Tech Perspective

Down the Chimney

Here are some cost-effective ways to target inflow and infiltration in an area of infrastructure that provides high return on repair investment

By John Keffer

There's a simple reason to invest in prevention of clear-water infiltration into sewers: it's an expensive problem that has affordable solutions.

Manholes are a common source of infiltration. They are also a significant source, and one that's relatively simple to address. Mainlines are the largest contributors to infiltration; manholes and service laterals are approximately tied for second place (see accompanying graph). But the cost of rehabilitating manholes is by far the lowest among those sources.

Clearly, manhole rehabilitation delivers excellent "bang for the buck." The three areas of focus in manhole infiltration are covers, deteriorated grade adjustment rings, and the frame-chimney area. Cities and the contractors who serve them can readily find effective remedies that exist for all three areas.

A big expense

The biggest cost of infiltration is well known: the need to treat essentially clear water at the wastewater treatment plant. The U.S. EPA estimates that anywhere from 25 to 60 percent of all flow in sewer lines is inflow and infiltration (I/I). For a 10 mgd treatment plant, that amounts to an excess cost of $3,000 to $8,000 per day — more than $1 million a year.

Even a seemingly small leak can add significant clear water to a sewer system. A leak equivalent to a half-inch-diameter hole can admit more than 5 million gallons per year at a treatment cost of some $13,000 (see Table 1).

But I/I has other costs, too. If I/I pushes wastewater flow close to treatment plant capacity, the community's residential and industrial growth can be constrained. Adding treatment capacity means assuming construction and maintenance costs that otherwise would not be necessary. Finally, the flow or trickling of water into sewer pipes can carry soil particles with it, causing erosion under streets and around structures such as manholes and storm drains.

Minding manholes

In large part, infiltration is a consequence of aging infrastructure. Manholes develop leaks through frost heaving, the normal expansion and contraction of pavement with changing temperature, the effects of traffic loading, and ground movement. All these forces are working on the manhole to push the riser rings and other components apart.

For example, in winter, if expansion occurs because of frost, once the riser ring is lifted and dirt particles come in behind it, the seal is lost and an infiltration path is created. With thermal expansion in summer, the result is the same.

Leakage also can result from use of poor construction materials and methods. Unfortunately, some contractors installing manholes in new developments build the riser ring with bricks from the homes, then cover the brickwork with cement. That kind of structure is subject to rapid deterioration.

Sometimes manhole grade rings are improperly shimmed, leaving unsealed spaces between the ring and the concrete manhole structure. Often, grouting seals around riser rings are not installed carefully.

Some manholes are simply victims of time and aging. Older brick manholes — common in sewer systems more than 50 years old — can deteriorate and become major infiltration sources. Even properly installed seals around manhole riser rings will deform and decay over time.

Attacking the sources

All three sources of infiltration in the manhole chimney area lend themselves to affordable corrective action.

Manhole covers. During rain events, clear water can enter around manhole covers at 0.2 to 5 gpm. Remedies include:

- Replacing or repairing missing or damaged lid gaskets.
- Installing manhole lids with pick holes that do not penetrate the casting.
- Replacing ill-fitting, cracked or broken lids.
- Adding inflow pans — usually made of stainless steel or high-density copolymer, and custom-sized to fit.

Grade adjustment rings. These devices are installed after streets are resurfaced to bring the manhole assembly up to grade. Conventional adjustment rings are made of cast iron. Newer designs include lightweight units made of high-density polyethylene that

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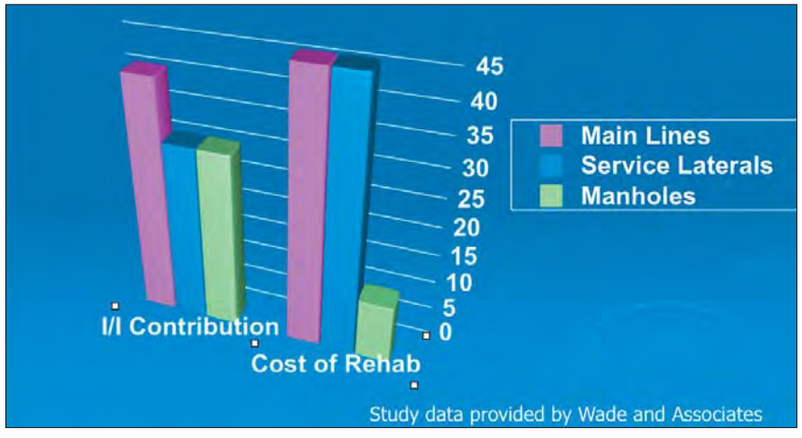
Comparison of I/I Contribution vs. Cost of Rehabilitation



This sequence shows the application of an external rubber manhole seal. From left, the surface is prepared, the seal is pulled into place, and the seal is tapped into final position with a hammer.

A urethane internal seal is applied to a manhole chimney. The finished project is at the right.

Table 1. Size of Leaks vs. Rate of Flow

Orifice Diameter	Gallons/day	Gallons/year	Annual treatment cost
1/8 inch	917	334,705	$ 813
1/4 inch	3,657	1,334,805	$ 3,244
1/2 inch	14,688	5,361,120	$13,028

These figures were calculated for a constant flow of water through circular, straight-edged orifices under 5 psi static pressure. The annual costs assume a sewage treatment rate of $2.43 per 1,000 gallons.

will not crack or corrode. They can be installed without mortar and sealed in place with a water-resistant adhesive.

Manhole frame/chimney. This can be a major source of infiltration. Cracking inevitably occurs at the interface between the top of the manhole chimney and the riser casting. Chimney areas can be sealed from the inside or the outside, and a variety of cost-effective methods are available.

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Sealing the chimney

External solutions include rubber seals and heat-shrink encapsulation seals. They are installed on new manholes or on existing manholes exposed through excavation.

For rubber seals, the surfaces of the riser ring and the manhole chimney are cleaned with a wire brush. The seal is stretched over the casting and cone to the correct position. The surface of the riser ring base is then primed, and the rubber seal, with mastic adhesive, is pulled up around the ring base and tapped down with a hammer. Installation takes about 10 minutes per manhole and requires no special tools.

Heat-shrink seals are installed with similar surface preparation. The material is supplied in rolls. A section is cut to fit and wrapped around the manhole assembly, and a closure seal is installed at the overlapped ends. A torch is then used to shrink the material. The seal must be allowed to cure before backfilling, which must be done with care to avoid puncturing.

Internal seals do not require manholes to be excavated for repair. An internal mechanical seal is essentially a rubber sleeve. Before installation, active leaks must be stopped with hydraulic cement. After surface preparation, the seal is positioned inside the manhole and a lubricant is applied.

Two bands are placed inside the seal, one at the top and one at the bottom. A special manual or hydraulic tool is used to expand the bands and force the seal snugly against the chimney surface. These seals can be removed and reused.

Urethane internal seals require surface preparation that includes stoppage of leaks, sandblasting, pressure washing and drying. The surface is then primed, and a urethane sealer is applied with a brush to a thickness of about 1/8 inch. This type of seal conforms to irregular-shaped manholes and provides a custom-fit seal.

After installation, manhole seal integrity should be tested, using a simple water or vacuum test.

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Under control

Infiltration in the manhole chimney area has been shown to be a significant source of infiltration to public sewer systems, and potentially a major expense.

Proper attention to manhole covers and the manhole chimney/frame area reduces clear water entering the sewer system, thereby helping to reduce or prevent sanitary sewer overflows, combines sewer overflows, and system surcharging and backups. It also reduces system maintenance, protects against pavement settling around manholes, and increases sewer systems capacity for new development.

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