



Grand Falls Dam and Spillway Rehabilitation

2020 Canadian Consulting Engineering Awards

HATCH

Constructed in 1909, Nalcor entered into a program to rehabilitate the ageing Grand Falls Dam. Faced with a design that presented constructability and safety concerns, Pennecon turned to Hatch to devise an alternative rehabilitation scheme. Hatch met the challenge developing a safe, innovative, environmentally friendly, cost effective, and constructible design within a month. Despite challenging conditions, construction was completed with no lost time incidents, no environmental losses, a year ahead of schedule and significantly below budget.

Project Highlights

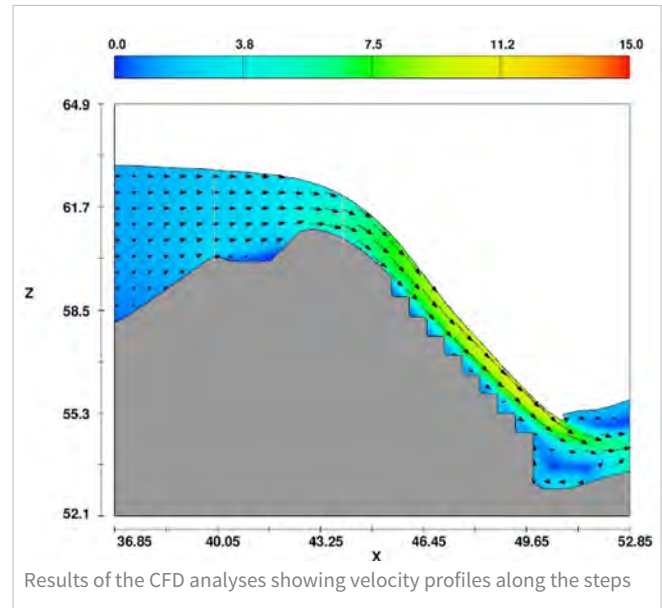
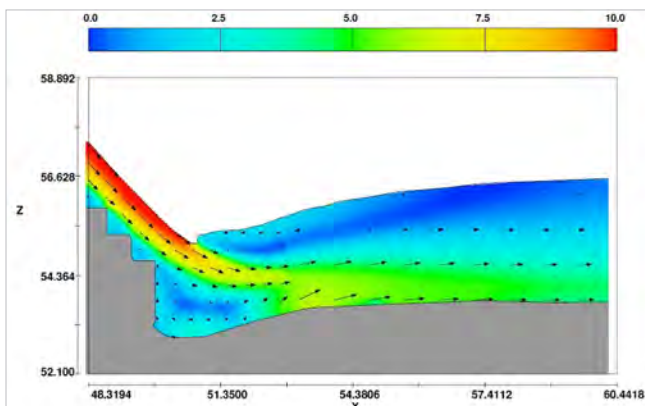
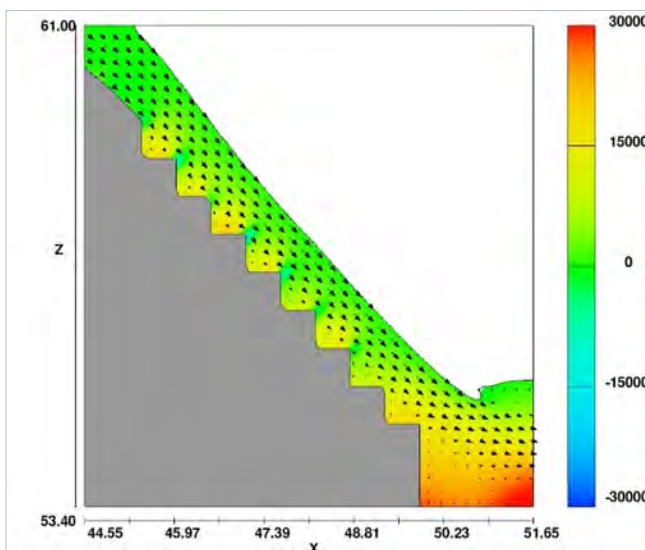
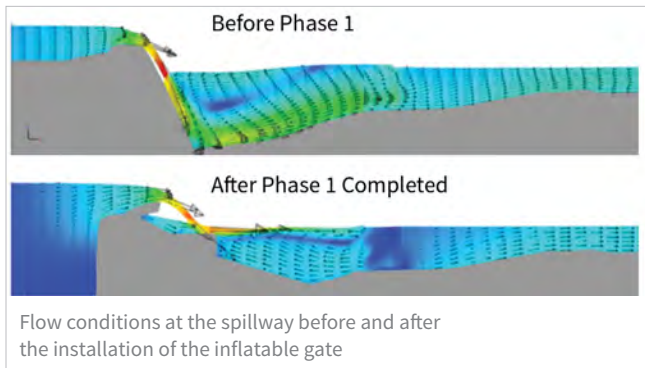
Innovation

During the initial construction phase of the rehabilitation of the Grand Falls Spillway, Nalcor (the owner) and Pennecon (the contractor) recognized that the design concept being implemented presented serious constructability and safety issues. Faced with a narrow window of time prior to the commencement of the construction season, Pennecon turned to Hatch to develop a constructible alternative. Hatch met the challenge by developing a new constructible and safe design within a month.

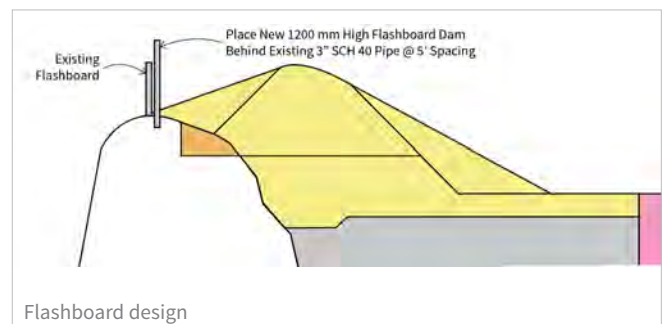


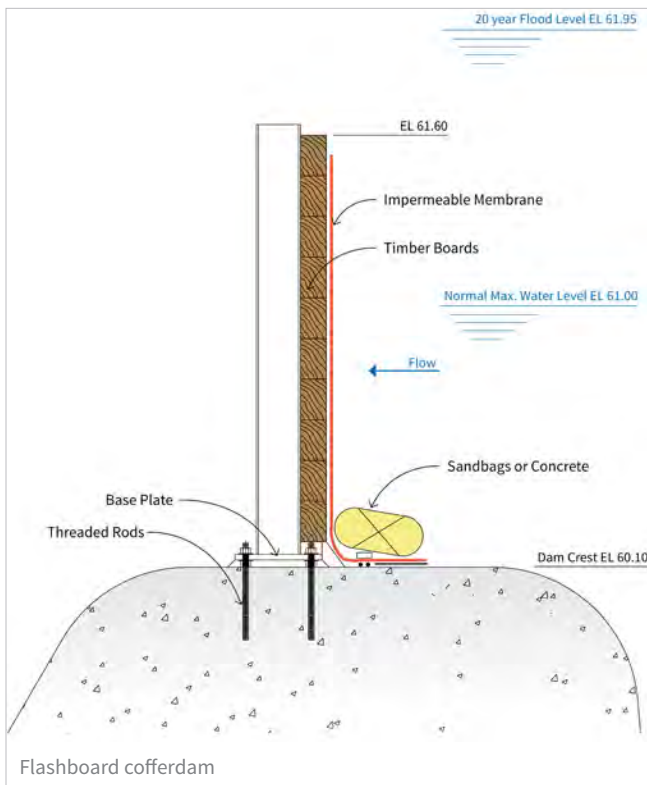
A key to the success of the new concept was the application of advanced hydrotechnical principles that demonstrated that the ten inflatable gates that had been thought to be required could be replaced with a simple overflow weir constructed immediately downstream of the existing spillway. This enhanced stability, provided the required discharge capacity and eliminated in-water work, thereby reducing environmental impacts. As part of the design,

advanced CFD analyses were performed to verify the ogee weir capacity and energy dissipation by developing step heights tailored to better suit the contractor's preference for formwork, reducing costs and enhancing schedule. The new design met all current dam safety requirements, was significantly less expensive, had virtually no environmental impacts, could be completed in one construction season and eliminated future operations and maintenance costs.

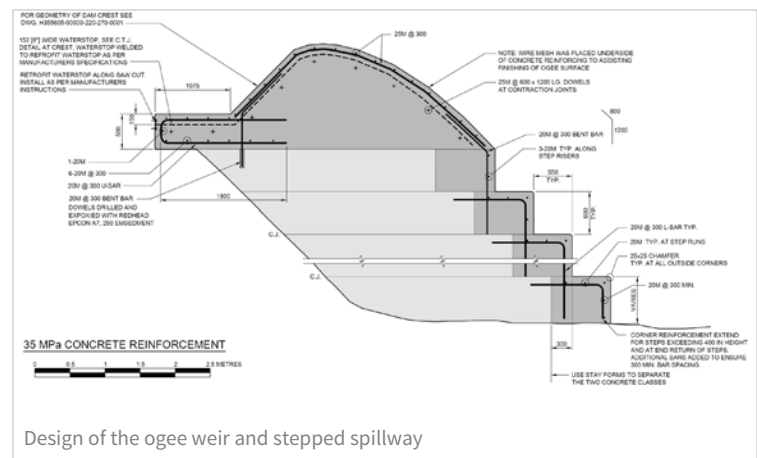


The original cofferdam concept was replaced by a first of its kind “flashboard” cofferdam solution that further reduced costs, enhanced constructability and safety and eliminated the environmental concerns that were associated with the original solution. The solution proved to be very effective. The cofferdam was erected in less than a week with no in-water work and with almost no leakage throughout the duration of the construction activities. Removal was also very efficient. It was completed in a week, avoiding in-water work resulting in reduced stress on the environment.





During construction, a team approach involving the owner, the contractor, and Hatch was adopted that enhanced communications and allowed changes to be implemented seamlessly. The team concept included collaboration to develop an innovative formless concrete placement technique for the ogee weir, saving significant time and costs.



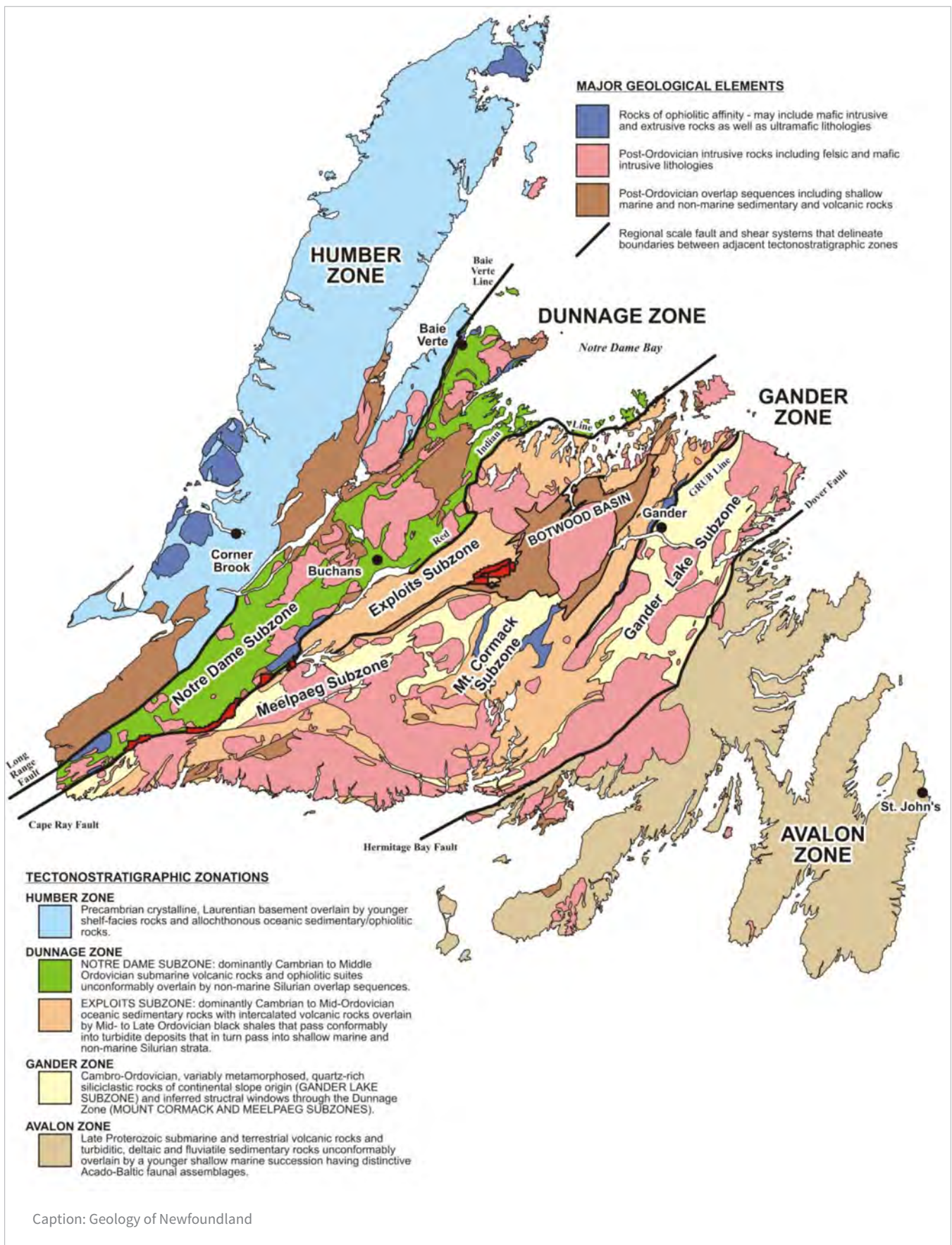
Through focused engineering efforts, a collaborative approach during the design and construction process, and the application of sound engineering principles, the project was completed well below the original design budget and a year ahead of schedule, with no lost time safety incidents, no environmental losses and no post construction claims. This approach, coupled with the innovative design solutions developed during the course of this highly successful project, will serve as a model for future rehabilitation projects.

Complexity

During the construction program, several significant challenges were addressed:

The foundation

The bedrock foundation, as exposed, was found to be composed to high-quality granitic rock but it was highly irregular. This resulted in the need for a fast-track change from the original Roller Compacted Concrete concept to conventional concrete when the foundation was exposed. The redesign, specifications, and drawings were completed in weeks, addressing the complexities introduced by an exceptionally irregular foundation with no impacts to the construction schedule or cost. Throughout construction ongoing field adjustments and design assessments were needed to ensure the base width of the dam was in accordance with the design requirements.

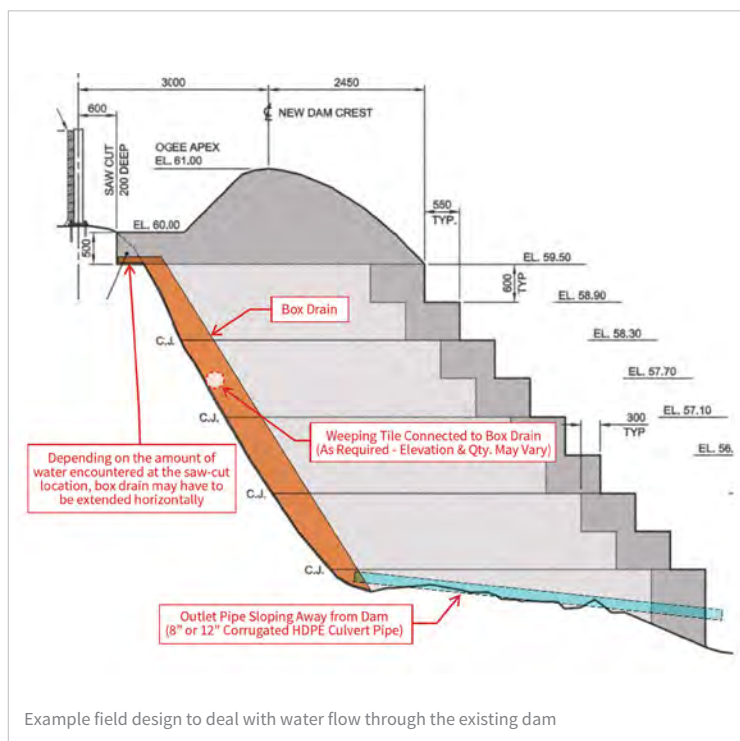


Caption: Geology of Newfoundland



Seepage through the dam

As construction progressed, seepage through the dam was found to be much greater than expected, with exceptionally high concentrated flows occurring through eroded construction and lift joints that precluded effective concrete placement. It was not feasible to reduce the leakage without lowering the head pond which would have resulted in significant lost generation and the need for environmental approvals that would have delayed the project for at least a year. Hatch's innovative solution involved the installation of a "plumbing" system within the body of the dam to collect seepage water at the source, control it during the concrete placement activities and discharge the seepage flow at the toe of the dam. This cost-effective measure had no impact on schedule and had the advantage that seepage pressures at the interface between the existing and new spillway were reduced, greatly enhancing the stability of the new rehabilitated spillway.



Hatch's innovative engineering solutions for challenging tasks led to cost savings, schedule improvement and successful delivery of this Challenging project. This project is an example of engineering innovation that befits recognition.

—Kevin Hunt, Operations Manager, Pennecon Heavy Civil Ltd.

Social and/or Economic Benefits

The Grand Falls spillway was completed in one season, a year head of the original envisioned construction schedule and well below the original design costs. There were no lost-time safety incidents, no environmental losses, and no post-construction claims. The success of this project allowed for other Nalcor projects to proceed with the funds that became available.

The development of a passive overflow weir concept greatly enhanced the reliability of the spillway and eliminated significant future operation and maintenance costs that would have been required had inflatable gates been used to provide the required discharge capacity.

The design was specifically tailored to ensure that there would be no interruption to power generation and no safety risks, thereby ensuring reliable power to the community and revenue to Nalcor.

Prior to the rehabilitation of the spillway, flashboards needed to be installed annually. The new design eliminated this requirement greatly enhancing worker safety and reducing costs.

The enhanced schedule and reduced costs were achieved both through innovative designs, but also a well-structured communication process that permitted Hatch to tailor solutions to the contractors means and methods as well as making use, to the extent that was practicable, of local materials providing benefits to the town of Grand Falls.

The maximization of local labour also provided benefits to the town of Grand Falls.

Designing for safety by means of well crafted, constructible designs, tailored to the contractors means and methods, were a contributing factor in the enviable safety record on this fast-track, complex project.



Environmental Benefits

Prior to Hatch's involvement in this project, a single inflatable gate had been installed. The operation of this gate led to concerns that utilizing the gate to pass high flows could impact fish passage during the critical spawning season. To address this environmental concern, Hatch developed a model of the fishway and undertook computational fluid dynamics (CFD) modeling to determine what, if any, remedial works were required to improve fish passage, protecting the critical salmon fishery. The results of the CFD analysis showed that the observed high velocity and turbulent flows only occurred near the water surface. Prior to the installation of the new gate, analyses showed that high velocity flows were occurring at depth along the riverbed, disrupting fish passage demonstrating that the inflatable gate improved the potential for fish passage. This resulted in the avoidance of any need for remedial measures, with ongoing monitoring confirming this conclusion.

The original design would have had some potentially significant environmental impacts to an important salmon river due to the need for extensive in-water work. There were also safety issues associated with exposing workers to power flows; Hatch's design completely eliminated all of these potential issues to the complete satisfaction of the owner and regulators.

It was clear that the deterioration of this dam could pose a danger to the public, the environment, and the fishery. Completion of this project has eliminated all these concerns, with no environmental incidents of any kind during the construction program.

Finally, waterpower is a cornerstone of Newfoundland's energy portfolio. This project ensures that reliable, clean energy is available to Newfoundland for many decades to come.



Installed Obermeyer gate



Meeting Client's Needs

Nalcor's ultimate goal was to rehabilitate the Grand Falls Spillway to meet current dam safety requirements. In implementing a solution to achieve this goal, it became apparent that the original solution that had been developed presented constructability and safety concerns. With a rapidly closing window for constructing the project, an alternative cost effective and constructible design was needed within a very short period of time.

Hatch rose to the challenge. Using advanced engineering tools and tried and true experience a revised constructible concept that addressed the concerns and reduced both cost and schedule was developed within a month's timeframe.

The remarkable success of this project was achieved through the application of sound engineering and a teaming arrangement in which the engineer, contractor, and owner worked together to develop well thought out, constructible designs tailored to the contractors means and methods, as well as to the complex site conditions.

The team worked together to monitor the construction program to proactively identify potential issues that could result in cost increase or delays, and to develop innovative solutions to these issues cooperatively considering safety, the environment, constructability, cost, and technical considerations. The results were clear. Despite numerous unexpected challenges, the team consistently rose to the challenge, maintaining construction progress and, ultimately, achieving a safe, reliable dam that will deliver clean energy for decades to come.

The project met and exceeded the owner's goals, as well as the goals of the contractor: to implement a safe and efficient design.

The lesson to be learned is the value of engineering and in working collaboratively with full-time engineering presence on site to proactively identify potential issues and develop solutions that work for the contractor, the owner, and the engineer prior to and during construction.

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