Stormwater Culvert and Manhole Repairs Using High Density Polyurethane
Sewer Rehabilitation
“Outside and Inside”
Assess · Rehabilitate · Renew
Polyurethane Grout
Structural Polymer for Soil Stabilization
Polyurethane Grout
URETEK

Chemistry: Characteristics

Rapid Cure
Can support loads after 15 minutes; full strength after 24 hours

Strength
Rigid Structural Polyurethane created as material cools
E Modulus, Compressive Strength, Tensile Strength directly proportional to Density
Spread is limited due to speed of reaction

Weight
Lightweight: 4 to 25 pcf (installed density)

Water Resistance
Hydro-Insensitive
Contains water insoluble diluents - can be injected into wet soils and even standing or flowing water
Resists water intrusion into the chemical reaction that forms polyurethane
### Chemistry: Composition

<table>
<thead>
<tr>
<th>Composition</th>
<th>Resin &amp; Hardener</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing Ratio</td>
<td>1:1</td>
</tr>
<tr>
<td>Chemical Reaction</td>
<td>Exothermic chemical reaction generates C0₂ gas</td>
</tr>
<tr>
<td></td>
<td>C0₂ gas causes expansion of material, creating lifting pressure/ strength</td>
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<tr>
<td>Reaction Time</td>
<td>Fast</td>
</tr>
<tr>
<td></td>
<td>Adjustable – varying injection methods</td>
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<td></td>
<td>Can be completed in 1 minute</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>Environmentally benign material: NSF-61 certified and only patented hydro-insensitive polyurethane foam</td>
</tr>
</tbody>
</table>
## East Main Culvert
**Durham, NC**

### Project Challenges
- Aging culvert, originally constructed in 1930s.
- Large tree growing into the side of the structure.
- Actively flowing creek.
- Soil loss around the structure.

### Solution
- Inject URETEK 486Star Polymer to densify the surrounding soils and allow for structural repairs to the box culvert.
- Cofferdam and bypass pumping.
- Structural repairs to culvert, including rebar and epoxy, crack injection, and shotcrete.

### Support
- Designed injection plans for culvert stabilization.
- Oversaw tree removal.
- Set up cofferdam and bypass pumping.
- Coordinated with restoration company on rebar and epoxy.
- Performed shotcrete.
- Placed rip rap.

### Outcome
- Work was completed in a few weeks.
- Culvert was stabilized and restored to functionality.
- The city of Durham was able to avoid multi-million replacement of culvert.
Cutler Spur Culvert Stabilization
Crystal River, FL

<table>
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<tr>
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<tbody>
<tr>
<td>• Concern of weak soil zones underneath a culvert and new two lane road</td>
<td>• Inject URETEK polyurethane from surface to stabilize soils to create a solid support for the culvert</td>
<td>• Specifications</td>
<td>• Minimal downtime: All work performed in one day</td>
</tr>
<tr>
<td>• Area is in an environmentally sensitive area known for natural springs and manatee migration</td>
<td>• Injection points at various locations and depths</td>
<td>• Designed injection points quantity and depth</td>
<td>• Stabilized soil: Final roadway work was able to continue on schedule</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pre-construction meeting with contractor, city and L3 Communications</td>
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<td></td>
<td></td>
<td>• On-site installation</td>
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</table>
### Project Challenges

- 72" RCP dam outfall pipe had water flowing along the outside of the pipe and entering the weak pipe joints
- Customer did not want to remove / replace the RCP because was in good condition
- Customer tried cementious grout to seal joints and failed (see cementious grout attempt in pipe haunch of picture on right)

### Solution

- Stabilize and densify surrounding soils, creating a non-permeable layer to stop water movement by use of Deep Injection of high density polyurethane
- Inject the Uretek 486 material to seal the leaking joints
- Injections made at 5 & 7 o'clock positions of the pipe

### Support

- Uretek designed the injection process using a hydrophobic 2 part Star 486 HDP material
- We were able to fix the joints from inside the pipe and did not need to close the road

### Outcome

- **Quick Installation:** Project took 6 hours compared to 4 days to remove and relay the RCP (would not have needed to replace).
- **Cost Effective:** Project was more cost effective than remove/relay and bringing in additional fill material. Also, slip lining was not a viable option since the water was coming from the outside of the pipe.
NAS – Inflow & Infiltration Restoration
Pensacola, FL

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<tbody>
<tr>
<td>• Inflow &amp; Infiltration into storm drain system</td>
<td>• Inject URETEK polymer using The URETEK Method to encapsulate and seal faulted joints from inflow and infiltration</td>
<td>• Pre-estimate meeting with NAVFAC</td>
<td>• Infrastructure Restoration: URETEK polymer compacted and void filled loose surrounding soils to rehabilitate storm drain system</td>
</tr>
<tr>
<td>• Pavement and manhole structure settlement due to loss of bearing soils</td>
<td>• The Deep Injection Process at 4 distinct elevations to fill voids and densify weak base soils to prevent additional pavement and structure settlement</td>
<td>• Designed injection locations, quantities and depths</td>
<td>• In-situ Technology: Restored and increased soil load-bearing capacity at depth in two days with minimal disruption</td>
</tr>
<tr>
<td>• Surface depressions due to soil migrating into storm drain system</td>
<td></td>
<td>• Pre-construction and safety meeting onsite with crew</td>
<td></td>
</tr>
<tr>
<td>• Manhole, joint, and lateral line encapsulation and sealing</td>
<td></td>
<td>• On-site installation</td>
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USAF – Andrews Air Force Base
Joint Base Andrews, MD

<table>
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<tbody>
<tr>
<td>Runway settlement caused a dip 11 years before scheduled replacement</td>
<td>Seal pipe and densify compacted soils</td>
<td>Specifications</td>
<td>Sustainable Solution: work sustained until scheduled replacement took place.</td>
</tr>
<tr>
<td>Settlement was caused by faulted joints in 60” reinforced concrete pipe beneath runway</td>
<td>Lift runway back to original elevation</td>
<td>Designed injection port quantity and depth</td>
<td>Minimally Invasive: work performed allowed USAF to avoid ripping up the runway for repair and avoid delays in its operations</td>
</tr>
<tr>
<td>USAF wanted to avoid rip &amp; replace due to downtime</td>
<td></td>
<td>Pre-construction meeting</td>
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<td>On-site installation under strict security</td>
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GROUNDWORKSSOLUTIONS.COM
## Project Challenges
- Sinkhole formed on HWY61 in Natchez, MS
- 24” RCP misaligned due to a leaky joint that degraded the support soils and caused voids beneath the pipe
- The RCP shifted and caused a sinkhole that shut down a portion of the highway route to a nearby hospital

## Solution
- Mechanically align the pipe utilizing a trackhoe
- Stabilize and seal the pipe utilizing URETEK’s Deep Injection method
- Fill excavated area with #57 stone aggregate and stabilize the aggregate at every 4-5ft of fill

## Support
- Specifications
- Utility locates
- Pre-construction meeting
- MDOT construction support
- Emergency Response

## Outcome
- Sealed and rehabilitated stormwater drainage system
- Stabilized support soils: bound #57 aggregate to form a solid monolithic mass below highway
- Quick Installation: Project was completed over 2 Days
### Project Challenges
- Extensive voids and extremely weak soil zones underneath a culvert and two lane road
- Water flowing completely under rather than through culvert
- Culvert & road settled 2.5"

### Solution
- Inject hydro-insensitive URETEK polyurethane through floor surface of culvert surface to cutoff flow of water, fill voids, and stabilize soils to create a solid support for the culvert
- Lift culvert and pavement full 2.5" to original elevation

### Support
- Designed injection points quantity and depth
- Pre-construction meeting with DOT and local authorities to minimize disruption
- On-site installation with no bypass required

### Outcome
- **Minimal downtime:** All work performed in 6 hours
- **Stabilized soil:** Final roadway work was able to continue on schedule
- **No Road Closure:** Traditional repair methods would created 50 mile detour to closest river crossing
Jackson Lakes Box Culvert Lift
Pensacola, FL

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<tr>
<td>• Significant undermining and soil displacement from under culvert caused by a flood event April 2014 of rain over 20” in 2 days.</td>
<td>• Inject using The Deep Injection Process to lift and realign the southwest corner of culverts. • Inject on 4’ grid using a string line to void-fill, stabilize and ensure a uniform lift. • Onsite testing identified an average of a 2’ void across all four barrels.</td>
<td>• Designed injection points quantity and depth • Pre-construction meeting with Escambia County Engineering Department. • Holland Pump assisted with dewatering. • H2O Environmental completed masonry repairs.</td>
<td>• 24” Lift of quadruple barrel box culvert • 25% the cost of rip and replace • Typical flow of Jackson Creek and overflow of rainwater restored.</td>
</tr>
</tbody>
</table>
Sealing and Stabilizing
Rehabilitate the OUTSIDE

Without proper void fill, the structure and road are not supported to the originally designed weight-bearing capacity.
City of Dunlap – I&I Mitigation
Dunlap, TN

<table>
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</table>
| • Excessive groundwater inflow identified at two pump stations and a manhole | • Seal leaking pipe collars and cracks.  
  • Use the URETEK Deep Injection® Process to place material into the soils around the structure, at specific depths, to seal the leak from the outside  
  • Use the URETEK Method to place material directly through the structure walls and/or bases where it then reacts, expands, and seals the leaks. | • Public Works Director attended URETEK technical presentation.  
  • URETEK provided case studies from similar projects.  
  • Pre-estimate site visit to evaluate magnitude of I&I issues and plan logistics. | • Fast Repair: Work performed in 3 structures in ½ a day.  
  • Inflow Mitigation: The operation successfully stopped groundwater inflow at all 3 structures  
  • Minimally Invasive: No excavation or bypass pumping required for this operation |
## Manhole Infiltration Repair

**Clarksville, IN**

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<tbody>
<tr>
<td>TV inspection showed large amounts of Inflow and Infiltration (I&amp;I) in 7 manholes</td>
<td>Inject URETEK 486Star Polymer directly through manhole walls and through base of structure, beneath pipe invert to fill voids and seal leaks</td>
<td>Designed injection quantity, depth, and location to address I&amp;I in the 12” sanitary manhole intersections as well as the structure joints</td>
<td>Work completed in a day and a half</td>
</tr>
<tr>
<td>I&amp;I caused flow to exceed pump station design</td>
<td>Where other methods failed, GWS successfully mitigated infiltration</td>
<td></td>
<td>Stopped high pressure leaks in minutes</td>
</tr>
<tr>
<td>High ground water table (at grade in some locations)</td>
<td></td>
<td></td>
<td>Significantly reduced I&amp;I flowing through sanitary system to pump station saving the City over $90K per month</td>
</tr>
<tr>
<td>Failure in structure joints and pipe to structure joints</td>
<td></td>
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<td>Since repair, 49 pump hours per week reduced to 17</td>
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<td>Cost savings of $100k per month since repair</td>
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Manhole B-8, Neyland Drive  
Knoxville, TN

<table>
<thead>
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<th>Outcome</th>
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</table>
| • Sheared 8” lateral line was causing extensive voids and loose soil around manhole | • Inject around the perimeter of manhole and stabilize loose soils and the manhole, utilizing strict penetrometer measurement  
  • Fill 75’ of 8” line | • Specifications  
  • Designed injection port quantity and depth  
  • Pre-construction meeting  
  • On-site installation | • Minimal downtime:  All work performed in one day  
  • Stabilized soil:  Stabilized brick manhole and avoided roadway settlement. Additionally sealed the perimeter from further water intrusion. |
## Project Challenges

- Inflow and infiltration at 25’ deep manhole and 5ea storm drain lines
- Multiple, recurring sinkholes caused by Inflow & Infiltration with 30’ radius of manhole

## Solution

- InjectURETEK polyurethane through manhole to seal
- Deep Injection Process along rim of each of the 5ea pipes at engineered locations within 30’ radius of manhole and down to 30’ depths to displace water, fill voids & stabilize soils outside of pipe.
- URETEK used in conjunction with CIPP lining

## Support

- Pre-Estimate Meeting with USACE to determine project scope
- Designed injection quantity and method to meet USACE specification
- Pre-construction meeting
- On-site installation

## Outcome

- **Minimal intrusion:** Work performed in two days with no excavation
- **Manhole Sealing:** Provided Positive Side Seal
- **Soils stabilized:** Soils stabilized to prevent future seepage and stability to soil
AP/M Permaform
Trenchless Sewer Lining Systems
AP/M Permaform
CentriPipe Process

First
- Place 12,000 psi cementitious flowable fill
- Repair damaged invert, stop infiltration and stabilize the soil/invert
- Necessary step for success
- New floor that is contoured to radius to enhance flows***If invert only treatment; can stop here

Second
- High speed spin caster is placed at downstream end
- High Strength mortar is centrifugally cast around the interior of the pipe; applied at ½” passes
- Application head speed can be adjusted based on thickness needed
- Spin caster can stop/start without joints/gaps
### Project Challenges
- New York I-684 is one of the state’s busiest thoroughfares
- 300’ of 36” CMP under I-684
- Work performed in December, so cold temperatures
- Emergency project
- Bends present, including a 45 degree

### Solution
- Worked the 300’ in 5 sections
- Staging areas in the median and adjoining land
- PL-12,000 used for inverts
- PL-8,000 used for 1” of total thickness
- PL-8,000 sets up in a few hours

### Support
- New York State DOT
- Work performed by another applicator – Arolid Construction Company

### Outcome
- Remove and replace was ruled out due to extreme project cost and disruption
- Cured in place (CIPP) more not feasible due to bends
- Bends did not allow for slipline
# 48” Brick Storm Sewer

**Warsaw, IN**

<table>
<thead>
<tr>
<th>Project Challenges</th>
<th>Solution</th>
<th>Support</th>
<th>Outcome</th>
</tr>
</thead>
</table>
| • 48” brick and mortar storm sewer  
  • 1,500’ long sewer below a roadway  
  • Cracks at bottom of pipe and long cracks running the length of the pipe  
  • Inflow and Infiltration (I&I) | • Long cracks sealed with MS-10,000  
  • Plugged holes, filled cracks, and stabilized loose brick; more I&I than expected  
  • Cleaned pipe with high-pressure jetting  
  • PL-8000 applied | • Warsaw Public Works  
  • Thin wire wet gauge inserted into grout to determine thickness  
  • Work performed by another applicator – ProForm Pipe Lining Inc. | • CentriPipe designed 1” thickness with two passes of 0.5”  
  • Overall project took 5 weeks; CentriPipe portion took 1 week and rest of time spent plugging and patching pipe |
CentriPipe
Installation Video

GROUNDWORKSOLUTIONS.COM
### Project Challenges
- Part of Atlanta metro so densely populated
- 20’ deep, 220’ long, 66” CMP
- Parking lots were failing above the pipe and buildings settling
- Completely corroded inverts and sidewalls curling up into the interior

### Solution
- First - Cut out curled-in pieces
- Second - Install 54” tunnel liner plates used to stabilize structure
- Third – Grout annular void
- Fourth – PL-8000 applied

### Support
- Clayton County Water Authority
- Work performed by another applicator – Utility Asset Management (UAM)

### Outcome
- Commercial building above so trenching out of question
- Capacity could not be reduced, so sliplining was ruled out
- CentriPipe designed 1” thickness
156” Multi-Plate – FDOT
SR16 – Clay County, FL

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<tbody>
<tr>
<td>• 156” (13’) diameter Multi-Plate with leaks; 96’ long</td>
<td>• Manually applied CentriPipe – one sprayed with hose, then second hand troweled</td>
<td>• Worked with Florida DOT, Clay County</td>
<td>• Headwall and wing walls by others</td>
</tr>
<tr>
<td>• Leaks created a void along side of road 10’ deep by 20’ wide</td>
<td>• PL-8000 was mix used</td>
<td>• Transfield Services was General Contractor</td>
<td>• CentriPipe more economical than remove replace</td>
</tr>
<tr>
<td>• Minimal cover</td>
<td>• Built cofferdam to stop the water from entering pipe</td>
<td>• Custom engineered to help with min. cover</td>
<td>• 25% less than slip lining</td>
</tr>
<tr>
<td>• 2 lane rural road so did not want to rip and replace</td>
<td>• 1.5” thickness</td>
<td>• Work performed by another applicator – TV Diversified</td>
<td>• Project took 2 weeks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Performed in March 2010</td>
</tr>
</tbody>
</table>
Multi-Plate CMP - ODOT
Cincinnati, OH

Project Challenges  Solution  Support  Outcome
• Multi-Plate CMP fails at bolts and seams  • Diverted water into other culvert while working in one  • Ohio Department of Transportation  • CentriPipe designed 2” thickness
• Rehab needed to be structural and waterproof  • PL-8000 applied on pipe  • Self-tapping screws put in at 2” height to verify thickness  • Concrete and other waste could not flow downstream so was captured with plastic sheet in invert before water rerouted
• Twin arch culverts  • Crystal-X, a waterproofing admixture from ConShield Technologies was used  • Work performed by another applicator – Indiana Reline  • Work performed in 2013
• 12’ 6” wide by 7’ 11” tall, both 90’
# Concrete Box Culvert - FDOT

**Bradenton, FL**

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>• 6’ x 6.75’ Concrete Box</td>
<td>• Rebuild a box culvert under State Road 64</td>
<td>• FDOT</td>
<td>• Manually applied</td>
</tr>
<tr>
<td>• 61’ long</td>
<td>• PL-10,000 hand applied</td>
<td>• Engineer was Stantec</td>
<td>• 35% less than shotcrete</td>
</tr>
<tr>
<td>• One of state’s busiest commuting routes</td>
<td>• Metal reinforcement cage out of Grade 60 mesh</td>
<td>• Gibbs &amp; Register, Inc (G&amp;R) was the General Contractor</td>
<td>• 5” thick walls and 18” radius top corners to improve load distribution</td>
</tr>
<tr>
<td>• Culvert handles tidal surge and storm activity</td>
<td>• By-pass water system used 60” pneumatic pipe plugs</td>
<td>• Work performed by another applicator – TV Diversified</td>
<td>• No traffic impact</td>
</tr>
<tr>
<td>• Culvert was experiencing severe MIC corrosion</td>
<td></td>
<td></td>
<td>• Project completed in 3 weeks</td>
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</table>
Inversa Systems
Asset Integrity Assessment Tool
Inversa Systems
Technologies

Approach

Three Part Condition Assessment

1. Visual Inspection
2. Acoustic Inspection
3. BCT Imaging with Insight™
   (BCT is Backscatter Computed Tomography)

Results:

• Conclusive and quantifiable data
• Information for repair/replace decision
Backscatter Computed Tomography Image Transition

No Void

Transition to Void

Void

Soil

Void
From the inspection, a pipe map is developed to give a visual display of the problem areas and the suspected problems.
### Culvert Emergency Assessment

**Route 365, York County**

<table>
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</thead>
<tbody>
<tr>
<td>• CMP structure supporting major highway</td>
<td>• Structural condition assessment, including all conventional methods as well as diagnostic soil imaging</td>
<td>• Generally, pipe in good condition. Minor defects to pavement, embankment and pipe. Pipe well aligned, no significant ovality.</td>
<td>• Sewer Rehabilitation: By conducting full condition assessment, a clear path towards a safe and cost effective operation was shown</td>
</tr>
<tr>
<td>• Highly disruptive and costly to replace CMP structure – virtually impossible to dig up</td>
<td>• Prioritization of risk and list of assets in stable condition provided</td>
<td>• Fifteen acoustic anomalies identified - all chosen for BCT imaging.</td>
<td>• In-situ Technology: Trenchless rehabilitation techniques used to extend the service life of asset</td>
</tr>
<tr>
<td>• Pipe is 8ft diameter and 136ft length</td>
<td>• Options that optimize safety and spending are chosen as the preferred method</td>
<td>• Confirmed five void regions in the pipes supporting soil.</td>
<td></td>
</tr>
<tr>
<td>• Depth of CMP is 23 ft below asphalt surfaced</td>
<td></td>
<td>• Two of voids span corrugations, representing structural instability.</td>
<td></td>
</tr>
</tbody>
</table>
### Project Challenges

- **CMP structures used as flood gates** within a levee structure were of unknown condition.
- Especially, *soil side integrity* was unknown.
- The grouting procedure used in slipples was being evaluated to ensure the annular space was completely filled.

### Solution

- **Soilsight** procedures provided information about the structural condition of the levee structures.
- Identified where there was an elevated risk of failure during a flood event.
- Rehabilitation recommendations made to optimize safety.
- This included the recommendation of filling soil side voids with a material that matched the native clay.

### Support

- 5 sections of CMP were evaluated. 5-6ft diameter under approx. 22ft of fill.
- One pipe had been previously lined with an HDPE Slipline
- 39 acoustic anomalies total
- BCT confirmed **14 soil voids**
- The annular space between the slipline was shown to have a void location indicating **poor grouting** procedure.

### Outcome

- A unique soil failure was documented which was characterized by the soil expanding and contracting seasonally around the pipe. The pipe was shown to have slipped down slope.
- **This Information** allowed the rehabilitation of the soil to be properly planned.
- **USACE Slipline Grouting Procedure was Changed** based on the findings.
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