City of Baltimore, Maryland
Department of Public Works – Bureau of Water and Wastewater
Flow Monitoring Services for Sanitary Sewer System
Project #995

GUIDELINES FOR DATA COLLECTION, PROCESSING, VALIDATION AND TRANSFER OF FLOW MONITORING DATA

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June 2006

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DEFINITIONS

The following terms and phrases are used in this document:

ADS	ADS Environmental Services.
CSO	Combined System Overflow.
DOJ	U.S. Department of Justice.
DPW	Department of Public Works.
Enterprise	The Telog Enterprise System.
Final Data	Flow, rainfall, and groundwater data that have been collected and processed by the flow monitoring firm and validated by the Program Manager.
FTP	File Transfer Protocol.
GPS	Global Positioning System.
GIS	Geographic Information System.
I/I, I&I	Inflow and Infiltration.
IT	Information Technology.
MDE	Maryland Department of the Environment.
Processed Data	Flow, rainfall, and groundwater data that have been collected and processed by the flow monitoring firm.
Program Manager	Engineering Consultant retained by the City to assist in technical matters of the Wet Weather Program.
QC/QA	Quality Assurance/Quality Control
Raw Data	Flow, rainfall, and groundwater data that have not been processed by the flow monitoring firm.
RJN	The RJN Group.
RTU	Recording Telemetry Unit.
Severn Trent	Severn Trent Pipeline Services.
Sewershed Consultant	Engineering Consultant awarded a Sewershed Study by the City.
Sliicer.com	A web accessed I/I evaluation software product by ADS Environmental Services. The Sliicer.com software brings uniformity to the methods used by the Sewershed Consultants and will assure consistent results.
SQL	Structured Query Language.
SSO	Sewer System Overflow.
Telog	Telog Instruments, Inc.
The City	The City of Baltimore represented by the Department of Public Works, Bureau of Water and Wastewater.
The Program	The Baltimore City Consent Decree Wet Weather Program.

A. INTRODUCTION

The City of Baltimore has embarked on a comprehensive sewer system improvement effort as mandated by the Consent Decree issued by the DOJ and the MDE. A significant component of this effort is to measure the rainfall and sewer flows throughout the collection system for a period of 18 months. The City developed a plan to measure sewer flows at 366 locations simultaneously, using Doppler rainfall measurement and a network of 20 rain gauges and 33 groundwater gauges. The City selected three national flow-monitoring firms experienced in large-scale flow monitoring projects. Each firm was assigned a contract consisting of between 120 and 150 sites, including rain gauging, groundwater gauging, and flow metering sites. The estimated value for each contract is in the range of $5.5 Million to $6.5 Million. The estimated duration of the program is 3 years, with all three flow monitoring firms working concurrently.

The objectives of the Comprehensive Flow Monitoring Program are:

- ✓ To collect accurate sewer flow and rainfall data.
- ✓ To establish pre-construction, base line flows for each sewershed basin.
- ✓ To support Sewershed Consultants in developing effective Sewershed Field Inspection Programs by assisting in the development of dry-weather and wet-weather flow characteristics using Sliicer.com.
- ✓ To assist Sewershed Consultants in developing calibrated hydraulic models using current and accurate rainfall and flow data.

Each flow monitoring firm is required to provide the following services:

- ✓ Perform site investigations and if necessary cleaning the pipe segments upstream and downstream of the metering manhole.
- ✓ Develop electronic site reports including GPS coordinates and digital images.
- ✓ Install and calibrate up to 150 flow and rainfall monitoring equipment simultaneously under the time frame of a demanding project schedule. Install equipment in sewer pipes ranging in size from 8-inch to 12-foot in diameter, including odd-shape pipes and overflow structures.
- ✓ Measure flow from pump stations and in pressure sewers.
- ✓ Remotely collect flow and rainfall data using wireless communication.
- ✓ Operate and maintain the equipment for a period of approximately 18 months.
- ✓ Process and report data monthly for a period of approximately 18 months

B. THE TELOG ENTERPRISE SYSTEM

Telog Instruments Inc. has been selected to provide the field RTUs, wireless communications and host application software system for this project. Telog provides extensive and proven remote data acquisition products and systems serving the water and wastewater utility market.

The Telog wireless monitoring system provides an automated means of collecting, archiving, presenting and sharing data from collection system remote assets including flowmeters, rain gauges, CSO/SSO surcharge sensors, pumping stations and pre-treatment water quality sensors. Supported communication options include telephone, cellular, radio, satellite, and Ethernet (Figure 1).

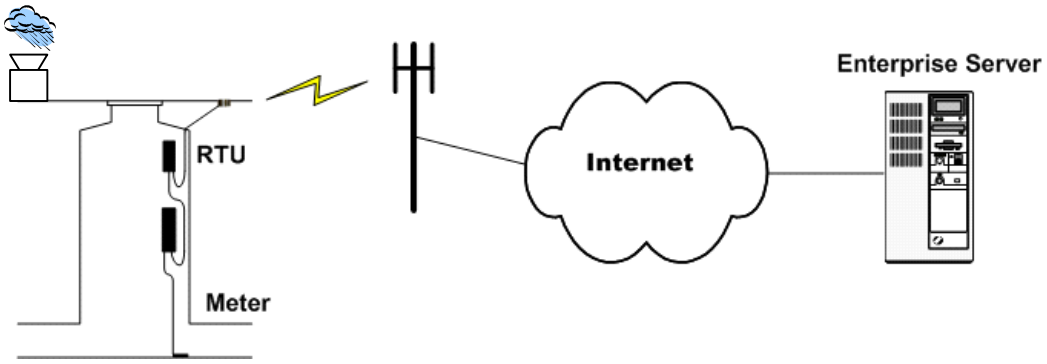


Figure 1

1. Data Collection

The Telog RTUs directly interface with all flow meters and rain and groundwater gauges used by all the flow monitoring service providers selected for this project. Referring to Figure 1, the RTUs will collect and store the data from these meters and then transmit the data to each service providers' Enterprise server. 1XRTT wireless cellular is the primary means for transmission of data across the Internet to the designated host Enterprise server. At least once a day the raw data will be remotely collected from the metering equipment. This Raw data will reside in the Enterprise server of each flow monitoring firm and will undergo first-tier QC/QA. Figure 2 below depicts how the program will collect, process, finalize, and share the rainfall and flow data.

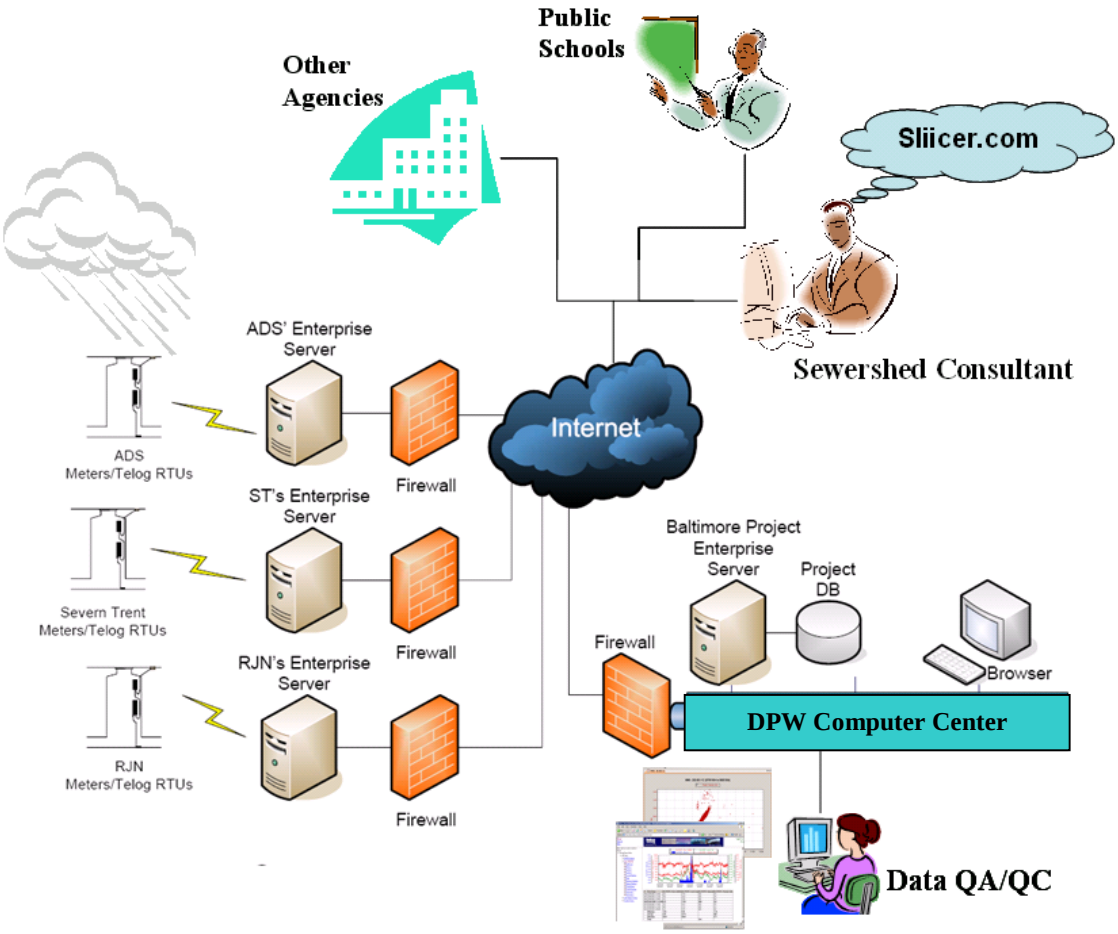


Figure 2

2. Naming Conventions, FTPing & Time Standards

Naming

A standard naming convention should be used for sites and measurements in this project. Baltimore already has a naming convention for its sites and those names have already been distributed. Those same site names will be used within the Telog Enterprise software.

Three grades of measurements will be used in this project – Raw, Processed and Final. The flow service providers are responsible for data of the first two grades – Raw and Processed. These levels of data are defined as follows:

> **Raw Data** – Data collected from field equipment. These data will not be submitted to the City, but must be maintained by the service provider.

Processed Data – Data submitted to the City each month after it has been reviewed and processed by the service provider.

Final Data – Data that has been reviewed and validated by the City's Second-Tier QA/QC Process. These data will be used by Sewershed Consultants for I/I evaluation.

Measurement naming in Telog Enterprise (Tier One QA/QC)

Name	Type	Default Units
Drawu	Raw Level Ultrasonic	Inches
Drawp	Raw Level Pressure	Inches
Qraw	Raw Flow	Millions of Gallons per Day (MGD)
Vraw	Raw Velocity	Feet per Second (f/s)
Dprocessed	Level	Inches
Qprocessed	Flow	Millions of Gallons per Day (MGD)
Vprocessed	Velocity	Feet per Second (f/s)
iRaw	Raw Rain	Inches
iProcessed	Rain	Inches
GWraw	Raw Ground Water	Inches
GWprocessed	Ground Water	Inches
Vinferred	Inferred Velocity	Boolean

Table 1

For ease of comparison, all flow, level and velocity data should use the **exact** names shown in Table 1 above. When setting the measurement properties in Telog Enterprise the Type and Default Units should also be set to those shown in the Table 1.

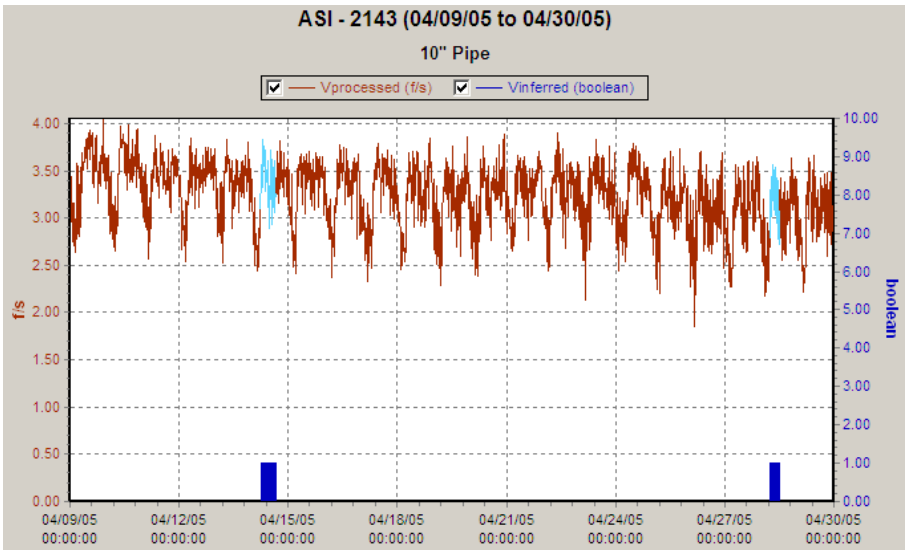


Figure 3

Vinferred is an indicator measurement - a processed velocity that is derived from a valid depth measurement and the pipe curve, for which there was no valid raw velocity measurement. Vinferred equals a 1 when the Vprocessed measurement was inferred and it equals a 0 all other times – see figure 3.

Raw rain data (iRaw) will be available to the flow monitoring firms within 48 hours of a rain event. This will be accomplished normally by providing access to the Enterprise server containing the iRaw via the web, or by electronic transfer of the data from the Enterprise server containing the iRaw using Enterprise's FTP function.

FTPing

For this project, each service provider will publish their monthly Enterprise data to their own FTP server for collection by the City. The appropriate username and password for each site must be given to Baltimore Enterprise server administrator to facilitate collection of the monthly data.

Measurement Types are used in the monthly process of publishing the QA/QC'd data to the FTP sites. It is important that all similar measurements use the same units of measure.

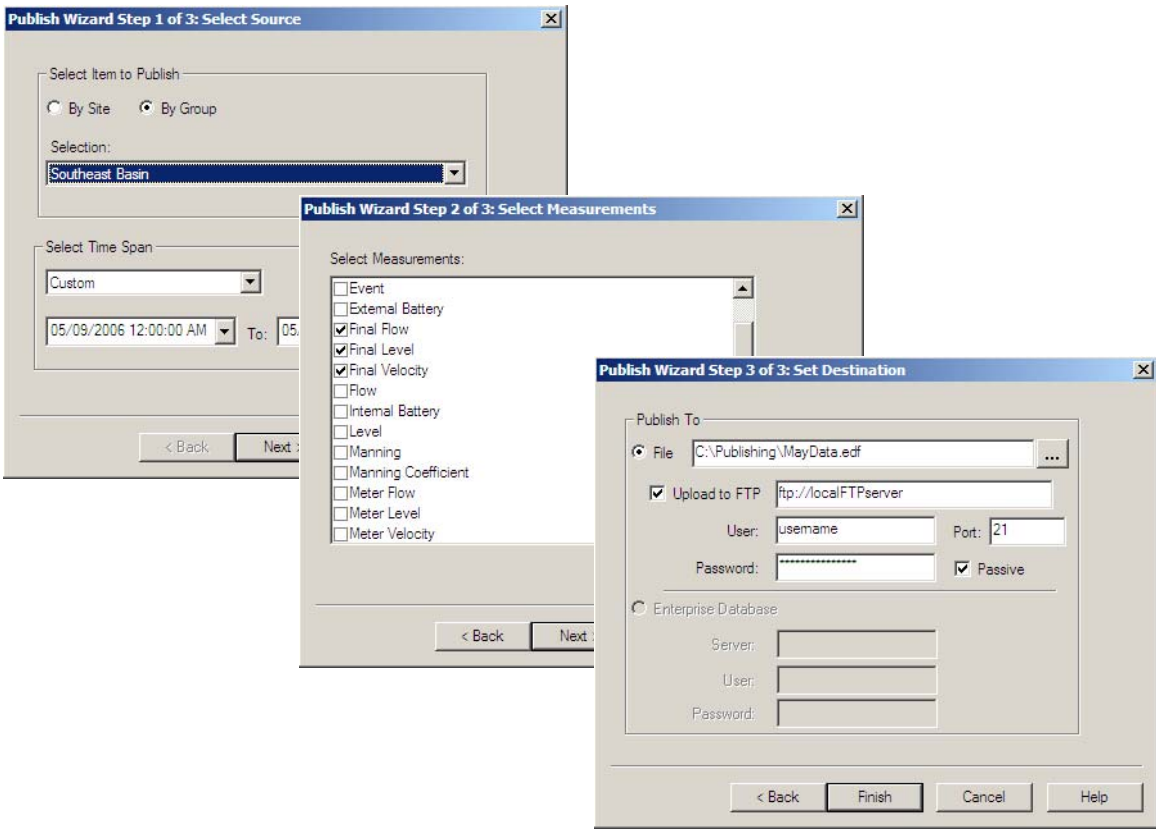


Figure 4

The 3 steps used in the Publishing Wizard are shown in Figure 4. In step 1 the data group and time are selected. In step 2 the measurement Types to be published are selected. This

step highlights the importance of using the Types specified in the Tables 1 & 2. Step 3 is where the FTP server is selected and the data are published after the Finish button is depressed.

Measurement naming in Telog Enterprise (Tier Two QA/QC)

Name	Type	Default Units
Dfinal	Final Level	Inches
Qfinal	Final Flow	Millions of Gallons per Day (MGD)
Vfinal	Final Velocity	Feet per Second (f/s)
iFinal	Final Rain	Inches
GWfinal	Final Ground Water	Inches

Table 2

The Tier Two QA/QC will use the measurements Names, Types and Default Units shown in Table 2. These data will be added to the project's Enterprise database which will contain data from all of the project's sites.

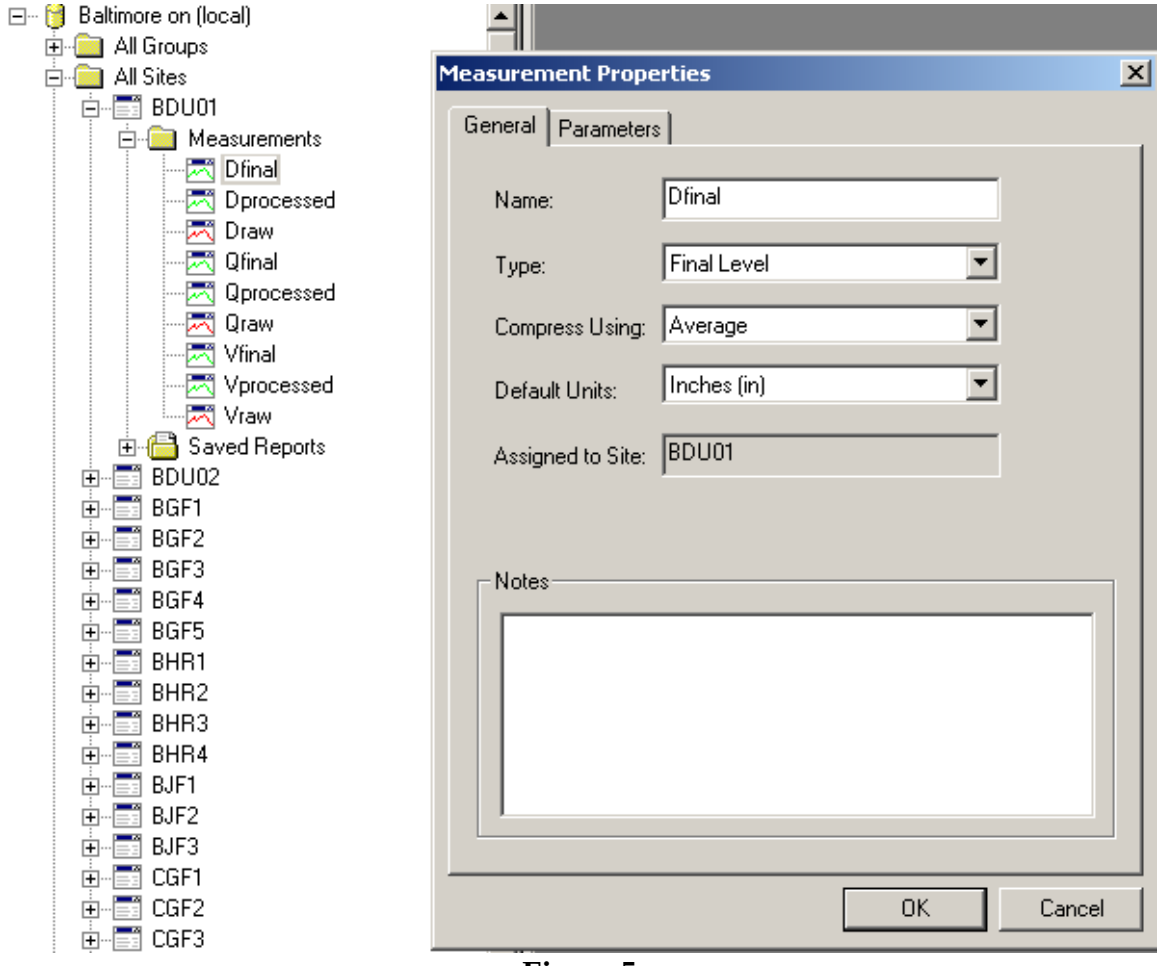


Figure 5

Figure 5 displays the measurement properties dialog box. Under the General tab there is a field named Type. It is within this field that the appropriate measurement type is selected.

Time

All data stored in the Enterprise database will be stored in Eastern Standard Time. It is required that all of the Enterprise servers for this project have their clocks synchronized to an accurate time service e.g. the Navy's Internet Time Service.

All of the Telog RTUs automatically synchronize their time to the time of their host Enterprise server. Therefore the time accuracy of the data is dependent upon each server's clock accuracy.

When viewing data in the Telog Enterprise Client or the Telog Web Module it is suggested that the option to view data in daylight savings time is left unchecked.

3. First-Tier QC/QA Processing

The data will be checked and processed using Telog Enterprise tools or other 3rd party software such as ADS's Profile software. The First –Tier QC/QA will consist at a minimum of Dry Day Balance and Hydraulic Review. At the completion of the First-Tier QC/QA process the data will be deemed "Processed Data".

a) Dry Weather Balance – Dry-weather flows must be normalized by basin acres or LF of pipe in basin. The result of this analysis is a calculated "wastewater production rate" for each basin. Each land use type has a characteristic wastewater production rate and unusually high or unusually low rates may identify errors in metering, pipe sizes, connectivity or basin sizes. This is one of the most important QC tasks because it can spot errors that are invisible to other QC methods.

b) Hydraulic Review - Flows from all sites must be reviewed through hydrographs and scattergraphs to spot irregular and unexplained diurnal patterns, and depth or velocity out of reasonable ranges during minimum and maximum flows. Scattergraphs with iso-Froude lines may be used to reveal the presence of hydraulic jumps that could contribute to meter error or imbalances. With the Manning pipe curve displayed on the scattergraph, backwater, surcharge and sensor failures are easy to spot.

c) Uptime Analysis – 90% uptime is a requirement for this study. Graphing the uptime gives immediate indication of trouble periods that require further review and explanation. Monitor uptime is defined as the number of five (5) minute measurement intervals where a flow value can be calculated from a measured depth and a measured or inferred velocity for a common time interval divided by the total number of measurement intervals in the reporting period. This uptime requirement is to be generally satisfied with actual measured data. However, there may be occurrences where a velocity measurement may not be required to

develop accurate data. Accordingly, inferred data would not be considered downtime if the flow monitoring firm documents to the satisfaction of the City that accurate data can be obtained without the velocity measurement and that the loss of velocity data was not caused by maintenance neglect. In any case, however, no velocity data shall be inferred for any measurement interval where (1) a corresponding depth measurement has not been obtained for that measurement interval or (2) independent calibration measurements have not been acquired for the site. Enterprise allows all inferred velocity data or other data derived from inferred data to be identified in the hydrographs (Figure 6).

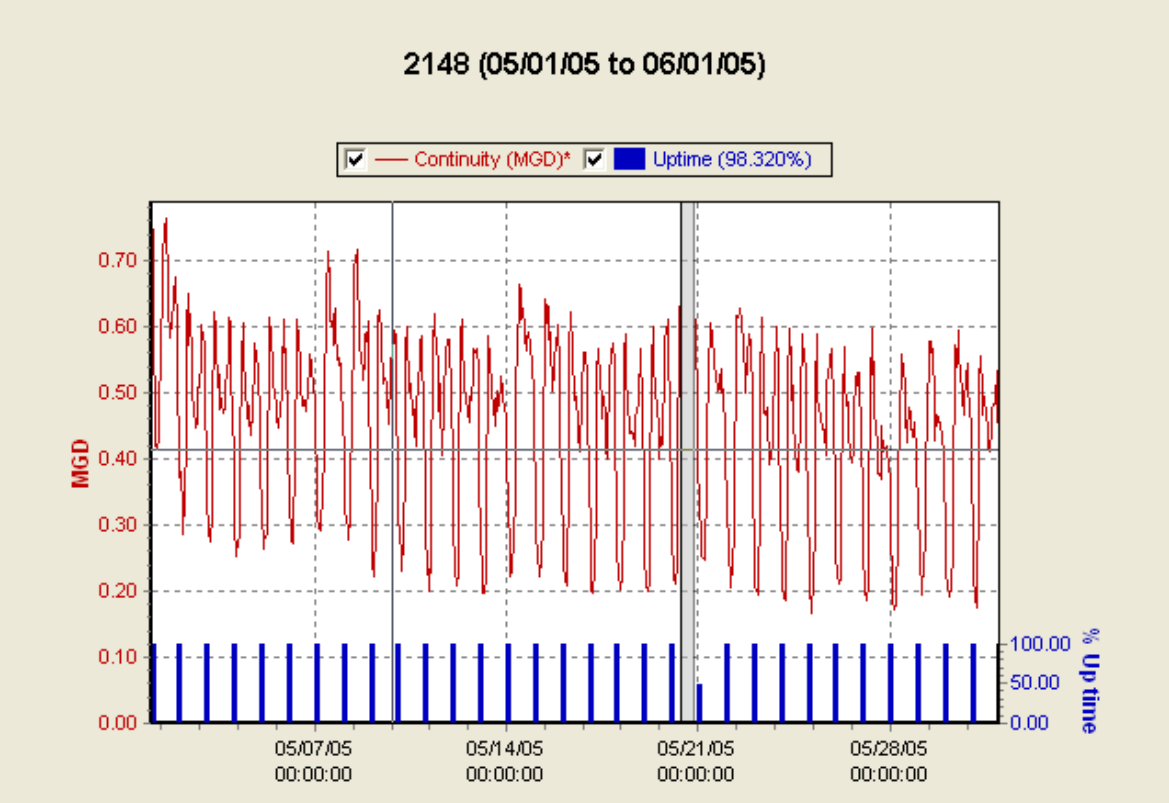


Figure 6

By the last day of each month, each service provider will make the Processed Data for the previous month available to the Project's Enterprise in the City server, via FTP, for second-tier QC/QA processing. The City's Enterprise will interrogate the process and pull (fetch) the processed data from the flow monitoring firms. For example, data for the month of July should be processed and transferred to the City's Enterprise server by August 31st. The Processed data will be checked by the Program Manager using the Telog QC/QA tools. Once validated, the data will be deemed Final data at the completion of this check.

4. Hardware

The Telog **RTUs (*Recording Telemetry Unit*)** used in this project are standard Telog multi-channel data recorders designed for installation in wastewater manhole environments. This family of Telog recorders has been in production for more than 10 years with thousands of field installations.

The RTUs provide multiple input types including:

- Direct digital interface via RS-232/485 to common open channel flowmeters, including;
  ADS FlowShark
  Hach Sigma 900 Series Flowmeters (e.g. 910, 920 etc.)
  ISCO 2150 Flowmeter and supported plug-in modules
  MGD ADFM Flowmeter (canister and above ground packaged models)
  Marsh McBirney 460 Series with Flodar and Flo-Tote III Sensors
- Hardware connected analog inputs including submersible pressure level sensors, temperature sensors, water quality sensors (e.g. pH, ORP etc.), current loop and/or analog voltage inputs.
- Hardware connected digital inputs including rain gauges, float switches, flowmeter digital pulse outputs (water meters, turbine flow sensors etc.)

The RTUs contain over 250 Kbytes of data memory and can store information collected at the monitoring sites for greater than 6 months. Detailed information on the Telog RTUs' inputs, memory, power, and software and communication options is available on the Telog website at www.telog.com.

a) RTU Flowmeter Interface – Telog has executed confidentiality agreements with each supported flowmeter vendor providing Telog access to the proprietary protocol for each meter. The Telog RTU provides a custom interface driver for each meter type to interrogate the meter for all key measurements (e.g. level, velocity, flow, battery voltage) and other parameters specific to each meter.

The RTU may be configured to collect data from the flowmeter as frequently as desired, including following each flow measurement. Collected flow data will be stored in the RTU for many months (a valuable data back-up feature) and forwarded to the host Enterprise computer at a user defined schedule. Call schedules are user configurable and can range from once per minute to once per day and/or automatically on alarm. Alarm conditions may be programmed for any collected or computed measurement as well as RTU battery voltage or the failure to collect data from the meter.

The RTU also provides a *pass-through* mode, which permits a communications session to be established between the host computer and the flowmeter for the purpose of collecting meter diagnostic information or re-configuring the flowmeter operating parameters using the flowmeter vendor's application software.

b) Remote Communications – The remote RTU shall communicate with the host computer to:

- Transfer data, alarms and RTU log files
- Reconfigure RTU computations, schedules and site parameters
- Perform RTU clock synchronization
- Reconfigure flowmeter configuration or perform diagnostics using **pass-through**

c) Communication Options - The RTUs for this project will support the following communication methods:

- Local RS-232 Communications - An environmental circular connector will be installed on each RTU enclosure permitting RTU local programming or data collection with a portable PC.
- CDMA – Circuit Switched data communications using dial-up.
- 1xRTT - Packet switched IP protocol data over the cellular

The primary communications method is 1xRTT packet switched data over the Verizon Wireless cellular network. 1xRTT (equivalent to wireless Ethernet) offers the following benefits:

- Broad footprint coverage
- Low data cost (~ $12/month/site)
- Low power radio modems
- Internet compatible data
- Server can manage many hundreds of RTUs forwarding data frequently

d) Energy Consumption - Wireless cellular modems consume substantial energy if continuously powered to accept in-coming calls. Telog recommends that the RTUs initiate all calls (scheduled data or alarm calls) permitting the wireless modem to be powered off between calls. This method can provide real time flow data on the service provider's website while consuming far less total energy than a method that permits direct call access to collect flow data.

e) Instant Message - An Instant Message data call following a flow measurement over the Verizon 1xRTT network consists of two IP data packets; one from the RTU to the host; the second from the host to the RTU confirming valid receipt of error free data. The contents of the RTU packet will include the most recent measurements (e.g. level, velocity, and flow) along with the battery voltage and any existing alarm conditions. All data packets transmitted in either direction includes a two byte CRC (*Cyclic Redundancy Check*) error detection code. When these packets are received, the CRC is recomputed for each packet and verified to the CRC transmitted with the data. If a data error is detected, the suspect packet is requested again from the transmitter. This approach ensures data reliability.

f) Alarms - The RTUs provides an extensive set of alarm call criteria, which include:

- High and/or low flow, level and velocity (user programmable levels)
- RTU battery pack low voltage detection
- Flow sensor not responding
- AC Voltage fail (AC powered sites only)
- Tamper detect (vault or locked enclosure sites)

In addition to alarms, the RTU retains information in an event log regarding all events other than normally expected events. For example, communications with all remote computers, clock adjustments, and configuration changes, etc. The event log is downloaded to the host computer during the daily maintenance communications with the host computer.

5. Software

Telog Enterprise software is an enterprise level software package providing communications and data management for all of the project's remote data acquisition. Enterprise will store all data from remote sites into an SQL database on each service provider's system, as well as all RTU configurations, event logs, site parameters, etc. Any networked computer (with the appropriate access rights) may then access the data stored in the SQL database using a common web browser (e.g. Microsoft Internet Explorer). This can include any computers connected to the user's intranet, or if desired the Internet. See Appendix A for Telog Enterprise server requirements.

Enterprise is a site centric software package which allows users to easily view the project's data in a well organized tree-based structure. All measurements are stored by site and those sites can be grouped by basin, area of responsibility or any other logical organization. By using a common platform for data collection and management the processes of data repair, validation, adherence to naming conventions are simplified.

Enterprise provides all the tools and capability required from collection of the raw data through the data repair of Processed data to Final data validation.

a) SQL Database – This project will generate large volumes of data. Using SQL Server allows Enterprise to easily manage large volumes of data. The maximum database for MS SQL is 1,048,516 Tbytes. This effectively limits the size of one's database to the amount of disk space that is available to the server.

b) Website Data Access – Each service provider's project website can provide the following data access to authorized personnel using Internet connected computers operating common web browsers.

- Real time and historic flow data reports from any flowmeter with or without associated rain gauge data and meter calibration data
- Real time and historic flow data report for any defined pseudo site (Netflow)

- Presentation of up to 10 parameters in one graphic presentation
- Scattergraphs of any flowmeter site over any time period
- Flow data presentation in a choice of statistical formats, e.g. Continuity, Manning
- Powerful graphic manipulation tools including active cursor, zoom and pan tools, and calendar selections (daily, weekly, monthly, quarterly, annually or custom times)
- Numerical spreadsheet report formats exportable in a variety of formats and time periods.
- Site status information, including RTU battery capacity, sample rate, call schedule, calibration data, physical parameters, etc.

Access to these project websites will be limited to authorized personnel by user name and password. Access permissions are controlled by the system administrator (Figure 7). This would permit a specific user to gain access only to specific data in the system via the internet. An example would be sharing rainfall data with the City's Public Schools as shown on Figure 2 above.

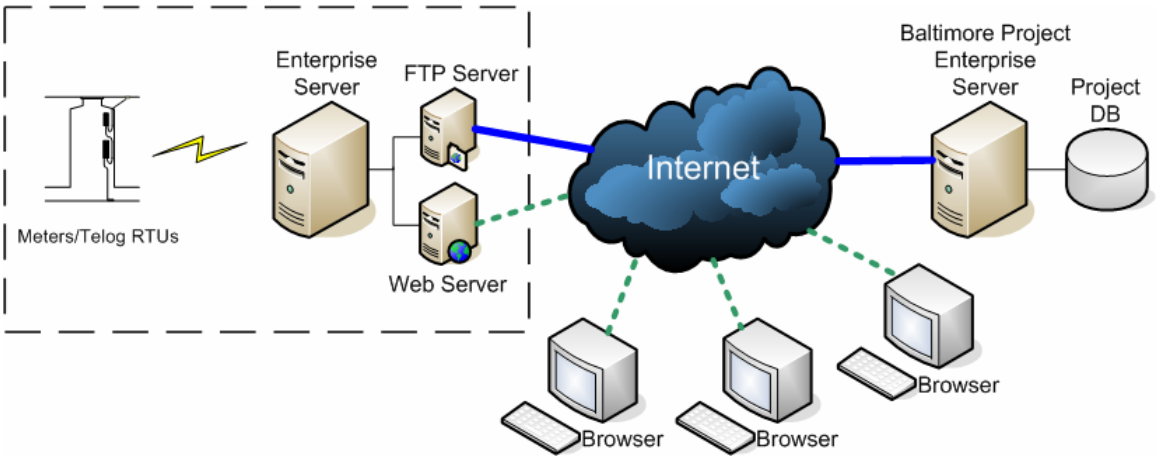


Figure 7

Data which has been processed using Enterprise or re-imported from a 3rd party package will be transferred to the FTP server using Enterprise's FTP data export utility. These data will be available on each service provider's FTP site for monthly transfer to the Baltimore project server.

C. SECOND-TIER QC/QA

The second-tier QC/QA will be performed by the Program Manager on the City's Enterprise. The tools within Enterprise facilitate verification of key second-tier parameters. Enterprise permits users to verify that flows are:

- Produced from valid level and velocity measurements
- Contain no missing data
- Agree with expectations of similar historical conditions
- Agree with system wide flows
- Reflect wet and dry weather conditions
- Agree with composite flow data (balancing)

Properly validating data from hundreds of flowmeter sites is a complex task which can be labor intensive. Telog Enterprise software is being used to simplify that task through its automated processes. Below is a description of the tools that will be used to reliably validate the project's processed data.

1. The Telog Tools

Telog Enterprise provides an assortment of tools for both processing raw data and validating, or finalizing the data. Enterprise maintains the data for each monitored location in a site folder. These Enterprise sites can relate to actual physical sites but virtual site can be created as well (see figures in section d. Flow Balancing).

Virtual sites and computed measurements (virtual measurements) allow users to edit or repair data, analyze net flows, view multiple sites data on the same graph, and compare dry weather vs. wet weather flows and numerous other functions.

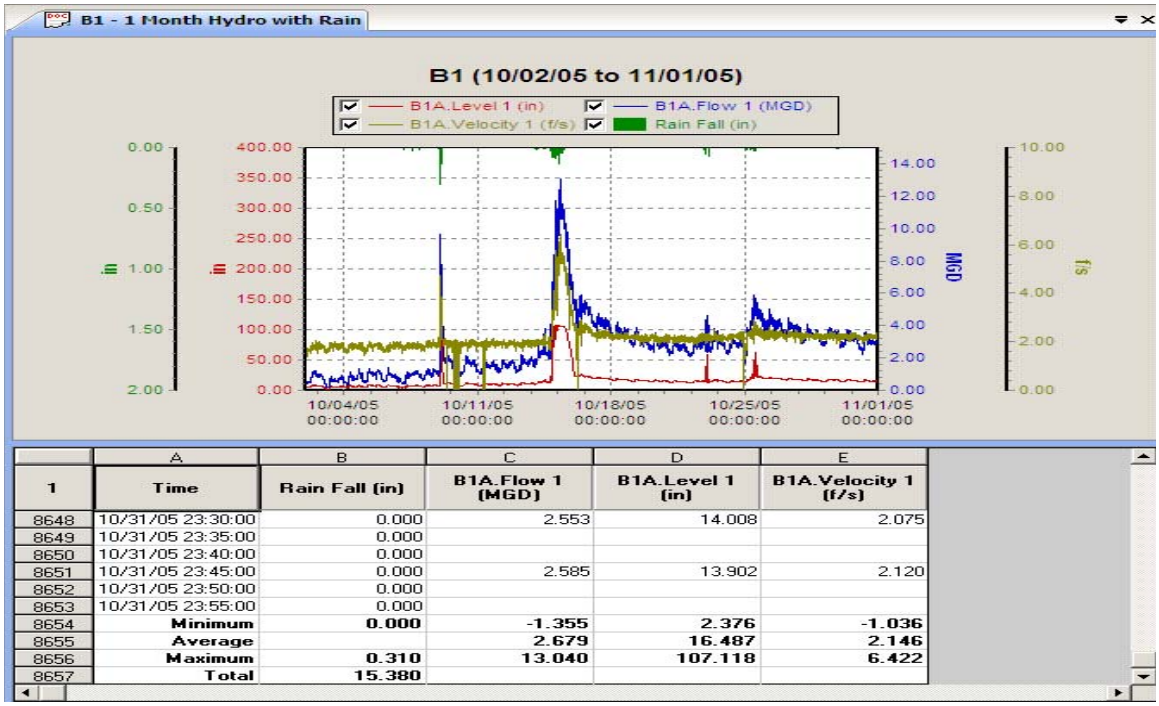
Original (raw) data is stored and protected from changes so one needn't worry about losing or altering original data while performing QC/QA operations.

Data gaps and out of bounds data can be automatically highlighted for quick identification. These data may then be automatically repaired (either individually or as a group) or they can be dealt with manually.
Enterprise contains a full featured equation editor with arithmetic and trigonometric functions as well as conditional logic. Several math functions are designed specifically for the wastewater market (e.g. fContinuity, fManning, etc.). The equation editor is powerful tool for creating measurements which can automatically calculate important data such as dry weather overflows, I & I and net flows.

2. The Hydrograph

Hydrographs are easily displayed in Enterprise. One simply drags the desired measurements into the report area or opens a previously saved report or report template by double clicking on that report's name.

The cursor is synchronized with the tabular data such that as the cursor is moved across the chart the data which corresponds to the current cursor position is highlighted below in the tabular columns. Zooming is accomplished by clicking and dragging the cursor across the desired data. Rain data from a single tipping bucket rain gauge can be associated with several sites within the area. By associating the rain measurement with all affected sites.



1	A Time	B Rain Fall (in)	C B1A.Flow 1 (MGD)	D B1A.Level 1 (in)	E B1A.Velocity 1 (f/s)
8648	10/31/05 23:30:00	0.000	2.553	14.008	2.075
8649	10/31/05 23:35:00	0.000			
8650	10/31/05 23:40:00	0.000			
8651	10/31/05 23:45:00	0.000	2.585	13.902	2.120
8652	10/31/05 23:50:00	0.000			
8653	10/31/05 23:55:00	0.000			
8654	**Minimum**	**0.000**	**-1.355**	**2.376**	**-1.036**
8655	**Average**		**2.679**	**16.487**	**2.146**
8656	**Maximum**	**0.310**	**13.040**	**107.118**	**6.422**
8657	**Total**	**15.380**			

Figure 8

Data from a single site or multiple sites can be displayed in a single hydrograph, and multiple graphs can be displayed simultaneously. Data will be viewed in hydrographs including flow rate, depth of flow, flow velocity, and rainfall (Figure 8). The Data Analyst will verify that these parameters are consistent and will observe how the system reacts to rain events. In general, the flow should exhibit a diurnal pattern, which varies depending on the make-up of the community (residential, commercial, industrial). A typical residential community will exhibit an increase in flow during early morning hours (06:00 to 08:00 AM) as residents begin to rise and prepare for the daily routine. The flows subside during the mid-day hours (09:00 AM to 04:00 PM), and begin to increase again as residents return home in late afternoon (05:00 PM). The flow typically peaks during dinner time, between the hours of 06:00 and 09:00 PM. Non-residential sectors will exhibit flow patterns that depend on the type and level of business and industrial activity.

3. The Scattergraph

The Data Analyst will use scattergraphs to determine the hydraulic performance of every site. In layman's terms, a scattergraph is a plot of flow depth (x-axis) versus flow velocity (y-axis). In sewer flows, the target is not a bull's eye, but a line (or pipe curve) that defines the depth and velocity relationship in a free-flowing sewer. In a sewer, precision, or repeatability, is determined by how tightly the data conform to a pipe curve (Figure 9)

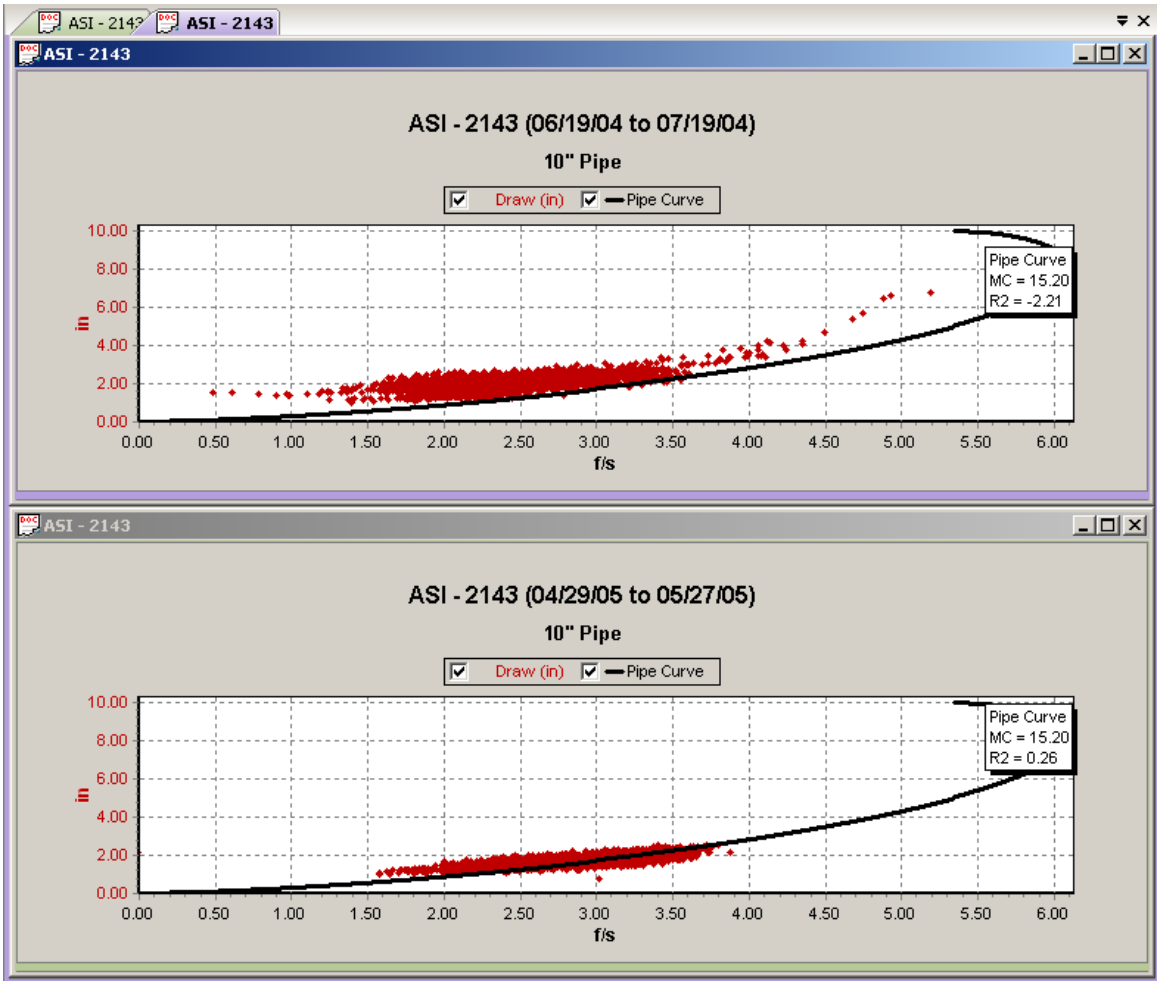


Figure 9

Telog Enterprise software allows multiple scattergraphs of the same site from different time periods to be displayed (Figure 10). One method is to drag the two measurements (depth and velocity) into the report area and then right click and select "convert to scatter". The time series trend data will be immediately converted to a scattergraph. Another method is to have the scattergraph stored as a report or as a report template and double-click on the report. Scattergraphs can also be displayed with a trend line using polynomial curve fitting (pipe curve). All Enterprise reports can be saved to the clipboard and then pasted in another application such as Microsoft Word or Excel.

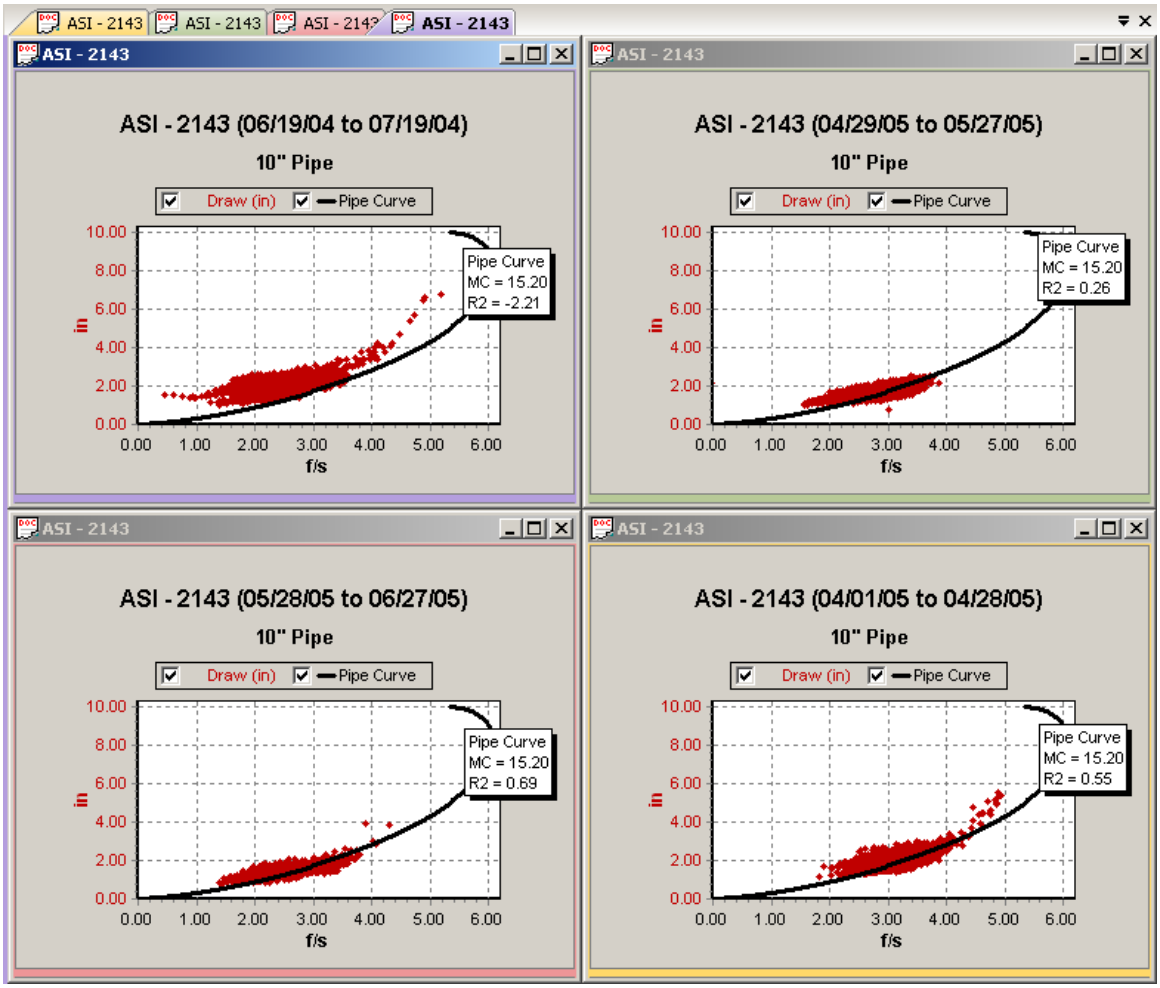


Figure 10

Scattergraphs will be used as quality indicators to quickly determine if a monitor is collecting accurate data. The method uses three sets of data plotted together on a scattergraph (Figure 10): 1) depth and velocity readings from the monitor, 2) manual depth and velocity confirmations collected with a ruler and portable velocity meter by the field crew and 3) a Manning pipe curve. The figure shows how these data should appear in a good free flow site with a properly performing monitor. All three data sets should be aligned with each other. If the monitor's data do not line up with a pipe curve, one of only two things is occurring. Either 1) the sewer is not experiencing normal open channel flow or 2) the monitor is failing to make valid measurements. Data exhibiting apparent sensor drift unconfirmed with manual readings will not be accepted.

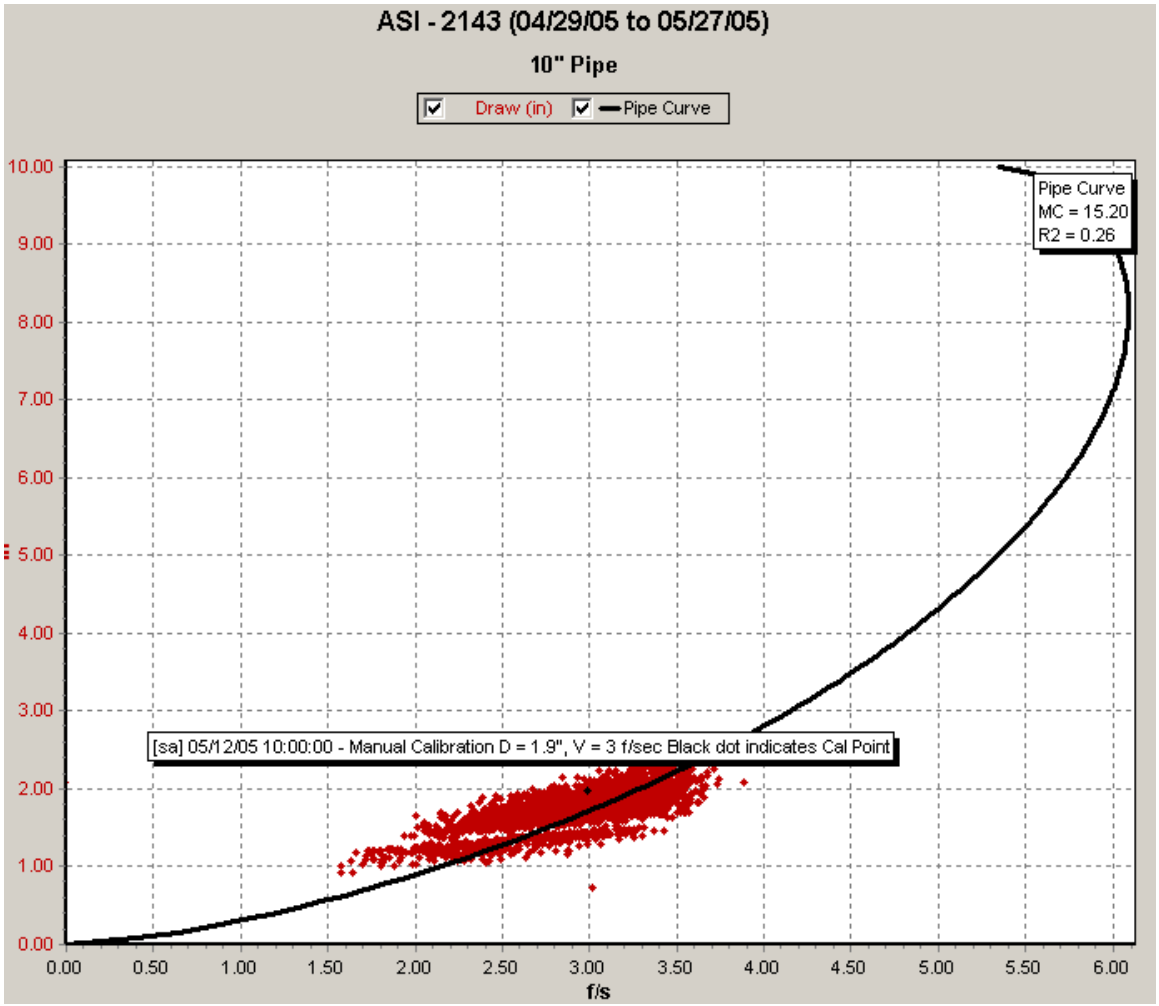
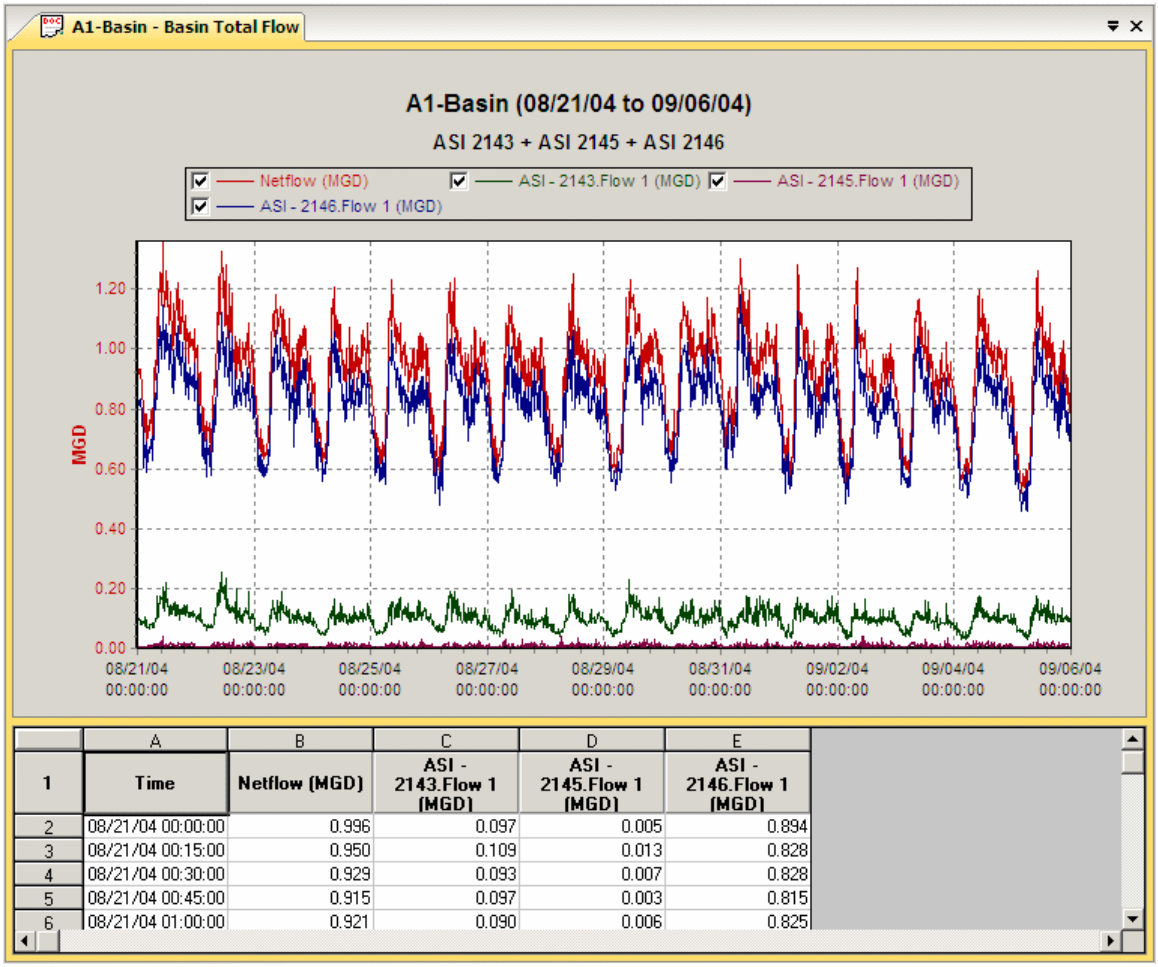


Figure 11

4. Flow Balancing

Another important task performed by the Data Analyst is to balance the flows within the network of flow monitors. An unlimited number of pseudo or virtual sites may be created in Enterprise. A practical example of this is to create a site which represents a basin (Figure 12). Balancing involves computing flow quantities for different points in time and analyzing the consistency of downstream readings to upstream readings. The purpose of flow balancing is to add yet another assurance that the flow meter network is producing reliable and accurate data. Because virtual sites and measurements are stored in the database in the same fashion as actual site, daily, weekly, monthly review of balancing is greatly simplified.



	A	B	C	D	E
1	Time	Netflow (MGD)	ASI - 2143.Flow 1 (MGD)	ASI - 2145.Flow 1 (MGD)	ASI - 2146.Flow 1 (MGD)
2	08/21/04 00:00:00	0.996	0.097	0.005	0.894
3	08/21/04 00:15:00	0.950	0.109	0.013	0.828
4	08/21/04 00:30:00	0.929	0.093	0.007	0.828
5	08/21/04 00:45:00	0.915	0.097	0.003	0.815
6	08/21/04 01:00:00	0.921	0.090	0.006	0.825

Figure 12

D. Final Data Transfer to Sliicer.com®

Once the data have gone through the Second-Tier QC/QA Process it will be deemed "Final Data". The Final Data from all three service providers will be transferred to ADS about once a month. The data then will be imported into to a Profile® (a registered mark of ADS Corporation) database. This will allow the Sewershed Consultants to perform the I/I evaluation using Sliicer.com®.

The City will deliver "Final" data to ADS, for uploading to Sliicer.com, via DVD. This requires the City to export the monthly data from the City Telog server into a format that can easily be imported back into a separate Telog database. Upon receipt of the DVD, ADS will import the data into a Telog database that contains the monitoring locations from all three flow monitoring firms, then use a data transfer utility to transfer the data from the Telog database to eight individual Profile® databases, one for each sewershed, so that the data can be accessed through Sliicer.com by the sewershed consultants (Sliicer.com is designed to work with Profile® databases)

Figure 13 on the following page provides a high-level overview of the proposed data flow for this project.

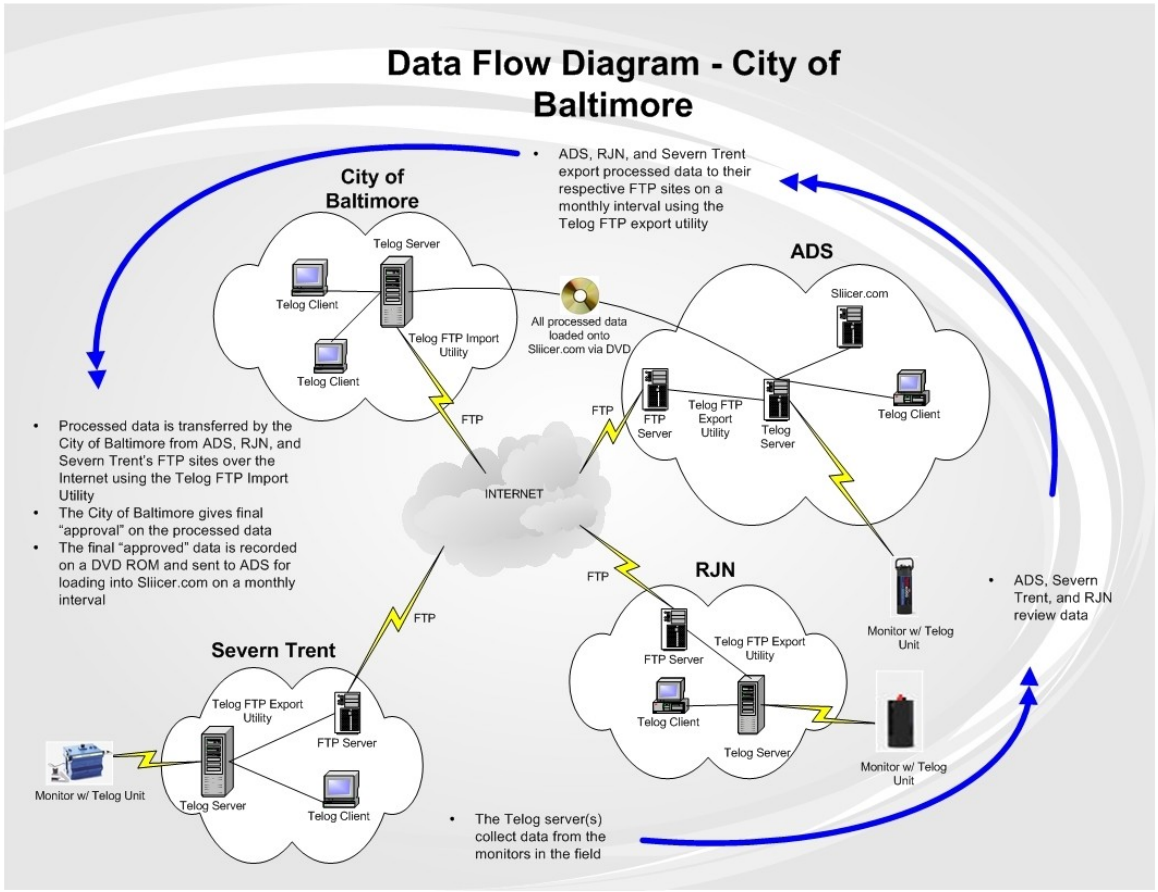

Data Flow Diagram - City of Baltimore
City of Baltimore
Telog Server
Telog Client
Telog FTP Import Utility
Telog Client
ADS, RJN, and Severn Trent export processed data to their respective FTP sites on a monthly interval using the Telog FTP export utility
All processed data loaded onto Sliicer.com via DVD
ADS
Sliicer.com
FTP Server
Telog FTP Export Utility
Telog Server
Telog Client
FTP
FTP
INTERNET
Processed data is transferred by the City of Baltimore from ADS, RJN, and Severn Trent's FTP sites over the Internet using the Telog FTP Import Utility
The City of Baltimore gives final "approval" on the processed data
The final "approved" data is recorded on a DVD ROM and sent to ADS for loading into Sliicer.com on a monthly interval
FTP
RJN
FTP Server
Telog FTP Export Utility
Telog Client
Telog Server
Monitor w/ Telog Unit
Monitor w/ Telog Unit
ADS, Severn Trent, and RJN review data
Severn Trent
Telog FTP Export Utility
FTP Server
Telog Server
Telog Client
Monitor w/ Telog Unit
The Telog server(s) collect data from the monitors in the field

Figure 13

Appendix A

Telog Enterprise Software System requirements

Computer Hardware - Server

- Processor - Intel P4 or equivalent (3GHz or higher recommended)
- RAM – 512MB minimum (1024MB per CPU recommended)
- Hard drive space - 20GB minimum (40GB recommended)
- Network Adapter – 100Mbit minimum (1 Gigabit recommended)
- Telog supplied external modem and analog line (optional, required for telephone data collection)

Operating System - Server

- Minimum - MS 2000 Pro or MS XP Pro
- Recommended - MS 2000 Server or MS 2003 Server (required when running the Telog Web module)

Computer Hardware - Workstation

- Processor - Intel P3, equivalent or higher (500MHz or higher recommended)
- RAM – 256MB minimum (512MB recommended)
- Hard drive space – 250 MB minimum (1GB recommended)
- Network Adapter – 100Mbit minimum

Operating System - Workstation

- Minimum - MS 2000 or MS XP Home
- Recommended - MS 2000 Pro or MS XP Pro

Software

- Telog Enterprise Client (required)
- Telog Communication module (required)
- Microsoft .NET Framework 1.1 (required)
- Telog AutoCalc module (optional)
- Telog Web module (optional)
- Microsoft IIS (optional, required for Telog Web module)

Database

- MS MSDE 2000 for small systems (15 or fewer remote RTUs) which is limited to 2GB maximum database size and 25 maximum concurrent users
- MS SQL server 2000 for all other applications

Connectivity

- High speed Internet connection (T3, T1, Cable modem, etc.)
- Static IP address if using Packet Switched Cellular (1xRTT or GPRS)

- Optional - VPN or remote desktop access rights to Telog for installation and start-up assistance

IT Considerations

- Open inbound TCP port (4020 by default) for 1xRTT and GPRS applications

Example Server System

Telog Data Management Server - Dell 2650 rack mount server with:

- Intel Xeon 3GHz processor
- 1GB RAM
- 4 - 73G Ultra 320 SCSI Drives configured RAID 10
- Redundant power supplies
- Windows Server 2003 Standard Edition
- IIS installed