Case Study

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105 Decker Court, Suite 825
Irving, Texas 75062
Phone: 469.499.1044
www.plasticpipe.org

STORM WATER SYSTEM DESIGNED TO PROTECT 380-YEAR-OLD NATIONAL HISTORIC SITE FOR ANOTHER 100 YEARS

QUEBEC CITY - The Saint-Louis Forts and Chateaux historic site here has a new storm water retention system that will provide erosion protection for the next 100 years due to the use of corrugated high-density polyethylene (HDPE) pipe. In addition to the long projected life of the pipe system, it was possible to install it with minimum disturbance in an historic area that dates back to the early 1600's. The project, located under Dufferin Terrace in Quebec City near the Chateau Frontenac, was finished in early 2011. The use of the HDPE pipe system enabled beating many odds including the difficult terrain of a cliff face and the demands inherent in the preservation of centuries-old buildings.

Between 1620 and 1834, four forts and two chateaux were constructed in upper Quebec City. The site has three elements - the forts, the chateaux and gardens. The first of the forts encompasses a few wooden buildings surrounded by a palisade that was constructed by Samuel de Champlain in 1620 after his discovery of the area in 1608. Champlain expanded by building a second fort, which he called St. Louis, in 1626. Later, a third fort was constructed in 1636 by Charles Huault de Montmagny who built over Champlain's second fort during a 24-year construction project, which included the first chateaux. The fourth fort was built in 1693, followed by a new chateaux the next year. The Dufferin Terrace was added to the complex in 1879.

In 2005 an archeological research project commenced there uncovering significant artifacts from the 1620's in the area. Parks Canada archeologists and specialists found walls, platforms and cannon balls and removed 1,500 square meters of the terrace's wooden platform to reinforce the fortification wall. Because of the extensive work on the archaeological site under the Dufferin Terrace, visitors now have access to the remains of the basement of Castle St. Louis and the new storm water retention system built under the structure enables the recovery and control of runoff. Every year, an average of 2.5 million visitors walk along Dufferin Terrace that overlooks the St. Lawrence River.

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The installation of the storm water system in conjunction with the creation of a venerable outdoor museum at the site required JES Construction (Quebec City) to assemble the under-terrace retention system during November and December 2010. JES also rebuilt the steel structure supporting the Terrace, replaced joists and wooden planks and improved lamppost wiring.

Located under the terrace, the storm water retention system is more than 300 feet (91 meters) long and consists of four rows of 48-inch (1200 mm) diameter watertight and one run of 36-inch (900 mm) diameter perforated HDPE pipe in order to contain the 4400 cubic-feet (125-cubic-meter) of water runoff from the roofs of the buildings and surrounding areas. For the watertight sections, the pipe used was a double walled (smooth inside, ribbed outside) corrugated HDPE pipe from Soleno, Inc. (Quebec City) called Solflo® Max and manufactured locally at the company's Saint-Jean-sur-Richelieu plant. The corrugated HDPE pipe used is AASHTO M294 certified, meets ASTM standards for F405 and F667, and complies with Canadian Standards Association, CAN/CSA B182.8. A 32-foot (10m) long section of the company's 36-inch (900 mm) diameter perforated Solflo Max corrugated HDPE pipe is tied in at the end and will vent any overflow in case the system reaches maximum capacity. Manhole height ranged from 6.5 feet (2 m) to 11 feet (3.41 m). A clean stone cover was used to wick away extraneous water. The system was also covered with extruded polystyrene insulation as well as a waterproof membrane and a geotextile added protective layer.

"This is a very innovative use of corrugated HDPE pipe," stated Tony Radoszewski, president of the Plastics Pipe Institute, Inc. (PPI). "Mostly we see its use in road work, under parking lots and in other modern building projects. To see the attributes of the pipe being used at a very important North American historic site is reassuring – it ensures the site will be well protected from flooding for future generations to enjoy. The pipe is strong, durable, light-weight and flexible while providing excellent watertight protection for the centuries-old, fragile, delicate site.

"For more than 200 years this was the hub of French and English rule in Quebec and served as the official residence and seat of power for most governors. And Champlain himself built the first fort on the site plus his residence where he later died. It's gratifying to know that the pipe systems and products we at PPI promote are now safeguarding these treasures for more to enjoy."

PPI is the major trade association representing all segments of the plastic pipe industry. The pipe manufacturer, Soleno, is a member company of PPI.

The limited space and the age of the site posed logistical challenges for the construction team. "We felt fortunate that the engineering design firm, Roche, selected the HDPE pipe,"

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shared Eric Blanchette of JES. "The installation would not have been possible without it. We had to make sure all the pipe could fit between the new support columns. We couldn't use heavy equipment; it was like working in a small basement. One advantage of HDPE pipe is that it is big and strong but still light; so it was easy to take the pipe sections under the terrace. The pipe is 3.08 meters long - about 10 feet - and easy for our crew to carry and maneuver them around the support columns.

"The other challenge was backfilling. Soleno's Johanne La Roche suggested that we put in clean stone so we would have voids between the stones that would take the water around the pipe. We surrounded the whole system with non-permeable membrane to protect and contain any water volume inside. The retention system outlet connects to the city's system."

"In fact, there were very few viable alternatives for the pipe," explained Bernard Marquis, eng., technical director of Roche Ltd. Consulting Group (Quebec City). "We needed a product that would provide a very specific solution including being able to handle the water volume, flow rate, as well as having the strength and the projected longevity that a storm water retention system requires. Only this time, the pipe had to do all of that, plus maneuver easily, fitting into tight spaces and providing maximum holding capacity.

"Water volume, available space and the restricted room to transport the pipe into place presented significant challenges. One of the biggest was putting the pipe under the terrace between the columns and support beams. Roche had to make sure in its planning that the pipe would fit and could be maneuvered into place - without the use of any heavy equipment because of the area's size and somewhat delicate condition. We were able to fit in a mini-excavator that has a cab about as big as a phone booth," he said. "The constraint made the installation nearly impossible - but HDPE pipe provided a solution -- the only solution.

"The reason Parks Canada wanted a closed-in storm water retention system was because it would enable part of the area under Dufferin Terrace to become the museum," Marquis continued. "To protect this area and make it possible for visitors to actually see and walk around structures that date to the 1600's, it had to be enclosed with walls and windows. But by doing this, the storm water that used to come through the Terrace can no longer go into the ground. This created an overflow of rain water, which had to be detained before it flowed over the cliff and onto the houses and buildings below, so the water had to be held and flow at a specified rate into the sewer system of the city."

"Champlain built on this very site nearly 400 years ago," said PPI's Radoszewski. "And it has been wonderfully preserved. With the HDPE pipe storm water retention system controlling water runoff and erosion, it will last for hundreds more."

For more information, go to: www.plasticpipe.org.

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About PPI:
The Plastics Pipe Institute Inc. (PPI) is the major trade association representing all segments of the plastic pipe industry and is dedicated to promoting plastics as the material of choice for pipe applications. PPI is the premier technical, engineering and industry knowledge resource publishing data for use in development and design of plastic pipe systems. Additionally, PPI collaborates with industry organizations that set standards for manufacturing practices and installation method.

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