Force Main Flow Monitoring with Complex Hydraulics and Heavy Aeration

Virginia Beach, VA, USA *Case Study*

TELEDYNE ISCO
Everywhereyoulook™

Expertise in Flow

Limited straight runs of piping and aeration within large pump stations presented multiple wastewater monitoring challenges for Hampton Roads Sanitation District. Teledyne Isco's ADFM Hot Tap Insertion flow meters with Pulsed Doppler technology provided the solution.

ADFM Hot Tap Sensor

Benefits:

- 2% Flow accuracy
- Quad-redundant sensors in a single housing
- No calibration required
- Capability in minimal straight-runs
- No bypass requirement
- No pipe shutdown/ dewatering needed for installation and maintenance

Options:

- Additional safety equipment for pressures of 100-300 psi
- Custom length sensors available

"The Future of Flow!"™

Virginia Beach, Virginia

Hampton Roads Sanitation District (HRSD) in Virginia Beach, Virginia, is one of the largest pumped wastewater transmission systems on the East Coast of the US, with 69 lift stations, 13 pressure reducing stations (and plans for 17 more), and 232 master metering sites. Due to wet weather sanitary sewer overflows (SSO), HRSD and the surrounding municipalities have been faced with a consent decree from the US Environmental Protection Agency (EPA) and the Virginia Department of Environmental Quality (DEQ).

Photo of Williamsburg Treatment Facility courtesy of HRSD

As HRSD developed a master metering plan for the large pump stations, they encountered difficult hydraulic conditions due to limited straight runs of piping and aeration at high flow rates, which precluded the installation of clamp-on, transit time flow meters. A preliminary design focused on building metering vaults outside of the pump stations while replacing the existing concrete pressure piping with ductile iron pipe to accommodate the straight-run requirements of clamp-on, transit time technology further away from the pumps. However, this plan would substantially drive up construction costs due to right-of-way issues, dewatering with high water tables, and the installation of bypass equipment to make the necessary ties to the facilities.

The Challenge

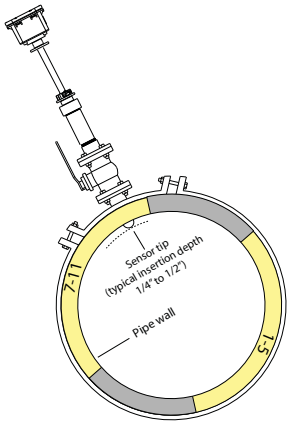
HRSD was looking at two seemingly prohibitive courses of action: Install the costly new metering vaults and bypass systems, or find a flow measurement technology that could meet the stringent demands of the existing metered sites. Traditional metering technologies such as magmeters and venturis were tried, but these proved unreliable in some locations, as these technologies assume that pipes are free of sediment and debris buildup.

In the fall of 2007, HRSD officials met with Teledyne Isco to arrange for demonstrations of the ADFM Hot Tap Insertion flow meter and the 2105c cellular communication module.

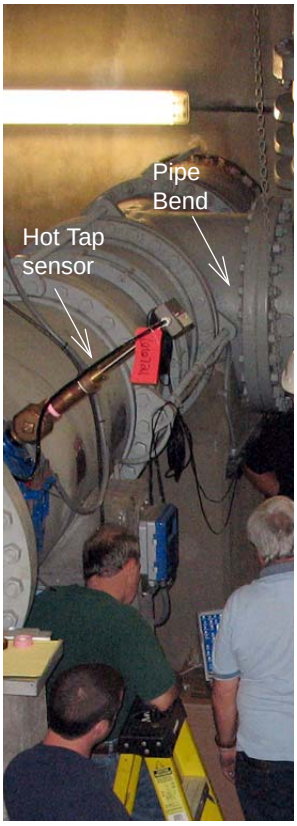
Solution: Isco ADFM Hot Tap Insertion Flow Meter

The Hot Tap can be inserted into pressurized lines, without disrupting flow, through a standard 2" corporation stop or tap. It installs near bends, pumps, and

Hot Tap Sensor & pipe cross-section

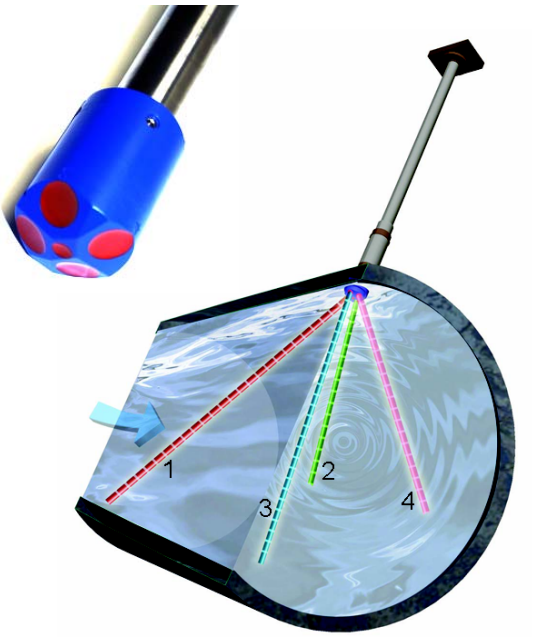


Gum Road master meter pump station
Chesapeake, Virginia



tees, and still yields reliable data. Protruding into the flow stream less than 1/2", the Hot Tap's sensor tip emits four velocity beams (Figure), two pointing upstream and two pointing downstream. Each beam is made up of multiple, distinct cells pinged hundreds of times per minute, yielding thousands of velocity data points throughout the water column.

Hot Tap sensor installed in 30" ductile iron pipe



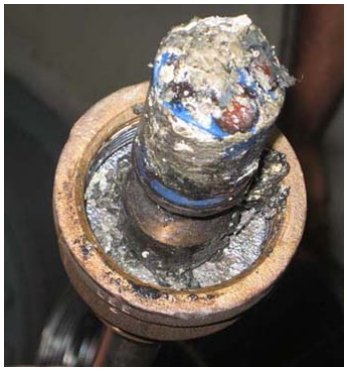
Hot Tap sensor installation and operation

Accurate Flow Measurement + Comprehensive Diagnostic Data

Data obtained from the return signals not only provides a complete velocity profile of the flow cross section; it also contains diagnostic information used by the software to continually monitor the quality of each signal, detecting air or debris in the line, as well as sediment buildup and fouling of the sensor.

Fouling Detection

The ADFM diagnostic data indicated that the Hot Tap's tip had become fouled with grease and sludge; however, the sensor's ability to measure velocity was not affected. Although the signal showed a slight decrease in amplitude for the two upstream velocity beams, the sensor continued to operate within specification at all times. The sensor was simply cleaned with a paper towel and reinserted into the pipe.



Sensor tip fouled w/ grease & sludge after nine months in service

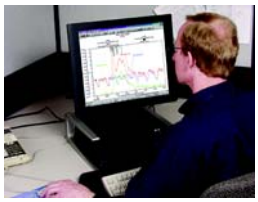
Detection of Reverse or Bi-Directional Flows

At one site, the team noted that when the pumps were shut down, the ADFM flow meter reported immediate reverse flow at the pumping station. It was quickly discovered that a defective check valve was causing considerable backflow to the low pressure side of the pumping station. The valve was repaired immediately, resulting in significant cost savings on power required at this pump station.

Isco 2105c CDMA Interface Module

1. Logs and transmits Q,V,D data from ADFM flow meters
2. Stores and transmits bin file information
3. System integration: rain gauge input - SDI-12 input - sampler enabling
4. Cellular communication (CDMA/1xRTT-GSM/GPRS)

Flowlink® Software



- Data analysis
- Diagnostics
- Graphs/tables
- Editing

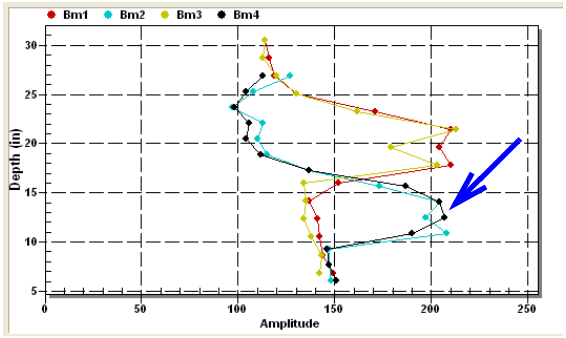
"The Isco Hot Tap Insertion meter has met and exceeded all of HRSD's flow metering requirements at our master metering sites, over other technologies. As a result, the District has saved hundreds of thousands of dollars at each site."

-Ken Donahue, HRSD Instrumentation Supervisor

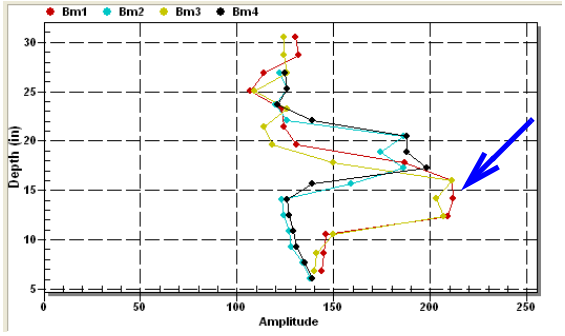
Boundary Layer Detection

Figure shows data from an installation in which beams 1 & 3 hit the opposing pipe wall, as expected; however, beams 2 & 4 hit sediment build-up in the pipe, as indicated by the signal amplitude and depth of flow (top). When the sensor position is rotated, beams 2 & 4 hit the wall and beams 1 & 3 indicate sediment (middle). The bottom figure shows similar depth and amplitude for all four beams, meaning the pipe is free of obstructions.

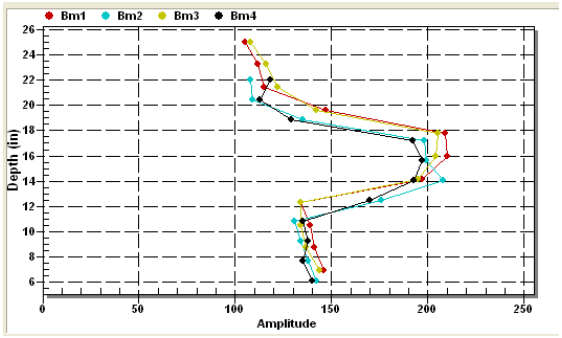
Sediment build-up is not uncommon for a pumping station of this design, as the flow enters either the north or south end of the inlet header, according to the seasonal flow. Therefore, when one end of the header is closed off, solids will settle in the section of the pipe where flow is not present. It is important, therefore, to be able to distinguish the depth of sediment or sludge within the pipe for an accurate calculation of flow. As this build-up typically is flushed away when the flow orientation into the station is changed, the software has the capability to account for the sediment layer and for the reduced cross-section.



Beams 2 & 4 hitting debris



Beams 1 & 3 hitting debris



Good signal (no debris)

Velocity beam signals showing sediment build-up

Challenge Met.

Hampton Roads continues to use ADFM Hot Tap systems to meet its challenging site demands, as well as Isco's 2105c Communication Module and Flowlink® 5.1 software for annual calibration and preventative maintenance.

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