# STORMWATER MANAGEMENT
## From Catch Basins to Culverts:
### Two Counties Tackle Two Very Different Challenges

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## FROM CATCH BASINS TO CULVERTS

Stormwater management is an ongoing process—for counties, municipalities, DOTs, and even commercial and industrial entities. From catch basins to culverts, keeping infrastructure in good condition saves time and headache in the long run. And sometimes even then, surprises happen. For planned and emergency repairs, centrifugally cast concrete pipe is a solid, cost-effective, structural solution. It can be applied vertically or horizontally, using similar equipment and fine aggregate composite concrete materials.

This report features two very different county stormwater rehabilitation projects. One involves ongoing maintenance of vertical catch basin structures, while the other addresses an emergency repair of a severely deteriorated horizontal culvert. Both counties turned to centrifugally cast fine aggregate composite concrete systems to structurally repair and maintain their stormwater infrastructure assets.

## MATERIAL PROPERTIES

When specifying centrifugally cast concrete, the material used should have ASTM C1609 testing, exhibit strain hardening, and should have a quantifiable amount of toughness as well as minimal residual stress after initial cracking.

PERMACAST® MS-10,000 and PL-8000 are fine aggregate composite concrete (FACC) materials, engineered specifically for application in either vertical or horizontal structures. They rely on precisely graded quartz sands, non-metallic fibers, and other complex admixtures to achieve a unique blend of strength and other desirable properties that make them excellent choices for catch basin, wet-well, lift station, manhole, horizontal pipe, and sewer rehabilitation.

"The sophistication of this fine aggregate concrete should not be taken lightly by the design engineering community," says Kampbell. "And it's not just its strength characteristics, which dramatically exceed those of most concrete products. Low permeability, good freeze/thaw characteristics, the right thixotropy and thin shell toughness—AP/M Permaform has really got all these right with both MS-10,000 and PL-8000, and that makes them a great choice for catch basins, manholes, culverts, and buried bridges."

*Figures 1 and 2.* Flowable Engineered Fine Aggregate Composite Concrete is centrifugally cast in vertical and horizontal structures

In a technical paper prepared for AP/M Permaform, Kampbell examined some of these properties in detail.

- **Thixotropy:** "MS-10,000 and PL-8000 have the ability to become fluid—i.e. experience a viscosity decrease—when stirred or shaken," explains Kampbell. "That produces a flowable mixture that can then be pumped long distances. And once it's cast into position onto the wall of a structure it thickens

up quickly, providing sufficient 'hang-time' for the wet concrete applied to take its initial set. Getting the thixotropy right is so important—it helps the contractor apply consistent layer thicknesses, it enables good flow into low areas like corrugations and open joints, and it means the initial layers stick well to substrates, providing a dense foundation for the new concrete liner with the host pipe structure."

- **Permeability:** "Obviously, a very low permeability is a design parameter needed in a sanitary and storm sewer pipe application," points out Kampbell. "One of the commonly employed qualifications-based tests cited for judging this parameter is ASTM C-1202, the Rapid Chloride Permeability Test, and MS-10,000 and PL-8000 do very well on this test. And low permeability is also associated with better freeze/thaw performance."

- **Thin-shell Toughness:** "The use of fibers in MS-10,000 and PL-8000 is one factor that increases the ductility of the hardened liner's overall in place performance," says Kampbell. "This gives the rehabilitation outstanding abrasion, impact, and shatter resistance, lengthening the service life of rehabilitated sewers, pipes, catch basins, manholes, and similar underground structures."

## GENESEE COUNTY ROAD COMMISSION TACKLES ONGOING SELF-INSTALL CATCH BASIN REPAIR PROGRAM

"We are the fifth largest road commission in the county, out of 83," says Randall Dellaposta, Director of Equipment and Facilities at Genesee County Road Commission (GCRC). "And of course we have a lot of roadway to take care of—almost 2,000 miles of paved and unpaved primary and local roads, and are under contract with MDOT (Michigan Department of Transportation) to maintain an additional 799 lane miles of state highway. Like other road commissions, we're pressed to get it all done."

One particular challenge is catch basin rehabilitation. There are several thousand catch basins in the 17 townships within GCRC's jurisdiction, and many are made of brick and date back to the 1920s and 1930s. As they age, catch basin failure has caused major problems for Genesee County motorists. "We have certainly experienced failures, including collapse and roadway sinkage," explains Dellaposta. "When that happens, we have no choice but to put up signs, close the road, and immediately start emergency repairs. And depending on conditions, we may see flooding before repairs can be completed. A failed catch basin really can be a severe roadway hazard."


*Figure 3.* Genesee Country Road Commission Crew & Trailer

To prevent these major failures and keep traffic flowing, GCRC has committed to repairing catch basins proactively, before they collapse and sink. They've worked with a GIS expert and the Genesee County Drain Commission to identify and prioritize catch basins in need of rehabilitation, and most importantly, GCRC made a major investment in an innovative catch basin repair solution that enables their own crews to rehabilitate catch basins proactively. And the new solution is fast and high-quality, with a very long life cycle expected. "Using our own crews or subcontracting with traditional methods, we were used to a three-man crew taking two to three days to reconstruct a catch basin," says Dellaposta. "Now, with the AP/M Permaform trailer and spincaster, our own two-man crew is able to complete a basin rehabilitation in just two or three hours, and if conditions are right they can do as many as eight in one day. That's a big difference, and in the first,

partial, season—we took delivery of the trailer in June 2016—that we used this system, we were able to rehabilitate 86 catch basins, with just 188 hours of time logged on the trailer. So I'm confident we're seeing substantial return on our investment."

**Everything Needed, On One Trailer**

The PERMACAST® PC-20HD (Hydraulic) Material Application Platform is a dual axle trailer, about 7 feet wide and 20 feet long, that supports a mortar mixer, a hydraulically powered progressive cavity pump, a bidirectional spincaster and spin washer, and all the accompanying equipment—such as quick connect hoses, concrete spray gun, and 250-gallon water tank—needed to keep a crew working all day.

Their decision to self-perform stormwater catch basin and manhole restoration provides significant savings (reducing the cost of government) for the Genesee County Road Commission.

But, what exactly *is* the process?

**What Actually Happens?**

The heart of the PERMACAST® system is the bidirectional spincaster, a technology pioneered by AP/M Permaform and used in several applications, including manhole rehabilitation and trenchless centrifugally cast concrete pipe (CCCP) storm sewer rehabilitation. The spincaster sprays on thin, smooth layers of high-strength cementitious mortars. In Genesee County, GCRC uses a winch to lower the spincaster into 36-inch-by-48-inch (typical, some are deeper) brick catch basins, using multiple passes to spray on concrete layers about an inch and a half thick. For this application, AP/M Permaform's MS-10,000 is used, a fine aggregate, waterproof, corrosion-resistant cementitious liner that adheres tightly to the brick substrate, forming a monolithic new "pipe" that is sealed and structurally sound, independent of the original catch basin. "The seamless and structural aspects of the rehabilitation are excellent for our brick catch basins," says Dellaposta. "Really, the end result is a much stronger and better catch basin than the brick basins were even when they were new."

"This is the first alternative that we've come across that is both better and faster than the method we'd been using," says Nims. "The old way worked, but it was very time consuming—we'd have to cut the road and remove surface material around the basin, then patch or rebuild by hand. And then of course we'd have to patch and repave the road around the basin. Using the trailer and spincaster, most of that work is now unnecessary."

Nims says that the PERMACAST process is much more efficient. "Now we're catching the basins before

*Figure 4.* GCRC Crew Lowers Spincaster into Catch Basin

*Figure 5.* Structurally rehabilitated catch basin

total failure. We inspect and clean them as needed, with the spinwasher on the trailer, then do minor repairs like filling voids and replacing loose block. If there are any inlet or outlet tubes we cover them with disposable bowl covers before spraying," he says. "When all that's done, we hook up the machines and mix the cement. Most basins take about five bags of MS-10,000, and that usually takes about five passes with the spincaster to get even coverage between an inch and an inch and a half thickness. Then we remove the bowl covers, replace grates, and we're done." Quality control is straightforward; by counting the bags of mortar used, Nims has a good idea of the total volume of material used, and a simple gauge can be used before the material cures to spot check layer thickness as needed.

Depending on conditions, up to eight basins can be rehabilitated in a day. The biggest factor, according to Dellaposta, is weather. "The mortar has a 24-hour cure time, so we don't do rehabilitations when rain is expected," he says. "On the other hand, when conditions are warm and humid, that's good for the machines, because we can run the equipment longer without breaking down to clean. If we've prepped several catch basins that are close together, so we can keep the pump and spincaster working without a long break, we really can do eight catch basins in a day. But you have to be careful not to let a batch set up—20 minutes is too long to sit."

Cleaning is, of course, the primary maintenance required. A total cleanout is required at the end of any day of trailer use, and depending on the work scheduled, one or more cleanouts may be needed during the day. AP/M Permaform also helps with equipment maintenance. "Under our government agency contract agreement, we provide one annual complete rebuild on our robotic spincaster, no charge," AP/M Permaform representative Dennis Buckshaw explains. "And of course I visit with GCRC occasionally, routine sales calls, and am always available for technical support as needed."

*Figures 6 and 7.* Parking lot collapsing above ground; Culvert sidewalls curling into pipe interior

**Possibilities**

In the first season of use, GCRC concentrated on the backlog of catch basin repair needed. But going forward, Dellaposta is excited about the possibilities for different types of rehabilitation work. "The trailer is set up to support rehabilitation of storm water culverts up to 60 feet long, and we expect to be doing some of that work," he says. "And the hand sprayer on the unit is also very handy, and is often all we need for spot repairs on all our storm and drainage infrastructure."

GCRC demonstrated, in its first season of use, that the PERMACAST® PC-20HD (Hydraulic) Material Application Platform does quality work in short time frames, demonstrating a major return on investment compared to conventional methods and subcontracting. Perhaps more importantly, by proactively rehabilitating catch basins before failure, GCRC is avoiding the

expenses and hazards of emergency repairs.

When investing in maintenance systems, and devoting government crew time to rehabilitation work, analyzing return on investment compared to subcontracting can be a tricky chore. But for Genesee County, this particular investment appears to be a slam-dunk.

## CLAYTON COUNTY WATER AUTHORITY COMPLETES CHALLENGING CULVERT PROJECT

Lake City, in Clayton County, GA, is part of the Atlanta metro core, and in recent years, new construction has overgrown some existing underground assets, making rehabilitation of existing infrastructure challenging.

In one case, a 66-inch, 20-foot-deep, 220-foot-long CMP culvert was failing so dramatically that parking lots and commercial buildings overhead were subsiding noticeably and had to be monitored throughout subsequent rehabilitation.

Inspection revealed inverts that were completely corroded, sidewalls that were curling up into the pipe interior, and some collapsed pipe. And after discovery, the failure accelerated. "From quote to award, the culvert had collapsed even further," says Anita Clyne, President of Utility Asset Management Company (UAMC). "That's when we realized typical procedures would not be enough for this project."

"It wasn't a surprise," says Terry Moy, P.E., M.ASCE, Manager of Program Management and Engineering at the Clayton County Water Authority (CCWA); "We'd identified it for rehabilitation a year before and were in the process of working through access and business impacts with the property owners, but increased storm runoff accelerated the migration of the backfill around the pipe. This eliminated the possibility of a cured-in-place solution."

Surprise or not, it was very nearly a worst-case scenario for culvert rehabilitation. The CMP was no longer reliably supporting overhead soil, so just being in the pipe was unsafe. There were active commercial buildings directly over the culvert, so trenching was out of the question. And culvert capacity couldn't be reduced significantly, according to Clayton County Water Authority engineers—this ruled out slip-lining and other minimally invasive procedures.

**A Three-Phase Rehabilitation**

A three-phase solution was implemented to rehabilitate a critical piece of stormwater infrastructure safely, without significant capacity reduction and without disrupting overhead businesses.

In phase one, 54-inch tunnel liner plates were used to stabilize the culvert structurally. These are four-part steel rings, 18 inches wide, that were assembled within the pipe. "First, we had to cut out curled-in pieces of the old culvert by hand," explains Clyne. "Then we assembled the liner plates inside the culvert, section by section—basically, we were building a new pipe, 18 inches at a time. And meanwhile, cars and trucks were driving by in the parking lot above us."

The liner plates' four arched sections were bolted together manually, and each completed section created a new 18-inch safe zone for workers, who then repeated the process…146 times. After the new bolted-together "tunnel" was completed, the void between the liner plates and the existing 66-inch CMP (what was left of it, anyway) was filled with injected grout. It was tedious work in a cramped space but it was safe and effective; phase one was completed with no injuries and no further subsidence of overhead buildings, and at least the culvert was stable.

*Figure 8.* Phase 1: Tunnel liner plates installed

Phase two was to create a smooth, watertight, structurally-sound pipe within the new tunnel liner plates and to smooth out the corrugations created by flanges. For this phase, UAMC utilized CentriPipe, a trenchless repair technology they have had good success with on previous projects. Developed by AP/M Permaform, CentriPipe is a centrifugally cast concrete

pipe (CCCP) technology that relies on a computer-controlled spincaster that is inserted into round, large-diameter pipes, spraying on thin layers of fine aggregate composite concrete (FACC) as it is pulled back through the pipe at precisely calculated speeds.

In the Forest Parkway project, UAMC began by hand troweling grout to fill in flange gaps and to create a smooth invert so that the CentriPipe spincaster could be pulled back without jerking. An engineered 1-inch thickness of AP/M Permaform's PL-8000 material was then applied, completing the culvert rehabilitation.

*Figure 9.* Phase 2: Spincasting

The CentriPipe lining system created a new concrete pipe within the new tunnel liner plates. Since both are structurally sound, and the PL-8000 adheres to steel (and most pipe materials), the combination of tunnel plates and new pipe is exceptionally sturdy and will last indefinitely, even while subject to the heavy loads of a commercial center.

The third and final phase involved addressing the cause of the dramatic failure—the extremely unstable soil surrounding the pipe. To prevent similar problems for the rehabilitated culvert, CCWA called for stabilization of the surrounding soil with cementitious grout, injected until refusal.

To ensure quality, CCWA had very tight project specifications, applied normal inspection procedures, and contracted with an independent geotechnical firm for onsite representatives. The completed project is performing well, and CCWA's Manager of Program Management and Engineering, Terry Moy, P.E., M.ASCE, is pleased with the results. "I'm an active member of the Pipeline Division of the American Society of Civil Engineers (ASCE)," he explains, "and centrifugally cast pipe is proving to be a viable solution. Together with the tunnel plates and grout injection, it was certainly effective for us."

*Figure 10.* Phase 3: Soil stabilization with grout injection


## CONCLUSION

While the projects featured in this paper vary greatly in their application, both reflect the versatility and strength of centrifugally cast fine aggregate composite solutions.

The flexibility in adapting to these varying situations, while providing a tested and sound structural solution, made the Permacast and CentriPipe systems an ideal fit for these very differing scenarios. The end results are long-lasting, cost-effective, structurally renewed infrastructure assets that will serve their counties well for many decades to come.

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