AECOM

2011 Canadian Consulting Engineering Awards
Environmental Remediation

Rupert River Weirs

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Environmental Remediation

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Executive summary

The Rupert River weirs are part of an extensive hydroelectric resource development project implemented in the James Bay Region. They comprise a portion of Quebec's energy wealth and generate significant economic benefits, both locally and nationally. The dual challenge of developing these renewable resources lies in increasing electrical power production while lessening the environmental impact.

In 2007, the James Bay Energy Corporation (JBEC) established the Eastmain-1-A–Sarcelle–Rupert project site in order to meet the growing demand for energy. At that time, the goal was to maximize the energy production of the existing powerhouses of the La Grande Hydroelectric Complex by increasing their inflow of water due to the Rupert River diversion. The weirs were constructed in this context, as they were intended to allow the Rupert River to retain its own identity, as the result of intelligent development. In September 2004, AECOM was assigned to implement six of these eight weirs for the Eastmain-1-A–Sarcelle–Rupert Project.

AECOM's ability to assemble an experienced multidisciplinary team, experience within the region and capabilities in meeting the challenging scope of the overall project (which comprised eight weirs distributed over more than 300 km) as well as its understanding of the crucial importance of the schedule for each site, which aimed to limit the impact on ecosystems, made the firm a crucial player within the project.

In carrying out this mandate, AECOM drew on its expertise to develop a number of original and tailor-made solutions that restored the initial water level to the greater part of the streambanks to maintain fish habitat, spawning grounds and migration, and to ensure the navigability of the waterways while also giving the Cree communities waterway access to critical resources. Following an in-depth analysis of the 314-km-long reduced-flow section, eight sites were selected for the construction of hydraulic structures. Once the environmental issues and the constraints associated with the different sites were accurately established, the sections were determined in collaboration with the team's environmental experts.

The weirs were created specifically to meet the criteria for protecting the streambanks and spawning grounds. Fish passes allow aquatic species to circulate freely, and the project incorporates rock blanket that are passable by fish and navigable by boats. After the construction of the weirs, the water levels of the target weir sections came to within 10 cm of the levels under natural conditions!

The river stretch influenced by the weirs are delimited by the upstream rapids. The project will ensure natural water levels are maintained over 48 percent of the river's length.

As four of the environmentally-challenging weir sites required water levels to be maintained during the construction phase, the team was faced with new concerns. In addition to the cofferdams, other tailor-made solutions were created, including temporary spur dykes and modified diversion sequences.

The team could select appropriate and innovative solutions for each site, namely:

- favouring certain rockfill structures rather than concrete structures (excellent integration in the host environment, and production cost reduction);
- KP 20.4 rock bed, navigable by boats and passable by fish (this structure erected under the water is barely visible from above ground)
- in-stream built dam at KP 33, north branch remained natural for the fish passage
- spur Dyke at KP 49
- promoting the use of streamlined crests made out of prefabricated concrete for the KP 170 weir (saving time);
- Rockfill weirs at KP 290
- optimizing the structures at the scope statement phase using CATIA design software (a new Hydro-Quebec standard) and preparing the necessary resources in a timely manner;
- optimizing hydraulic structures in order to develop different phases of diversion and cofferdam work using FLOW-3D modeling (at the time, these were the first applications of this software, which subsequently became the Hydro-Québec standard);
- developing original concepts for fish passes, in keeping with the specific constraints of each site. The method used for monitoring the fish pass structures is based on hydraulics rather than the counting of fish.

Given the fact that the different phases of the life cycle of fish have to be considered in establishing the work schedule, the available ranges were consequently considerably reduced. The engineering schedules were nevertheless met, and construction was two months ahead of schedule at the KP 170 weir. Reliable schedule performance constituted one of the major challenges of the work, given the expected diversion sequence. A delay could have resulted in the work being taken out of the contractor's hands or could have caused flooding.

While the JBEC supervised the work, AECOM collaborated closely in the monitoring aspect by providing technical assistance services at the six jobsites, spread over a 314 km distance.

AECOM's finely honed understanding of the work to be carried out, which was acquired during the project's identification and definition phases, enabled the firm to anticipate different questions likely to be raised during the project implementation, minimizing the response time and in turn maintaining a high-level of efficiency in the jobsite work progress. Daily monitoring of the water levels at each of the six structures was conducted from a distance using real-time hydrometric data.

Engineering meetings took place on-site at the rate of two days per month and regular jobsite visits and stays by experts during the project implementation also occurred as required during the entire duration of the work. This ongoing dialogue between all the stakeholders, akin to tributaries, provided an additional voice to the river.

The intelligent construction of the Rupert River weirs enabled AECOM to bridge the gap between energy needs and environmental requirements. In carrying out this mandate, AECOM drew on its expertise to develop a number of original and tailor-made solutions that restored the initial water level to the greater part of the streambanks to maintain fish habitat, spawning grounds and migration, and to ensure the navigability of the waterways while also giving the Cree communities waterway access to critical resources.

Project Summary

The Rupert River weirs are part of an extensive hydroelectric resource development project implemented in the James Bay Region. They comprise a portion of Quebec's energy wealth and generate significant economic benefits, both locally and nationally. The dual challenge of developing these renewable resources lies in increasing electrical power production while lessening the environmental impact.

Energy concerns:

In 2007, the James Bay Energy Corporation (JBEC) established the Eastmain-1-A–Sarcelle–Rupert project site in order to meet the growing demand for energy. At that time, the goal was to maximize the energy production of the existing powerhouses of the La Grande Hydroelectric Complex by increasing their inflow of water due to the Rupert River diversion. The weirs were constructed in this context, as they were intended to allow the Rupert River to retain its own identity, as the result of intelligent development.

Context of public consultation upstream of the project design:

In September 2004, AECOM was assigned to implement six of these eight weirs for the Eastmain-1-A–Sarcelle–Rupert Project. As part of a consultative development, a collaborative approach between the communities involved and the JBEC was necessary in order to mitigate cultural, social and environmental impacts.

A project resulting directly from these environmental concerns:

The intelligent construction of the Rupert River weirs enabled AECOM to bridge the gap between energy needs and environmental requirements. In carrying out this mandate, AECOM drew on its expertise to develop a number of original and tailor-made solutions that restored the initial water level to the greater part of the streambanks to maintain fish habitat, spawning grounds and migration, and to ensure the navigability of the waterways while also giving the Cree communities waterway access to critical resources.

Following an in-depth analysis of the 314-km-long reduced-flow section, eight sites were selected for the construction of hydraulic structures. As a result of its previously acquired expertise, AECOM provided design services for the structures located at KP 20.4, KP 33, KP 49, KP 170, KP 223, and KP 290.

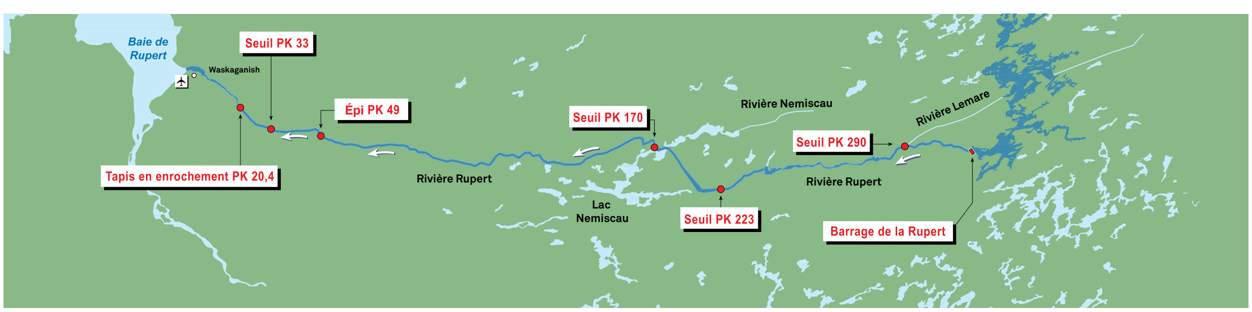


Figure 1 – From its headwaters in Lake Mistassini, the Rupert River flows 600 km west into Rupert Bay on James Bay – a significant hydroelectric power potential in the heart of rich ecosystems to be preserved.

Complexity

Analysis of the characteristics of the Rupert River

The spawning grounds and grass beds for aquatic fauna require specific water levels. These natural levels are also vital for preserving the streambanks from erosion. The team's hydrologists, hydraulic engineers, biologists, and environmental experts have been working to deliver structures designed to maintain levels that are close to the values generally observed during the summer under natural conditions.

Environmental preservation through partial water diversion

Hydraulic criteria for each of the sites were determined through simulations of the summer, spring, winter and flood periods' natural hydraulic conditions. The weirs were created specifically to meet the criteria for protecting the streambanks and spawning grounds. Fish passes allow aquatic species to circulate freely, and the project incorporates rock blanket that are passable by fish and navigable by boats. After the construction of the weirs, the water levels of the target weir sections came to within 10 cm of the levels under natural conditions!

Targeting specific river sections for weir construction

Once the environmental issues and the constraints associated with the different sites were accurately established, the sections were determined in collaboration with the team's environmental experts. The diversion bays influenced by the weirs are delimited by the upstream rapids. The project will ensure natural water levels are maintained over 48 percent of the river's length.

Maintaining water levels during the construction phase

As four of the environmentally-challenging weir sites required water levels to be maintained during the construction phase, the team was faced with new concerns. In addition to the cofferdams, other tailor-made solutions were created, including temporary spur dykes and modified diversion sequences.

Establishing and monitoring minimum river flows

It had never been possible to gauge the Rupert River at flows corresponding to the instream flow release, except in winter conditions. The data was therefore collected during the winter, with the full knowledge that there was a bias due to the ice effect, which was very difficult to quantify. A survey of the levels was also conducted at the time of the flow diversion. This anticipated intervention by the jobsite surveyor made it possible to quickly adjust the calculations to the actual site conditions, and correct the rating curve.

Innovation

Why AECOM

Background

In 2002, Hydro-Quebec, the James Bay Energy Corporation, the Cree Regional Authority, and the Grand Council of the Crees signed the Boumhounan Agreement, which adapted different aspects of the development of the Eastmain-1-A-Sarcelle-Rupert Project in response to the concerns raised by local communities. In 2003, AECOM was invited to design the KP 207 weir for the Eastmain River, a project that subsequently served as a test bench for the structures planned for the Rupert River. At the same time, by 2004, the following activities had already started: basic data appropriation, validation of Hydro-Québec's preliminary design study, investigation campaigns, and contributions to the impact assessment. The preparatory site work was then launched in the summer of 2009, the diversion became operational in November of the same year, and the jobsite simultaneously began operations targeted for completion in December 2010.

The JBEC chose AECOM for two reasons:

AECOM's skills in assembling a multidisciplinary team suited for the project's technical challenges, and its specific demonstrated experience in the field.

A multidisciplinary team

- Management team promoting a proactive and collaborative approach with the JBEC
- Hydraulic engineers with a recognized expertise in modelling and engineering structures for fish spawning runs
- Geotechnical and structural engineers willing to use innovative approaches
- Biologists specializing in the aquatic environment

A test bench for the river and its fish shoals

The Eastmain River KP 207 weir project carried out by AECOM between 2003 and 2005 constituted a test bench to demonstrate the efficiency of this type of mitigation measure before it was applied on a larger scale on the Rupert River. As with many of the Rupert River weirs, the KP 207 weir included a fish pass and spawning grounds designed to meet the needs of different species, including sturgeon.

AECOM's ability to assemble an experienced multidisciplinary team, experience within the region and capabilities in meeting the challenging scope of the overall project (which comprised eight weirs distributed over more than 300 km) as well as its understanding of the crucial importance of the schedule for each site, which aimed to limit the impact on ecosystems, made the firm a crucial player within the project.

Continuity provided by the AECOM team in order to preserve the essence of the project

AECOM's successful participation in this project is also due to the involvement of its core team at the early stages of design development and preparation of the impact assessment. Their participation throughout the duration of the project gave these team members a solid foundation for the project's continuity while the client was experiencing staff changes.

Early involvement in the project

Translating the language of the river

- AECOM's role in the preliminary design studies comprised:
- appropriating project data;
- preparing a report on environmental issues and appropriate design criteria to address them;
- assisting in the drafting of the impact assessment;
- planning and monitoring the geological and geotechnical investigation campaigns.

Promoting the most appropriate solutions

Design criteria targeting environmental challenges: engineering serving ecosystems.

Specific challenges to be met as soon as the project is defined:

- developing an excellent understanding of the Rupert River's 314 km reduced-flow section;
- optimizing the structures by integrating the constraints associated with the construction methods into the work schedule;
- limiting the environmental impact of the work sites at each location;
- developing tailor-made solutions to meet each site's specific challenges;
- coping with the natural constraints on each site.

Out of concern for the environment, AECOM harnessed its ingenuity to design harmonious solutions.

The project team paid site visits to assess the hydraulic and geological conditions and identify specific needs so that they, in turn, could select the most appropriate solutions, namely:

- favouring certain rockfill structures rather than concrete structures (excellent integration in the host environment, and production cost reduction);
- promoting the use of streamlined crests made out of prefabricated concrete for the KP 170 weir (saving time);
- optimizing the structures at the scope statement phase using CATIA design software (a new Hydro-Quebec standard) and preparing the necessary resources in a timely manner;
- optimizing hydraulic structures in order to develop different phases of diversion and cofferdam work using FLOW-3D modeling (at the time, these were the first applications of this software, which subsequently became the Hydro-Québec standard);
- developing original concepts for fish passes, in keeping with the specific constraints of each site.

Participation in the implementation and commissioning phases

A proactive, collaborative approach

While the JBEC supervised the work, AECOM collaborated closely in the monitoring aspect by providing technical assistance services at the six jobsites.

AECOM's finely honed understanding of the work to be carried out, which was acquired during the project's identification and definition phases, enabled the firm to anticipate different questions likely to be raised during the project implementation, minimizing the response time and in turn maintaining a high-level of efficiency in the jobsite work progress. Daily monitoring of the water levels at each of the six structures was conducted from a distance using real-time hydrometric data.

Engineering meetings took place on-site at the rate of two days per month and regular jobsite visits and stays by experts during the project implementation also occurred as required during the entire duration of the work. This ongoing dialogue between all the stakeholders, akin to tributaries, provided an additional voice to the river.

Project Particulars

Original solutions

- Innovative approaches spread over 314 km
- KP 20.4 rock blanket, navigable by boats and passable by fish (this structure erected under the water is barely visible from above ground)
- In-stream built dam at KP 33, north branch for the fish
- Spur at KP 49
- Prefabricated weirs at KP 170
- Rockfill weirs at KP 290
- Fish passes at KP 223 and 290 (the method used for monitoring the fish pass structures is based on hydraulics rather than the counting of fish)
- Extensive use of 3D hydraulic modeling

Rock blanket at KP 20.4

While it was fairly easy to design the geometry of the structure in compliance with the design criteria, the planning of the work sequence was far more complex. Given the use of the site by numerous fish species and the need to protect the spawning grounds (lake Cisco and lake Whitefish), the major part of the work had to be carried out during the winter, after a temporary bridge and rockfill jetties were put in place in order to maintain the water levels until the permanent structure was completed.

One of the main issues was to ensure that none of the work phases caused erosion of the river bed. To this end, a 3D flow simulation was conducted for each of the construction phases, through an efficient collaboration between experts in construction methods and hydraulics.

Figure 2 – Rock blanket at KP 20.4: the structure, erected under the water, is navigable by boats and passable by fish, and is barely visible from above ground.

KP 33 weir
Design for an in-stream built dam

The layout of the structures at KP 33 was guided by the need to encourage the fish to migrate upstream using the secondary north branch. The structures were designed in such a way as to concentrate the flow towards the right channel, which, as an average flow coefficient, conveys around 40 percent of the natural flow. The weir is built in the right channel, and the other two channels are closed by dams.

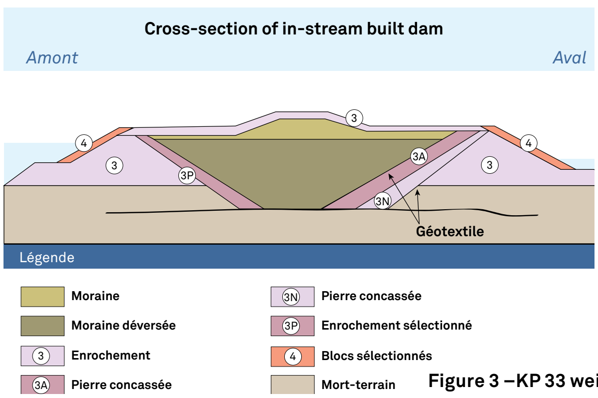


Figure 3 –KP 33 weir

With this arrangement, a flow comparable to natural conditions can be retained in the right channel, and drawdown can be prevented downstream of the north branch. This enables hydraulic gradients conducive to the entry of fish in the north branch, and also reduces the chances of river bed erosion in the downstream section of this branch.

These structures also have an element of innovation. Given that the construction in the dry of a rockfill dam between the islands would have required cofferdams with a low hydraulic head and an oversized span, the team favoured a design for an in-stream built dam. The selected approach is similar to a cofferdam design, but includes additional protective measures to ensure its long-term operability, and to comply with dam design criteria.

Figure 4 - KP 33 weir

Spur dyke at KP 49
Favouring a rockfill spur dyke rather than a concrete weir, and adjusting to field conditions

Originally, a concrete weir incorporating the construction of cofferdams and a long diversion canal was planned for this site. It was finally built entirely out of rockfill reaching up to 2 metres in diameter in order to withstand the flow from these tumultuous rapids. The change in design required detailed hydraulic studies to ensure the long-term operability of the weir.

An ice bridge was required to put the rockfill protecting the right bank into place. Its construction was completed as planned, in spite of the slow start of the winter in 2009, during which the very mild climate delayed the formation of ice.

As the work approached completion, AECOM engineers became aware that the water levels were slightly below target. In spite of all the efforts made, it had not been possible to conduct an accurate bathymetric survey of the rapids during the engineering design process, and certain low readings were missing. Thanks to the design approaches retained, it was possible to respond quickly and modify the geometry of the spur dyke tip in compliance with the design criteria.

Since the completion of the work, road access to this structure has been dismantled, restoring the land to nature.

Figure 5 – Spur dyke at KP 49

KP 170 weir
Use of prefabricated components for time savings and increased control

The KP 170 weir was built at the main outlet of Lake Nemiscau. This structure controls the lake levels, as well as those of the Rupert River over a distance of about 45 km, and those of the Nemiscau River over about 24 km. The area is used extensively for boating, fishing, trapping, and hunting activities. Many camps are located there.

In addition, KP 187 is the location of the Old Nemaska site, which is vitally important to the Crees. The area is rich in aquatic grass beds and marshes used a lot by dabbling and diving ducks for feeding and breeding. Spawning grounds were identified downstream from the KP 170 site, on each of the branches of the Rupert River, and on either side of the island that is located on the site.

The KP 170 weir substantially maintains water levels in order to meet the following objectives:

- maintaining the level of Lake Nemiscau;
- conserving breeding habitats of dabbling and diving ducks;
- protecting fishing, hunting, and trapping areas.

At the site of the KP 170 weir, an island divides the flow into two branches. The right branch, which has a lower capacity, is situated in the extension of the main flow from upstream, while the left branch bifurcates at 90 degrees. In addition, the presence of the two river branches worked in favour of interim diversions during the work, which was carried out in three diversion phases.

Phase 1 of the KP 170 weir included preparatory site work to facilitate closure of the left channel and enabled water levels to be maintained as soon as the diversion bays were impounded. It was completed prior to the partial closure of the Rupert Dam gates.

Phase 2 corresponds to the construction of the left weir: it began in November 2009 as soon as the Rupert Dam gates were partially shut with the closure of the left channel, and ended in April 2010, before the spring flooding. It was particularly important to adhere to this schedule, given the lower hydraulic capacity of the right branch.

The right weir was built during Phase 3, which began with the impounding of the left weir. The work was completed in the fall of 2010.

The weirs have a streamlined crest. In order to achieve accurate formwork and to have better factory control of manufacturing while saving precious time, these structures were built using prefabricated components and are now anchored at two points on a base of cast-in-place concrete. This tie system has the advantage of being able to remain in place between the time of casting of the base and the installation of the component. The pyramid-shaped, truncated, and inverted blockout left in place for the tie system to fit through ensures that the uplift force of the component is transferred towards the tie system. There are 58 components, measuring 1.4 metres high and 5.0 metres long, for a total design gross weight of 33.5 metric tons each.

Prefabricated crest component delivered at work site

Figure 6 – KP 170 weir

KP 223 weir
Monitoring of the Rupert River water line over a distance of about 48 km

Due to the abundance of aquatic grass beds and feeding habitats, this area is widely used for waterfowl migration and breeding. The key environmental issues justifying the construction of the KP 223 structure are as follows: preservation of the aquatic grass beds and feeding habitats; conservation of an area that is extensively used for waterfowl migration and breeding; and protection of fishing and goose hunting areas, as well as fish passability.

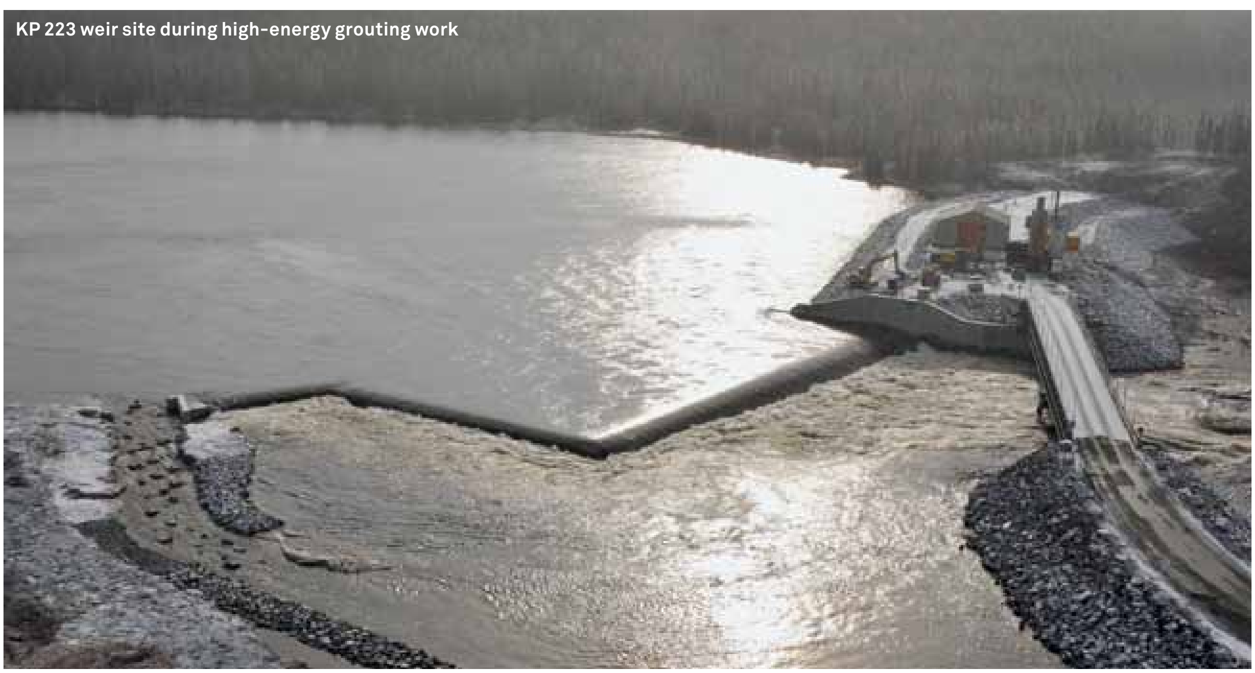
The layout of the KP 223 structures, erected in the section of the river where the flow is subdivided by an island, was defined in such a way that meets the different environmental criteria, while at the same time reduces the volume of concrete by taking advantage of the rock outcrops.

The site development comprised the closure of the left channel and the implementation of a weir on the right bank. The structures included a rockfill dam on the left bank, a concrete trapezoidal weir in three sections, a fish pass built on the right bank in two flights and a spawning ground distributed over two zones situated downstream of the upstream and downstream flights of the fish pass.

The distribution of the difference in elevation between the two flights of the fish pass required excavating the bedrock at the level of the second control point downstream of the weir.

In order to ensure the imperviousness of the dam, high-energy grouting was placed at the centre of the structure. This solution was preferred over a till core in bedrock due to the great depth that would have been required for a cutoff trench to bedrock (11 metres in the deepest places).

KP 223 weir site during high-energy grouting work



KP 290 weir
Weir type chosen to preserve the natural characteristics of the site

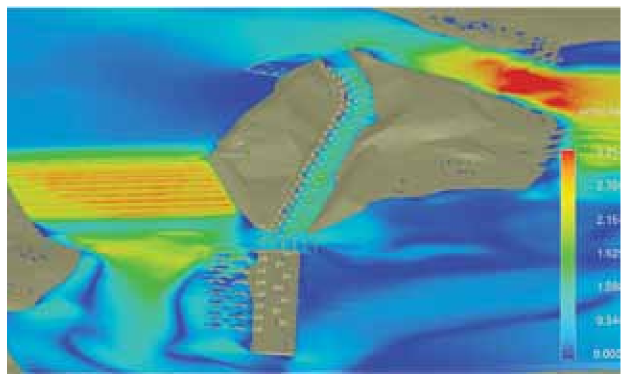
The water levels are maintained by two rockfill weirs, which have no impervious component. The stability of the rockfill was previously assessed according to the flow and ice effects. The layout ensures that fish can circulate freely.

Sturgeon and brook trout spawning grounds, and a nursery area were developed in order to compensate for the habitat loss downstream from the rapids, due to drawdown of the water levels. The fish pass was built to accommodate natural constraints, by duplicating site crossing constraints similar to the conditions before the diversion. It is built on an island separating the left channel from the centre channel. It is 10 metres wide and 155 metres long, and presents a 1.7-percent longitudinal slope and a 10-percent transverse slope in order to concentrate the flow on the left side during low-flow summer conditions. Large-sized derrick stones serve as shelter for the fish.

The design of this structure was largely based on 3D flow modeling. The accuracy of the representation can be assessed by comparing the photo and the results of the Flow-3D modelling. It would have been unthinkable to conduct this type of simulation 10 years ago: the advances have been astounding, and the application is revolutionary.

A detailed presentation of the fish passes was made by the project engineer during a meeting with the Monitoring Committee (follow-up committee made up of local community representatives). The objective of the meeting was to acquaint the committee members with the solutions being considered in order to address all their concerns.

Figures 7 and 8 – KP 290 centre weir and flow modeling using Flow-3D



Environmental impact

Functionality
A living environment maintained

The Rupert River water levels are in compliance with target tolerance limits, and the tailor-made solutions were developed to immediately assist with ensuring the survival of local fauna (fish and birds), while maintaining access to the river for the communities concerned. The monitoring conducted to date confirms that the weirs are functioning well. Spawning grounds and fish passes will be monitored during the coming summers. It should be noted, however, that Cree workers reported that they observed sturgeon using the passes as soon as the impounding occurred.

Figure 9 – Fish pass at KP 290

Social and economic benefits

Sustainable Development
Natural conditions maintained

From an economic standpoint, vacation activities were maintained. From a social standpoint, the traditional activities of the Cree populations were maintained. From an environmental standpoint, the diversion mitigation measures made it possible to maintain the natural condition of the fish habitat (migration, breeding, etc.). The ability of wildlife to cross the weir sites was maintained, as was navigability by boats. The aquatic grass beds and wetted perimeters were protected. Particular attention was paid to limiting water turbidity. All of these measures were determined by Hydro-Québec, in partnership with the Cree populations that were affected. AECOM demonstrated an in-depth understanding of the challenges to be met, and in spite of the constraints, was thus well-positioned and proud to contribute to this sustainable development project. In connection with the approach to managing instream flow release, the weirs also play a role in breeding, which fluctuates according to the season. Hydro-Québec is currently carrying out close environmental monitoring.

In order to ensure the safety of users while the weir project work was underway, the team was assigned to monitor the safety of the ice cover used by the Cree community for crossing by snowmobile. In addition, ongoing efforts to publish work-related warnings and maintain a regular communication with the Monitoring Committee (work follow-up committee comprised of representatives of the communities concerned) were made. Finally, the sites were supervised throughout the duration of the work, and subsequently rehabilitated.

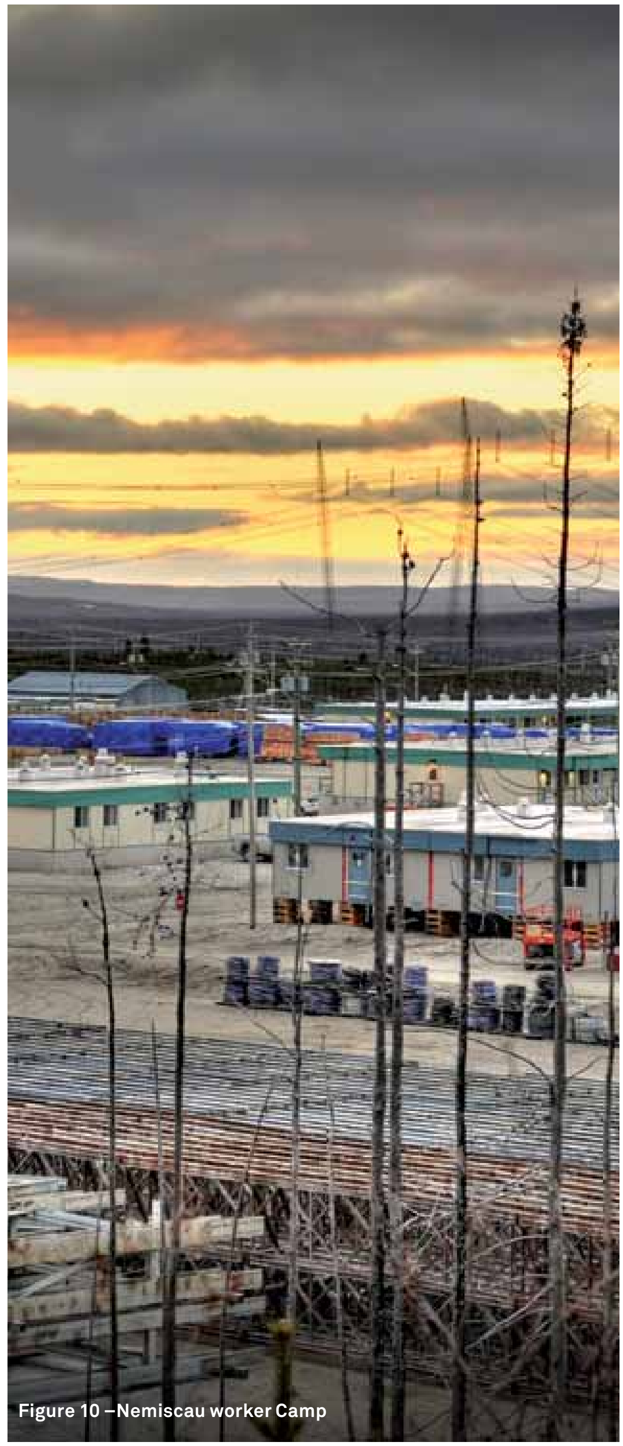


Figure 10 –Nemiscau worker Camp

Exceeding Client Needs

Budget

When the environment and the economy go hand in hand

All the professional services complied with the budgets approved by the client. It should be emphasized, however, that the AECOM team's involvement in identifying and defining the project enabled the reduction in some work-related costs thanks to the proposal of designs with less expensive materials that were more suitable to meet the integration requirements of the host environment. Thus, within the framework of this project estimated at around $150 million, the solution of replacing the KP 49 concrete weir by a rockfill spur dike generated all on its own an economy of more than $10 million.

Schedule

When the fish call the tune

Given the fact that the different phases of the life cycle of fish have to be considered in establishing the work schedule, the available ranges were consequently considerably reduced. The engineering schedules were nevertheless met, and construction was two months ahead of schedule at the KP 170 weir. Reliable schedule performance constituted one of the major challenges of the work, given the expected diversion sequence. A delay could have resulted in the work being taken out of the contractor's hands or could have caused flooding.

Human Resources Management

Choice of resources:

Development of experience to enhance the transmission of knowledge

- Harnessing the core of the Eastmain River Project team:
  Taking advantage of the experience acquired, consolidating team spirit, and acquiring in-depth expertise in a new area;
- Assignment of tasks taking into account the individual challenges of each stakeholder:
  Given the complexity of the projects, the hydraulic engineers met challenges that were tailor-made for them;
- Learning:
  Integration of junior members within a very experienced team;
- Coaching and skills development:
  This project provided an opportunity to gradually transfer responsibilities between the project director and the project engineer.

Mobilization
Close monitoring of the project components

Although it had successfully completed a similar structure as part of the Eastmain River Project, the AECOM team never considered for one moment resting on its laurels.

First step: visit the Eastmain jobsite, meet the KP 207 weir construction managers, and conduct an analysis of the project's strengths and weaknesses. The team was then ready to plan its actions in order to provide a remarkable design of the Rupert River weirs, each of which had its own set of challenges.

During construction: great importance was given to the jobsite visits organized to give all parties involved the chance to see firsthand the fruits of their labour. These visits provided a lively supplement to the photos, regularly sent to the team by the key jobsite workers, and which showed the progress of the work.

Motivation
Supporting life

Each phase of the Rupert River weir project (identification, definition, implementation, start-up, and final overall operation) was consistently marked by a desire to preserve and protect river life. A combination of circumstances demonstrating how such a project gathers people who believe in it the most; the majority of the engineers involved in the project are great outdoor enthusiasts. When professionals commit to serving a large-scale hydroelectric power project through their skills, hard work, and drive, they find within themselves a single-minded devotion to preserving life in all its wondrous complexity.

Impact on the Canadian Consulting Engineer

Impact on the Profession

A new philosophy that is gaining ground

From a technology standpoint, AECOM was a leader in the use of FLOW-3D software, which has since become the referencing software for Hydro-Québec. This highlights AECOM's contribution to advances in the development of design techniques.

From a technical standpoint, the expertise acquired in implementing the rock blanket at KP 20.4, a structure erected under the water that was barely visible from above ground, caught the attention of Yukon Energy. The corporation would like to entrust AECOM with the implementation of a similar project in the Yukon, at a site where the natural aesthetic features of the river will require particular attention after the work is completed. This project involves a component similar to the KP 20.4 structure. This new contract emphasizes the growing interest of clients in preserving the environment as part of their projects.

For this reason, AECOM is very proud to have participated in the implementation of the Rupert River weirs, one of the key components of the Eastmain-1-A–Sarcelle–Rupert Project. This type of project helps disseminating our expertise worldwide.

Conclusion

Measured against the yardstick of the James Bay development, the Rupert River weirs are emerging as a significant project, in that they are the direct result of a change in philosophy within the industry, a desire to reconcile the growing need for energy resources with an energy conservation ethic. In this context, the work of engineers is driven more than ever by exciting challenges. While this project is an integral part of a large hydroelectric production complex, it nevertheless does not contribute to increasing the energy production of the powerhouses in question. In a certain way, however, it does represent a surety.

Holding back the water is retaining the essence of our collective memory, which is nourished by these large open spaces and by humankind's respect for nature.

About AECOM

AECOM is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. With approximately 45,000 employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation and technical excellence in delivering solutions that create, enhance and sustain the world's built, natural and social environments. A *Fortune 500* company, AECOM serves clients in approximately 125 countries and has annual revenue in excess of $7.0 billion.

More information on AECOM and its services can be found at www.aecom.com.

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