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Inflow and Infiltration (I&I): Where is it Coming From?

By: Al Vanderpoel, PE

Almost every community in the country has infrastructure problems, and one of the most demanding is the condition of sanitary sewer lines. Extraneous flow can overwhelm the capacity of the treatment plant, and cause backups in the sewer lines, resulting in surcharges from manholes and residential drains.

Work to remove the inflow and infiltration from the system is an on-going item with no ending point. We have seen problems in a system as new as five years old, and as soon as one year after extensive work to correct the extraneous flow problems. Some of the problem points can be easily seen; some need a televised report to see; and others are hidden in laterals.

The most obvious inflow and infiltration points are at manholes. Surface water can drain into the lid. Ground water can enter through joints that are no longer water tight, or around the pipe connections. Brick manholes are prone to leakage from top to bottom.

Sanitary sewer pipes, especially the old clay tile pipes, can have a number of problem areas. We have seen a sewer line broken at a creek crossing, obviously picking up a large flow. We have also seen a break in the sewer line picking up drinking water from a leak in an adjacent water pipe. (This fix solved two problems simultaneously.)

One community has ground water monitoring wells, and whenever it is noted that the groundwater goes above the sewer lines, every joint of the clay tile pipe acts as a french drain. Leaky joints anywhere in the system will try to drain ground water. Storm sewer lines are occasionally connected to the sanitary system, which was common practice until the 1960's.

A community can find and fix every inflow and infiltration point listed above, and still not have a system that is in compliance, unless the laterals are also corrected. One small new system had an unauthorized handful of residences with sump pumps in basements, which caused flows well over limitations with every storm event. Re-directing the sump pumps to other discharge points solved this problem (but they are not easy to find). Downspouts and other storm water drains which are connected to the system were also the norm at one time, and are able to be located with some effort. However, basement floor drains, and especially footer drains around residences may be very difficult to locate, and determine where the connection point is at. Residents often are not even aware of these lines.

The solution is a continuous program of observation and repair. Flow meters, televising, smoke testing and dye testing are essential to find where the problems are. We promote the most basic process of looking into manholes and recording an increase from one manhole to the next. Unfortunately, this has to be done during a rainstorm, or immediately after.

Laterals are the responsibility of the owner, and a thorough lateral inspection at the time of the sale of a residence is recommended to be required by the municipality. Unfortunately, this may take thirty years or more to finally cover every lateral.

There is no ending point to this problem, and it will only get worse without an active, everyday process. It requires an annual budget item to stay on top of this issue

Skinner Hollow Road Bridge Replaced

By: Chris Ernst, P.E.

The replacement of the New Albion 40 bridge that is used to cross the Skinner Hollow Road over the South Branch Cattaraugus Creek in the Town of New Albion, Cattaraugus County, NY was recently completed. Skinner Hollow road is a dead end road that is owned and maintained by the Town of New Albion and the bridge is owned and maintained by Cattaraugus County.

A majority of the construction work was completed during the 2008 construction season, with a little earthwork and landscaping being completed during the spring of this year.

Figure 1: Former Pony Truss Bridge

The bridge was originally built at another location in 1895, was moved to Skinner Hollow in 1949 and was rehabilitated in 1990 (See Figure 1).

The approaches to the existing bridge were gravel with a very sharp horizontal curve (approx. 150 ft. radius) on the east approach and a 350 ft. radius curve on the west approach. The maximum grade for the east approach roadway was approximately 10.8% and the maximum grade for the west approach was approximately 5%. The combination of the sharp horizontal curves and the steep grade made accessing the bridge dangerous, especially during inclement weather. The bridge was posted for a maximum load of 16 tons prior to its replacement.

The new bridge is an approximate 107 ft. single-span prestressed adjacent box beam bridge with a concrete deck on reinforced concrete abutments and wingwalls (See Figure 2).

Figure 2: New Prestressed Box Beam Bridge

The foundations for the new abutments and wingwalls are reinforced concrete spread footings that were installed on and connected to bedrock, which is located close to the ground surface. The foundations for the wingwalls were stepped in order to reduce the excavation, concrete, backfill material and ultimately the cost required to construct the new bridge.

The clear distance between the steel bridge railings on the new structure is approximately 19 ft. and there are concrete approach slabs on each end of the bridge.

The new bridge was built upstream of the existing structure in order to improve the horizontal alignment of the approach roadway to the bridge. 500 ft. radius curves are now used to access the bridge from each end and the maximum grade of the east approach is 10%.

Relocating the bridge upstream of the existing structure also allowed traffic to continue using the former bridge, which was very important considering the fact that Skinner Hollow is a dead end road.

There was a large cost savings by continuing to use the former bridge during construction when compared to the installation of a temporary roadway, especially when considering the terrain adjacent to the former bridge.

The bridge was designed using NYSDOT Standards and under the direction of the Cattaraugus County Department of Public Works.

The bridge replacement project was bid in April 2008 and the low bidder was UCC Constructors, Inc. of West Seneca, NY, with a price of approximately $800,000. UCC Constructors, Inc. began work in June 2008 and had a majority of the work completed and had traffic using the new bridge and approach roadway by November 2008.

Seismic Retrofitting Highway Bridges

By: Roy Pedersen, P.E.

Highway and bridge engineers need to consider how well bridges on our highways will perform if they are subjected to an earthquake.

The FHWA (Federal Highway Administration) in conjunction with the National Center for Earthquake Engineering Research, State University of New York at Buffalo, N.Y., has published a manual to address the methodology to be used when deciding which existing bridges need to be retrofitted, and to what degree.

A method has been developed to rate a bridge with a "Seismic Performance Category" from A-D.

First, a bridge is rated "essential" or "standard". An essential bridge would be needed to stay functional after an earthquake to provide access to emergency services, or serve as a critical link in the national security/defense network. All bridges not considered essential are rated standard. Essential bridges that are in high earthquake areas are rated D.

Standard bridges that are in low earthquake areas are rated A. This allows engineers to decide which bridges to focus on retro fitting. Bridges rated A are not retrofitted. B, C and D rated bridges get respectively more rigorous attention.

The FHWA has developed retrofit measures for all areas of a bridge, starting with the bearings and joints, all the way to the foundation.

One measure that is used on multi span bridges is restrainers that connect one span to the next to prevent beams from slipping off a pier. Another technique to prevent slipping off is to widen the bearing area for the beams, so if movement occurs, the beams would still be supported.

Also used are new bearings which are more elastic and can absorb energy during an earthquake. There are many proprietary bearings and shock absorbs used in bridges as well as buildings to protect the structure from earthquakes.

The picture below shows a large friction pendulum seismic isolation bearing used on a bridge in the San Francisco Bay area.

Owner: State of California, Department of Transportation
Engineer: Imbsen & Associates, Sacramento, California

Another method used in bridge pier columns is to wrap the concrete with high strength fiberglass which helps to contain the reinforcing steel when subjected to earthquake forces. Most of the readers of this article live in a low earthquake zone. The following table shows some charted values of anticipated ground forces in areas of the U.S. The forces are a percentage of gravity, or “g.”

Western New York	5% g
Western Pennsylvania	5% g
South Carolina	40% g
California	100% g
Tennessee	100% g

In closing, much work is being done by scientists and engineers to improve the safety of our bridges in the event of one of our most dangerous natural events, an earthquake.

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