

# concretepipenews

The Magazine of the American Concrete Pipe Association

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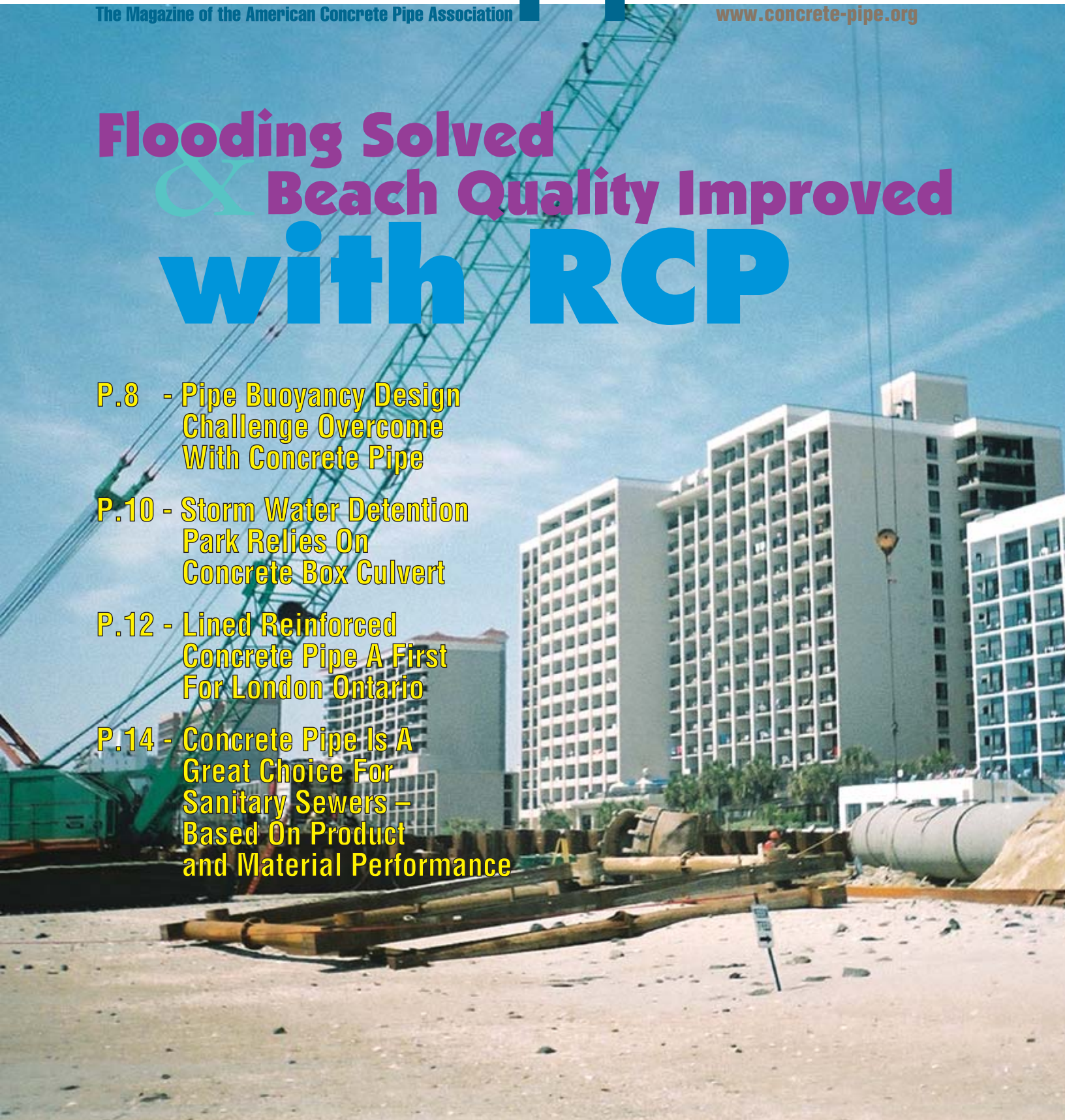
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**This issue:**

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*Concrete Pipe News* is published four times each year by the American Concrete Pipe Association. It is designed to provide information on the use and installation of precast concrete pipe products for a wide variety of applications, including drainage and pollution control systems. Industry technology, research and trends are also important subjects of the publication. Readers include engineers, specifiers, public works officials, contractors, suppliers, vendors and members of the American Concrete Pipe Association.

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American Concrete Pipe Association

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Twin 60-inch  
diameter RCP  
storm sewer to  
relieve  
flooding and  
improve  
shoreline  
environment.**







*John J. Duffy*

## Design Engineers Are Legally Bound and Responsible To The Public

Increasingly tough national and state legislation places an extraordinary duty of care on the shoulders of engineers when it comes to risk assessment of their professional opinions and designs, as well as the ever-present scepter of negligence for actions taken without sufficient knowledge.

We know through documented court cases of drainage pipe and culvert failures that problems most often begin following release of specifications based on the design engineer's concept for the servicing of a project. Such problems may be related to the owner's cost-driven instructions, the standards of a jurisdiction that may allow alternate products, a cost-cutting proposal from the contractor to use a product or plan not specified by the engineer to meet "value engineering requirements," or a contract poorly considered and executed. Decisions are made, and eventually the public may wind up with an inadequate facility that will not meet its design life because the service life of materials and products used in the construction was too short.

The American Concrete Pipe Association (ACPA) challenges misinformation and unsubstantiated claims of competitive products, while placing concrete pipe under a microscope for all to see its features and benefits. ACPA champions research and development of many aspects of concrete pipe performance, as well as that of competitive products. It does this to advance the body of knowledge of pipe materials so that designers, specifiers, pipe producers and contractors get it right the first time by installing drainage systems that last for their full design life. Material and installation costs, however, often override engineering knowledge, leading to high-risk installations.

Value engineering is focused to a large degree on cost cutting measures, usually centered on initial cost of materials. In many projects, life cycle cost analysis (LCA) considerations are absent or minimized during value engineering exercises. Value engineering should include a life cycle cost analysis that accounts for the replacement costs of using products with documented shorter

service lives. ASTM C 1131 *Standard Practice for Least Cost (Life Cycle) Analysis of Concrete Culvert, Storm Sewer, and Sanitary Sewer Systems*, covers procedures for least cost analysis for drainage pipe materials. The concrete pipe industry's *PipePac* software includes an LCA program plus a cost analysis of the pipe envelope to help contractors and specifiers compare installation costs other than the cost of pipe material alone. If value engineering were applied as it was originally conceptualized, the engineer would be better able to identify and manage risks associated with a project.

It is important to be realistic about the fundamental differences between a rigid and a flexible pipe. Bearing this in mind may keep the design engineer out of court. Durability of concrete pipe is certain, as it is an engineered product for each application and comes with most of its structural performance in the product. On the other hand, thermoplastic products need to have their structure built in the field by the contractor's crew. Concrete pipe is more forgiving if a contractor's crew is not willing to take the time, or make the effort necessary to achieve proper installation requirements. The integrity of the soil envelope is a critical component of the structural performance of flexible pipe design. Trench box use specifications, pipe bedding and envelope standards, installation techniques, and material handling on site - all work together to provide a proper installation. Installing thermoplastic pipe is unforgiving. The installation must be rigidly controlled and monitored to prevent such common occurrences as snaking and deflection.

ACPA has worked with the buried pipe industry over the last two decades to introduce new bedding specifications called Standard Installations that take into consideration the strength of concrete pipe, product application and native soil conditions. Designers can be more confident that a concrete pipe installation has a broader range of bedding alternatives than metal or plastic materials, thereby potentially reducing construction costs through LCA calculations and the use of new bedding standards that are steadily being adopted across the Nation.

What about keeping the industry informed to raise the level of knowledge about buried infrastructure? ACPA, its members and allies are constantly offering educational programs in the form of seminars, conferences, plant tours and published material to keep industry current on technology and ongoing research. The pursuit of product and technical knowledge never ends for concrete pipe producers, and their national and state associations. This information is readily shared with industry partners to help contractors, owners and civil engineers to do their job in an environment where the possibility of legal action is reduced. Indeed, engineers are legally bound and responsible to the public for their professional opinions and designs. A sound knowledge of the products and materials they work with to provide the Nation's lifelines will go a long way to keep them doing the job they were called to do and away from the needless anxieties faced in litigation. ☺



## Tom Wheelan, P.E. Senior Vice President, South Central Region Hanson Pipe & Products, Inc. Houston, Texas

Tom Wheelan is a professional engineer who came to work with Gifford Hill (now Hanson Pipe & Products, Inc.) some 25 years ago. A graduate of the University of Iowa, his experience with pre-cast concrete spans more than 40 years.

Tom is past chairman of the Texas Concrete Pipe Association while significantly contributing to the work of committees and the Board of Directors of the American Concrete Pipe Association (ACPA). He has served as Chairman of the Marketing Committee and chairs subcommittees of ACPA's Technical Committee. Tom is currently involved with technical and marketing issues as they relate to the use of concrete pipe for sanitary sewers. We asked Tom a few questions, knowing that his answers would assist concrete pipe producers and specifiers in recognizing that a strong case can be made for the use of concrete pipe for sanitary sewers.

**Q:** *Today's concrete pipe is a much different product than the concrete pipe of twenty years ago. What improvements have been made that will benefit the sanitary sewer market?*

**Wheelan:** There are two improvements that probably had the greatest impact on the concrete pipe industry over the past twenty years.

The first impact that comes to mind is the

pipe joints. Before the 1980s, concrete pipe had a reputation for having bad joints which was deserved in some cases. Producers reacted by improving the quality of joints, industry-wide. This was accomplished by using steel headers to form the spigots of the pipes, and leaving the headers on the pipes throughout the curing process, thereby assuring the roundness of the spigot. Improvements in gasket designs that made field installations easier and better, also improved pipeline systems.

The other major factor has been the replacement or upgrading of pipe manufacturing equipment over the same period. The introduction and wide use of the two directional packerhead method, and the improvements in the performance of the vibration process has raised the quality and density of concrete

pipe. Concrete mixer design has also improved, which has raised the quality and consistency of the concrete used in the pipe. Introduction of automation and robotics in the pipe manufacturing processes has further improved quality and consistency in the products.

**Q:** *What conditions tend to be the primary cause of the formation of sulfuric acid in sanitary sewers that can sometimes be a problem for concrete pipe?*

**Wheelan:** Flow velocity, temperature, and concentrations of the sewage are the primary factors in the formation of sulfuric acid in sewers. The most reliable way to control sulfuric acid formation in sanitary sewers is by providing adequate slopes which results in velocities of greater than two feet per second in the pipeline. Engineers performing a sanitary sewer design should check conditions for possible acid formation and alter designs to prevent the formation of hydrogen sulfide and sulfuric acid.

Hydrogen sulfide, alone, is not deleterious to concrete. Concrete corrodes only after the conversion of hydrogen sulfide to sulfuric acid,



although hydrogen sulfide gas does affect metals such as ductile iron pipe. Sanitary sewer designers should design for the prevention of hydrogen sulfide formation, not only to prevent corrosion, but for health reasons as well. Hydrogen sulfide gas is toxic to humans and sometimes results in death.

The ACPA offers a Sulfide Design Manual to aid designers with sanitary sewer design to avoid hydrogen sulfide formation.

**Q:** *Please comment on today's best practices for designing a concrete pipe system to convey ordinary municipal sanitary sewage.*

**Wheelan:** Today's practices, whether or not they are the best, do not always direct the design to reduce the formation of sulfuric acid, but instead to protect against the effects of the acid. The materials that offer the protection from acids normally do not offer the structural capability that is inherent in concrete pipe. Though I am prejudiced, the best practice is to design the sewer system with adequate slopes and proper pipe sizing to prevent the acid formation, and if necessary, add protection to the concrete pipe with inert materials, such as plastic liners. This will give the owner of the sewer system a pipe that is less likely to have an acid problem along with the ability to protect the pipe structure, if there is an acid condition.

**Q:** *In the last 20 years, several joint designs have become available for precast concrete pipe. What joint options are available for precast concrete sanitary sewers?*

**Wheelan:** The introduction of profile and self lubricated joint gaskets to compliment circular gaskets has made it simpler for contractors to make good field installations, nearly eliminating the possibility of joint infiltration or exfiltration.

**Q:** *Do you believe that federal and state legislation regarding sewage discharge regulations is providing opportunity for the use of concrete pipe as sanitary sewers? Why?*

**Wheelan:** Both federal and state legislation require more stringent infiltration/exfiltration rates than in previous years. Precast concrete

pipe is the best solution for these new limits because of two reasons:

1) As stated previously, precast concrete pipe joints are watertight and easy to install, and

2) Concrete pipe to manhole connections and concrete pipe to lateral connections are much more watertight than connections using flexible pipe products. This is because flexible pipe products are designed to deflect, thus preventing a watertight connection to manholes and laterals that don't deflect. Also, because the flexible pipe is much lighter than the adjacent manholes, differential settlement may result between the pipe and the manhole causing excessive stresses in the pipe which may cause cracks and tears.

While much of the focus of watertightness in sanitary sewer systems has been on pipe joints, a great deal of leakage actually occurs in the pipe to manhole connections.

**Q:** *The ACPA has generated software to help design sanitary sewers, and has a large body of information to assist specifiers and designers in understanding the performance of concrete pipe in many applications. What additional work do you see is needed to strengthen the evidence that concrete pipe is a strong choice for sanitary sewer systems?*

**Wheelan:** The biggest challenge currently facing the precast concrete pipe industry in regards to sanitary sewers is educating decision makers about the improvements in concrete pipe for sanitary sewers in the last twenty years.

One great advantage of precast concrete pipe is the variety of options available to satisfy any storm or sanitary sewer project. Modern concrete pipe joints may be designed for either soil tight, silt tight or watertight joints. Plastic liners offer an impenetrable defense to sulfuric acid and other deleterious substances, and concrete pipe provides the strength to handle any load or depth.

I would encourage anyone interested in more information regarding concrete pipe for sanitary sewers, or any other application to contact the ACPA offices. ☺



# Flooding Solved And Beach Quality Improved With RCP

By Curtis Carroll  
N.C. Products, Raleigh, North Carolina  
(A Division of Oldcastle Precast East)  
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Flooding within the 189-acre Yaupon Drive Drainage Basin of Myrtle Beach is a distant memory to many residents and commercial business owners, while locals and tourists alike take pleasure in a healthier beach and near-shore waters. A major two-part project completed in the summer of 2003 made this possible. A twin 60-inch diameter reinforced concrete pipe storm sewer routed along 25<sup>th</sup> Avenue South collects runoff from the basin and discharges the treated storm water into the ocean at a point approximately 1,100 feet offshore. The ocean outfall pipe is not visible on the shore or in the water. Along with surrounding structures, it acts as a reef to encourage the establishment of a natural aquatic habitat.

Before the drainage basin improvement projects were initiated, many properties along Yaupon Drive experienced flood damage during major storm events because of changes in drainage flows due

to recent development. The basin is approximately 80% developed. The residential area is estimated to have a 70% impervious surface while the commercial area has a 95% impervious area. Once funding was secured through a ballot referendum in 2001, construction of the Yaupon Drive project began in January 2003.

The piped system commences at mid block of 25<sup>th</sup> Avenue South from an open drainage channel. Designed for a 50-year storm condition, the twin sewer intercepts several existing storm sewers, collecting the water for discharge far from the shores of the beach. These smaller sewers and drains had formerly discharged directly onto the beach and were considered by many as an eyesore.

Some had the potential of causing beach erosion, and others may have contributed to higher bacteria counts that affected recreational activities. The landward side of the



**Cleaner shores with elimination of small storm sewers.**



Photos: N.C. Products

project included several large underground junction boxes that allowed water quality improvements before the storm water was released into the ocean. Oil and grease was removed, along with street litter, sand, trash and cigarette butts.

N.C. Products of Raleigh, N.C. supplied 1,632

side, under the beach and 1,100 feet offshore where it dilutes in the ocean. Other areas of the Myrtle Beach oceanfront are being considered for ocean outfalls.

The City's goal is to reduce the number of pipes on the beach, maintain high water quality standards, and provide a reliable storm water drainage system to alleviate flooding.

Greenwall Construction Services Inc. of Myrtle Beach was responsible for acquiring and installing the product for the \$1.3 million landward side contract. Mysener Marine of Tampa, Florida was contracted at \$4.3 million to install the precast concrete cylinder pipe on the ocean side. Project engineering was carried out by DDC Engineering of Myrtle Beach. ☺



**Installation of twin 60-inch diameter RCP storm sewer.**

**Storm water carried under the beach to discharge 1,100 feet offshore. ▼**



feet of twin 60-inch diameter Class III reinforced concrete pipe for the landward contract of the project. All pipe units were supplied with O-ring rubber gaskets to provide watertight joints and restrict the migration of fines into the sewer lines.

The outfall is described as the ocean side of the project. Other communities along the east coast have used ocean outfalls for storm water successfully, but all must be evaluated and carefully designed to function properly. Rainfall runoff travels through the pipes on the landward

<b>Project:</b>	Yaupon Drive Drainage Basin Improvement Project City of Myrtle Beach
<b>Owner:</b>	City of Myrtle Beach South Carolina
<b>Consulting Engineer:</b>	DDC Engineers, Inc. Myrtle Beach, S.C.
<b>Contractor:</b> (landward side)	Greenwall Construction Service, Inc. Myrtle Beach, S.C.
<b>Contractor:</b> (ocean side)	Mysener Marine Tampa, Fla.
<b>Quantities:</b>	Two lines (1,632 feet each) of 60-inch diameter Class III RCP
<b>Producer:</b>	N.C. Products (A Division of Oldcastle Precast East) Raleigh, N.C.

N.C. Products/Oldcastle Precast at Raleigh NC and its two satellite plants at Fuquay, NC and Vander, NC have supplied the construction industry of the Carolinas with quality precast concrete products for over 50 years. Oldcastle's Raleigh facility manufactures a wide range of precast concrete products including: concrete pipe, grease traps, oil water separators, pump stations, box sections, catch basins, and manholes. For more information, visit [www.ncpproducts.com](http://www.ncpproducts.com).



*Architect's rendering of new municipal complex.  
Photo: Kellit Fedele, P.E., Charles E. Rains and Company*



# Pipe Buoyancy Design Challenge Overcome With Concrete Pipe

*By Robin Woodbury  
Premarc Corporation, Durand, Michigan  
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Steadfast and strong, like the name of their city, the citizens of Gibraltar Michigan voted to build a new 35,000 square foot municipal complex in 2002 that includes a city hall, fire station, and police station. It also houses employees from the Clerk's and Treasurer's offices, the Department of Public Works, council chambers, and a museum. The longevity of the new complex is assured by the architectural and engineering design for the 3 1/2-acre site serviced by a concrete pipe storm sewer with a 100-year service life.

Upon request by the City, engineers from

Charles E. Rains designed the layout of the project including a new parking lot, roof drains, driveways and a storm drain outlet to the Detroit River. Due to its strength and 100-year service life, reinforced concrete pipe was specified for the drainage of this project. Since the City of Gibraltar borders the Detroit River, and is characterized with many canals and a low laying landscape, it was important that storm drain system floatation issues were carefully addressed when selecting the pipe material. The weight of the concrete pipe minimized any floatation issues, ensuring a solid structure with well-connected joints.

Gibraltar is the marshland and wetland of

***Reinforced concrete pipe selected for service life and resistance to buoyancy.***



Photos: Premarc Corporation

***Site of 35,000 square foot municipal complex.***





Metropolitan Detroit. In a low laying or marshy environment, the buoyancy of buried pipelines depends on the weight of the pipe material, the weight of the volume of water displaced by the pipe, the weight of the liquid load carried by the pipe, and the weight of the backfill material. Whenever the water table level is above the invert of the pipeline, the potential for floatation or buoyancy exists. Although the trench for a pipe installation in a marshy area is dewatered, the trench area downstream (after initial backfill) may become saturated. This would lead to a buoyant effect on the pipe. The mass of the concrete pipe typically counteracts this buoyant force. Alternate materials such as thermoplastic pipe and corrugated metal pipe may heave vertically or snake horizontally in wetland conditions. During the backfill operation, the fill may accumulate more on one side of the pipe than the other. The mass of the concrete pipe resists lateral forces, and the structure remains true to line and grade. These are some of the technical issues that the engineer faced when preparing the design of the storm sewer which helped lead to a specification for concrete pipe.

Compeau Brothers, Inc., was awarded the contract for the site preparation, paving and installation of the new storm sewer. Premarc Corporation supplied the reinforced concrete pipe. When construction was completed in the fall of 2004, Gibraltar citizens were able to showcase a new municipal complex that would meet their needs for decades. ☺

<b>Project:</b>	City of Gibraltar Municipal Complex Southern Wayne County, Michigan
<b>Owner:</b>	City of Gibraltar
<b>Consulting Engineer and Surveyor:</b>	Charles E. Raines Company (site servicing design) Riverview, Michigan
<b>Architect:</b>	Wilkie & Zanley Wyandotte, Michigan
<b>Contractor:</b>	J.M. Olson Corporation (construction management general contractor) St. Clair Shores, Michigan
<b>Contractor:</b>	Compeau Brothers, Inc. (site preparation, paving and sewer installation) Flat Rock, Michigan
<b>Quantities:</b>	968 feet of 12-inch diameter Class IV RCP 184 feet of 15-inch diameter Class IV RCP 112 feet of 18-inch diameter Class IV RCP 384 feet of 24-inch diameter Class IV RCP 280 feet of 30-inch diameter Class IV RCP 11 (48-inch) precast concrete manholes 3 (60-inch) precast concrete manholes 1 (72-inch) precast concrete manhole
<b>Producer:</b>	Premarc Corporation Durand, Michigan

The Premarc Corporation is a leading manufacturer of concrete products for the construction industry. Founded in 1927 in Durand, Michigan by the Marsh family, the company operated primarily in the Flint and Lansing area. In the past 15 years, it has expanded its sales territory with facilities in Cadillac, Traverse City, Grand Rapids, and Clarkston. Premarc's delivery fleet supplies the entire lower peninsula of Michigan and extends into Indiana.

Premarc's manufactured product line includes all shapes and sizes of precast reinforced concrete sanitary and storm sewer pipes, manholes, catch basins, wet wells, and pump stations. Bridge products include concrete box culverts, prestressed bridge beams and CON/SPAN. For more information, see [www.premarc.com](http://www.premarc.com).

Photo: Randy Wahlen, PE

# STORM WATER DETENTION PARK RELIES ON CONCRETE BOX CULVERT

By Randy Wahlen, P.E.  
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Utah's second largest city, West Valley City, has seen significant growth. The population has increased by 25 percent since the last census to a total of nearly 114,000 residents. Lately, City projects have included the 12,000-seat Olympic Hockey Arena and a 20,000 seat outdoor amphitheater. One of the City Engineering Department's more significant achievements has been the establishment of its Storm Water Utility. Initiated in 2001, the Storm Water Utility has helped the city deal with the EPA requirement to use Best Management Practices with regards



*A specially constructed precast section provides for a change in the outfall alignment.*

*A trackhoe excavates to install another 11-foot x 4-foot precast box section.*

to storm water management. One of West Valley City's major capital improvement projects has been its Storm Water Detention Park.

Spurred by major growth in a relatively undeveloped area of the City, engineers developed the concept of a large storm water detention park that would serve the critical need of storm water detention, while providing storm water education and a demonstration facility for students. The concept included purchasing and assembling over 70 acres of open space, much of the land being wetlands. Designed by in-house engineers, the project also relied on a detention area that incorporated an unusable power corridor. The detention area reduced the storm water impact from the residential areas which encompass several square miles of the city.

Mr. Trace Robinson, West Valley City Engineer, explained the concept. "Residential growth on the west side of the City had created the need for a major storm water outfall. The existing outfall does not have the capacity to handle direct runoff, and therefore detention is necessary. This was a great opportunity for us to create a natural storm water park that could pre-treat storm water, help educate young people, and meet the goals related to EPA requirements."

One important element of the storm water detention park is the connection of storm water drainage areas to the park. Once the storm water connections are made, the park's interior channel system has to be designed to maintain



the wetlands, provide aesthetics to the park, and perform the critical storm water detention function.

West Valley City requires all public storm drains to be constructed using concrete pipe. “We rely on concrete pipe because we have a great track record with its durability,” said Jerry Schlieff, West Valley City Operations Manager. “When working in the high ground water areas around wetlands, you wouldn’t want to use anything else.”

While the overall detention park will take several years to complete, one of the first phases of the project was to connect the drainage basins to the park. The 6800 West Outfall project addressed this need. An 11-foot x 4-foot reinforced precast box culvert, with height of cover varying between less than two feet under the road and five feet, was used to convey nearly 400 cfs to the detention ponds. The contractor selected for the project was given the choice to use either cast-in-place or a precast box culvert. His decision to use precast box culvert sections produced to ASTM C 1433 was essential to assure minimal impact to traffic at the road crossing, and help meet project schedules.

“I was surprised at how quickly the precast box culvert was placed,” said Mr. Bruce Cunningham of Cunningham Construction. “We were able to complete the road crossing in three days which would never have been possible with a cast-in-place job.”

Along with the box culvert, a 54-inch diameter storm drain pipe was also installed. The largest challenge to the pipe installation was dewatering the site. This related to groundwater, storm water, and irrigation tail water. Working under power lines and through narrow corri-



Photo: Jerry Schlieff

**Casting of a transition between the 54-inch pipe and the 11-foot x 4-foot box section.**

dors between existing ranch houses was also challenging. With this outfall now completed, City staff will concentrate on finishing the future phases of the detention park, a beautiful natural area that will satisfy an important need for growth and recreation. ☺

<b>Project:</b>	6800 West—Detention Basin Outfall West Valley, Utah
<b>Owner:</b>	West Valley City
<b>Design Engineer:</b>	Trace Robinson, P.E. West Valley City Engineering
<b>Project Manager:</b>	Jerry Schlieff, West Valley City Engineering
<b>Contractors:</b>	Cunningham Construction
<b>Supporting Utilities:</b>	Magna Water Company Comcast Cable Questar Gas Pacific Power
<b>Quantities:</b>	1100 feet of 36-inch Class III RCP 380 feet of 54-inch Class III RCP 277 feet of 11-foot x 4-foot (span and rise) precast box sections 515 feet of 13-foot x 4-foot (span and rise) reinforced concrete flume Various reinforced concrete transition sections and cleanout boxes Gabion retaining walls 380 feet of open overflow channel
<b>Producer:</b>	Amcor Precast (a division of Oldcastle Precast, Inc.) Ogden, Utah



Photo: Jerry Schlieff

**54-inch pipe being transported to the trench.**

Amcor Precast’s Ogden, Utah facility has been in service for over 50 years. Along with a full line of concrete pipe and manhole products, Amcor also produces utility vaults, catch basin products, box sections, and a wide variety of other precast products. See [www.oldcastle-precast.com](http://www.oldcastle-precast.com).

# Lined Reinforced Concrete Pipe A First For London Ontario

By Neil Wyatt • Hanson Pipe & Products Canada, Inc., Cambridge Ontario • 519-622-7574

A 675 mm (27-inch) diameter concrete sanitary sewer commissioned in the late 1960s was replaced with a specially designed 590 meter (1,935 foot) precast concrete system to improve the environment of a London Ontario neighborhood, and solve major structural problems caused by sulfuric acid ( $H_2SO_4$ ). Residents along Gordon Avenue brought the problem to the attention of City officials when they began reporting a strong odor of rotten eggs, associated with the presence of hydrogen sulfide gas ( $H_2S$ ). Evidence of a major problem with the sanitary sewer line mounted when homeowners complained about deteriorating piping in their houses that needed repair by licensed plumbers. Inspections of a major manhole at the intersection of Commissioners Road and Gordon Avenue followed, along with video inspections of sections of the sanitary trunk sewer. It was clearly evident that the sanitary sewer had been aggressively attacked by  $H_2SO_4$  and sections were in need of replacement.

The Gordon Avenue trunk sewer begins near Hooks Restaurant (Wharncliffe Road and Southdale Road) where it receives the flow from the Dingman Pumping Station. From there, the sewer weaves through a combination of streets and easements as it directs flow to the Greenway treatment plant by the Thames River. Overall, the length is approximately 4,500 meters (14,750 feet) with pipe sizes from 675mm to 1200 mm (27-inch to 48-inch) diameter. The 590-meter section of this project is just the first problem area to be addressed by the City over the coming years.

The line of reinforced concrete sanitary sewer installed around 1967 had been designed to receive effluent from the Dingman pumping station. Composition of the effluent was undetermined, and even today with a sewer use by-law in place, there are concerns that aggressive chemicals are entering the effluent from unknown sources. Although the concrete pipe had significant damage to the crown of the pipe, it was still structur-

ally sound, but too costly and almost technically impossible to repair. The new sewer was designed with an increased diameter to reduce the velocity of the effluent and the turbulence that contributes to the production of  $H_2SO_4$ . Designers decided to replace an aging waterline and also a storm sewer while Gordon Avenue was under construction. The manhole at the intersection of Commissioners Road and Gordon Avenue contributed significantly

to the premature deterioration of the sanitary sewer in two ways. First, the 90-degree bend in flow for the sewage created a very turbulent situation, which combined with other environmental conditions in the sewer to generate  $H_2SO_4$ . Flows into the structure were expected to be in the range of 2.5 to 3.5 million gallons per day. In fact, the flows were found to be in excess of 6 million gallons per day. Secondly, the inspections of the system discovered a 2-inch x 4-inch timber about 8 feet long that appeared



Photos: Neil Wyatt, Hanson

**Installation of 36-inch reinforced concrete pipe.**

more like a railway tie because of the build up of debris on it. The lodged timber in the flow-through manhole created turbulence and generated  $H_2SO_4$ . These two factors contributed to the corrosion in the manhole and left an unstable situation which the City discovered as they entered the structure. When lowered into the manhole, the inspector reached for the ladder rungs and discovered the reinforcing steel was more than accessible to his hand. Considering the level of corrosion, the City took action to cover the flow with some piping, and then fill in the manhole with concrete. One can speculate that conditions in this manhole had contributed significantly to the premature deterioration of the sani-

**Lined concrete pipe ready for shipment.**





tary sewers in the area.

In circumstances where sanitary effluent displays common chemical composition and sewers perform as designed, a reinforced concrete sewer is expected to have a service life that meets the design life of the system. It is well documented that service life can be extended or reduced by changes in environmental conditions within and outside of the concrete pipe.

The solution that engineers devised to protect the new reinforced concrete sanitary sewer was to enhance its structural performance with a liner. This solution will extend the service life of the system well into the 22<sup>nd</sup> century, barring any further unforeseen hydraulic or effluent composition changes to the sewage from the catchment area or internal environment of the system. Production of the lined pipe and installation by the contractor were carefully planned, engineered, and documented. The installation of this product is a first for the City of London, and one of only a few in all of Canada. Lined reinforced concrete pipe is available in Ontario, and may be used where special circumstances warrant. Small diameter reinforced concrete pipe does not need to be lined to collect and carry common sanitary sewage.

Hanson worked with the installation crew of Elgin Construction to devise a technique for joining the liner in the field with 10-inch flaps covering the joints, after the sealed joints of the concrete pipe had been properly homed. Hanson produced 260 units of lined 900 mm (36-inch) and 1200 mm (48-inch) diameter pipe in its Cambridge plant. Liners were incorporated into the pipe as it was being produced, and seams welded in-plant before shipment to the site. The seams were located at the crown of each pipe, and Swift Lift anchors located on the barrel so that when pipe was lowered into the trench, the seam location would be consistent along the crown. Installation crews were then able to enter the pipe and weld liner flaps to the liner of the homed pipe to provide a completely sealed interior space with little impact on hydraulics of the system.

Delcan Corporation, the consulting engineering firm for the project had to design the project so that the flows would not be interrupted until it was time to decommission the old line and connect the new. Engineering called for the construction of a larger diameter parallel line, complete with lined manholes, to a location where the new line would cross over the trench to connect with the existing sewer, approximately 590 meters (1935 feet) upstream from the manhole at the intersection of Gordon Avenue and Commissioners Road. As the new system was being constructed, a 300 mm (12-inch) reinforced concrete storm sewer was also installed. Construction was required along the existing paved portion of Commissioners Road at a depth of approxi-

mately 7 meters (23 feet), while maintaining the flow of through-traffic. A trench box was required, along with a series of steel I-beams placed across the top of the open trench to support the exposed watermain and utility conduits during the installation of the sanitary sewer. At the upstream end of the project on Gordon Avenue, the installation ended with a complex crossover of the sanitary and storm sewers. The sanitary sewer manhole at the crossover has a drop structure built into the invert to eliminate, or reduce turbulence in the line. The contractor used a series of two Godwin Pumps to maintain the flow of the sanitary sewage as construction proceeded between manholes.

Engineers redesigned the manhole at Commissioners Road and Gordon Avenue so that the benching directs the inflow to the outflow at a wider angle, thereby significantly reducing the opportunity for turbulence of the sewage to occur. The manhole was also lined to enhance the performance of the structure.

The final phase of the project may be the construction of a biofilter to pull any H<sub>2</sub>S gas from the air in the sewer. The City has decided to monitor gas emissions in the new line to determine if a biofilter is necessary.

The \$CAD 1.7 million contract began in late April and concluded by the end of July 2004. ☺

<b>Project:</b>	Gordon Avenue Sanitary Trunk Sewer Replacement London Ontario, Canada
<b>Owner:</b>	City of London
<b>Consulting Engineer:</b>	Delcan Corporation Toronto, Ontario
<b>Contractor:</b>	Elgin Construction London, Ontario
<b>Quantities:</b>	260 units of lined 900 mm (36-inch, 65D and 100D) and 1200 mm (48-inch, 50D)RCP
<b>Producer:</b>	Hanson Pipe & Products Canada, Inc. Cambridge Ontario

Hanson Pipe & Products, Inc. is a diversified manufacturer of concrete pipe and a variety of supporting products including manholes, drainage structures, box culverts, bridge components, retaining walls and concrete block. Its plant locations throughout North America enable the company to serve the most rapidly growing parts of the U.S. and Canada. Hanson is an international building materials company. It is one of the world's largest producers of construction aggregates, concrete gravity and pressure pipe, precast concrete, and is the leading manufacturer of facing bricks in Europe. See [www.hansonconcreteproducts.com](http://www.hansonconcreteproducts.com) for details.



*Pipe installed through I-beams.*



# Concrete Pipe Is A Great Choice For Sanitary Sewer

Concrete pipe has a history of excellent performance as a durable product for sanitary sewer pipelines and storm water conveyance. The challenge is to know and understand the environment and service conditions that a sanitary sewer would be subjected to, before it is designed and specified.

Concrete sanitary sewers continue to serve the Nation well, at a time when a majority of buried pipelines have reached the end of their planned service lives. It is concrete pipe sanitary sewers (many produced and installed in the late 1800s), that continue to perform while funds are made available for their replacement and upgrade with new concrete pipe that is designed to last at least 100 years.

Acids are the only significant environmental challenge that impacts the design considerations of concrete pipe sanitary sewers.

Sulfides and hydrogen sulfide gas in sewage do not attack concrete. Hydrogen sulfide does attack iron, steel and other materials, and is toxic and flammable. Under favorable conditions, hydrogen sulfide gas is converted to sulfuric acid on the crown of the pipe. A continuous level of acid in sewage below a pH of 5.0 is considered aggressive to concrete pipe and below 4.0 is highly aggressive. Hydrogen sulfide gas can be controlled in sewers, and there are scientific means to predict hydrogen sulfide levels in new sewers. If the problem cannot be controlled by system design in new sewers, concrete pipe can be engineered to be resistant to sulfuric acid and meet the required project design life.

Premature deterioration of concrete sanitary sewers can be caused by the effluent being carried by the system. Damage from acidic effluent is limited to the wetted perimeter, and is affected by pH, total acidity, effluent velocity, and total alkalinity of the pipe. Under United States and state environmental and sewer use laws, it is illegal to discharge acid into a sewer or stream. Pretreatment is required, and this mitigating action has successfully alleviated

corrosion problems in sewers often attributed to acidic effluent. Today, concrete sanitary sewers should not be viewed as a material and product any less suitable than other pipe materials for conveying common sewage effluent.

During the planning and design stage of a sanitary sewer, the potential biochemical profiles of the system should be determined along with current rates of acid development, and projected rates for the design life of the sewer. Once determined, the pipe can be protected with a liner. Pipe can also be produced with an increase in total alkalinity using



Photos: Lafarge

*Technology for 21st century quality assurance. Testing of the strength of concrete pipe.*

calcareous aggregates. It is also common to increase the concrete cover over the reinforcement. Known as sacrificial concrete, the rate of deterioration of the system can be matched to the design life of the project.

Where acidic effluent is anticipated, designers need to determine the pH, including cyclic variations, as well as continuous or intermittent flow characteristics. The pH and total acidity for the design life of the system is critical. In addition, designers must determine the potential for the development of sulfuric acid due to potential changes to the environment of the interior atmosphere of the sewer. When highly corrosive environments are expected, consideration should be given to lined concrete pipe and manholes for the portions of the sewer expected to



# ers - Based On Product and Material Performance

be affected.

Exterior damage by acid involves a completely different environment than that associated with sewage. Concrete pipe has been documented as performing very well in old industrial sites containing mildly acidic soils, and can sometimes be re-used. When an acidic soil or groundwater is encountered, its effect on concrete is governed by pH, total acidity, groundwater conditions, and backfill material. Total acidity is the amount of acid available to attack the surface of the pipe. A total acidity of 25 milligrams per gram of soil equivalent with a pH of 5 would indicate an aggressive acid condition, and a comprehensive analysis of the site and countermeasures would be required. Such soil conditions may be expected in waste disposal and brownfield development sites in most old industrial areas of major cities. In an installation with no movement, or slow movement of groundwater, the acid in contact with the concrete would be neutralized and form a neutral zone which stops further corrosion.

Technology is now in place for making concrete pipe more reliable than it has ever been before. Decades of research and development of many aspects of concrete pipe has enabled concrete pipe producers to change concrete mixes and pipe design to provide products that can withstand a complete range of underground environments and effluent profiles. As we enter the 21<sup>st</sup> century, our economy, societal values and international threats to the American way of life, have placed the application of concrete pipe in a new light.

Economic growth has taken on new meaning because of GASB 34, which radically changes how state and local governments must report their finances. Governments must perform condition assessments on all existing major infrastructure assets every three years. The National Cooperative Highway Research Program's project 19-04 states, "How state DOTs respond to GASB 34 may have a significant impact on statewide costs of public borrowing, the long-term costs of infrastructure programs, and the proportion of agency funds devoted to construction versus preservation."

The economic benefits of applying an asset man-

agement approach to public infrastructure reinforces the choice of concrete pipe for sustainable sanitary sewer systems. A sanitary sewer built today with low-maintenance reinforced concrete pipe would last until 2100, if the system is planned and designed for 100 years with full knowledge of existing and future effluent characteristics and loading. When projects are designed with life cycle costs in mind, concrete pipe is truly a product that falls within the accepted general notion of sustainability by meeting the needs of the present generation, without compromising the needs of future generations.

Sanitary sewers can and do perform well when constructed with concrete pipe. Even if a liner is required in a situation where the effluent is acidic and has the potential to corrode concrete, the initial cost of such a system should not be a deterrent, if municipalities want a sewer system that will perform as required, and to secure future funds for infrastructure based on asset management plans driven by GASB 34. Standard Installations alone are proving to be able to reduce the installation costs of construction projects significantly. For sanitary sewers that are expected to last 100 years or more, there is no doubt that a concrete pipe sanitary sewer would meet that target and likely keep on functioning for many more years. It only makes sense that concrete



*Concrete pipe designed to last 100 years.*

pipe be reconsidered in some states to enhance its sanitary sewer assets, and have concrete pipe reaffirmed as a 21<sup>st</sup> century technology in states that already use concrete for major sanitary sewer systems. Based on durability and performance, concrete pipe is the confident choice for sanitary sewers. ☺





## ACPA Releases New Hydraulics Brochure

Engineers responsible for designing and selecting proper size drainage pipe for a specific culvert or sewer application will find the “Hydraulic Efficiency” brochure an informative tool. The brochure includes important hydraulic analysis

considerations such as types of flow and design factors including the two basic values – laboratory test values and design values, which can be significant. Examples problems are included in the brochure as well as numerous charts and tables. The brochure can be ordered from the ACPA Resource Center for non-members at \$75.00 per package of 25, [Resource # 07-127](tel:800290127) or contact a local ACPA member company. You can call the Resource Center at 800-290-2272 or place your order online at [www.concrete-pipe.org](http://www.concrete-pipe.org), go to “Resources” and “Online order form.” ☺

## PipePac Upgrade Improves Ease Of Use And Applications

Over 12,000 copies of PipePac have been distributed and downloaded by engineers, educators, government officials, contractors and consultants. You can download Version 3.0 at no charge at

[www.concrete-pipe.org](http://www.concrete-pipe.org),

or obtain a CD-ROM through members of the state concrete pipe associations. You may also order a copy of the program from ACPA’s Resource Center by calling 1-800-290-2272. Cost: \$5.00 member/\$10.00 non-member, plus shipping and handling. Company check, VISA, MasterCard, and American Express are accepted. ☺



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