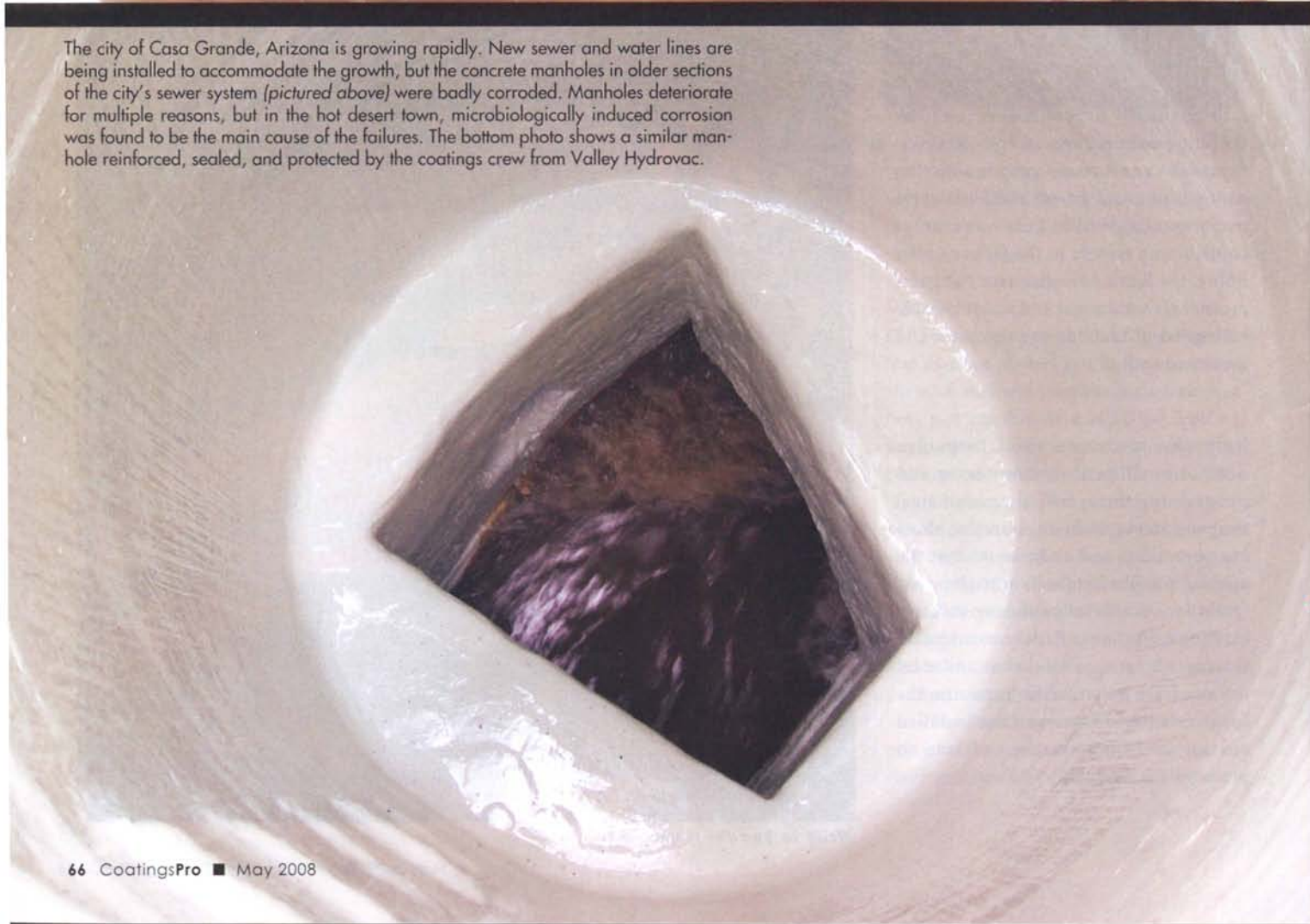




The city of Casa Grande, Arizona is growing rapidly. New sewer and water lines are being installed to accommodate the growth, but the concrete manholes in older sections of the city's sewer system (pictured above) were badly corroded. Manholes deteriorate for multiple reasons, but in the hot desert town, microbiologically induced corrosion was found to be the main cause of the failures. The bottom photo shows a similar manhole reinforced, sealed, and protected by the coatings crew from Valley Hydrovac.



# MANHOLE COATINGS REPAIR

BY SYNDEE HOLT

PHOTOS COURTESY OF  
AP/M PERMAFORM AND  
VALLEY HYDROVAC

## PAY ME NOW OR PAY ME LATER

**H**alfway between Phoenix and Tucson is one of the fastest growing areas in the United States — Casa Grande, Arizona. Its southwestern desert climate is not only near perfect for its sun-loving population, but the warm climate is also nearly perfect for something far less desirable. Lurking far below Casa Grande, is another fast-growing population: microbes. The growth of Microbial Induced Corrosion (MIC) in Casa Grande's concrete sewers was quickly becoming a concern for the desert community.

MIC is caused by the interaction of hydrogen sulfide gas and Thiobacillus (pronounced thahy-oh-buh-sil-uhs) bacteria. The warm desert air, along with other necessary conditions for growth — oxygen, undisturbed retention time, and turbulent effluence — all combine, allowing the bacteria to thrive in the concrete sewers below Casa Grande. The sulfuric acid produced by this combination of hydrogen sulfide gas and bacteria corrodes concrete in the sections with the most turbulence, which are predominantly the manhole areas.

In order to address the growing problem, Casa Grande put their manhole rehabilitation project out to public bid. "After an involved bidding process, we won the bid for one year with an option to continue another year," says Todd Lorenzen, owner of Valley Hydrovac. He explains the location of the problem

in the Casa Grande sewers: "We found that the corrosion is most often located in commercial areas where there is a higher flow of sewage as opposed to the quieter residential areas." This knowledge of corrosion patterns was critical in devising a plan of attack for the year-long project. But, the Valley Hydrovac coatings crew are experts at combating the effects of bacteria-induced corrosion.

Valley Hydrovac began as a sewer cleaning service for new sewer lines about four years ago, after branching from their parent company, Sahuaro Contracting, a pipeline construction company specializing in water/sewer lines. Lorenzen and his Valley Hydrovac crews started doing manhole work a couple of years ago when they began providing grouting and vacuum testing services for contractors working in new manholes. Lorenzen, however, soon realized the urgent need for concrete repair for existing manholes in their area.

"So," he explains, "when AP/M PermaForm proposed that Valley Hydrovac become an AP/M PermaForm-certified coatings applicator, we again expanded to service both new manholes and to rehab existing manholes."

With old and new manholes in their game plan, the crew from Valley Hydrovac was more than ready for anything lurking beneath the sewers of Casa Grande.



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**ABOVE** ▲ Before any work begins, the manhole is ventilated and tested for gases. Then, the concrete is cleaned with a high pressure water blast to remove debris and degraded cement material. Next, using a SpinCaster (shown above), the crew spray-applies one 1/4" to 1/2" thick coat of PERMACAST MS-10,000 onto the concrete. Entering the manhole, the crew rebuilds areas that are heavily creviced by hand-troweling PERMACAST MS-10,000 UL with ConmicShield underlayer. Then, they again use the SpinCaster to spray-apply a final coat 1/2" to 3/4" thick of PERMACAST MS-10,000 with ConmicShield. Once the coating sets up, the crew manually brushes and sponges smooth the surface. As a top coat, the crew uses Graco Extreme Mix spray equipment to spray-apply COR+GARD epoxy to 125 mils.

## ALWAYS, ALWAYS MONITOR FOR GAS

Since there are hundreds of manholes included in the bid, Lorenzen describes the typical job site: "We will send out a crew of three workmen and one supervisor to work on a targeted manhole. The crew will go either downline or upline from the targeted manhole they plan to work on and install a Hurco rip cord ventilator to draw air out of the downline (or upline) manhole, creating a pull of air in the targeted manhole to draw air into it and ventilate it." Lorenzen emphasizes, "We always, always monitor for gas in the manhole before we begin work on it to stabilize it and we continue monitoring constantly during entry. Confined space entry sheets are used to calibrate this information."

They also use a small ventilator above ground to blow fresh air down into the hole when a crewmember is deployed in the manhole. In the extreme hot and dry summer conditions, they often add a water spray to create an evaporation cooler effect.

Once the gases are stabilized and the ventilation is established, the crew cleans the concrete by water blasting with a Honda

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pressure washer at 3,000 psi. Once the concrete is clean and dry, the crew will apply a quarter-inch to half-inch coat of Permacast MS-10,000 onto the manhole surface, which creates a reinforced structural shell. "Permacast MS-10,000 is a fiber re-enforced material that allows us to build thicker layers as it can be applied up to about two inches before sagging," Lorenzen explains. Additionally, the Permacast is fortified with ConmicShield which kills the Thiobacillus bacteria and prevents the colonization of the bacteria, thus preventing the production of the sulfuric acid that causes the concrete corrosion.

"ConmicShield has the ability to disrupt the cell in close proximity by rupturing or damaging the cell wall with an electrostatic charge," explains Keith Walker of AP/M PermaForm. Walker, who originally trained the Valley Hydrovac team for AP/M PermaForm, performed a site visit prior to the beginning of the job and visited during the project.

Next, the Valley Hydrovac crew mixes the Permacast MS-10,000 in a Whiteman paddle-style cement mixer mounted in the work truck. Lorenzen describes the process: "While mixing, the crew adds 11 ounces of ConmicShield per 50 pound bag of MS 10,000 (24 cubic feet when wetted out). The mixture is dropped into a peristaltic pump that squeezes the material through the hose and into the PermaCast SpinCaster. This SpinCaster is hung on an arm — mounted on the back of the work trailer — and is controlled by an electric motor, which allows the SpinCaster to be raised and lowered into the manhole."

### **The warm desert air, oxygen, undisturbed retention time, and turbulent effluence in the sewer system combine, allowing the bacteria to thrive in the concrete sewers.**

The crew drops the SpinCaster into the manhole and then spin sprays the coating in one direction to the flow line and then back up to the top of the manhole. Next, the spray direction is reversed and the crew repeats the procedure, dropping the spraying SpinCaster into the manhole to the flow line and back up again. Once the manhole is coated, the SpinCaster is flushed with standard solvent to clean it.

"The use of the SpinCaster reduces the amount of the crew's confined space entry and increases production as they can cover more area when they are controlling the equipment from above ground," explains Lorenzen. The crew has no need to wear PPE during this process; however, during the hot days of the summer months, umbrellas are deployed above ground for the crew. "We also stock water coolers filled with ice and bottled water, to keep hydrated," Lorenzen says.

The first coat is allowed to dry overnight before the crew returns and rebuilds areas that are heavily creviced or holed. Permacast MS-10,000 UL, with ConmicShield added in the same ratio of 11 ounces per 50 pound bag, is used as an underlayment to build up these areas. This self-leveling material flows back into the nooks and crannies, applying approximately 6,000 to 7,000 pounds per square inch of strength to these areas.

## JOB AT A GLANCE

### PROJECT:

Repair and coat concrete manholes for the city of Casa Grande, Arizona

### COATINGS CONTRACTOR:

Valley Hydrovac  
P.O. Box 2989  
Gilbert, AZ 85299-2989  
(480) 570-0316

### SIZE OF CONTRACTOR:

Varied; a 3 member and 1 supervisor team worked on this project

### PRIME CLIENT:

City of Casa Grande, Arizona

### SUBSTRATE:

Concrete

### SUBSTRATE CONDITION:

The concrete had varying degrees of deterioration due to MIC involvement

### DURATION OF PROJECT:

Initially one year; city has exercised contract option for a second year

### UNUSUAL FACTORS:

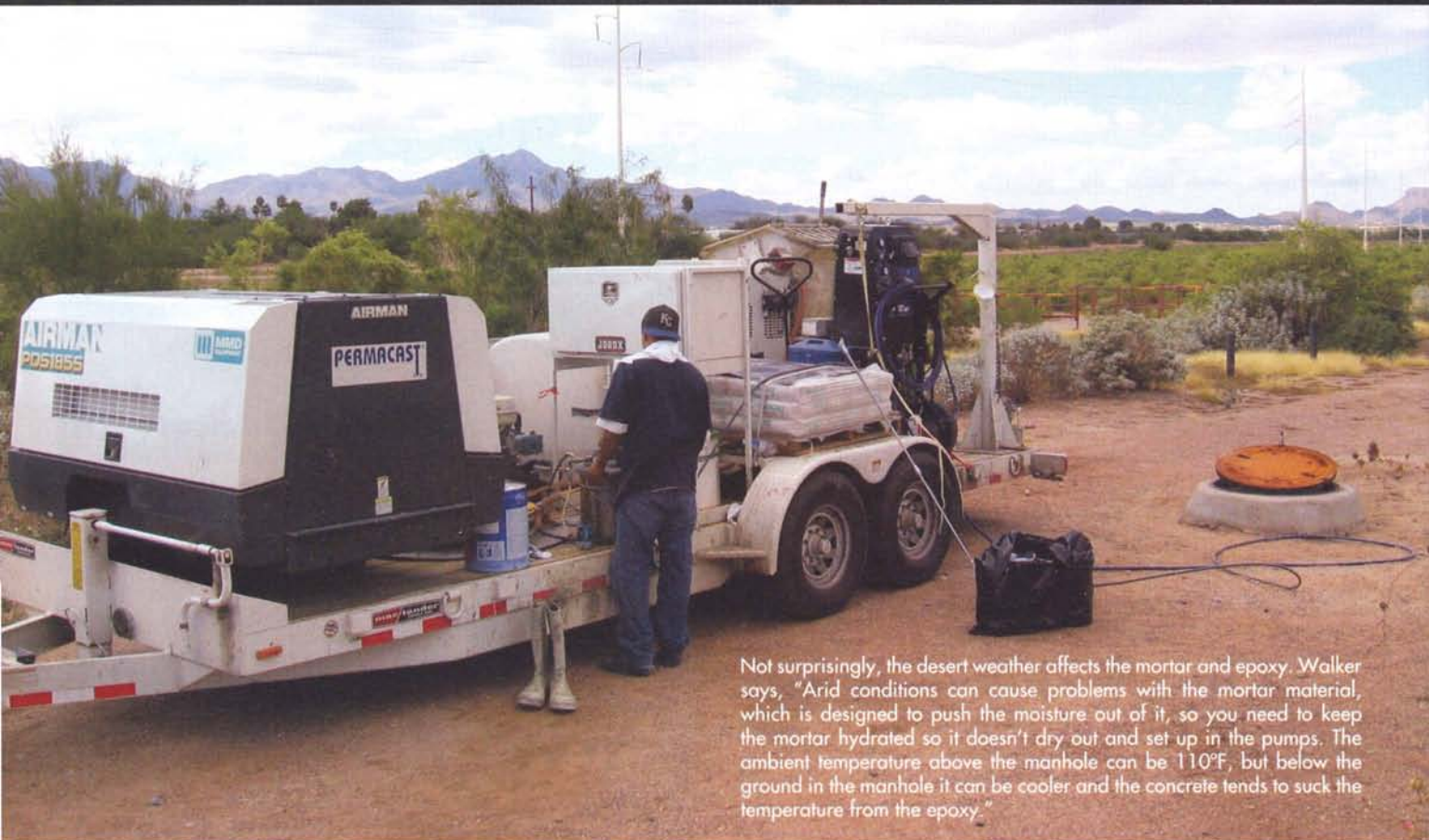
- Southwestern desert climate provides challenging conditions of both heat and low humidity that affect both the work crew and the materials involved.
- Due to the desert temperatures, the crews start very early in the morning and stop around noon during the warm season.
- Crews will work at night if manhole is located in heavily used intersection.

### MATERIALS/PROCESS:

- The manhole is ventilated and tested for gases prior to beginning the job.
- The concrete is cleaned with a high pressure water blast to remove debris and degraded cement material using a Honda pressure washer at 3,000 psi.
- Using a SpinCaster, the crew spray-applies one ¼" to 1/2" thick coat of PERMACAST MS-10,000 onto the concrete.
- The crew rebuilds areas that are heavily creviced by hand-troweling PERMACAST MS-10,000 UL with ConmicShield underlayer.
- The SpinCaster spray-applies final coat ½" to ¾" thick of PERMACAST MS-10,000 with ConmicShield. Once coating sets up, the crew manually brushes and sponges smooth the surface.
- Using Graco Extreme Mix spray equipment, the crew spray-applies COR+GARD epoxy to 125 mils.
- Coating is checked for holidays and crew repairs by hand.

### SAFETY CONSIDERATIONS:

- Ventilation is established by using a Herco Rip-Cord ventilator to draw out air of a downline or upline manhole, drawing fresh air into the targeted manhole.
- Work site is continually monitored for dangerous gases.
- Confined Space Entry protocols are followed whenever a crewmember enters a manhole.
- Crew wears cotton lined rubber gloves and boots most of the time. No PPE required when using the SpinCaster.
- Full Tyvek suits, masks, respirators, and gloves are used during the application of the epoxy in the manhole.
- Fall protection — a tripod with harness system — is used whenever a crewmember enters a manhole.



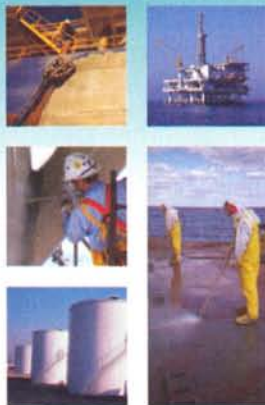
Not surprisingly, the desert weather affects the mortar and epoxy. Walker says, "Arid conditions can cause problems with the mortar material, which is designed to push the moisture out of it, so you need to keep the mortar hydrated so it doesn't dry out and set up in the pumps. The ambient temperature above the manhole can be 110°F, but below the ground in the manhole it can be cooler and the concrete tends to suck the temperature from the epoxy."

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Suspended from a tripod and harness system, a crewmember will hand trowel each area to bring it up to the level surface area. MS-10,000 UL is also used to build up the bench area at the bottom of the manhole, if needed. The crew wears respirators, rubber boots, and cotton-lined rubber gloves during this manual process.

"Once the areas treated with Permacast MS-10,000 UL have set up — usually overnight depending on the depth of the crevices and holes — the final coat of Permacast MS-10,000 with ConmicShield is applied using the SpinCaster," Lorenzen says. This coat varies from a half-inch to three-quarters of an inch thick, depending on the specifications required by the individual client. When this final coat is set up to the point it can be worked manually, the crew will do a final smoothing of the coat using brooms and sponges. Once the coat is smoothed, it is allowed to setup and harden overnight.

### BEAUTY IS 125 MILS DEEP

This final smoothing sets the stage for the application of the two-part epoxy coating of COR+GARD. Lorenzen explains the epoxy application: "We prefer to apply the



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epoxy with a Graco Extreme Mix Pump as opposed to application with the SpinCaster. The Graco Extreme Mix Pump has a hopper for the A and B parts of the coating and is computer-controlled for both the 50/50 mixing from the hoppers and the 100°F to 120°F heating of the coating.”

The crew applies a three coat process to achieve a 125 mil coating. “When the coating is heated to this temperature you get a beautiful spray, but you don’t get a thick suspension, so repeat coats are necessary,” continues Lorenzen.

The crew member suspended into the manhole with the tripod and harness system dons a full Tyvek jumpsuit with hood, safety goggles, respirator, and gloves when spraying the epoxy. The crew will typically spray a coat in each of four or five manholes, and then return to the first manhole to repeat the process, as the first coat will be tacky enough to recoat by then.

Lorenzen loves the beauty of the cleanup process with the Extreme Mix: “We just hook up lacquer thinner to the hose and blow it through the gun to clean it and leave A and B parts stored in their containers.” Using the SpinCaster to apply the epoxy would keep the crew members out of the manhole during application, but it’s more difficult to get 125 mils since it basically sprays the material as fast as you can supply it.

The last stage of the project is one of the most interesting — the crew performs a spark test, sometimes called a holiday test, using a Tinker & Rasor holiday detector. The crew operator will descend into the manhole and sweep the sides of the manhole, checking for any “holidays” or voids that will provide entry for the bacteria’s destructive acids. “With epoxy, you are typically testing



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with 12,500 volts and the voltage will find its way through the thin spots in the epoxy to the mortar and ground, causing a spark or alarm to sound," explains AP/M PermaForm's Walker. "Multiple coats of epoxy will also help avoid this problem."

The term "holiday" comes from wooden ship days when the sailors were required to coat the wood with tar to prevent it from rotting. If a sailor missed an area of wood and it subsequently rotted, it was said that the sailor "took a holiday" instead of properly coating that area. The term continues in use today, although it is often replaced with the less-colorful terms of voids or pinholes. Any holidays located in the coating are indicated with a marker by the crewmember operating the holiday detector and then epoxy is hand mixed and applied to the marked areas to create a consistent epoxy sealant.

## DESERT WEATHER STRIKES AGAIN

As you can expect, the weather in the Arizona desert area plays a large role in any outdoor construction project. Since the majority of the work is in commercial areas, the crews will generally start their work in the summer months as early as 4:30 or 5 a.m. and stop work at noon. If the manhole is located in a major intersection, the crews will work in the evening to lessen the impact on the

intersection traffic.

The weather affects the mortar and epoxy materials, also. Walker explains, "Arid conditions can cause problems with the mortar material, which is designed to push the moisture out of it, so you need to keep the mortar hydrated so it doesn't dry out and set up in the pumps." The heat and lack of humidity also cause the material to set faster, so any hand smoothing has to be accomplished with speed.

While humidity (or the lack thereof) is important for mortar, temperature is a factor with the epoxy application. "The ambient temperature above the manhole can be 110°F, but below the ground in the manhole it can be cooler and the concrete tends to suck the temperature from the epoxy," Walker explains. Likewise, in the winter when the temperatures can be quite cool, it is important to keep the epoxy temperature consistent as the chemical reaction in the epoxy literally stops below 40°F.

Casa Grande loved the manhole rehabilitation work that Lorenzen and Valley Hydrovac did for them in the first year so much that they did exercise their option for a second year's work. Lorenzen is hoping for yet another contract extension for a third year, saying, "We love working for Casa Grande; they are great people. They truly understand the importance — the 'pay me now or pay me later' aspect — of manhole repair." CP

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