16 A
A11392	Set up shoring - Sending - (SR) - WWE#34 add one day.	CNR Railroad - 89m (CNR - Airport KP 22.87)	7d	07-Jan-16 A	15-Jan-16 A
A11377	Remove Receiving Shoring	Goreway Drive - 62m KP 23.78	4d	07-Jan-16 A	12-Jan-16 A
A11770	Remove Sending Shoring	Etobicoke Creek - 104m KP 17.2	2d	08-Jan-16 A	09-Jan-16 A
A11990	Remove Shoring - Pit 2	Hydro One Railway - 42" - 36m - KP 0.14	13d	09-Jan-16 A	22-Jan-16 A
A11481	Reset Shoring	Dixie Road - 110m KP 17.87	5d	11-Jan-16 A	16-Jan-16 A
A11780	Remove Receiving Shoring	Etobicoke Creek - 104m KP 17.2	4d	13-Jan-16 A	16-Jan-16 A
A11740	Remove Receiving Shoring	Airport Road - 99m - KP 22.37	6d	15-Jan-16 A	21-Jan-16 A
A10810	Remove Sheetpiling - Sending	CNR Rail Road Keele - 11.8m (KP 0.05)	6d	18-Jan-16 A	24-Jan-16 A
A10820	Remove Sheetpiling - Receiving	CNR Rail Road Keele - 11.8m (KP 0.05)	6d	18-Jan-16 A	24-Jan-16 A
A11730	Remove Sending Shoring	Airport Road - 99m - KP 22.37	8d	19-Jan-16 A	26-Jan-16 A
A11430	Remove Receiving Shoring	CNR Railroad - 71m (CNR - Goreway KP 23.4	2d	22-Jan-16 A	24-Jan-16 A
A11420	Remove Sending Shoring	CNR Railroad - 71m (CNR - Goreway KP 23.4	2d	22-Jan-16 A	24-Jan-16 A
A10916	Remove Receiving Shoring	CNR Torbram - 85m KP 20.64	1d	23-Jan-16 A	24-Jan-16 A
A10915	Remove Sending Shoring	CNR Torbram - 85m KP 20.64	1d	23-Jan-16 A	24-Jan-16 A
A11396	Move shoring boxs	CNR Railroad - 89m (CNR - Airport KP 22.87)	2d	25-Jan-16 A	27-Jan-16 A
A11750	Remove Receiving Shoring - CW	Dixie Road - 110m KP 17.87	4d	26-Jan-16 A	30-Jan-16 A
A11520	Remove Sending Shoring - CW	Dixie Road - 110m KP 17.87	3d	26-Jan-16 A	29-Jan-16 A
A11406	Remove Receiving Shoring	CNR Railroad - 89m (CNR - Airport KP 22.87)	5d	01-Feb-16 A	05-Feb-16 A
A11405	Remove Sending Shoring	CNR Railroad - 89m (CNR - Airport KP 22.87)	5d	02-Feb-16 A	07-Feb-16 A



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

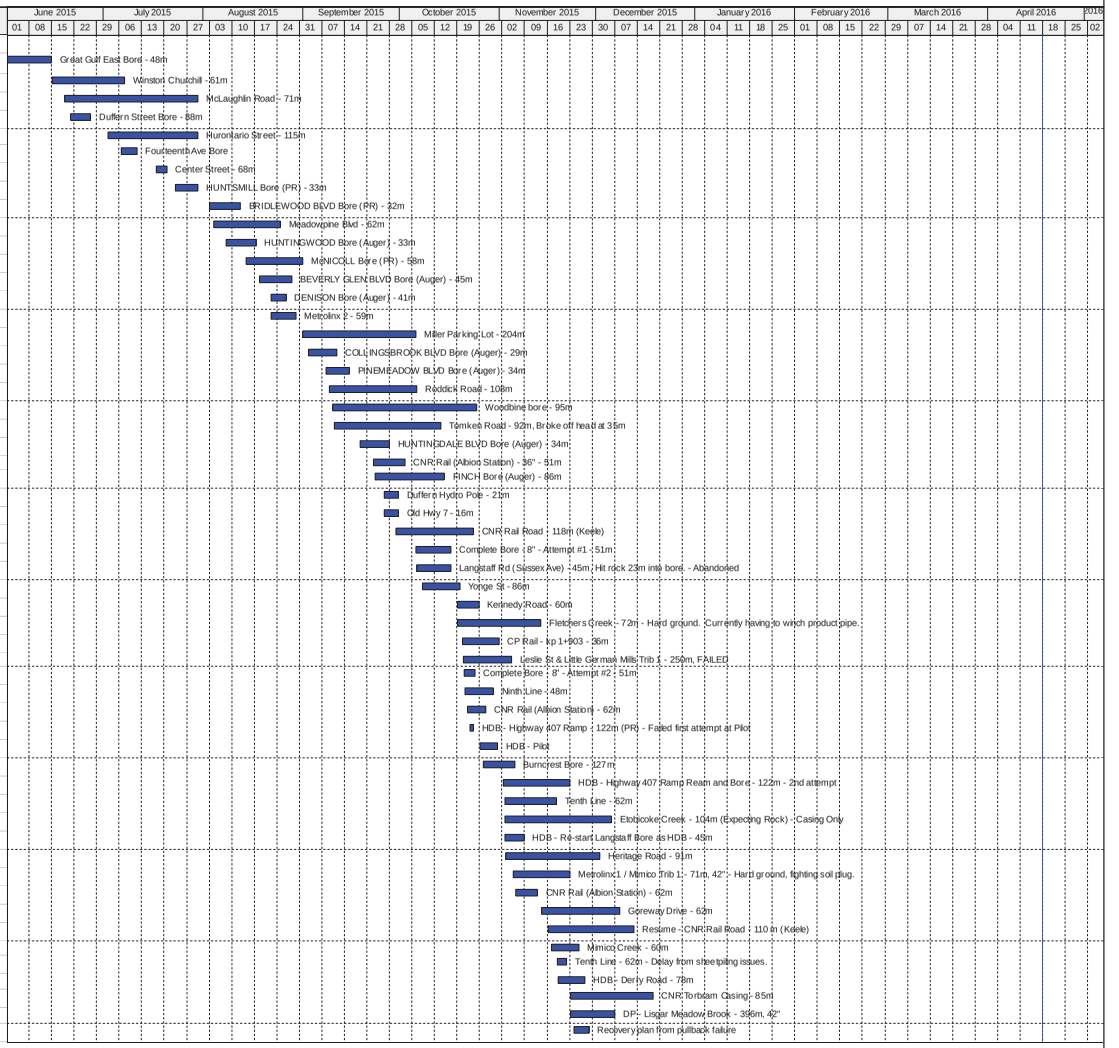
TASK filter: Mike - TEMP Code.

APPENDIX H

Boring Schedule

Michels GTA Schedule - Track Bores

Activity ID	Activity Name	WBS Name	Actual Duration	Start	Finish
A12240	Great Gulf West Bore - 20m	Great Gulf West - 20m (KP 0.89)	6d	01-Mar-15 A	09-Mar-15 A
A12230	Great Gulf East Bore - 48m	Great Gulf East - 48m (KP 0.32)	17d	26-May-15 A	15-Jun-15 A
A13250	Winston Churchill - 61m	Winston Churchill - 61m KP 5.07	19d	15-Jun-15 A	07-Jul-15 A
A10990	McLaughlin Road - 71m	McLaughlin Road - 71m KP 12.18 (SR)	35d	19-Jun-15 A	30-Jul-15 A
A12430	Duffern Street Bore - 88m	Duffern St - 88m (KP 3.42)	5d	21-Jun-15 A	27-Jun-15 A
A11610	Hurontario Street - 115m	Hurontario Street - 115m KP 13.56 (SR)	22d	02-Jul-15 A	30-Jul-15 A
A13220	Fourteenth Ave Bore	FOURTEENTH AVE - 39m (KP 0.90)	5d	06-Jul-15 A	11-Jul-15 A
A10590	Center Street - 68m	Center Street - 68m (KP 2.68)	3d	17-Jul-15 A	21-Jul-15 A
A9985	HUNTSMILL Bore (PR) - 33m	HUNTSMILL - 33m (KP 4.24)	7d	23-Jul-15 A	30-Jul-15 A
A10140	BRIDLEWOOD BLVD Bore (PR) - 32m	BRIDLEWOOD BLVD - 32m (KP 7.31)	8d	03-Aug-15 A	12-Aug-15 A
A11050	Meadowpine Blvd - 62m	Meadowpine Blvd - 62m KP 5.28	18d	04-Aug-15 A	25-Aug-15 A
A10223	HUNTINGWOOD Bore (Auger) - 33m	HUNTINGWOOD - 33m (KP 6.90)	8d	08-Aug-15 A	17-Aug-15 A
A9973	McNICOLL Bore (PR) - 58m	McNICOLL - 58m (KP 4.42)	14d	14-Aug-15 A	01-Sep-15 A
A10100	BEVERLY GLEN BLVD Bore (Auger) - 45m	BEVERLY GLEN BLVD - 45m (KP 5.12)	9d	18-Aug-15 A	28-Aug-15 A
A9953	DENISON Bore (Auger) - 41m	DENISON - 41m (KP 2.02)	4d	22-Aug-15 A	27-Aug-15 A
A10743	Metrolinx 2 - 59m	Metrolinx 2 - 59m (KP 1.3)	7d	22-Aug-15 A	30-Aug-15 A
A10803	Miller Parking Lot - 204m	Miller - 204m (KP 14.30) (Wetland to Golf Net)	29d	01-Sep-15 A	06-Oct-15 A
A10170	COLLINGSBROOK BLVD Bore (Auger) - 29m	COLLINGSBROOK BLVD - 29m (KP 6.41)	7d	03-Sep-15 A	11-Sep-15 A
A10183	PINEMEADOW BLVD Bore (Auger) - 34m	PINEMEADOW BLVD - 34m (KP 5.97)	6d	08-Sep-15 A	15-Sep-15 A
A10655	Roddick Road - 108m	Roddick Road - 108m (KP 15.16)	23d	09-Sep-15 A	06-Oct-15 A
A10855	Woodbine bore - 95m	Woodbine (Woodbine to Miller) - 95m	38d	10-Sep-15 A	25-Oct-15 A
A11540	Tomken Road - 92m, Broke off head at 35m	Tomken Road - 92m KP 16.39	27d	11-Sep-15 A	14-Oct-15 A
A10070	HUNTINGDALE BLVD Bore (Auger) - 34m	HUNTINGDALE BLVD - 33m (KP 5.43)	7d	19-Sep-15 A	28-Sep-15 A
A11303	CNR Rail (Albion Station) - 36" - 51m	CNR Rail (Albion Station) - 36" - 51m KP 0 Spr	9d	23-Sep-15 A	03-Oct-15 A
A9963	FINCH Bore (Auger) - 86m	FINCH - 86m (KP 5.59) (7.5m) (SR)	17d	23-Sep-15 A	15-Oct-15 A
A13100	Duffern Hydro Pole - 21m	Duffern Hydro Pole - 21m	4d	26-Sep-15 A	30-Sep-15 A
A13090	Old Hwy 7 - 16m	Old Hwy 7 - Slip Bore - 16m	4d	26-Sep-15 A	30-Sep-15 A
A10700	CNR Rail Road - 118m (Keele)	CNR Rail Road Keele - 118m (KP 0.05)	20d	30-Sep-15 A	24-Oct-15 A
A13310	Complete Bore - 8" - Attempt #1 - 51m	CNR Rail (Albion Station) - 8" - 51m	9d	06-Oct-15 A	17-Oct-15 A
A10446	Langstaff Rd (SussexAve) - 45m, Hit rock 23m into bore. - Abandor	Langstaff Rd (Sussex Ave) - 45m (KP 9.67) Fa	9d	06-Oct-15 A	17-Oct-15 A
A10493	Yonge St - 86m	Yonge St - 86m (KP 8.16)	9d	08-Oct-15 A	20-Oct-15 A
A11570	Kennedy Road - 60m	Kennedy Road - 60m KP 14.97	6d	19-Oct-15 A	26-Oct-15 A
A11150	Fletchers Creek - 72m - Hard ground. Currently having to winch pr	Fletchers Creek - 72m KP 12.81	23d	19-Oct-15 A	14-Nov-15 A
A11180	CP Rail - kp 1+903 - 36m	CP Rail - kp 1+903 - 36m KP 1.9	10d	20-Oct-15 A	01-Nov-15 A
A10545	Leslie St & Little German Mills Trib 1 - 250m, FAILED	Leslie St & Little German Mills Trib 1 - 250m (K	13d	21-Oct-15 A	05-Nov-15 A
A13330	Complete Bore - 8" - Attempt #2 - 51m	CNR Rail (Albion Station) - 8" - 51m	4d	21-Oct-15 A	24-Oct-15 A
A11090	Ninth Line - 48m	Ninth Line - 48m KP 2.6	8d	21-Oct-15 A	30-Oct-15 A
A11333	CNR Rail (Albion Station) - 62m	CNR Rail (Albion Station) - 42" - 62m KP 0 Sp	5d	22-Oct-15 A	28-Oct-15 A
A11120	HDB - Highway 407 Ramp - 122m (PR) - Failed first attempt at Pilot	Highway 407 Ramp - 122m KP 2.18	1d	23-Oct-15 A	24-Oct-15 A
A11318	HDB - Pilot	Highway 407 Ramp - 122m KP 2.18	6d	26-Oct-15 A	31-Oct-15 A
A13130	Burncrest Bore - 127m	Burncrest (Burncrest to Pit #2) - 127m	9d	27-Oct-15 A	06-Nov-15 A
A11328	HDB - Highway 407 Ramp Ream and Bore - 122m - 2nd attempt	Highway 407 Ramp - 122m KP 2.18	18d	02-Nov-15 A	23-Nov-15 A
A12100	Tenth Line - 62m	Tenth Line - 62m KP 4.19	14d	03-Nov-15 A	19-Nov-15 A
A11510	Etobicoke Creek - 104m (Expecting Rock) - Casing Only	Etobicoke Creek - 104m KP 17.2	29d	03-Nov-15 A	06-Dec-15 A
A13260	HDB - Re-start Langstaff Bore as HDB - 45m	HDB Langstaff Rd (Sussex Ave) - 45m (KP 9.6	5d	03-Nov-15 A	09-Nov-15 A
A11020	Heritage Road - 91m	Heritage Road - 91m KP 6.5	25d	03-Nov-15 A	02-Dec-15 A
A12770	Metrolinx 1 / Mimico Trib 1 - 71m, 42" - Hard ground, fighting soil plu	Metrolinx 1 / Mimico Trib 1 - 71m KP 20.45	15d	05-Nov-15 A	23-Nov-15 A
A11337	CNR Rail (Albion Station) - 62m	CNR Rail (Albion Station) - 42" - 62m KP 0 Sp	6d	06-Nov-15 A	13-Nov-15 A
A11364	Goreway Drive - 62m	Goreway Drive - 62m KP 23.78	22d	14-Nov-15 A	08-Dec-15 A
A10750	Resume - CNR Rail Road - 110 m (Keele)	CNR Rail Road Keele - 118m (KP 0.05)	25d	16-Nov-15 A	13-Dec-15 A
A12160	Mimico Creek - 60m	Mimico Creek - 60m - KP 23.97	8d	17-Nov-15 A	26-Nov-15 A
A12105	Tenth Line - 62m - Delay from sheetpiling issues.	Tenth Line - 62m KP 4.19	3d	19-Nov-15 A	22-Nov-15 A
A11210	HDB - Derry Road - 78m	Derry Road - 78m KP 0.61	7d	19-Nov-15 A	27-Nov-15 A
A10904	CNR Torbram Casing - 85m	CNR Torbram - 85m KP 20.64	25d	23-Nov-15 A	19-Dec-15 A
A13504	DP - Lisgar Meadow Brook - 396m, 42"	Lisgar Meadow Brook - 396m, 42" KP 3.09 - D	13d	23-Nov-15 A	07-Dec-15 A
A11348	Recovery plan from pullback failure	Highway 407 Ramp - 122m KP 2.18	5d	24-Nov-15 A	29-Nov-15 A

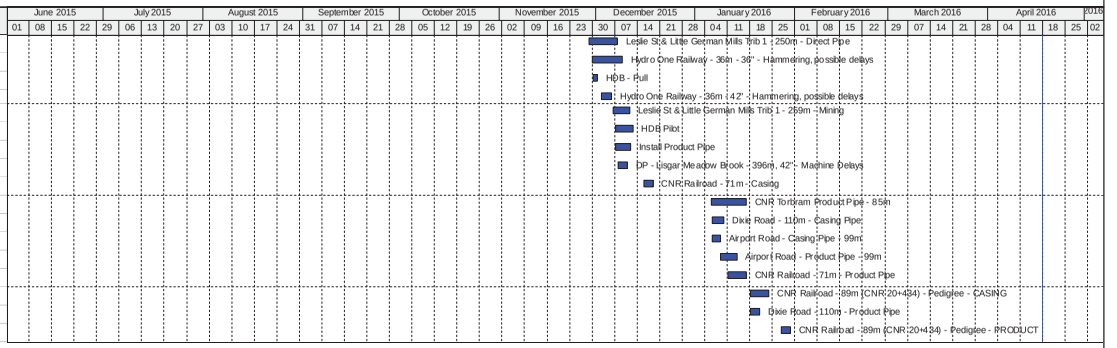


Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

TASK filter: Mike - TEMP Code.

Michels GTA Schedule - Track Bores

Activity ID	Activity Name	WBS Name	Actual Duration	Start	Finish
A13370	Leslie St & Little German Mills Trib 1 - 250m - Direct Pipe	Leslie St & Little German Mills Trib 1 - 250m (K	9d	29-Nov-15 A	07-Dec-15 A
A11240	Hydro One Railway - 36m - 36" - Hammering, possible delays	Hydro One Railway - 36" - 36m - KP 0.14	9d	30-Nov-15 A	09-Dec-15 A
A11215	HDB - Pull	Derry Road - 78m KP 0.61	2d	30-Nov-15 A	01-Dec-15 A
A11270	Hydro One Railway - 36m - 42" - Hammering, possible delays	Hydro One Railway - 42" - 36m - KP 0.14	3d	03-Dec-15 A	06-Dec-15 A
A13560	Leslie St & Little German Mills Trib 1 - 259m - Mining	Leslie St & Little German Mills Trib 1 - 250m (K	6d	06-Dec-15 A	11-Dec-15 A
A11447	HDB Pilot	Airport Road - 99m - KP 22.37	6d	07-Dec-15 A	12-Dec-15 A
A11511	Install Product Pipe	Etobicoke Creek - 104m KP 17.2	5d	07-Dec-15 A	12-Dec-15 A
A13505	DP - Lisgar Meadow Brook - 396m, 42" - Machine Delays	Lisgar Meadow Brook - 396m, 42" KP 3.09 - D	3d	08-Dec-15 A	11-Dec-15 A
A11417	CNR Railroad - 71m - Casing	CNR Railroad - 71m (CNR - Goreway KP 23.4	3d	16-Dec-15 A	19-Dec-15 A
A10905	CNR Torbram Product Pipe - 85m	CNR Torbram - 85m KP 20.64	11d	06-Jan-16 A	17-Jan-16 A
A11480	Dixie Road - 110m - Casing Pipe	Dixie Road - 110m KP 17.87	4d	06-Jan-16 A	10-Jan-16 A
A11448	Airport Road - Casing Pipe - 99m	Airport Road - 99m - KP 22.37	3d	06-Jan-16 A	09-Jan-16 A
A11450	Airport Road - Product Pipe - 99m	Airport Road - 99m - KP 22.37	5d	09-Jan-16 A	14-Jan-16 A
A11418	CNR Railroad - 71m - Product Pipe	CNR Railroad - 71m (CNR - Goreway KP 23.4	6d	11-Jan-16 A	17-Jan-16 A
A11394	CNR Railroad - 89m (CNR 20+434) - Pedigree - CASING	CNR Railroad - 89m (CNR - Airport KP 22.87)	6d	18-Jan-16 A	24-Jan-16 A
A11485	Dixie Road - 110m - Product Pipe	Dixie Road - 110m KP 17.87	3d	18-Jan-16 A	21-Jan-16 A
A11397	CNR Railroad - 89m (CNR 20+434) - Pedigree - PRODUCT	CNR Railroad - 89m (CNR - Airport KP 22.87)	3d	27-Jan-16 A	30-Jan-16 A

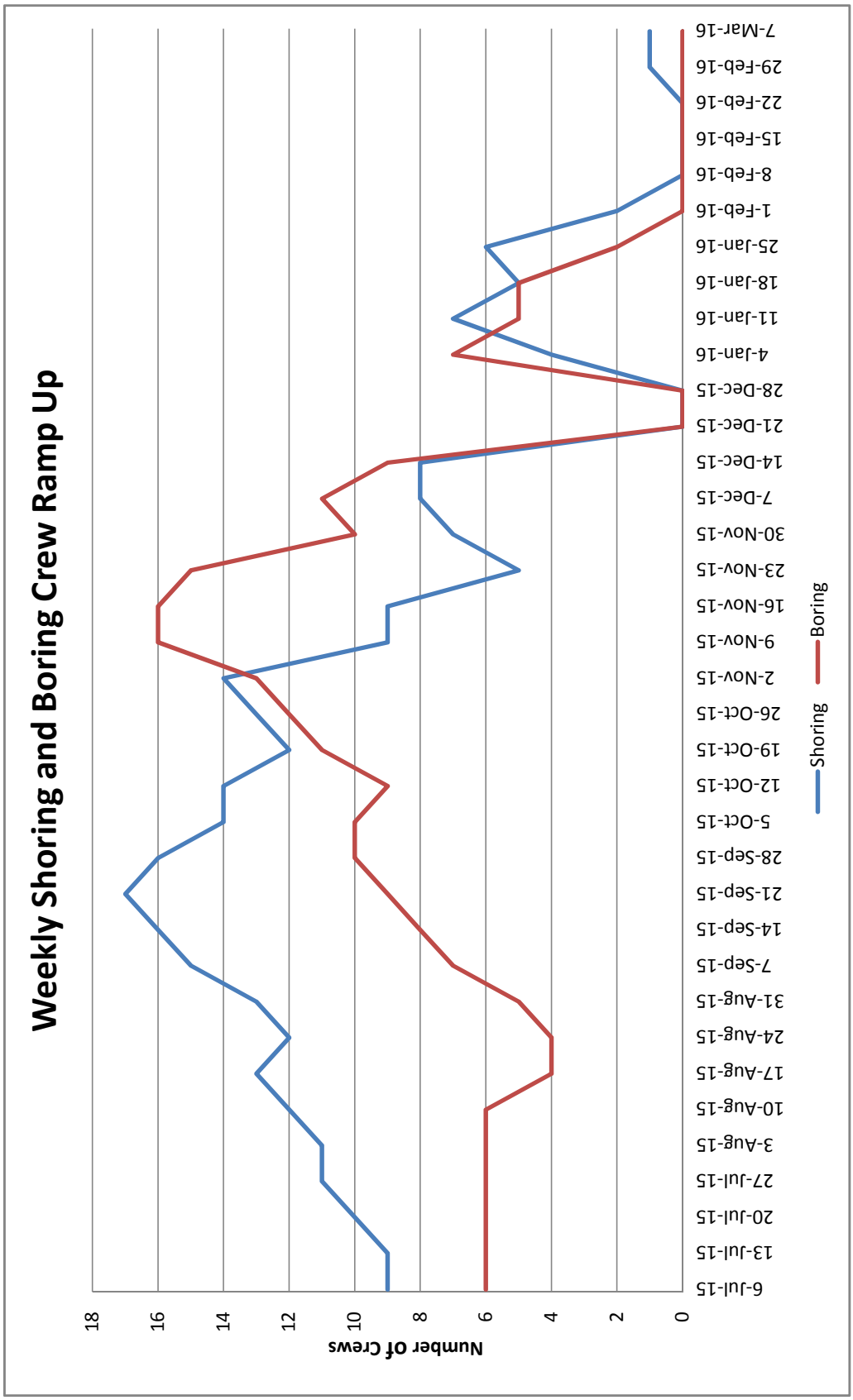


Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

TASK filter: Mike - TEMP Code.

APPENDIX I

Shoring and Boring Crew Ramp Up


Weekly Shoring and Boring Crew Ramp Up
Number Of Crews
0
2
4
6
8
10
12
14
16
18
6-Jul-15
13-Jul-15
20-Jul-15
27-Jul-15
3-Aug-15
10-Aug-15
17-Aug-15
24-Aug-15
31-Aug-15
7-Sep-15
14-Sep-15
21-Sep-15
28-Sep-15
5-Oct-15
12-Oct-15
19-Oct-15
26-Oct-15
2-Nov-15
9-Nov-15
16-Nov-15
23-Nov-15
30-Nov-15
7-Dec-15
14-Dec-15
21-Dec-15
28-Dec-15
4-Jan-16
11-Jan-16
18-Jan-16
25-Jan-16
1-Feb-16
8-Feb-16
15-Feb-16
22-Feb-16
29-Feb-16
7-Mar-16
Shoring
Boring

APPENDIX J

Construction Pictures

MAINLINE CONSTRUCTION

SHEPPARD CROSSOVER TIE-IN

COLLINGSBROOK BOULEVARD TRACK BORE

PINEMEADOW BOULEVARD TRACK BORE PIT

MCNICHOLL AVENUE TRACK BORE PIT

14th AVENUE TRACK BORE (TYPICAL BORE PIT SLOPING)

RODICK ROAD TRACK BORE (WEST SIDE)

RODICK ROAD TRACK BORE PIT (EAST SIDE)

BEAVER CREEK TRIB 2 (INSTALLING CONCRETE COATED PIPE)

MILLER PARKING LOT (EAST TRACK BORE PIT)

LESLIE STREET BORE PIT (EAST SIDE)

LESLIE TRACK BORE (SANDED AUGERS LED TO DIRECT PIPE METHOD)

LESLIE STREET DIRECT PIPE

GERMAN MILLS CREEK

LANGSTAFF ROAD EAST BORE

YONGE STREET (WEST BORE PIT)

DUFFERIN STREET BORE PIT (WEST SIDE)

CENTRE STREET (DEWATERING BORE PIT)

CENTRE STREET (BACKFILL AND COMPACTION AFTER PIPE INSTALLED)

GREAT GULF DRIVE EAST TRACK BORE

GREAT GULF DRIVE EAST (INSTALLING PNEUMATIC HAMMER TO BREAK BOULDER BLOCKING THE BORE)

CN/KEELE INSTALLED TRACK BORE

KEELE STREET TIE-IN (EXISTING PARKWAY NORTH STUB IN BACKGROUND)

ALBION OUTLET VALVE INSTALLATION (TYPICAL SLOPING)

NPS 36 CN TRACK BORE TO ALBION STATION (NORTH SIDE PIT WITH PIPE INSTALLED & SOUND CURTAIN)

NPS 36 CN BORE PIT (SOUTH SIDE WITHIN ALBION STATION PROPERTY)

CONSTRUCTION OF L-SHAPED NPS 42 CN TRACK BORE PIT (NORTH SIDE TO TIE IN OF FINCH-CLAIREVILLE HDD)

INSTALLATION OF SHEET PILE FOR NPS 42 CN TRACK BORE PIT (SOUTH SIDE WITHIN ALBION STATION PROPERTY

VIEW OF SHEET PILING IN ALBION STATION PROPERTY (REASON FOR DELAY IN STATION CONSTRUCTION)

MIMICO CREEK TRACK BORE

GOREWAY DRIVE (EAST BORE PIT)

CN/AIRPORT ROAD TRACK BORE PIT

CN/TORBRAM TRACK BORE

METROLINX 1 TRACK BORE

SPRING CREEK TEMPORARY BRIDGE INSTALLATION

INSTALLED PIPE AT SPRING CREEK (TEMPORARY BRIDGE ON LEFT)

ETOBICOKE CREEK TRACK BORE (EAST SIDE IN SOLID ROCK)

TOMKEN ROAD TRACK BORE (WEST SIDE IN ROCK)

KENNEDY ROAD TRACK BORE (WEST SIDE)

KENNEDY ROAD TRACK BORE (EAST SIDE)

HURONTARIO STREET TRACK BORE TIE IN (EAST SIDE)

HYDROVAC SEARCH TO LOCATE UNMARKED HONI CABLES AT FLETCHERS CREEK

FLETCHERS CREEK TRACK BORE (EAST SIDE)

MCCLAUGHLIN ROAD TRACK BORE (WEST SIDE)

WINSTON CHURCHILL BOULEVARD TRACK BORE (WEST SIDE)

10TH LINE TRACK BORE BEFORE PUMPING WATER (WEST SIDE)

ARGENTIA ROAD (NPS 42 PIPE CROSSING OVER PEEL WATER MAIN)

ARGENTIA ROAD (WATER MAIN RELOCATION TO ENABLE CASING EXTENSION)

LISGAR MEADOWBROOK EAST BORE PIT (UNSTOPPABLE SAND FLOWING INTO PIT LED TO DIRECT PIPE)

LISGAR MEADOWBROOK (BOILING SAND FLOWING THROUGH SHEET PILING)

LISGAR MEADOWBROOK DIRECT PIPE

9TH LINE TRACK BORE (EAST SIDE)

HIGHWAY 407 HORIZONTAL DIRECTIONAL BORE

HIGHWAY 407 SPECIAL ROCK TOOLS/REAMERS

CROSSING UNDER TCPL MAINLINE SOUTH OF DERRY ROAD

NPS 36 AND NPS 42 CP HONI RAIL CROSSING (EAST SIDE) AT PARKWAY WEST EXIT

HDD CONSTRUCTION

CREDIT RIVER DIRECT PIPE TUNNELING HEAD AND THRUSTER

CREDIT RIVER PIPE STRING

CREDIT RIVER DIRECT PIPE ENTRY (AERIAL VIEW)

CREDIT RIVER MUD SYSTEM

FINCH-CLAIREVILLE DRILL ENTRY (WITH ALBION STATION IN BACKGROUND)

FINCH-CLAIREVILLE HDD PULLBACK ATTEMPT

FINCH-CLAIREVILLE "TORPEDO" PULL HEAD (THIRD ATTEMPT)

BEAVER CREEK HDD RIG

HIGHWAY 401 DRILL ENTRY PAD (TYPICAL SET UP)

STEELES AVENUE HDD (HOLE OPENER/REAMER)

BAYVIEW AVENUE DAMAGED PIPE (FIRST PULLBACK)

POMONA DRILL (WITH SOUND BARRIER TO CEMETARY)

EAST DON RIVER INADVERTENT RETURN CONTAINMENT AND CLEAN UP (EAST OF CREEK)

EAST DON PIPE STRING SUSPENDED WITH CRANES DURING PULLBACK

BATHURST HDD - SUCCESSFUL PIPE PULLBACK

REAMER PACKED WITH CUTTINGS

BRAMALEA ROAD HDD – 54" SWAB BALL

HIGHWAY 410 HDD – 6" PLASTIC BUOYANCY PIPE INSTALLED FOR PULLBACK

MISSISSAUGA ROAD HDD – INSTALLING 60" CASING AT ENTRY

FACILITIES CONSTRUCTION

CONSTRUCTION OF INDIAN LINE TEMPORARY BRIDGE TO ALBION STATION

COMPLETED INDIAN LINE ROAD TEMPORARY BRIDGE

TRACK BORE TIE-IN OF OUTLET PIPING AT ALBION STATION

CONCRETE SLAB BUILDING FOUNDATION INSTALLATION AT ALBION STATION

VARIOUS SPOOL PIECES READY FOR WELDING AT ALBION STATION

REGULATOR RUNS AT ALBION STATION

HEAT EXCHANGER AND GLYCOL LOOP AT ALBION STATION

COMPLETED ALBION STATION

LARGE BORE FITTINGS READY FOR FABRICATION AT FAB SHOP

COMPLETED VALVE ASSEMBLY AT FAB SHOP

BOILER BUILDING CONSTRUCTION AT PARKWAY WEST

INSIDE BOILER BUILDING AT PARKWAY WEST

NPS 42 VALVE ASSEMBLY BEING LIFTED INTO PLACE (APPROX. 56 TONS) AT PARKWAY WEST

METER RUN INSTALLATION AT PARKWAY WEST

UNION GAS TIE-INS AT PARKWAY WEST

NPS 42 PIG LAUNCHER BEING LOWERED INTO PLACE AT PARKWAY WEST

COMPLETED PARKWAY WEST GATE STATION

HYDROTESTING

ONE OF TWO LAKE TANKS AT RODICK ROAD FOR SEGMENT B HYDROTESTING

TEST HEAD AT RODICK ROAD

DRYING PIG RECEIVER AT SHEPPARD AVENUE

TWIN LAKE TANKS AT KENNEDY ROAD FOR SEGMENT A HYDROTESTING

HOARDING TEST HEAD FOR WINTER HYDROTEST

SEDIMENT FILTRATION FOR DISCHARGE WATER AT KENNEDY ROAD TEST SITE

APPENDIX K

KPMG Assessment Report

Enbridge Gas Distribution

GTA Project Report

KPMG LLP

June 2017

Enbridge GTA Project Assessment Report - 23June2017

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Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

Contents

Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

Enbridge GTA Project Executive Summary

KPMG provided independent oversight of the GTA Project to Enbridge Gas Distribution ("EGD") management with respect to i) identifying gaps with leading project process, project management and governance practices, ii) monitoring project risks and iii) assessing prudency in the utilization of funds in carrying out the GTA Project.

In concluding our assessment, we have considered the performance of the EGD GTA Project team against Good Utility Practice, defined as the following:

> *Consideration of the practices, methods and acts engaged in or approved by a significant portion of the utility industry during the relevant time period, or any of the practices, methods or acts which, in the exercise of reasonable judgment in light of the facts known at the time a decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition.*

We have further considered "prudency" as follows[1]:

- Decisions made by the utility's management should generally be presumed to be prudent unless challenged on reasonable grounds.
- Decisions must have been reasonable under the circumstances that were known or ought to have been known to the utility at the time the decision was made.
- Hindsight should not be used in determining prudence, although consideration of the outcome of the decision may be used to overcome the presumption of prudence.
- Prudence must be determined in a retrospective factual inquiry, in that the evidence must be concerned with the time the decision was made and must be based on facts about the elements that could or did enter into the decision at the time.

EGD energized the GTA Project pipeline for in-service use in March 2016 with an installed cost of $850M. This represented a $182M increase in costs and a five month delay in completion date over the initial estimates submitted to the OEB. Nevertheless, in the course of our review, KPMG found that the GTA Project team made efforts to mitigate against cost and schedule increases and demonstrated prudency in the delivery of the project. The 27% cost increase is within AACE acceptable range of accuracy for a Class III estimate guideline.

Our report initially identified 14 Project Governance and Process improvement areas, all of which were successfully implemented or mitigated by Project completion.

We conducted a Commercial Contract Review on the 4 main construction contracts and found the process of contract procurement to be competitive and well documented. The

[1] Based on the Ontario Court of Appeal's decision in *Enbridge Gas Distribution Inc v Ontario Energy Board* (2006)

contract terms are relatively favorable to EGD and in-line with industry practice in terms of level of security and change management.

During construction activities (January 2015 to March 2016), we monitored Construction Cost Challenges and Schedule Performance. Based on our review and information provided, the GTA Project team demonstrated prudency in managing cost and schedule.

Our Operational Readiness review focused on the procedures and systems utilized for an effective transition of the assets from project to commercial operations. We have identified 4 opportunity areas for consideration on future projects to ensure a successful transition.

Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

Enbridge GTA Project Background

Enbridge Gas Distribution Inc. ("EGD") is a natural gas utility regulated by the Ontario Energy Board ("OEB") and is responsible for building and maintaining the infrastructure required to support the distribution of natural gas. In January 2014, EGD received approval from the OEB in the matter of an application by EGD to construct the GTA Project (EB-2012-0451) (the "GTA Project").

The GTA Project consists of the construction of two segments of a natural gas pipeline and associated facilities in and around the City of Toronto. The two segments include a 27 km pipeline running west of Toronto ("Segment A") and a 23 km pipeline running east of Toronto ("Segment B"). The GTA Project will allow for continued system reliability and increased supply diversity through access to gas supplies from the U.S. Northeast. It will also allow greater system capacity to enable EGD to prepare for future natural gas needs within the Greater Toronto Area ("GTA") now and in the long term. The initial cost estimate presented to the OEB was $686.5M for the GTA Project.

At the end of October 2014, following the completion of the initial cost estimate and the signing of the main commercial contracts, but prior to the start of project execution, EGD retained KPMG to provide independent oversight of the GTA Project to EGD management with respect to i) identifying gaps with leading project process, project management and governance practices, ii) monitoring project risks and iii) assessing prudency in the utilization of funds in carrying out the GTA Project. Specifically, the following services were provided by KPMG to EGD:

1. Review of *Project Governance and Process*
2. Review of *Contracting Process and Key Commercial Contracts*
3. Monthly review of *Construction Cost Challenges and Schedule Performance*
4. Assessment of *Operational Readiness* procedures and controls

Upon completion of the GTA Project, KPMG has prepared this report to summarize our key findings and recommendations, and our assessment of the prudency demonstrated by EGD, in delivering the GTA Project based on our review under each of the four service areas listed above.

KPMG

Enbridge Gas Distribution
GTA Project Report
June 2017
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1 Project Governance and Process

1.1 Approach

KPMG conducted a Project Governance and Process framework assessment that included a baseline review of the existing GTA Project governance processes, project controls and project management tools in order to analyze the GTA Project with KPMG's understanding of Leading Project Management Practices.

Our review utilized a KPMG Global methodology that aligns with industry-accepted Project Management Institute ("PMI") guidelines and allows for the collection of industry benchmarks. Our review focused on 13 project management elements, grouped under five Project Control Categories ("PCC"), as follows:

Project Strategy, Organization & Administration	1. Integration Management 2. Reporting & Stakeholder Management 3. Human Resources & Labour Relations	Process, Quality & Risk Management	8. Scope Management 9. Risk Management 10. Regulatory & Environmental Management 11. Quality Management 12. Information Management
Cost & Financial Management	4. Estimating & Cost Management 5. Financial Management 6. Asset Management		
Schedule Management	7. Development, Progress, Change & Integration	Procurement Management	13. Planning, Contracting, Administration & Claims

The existing project control and governance environment for the GTA Project was assessed for maturity under the above 13 PCC sub-categories and ranked in the following categories:

Informal – Not fully developed, little or no documentation or formalized procedure exists.

Standardized – Developed, appears adequately documented and appears to function appropriately but below Leading Practices.

Monitored – Developed, adequately documented for standardized use across the organization and appears to function effectively compared to Leading Practices.

Optimized – Developed, adequately documented for standardized use across the organization and appears to be a Leading Practice.

For a project of this size and duration, using generally standard construction methodologies and materials, and within a regulated utility that requires additional scrutiny and control over costs and revenues, KPMG's experience recommends a minimum PCC maturity of 'Standardized' for each element, with leading organizations consistently achieving 'Monitored' maturity, and select PCC's achieving 'Optimized'.

Following our initial assessment in December 2014, KPMG continued to monitor and report on EGD's progress in implementing the initial governance and process recommendations during project execution. KPMG also assisted EGD with the rollout, adjustment and refinement of such recommendations, as appropriate in the context of the GTA Project.

1.2 Assessment

KPMG's review provided the basis to identify existing gaps and to proceed with governance and process recommendations through the remaining duration of the GTA Project. Opportunities for improvement were identified based on monitoring tools, governance systems and other project management functions, and mitigation of project risks.

KPMG's assessment included: 1) the review of 45 documents provided by the GTA Project team identified as key governance and process documentation; 2) interview of six key GTA Project team personnel.

Based on the steps noted above, our overall assessment of the GTA Project's governance, process and project management was as follows:

- All five assessed PCCs had developed processes and procedures that met a minimum 'Standardized' maturity or greater;
- Six of the 13 PCC sub-categories were assessed at a 'Monitored' maturity, representing a level that is effectively comparable with Leading Practices; and
- 14 improvement areas identified across four PCCs.

KPMG recommended an improvement plan for each area that was accepted and actioned by EGD. All of the improvement areas were ultimately implemented or mitigated within the project lifecycle, with the majority accomplished within the first four months of the project. The areas of improvement are summarized in the table below.

PCC	Description	Target Date	Implemented Date	Status
Project Strategy, Organization & Administration	Detailed Role Clarification	January 2015	January 2015	☑ Implemented
	November 2014 Project Management Plan included a Roles & Responsibilities summary; Meetings were then held in January 2015 to clarify roles & responsibilities and job specific responsibility documents prepared and issued to team members for added clarity; Project controls provided training on scope, role and budget ownership			
	Clear Reporting Lines & Approvals	February 2015	February 2015	☑ Implemented
	Delegation of Authority document completed and signed by Enbridge VP to include revisions to approval lines for all documents and decision making processes; clarification of authority sent to contractors			
	Resource Needs Assessment	April 2015	April 2015	☑ Implemented
	Additional resource needs were identified through the organizational chart to ensure the necessary critical path resources were obtained and trained in a timely manner to advance various phases of the GTA Project; A comparison of the July 2014 to the January 2015 organizational charts evidenced the progress made in filling roles			
	Team Building	January 2015	January 2015	☑ Implemented
	Conducted staff workshops and team building exercises to establish relationships and facilitate communication and information sharing across functions and between employees and contractors			

Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

	Delegation of Approval & Authority	February 2015	February 2015	☑ Implemented
	Allocated approval and authority of budget items and delegated responsibilities to appropriate owners to ensure they are part of the planning process to develop early buy-in and accountability			
Cost & Financial Management	Contractor Cost Overruns	March 2015	July 2015	☑ Implemented
	Key Performance Indicators ("KPI") defined at outset in January 2015 to evaluate project performance against incurred cost; however, contractor overruns and understated cost forecasting continued; Refined metrics and enhanced procedures by July 2015 to address the challenges the project was experiencing (i.e. permits, crossings)			
	Cost Allocations	April 2015	April 2015	☑ Implemented
	Developed allocation methodology for transmission and distribution assets; Reviewed overhead cost allocation (vs. direct billing) to ensure costs are properly assigned; allocation not required until in-service			
	Variance Analysis Baseline	March 2015	July 2015	☑ Implemented
	EGD had been performing variance analysis since January 2015, but in July 2015 expanded root cause analysis for variance explanations; Re-forecast estimates based on available information for purposes of variance analysis, using original budget, project control baseline, and monthly forecasts			
	Financial Systems	February 2015	February 2015	☑ Mitigated
	Refrained from any system implementations mid-project; including the new TeamWork to ECOSYS			
Project Process, Quality & Risk Management	Project Experience	February 2015	February 2015	☑ Mitigated
	Developed relevant urban project experience and standards using external or contracted industry experts for guidance and to conduct lessons learned session			
	Quality Monitoring Resources	February 2015	February 2015	☑ Mitigated
	Quality monitoring of materials should have resided directly under quality management, but instead resided with procurement function; at time of review material purchases had been largely completed			
Schedule Management	Detailed Baseline Schedule	February 2015	August 2015	☑ Mitigated
	Mitigated the lack of a detailed resource loaded schedule with an activity breakdown to monitor progress; Assessed against current schedule and used as the baseline to monitor progress performance			
	Materials Delivery	April 2015	April 2015	☑ Mitigated
	Established material management process with key pipeline and facilities suppliers to ensure regular updates and inspections are conducted to manage timing of deliveries and impact			
	Permitting	March 2015	August 2015	☑ Mitigated
	Permit management process developed in 2014 to link permit requirements to the schedule and monitor against construction progress, however assumptions around urban permitting timelines may have been optimistic as EGD did not have all winter construction permits in place prior to the planned January 2015 construction start; Accordingly EGD developed a process for detailed management of permits identified as critical path and micro-managed the early HDD permits; Even with these efforts, the final major permit was not received until August 2015			

Following the delivery of our recommendations in December 2014, throughout the course of the GTA Project, KPMG continued to assess the maturity level of each of the above PCCs specific to the GTA Project. Based on the progress made in implementing our recommended improvement areas as well as our assessment of the current status and progress of the construction activities, as of August 2015, ***all 14 of the improvement opportunities had been successfully implemented or mitigated***.

Priority Category	Recommendations	Closed
#1 Project Strategy, Organization & Administration	5	5
#2 Cost and Financial Management	4	4
#3 Project Process, Quality & Risk Management	2	2
#4 Schedule Management	3	3

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Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

2 Contracting Process and Key Commercial Contract Review

2.1 Approach

KPMG carried out a commercial risk review to assess the commercial terms found in key contracts. We concluded that these commercial terms were relatively favorable to EGD and in-line with industry practice in terms of specifying the appropriate levels of security.

The four main construction contracts for EGD's GTA Project, as identified by the GTA Project team, are as follows:

1. Michels Canada Co. re Mainline – Contract No. C#2-200574 dated December 3, 2014
   - Installation of the mainline pipeline including facility tie-ins and provide Horizontal directional drilling (HDD) support.
2. Michels Canada Co. re HDD – Contract No. C#003-102601 dated November 3, 2014
   - HDD services to be provided and crossings for pipeline systems at seven individual locations to be installed.
3. Mears Canada Corp. re HDD – Contract No. C003-102600 dated November 13, 2014
   - HDD services to be provided and crossings for pipeline systems at seven individual locations to be installed.
4. Aecon Utilities Inc., a division of Aecon Construction Group – CO No. 20150129-CO-AU-66-RO dated February 10, 2015
   - Facilities projects that will connect the pipelines to the EGD gas distribution system.

Key risk areas were categorized as either Category A or B in accordance with explanations provided in the table below. The Category B rating was used when it was deemed that there was uncertainty in the particular risk area or further information or clarification was potentially thought to be needed.

Category	Definition
A	From our analysis of the information reviewed it appears that the risk has been allocated to an appropriate party; and is being managed according to what is regarded as Leading Practice.
B	Although the risk appears to be appropriately managed according to the principles in Category A; there appears to be some uncertainty in the contract documents that requires further clarification before a Category A rating can be achieved.

Each key contract was assessed and categorized as Category A or B for the following risk areas:

- Liability cap / liquidated damages;
- Indemnity;

- Performance securities and guarantees;
- Contract suspension/ termination;
- Dispute resolution;
- Changes;
- Milestones and key dates;
- Payment mechanism and penalties/ incentives; and
- Delays.

Comments and mitigation strategies were provided for each risk area and referenced the schedule or section of each key contract.

2.2 Assessment

At the time that KPMG's engagement commenced in late October 2014, the main commercial contracts had either been finalized or were in the process of being finalized. Accordingly, our assessment focused on a review of the contracting process that EGD had undertaken in selecting and entering into the contracts as well as on a review of the commercial terms and risks of the contracts that had been signed.

KPMG found evidence that there was a robust contract assessment and approval process followed for each of the main commercial contracts. EGD created Contract Development Plans ("CDP") for each of the Mainline, HDD and Facilities contracts. The plans included detailed documentation of the contract requirements, terms, milestone dates, budget and contracting strategy.

In the process leading to vendor selection, multiple bidders were assessed and considered for contract award on the basis of technical and commercial bid considerations.

In awarding the contract, EGD followed a Contract Award Recommendation ("CAR") review and approval process. The CAR documents the results of the bid assessment and the rationale for selecting the winning proponent based on the EGD technical scorecard and commercial evaluation scorecard.

With respect to the mainline contract, which was initially estimated at $215M in the Contract Development Plan, the final contract awarded to Michels at $320M represented a significant increase of $105M to the original cost estimate. However, in reviewing the multiple bids received, EGD demonstrated cost prudency in selecting Michels as the lowest bid and a high technical evaluation score. EGD were also able to negotiate a further reduced contract price from Michels following subsequent rounds of clarification meetings with Michels on the scope of work and a detailed assessment and scrutiny of Michels estimate. Further, EGD made certain commercial contracting decisions to reduce the overall GTA Project cost. For example, EGD decided to assume the cost risk by paying for work

stoppages relating to weather and environmental delays. This allowed EGD to manage the risk and associated costs, as opposed to passing that risk on to the contractor and in turn potentially paying a higher contract price for the risk premium.

The result of the mainline contracting process are summarized as follows:

	[redacted]	[redacted]	[redacted]
Initial Bid	[redacted]	[redacted]	[redacted]
Revised Bid	[redacted]	[redacted]	[redacted]
Technical Score	[redacted]	[redacted]	[redacted]

Following our assessment of the contracting process, KPMG reviewed the commercial terms of the contracts ultimately entered into, and provided EGD with a list of recommendations and opportunities to strengthen certain conditions in the contracts. The existing contracts were not amended to incorporate the recommendations as the contracts were already signed at the time of KPMG's review. These recommendations were assessed by KPMG as not expected to have a material impact on the existing GTA Project contracts. Instead, these recommendations were accepted as opportunities to strengthen future contracts.

The contracts EGD drafted are generally strong from a commercial perspective and our assessment did not identify significant gaps or flaws in the contract documents. When assessing the opportunities identified, we took into account the prevailing local construction market conditions, the specific contracting strategy in place, payment mechanisms and the risk profile of the scope of work being executed by the contractors. In addition, the benefit of the various opportunities (i.e. additional security and risk transfer) should be balanced against the fact that a contractor may factor in a risk premium that could potentially increase the overall contract price.

Overall, the KPMG team found that the *contract process was fair and robust* based on the CDP and CAR process. The *commercial terms were also relatively favorable to EGD and in-line with industry practice* based on the key risk areas assessed for each contract, including specifying the appropriate levels of security (i.e. 50% performance bond) to increase the likelihood of successfully replacing a contractor in default. In addition, there was a reasonable contractual framework in place for requiring contractors to provide the necessary information transparency (i.e. employees, rates, classifications, etc.) in the event of a change to minimize the risk of over-payment.

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Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

3 Construction Cost Challenges and Schedule Performance

3.1 Approach

KPMG provided monthly project management cost and schedule monitoring services. This involved reporting on the progress of the project against the initial capital expenditure and construction timeline estimates, summarizing the work progress and performance achieved each month, and identifying or validating key financial, technical and/or strategic risks to the project. Findings were developed through monthly interviews with members of the GTA Project team, independent reviews of monthly project reports (including contractor and EGD progress reports, and EGD internal management presentations), and periodic site visits.

Our monthly assessments considered:

- Construction schedule and budget updates;
- Construction progress assessment; and
- Governance and Process implementation update.

Each monthly review was designed to provide an update and inform EGD management of project developments, costs, and delays. The monthly review also provided our independent assessment of the key risk impacting the GTA Project and the actions taken by the GTA Project team.

3.2 Assessment

Based on our review of the project status as at October 2016, the following summarizes the identified cost and schedule variances against the initial estimate:

3.2.1 COST ANALYSIS – Initial $667M compared to Current $850M (excluding Ashtonbee and Buttonville which are out of scope for this report)

The total GTA Project cost was initially forecasted and filed with the OEB at $686.5M. This forecast included $19M for Buttonville and Ashtonbee, which are out of scope for this report, resulting in an adjusted control budget of $667M. Over the course of the project, actual costs increased by $182M, or 27%, driven largely by the following three factors:

- Market conditions resulting in higher contractor costs;
- Additions to scope to address technical requirements, including shoring; and
- Productivity delays due to underestimated effort required for certain activities in an urban environment, caused by EGD's delay in attaining third party permit approvals, and the execution of track bores (which were partially mitigated by the lump sum contract).

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Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

These cost increases can be summarized over time in the tables that follow:

Forecast-At-Complete (FAC) (excluding Buttonville and Ashtonbee scope)					
[all figures in CAD millions]	Oct. 2013	Feb. 2015	Oct. 2015	Feb. 2016	Oct. 2016
Subtotal	578.4	723.5	872.4	872.3	849.6
Contingency	89.0	18.8	25.3	15.6	$0.00
TOTAL	**667.4**	**742.3**	**897.7**	**887.9**	**849.6**

Timeline *[all figures in CAD millions]*	FAC	Change	Root Cause	Management Action
Initial Estimate Oct. 2013	**667.4**	-	Initial OEB estimate submission	
Feb. 2015	**742.3**	**+74.9**	Market conditions resulting in **higher mainline bids** than Class III estimate and engineering overage, partially offset by contingency draw and reduced land cost forecast	EGD negotiated the bids down by providing additional information; Prioritized HDD permits that were on critical path
July 2015	**802.0**	**+59.7**	Contractor underestimation of **crossing durations** (average 7 day estimate vs 40+ days actual)	EGD worked with Michels to break down high level schedules into detailed activity based schedule to understand logic, and track and optimize crews
Aug. 2015	**847.0**	**+45.0**	**Shoring** cost underestimated in Class III, delayed permits and permit changes resulting in constructability challenges, unanticipated changes and increased complexity to track bores	Re-estimate quantities for all Unit Price Items (UPI) (mainly boring, shoring and dewatering); work with Michels to bring in additional shoring and track bore crews and added night shifts
Oct. 2015	**897.7**	**+50.7**	Early **productivity delays** during the winter and spring construction that weren't visible to address until the summer months	Bottom up estimate with provision for Michels' request for additional funding, Aecon's schedule extension, IDC and indirects
Feb. 2016	**887.9**	**-9.8**	Re-estimate of UPI costs	Reduction of UPI FAC by $10.0M
Oct. 2016	**849.6**	**-38.3**	Mainline cost less than forecast; Less project management costs; Removal of remaining contingency	No management action required

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Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

At the time of filing the initial estimate with the OEB, the level of maturity of the estimate was categorized by EGD as a Class III estimate, reflecting a level of maturity of project definition of between 10% and 40%. As per AACE International Recommended Practice No. 18R-97, "Cost Estimate Classification System", a Class III estimate has an expected accuracy range of -10% to +30%. Accordingly, the 27% variance experienced on the GTA Project is within the acceptable accuracy range of the AACE guideline. The cost variance can be further broken down by the major tasks undertaken for the GTA Project, as follows:

Major Task *[all figures in CAD millions]*	Oct 2013 Est.	Oct 2016 Est.	Change	Variance Explanation
Management	57.1	54.5	-2.6	• Effective management of overheads
Engineering	19.1	36.4	+17.3	• Engineering rework based on subsurface utility engineering and requests from permitting agencies
Procurement	63.9	77.4	+13.5	• Pipe quantities ordered higher than estimate • USD currency exchange from time of estimate to purchase • Storage costs not included in estimate
Land / ROW	85.0	72.0	-12.0	• Lower land acquisition costs than forecasted
Construction – pipe	288.2	480.1	+191.9	• Higher than estimated initial bid • Construction challenges including shoring • Permit delays including additional payment to Michels • Change orders • Weather delays
Construction – facilities	19.3	44.5	+25.2	• Higher than estimated initial bid • Permit delays • Change orders • Trackbore at Albion and extension at Parkway
Construction support	24.7	55.8	+31.1	• Increased support service indirects, inspection and surveying costs to support construction challenges and schedule delays • Higher hydro testing costs
Commissioning	1.2	2.8	+1.6	• Immaterial increase, in-line with initial estimate
Interest During Construction	19.8	25.0	+5.2	• Interest calculated based on CWIP (rate of 4.92% in 2016) • Schedule delays and cost increase resulted in a higher CWIP balance for the project
Contingency	89.0	0.0	-89.0	• Contingency used at project completion
Total Project Execution Costs	667.4	849.6	+182.2	

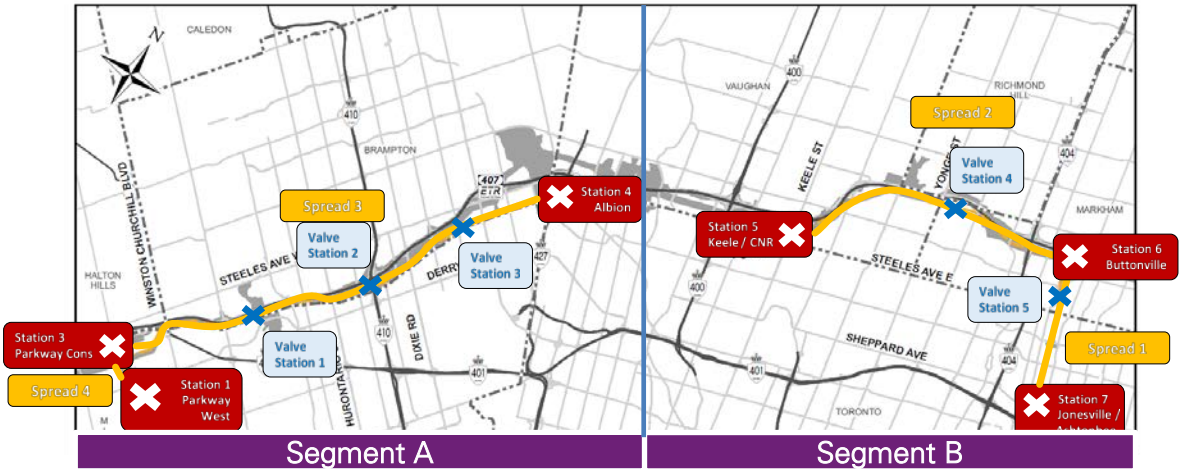
Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

As illustrated in the above tables, the $182M cost overrun was driven by the higher material costs and underestimating the effort related to construction activities for pipe (~$190M) and facilities (~$25M) as well as construction support activities through the extended schedule (~$30M). These increases were partially offset against the contingency. EGD was also able to keep overhead, administrative and pre-construction costs such as management, procurement and Land / Right-of-Way generally in-line or lower than the initial estimate.

3.2.2 SCHEDULE ANALYSIS – Initial November 2015 compared to March 2016

The in-service date was delayed five months from the initial estimate, increasing the overall construction duration from 10 to 15 months, primarily due to permit delays as agencies took longer than expected to approve and imposed stricter requirements. The actual completion dates for the major project milestones, compared to the baseline estimate dates, are summarized as follows:

GTA Project Map



	Initial Estimate	Actual Energization	Variance (Days)
	(a)	(c)	(c) - (a)
Spread 1	01-Nov-15	30-Mar-16	+150
Spread 2		31-Mar-16	+151
Spread 3		22-Mar-16	+142
Spread 4		01-Mar-16	+121
Parkway West Station		28-Mar-16	+148
Albion Station		23-Mar-16	+143

The 5 month schedule delay was primarily on Segment A mechanical completion, with delays at Spread 3 and the Albion and Parkway stations. These delays can generally be attributable to constructability challenges resulting in additional scope to address technical

requirements and productivity delays, due to underestimated effort for certain activities in an urban environment, including attaining permit approvals and the execution of track bores.

3.2.3 PERFORMANCE ASSESSMENT

KPMG assessed the general project performance during reoccurring EGD-guided site tours of the GTA Project. Four tours were conducted over the duration of GTA Project construction at the following points in time: August 2015, November 2015, February 2016 and March 2016.

KPMG used these guided site tours to ensure the overall accuracy of the monthly reports and operational documents that EGD had provided for the reporting of cost and schedule variances.

During the tours, KPMG observed that the project site was well coordinated with safety signoffs and "Job Assessment Risk Reviews" followed at every work location. Discussions with the site personnel detailed their crew's "plan of the day" and confirmed they were well versed in the quality and safety procedures for their operation. These operations generally displayed good "housekeeping" practices, and presented staging areas that were clear of obstructions and well maintained. These tours also witnessed continual challenges with geotechnical and underground obstructions.

The individual details of these site tours are summarized as follows:

August 31, 2015: Weather 23.5 °C, Clear
Peter Simpson (KPMG), Geoff Hayes (KPMG), Brian Wikant (EGD)
Picture: Finch and Claireville HDD entry (Albion inlet / outlet CN crossing)

August Tour Progress & Observations:

- Track bore progress, project wide, behind schedule
- Bayview HDD Operation on Spread 2 progressing well
- 410 & Bramalea HDD Operations on Spread 3
- Keele Station operations wrapping up while Albion Station was just initiating

November 6, 2015: Weather 13.5 °C, Light Rain
Peter Simpson (KPMG), Brian Wikant (EGD)
Picture: Leslie bore (South of Hwy 407 and east of Leslie St)

November Tour Progress & Observations:

- Spread 1 Hydrotesting complete, drying proceeding
- Leslie St. Challenges: staging area foreman expressed concern about delays caused by pilot tube augers locking up due to silty sand during track bore operation (40m in). Direct Pipe will be required
- Lisgar-Meadowbrook Crossing Challenges: Flowing sand resulting in Direct Pipe installation requirement

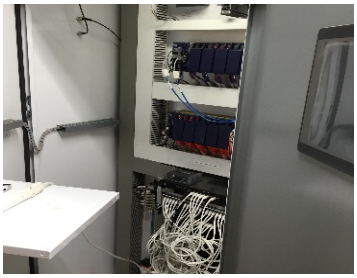
Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

February 17, 2016: Weather -6.0 °C, light snow cover
Peter Simpson (KPMG), Brian Wikant (EGD)
Picture: Heating and hording operations, NW of Albion Station (west of 427 & north of Indian Line road)

February Tour Progress & Observations:

- Riviera Drive at the location of the Segment B re-test section
- Tie-ins are completed and post-drying has finished
- Hydrotesting for Spread 4, and the east and west sections of Spread 3 were completed in the month

March 31, 2016: Weather 12.0 °C, Heavy Rain
Peter Simpson (KPMG), Augusto Patmore (KPMG), Brian Wikant (EGD)
Picture: Parkway West Electrical/telemetry construction



March Tour Progress & Observations:

- All facilities are commissioned and energized
- Segment B was re-energized 31-Mar-16
- Parkway West Electrical and telemetry construction completed to enable remote operability

Construction Challenges

Construction challenges were noted in various locations along the mainline build. Based on EGD calculations, these construction challenges have been estimated to account for $56M in cost overruns to the project (included in the "Construction – pipe" cost overrun identified above). In many cases, these challenges were the result of unexpected ground conditions that would not have been anticipated as limited geotechnical work had been done at the time of the estimate preparation.

The most significant construction challenge related to $30M in additional shoring costs. The average depth of coverage per crossing in the initial estimate was slightly greater than 2 meters deep; however, the actual crossing depth exceeded 5 meters on average. Further, 96% of the bore pits ultimately ended up requiring shoring, resulting in actual total costs for Unit Price Items ("UPI") of $120M compared to the estimate of $89M.

Based on KPMG's review of the challenges experienced during construction, cost overruns appear to be generally attributable to unforeseen geological conditions or an underestimation in the initial estimate for Unit Price Items (i.e. actual cost and effort of shoring and track bores). In resolving the construction challenges, EGD appeared to demonstrate prudency as indicated through their Decision Records which detail the major GTA Project challenges at East & West Don, Lisgar Meadowbrook, Torbram Road and Leslie Street. These Decision Records included relevant information to support a prudent decision-making process, including details regarding the particular issues, multiple potential options to mitigate cost and project impacts, and the recommended course of action selected by EGD with the overall justification and rationale to support the decision.

Permit Delays

At the outset of the GTA Project, the EGD team defined a detailed permit tracking process and implemented a permit tracker to monitor permits received by agency, identify challenges in obtaining permits, and ensure receipt or management of permits in advance of critical path.

The GTA Project team identified 236 permits required for the GTA Project, of which 97 were affected by approval delays. Based on EGD calculations, these permit delays have been summarized to account for $41M in cost overruns to the project ($38M included in the "Construction – pipe" cost overrun identified above, and $3M included in the "Construction – facilities" cost overrun). These permit delays drove additional costs primarily as a result of schedule extensions or the scheduling of additional shifts to accelerate productivity.

The most significant cost overrun component of the permit delays was related to the Michels mainline contract, discussed in the following section.

Michels Mainline Contract Productivity Delays

In April 2015, Michels submitted a request for additional compensation for the acceleration of work on Spreads 2, 3 and 4 resulting from alleged delays in EGD's procurement of permits and access/egress agreements in the amount of $81.5M. Ultimately the matter was settled in the amount of $30M.

EGD reviewed the components of the Michels' $81.5M additional compensation request and internally determined the quantum of this impact to be [redacted] as summarized below:

Request Item	Description	Impact Analysis
Extended Indirects and General Support	Additional indirect labour costs for project management, environment, safety, accounting, general administration, security, traffic control, etc. due to schedule extension. This also included additional fixed overhead costs such as construction yard and office rent.	[redacted]
Shoring	Impacts of schedule compression on installation efficiency, including the requirement for more shoring material to accommodate simultaneous construction at a greater number of locations. Depleted material from local suppliers required sourcing from jurisdictions across the U.S. and Canada.	[redacted]
Idled Equipment	Costs for mobilized equipment that was unable to be utilized due to lack of permitted access and crossings in winter/spring 2015.	[redacted]

Additional Personnel & Equipment	Condensed summer crossing work on spreads 2 & 3 carried forward from the winter delays resulted in changes to the planned work sequence which required more crews/equipment and led to right-of-way congestion and loss of efficiency. Shifting work into fall and early winter also negatively impacted efficiency due to poor weather conditions and reduced daylight work hours.	[redacted]
Productivity & Efficiency	Mainline (ie. stringing, bending, welding, coating, lowering in) impacts associated with disruption of work flow, move backs, and congestion due to overlap with crossing crews. Also includes time spent helping EGD respond to agency information requests required for permitting.	[redacted]
Delay into following season	Extension of full crew into 2016 for remaining spread 2 & 3 work, additional mobilization/demobilization costs over Christmas 2015, and higher union rates from May 2016 onwards.	[redacted]
Total		[redacted]

After a review of the impact analysis completed by EGD it is concluded that the settlement of $30M was deemed a fair and reasonable conclusion to the Michels' request as it represents a negotiated 60% reduction to the original claim request by Michels and a [redacted] reduction against EGD's own impact analysis.

Project Risk Register

The GTA Project was developed with a robust risk register that ultimately included 358 unique risks identified over the course of the project, each of which were monitored, tracked and mitigated throughout the project. The following table provides examples of some significant project risks that were identified by the GTA Project team, as well as the response strategy that was implemented to address the risk.

ID	Description	Response Strategy
325	Schedule and cost impact due to 42" pipe reorder.	• Proposed doing the 36" track bores first (spreads 1, 2 and 4); additionally 1 km of 42" HDD pipe is available for some of the 42" pipe bores (spread 3).
339	EGD's decision to change scope and require double isolation for each of the 11 tie-in locations.	• Determine a prioritized schedule so that the critical items to make the line operational are completed first.

106	Unsatisfactory vendor data quality and delays in submission by vendors.	• Vendor data requirements will be clearly communicated through the Vendor Data Requirements Table included in the MR. • PM will ensure quality reviews of MRs to mitigate any potential errors/omissions. • Purchase Orders will clearly delineate deliverables associated with vendor drawings. • Expediting meetings will be held with vendors and the engineering consultant as required. • Expediting with Stantec to finalize documentation with vendors.
203	Difficulty in obtaining Metrolinx permits.	• Pull forward crossing drawings for permits. • Two permit packages submitted, have received feedback. Communication lines are open which should mitigate portion of this risk. • Lessons Learned from Metrolinx 1 and 2 have been incorporated into Metrolinx 3, to reduce changes. • Pomona drill rescheduled. • Permits submitted, Metrolinx 2 has been approved by AECOM (Metrolinx's agent) waiting for documentation from Metrolinx. • Metrolinx 1 resubmitted due to Hydro 1 change.
262	Schedule delays due to PAN AM games	• Sept 24 meeting with municipal coordinator to begin logistics discussions. Continue to plan and coordinate the construction schedule. • Transportation of goods and materials off peak hours. 407 Permit to move pipe will incorporate times that we are not allowed due to the Pan Am activities. Work with individual municipalities. • Internal session to go over maps received from PAN AM by municipality, determine our questions and concerns, create requests if needed for future meeting. • Meeting supplied schedule and routes. Large loads will be delivered off-hours. Contractors are aware. Waiting for timing.
343	Mainline Schedule and productivity risk	• Adding track bore crews.

Performance Benchmarking

KPMG benchmarked the GTA Project performance against the following four recently completed pipeline projects with respect to cost incurred per kilometer of pipeline, cost incurred per month of construction activities and pipeline progress per month.

Project	Cost ($M) / km pipeline	Cost ($M) / month	Km pipeline / month
Spectra Energy New Jersey – New York Expansion *$1,650M | 33 km | 30 inch | 17 months*	50.00	97.06	1.94
TransCanada King's North Connection *$310M | 11 km | 36 inch | 12 months*	28.18	25.83	0.92
Union Gas Brantford – Kirkwall *$116M | 14 km | 48 inch | 6 months*	8.29	19.33	2.33
ATCO Northeast Calgary Connector *$78M | 16.7 km | 24 inch | 5 months*	4.67	15.60	3.34
Average	22.79	39.46	2.13
Enbridge GTA Project – Total *$848M | 50 km | 36/42 inch | 15 months* GTA Project – excl. Facility Construction *$803M | 50 km | 36/42 inch | 15 months*	 16.96 26% < avg. 16.06 30% < avg.	 56.53 43% > avg. 53.53 36% > avg.	 3.33 56% > avg. 3.33 56% > avg.

In benchmarking the GTA Project, it is important to note that there can be variations between the projects used for comparison. While these benchmarks were selected as all can generally be categorized as "urban" projects, each project may be impacted by unique project-specific circumstances, including the geography, pipe size, local regulations, facilities, and other overhead and planning charges, etc. Further, final cost figures have not been disclosed for TransCanada and ATCO projects. The figures above are current estimates for those projects.

Similar to the various construction challenges, delays and risks noted above that were experienced on the GTA Project, our benchmark projects also experienced delays and cost overruns due to a number of circumstances, including weather and permitting. For example,

Spectra Energy's New York – New Jersey Expansion[2] was delayed by six months on the outset of the project, and although the schedule was caught up and completed on time, it was done so at a 40% cost overrun due to increased labour to accelerate the schedule. TransCanada's King's North Connection[3] project was placed in to service in December 2016 for $310M, representing a delay of four months and a cost overrun of $90M primarily associated with some issues on their horizontal drilling alignment and depth, and historical environmental contamination that required clean-up. ATCO's Northeast Calgary Connector[4] project also experienced a cost increase from the initial $44M estimate to an adjusted $78M cost, substantially as a result of increased contractor construction costs from the time the initial competitive bid information was provided for the cost estimate to the actual start of construction.

In benchmarking the performance of the EGD GTA Project, on a cost per kilometer of pipeline the GTA Project is relatively favourable with the benchmark average, particularly when removing the costs related to the facilities.

While the cost per month was significantly higher than the benchmark average, this is tied to the kilometers per month also being significantly higher than the benchmark average, indicating that EGD was effective in being able to construct the GTA Project at a faster rate than the benchmark comparative projects.

Assessment Conclusion

EGD energized the GTA Project in March 2016 at a cost of $848M, representing a $181M cost overrun and five months delay over the initial estimate submitted to the OEB. Based on our review of the issues that drove the cost and schedule variance, and the actions undertaken by EGD to address these issues in a timely and effective manner, and in consideration of the performance challenges and risks experienced during the GTA Project (those that were within and those that were beyond the reasonable control of EGD), KPMG's observations generally found the GTA Project team made efforts to mitigate against cost and schedule increases and *demonstrated prudency in managing the cost and schedule on the GTA Project*.

[2] http://trenchlessonline.com/project-of-the-year-new-installation/
http://www.spectraenergy.com/Newsroom/News-Archive/Spectra-Energy-Places-New-JerseyNew-York-Natural-Gas-Pipelie-into-Service/

[3] http://www.transcanada.com/announcements-article.html?id=1957529&t
https://www.vaughan.ca/council/minutes_agendas/AgendaItems/CW(WS)0304_14_1.pdf

[4] http://www.atcopipelines.com/upr/Projects/Documents/NE_CGY_Brochure_FINAL.pdf
http://www.atcopipelines.com/upr/Projects/NE-Calgary-Connector
http://www.rbsomerville.com/project/regent-street-district-energy-piping/

4 Operational Readiness

4.1 Approach

The Operational Readiness Review ("ORR") focused on the procedures and management control systems utilized by the project management team responsible for the effective delivery of the asset to commercial operations.

4.2 Assessment

Our scope included a review of the Ready to Operate ("RTO") process used by the GTA Project, utilizing KPMG's Operational Readiness framework as a guideline. Based on our review, a summary of the strengths and opportunities are provided below:

Key Strengths:

Strategy

- ✓ EGD strategic priorities to (1) drive safety and operational reliability; (2) Execute; (3) Secure the longer-term future; and (4) Maintain that the foundation are clearly and effectively incorporated into key project documents such as the Operation Plan, RTO Standard and workshop presentations and ELT updates. This ensures that the GTA Project is aligned with the EGD strategic priorities to provide safe and reliable delivery of natural gas to EGD customers.
- ✓ The GTA Project objectives and requirements were well understood across the organization and aligned with the organization's strategic plan.

Program Integration

- ✓ The RTO standard provided EGD with a robust process for operational readiness of a major project with a formal project life-cycle stage gating process.
- ✓ The JIRA Issue Resolution Workflow software is a comprehensive issues tracking management system that was rolled out across the organization to provide an effective day-to-day issues management process.
- ✓ The reporting to the Executive Management Team ("EMT") provided key information related to project scope, cost, and schedule to ensure transparent and robust decision-making. This included a 'Monthly RTT ("Ready to Transition") Status Update' documenting the outstanding issues on the project and tracked to an issue owner, and a 'High Level GTA Project Integration Timeline' to inform the EMT on the project integration schedule.

Operations Management

- ✓ A concerted effort was made to include all RTT area stakeholders at an early stage in the project to assist with issue resolution. Operations was held accountable for completing a formal inspection prior to energizing activities approved by the EMT.
- ✓ Strong safety culture within EGD was noted in the project documents and presentations with a focus on Process Safety Records ("PSR"), Pre Start-up Safety Reviews ("PSSR"), and Change Management.

Asset & Risk Management

- ✓ A comprehensive risk register was developed with documented probabilities, consequences, contingencies and mitigation plans.
- ✓ Developed a 42" pipeline manual including documentation of policies, procedures, and requirement for qualified personnel to work on or near the pipeline.

External Stakeholder Management

- ✓ Communication plans related to customer care and the community were proactive and adequately addressed project issues.

Key Opportunities:

RTO Standard

- ✓ RTO standard provides a robust guideline for Operational Readiness, but it has been developed specifically for Enbridge Liquid Pipelines and is not necessarily applicable to EGD. As part of the GTA project, additional requirements for Enbridge Gas Distribution were identified through stakeholder engagement to ensure appropriate safety and reliability for gas distribution. Leveraging the standards and lessons learned from the GTA Project, EGD should develop its own project integration standard for use on future projects of similar scale to the GTA Project.

Roles & Responsibilities

- ✓ While accountabilities for project integration are generally understood for the GTA Project, for a future gas distribution specific integration plan, EGD should document the roles and responsibilities specific to each member of the Project Integration team in the RTO standard to provide clear accountabilities across the project lifecycle.

Perform Quality Checks on Completed Actions

- ✓ Develop a process to independently audit the issues marked as resolved to ensure quality, consistency and completeness by each issue owner.

Documentation and Records

- ✓ Complete a review of the project documentation management process to ensure a successful transfer of all project related information to Operations.

Enbridge Gas Distribution
GTA Project Report
June 2017
CONFIDENTIAL

Enbridge GTA Project Lessons Learned

In general, KPMG found that the GTA Project team demonstrated prudency in managing cost and schedule against the original budget and mitigating the impact from change events on cost and schedule. Based on our assessment throughout the Project, we would recommend EGD incorporate the following lessons learned into future projects:

Increase awareness between project progress and cost, and improve cost variance & trend analysis

It was noted that actual spend consistently varied from monthly forecasts, even after re-estimates were completed that should have reflected current trends in actual spending levels. The table below shows the monthly estimated spend versus actual spend during the main summer construction months, with an average underspend of approximately 30%.

Timeline	Monthly est.	Actual	Change
June 2015 plan	$72M	$41M	-$31M
July 2015 plan	$99M	$73M	-$26M
August 2015 plan	$85M	$48M	-$37M
September 2015 plan	$75M	$58M	-$17M

There is a future opportunity to increase the level of communication and information sharing between the project controls team and the site cost control and accounting team. This will help to ensure that future forecasts issued by the project controls team take account of the realities of earned value and costs incurred in the previous months. In particular, any schedule delays or impacts incurred need to be accurately reflected in future forecasts both in terms of earned value and cost projections to increase the accuracy and reliability of these projections. Past productivity levels and performance progress should be carried forward to base future performance estimates on historical performance data.

Adding additional scheduling resources early on in the field will help ensure that contractors and the owner's team are communicating effectively and updating future progress projections based on past performance data and risks affecting future performance.

Conduct cause analysis on permit delays and benchmark time to obtain

Permit delays were identified as a significant contributor to the schedule extension and cost overruns. Mainline winter construction was delayed as the required permits were not in-hand, with only 10% available by December 2014 (primarily related to critical path HDDs). Further, the last outstanding permit was not received until August 2015, which would have

been only three months before the Project's initially estimated completion date and is reflective of the overall schedule delays experienced by the project.

The permit tracker was managed by EGD during construction based on upcoming critical path activities. As a result of EGD initiating early engagement with the various agencies, additional technical requirements and design changes were identified and incorporated in the drawings by EGD to accommodate agency design requests. In some cases, this required EGD to add revised scope elements and cost to the project. Further, despite this early engagement, many agencies would not complete their detailed permitting review until final construction drawings were issued to the agency. For future projects, a mitigating action would be to further advance detailed engineering to ensure final construction drawings are available earlier for permitting, providing more time for permit issuance in advance of construction start.

Permit delays were noted as the primary cause for overall project execution delays and were the basis of Michels' request for additional compensation due to delayed productivity and stand-by time. To control claim amounts for issues related to project delays, in future contracts EGD could consider including a flat rate per crew for compensation for floating equipment / manpower (per Km) where move-arounds are company caused.

Hold contractor responsible for providing a sufficiently detailed schedule on critical items (i.e. crossings) in advance of project execution and consider some form of exposure or risk transfer to the contractor for late completion of milestones

Michels did not provide an adequately detailed schedule until the project was more than 50% complete; as a result there were challenges for the owner in measuring progress against baseline and in identifying resource constrained items on the critical path.

In future contracts, EGD could require contractors to provide sufficient detail on the higher risk critical path activities (such as crossings) in the schedule, so that the owner can challenge the schedule assumptions made by the contractor.

In evaluating bids, more focus / weighting should be placed on bidders' project control methodologies in order to take into account contractors' ability to deliver on schedule. For example, EGD should test the contractors on their ability to produce a valid and realistic schedule. Including penalty clauses in the contract could also be considered as a mechanism to transfer more risk to the contractor for non-compliance in providing contractually required documents (such as the detailed schedule).

Perform lessons learned analysis on the final impact of change orders, UPIs and claims, and ensure future similar projects capture the impact of these items in the forecast

Total costs for Unit Price Items ("UPI") were 32% higher than the contractor's initial bid estimate ($120M vs $89M). This was largely driven by shoring costs which alone were observed to be 5-times the initial contractor bid estimate ($39M vs $8M). Michels was initially selected as they were willing to lower their initial bid during the contract negotiation

process, but with change orders and claims throughout the GTA Project the final cost ended up higher than the initial bid estimate.

Future estimates could be more conservative on level of effort and associated costs for shoring, increasing the allowances and unit costs of shoring, as well as reviewing quantities and ensuring higher quantities are allocated to items such as shoring that represent a greater risk of causing cost variances.

UPIs also provided the contractor with a variable cost mechanism that made it harder for EGD to estimate total final costs, given uncertainties in the quantities that would be claimed. EGD developed its own estimate of the take-off quantities, and also requested that the contractor provide unit estimates to validate its internal estimates. Certain UPIs, such as shoring, were underestimated across all contractor bids when compared to the EGD internal estimate. Accordingly, EGD should consider higher shoring cost allowances for future project estimates in urban areas. Further, for future contracts EGD could also consider including certain UPIs, such as matting and top-soiling, as part of the fixed price portion of the contract, thereby reducing the numbers of items subject to variable unit price changes.

Tab 3

Ashtonbee Station Post Construction Financial Report on Costs and Variances

Bonnie Jean Adams
Regulatory Coordinator
Regulatory Affairs

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Enbridge Gas Distribution
500 Consumers Road
North York, Ontario M2J 1P8
Canada

September 13, 2018

VIA RESS, EMAIL, and COURIER

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Walli,

Re: Enbridge Gas Distribution Inc. ("Enbridge") – GTA Project
Ontario Energy Board ("OEB") EB-2012-0451 and EB-2016-0034
Conditions of Approval – Post Construction Financial Report

On February 18, 2016, the OEB issued the Decision and Order in the EB-2016-0034 proceeding. As per the OEB's Decision, Enbridge was required to complete and file with the OEB a Post Construction Financial Report within fifteen months of the in-service date. The in-service date for the Ashtonbee Station was June 13, 2017.

Enclosed please find the Post Construction Financial Report for the Ashtonbee Station.

Please contact me if you have any questions.

Sincerely,

(Original Signed)

Bonnie Jean Adams
Regulatory Affairs Coordinator

cc: Zora Crnojacki (Chair, OPCC) via email

EB-2016-0034

Ashtonbee Station

Post-Construction Financial Report on Costs and Variances – September 13, 2018

1.0 INTRODUCTION

On February 5, 2016, Enbridge Gas Distribution Inc. (Enbridge) filed a Request to Vary for file number EB-2012-0451 (GTA Project) to relocate the proposed Jonesville Station from the original planned site at the corner of Jonesville Crescent and Eglinton Avenue to a new site at the northeast corner of Pharmacy Avenue and Ashtonbee Road ("Ashtonbee Station"). The Ontario Energy Board (the Board) assigned file number EB-2016-0034 to the Request to Vary. On February 18, 2016 the Board approved Enbridge's Request to Vary and granted leave to construct the proposed Ashtonbee station and associated facilities.

An Interim Monitoring Report for the Ashtonbee Station was filed with the Board on December 13, 2017.

Enbridge is filing this Post-Construction Financial Report Pursuant to the Conditions of Approval set out in the GTA Project Decision. This Post-Construction Financial Report summarizes the actual capital costs of the project and provides an explanation of variances from the original estimate.

2.0 PROJECT SUMMARY

Station construction activities began in July 2016. On June13, 2017, Enbridge informed the Board that Ashtonbee Station had been energized. Monitoring was completed during construction work to ensure measures were implemented to mitigate any environmental impacts. Final restoration was completed in November 2017 following completion of the paved walking path repairs. A commitment was made to the City of Toronto to assist with reconditioning the Wexford Park Car Lot. Construction of the parking lot was completed in 2018. No residual or cumulative effects on environmental or socio-economic features are anticipated from this project. No further monitoring is required.

3.0 COST AND VARIANCE REPORTING

The total original cost estimate for Jonesville Station was $10.9M including escalation, as reported in EB-2012-0451 Exhibit C Tab 2 Schedule 1. The estimated incremental cost due to the site change from Jonesville Station to Ashtonbee Station was reported in the Request to Vary under file EB-2016-0034 as $3.5M. The updated cost estimate for Ashtonbee Station was $14.4M. The actual project cost is $22.4M.

A detailed comparison of actual versus estimated project costs is shown in Table 1 below.

Table 1 – Total Project Costs

Ashtonbee Station Project

Item No.	Breakdown	Costs filed with OEB (Jonesville Station)[1]	Incremental Costs (Request to Vary)[2]	Updated Cost Estimate	Actual	Variance
1.0	Land	$22,089	$1,500,000	$1,522,089	$850,341[3]	$(671,748)
2.0	Engineering	$694,339	$500,000	$1,194,339	$1,747,281	$552,942
3.0	Procurement	$3,390,109	$700,000	$4,090,109	$3,969,402	$(120,707)
4.0	Construction Contractor Costs	$6,026,974	$800,000	$6,826,974	$11,493,051	$4,666,077
5.0	Construction Management and Project Management	$565,832	--	$565,832	$3,499,050	$2,933,218
6.0	Commissioning and Start Up	$179,255	--	$179,255	$154,370	$(24,885)
SUBTOTAL			--	--	$21,713,495	--
7.0	Contingency	--	--	--	--	--
8.0	Interest During Construction	--	--	--	$702,771	$702,771
TOTAL		**$10,878,598**	**$3,500,000**	**$14,378,598**	**$22,416,266**	**$8,037,668**

Reasons for the cost variances are set out below:

1. The final land cost is approximately $0.84M and the final variance from the original estimate to ($0.68M). The land lease costs for a twenty year lease are $0.74M, approximately $0.78M less than the original estimate submitted to the Board. In order to receive permanent easement rights for the station lands, an additional estimated $0.1M will be required to complete the Official Plan Amendment process.

2. The final costs for engineering are $1.7M, approximately $0.6M more than the original updated estimate. The difference between the estimated and actual costs can be attributed to design scope changes encountered throughout the project as a result of permitting processes/conditions and unanticipated site conditions including:

[1] Costs in this column include escalation
[2] Costs in this column were estimated to be directly attributable to the site location change as per Request to Vary under case number EB-2016-0034
[3] This cost includes an estimate of $95,000 to complete an Official Plan Amendment application. The land costs to date are $745,341.

- The need to relocate the proposed hydro service for the station due to future expansion plans for a nearby Toronto Water substation impacting the station design
- Additional design work for a deeper foundation and on-site verification of work completed for the building for City building/occupancy permit requirements
- Engineering assessment work to create a settlement monitoring plan for the Ministry of Environment and Climate Change Permit to Take Water
- Additional design work to increase clearances beyond the minimum required distances between proposed piping in the hydro corridor and existing infrastructure
- Additional design work due to the required relocation of the station outlet piping to account for unanticipated ground conditions

3. The final costs for procurement are $4.0M, marginally less than the updated cost estimate.

4. The final costs for construction contractor costs, construction management and project management are $15M, approximately $7.6M more than the original updated estimate.

   The construction contractor cost variance is explained as follows:

Sub-Category	**Variance**	**Comments**
Contractor Bid Updates for Location Change	$2.7M	The original contractor cost estimate for completing Jonesville Station was approximately $6.0 M. At the time the Request to Vary was submitted, the additional cost to construct what was essentially the same station design, but with longer tie-in piping connections at the Ashtonbee Station site, was estimated at $0.8M for total $6.8M in costs for the relocated station. At this time, estimates were based on preliminary designs. At the start of construction when the project scope was more clearly defined, the revised contractor costs for relocating the station site from the Jonesville site to the Ashtonbee site resulted in an initial contract target price of $9.5M. This variance of $2.7M includes costs for: - Relocating the Jonesville site to the Ashtonbee site, resulted in more difficult tie-ins due to greater depth of the existing pipeline. In addition,

		the existing piping system could not be taken offline and required additional piping configuration to remain online. These additional requirements resulted in extra contractor cost to support this work. - Carrying a contractor project team dedicated to Ashtonbee Station beyond the timelines of the GTA Project - Additional requirements for working around site specific constraints at the Ashtonbee location including: o Temporary working space site constraints such as low hanging Toronto Hydro wires and a large Toronto Water reservoir in vicinity of the tie-in piping o Access/egress and working hour restrictions to minimize impacts on nearby Toronto Water and City Parks lands and on an Emergency Medical Services building in close proximity to the site
Permit Delays	$0.4M	The original anticipated construction start period that initial contractor estimates were based on was early May 2016 in order to have Ashtonbee Station in-service for the Winter 2016/2017 heating season. Due to delays in securing a land lease for the Ashtonbee Station land, construction on the station site could not begin until mid-July 2016. In addition, delays were experienced in receiving the Building Permit for the site. Due to the later construction start date and time lost from permitting delays, weekend work at an additional cost was implemented with the goal of maintaining the original in-service date prior to the 2016/2017 heating season. The weekend work aided greatly in expediting the construction schedule but this measure was not enough to overcome the late construction start. Work was extended into the winter season, decreasing efficiency and therefore increasing construction costs. The schedule delays placed the anticipated timeframe to complete complex work to connect the station into

		existing vital infrastructure during the unpredictable, cold temperatures of the winter season.[4] Additional costs for maintaining the construction site were incurred due to the need to delay this work to the warmer spring months to mitigate risks to gas supply and to ensure safe, reliable system operations in the Greater Toronto Area.
Scope Changes	$1.6M	This consisted of: - Implementing construction field changes due to permitting conditions as previously outlined in the engineering design revisions - Implementing measures as required by stakeholders in proximity to the project site to minimize the impact of construction (e.g. restoring condition of nearby parking lot, completing pre- and post-construction surveys on infrastructure in the vicinity of the site, additional security measures, laying of sod to restore park lands) - Due to limited working space, the tie in excavation could not be fully excavated in advance. Upon excavation, there were unsafe and unfavorable ground conditions, resulting in relocating the tie in point. This relocation required in an amendment to the existing easement agreement. This amendment had a turnaround time of approximately 3 months.
TOTAL	$4.7M	

The construction management and project management variance is explained as follows:

Sub-Category	**Variance**	**Comments**
Project Management	$1.1M	Project management costs are related to project delivery timelines for Ashtonbee Station that were not concurrent with the remainder of the GTA Project work. Had Ashtonbee Station been completed at the same time that other stations on the GTA Project were constructed, there would have been cost efficiencies for having the same project team personnel manage all of the station work simultaneously (e.g. construction managers, project managers, project controls staff,

[4] Ontario Energy Board advised of this schedule update through a letter under case number EB-2016-0034 dated January 13, 2017

		quality control staff). As Ashtonbee Station was completed separately at a later date, a project team was assembled solely for the purpose of executing the work for this one station. In addition, schedule delays caused by permitting and unanticipated scope changes in the tie-in work lengthened the construction schedule and led to additional project management costs for timelines that extended beyond the original anticipated schedule.
Construction Support	$1.8M	Similar to project management costs, construction support costs were related to project delivery timelines for Ashtonbee Station that began after the conclusion of the remaining GTA Project work. This included costs for items such as permitting support, environmental support, radiographic inspection and internal labour for tie-in activities. These were all resources that would have been readily available during the GTA Project at minimal additional costs but with delayed timelines, needed to be sourced at a later date at full cost specifically for Ashtonbee Station work. The schedule delays mentioned above also led to additional construction costs for requiring construction support such as third party inspection for extended timelines. As well, scope definition that identified the need for hot tie-in work to take place added construction management costs for equipment and labour to perform this specialized task.
TOTAL	$2.9M	

5. The final costs for commissioning and start up are $0.2M, marginally less than estimated at the time of filing the Request to Vary.

6. The costs for interest during construction are $0.7M. Costs were incurred for interest due to the delays associated with the relocation from the Jonesville site to the Ashtonbee site and due to permit delays as outlined above.

4.0 CONCLUSION

The Ashtonbee Station Project was completed with a total project cost of $22.4 million, approximately $8 million over the revised cost estimate for the project. The primary reasons for the variances are additional construction and construction support costs related to the change in location of this station, permitting delays, and scope changes.