Ted Chant | P. Eng.

President, CEO

Ted has over 43 years of direct, hands on experience in the hydroelectric power sector of the North American power production and transmission industry, beginning and spending the first 20 years of his career with a major US based construction contractor.

During his formative years, he gained experience as a field engineer, foreman, superintendent, project manager, senior manager, shareholder and eventually a principle of a firm working on some of the largest Canadian hydroelectric and water management projects of the day.

Ted desired to have his own business and when the opportunity arose in late 1998, he seized the moment and opened Chant Limited's corporate office in Aurora, Ontario. Chant Power Inc., the wholly owned US subsidiary, opened its doors in Green Island, NY in 2005.

As Chant grew in experience and reputation, our almost exclusive focus on the renewables power industry and innovative employment strategies attracted many highly qualified individuals. The firm specializes in the planning, permitting, design and construction of hydroelectric power generation stations and appurtenances including water management structures such as dams, dikes, canals, locks, and electrical transmission and distribution. Chant's construction menu of professional services includes program and project management, pre-feasibility and feasibility studies, design engineering support, facilities assessment (brownfield sites), supply chain management, estimating and budgeting (cost confidence/opinions of the probable construction cost at completion processes), constructability reviews and construction planning.

BOX CANYON

BOX CANYON

HYDROELECTRIC PROJECT

Project Value:
$2.4 million (Chant Fees)
Client:
Box Canyon Hydroelectric Corp. (Elemental Energy)
Project Date:
2013 – 2016

Provide a Description of the Scope of the Project.

A 16 MW run-of-river hydroelectric generating station located near Port Mellon, B.C. The project consists of three high elevation intake diversions (Box Canyon Creek, Marty Creek and Cascara Creek), a conveyance pipeline (including the capture of several tributary flows long the pipeline route), a penstock network and a single unit powerhouse that discharges (approximately at sea level) into McNabb Creek.

Chant provided project, construction, and quality management system (QMS) services including:

- Provision of a construction site management team engaged by the owner on the project's behalf.
- Environmental site monitoring ensuring permit condition compliance and coordination of provincial environmental agency and agent engagement/oversight when required.
- Overall construction schedule assembly, maintenance and performance tracking.
- Detailed productivity and cost tracking/reporting/forecasting, including contractor payment certifications.
- Change management and establishment with the main civil contractor of the eligibility of costs for reimbursement under the terms of the construction contract (main civil contract was a Target Cost delivery model).
- Advising owner on issues that arose and dispute resolution/solution scenarios.
- Quality assurance on behalf of the design engineer (Engineer of Record) and certain quality control services on behalf of the various contractors.
- Coordination of the site activities of other contractors.

Describe the Approach to Performance Measurement and Quality Control Throughout the Project.

Quality performance measurement is an integral part of Chant's ISO registered corporate QMS and includes time and cost tracking, physical quality outcome measurement against accepted standards and tracking/trend analysis of quality performance. The objective of this measurement and monitoring/tracking effort is to know the current state of the effectiveness of project controls and to foster a culture of continuously seeking improvement in the means, methods, and sequencing of work.

Chant lead the developed of a project specific QMS that proactively engaged the other parties to the Alliance Agreement. Critical inputs were the design drawings and technical specifications as produced by the design engineer, the project communications plan (including submittal/transmittal routing and status tracking), non-conformance report (NCR) creation (a contractor responsibility), NCR verification/validation, reporting, status tracking and ensuring timely disposition, creation and execution of the project inspection/testing plan (ITP) forms that seamlessly integrated with designated witness, hold and observe/verify points.

Chant's role in the delivery of project quality controls at Box Canyon included the witnessing and acceptance of (ITP) related activities, non-conformance report (NCR) verification/tracking including resolution and disposition of same and overseeing/ensuring by our proactive involvement the continuous improvement of quality outcomes throughout the project timeline.

There was no full-time resident engineer function on the site and as such Chant was tasked with being the design engineer's day to day *boots on the ground* agent. There grew to be a great deal of trust by the design engineer with respect to Chant's competence in the execution of these day-to-day quality oversight responsibilities. This trust coupled with both the timeliness and thoroughness of the project specific QMS related communication protocols and inputs/outputs resulted in a significant cost saving when compared to traditional approaches to providing design engineering services during construction.

Describe the Method of Schedule Control and Cost Control Utilized Throughout the Project.

The provision of comprehensive front end engineering (FEED) and construction management services to the Box Canyon project conformed (in accordance with company policy) to the requirements of our QMS. A primary requisite of our approach is the assembly of a detailed, realistic, execution plan(s) and master schedule before the start of any assignment or project, and then to measure and monitor actual time and cost performance against the execution program (as may be amended from time to time to reflect changing assignment or project conditions) during implementation.

Key Chant schedule measurement and monitoring tools included the detailed review of and variance identification (compared to the master schedule) evidenced from contract specific/contractor prepared monthly schedule updates, tracking of progress through contractor assembled three-week look ahead schedules (prepared and submitted weekly), daily construction activities tracking and reporting, weekly progress summary reports and trend/forecast analysis, material procurement tracking, and construction equipment usage (hours per unit) against targets/available hours reports.

Onsite cost monitoring, measurement and tracking were also functions of the Chant construction management team during the execution phase. Monitoring included the taking and logging of daily photographs of construction activities, construction means, methods and sequence recording/effectiveness analysis/reporting, delivered product tracking, daily measurement and verification of accomplished work quantities and the preparation of comprehensive daily and monthly summary reports (including trend and variance analysis) of measurable accomplishments for stakeholder communication purposes and the project record.

The premise of the construction contract (one component of an overarching Alliance Agreement between the owner, contractor, design engineer and construction manager for the project) was the contractor being reimbursed for eligible costs (which were exhaustive in nature) up to a set target cost. Chant developed a project specific Excel based cost control model for the project that included means and methods of tracking/accepting eligible project costs and the generation of formal amendments to the target cost dictated by triggering events (certain agreed to events that constituted changes to the work) as established in the Alliance Agreement. The system as developed included tracking and acceptance identification of the contractor's supporting cost information (individual vendor invoices), contractor generated invoices (staff payroll costs/related expenses and owned equipment rent, for example) and eligible contractor home office expenses (which were periodically audited by Chant to ensure conformance with the Alliance Agreement).

Chant certified as compliant with the Alliance Agreement all contractor payment draws and triggering event cost and schedule submissions. Disputed eligible cost related items and triggering events were logged and the vast majority resolved as the work progressed.

Chant worked with the Alliance partners through closeout of the project to finalize eligible costs, reconcile final target costs with actual costs incurred and establish (with the agreement of all parties) the performance (primarily cost and schedule based) incentives/disincentives in accordance with the terms of the Alliance Agreement. *

*There were no outstanding disputes between the Alliance parties at the end of the project's execution timeline.

Demonstrate Your Expertise by Identifying 3 Dominant Risks and Your Mitigation Strategy.

RISK 1

Description of Risk

An Alliance Contract model was used for this project. The concept was new and was a first for each the four (4) parties involved (owner, contractor, design engineer and construction manager). The premise of the model was a defined sharing of certain execution risks between all parties operating within a culture of transparency, trust, fairness and the common good (best for project).

Much of the Alliance Agreement language was new and untested. Integration of the more traditional individual contracts between the owner and the other three (3) parties to the Alliance Agreement included known gaps and inconsistencies that the parties would need to resolve during execution.

It was also readily apparent at the outset that working under a culture of transparency, trust, fairness, and a focus on the common good (best for project) was not a normal or arguably a comfortable operating space for certain of the parties, with respect to executing construction contracts most notably the design engineer and contractor.

Risk Mitigation Strategy

Under the Alliance Agreement, the project was to be directed and controlled by an Integrated Management Team (IMT) made up of one representative from each party (total of 4 people), each with one (1) vote. The Alliance Agreement contemplated voting on courses of action when and as necessary and did contain a dispute resolution methodology that could be triggered by a dissenting party. In the event of a tie, the owner's vote would govern (but only insofar as to keep the project moving).

From the outset of the implementation phase, Chant took ownership of the functionality of the IMT and lead a communicative process that facilitated open, frank discussions and consensus building.

The IMT protocols were structured to focus on timely resolution of issues that arose as a result of an individual party's interests conflicting (real or perceived) with the common good, looked at recognizing relationship flash points before they occurred, provided timely and complete information to support transparent group decision making and drove a best for project spirit as the governing premise.

Outcome

The IMT was called upon to informally extend the reach of the Alliance Agreement and foster a spirit of inclusivity as several key stakeholders in project outcomes were not directly signatory to the Agreement. This stakeholder group included the project's host indigenous communities, the turbine/generator supplier, transmission line and substation contractor, various subcontractors of the signatory contractor and regulatory agencies.

The same spirit (a best for project approach) that made the IMT function substantively as envisioned by the original proponents of the Alliance Agreement for the four (4) signatory parties also worked well with external stakeholders involved in this outreach.

The signatories to the Alliance Agreement deserve much credit for their ultimate willingness to accept and maintain a cooperative, transparent premise and in many cases, step back from traditional adversarial, non-trusting and inward focused positions.

Some personality driven issues did arise but were quickly dealt with and not allowed by the IMT to fester.

The incentive/disincentives provisions of the Alliance Agreement were reconciled at the end of the project, again by consensus within the IMT.

Impact on Project

The Alliance model and its team approach to project governance (including the dispute resolution process) was largely unproven in concept, and much of the language in the Alliance Agreement was new. A lack of resolve for the developing a best for project driven consensus at the IMT level would have been extremely problematic.

There were few votes taken within the IMT and no formal dispute resolution processes triggered. This does not imply the project was without challenges (cost, schedule, and quality related) but these were cooperatively overcome or effectively mitigated by the IMT in the best interests of the project.

The construction project was successful (completed on time and within the owner's original budget) which at the time was an atypical outcome of like private developer driven hydroelectric projects in British Columbia.

RISK 2

Description of Risk

Variations between estimated and actual quantities– this outcome is historically the cause of significant cost overruns within the civil component of other similar style hydroelectric projects in British Columbia.

Civil related quantities often increase from the base line take-off as provided by the owner (in this case compiled by the construction manager in cooperation with the design engineer) to the contractor. The risk of quantity growth is typically retained by the owner (in the final analysis often regardless of best efforts not to) under traditional construction contracts even though the contractor has direct control over many of the activities that lead to quantity creep.

Risk Mitigation Strategy

The Alliance Agreement made quantity growth a shared risk between the parties depending on the source and nature of the cause of growth. Chant tracked the yields against targets (anticipated quantities taken from the drawings with traditional/achievable waste/overbuild adders included). The IMT assigned responsibility for rectifying unacceptable quantity growth experience to the party best able to manage it. In some cases, this assignment was made to the entire project team.

Under the cost reimbursable model, the contractor was able to recover costs incurred in mitigating quantity overruns BUT exceeding estimated target costs for these activities would adversely impact the contractor's cost related incentive. A balance needed to be struck, and implementation strategies/practices that were not ultimately best for project changed. Timely yield/quantity information and cost tracking (a Chant responsibility) allowed the IMT to effectively manage this aspect of the work.

Having the design engineer as part of the IMT allowed the project to quickly and effectively capture value engineering opportunities that positively affected net quantity outcomes as the work progressed.

Outcome

There was a very high exposure to quantity variations due to the host high alpine environment. Collection of the three (3) creeks (individual drainage basins) into a common powerhouse meant long transverse stretches of pipeline and penstock with uncertain up-hill conditions and flashy creek flow characteristics. The IMT was able to balance pipeline/penstock routings by knowing quantities incurred to date and forecasting quantities of various options, tracking quantity growth daily, and optimizing alignments. With few minor exceptions, final quantity variations from baseline were within contingent expectations

Impact on Project

The project was successful (completed on time and within the owner's original budget) with few adverse quantity growth impacts. This was at the time an atypical outcome of like private developer driven hydroelectric projects in British Columbia.

RISK 3

Description of Risk

Geographical/geotechnical challenges due to the remote, water access only location of the project.

A high alpine environment with ideal hydrological conditions for power generation also meant short, wet construction seasons and flashy river and stream flows. This affected the design of bypass channels and diversions as well as penstock routing and the constructability of pipe bedding designs.

Risk Mitigation Strategy

Adopting a reasonable flood return period for temporary works (diversion structures and bypass channels) to permit the construction of permanent in stream intakes resulted in the requirement for significant facilities. It was often difficult to imagine the actual need for such large sized structures (and their associated costs).

The IMT took the decision to stay with the base case design of the temporary water management structures and resist the temptation to "skinny" up these temporary components of the work. Further, the schedule and means, methods and sequencing for all instream work (including their ultimate design) were selected to ensure only one construction season for each of the three (3) intake structure (no spring freshet needed to be addressed).

Outcome

Two of the three instream intakes were completed without any adverse water management incidents. The Marty Creek intake did experience a flood event (an overtopping) driven by a storm event of a return period greater than that the diversion structure was designed for. The rework delay was addressed, and the temporary works decommissioned on schedule (within one high alpine constructions season).

Impact on Project

The three high alpine instream intake structures were completed on time and at budget, including all temporary works although some targeted contingent funds were expensed in rework and schedule recovery at Marty Creek.

CHALLENGES AND OPPORTUNITIES

Design, routing optimization and physical construction of the water conveyance pipeline and transverse/steep slope penstock runs through heavily forested, mountainsides (rock, talus and overburden) was extremely challenging (more so than expected) and required a lot of flexibility on the part of design and construction crews during installation. This was the single largest challenge for the project team and presented the most significant opportunity for implementing adaptive management practices for the work.

Thorough geotechnical testing over a large geographical area (3 watersheds), predominately inaccessible areas ahead of construction crews and with a litany of possible pipeline/penstock routings was not feasible pre-construction. Investigation and route optimization/design was thus performed just in time for execution. Constraints existed in the that steel penstock materials had long lead times for delivery and commitments to size and wall thickness had to be made well in advance of construction start-up.

The outcomes of the projects pipeline /penstock alignment optimization efforts are an example to the effectiveness of an integrated team approach. Collectively the IMT, under Chant's leadership and with both the contractor and design engineer present, developed effective and efficient tests/ways to optimize quantities of work by section of pipeline and penstock. Each IMT meeting became a value engineering session in this respect.

The importance of having a means to effectively foster this flexibility within the project team and then efficiently capture it for the good of the project was Chant's most important lesson learned on the project.

The pipeline and penstock work did experience some quantity overruns with respect to rock excavation but underran in overburden/talus handled. The IMT was conscious of this in selecting optimized alignments trading the certainty of rock excavation over the risk of quantity overruns in unstable talus or overburden materials requiring a high up hill wall.

The cost to complete the pipeline/penstock excavation work was managed to a revised target cost that did not adversely affect the overall cost outcome of the project.

HOWSON DAM

HOWSON DAM ENGINEERING SERVICES

Project Value:
$46,860 (Chant Fees)
Client:
The Corporation of The Township of North Huron
Project Date:
2020 – 2021

Provide a Description of the Scope of the Project.

Chant competitively procured an assignment to confirm the suitability of an existing concrete spillway structure as a candidate for rehabilitation. The scope of work included a site visit, core sampling, compilation and interpretation of findings and submission of a report to the Township of North Huron council, owner of the facility. All work associated with this project were related to the south section of the facility, which consists of an overflow spillway approximately 54m long and 6.5 m high.

Chant and its subcontractor Fordes Engineering conducted a review of existing reports on the condition of the structure as well as field work. Field testing included the taking of thirteen (13) concrete cores (total of horizontal and vertical) to a maximum depth of 1.8 m below the existing concrete surfaces. The objective of the coring program was to assist in determining concrete soundness and strength of the existing structures. The core holes were patched after the core extraction and the final report provided observations, conclusions. and recommendations for practical approaches to rehabilitation means and methods.

Chant and Fordes Engineering attended a council meeting to communicate findings, which concluded that the condition of the existing structural concrete did not, in accordance with widely accepted standards, qualify the existing dam as a candidate for rehabilitation. Chant recommended two (2) unsolicited revitalization conceptual solutions and provided order of magnitude cost estimates for each.

Describe the Performance Measurements and Quality Control throughout the Project.

Much of the work associated with this assignment was performed by subconsultants to Chant. We were careful in our subconsultant selection process to choose entities based on their previous quality and timeliness of deliverables to us or people we knew. Their respective scope of works were developed pre-tender and included the completion of both draft and final reports with respect to their work.

Chant reviewed the subconsultants draft reports and provided comments. After the subconsultant addressed Chant's input, they submitted their final report to Chant. Included in the scope of work for Fordes Engineering was attendance at the council meeting where Chant presented its final report.

Chant assembled the final assignment deliverable that was ultimately submitted to the client and presented to council.

Describe the Method of Schedule Control and Cost Control Utilized Throughout the Project.

Chant's Quality Management System (QMS) is registered to ISO 9001:2015. The provision of overall management and cost estimating services to this assignment conformed (in accordance with company policy) to the requirements of our QMS. A primary requisite of the QMS is the assembly of a detailed, realistic, execution plan and schedule (referred to as a Service Plan for assignments under $100,000) as part of the proposal preparation process and then to revisit this plan before the start of any assignment or project.

Labour person-hours, labour costs, labour related expenses and subconsultant costs incurred in completing the cost were tracked against budget and reviewed periodically with both the estimating and execution teams.

RISK 1

Description of Risk

The major physical risk of the assignment was providing access for drilling equipment to the crest of the existing structure. We expected the area upstream of the dam to be frozen in January and February (typical of recent years according to local reports) such that drilling equipment could access the crest without having to construct or provide ancillary access. Under the scope of work with our drilling subconsultant, suitable access for drilling equipment and personnel was Chant's responsibility

Risk Mitigation Strategy

With the onset of climate change and extreme weather becoming more common than not, Chant took the risk that ice-based access would be available in January or February, and that COVID protocols would permit the drilling work to proceed at that time.

Chant developed a contingency plan of deploying smaller, more portable coring equipment and reflected a lower production rate than the equipment proposed by our subconsultants in our estimated costs for the work ahead of the tender closing. The portable equipment could be boated to the crest if open water or thin ice cover existed. We included in our proposal an additional 20% of the drilling subconsultant cost to address this contingent plan.

Outcome

The pond behind the structure was adequately frozen as we expected (hoped for) and provided suitable access for our more productive drilling equipment. In the best interest of the assignment, we did utilize some of the access contingency to take an additional core.

Impact on Project

The assignment was completed under budget and the final report positively received by Township staff and council.

RISK 2

Description of Risk

The scope of work of Phase One of the assignment included engineering and site work to confirm the suitability of an existing concrete spillway for rehabilitation. Chant and its subconsultants fully suspected from a pre-tender visit and literature review that the condition of the existing structural concrete would not qualify the existing spillway as a candidate for rehabilitation. Reports of local opinion indicated that this "conclusion" (decommissioning) was clearly not the answer that most local stakeholder residents (those living on or near the head pond) were looking for (they wanted to retain the pond) and we were unsure where council stood on the matter.

Risk Mitigation Strategy

We elected to include budget in our proposal budget to provide high level "revitalization" (as opposed to rehabilitation) options as an alternate to decommissioning if we were the successful proponent.

Outcome

We proposed Revitalization Option 1 and Option 2 and provided forecast order of magnitude costs for each. Council had few questions regarding the technical content of our report, appreciated the inclusion of high-level options for revitalization and voted on a future actions decision at the end of the same council session based on our findings and revitalization suggestions.

The inclusion of the revitalization options provided discussion points in the alternative to the seemingly unpopular decision to simply decommission the structure.

Impact on Project

Council ultimately decided that the cost of the revitalization options was too prohibitive and took the decision to decommission the structure (vote was 5-2 as we recall in favour of decommissioning).

RISK 3

Description of Risk

Within the scope of work for Phase One, the cost of the drilling subconsultant was approximately one-third of the total Phase One price. Although we knew of the entity through others and they had a good reputation for performance, we did not have a close relationship with drilling subconsultants at the time of tender closing. Non-performance of this subconsultant would have a dramatic impact on the quality and timeliness of our deliverable to the Township. Cost overruns for the base scope of work of the subconsultant was also a risk.

Risk Mitigation Strategy

We invited five (5) drilling subconsultants to price the work. According to Chant's QMS-P-06 Externally Provided Products and Services Procedure, we selected the subconsultant who not only was competitive in price but also had a reputation for performance and met all of Chant's quality and health and safety requirements based on an evaluation formula.

Outcome

The subconsultant worked very well, and there was no performance, undesirable additional costs (we added an additional core hole to the scope of work for our convenience), quality, or health and safety issues. The quality of the subconsultant's report was more than adequate, the draft was complete and both the draft and final report were submitted on time.

Impact on Project

Chant's approach to drilling subconsultant selection had a positive impact on the project as the Phase One work was completed on time. We have been invited by the client to prepare a proposal for decommissioning strategy development and execution.

CHALLENGES AND OPPORTUNITIES

The RFP from the Township specified a minimum of ten (10) core holes to be drilled in the concrete dam. Chant included twelve (12) in our proposal at the request of our engineering subconsultant. In addition, we added a thirteenth (13) hole in response to certain as found conditions.

Although our original proposal contemplated twelve (12) core holes and the access contingency was drawn upon for the additional hole we required, it was a lesson learned to always consider extra site investigation work that might be required to deliver an assignment, both in terms of cost and schedule.

It was also very convenient not to have to return to the Township for additional funding, which likely would not have been available or put Chant in a poor light with a new client.

SITE C

CLEAN ENERGY PROJECT - BC HYDRO

Transmission Lines

Overflow
Auxiliary Spillway

Spillway

Access Roads

Generating
Station

Log Boom

Earthfill Dam

Reservoir

Access Road

N

SITE C

CLEAN ENERGY PROJECT – BC HYDRO

GENERATING STATION AND SPILLWAYS (GSS) CIVIL WORKS DIRECT COST ESTIMATE

Project Value:
$400,000 (Chant Fees)
Client:
Bechtel Canada
Project Date:
2016 – 2017

Provide a Description of the Scope of the Project.

Chant was contracted by Bechtel Canada to provide an AACE Class 1 Cost Estimate related to GSS direct costs for the Site C Clean Energy Project:

•The scope of the cost estimate addressed civil works for the Powerhouse, Main and Auxiliary Service Bays, Operations Building, Penstocks, Intakes, Transition Block, Spillway, and Auxiliary Spillway Overflow Channel.

•Chant's deliverable included a comprehensive direct cost estimate, an estimate of provisional sum items requested in the tender, estimate of the cost of relevant plant type items (including aggregate and concrete batching/delivery) and a detailed Basis of Estimate document that also described the selected construction means, methods and sequencing of the work for each primary activity. The cost estimates were to be supported with detailed estimates from first principles for each line item.

•The provisional sum items included standalone cost estimates for three (3) items: second stage concrete for gate guides, assembly and installation of gantry cranes, and erection of the powerhouse bridge cranes.

Describe the Performance Measurements and Quality Control throughout the Project.

Quality related performance measurements and quality control procedures followed those described in Chant's corporate Estimating Manual.

Internal management review processes as described in the manual were followed. Quantity take-offs were reconciled with Bechtel Canada (who prepared their own) including those for temporary works such as formwork and falsework. A detailed cost estimate review meeting was held whereby every line-item (activity including sub activities) in the agreed to Work Breakdown Structure for the cost estimate was reviewed, discussed, supporting rationalization presented by each party and critiqued. Opportunities for improvement in the end-product were captured and cost estimate updates provided to Bechtel Canada.

Describe the Method of Schedule Control and Cost Control Utilized Throughout the Project.

Chant's Quality Management System (QMS) is registered to ISO 9001:2015. The provision of cost estimating services to this Site C assignment conformed (in accordance with company policy) to the requirements of our QMS. A primary requisite of the QMS is the assembly of a detailed, realistic, execution plan and schedule as part of the proposal preparation process and then to revisit this plan before the start of any assignment or project. During execution, we measured and monitored actual time and cost performance against the plan (as was amended from time to time to reflect changing assignment or project conditions).

Chant's fee estimate utilized a detailed Cost Breakdown Structure (CBS) for each primary activity of the assignment. Labour person-hours, labour costs and expenses incurred in completing the cost were tracked against the CBS and reviewed weekly with the Chant estimating team.

RISK 1

Description of Risk

The closing date for the tender was fixed and as Chant's client was going to respond to the tender call, Chant's assignment had to be completed by a date certain. This involved working throughout the Christmas and New Year season with adequate resources while ensuring sufficient time for our cost estimators to perform their tasks, the internal quality checks and balances required by Chant's corporate cost estimating policies and for Chant management review, acceptance and sign-off of the primary assignment deliverable.

This was the first time Bechtel Canada had approached us for such services, and as a leading global contractor who is active in the hydroelectric sector across the planet, Chant viewed this assignment as a huge opportunity to enhance our reputation. With this opportunity came the risk of falling short with respect to Bechtel Canada's timing and more important, expectations of the value added we would bring to Bechtel Canada compiling a competitive yet realistic cost estimate for the project.

Risk Mitigation Strategy

A primary requisite of Chant's QMS as it is applied to cost estimate assembly is the preparation of a detailed, realistic, execution plan and assignment schedule before the start of the assignment and then to measure and monitor actual time and cost performance against the plan (as may be amended) from time to time to reflect changing assignment or project conditions) during implementation.

The plan assembled for this project addressed the upper levels of the cost estimate CBS provided by Bechtel and then further detail the assignment by expanding the CBS to include additional sub-levels. Each CBS activity was assigned a Green Sheet (order of magnitude) value and using our experience Chant assigned productivity factors ($ of value/estimator person-hour) to determine approximate resource requirements. Items such as quantity take-offs (a significant effort – there was over 700,000 m3 of concrete required for the project) were assessed and budgeted resources in the same manner.

Aggregated resource requirements were assessed, allocated over the available time and a plan for delivery assembled. The detailed plan was compared to those identified in our higher-level fee proposal to Bechtel Canada. Adjustments were made to ensure alignment of budget and detailed execution plan and mitigation strategies identified for any disconnects. Certain resource saving software packages were selected as part of this alignment process (primarily to assist for quantity take-off related activities) and procured with training needs woven into the overall resource plan.

Ultimately the plan was implemented, performance tracked weekly at the beginning then daily as critical interim milestones approached, variances addressed by resource reallocation (if practical), additional resources mobilized or other means of providing extra person-hours implemented (overtime).

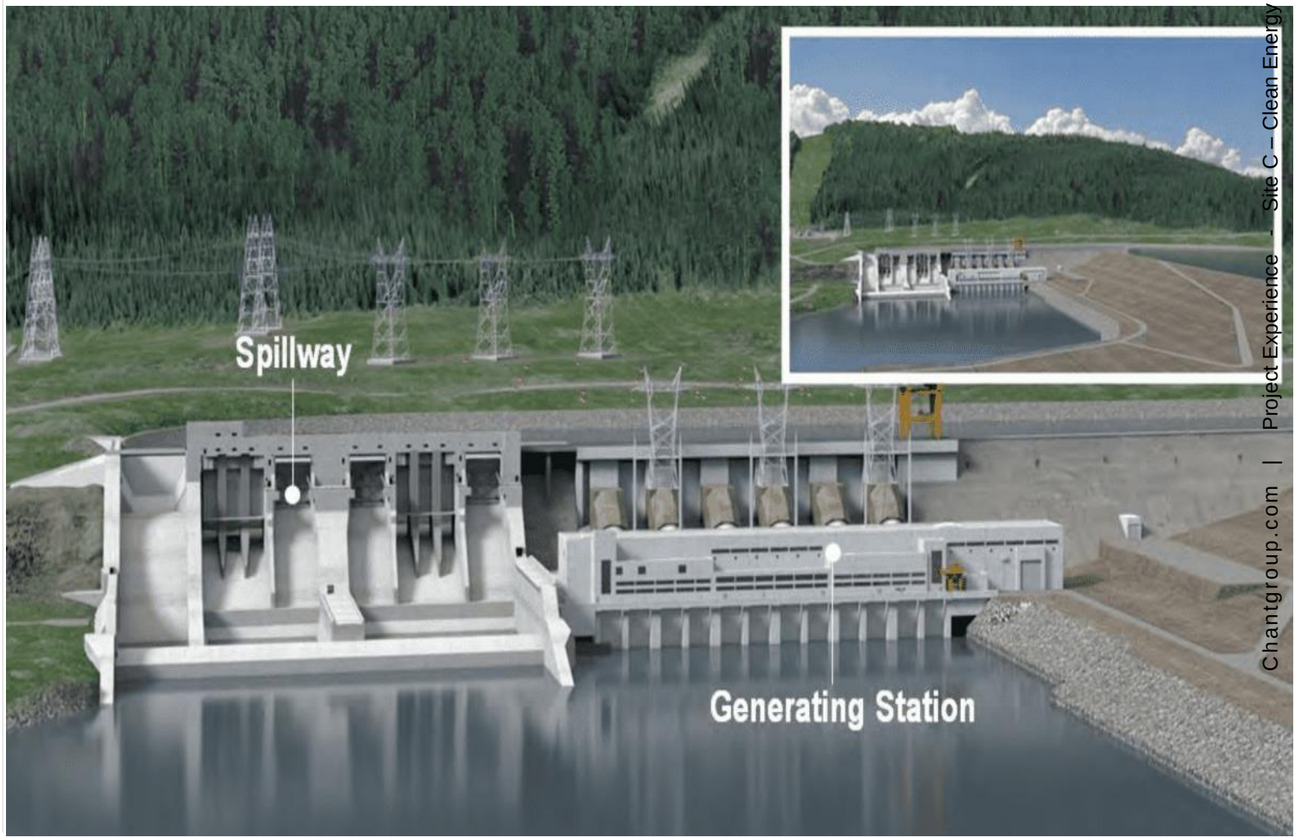
Outcome

The Chant deliverable was submitted to Bechtel Canada on time and within our budgeted costs for assembly.

Impact on Project

Chant's efforts both in the quality and completeness of the finished product and its timeliness of delivery were highly appreciated by the Bechtel Canada team.

Bechtel was not successful in procuring the project although we understand their proposal was technically complete and competitive. Bechtel has since changed its "second cost estimate" delivery model and are compiling check estimates in house for reportedly economic reasons.



RISK 2

Description of Risk

During the constructability and detailed schedule review, both Bechtel Canada and Chant agreed that BC Hydro's own schedule for the Auxiliary Spillway was very aggressive due to the late delivery of this area by others and the time of year (winter) of the turnover. Chant's cost estimate and schedule showed that the required milestone could be attained while Bechtel's did not think it feasible. The cost advantage of making the milestone was significant.

Risk Mitigation Strategy

After much discussion, Chant convinced Bechtel Canada that our approach was feasible but agreed it required allocation of additional execution resources. Bechtel adjusted their approach and their cost estimate to reflect meeting the interim date. Chant reviewed its own approach and added 12% more person-hours to the activities resource allocation within our cost estimate for this item of work.

Outcome

Chant's approach coupled with the allocation of additional resources was adopted by Bechtel Canada as the solution for this component of the work.

Impact on Project

The impact on the cost estimate brought our Productivity Index (multiplier with which historic productivities for like work are modified for project context) for this component of the work to 1.8 compared to the basic premise of the Chant cost estimate of 1.6, which is realistic. There was a minor impact to Chant's overall project estimated cost resulting from this change.

RISK 3

Description of Risk

Bechtel Canada and Chant were to meet to review Chant's cost estimate and compare costs, means, methods and sequencing approaches to the work with those developed by Bechtel Canada's project team. Having different approaches was not the risk as that kind of varying perspective is often a benefit of estimate comparisons such as the one Bechtel Canada had planned be performed for this project. The risk was the ability to identify and reconcile widely different approaches, quantities, or points of view with respect to major items in a timely manner and that the direct cost estimates might not be reconcilable in time.

Risk Mitigation Strategy

An agreed to Level 1 and Level 2 CBS for the work was established well in advance and both teams developed their cost estimates using this CBS. Activities below Level 2 were left up to the individual teams – the agreement to a general estimate structure provided a starting point for organizing the estimate comparison.

Advance reconciliation of major quantities was also scheduled well in advance of the actual comparison meeting. Bechtel used mostly software driven quantity determination solutions while Chant's effort was more manual focused.

Plug Prices were agreed to ahead of time for major materials, primary formwork acquisition costs, equipment, and subcontractors so the teams were on common ground for these items at the time of reconciliation. Bechtel Canada's estimate would be used for closing and pricing de-plugged to match actual quotations at that time.

The cost estimate review was scheduled over 3 days to allow the reviewers ample time to compare and discuss items. In addition, the review session was schedule well in advance of tender closing allowing time for reconciliation activities if necessary.

Chant was given a date certain for submission of adjustments to its cost estimate that arose from the cost estimate review session.

Outcome

As an outcome of the cost estimate comparison, Chant developed forty-three (43) post review estimate action items. Each of these items were reviewed, analyzed and disposition strategies developed. Where appropriate, cost outcomes were modified and incorporated into a revised cost estimate document.

The forty-three (43) item listing (including analysis, comments, outcome and supporting documentation) was provided to Bechtel Canada in a document entitled Post Review Estimate Action Plan. An add/cut summary reconciled the revised cost estimate with the original in terms of labour, materials, and equipment costs. The Basis of Estimate was also revised accordingly.

Impact on Project

There was only a relatively minor difference between the original and revised cost estimates produced by Chant, but the reconciliation was complete and thoroughly documented in the final submittal to Bechtel Canada.

CHALLENGES AND OPPORTUNITIES

Chant had planned on using a software application to improve quantity take-off production for formwork, a key element of the cost estimating effort in a concrete structure dominated project. Chant spot checked the quantities coming from the software application we had selected with those compiled by hand and found a continuum of discrepancies. This shook our confidence in the accuracy of the software generated quantities as our cost estimators clearly did not understand exactly what the software application was doing internally in its calculations.

As a result, Chant reverted to traditional quantity take-offs methodologies for formwork. This consumed more resources than planned but this demand was overcome by adding a spike of additional person-hours early in the project timeline. Our manual numbers ultimately compared very well with Bechtel Canada's, whose quantities were generated using an in-house state of the art formwork take-off software program that matched seamlessly with the drawing formats.

In Chant investigating possible software application, Sketchup showed good promise as a tool for future formwork quantity take-offs. This lesson learned will be implemented by Chant for the next project of like size and complexity.

DORENA LAKE

DORENA LAKE HYDROELECTRIC PROJECT

Project Value:
$403,000 (Chant Fees)
Client:
The Aquila Group - Aquila Infrastructure Management Inc.
Project Date:
2013– 2015

Provide a Description of the Scope of the Project.

The project involved construction of a new powerhouse adjacent an existing USACE dam and spillway basin, a 120" steel penstock from Dorena Lake through the existing dam's concrete abutment, a thrust block structure to sustain penstock lateral and horizontal pressures, a valve and siphon control house, steel penstock including an unbalanced bifurcation, supply and installation of a 1.4 MW horizontal Francis turbine/generator and 6.1 MW Kaplan turbine/generator, a concrete-lined tailrace channel to discharge flows into the river below the spillway basin, and a relatively short 15 kV transmission line.

Chant's scope of work included:

- Construction management services for the Aquila Group
- Providing a series of milestone deliverables
- Change management
- Commissioning planning, scheduling, and third-party services coordination
- Operations safety and hazardous energy control planning
- Support of owner/contractor dispute resolution processes
- Quality control/assurance services
- Construction scheduling

Describe the Performance Measurements and Quality Control throughout the Project.

Quality performance measurement is an integral part of Chant's ISO registered QMS and includes time and cost tracking, physical quality outcome measurement against accepted standards and tracking/trend analysis. The objective of this measurement and monitoring/tracking effort is to know the current state of the effectiveness of project controls and to foster a culture of continuous improvement in the means, methods, and sequencing of work.

Chant completely restructured the Inspection and Test Plans (ITP) that were being used for the project to reflect context and reality. The most significant area of quality related challenge was the poor fabrication and packaging of the turbine/generator and switchyard equipment that was procured overseas for the project. There was little to no stateside support from the vendor and factory technicians sent from Asia were unable to communicate with local millwright personnel. Major components arrived that had alignment issues for fastening (the contract stipulated pre-assembly of components at the factory which clearly was not performed), dried and cracked gaskets, and steel parts whose crates were swamped by seawater in transit and had experienced dramatic corrosion.

Chant took on a lead role in the equipment installation work – we assigned an engineer that was fluent in Mandarin and able to broker the communication of issues and solutions between stakeholders.

Chant initiated a new ITP checklist and quality tracking system that in addition to supporting equipment installation quality also assisted the owner in supporting warranty claims and component replacement demands.

Describe the Method of Schedule Control and Cost Control Utilized Throughout the Project.

Chant was brought in by the equity investor as an agent of change and turnaround to the project which at the time of our arrival was well behind schedule and significantly over budget with escalating negative trends in both. All the main contracts were awarded under lump sum models, making change management the primary aspect of cost control within our scope of work.

Chant developed and implemented a change tracking system specifically for the project such that the actual costs of alleged or real changes were tracked and used to validate estimated change costs being submitted by contractors and vendors. This change management system was communicated to all stakeholders and ultimately respected by the parties for its thoroughness, fairness of process and transparency. The equity investor's acceptance of Chant's determinations of what constituted a change to a site contract was of paramount importance to moving this aspect of the project progressively towards completion in a timely manner.

Schedule tracking was done monthly against the (widely if not unanimously) accepted Baseline Schedule, with variances identified and adjustments made to the critical path (many such paths were rapidly converging when we were engaged) and the various contractors, vendors and agencies attention focused as required. The complexities associated with grid connection where not even on the table when Chant arrived but soon become a parallel critical path to completion.

RISK 1

Description of Risk

Obvious quality issues related to the supply of turbine, generator, and switchyard equipment from offshore with little to no stateside service support.

Risk Mitigation Strategy

The advancement of the project precluded any meaningful pre-delivery interventions – we needed to deal with what was on site (which represented almost 100% of the required components and parts).

Chant provided a dedicated mechanical/electrical engineer to take ownership of these equipment related quality issues of the foreign supplied component. Equipment that had been randomly stored around the site and exposed to elements was gathered, inventoried, photographed as to current state, repackaged, and staged in a weatherproof structure. Receiving practices pre-Chant were shoddy at best – project records that did exist were compiled and assembled into a comprehensible document that while full of gaps set the stage for addressing the quality issues to follow.

The focus was on overcoming the equipment related issues, mitigating the existing risks, those foreseeable in the future and documenting the impacts of both on the costs of the work.

Outcome

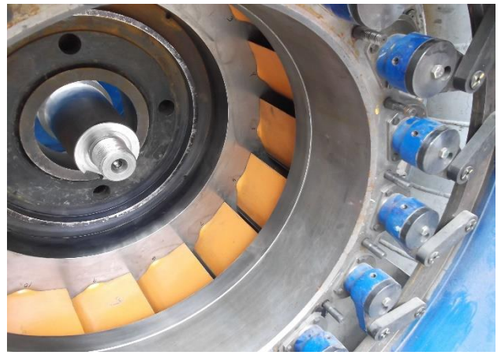
The offshore equipment was ultimately installed and commissioned. Poor receiving procedures cost the owner significant time and money. Not having a proactive factory presence was also a serious error in process, under the circumstances.

Site installation crews under Chant's leadership made the best of a bad situation but we estimate the equipment installation and commissioning productivity was not better than 50% of what it should have been had the components arrived as represented by the vendor and rework/fit up problems been largely avoided.

There was no "other side of the story" to this tale.

Impact on Project

There was a negative impact on the project schedule due to the fact the turbine, generator and switchyard equipment supplier was from offshore and the absence of rigorous FAC protocols. Replacing rejected equipment components and critical spares took weeks due to fabrication and shipping times, even with the use of stateside fabricators in the alternative.



RISK 2

oDescription of Risk

Bureaucratic procedures prevalent in both the USACE and National Grid (the grid operator) organizations when combined with the dysfunctionality of the project owner's organization posed very real risks to attaining commercial operation of the facility.

A complicated design (overly optimized?) with a syphon and two different types of turbines (Francis and Kaplan) further jeopardized (with complications) the commissioning process.

Dorena Lake functions under a fixed water regime with lake (head pond) elevations governed by season and not commissioning requirements. Certain commissioning activities required to power up the station depended on available net heads that if missed were not repeated for upwards of 6-8 months.

Risk Mitigation Strategy

A specialist commissioning company was added to the project team at Chant's insistence to assist in the provision of commissioning services not provided by the existing contractors and engineers (fill known and unknown commissioning scope gaps).

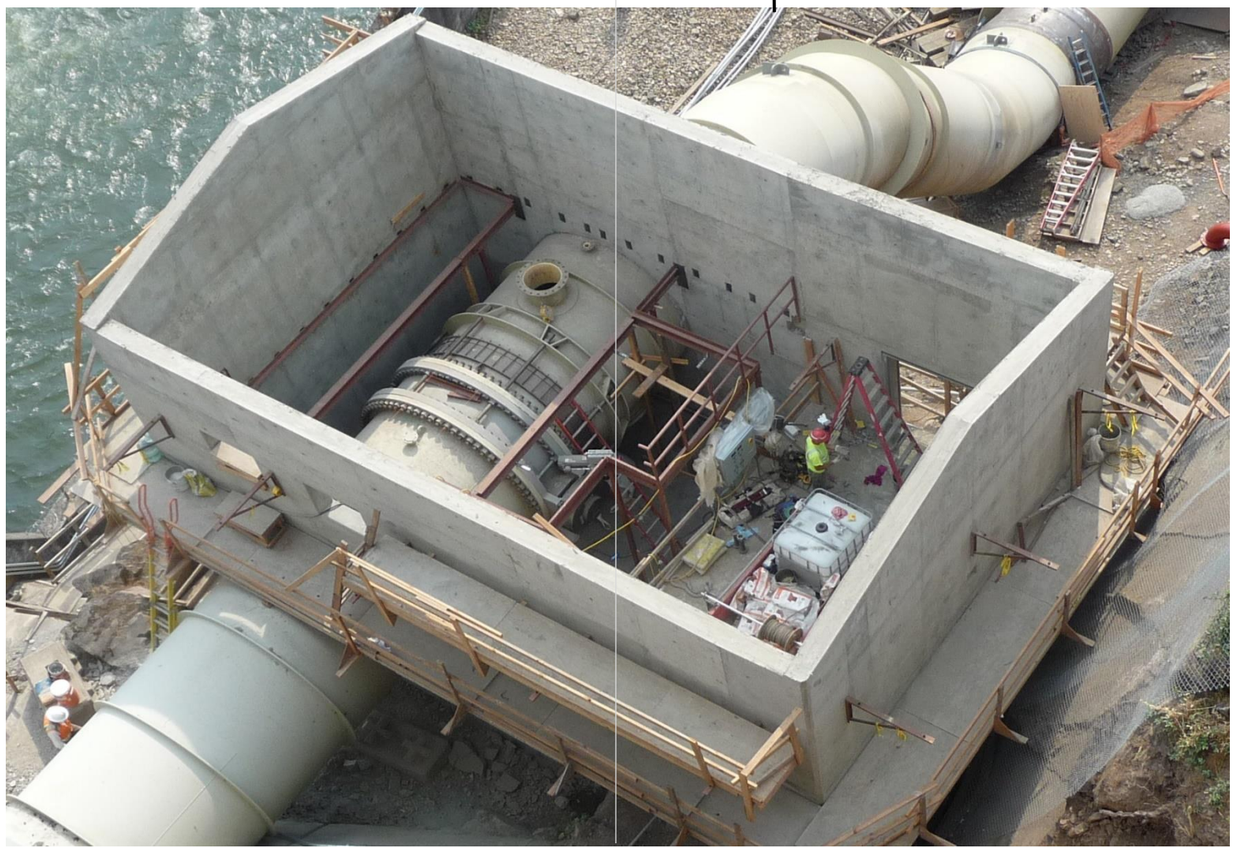
Chant took on the role of commissioning coordinator and worked with the design engineers (multiple entities), the contractors and vendors, the USACE and National Grid to develop and implement a commissioning plan (process and schedule) that was ultimately accepted by all parties.

Outcome

While not perfect, the commissioning plan as compiled by Chant and the specialist company was seen as a roadmap to unfettered commercial operation over time by all stakeholders which (ultimately) facilitate the more or less orderly conclusion to the project.

Impact on Project

The commissioning plan's schedule was executed in the timeframe anticipated. While commissioning was accomplished in steps in accordance with expectations, full commercial operation was attained over 1 year later than originally contemplated.



RISK 3

Description of Risk

Civil works surrounding the penstock and intake/powerhouse interface were complicated by design and occupied a very small footprint. Due to the proximity to an MSE wall along the tailrace channel, USACE was concerned with potential movement of the exposed section of penstock during a seismic event. There was less than 1' of separation between the penstock and the MSE wall. For USACE this was a fatal flaw in the design that had not been previously recognized and jeopardized the entire project at the 70% completion stage.

Risk Mitigation Strategy

Chant suggested the use of a low compressive strength flowable fill to surround the penstock adjacent the MSE wall.

Outcome

Chant's technical solution was considered constructable by the contractor, consistent with the design intent by the design engineer and agreed to as an additional cost by the owner. The resolution was proposed to USACE who accepted this as a solution.

Impact on Project

The use of this methodology allowed the project to move forward with little impact to the schedule, and though there was a significant cost component to it, flowable fill was the best solution to mitigate the potential of longer-term delays associated with concepts solutions, design changes and rework.

CHALLENGES AND OPPORTUNITIES

Next to the dysfunctional site organization (all aspects/all parties), the lack of the completeness of the project design was a significant challenge.

This was painfully obvious upon Chant's engagement. At our insistence, the design engineers were brought from Utah to site to be able to react in real time to the challenges with the detailed design and issues relating to quality with major equipment components coming from Asia.

The removable roof section as designed was good in theory, but the roof was not panelized and needed to remain entirely off during installation of the units, exposing electrical control cabinets and other sensitive equipment (which consistent with normal practice would have been installed at the same time as that of mechanical elements) exposed to a Pacific northwest climate prone to prolonged rain events. The adopted solution was to temporarily house the electrical units in weatherproof enclosures within the powerhouse so cable installation and termination work could proceed. Not ideal. This aspect of the removable roof concept solution should have been recognized and addressed/reflect in project planning at the preliminary design review stage.

The other principal challenge was the lack of quality control by the Asian based turbine/generator supplier (bolt holes not aligning for example) at the factory (and in packaging/shipping the components). Chant brought technical representatives of the fabricator to site to stay for the remainder of the project to deal with issues as they arose and to document problems. Their presence did assist in keeping the project moving and in resolution of fabrication, shipping and warranty related cost and schedule related challenges, including facilitating the timely (?) provision of replacement parts.

The lesson learned (that we passed on to the owner) was to assign representation by qualified personnel to the factory during the pre-assembly process (at a minimum) to ensure what was paid for, effective quality controls and documentation, are in place, and that critical spare components have undergone the same QC processes as the functional units themselves.


DECEW FALLS
2017/09/18

DECEW FALLS WEST

Approach Bridge Rehabilitation

Project Value:
$87,000 (Chant Fees)
Client:
Ontario Power Generation Niagara Plant Group
Project Date:
2017– 2018

Provide a Description of the Scope of the Project.

In 2017, Ontario Power Generation's (OPG) Niagara Operations Group undertook a project to rebuild the west approach bridge at their Decew Falls Generating Station No.1 in St. Catharines, Ontario. The project included the removal of the existing bridge structure, installation of 20 linear meters of new sheet piling, a new 2 story concrete stairway adjacent the sheet pile retaining wall, relocation of underground power cables, installation of 100 meters of new road structure with asphalt pavement, bridge/roadside guard rail, and roadside revegetation.

Chant was contracted by OPG to provide owner representative services. Chant's duties were:

- Monitoring and recording of daily construction activities, obtaining detail construction photos and submission of daily/weekly reports to the owner.
- Setup of the project server and shared information system with owner and developed of a comprehensive construction document control system.
- Tracking construction progress, schedule, and the management of change orders. Additional contractor scope (primarily discovery work) was delivered exclusively on a time and material basis requiring a rigorous cost tracking/reporting protocol.
- Providing quality assurance and prescriptive quality control services, including ensuring quality witness and hold points within the Inspection Test Plans had been completed in accordance with the project drawings and specifications.
- Compiling and submitting a project closeout report, providing a detailed description of Chant's services, and documenting the project lessons learned for future improvement.

Describe the Performance Measurements and Quality Control throughout the Project.

Quality performance measurement is an integral part of Chant's ISO registered QMS and includes time and cost tracking, physical quality outcome measurement against accepted standards and tracking/trend analysis. The objective of this measurement and monitoring/tracking effort is to know the current state of the effectiveness of project controls and to foster a culture of continuous improvement in the means, methods, and sequencing of work.

Sheet pile wall construction required a programmed quality control/quality assurance approach that addressed the as-found foundation conditions, delivery of required wall strength parameters, wall alignment and waterproofing strategies. Chant reviewed project drawings and specifications, the foundation investigation report, and steel mill test reports to glean an understanding of the design intent. During implementation, we verified as-built sheet pile wall alignment, depth, and tie-in to other work.

The concrete stairway was poured in wintertime, which required effective and efficient hoarding and heating. Our scope included verification of the adequacy of enclosures in place, confirmation of the compliance of the concrete mix design, plastic tests prior to the placement of concrete and plastic concrete sampling during casting. Concrete curing temperatures were monitored and recorded during the curing period.

Electrical cable relocation required the placement of existing power cabling in a configuration that provided adequate insulation, correctly sized conduits at the right depth and slope.

Construction of the pavement structure required Chant to confirm the asphalt mix design was compliant, foundation preparation and granular product compaction, asphalt layer thickness and access road surface slopes (drainage). Finally, all roadway signs and handrails were certified by Chant as having been installed in accordance with the technical specifications.

RISK 1

Describe the Method of Schedule Control and Cost Control Utilized Throughout the Project.

For this project cost tracking and progress draw certification were not part of Chant's scope. Monitoring of the construction schedule was one of the fundamental methods identified to control the project cost.

Key Chant schedule measurement and monitoring tools included the detailed review of and variance identification against the master schedule evidenced from contract specific/contractor prepared monthly schedule updates, tracking of progress through contractor assembled three-week look ahead schedules (prepared and submitted weekly), daily construction activities tracking and reporting, weekly progress summary reports and trend/forecast analysis, material procurement tracking, and construction equipment usage (hours per unit) against available hours reports.

Chant also developed, implemented, and maintained the document management system for the work.

Onsite monitoring included the assembly of a daily photograph record of construction activities, construction means, methods and sequencing record keeping, recording delivered product, measurement verification/confirmations, witnessing inspections/tests, and production of site notes, daily reports, and a comprehensive monthly report (for the parameters of Chant's scope of work).

Description of Risk

A concrete underground foundation structure was required to be constructed as an integral part of the project. Chant's scope of work required us to performed routine inspections of the formwork and reinforcing steel to ensure compliance with formwork drawings, lift drawings, shop drawings and the technical specifications prior to placement of concrete. It was Chant's responsibility to verify and accept the accuracy and completeness of the contractor's permanent and to a lesser extent, temporary (formwork) installations.

Risk Mitigation Strategy

Chant personnel are trained to diligently perform their inspection and verification duties and to take the written acceptance of a casting as serious business. We train our people to be effective, constructive value additions to a contractor's delivery team. We also require our people to identify and communicate to contractor staff incorrect installations or areas of concern/uncertainty immediately upon identification. When and as required (and in their opinion) they can execute their authority to stop work until the situation is remedied to their complete satisfaction.

Outcome

On multiple occasions the contractor had to rework the reinforcing steel to install the correct quantities at the required spacing, all as required by the project drawings.

Impact on Project

Effective and integrated quality control (typically a contractor responsibility) and quality assurance (typically a Chant responsibility on our owner representative work) processes can be very effective in ensuring the delivered product meets the project requirements - without expensive rework.

RISK 2

Description of Risk

The project required that construction traffic utilize residential roads for access. The likelihood of local resident complaints regarding construction traffic and pavement damage was rated as "likely" in the project risk register given OPG's high profile in the community. Heavy (legal load) equipment such as concrete transit (ready-mix) trucks, crane mobilization floats, and tractor trailers carrying materials were anticipated to be used for this project.

Risk Mitigation Strategy

Site restoration was part of the contractor's scope of work, but this was intended to address areas within the facility's fenced boundary.

Chant had performed as part of its as-found conditions of the site a detailed investigation including photographs and videos of the designated/anticipated residential road usage. Road conditions were recorded, identified repair locations complete with measurements and detailed descriptions of the nature of the deficiency recorded and a comprehensive existing condition report delivered to OPG.

Outcome

Two months after project completion, OPG received complaints from residents who lived nearby the project location and on the project's designated transportation routes that roadways (surface pavement structures) were damaged during project construction and that no repairs had been performed by OPG.

OPG asked Chant to investigate these assertions.

While OPG as a good neighbour consented to some repairs, Chant's report indicated that no damage beyond normal wear and tear had in fact occurred during the period of construction operations.

Impact on Project

Ultimately, the goal of any OPG project development initiative is intended to both respect the host community and to protect the broader consumer interests.

RISK 3

Description of Risk

Unharmonious or distrustful relations among delivery partners can impact the success of project outcomes as barriers to issue resolution and effective teamwork for a common purpose can occur.

Contractor personnel can feel intimidated by how their work and progress is monitored, site activities recorded, documented, and communicated.

Risk Mitigation Strategy

Chant is fully aware of the negative impact of such unwanted attention. Mitigation strategies include a positive, engaging mannerism and interactions outside of the operations being performed (safety meeting participation and taking breaks/eating in the craft personnel's lunchroom for example). Effective listening and positive feedback are key factors in building trust. Helping resolve issues to make the contractor's job "easier" obviously help build the trust needed for all parties to be 100% effective in executing the work.

Outcome

Being positive and professional lead to a harmonious working environment and created a win-win situation for all project stakeholders.

Impact on Project

Fostering a harmonious/cooperative working environment on a construction site with multi entity engagement improved project productivities and reduced conflicts.

CHALLENGES AND OPPORTUNITIES

Construction documentation workload (numbers of construction communication documentation of RFI, transmittal, etc.) was underestimated. The original estimate accounted for 70 documents. By the end of the project over 600 documents had been recorded and filed. The unexpected workload increased work hours and cause a delay in review time and resubmissions. It is recommended to carefully assess the Contractors contract deliverables with a better idea of expected workload during the project estimated stage. Even though the project was not at a large capital investment scale, but the complexity of the project still involved includes all engineering aspects (civil, mechanical, electrical, environmental), as a result, construction documentation was still a large part of the Owner's Representative scope of work.

OIL TANK FARM REPLACEMENT

OIL TANK FARM REPLACEMENT

Project Value:
$137,000 (Chant Fees)
Client:
Ontario Power Generation Niagara Plant Group **Project Date:**
2018 – 2019

Provide a description of the scope of the project.

In 2018, Ontario Power Generation, (OPG) Niagara Operations undertook a project to replace their existing generator bearing lubricating oil tank farm at the Sir Adam Beck Pump Generating Station. The scope of work included the replacement of the six (6) existing oil tanks with five (5) new oil tanks, repair of tank concrete piers and containment walls, application of an elastic waterproof lining, new piping with a Human Machine Interface (HMI) monitoring system, new linings in existing drain piping, and a new Oil Water Separator (OWS). A contractor was engaged by OPG to design build this project to the owner's requirements.

Chant was contracted as onsite owner representative to provide construction monitoring, document management and QA/QC services. Five (5) main communication documents (Requests for Information, Site Instructions, Transmittals from Contractor/OPG, Submittals, and Non-Conformance Reports) were utilized by Chant in support of formal communications between contractor and owner.

A project deliverable list was created and maintained to track the completion of project design deliverables at different stages (30%, 60%, 90%, IFR/IFC). Chant maintained this listing. We also inspected and recorded daily construction activities with photographs, ensured every quality witness point and hold point on the Inspection Test Plans had been completed in accordance with the appropriate standards and the project's drawings/technical specifications.

A project closeout report was compiled by Chant and submitted to OPG. This report included a detailed description of Chant's services and project lessons learned.

Describe the Performance Measurements and Quality Control throughout the Project.

The project's quality performance effort measured the consistency of the delivered product against stipulated project standards. These standards were established in the owner's requirements and prescriptively provided in the project's owner approved technical specifications and drawings as produced by the design-build contractor. Non-consistent performance was caused by poor quality or defective off-site fabrication, and/or a lack of proper planning on the part of the contractor. These factors lead to the issuance of five (5) Non-Conformance Reports (NCRs) (with the associated distraction/rework) during the project.

Chant's Quality Manual System (QMS) is registered to the International Standard ISO 9001:2015 and is designed to ensure compliance with our contractual obligations to customers. These obligations often require us to abide by specified, mandated, or generally recognized as relevant industry technical standards, codes, and acceptance criteria. This project referenced a litany of such standards, and Chant needed to be aware of the role and (at a minimum) be conversant with each as applicable to the execution of the work.

Chant maintained a detailed photographic and written log of construction progress. The daily construction reports included a section on quality inspection and oversight, as well as reporting on inspection or testing outcomes.
Inspection Test Plan (ITP) requirements (hold and witness points) were shown on the three weeks look ahead schedules for each activity. Chant created and maintained a *punch list* throughout the project's execution to ensure all deficiencies identified were known and their disposition status logged.

Chant's document management system handled all construction communications and turnover package documentation in a systemic, traceable manner. Summary level reports were reviewed at the weekly progress meetings. Issues requiring immediate attention from the owner or contractor where flagged and hot listed for immediate attention.

Describe the Method of Schedule Control and Cost Control Utilized Throughout the Project.

Consistent with our scope of work, Chant's project controls focused on schedule and change management.

Under the design-build delivery model, changes were triggered by owner asks that were outside of the original scope of work and as such were cost add-ons. There were also certain changes implemented from as-found conditions of the brown field site being different than what was represented in the tender documents (discovery work). Chant's role was to investigate and support the need for a contemplated or requested change order, document mitigation alternatives and develop with the contractor and owner a preferred solution. If the change order was on a time and material basis, Chant provided a heightened monitoring effort for tracking material quantities and labour/equipment hours. For this project overall cost control and contractor payment certification was not part of Chant's scope.

Weekly progress meetings were conducted by Chant with OPG and the contractor. The meeting followed a detailed agenda that touched on all aspects of the project. One of the key items dealt with schedule updates and progress reporting. Chant requested the contractor to produce the master schedule, monthly master schedule updates and weekly three-week look ahead schedules. During the weekly meeting, all three parties would review the completed/in progress tasks of the past week and forecast tasks for the following week. The discussions also cross referenced the three-week look ahead with the master schedule updates.

In addition to monitoring, tracking, and reporting onsite construction activities, Chant also tracked the status of material/permanent equipment procurement (with a focus on several long lead time items), construction equipment utilization and labour deployment. A daily diary was prepared by Chant and circulated to stakeholders. This document recorded the progress of all activities, safety/environmental or quality issues that arose, identified matters that might affect project cost or schedule and provided a record of available resources, including their daily allocations

RISK 1

Description of Risk

Projects of this nature typically have a single Chant person assigned as site representative. This person reports to Chant's Director of Projects but much of the project insight and understanding of issues and challenges is gleaned and retained by the onsite representative. In addition, personal relationships are formed between stakeholders which if properly nurtured can greatly contribute of overall project success.

There is a risk when for whatever reason a key representative of the owner, owner's representative or contractor is removed from the equation. Chant cannot control the other stakeholder's response, but there is a risk should Chant's representative be removed that the project will suffer. This risk needs to be addressed in our planning. We encourage other stakeholders to do the same.

At the early stage of this project's construction, the original Chant representative resigned from the company. This was an example of undesirable turnover and notice given was only one (1) week. The short transition period was mitigated somewhat by slow project progress due to weather conditions and certain supply chain issues, allowing our replacement representative additional time to transition into the role.

Risk Mitigation Strategy

The most important mitigation strategy for this risk is to have qualified, able personnel available as back up. Chant maintains a pool of trained owner representatives that it can readily deploy from corporate functions to projects.
A second key strategy to address this risk is keeping current, and consistent with Chant's QMS procedures and systems, the project record. Our owner representative candidates are familiar with our standard system classification index and can readily retrieve relevant information when assigned to a new task or project.

In addition, Chant's Director of Projects is responsible for understanding the scope and nature of all Chant's field assignments and be prepared, when required, to step in to ensure continuity in the delivery of our obligations to clients.

Outcome

Chant's replacement representative was quickly deployed and continued to deliver Chant's scope of work. Their first task was to establish communications and personal relationships with key project stakeholders and begin the process of building trust and demonstrating continued competence in the role. Any backlog of items or matters that had accumulated during the transition period was quickly addressed between the replacement and the Director of Projects.

Impact on Project

The owner reported no negative impact to the project. All quality inspections were performed in a timely manner and project updates compiled/submitted as required.

Chant's QMS review of the transition process revealed that documentation control fell slightly behind turnaround expectations during the first two weeks of the resource transition. This matter has been address as an opportunity for improvement.

RISK 2

Description of Risk

Pre-construction site investigations efforts for brownfield related work are often constrained/otherwise restricted by the presence of existing facilities. Discovery work is a fact of life on such undertakings and can be disruptive to costs and schedule.

Eight (8) of the oil tank concrete piers were discovered during construction to be exhibiting troublesome spalling of concrete. A site concrete conditions assessment was completed by a third party engineer prior to the tendering of the work. The spalling issue was not captured in the report or addressed during the definition or pre-implementation phases of the project

Risk Mitigation Strategy

Chant immediately informed the owner of the discovery and mobilized a response strategy from within the project team (owner, design consultant, design-build contractor, and membrane subcontractor). The problem was defined, options identified and a preferred solution with cost and schedule impacts presented to the owner within days of discovery.

Outcome

The issue was investigated by all parties and the owner decisioned that removal to sound concrete and repair of the affected areas was to occur prior to waterproofing membrane application.

The contractor removed spalling concrete with recommendations from the waterproofing membrane applicator, and new concrete was poured up to design elevation. Waterproofing membrane was applied after the applicator was satisfied with the concrete pier conditions.

Impact on Project

New concrete replacement at the piers was the correct repair option for long term use of the station facility even though the implementation of the concrete repair solution caused a schedule delay of 7 days.

RISK 3

Description of Risk

Supply chain risks are always present in construction projects, and disruptions can occur for any number of reasons – pandemic, canal closures, global material shortages or simply a reluctance on the part of vendors and fabricators to carry inventory.

For this project, certain items such as the grating mat for the tank farm containment area around the oil tanks presented long lead times that needed to be addressed with planning and fabrication/shipping tracking.

An issue arose when it was discovered the top cover of an oil tank was fabricated with the wrong orientation to its instrumentation portals. This was not identified until the piece was being set at site.

Risk Mitigation Strategy

At the weekly progress meeting, critical items with any significant lead time were discussed under the heading of Material/Equipment Procurement with estimated delivery dates and status updates reviewed. The contractor was responsible for soliciting and reporting schedule updates from the critical item vendors and manufacturers every week.

It is difficult to anticipate mistakes in the fabrication process, but these do happen often enough to warrant special attention to vendor selection processes, vendor quality management systems, timely production of shop drawings, experienced review of shop drawing submittals and factory inspections during fabrication by informed, competent persons.

In the case of the top cover issue, the root cause was found to have been a shop floor error that was not identified nor rectified by the fabricator's quality control processes prior to shipping.

Outcome

A material receiving inspection was performed upon receipt of the piece and it was during this inspection that the incorrect portal orientation was identified.

The problem was the fixed personnel ladder (attached to the exterior tank wall) would be on the opposite side of the instrumentation portal (the instrumentation portal and upper ladder landing would be diametrically opposite each other on the tank lid).

Re-ordering a new cover or modifying the top cover onsite were considered not practical, the former because of delay and the latter due to both repair times and the challenge of matching the quality of site welding with that of a factory environment.

Chant suggested that the access ladder be relocated to the instrument side. This solution was adopted by the project team and approved by the owner. New ladder brackets were welded on the tank wall such that the relocated ladder aligned with the instrumentation portal. Bracket welding was done with the tank manufacturer's knowledge and in accordance with their quality procedures manual. The ladder was relocated. A simple solution.

Impact on Project

Long lead time material procurements require extra attention and proactive management at the very early stages of any project.

Fabrication and factory pre-assembly of the grating mat was delayed from target by 4 weeks. The ladder/instrumentation portal alignment solution (relocating the ladder), including the investigation and alternative identification/development process, delayed that work 1 week.

CHALLENGES AND OPPORTUNITIES

The anticipated workload generated by the management of construction documentation (volume of construction related documents) was underestimated by the project team. By the end of the project over 600 documents (as opposed to the 70 documents anticipated) had been issued, responded to (often multiple times), managed (tracked or otherwise handled), recorded and filed.

This unexpected workload increased the document management level of effort required and caused delays resulting from review/document management time spent by all project personnel. It is recommended to carefully assess the contract deliverables and documentation expectations to better establish a realistic level of effort required to stay ahead of the demands of documentation, and then make certain this level of effort is deployed to the project.

This project did not represent a large capital investment, but the complexity of the work, the design-build context and its multi-disciplinary needs (civil, mechanical, electrical, and environmental) generated an enormous amount of documentation.

Long lead time material procurements require extra attention and proactive management (including visits to fabricators) at the very early stages of any project. Fabrication and factory pre-assembly of the grating mat was delayed. The ladder/instrumentation portal alignment solution (relocating the ladder), including the investigation and alternative identification/development process, delayed that work.

Contingency planning for responding to site employee turnover should be included in every Project or Service Plan developed. Orderly transitions require adequate overlap of personnel, and this should be documented, and site staff made aware of the company's expectations for notice. We would consider for projects of like nature a minimum of 2 weeks notice should be provided – this would allow the replacement staff person to experience weekly project routines at least twice. A project documentation management backlog (outstanding workload) should be managed to stay current (within 2 to 3 days of expectations).

TALBOT DAM

TALBOT DAM

– KIRKFIELD BUNDLE (TDKB)

Project Value:
$8 million (EDCJV Fees)
Client:
Public Works and Government Services Canada (PWGSC)
Project Date:
2016 – 2021

Provide a description of the scope of the project.

The project involves the rehabilitation and replacement of several Trent Severn Waterway heritage features located along the banks of the Talbot River. The Talbot River flows from Mitchell Lake to Lake Simcoe in Central Ontario.

The TDKB project includes the sites listed below:

- Site A: Dam at lock 38 – Talbot (complete replacement)

- Site B: Dam at lock 39 – Portage Talbot Dam (complete replacement)

- Site C: Talbot Earth Dams (rehabilitation of perched canal embankments)

- Site D: Structure Replacement and Resurfacing Work for Locks 39, 40, and 41.

EDCJV (a joint venture between EllisDon and Chant Limited) was contracted by PWGSC to act as overall construction manager for the work and to provide advisory services during the project's definition and pre-implementation phases. During the implementation phase, EDCJV let subcontracts (with the approval of PWGSC) that were competitively tendered for the execution of all works.

Advisory services included participation in project definition initiatives and detailed design reviews (the actual design work was by others-contracted directly with the client) at 60%, 90% and IFR/IFC and were led by Chant personnel.

Chant's focus for these reviews was on constructability and means, methods and sequencing optimization. Once 60% design was attained, Chant was tasked by EDCJV to prepare Class B cost estimates for each site. These cost estimates were used for budgeting and approval purposes by PWGSC. At 90% design definition Chant's cost estimates were upgraded to Class A. All of Chant's Class A estimates were within a few percentage points of the awarded value of the work.

With the Class B cost estimates accepted by PWGSC, tender packages were written and assembled by EDCJV. The various work packages publicly tendered in accordance with PWGSC approved procedures when and as 90% drawings and technical specification became available. Responses were evaluated by EDCJV using PWGSC approved criteria, negotiations undertaken with the preferred proponent(s) and ultimately an award recommendation made to PWGSC. With PWGSC having provided its approval of the subcontract award, the various work packages moved to the full implementation phase.

Chant provided the project manager, construction manager, a field superintendent, and an average of 4 project coordinators to the joint venture's construction management team. EllisDon contributed a contracts manager and a field superintendent.

Under Chant's leadership, an innovative integrated trestle/cofferdam solution for Site B was developed, tendered, and constructed. This approach proved to be cost effective and addressed the staged replacement of the existing structure, very confined working areas adjacent the dam and provided exceptional environment security to an important cold-water fishery downstream of the site. Significant savings over conventional approaches to like work on the waterway were realized.

Describe the Performance Measurements and Quality Control throughout the Project.

EDCJV, under Chant's leadership developed and administered the project's Quality Management System (QMS). Chant's own corporate QMS is registered to ISO 9001:2015. The provision of advisory and construction management services to the TDKB project conformed (in accordance with Chant's company policy) to the requirements of our QMS.

Quality performance measurement included time and cost tracking, physical quality outcome measurement against accepted standards and tracking/trend analysis. The objective of this measurement and monitoring/tracking effort was to know the current state of the effectiveness of project controls and to foster a culture of continuous improvement in the means, methods, and sequencing of work.

A detailed photographic record (58,000 photos) was chronologically catalogued and detailed written records of construction progress maintained. The comprehensive daily construction reports included a section on quality inspection and oversight, as well as reporting on inspection or testing activities. Quality outcomes were very transparent.

Inspection Test Plan requirements (including hold and witness points) were shown on the three week look ahead schedules for each activity. We also created and maintained a punch list throughout the project's execution to ensure all identified and known deficiencies were kept animated and their disposition status logged.

Chant's documentation management system handled all construction communication (Requests for Information, Submittals, Transmittals, Field Instructions, NCRs, and Turnover Package documentation) in a systemic, traceable manner. Summary level reports were reviewed at the weekly progress meetings. Issues requiring immediate attention from PWGSC, the design consultant or contractor were flagged and hot listed for immediate attention.

Describe the Method of Schedule Control and Cost Control Utilized Throughout the Project.

Construction Management Services:

The fee structure for the provision of construction management services to the owner was a lump sum for Advisory Services (by site) and a percentage of construction cost to a cap (again, by site and in aggregate). It was incumbent on the project and construction manager (both Chant personnel) to manage the personnel resources of the joint venture to ensure both the services we were contracted to provide were delivered with excellence AND that our person-hour and cost budgets were respected.

A detailed plan for staffing the project (the control estimate) was developed premised on the original cost estimate upon which our construction management contract was awarded. Actual staffing decisions during the work were governed by this document. Variances from the budget were reported to the Joint Venture Supervisory Board by the EDCJV project manager for review and approval prior to being incurred.

While the primary effort tracking tool was person-hours, expenses associated with personnel (including subsistence, living out allowances, vehicle expenses, travel and cell phone) and disbursements (construction trailer rent, wash car, power and office supplies/equipment) were all reviewed monthly against their targets.

EDCJV has 2 claims outstanding with respect to the provision of its services to PWGSC – both stem from the late delivery of IFC drawings for the works from PWGSC's design consultant. The resulting schedule disruption was largely mitigated by EDCJV through the course of the work, but this did require additional effort (person-hours) from EDCJV. The overall project was completed on time.

Construction of the Works:

Cost control for the actual construction work began with the preparation by Chant of Class B cost estimates (based on 60% design) and Class A cost estimates (based on 90% design). These estimates were utilized by PWGSC for project approvals and budgeting/cashflow planning.

Thorough, comprehensive, and publicly tendered contracts were created and awarded for each of the work packages. Most of the work was tendered as lump sums with some quantity variation contemplated for certain items of work. Under Chant's leadership, EDCJV would evaluate proposals and using a PWGSC approved evaluation criteria select a preferred proponent. After clarifications and in some cases negotiation of exceptions taken by the preferred proponent, an award recommendation was made to PWGSC. Upon receipt of a Task Authorization, EDCJV would award a subcontract and the subcontractor would mobilize.

Variances between 90% design and IFC were jointly identified, and cost increases/decreases negotiated with contractors. Changed, additional and extra work that occurred during the project was logged as having been properly noticed, and where compensation was based on time and materials, execution resources expended recorded by the subcontractors and accepted by EDCJV daily. EDCJV certified the subcontractor's progress draws and submitted the draws to PWGSC, who paid EDCJV the approved amount.

The Baseline Schedule and cost/resource loaded schedules for the project were created and updated by Chant. Baseline and schedule update preparation for individual work packages were prepared by the respective subcontractors and submitted to EDCJV complete with narratives that identified and analyzed progress, variances, and issues.

Bi-weekly progress meetings were held between the construction manager and each subcontractor. On the off-week progress meetings were also held (same agenda) that included PWGSC, the design consultant and the operator of the Trent Severn Waterway. The meetings were comprehensive in nature, minutes taken in real time on a screen viewed by all attendees and the documents considered a project record.

EDCJV took on responsibility for overseeing and reporting of the cost status for the entire bundle of work (multiple work packages) and reported status to the owner as an element of a comprehensive monthly report. The monthly report provided information on all aspects of the performance, including safety and environmental data, statistics and narratives, quality outcomes (KPIs), change management and cost/schedule performance by work package.

Change management was controlled through the issuance of Task Authorizations from PWGSC to EDCJV as individual items or bundles of items were resolved. The initial premise of the project was rehabilitation but the as-found condition of the structures shifted the nature of the work to replacement. Fortunately, the shift from rehabilitation to replacement was largely recognized and captured during the Advisory Services phase and before subcontracts were awarded. Subcontractor claims (change order requests from subcontractors unresolved at substantial completion) represent approximately 2.2% of the cost of the project.

RISK 1

Description of Risk

The Trent Severn Waterway (TSW) is a Canadian Level 1 heritage site. As such, the existing lock and dam structures, as well as the earthen (perched) canal embankments, are considered significant cultural resources. When the work started, the scope of the cultural resource management (CRM) program was not clearly defined and continued to evolve during the definition, pre-implementation and even the implementation phases.

Ultimately CRM directives originated from Parks Canada Agency (PCA), responsible party for the stewardship and operation of the TSW. This party was not directly linked to the project nor a primary stakeholder in cost and schedule outcomes. General CRM objectives provided for the rehabilitation and replacement of existing facilities included programs to replace in kind and replicate, to the extent possible, the distinctive features and finishes of the existing works.

In addition, the probability of encountering unexpected archeological resources during construction was considered high.

Risk Mitigation Strategy

Establishing definitive objectives for the CRM program, and developing means, methods, and sequencing for attaining these became of paramount performance to the integrated (construction manager, design consultant and PWGSC) project team during the Advisory Services (pre-implementation) phase.

Ensuring to properly describe the CRM requirements in subcontract packages pre-tender, preparing relevant mapping of high probability discovery zones and allowing adequate time for Archeological Overview Assessment/Archaeological Impact Assessment processes in the overall project schedule were identified as mitigation strategies.

Subcontracts in high probability of finds zones (areas of undisturbed ground) included provisions for a "standdown" hourly unit cost tendered item.

One significant CRM requirement was avoidance of the use of form ties (which normally with todays formwork strategies present in the finished vertical and sometimes horizontal surfaces of the completed works) as these devices were not used in the original construction. This meant that all form work had to be with PWGSC/PCA externally braced. EDCJV negotiated retention of the right to allow the use of form ties "where external bracing was not practical", in EDCJV's opinion. This premise was accepted by PWGSC and PCA given EDCJV's commitment to seldom use this "not withstanding clause". Eventually the use of form ties was generally permitted in buried or continuously submerged formwork faces as a cost reduction measure.

Horizontal and vertical concrete finish options were presented to CRM officials through mock-ups and selected outcomes retained as demonstration samples for construction crews AND to audit actual finish outcomes.

Outcome

For the most part, CRM targeted outcomes were met in the construction of the project to the satisfaction of PCA and PWGSC.

There were occasions where the desired CRM outcomes (concrete finish on horizontal surfaces with high public visibility for example) conflicted with common safety practices for high traffic public areas. These were of course resolved in favour of public safety.

Impact on Project

While the bulk of the CRM driven additional costs were incorporated into the work prior to tendering the work packages, there were delays and additional costs incurred associated with the evolving scope of CRM requirements, including the removal of same high public profile new concrete to replace and match the finish with revised CRM directives.

The cost of the CRM requirements ultimately included in the works are estimated by EDCJV to represent, after mitigation, approximately 6% of total project costs

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RISK 2

Description of Risk

There was limited geotechnical investigation performed prior to issuance of IFC drawings and the tendering of subcontract packages. Bedrock permeability was suspect and there were no as-built drawings of the existing works – only original IFC drawings – and as such no indication of foundation challenges encountered or treatments deployed during the construction of the original works existed in archives.

Original photographic records were scarce in the areas of most concern.

Risk Mitigation Strategy

A bedrock grouting program was accounted for in certain subcontracts as a contingency item and an allowance (contingent time) included in the master project schedule.

Bedrock in the area is limestone, typically thickly bedded (several quarries in the area exploit this trait of the host bedrock) and continuous. The available geotechnical information described a bedrock condition much worse than what could be observed locally.

Outcome

No temporary or permanent foundation grouting was required at Site B and only a modest permanent bedrock grouting program was implemented at Site A.

Impact on Project

The risks associated with the unknown foundation permeability were identified early, quantified and allowances made for both temporary and permanent bedrock grouting programs in terms of both cost and time. This was a case of plan for the worst and hope for the best.

RISK 3

Description of Risk

The TSW is a public use facility. Along its length, the waterway traverses a litany of public and private lands and is accessible by both land and water at multiple points of entry. The operator of the waterway, PCA, does not as a normal course of its business restrict access to any part of the waterway during navigation season.

The stakeholder group includes both PCA's capital construction group and waterway operations group, federal (including the Department of Fisheries and Oceans) and provincial regulators, the public, the boating public, a plethora of NGO agencies and in the case of the TDKB project site, a large conservation authority, the Ministry of Transportation of Ontario, 2 regional authorities, 3 townships, a treaty First Nation group, public utilities (gas and electricity) and PCA's agent, PWGSC.

The risk of conflicting interests and inconsistence expectations amongst stakeholders delaying the permitting process was the single largest risk faced by the project.

Risk Mitigation Strategy

A comprehensive risk management strategy was developed for the project with clearly defined lead and support roles in stakeholder management assigned.

PCA is a federal agency and as such PCA was tasked with managing ALL federal inputs in the work. This umbrellaed a significant component of the risk profile. PCA also accepted First Nation engagement and consultation as being their responsibility. EDCJV supported First Nation engagement with responsive archeological and cultural resource planning and finding response strategies. During navigation season, PCA managed boating public concerns regarding construction operations.

EDCJV took responsibility for relationship management of the municipal governments (5 entities) and the local conservation authority. It was quickly evident that municipal concerns focused on local road use by construction traffic.

Secondary concerns included response strategies to resident concerns about canal access, traffic, noise, work schedules and night lighting.

Time was devoted at each weekly progress meeting to discuss public and agency interactions and ensure that PCA, PWGSC and EDCJV responses to public and agency interfaces were coordinated and consistent. Dealings with stakeholders was prompt, coordinated and fair but firm. Stakeholder engagement was initiated early by the project team and not left to chance. Consistency was key.

An anonymous $15,000 donation to the Township of Ramara's Recreation Department addressed the only purely financial issue (road use) that arose during the course of the work with the host municipal governments.

Outcome

Early multi stakeholder planning sessions proved valuable.

PCA public relations staff stayed engaged throughout the project to work with the project team to ensure the public was informed, safe (and felt safe) and their TSW usage experience was positive during construction.

First Nations were involved and consulted in a timely manner whenever potential artifacts were unearthed.

Early face time and understandings with the host municipal governments ensured there were no significant delays during construction activities related to road (a few unexpected load restrictions were imposed on certain Ramara Township roads to get our attention), land use agreements or complaints from residents. Points of contact were established, maintained, relationships nurtured and EDCJV made timely response to municipal concerns a priority. EDCJV representatives regularly attended council meetings to be openly available for questions.

Impact on Project

Due to the investment in the early planning sessions and the coordinated execution of the risk mitigation strategies adopted by the project team, there were no material impacts to the project's delivery from this risk.

CHALLENGES AND OPPORTUNITIES

The single most impactful unexpected challenge of the project was the shift from a rehabilitation premise of the work to a replacement premise. The project identification phase focused on rehabilitation, as did the early stages of definition. The tendering strategy of the Construction Management (CM) Contract also contemplated a rehabilitation regime.

- Construction costs for the bundle of work packages at the time of tendering the CM Contact were estimated by PWGSC's own cost consultant at $26 million. As found conditions of the structures dictated replacement not rehabilitation and as a result, work was stripped form EDCJV's contract, and a $48 million budget ultimately set for amended in scope construction work.
- EDCJV's fee was also restructured by PWGSC from the as-tendered format and a fee cap introduced.
- A services extension was negotiated between EDCJV and PWGSC to address the reintroduction of certain stripped out work to the bundles scope, albeit under different terms and conditions then those of the CM contract.
- The restructuring of the CM Contract took place between March and June 2018. While the outcome was satisfactory to EDCJV, the disruption to the orderly execution of the work during this period was significant as no subcontracts could be issued until the issues surrounding the restructuring were resolved.

The projects amended work scope was ultimately delivered on time and within the revised budgeted cost. Always expect the of the CM contractor unexpected is the lesson learned from this aspect of the project.

The second most impactful challenge was managing the CRM issues described as Risk No.1 herein. This was an unexpected challenge that appeared during the definition phase of the project (fortunately). Early identification allowed proactive upfront mitigation strategies to be developed and CRM requirements largely incorporated into the tender documents for the various permanent work packages.

Lastly, PWGSC was to provide design deliverables for the work in accordance with 14 specific milestones. Largely (but not exclusively) because of the shift from rehabilitation to replacement, not one of these 14 milestones was attained. EDCJV had to adopt execution strategies to address the lateness of permanent works design which complicated execution.

Further, during the actual work, IFC revisions were frequent, problematic and caused delays. Virtually 100% of the outstanding unresolved change requests from EDCJV and our subcontractors (totalling approximately 3% of the value of the TDKB project) are based on the late issuance of initial or revised/updated IFC draw