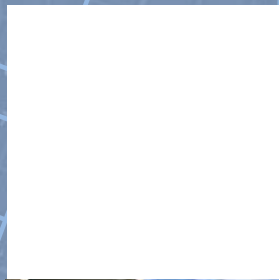
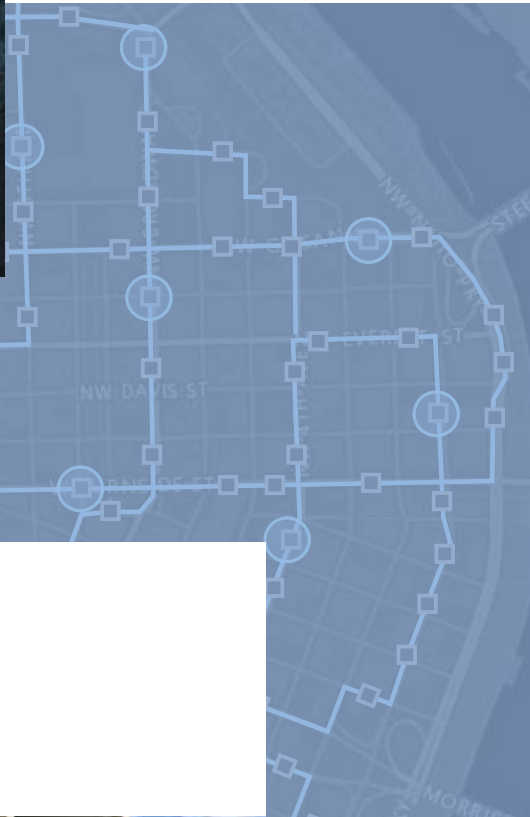
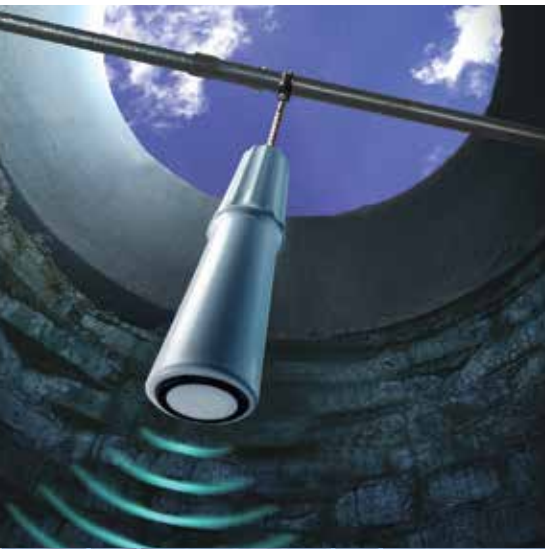


# Fact-Based Model Validation



Developing Sewer Models Using Empirically Derived Data Sets



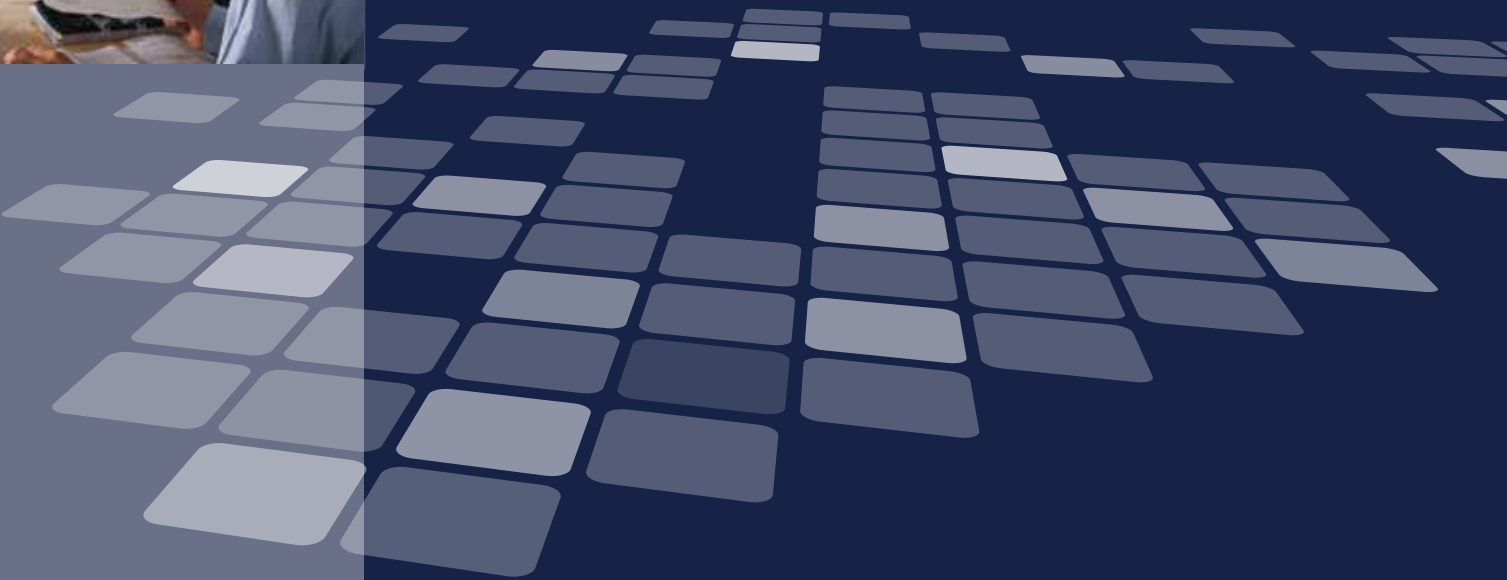


# iTracking®

## Fact-Based Model Validation

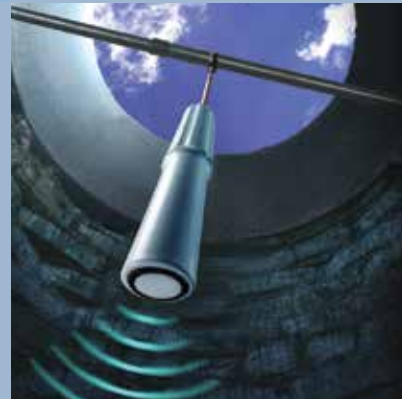
"A model is only as good as the data used to create it."

Thomas M. Walski Ph.D., P.E.  
Bentley Systems



## Empirical Modeling

A wastewater collection system model should be capable of simulating flow in the sewer at all locations and times by measuring the volume at each point of entry and then applying certain hydraulic principles to calculate the flow throughout the system. Unfortunately, up to the present, this has not been technologically efficient nor economically practical. Consequently, a recommended basin size for RDII analysis is 5 to 10 miles per flow meter. This translates to one flow meter per 100 to 200 manholes. iTracking® provides a new and highly cost-efficient solution for “model calibration” by ascertaining flow, pinpointing capacity issues, detecting and measuring I&I and recording SSO/CSO events as they occur within the collection system at a fraction of the cost of conventional methods.



## Real-Time Data Sets

Due to current advances in sensor, connectivity and analytical software technology (see iTracking® & SewerWatch™ Brochures), iTracking® provides wastewater collection system modelers with the ability to empirically, rather than theoretically, validate hydraulic models utilizing fact-based data. Volumetric differences in wastewater flows between periods of dry and wet weather can now be quickly and cost-effectively confirmed without the requirement for labor-intensive flow meter installation, confined space entry, constant maintenance and time-consuming field data retrieval. Collection system performance data is conveniently accessed through either Wi-Fi or cellular-based “desktop retrieval” technology.

# Primary Hydraulic Analysis

An iTracker® sensor is installed at the culmination of any major basin within the collection system that has been selected for verification of model integrity. By simple “population modeling” or by ascertaining average daily wastewater discharges through acquisition of municipal water bills, engineers can now empirically compare diurnal flow patterns to model assumptions, analyze capacity issues, and uncover areas requiring further investigation due to faulty infrastructure.

Fact-based modeling saves time and increases model accuracy by providing a real-time window into wastewater infrastructure performance. The process of empirically validating model integrity also provides the modeling team with the necessary data for conducting an I&I Detection Study.



## Population Model

iTracking analytical software, in conjunction with population models or municipal water bills, delivers a highly reliable and cost-effective method for ascertaining wastewater discharge per resident.

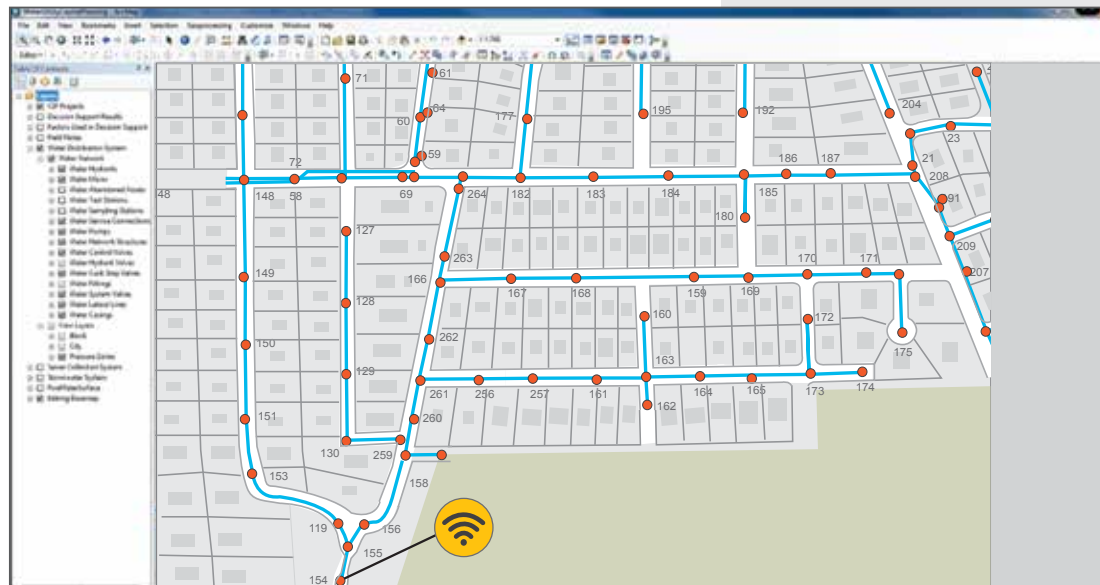
## Capacity Evaluation

iTracker® sensors record in real-time exactly what is transpiring within the collection system. Capacity issues are immediately brought to light and reported.

## I&I Analysis

By having the ability to record and measure collection system performance in real time, engineers are now armed with the knowledge for deciding whether the area under investigation warrants further analysis.

## Population • Capacity • I&I

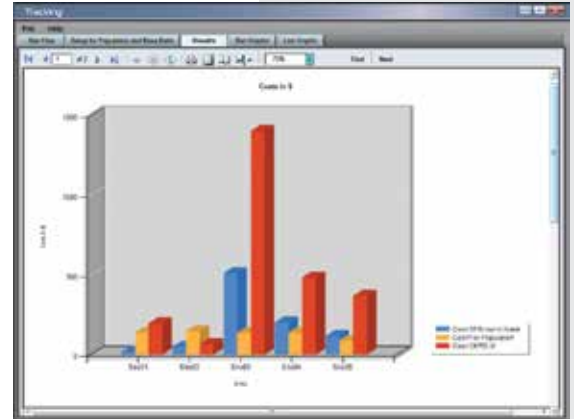


Population	182 Gal./Residence
Avg. Dry Day Flow	.412 MGD
Avg. Daily I&I	.197 MGD

# Secondary Hydraulic Analysis

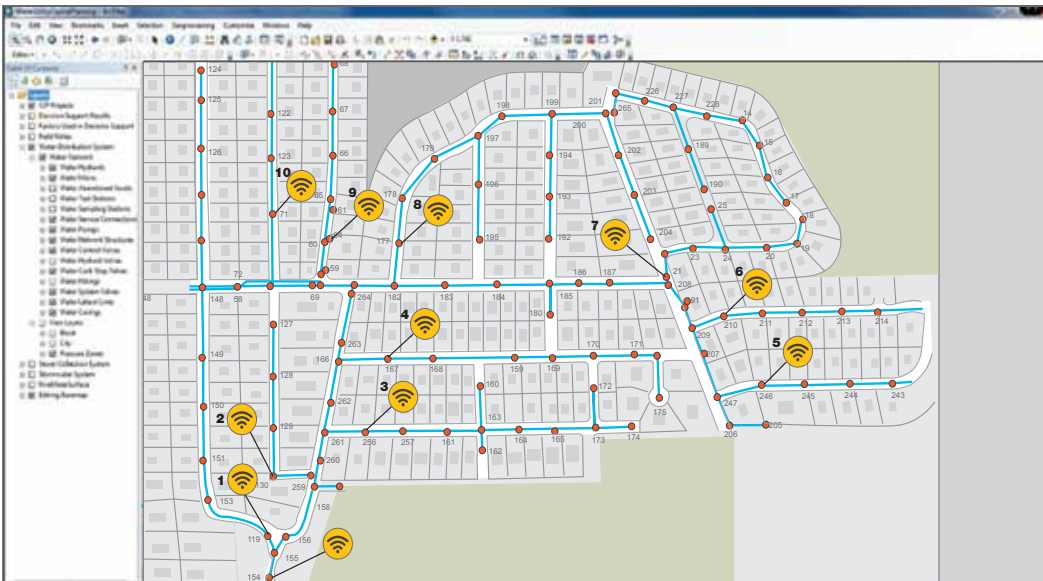
If a decision is made to conduct a more detailed analysis after completion of a "Primary Hydraulic Analysis", iTracker® sensors can be redistributed throughout mini and micro-basins within the area under investigation. Micro-basins may be as small as two adjoining manholes.

iTracking® systems, by recording and analyzing exactly what is transpiring within mini and micro segments of the collection system, provide a real-time picture of wastewater infrastructure behavior. In addition to validating hydraulic model assumptions, finite areas of inflow and infiltration are tagged for later analysis, capacity issues are verified and potential SSO's are proactively detected along with a record of exactly what had transpired within the problematic manhole.



High visualization bar graphs instantly highlight all Major, Mini and Micro-Basins responsible for the greatest influx of I&I.

## Capacity • SSO • I&I



### Capacity Evaluation

By further dividing the area into mini-basins, it is now possible to discover specific manhole segments that are prone to capacity issues.

### SSO Monitoring

Potential SSO's are detected and monitored by iTracker® sensors both as alerts and as a final record of the extent and duration of an overflow.

### I&I Analysis

Finite areas of I&I will be pinpointed by the detection, measurement and location capabilities of iTrackers® in combination with iTracking® analysis software.



Average I&I Volume			
MINI BASIN	GPD	MINI BASIN	GPD
1	54,000	6	8,000
2	18,000	7	12,000
3	6,000	8	36,000
4	9,000	9	11,000
5	27,000	10	16,000



# Hydraulic Analysis Software

## Model Validation

Validation is the process of running a model using a set of input data, comparing the results to actual measurements, and then making the necessary adjustments so that the model results and the actual measurements agree. Hydraulic sewer models are nearly always validated to match known flows at locations throughout the collection system. This also includes sanitary sewer and combined sewer overflows. The validation process can only be applied to a model if a sufficient number of measurements were taken throughout the system. There is no argument that a substantial increase in real-time flow data will ultimately result in an infinitely more accurate model.

This is exactly the function of iTracking®. iTracking enhances the sewer modeling process by considerably increasing real-time empirical data collection capability. Operating in tandem with location-based sensors, iTracking is an advanced technology software program that provides real-time hydraulic data to consulting and municipal engineers charged with the responsibility for creating GIS-based sanitary, storm and combined sewer collection system models.

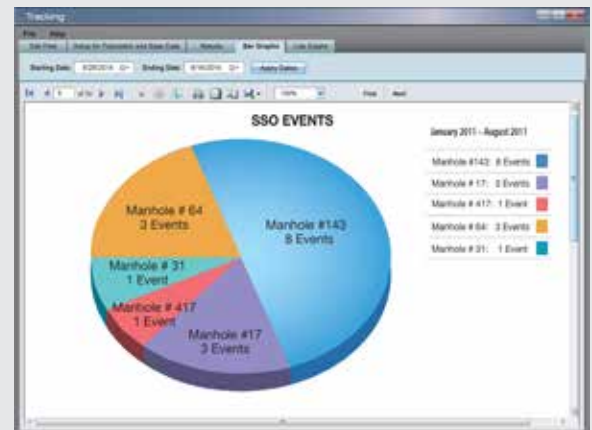
**CAPACITY MEASUREMENT:** iTracking software presents wastewater flows in municipal collection systems from 0-100% pipe capacity.

**OVERFLOW CALCULATION:** iTracking provides both level and duration data for sanitary and combined sewers experiencing surcharge and overflow conditions.

**INFLOW & INFILTRATION ANALYSIS:** iTracking analysis reports state exact volumetric changes in flow between dry day and wet weather events for each major, mini and micro-basin under investigation. A wide array of engineering functions provide a full understanding of collection system performance including; Rainfall, Groundwater, Dry Day Flows, RDII and Peak RDII.



*iTracking Analysis reports present volumetric changes in wastewater flows during periods of dry and wet weather. Capacity and SSO/CSO analysis reports are generated detailing the effects of both dry and wet weather upon specific areas within the wastewater collection network.*

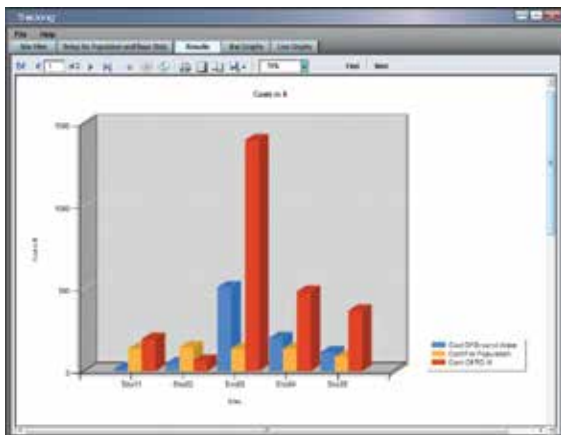


## SSO Monitoring

*SSO reporting software is provided that allows for quick graphical analysis of overflow events and duration pertaining to each monitored manhole site.*

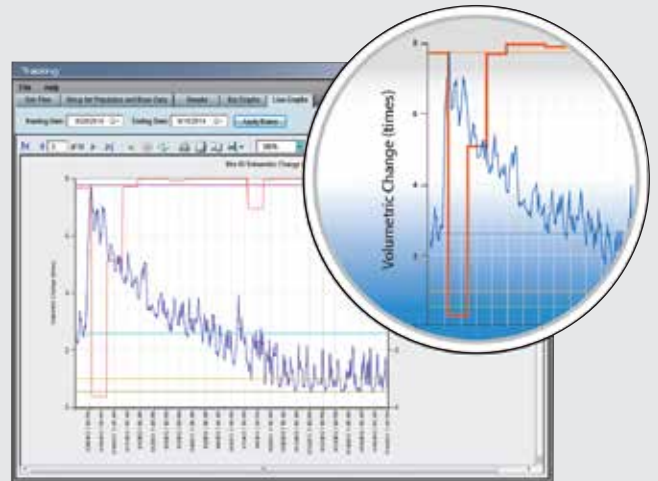
# Hydrographs, Charts and Reports

Recorded changes in wastewater infrastructure performance between dry days and wet weather events are transferred from iTracker sensors, via either Wi-Fi or cellular technology, to a PC running iTracking Flow Analysis Programs. Proprietary algorithms calculate mathematical factors, expressed in ratio form, showing the exact volumetric increases in flow between dry weather days and wet weather events for each major, mini and micro-basin within the wastewater network under investigation. Hydraulic analysis graphs perform an array of engineering functions to provide a full understanding of collection system performance that include Rainfall Analysis, Groundwater Analysis, Dry Day Analysis, Peak RDII Analysis, Cost Analysis and Pre-/Post-Remediation Analysis. Hydrographs provide a means for quickly and effectively detecting and locating those areas within the collection system experiencing flow capacity issues.



## I&I Identification

iTracking Analysis Programs start-off at the system level and drill down to greater detail as areas and sub-areas of I&I are identified and ranked by volume. This approach, in concert with detailed Hydrographs, greatly assists in distinguishing rain-derived inflow from infiltration caused by excessive groundwater or extraneous sources.



## Capacity Analysis

iTracking software displays an array of engineering functions that assist in providing a complete understanding of collection system performance.

Volume	RD II Volume
160.00	55890.54
300.00	20275.80
160.00	485132.02
30.00	161731.02
00	124151.14

## Condensed Reports

Location, Volume and Cost data is presented for each basin undergoing investigation in clear and concise reports.

