


Welcome
to the
PA Rural Water Association Annual Technical Training
Conference
We're Glad You're Here!

Friday 3/27/15
8AM – 11:30AM

 Please, put your cell phones on vibrate during sessions
and, take calls to the hallway

COLLECTION SYSTEM INSPECTION FOR FAILING INFRASTRUCTURE

PRESENTERS:

ENTECH ENGINEERING, INC

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UTILITY SERVICES GROUP (USG), INC

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REFERENCES

- Template for Developing Sewer Collection System Preventative Maintenance and Sewer Overflow Response Plans, US EPA, Region 1 working document, November 2009 version
- Wastewater Treatment Plant Operator Certification Training - Modules 23 and 24 on Wastewater Collection Systems
- PADEP - Domestic Wastewater Facilities Manual
- Pumping Station Design 2nd Edition, Sanks, Tchobanoglous, Bosserman, and Jones, 1998.

- PART 1 – Wastewater Collection System Overview
 - Killian; Approx. 50 min.
 - Break; Approx. 10 min.
- PART 2 – Inspections / Rehabilitation
 - Kalbach; Approx. 60 min.
 - Exeter Supply Demo
 - Break; Approx. 10 min.
- PART 3 – Resources and Budgets
 - Killian & Kalbach; Approx. 30 min.
- Questions / Quiz
 - Approx. 20 min.

PART 1 - Wastewater Collection System Overview

Out of Sight = Out of Mind

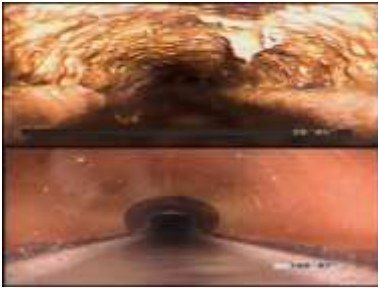


Inspection Challenges

- Lack of access / Buried Manholes
- Confined Space / Hazardous Environment
- Lack of accurate system drawings / as-built drawings
- Systematic Error
- Cost

WHY
INSPECT?





Hydrogen Sulfide - Odor

- Hydrogen sulfide (H_2S) is a product of stale sewage and has a rotten egg smell.
- Odors occur when waste water pH allows hydrogen sulfide to evolve from liquid phase hydrosulfide (HS^-).
- Steak, Cheeseburger, and 3-day old nachos.
 - O_2
 - NO_x
 - SO_x

Chart from: http://www.singaporewaterboard.com/Thesgwaterboard_direct.htm

Hydrogen Sulfide - Corrosion

- Certain bacteria convert Hydrogen sulfide (H_2S) to sulfuric acid, which is very corrosive to electrical equipment and to concrete, iron, and steel.

Chart from: http://www.singaporewaterboard.com/Thesgwaterboard_direct.htm



Main Goals

- Prevent public health hazards
- Comply with regulations
- Minimize SSOs
- Minimize complaints
- Quick response
- Efficiently use funds (limited budgets)

OK, ITS
IMPORTANT –
SO WHERE DO
I START MY
INSPECTIONS?

HOW ABOUT
THIS MH?



Mapping

- You must know what you have before you can inspect and assess its condition! At least an idea.
 - Existing Mapping / Available Data
 - Field locate MH / Pump Stations / Overflow Points (CSO & SSO) / Critical Monitoring Points / Etc.
 - Name each facility.
 - Operator Updates – they know more than what is on the map.

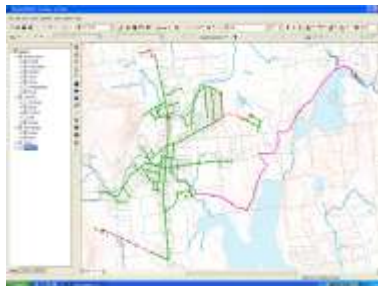
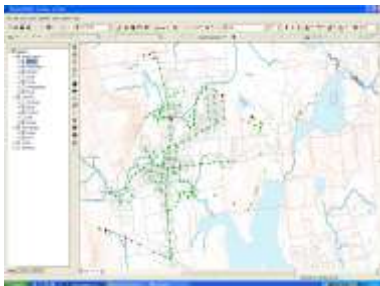
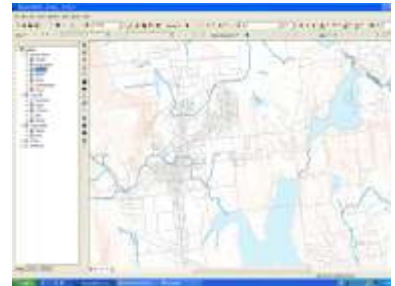


Mapping

- Existing Mapping versus Observed Conditions
 - It's on my map but I can't find it!
 - Need reliable data
 - Do you think it is there?
 - You know it is not there.
 - It is possible it is there.

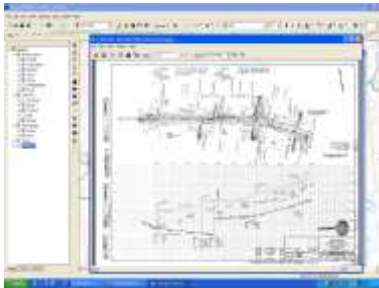
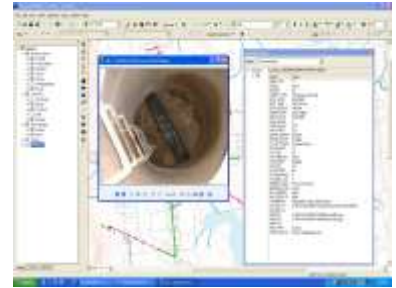
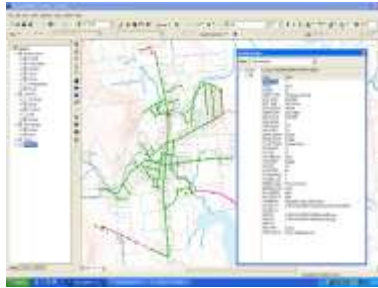
Easements and Paving: Maintenance and Access

- Maintenance of ROW and Easements
- Street Paving Coordination
- Utility Coordination



GIS Database Development

LENGTH	DIAMETER	MATERIAL	LENGTH	DIAMETER	MATERIAL
300.9148050007	8.00	Terra Conco	216.00723342014	8.00	PVC
343.53368015156	8.00	Terra Conco	182.46507506007	8.00	PVC
387.88912815151	8.00	Terra Conco	130.8526037501	8.00	PVC
388.9010060885	8.00	Terra Conco	234.6815060816	8.00	PVC
211.25174087883	8.00	Terra Conco	234.61219123264	8.00	PVC
183.4882444467	8.00	Terra Conco	135.078875246	8.00	PVC
137.643388150	8.00	Terra Conco	289.68713854780	8.00	PVC
274.24357077654	8.00	Terra Conco	151.13381948872	8.00	PVC
281.5563255467	8.00	Terra Conco	77.44601231505	8.00	PVC
248.7219188683	8.00	Terra Conco	28.08823814805	8.00	PVC
232.888771587	8.00	Terra Conco	244.4222254946	8.00	PVC



Why not stick with the old way (use the available mapping)?

- Unfortunately, the wide variety of maps and the diversity of their scales and designs at our disposal make it extremely difficult to access, use, and maximize the value of information they contain.
- GIS is an integrating technology; it integrates all kinds of information and applications with a geographic component into one manageable system.

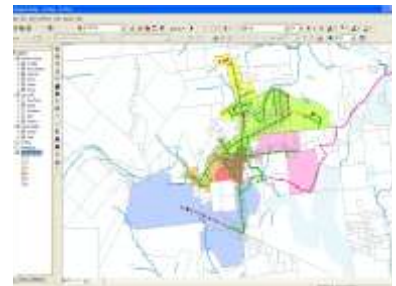
Mapping

- 100% Complete Sewer Map
 - Loch Ness Monster, Big Foot, Aliens.
- Continually update and revise.



Easier to Chew

- The sanitary sewer system should be broken down into basins (multiple pump stations) and later possibly sub-basins for future investigation.



OK, I NOW
HAVE A GOOD
(NOT PERFECT)
SYSTEM MAP
BROKEN INTO
BASINS



LETS TALK 1&I


Quick Review: Infiltration (Ground Water)

- **INFILTRATION** – "The total extraneous flow entering a sewer system or portions thereof, excluding sanitary sewage, because of poor construction, corrosion of the pipe from the inside or outside, ground movement or structural failure through joints, porous walls or breaks."

WPCF MOP No. FD-5


Quick Review: Inflow (Surface Water)

- **INFLOW** – “The extraneous flow which enters a sanitary sewer from sources other than infiltration, such as roof leaders, basement drains, land drains, and manhole covers. Inflow, in short, is usually man made and intentional.”



WPCF SHOP No. FD-5

I don't have I&I!



- Every sanitary sewer system has some I&I even newly constructed systems.
- For new construction, the leakage exfiltration or infiltration shall not exceed 100 gallons per inch of pipe diameter per mile per day for any section of the system

PAD&P Domestic Wastewater Facilities Manual (10/97), Page 29

- 3 mile (15,840 ft) of 8-inch sewer pipe would equate to 2,400 gpd of infiltration

A little water never hurt anyone.


- Problems associated with excessive I&I:
 - Basement back-ups
 - \$ - Result in litigation & potential liabilities
 - System deterioration
 - \$ - System repairs / upgrades (quantity and quality)

CATASTROPHIC FAILURE

- Undermining of piping/structures

A cross-sectional diagram of a sanitary sewer system. It shows a house with a sewer line leading to a manhole. The line continues through the ground, passing another manhole, and then turns into a larger pipe labeled 'SANITARY SEWER MAIN'. This main pipe has a 'CRACKED OR BLOWN PIPE' section and a 'SOLIDIFIED MANHOLE'. The system terminates at a 'PUMP STATION' with a 'PUMP' and a 'WASTE OILS SEPARATOR'. The pump station is connected to a 'WASTE OILS SEPARATOR' and a 'WASTE OILS SEPARATOR'.

Inflow & MH Covers




- Tests made on manhole covers submerged in only 1-inch of water indicate that the leakage rate per manhole may be from 20 to 75 gpm depending on the number and size of holes in the cover.
Remon, C.M., "What cost leaking manholes?" Wastewater and sewage, Vol. 84, 12, pg. 45, 1987
- MH Penetrating Pick Holes are common holes in covers.
- Solid Watertight Covers are to be used whenever the manhole tops may be flooded by street runoff or high water.

PCRP® Domestic Wastewater Facilities Manual (1995), Page 20

- MH Dishes

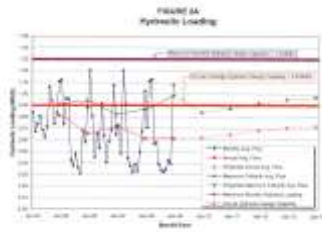
HOW BAD IS
MY
COLLECTION
SYSTEM?



Do I have a problem with I&I?

- Quick & Dirty.
 - DMRs and Chapter 94 Report
 - Hydraulic Loading Chart
 - 3-month max. versus annual average flow
 - Review Flow per EDU – 400 gpd/edu
 - Pump Stations
 - Hour Meters
 - Drawdown Test
 - Are the pumps properly working?
 - Known Overflows
 - Exceed Hydraulic Capacity / Blockages

Station	Flow (cfs)	Velocity (ft/s)	Depth (ft)	Width (ft)	Area (sq ft)	Volume (cu ft)	Time (min)	Distance (ft)	Time (hr)
1+00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2+00	2.00	2.00	2.00	2.00	4.00	4.00	2.00	2.00	2.00
3+00	3.00	3.00	3.00	3.00	9.00	9.00	3.00	3.00	3.00
4+00	4.00	4.00	4.00	4.00	16.00	16.00	4.00	4.00	4.00
5+00	5.00	5.00	5.00	5.00	25.00	25.00	5.00	5.00	5.00
6+00	6.00	6.00	6.00	6.00	36.00	36.00	6.00	6.00	6.00
7+00	7.00	7.00	7.00	7.00	49.00	49.00	7.00	7.00	7.00
8+00	8.00	8.00	8.00	8.00	64.00	64.00	8.00	8.00	8.00
9+00	9.00	9.00	9.00	9.00	81.00	81.00	9.00	9.00	9.00
10+00	10.00	10.00	10.00	10.00	100.00	100.00	10.00	10.00	10.00



Do I have a problem with other issues – such as imminent pipe collapse?

- Known Overflows
 - Possible Blockages / Partial Blockages
- Further investigation

WHATS THE BEST WAY TO MINIMIZE MAINTENANCE AND MANAGE YOUR COLLECTION SYSTEM?



New Construction

- Pre-Construction Meeting:
 - Review of Contract Drawings
 - Review of Contract Specifications
 - Review Shop Drawing Requirements
 - Review Testing Requirements
 - Review Permits Requirements
- PA 1 Call Field Mark-ups
 - WALK THE JOB



Legal Authorities and Control

- Ordinances/Resolutions & Agreements

How can paperwork help manage your collection system?

- Design Review
- Sewer Rules and Regulations / Ordinances (Up-to-date)
- Control of improper (illegal) connections
- Connection Permits.
- Lateral and sewer extension inspection

PART 2 - Inspections / Rehabilitation



Terms & Definitions

- Storm, Sanitary & Combined Sewers
- Inflow & Infiltration (I&I)
- Closed-Circuit TV (CCTV)
- Pipeline Assessment & Certification Program (PACP)
- Trenchless Pipe and Manhole Rehabilitation
- Cured-In-Place-Pipe (CIPP)
- NASSCO
 - Why so important?

Safety

- Municipal, Contactor, and Public Safety
 - Confined-Space Certifications
 - Air Monitors
 - Retrieval Tripods
 - Traffic Control
 - Entrapment
 - Steel-Toe Boots
 - Not just cones!!!



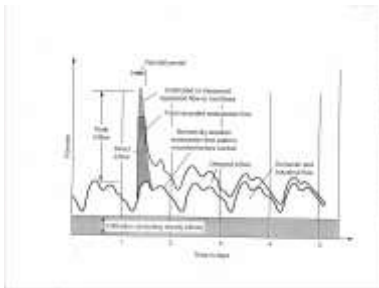
Inflow and Infiltration

- Four Primary Sewer Components:
 - Mainlines, Laterals, Lateral Connections & Manholes
- Underground Water Migration
 - French Drain Effect
- Wet-Weather and Spiked Flows

Flow and Rainfall Monitoring

Do I mainly have I or I?

- Methods for determining Quantity of Inflow
 - Graph wastewater flows and denote precipitation and spikes within the graph.
- Methods for determining Quantity of Infiltration
 - Nighttime flows during dry weather conditions.



No Magic Bullets

Table 3. Gravity Sewer Systems: Per-capita Flow Rates by Pipe Material and Diameter Range (FERC, 1944)

Material	Diameter, inches				
	8 to 12	14 to 18	21 to 24	27 to 30	36
CLP	4.4	1.8	2.2	1.4	1.1
DCP	1.5	1.8	4.6	8.9	46
Lead BCP	1.4	1.9	4.3	17	70
PVC	2.2	1.1	2	1.8	1
SGP	1.2	1.4	1	0.8	0
PVC	1.2	1.2	1.2	1.1	1
CLP	1.4	1.2	1.2	1	1
Steel	0.5	0.8	1.2	1.2	1.2
Other	0.8	1	1	0	0

Notes: CLP = cast-lead pipe; DCP = cast-lead concrete pipe; PVC = polyvinyl chloride; SGP = high-density polyethylene; SG = ductile iron (lead and asbestos); CL = cast iron (lead and asbestos); BCP = ball clay ball clay pipe.

I & I Investigation

- Mainline CCTV
- Lateral CCTV
- Manhole Inspection
- Smoke Testing
- Dye Testing
- Flow-Meters / Rain-Gauge
- Wet-Weather Investigation

Wet Weather / Night time Investigations

- Wet Weather
 - Select Manholes
- Night Time
 - Select Manholes



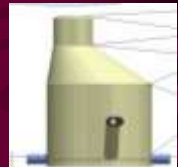
Smoke Testing

- An easy and cost effective method to identify I&I.
- Smoke testing can identify illegal connections, storm water cross connections, abandoned lines not properly plugged, cracked pipes, and bad service connections.
- Proper Trap does not allow smoke to enter.



Manhole Components

- Frame / Cover
- Chimney
- Cone / Corbel
- Barrel Section
- Bench
- Channel / Invert
- Inlet / Outlet Pipe



Inspection Form

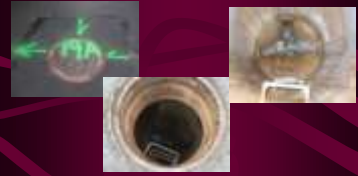
- Pictures
- Diagram
- Construction Method / Material
- Corrosion and pH Test
- Settlement / Washout of fines / VOIDS
- Structural Integrity
- Active / Inactive Leaks
- Watermarks
- Mineral Deposits
- Drops
- Flow
- Condition of Steps



Tricks of the Trade

- Daily catalog
- Digital everything
- Pictures, pictures and more pictures
- MACP
- Special attention to frame and cover
- Set a plug
- Crew Chief

Manhole Visual Inspections



Cleaning, Inspection and Assessment

- Cleaning
 - Sags
 - Trouble areas
 - Roots
 - Critical Service Areas
 - Hospitals
 - Schools
 - Prisons
- MH and Pipe Inspection / Assessment
- Staffing and Equipment

Flushing

- How to flush?
- Screen & Vacuum
- Pump Size & Spec
- "Flying Blind"
 - Value of competency
- Root Cutting
- Protruding-Tap Cutting



Easement Work



Light & Heavy Cleaning





Storm System Neglect



CCTV Inspection

- Certified Operator - PACP
- Max Speed = 30 ft / min
- Tracked, Wheeled, Boat and Lateral Launching Systems
- Pan, Tilt & Zoom Camera
- DVD, Viewing Software, Report & Index

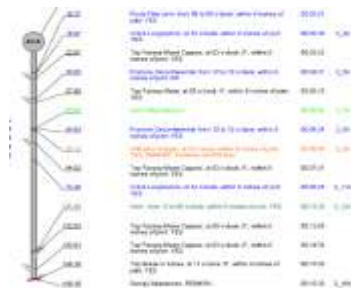


Lateral Launch



Decoding your TV Reports

- Understand the defect coding method used.
- How to Prioritize repairs?
 - Immediate Structural Repairs (ASAP)
 - Structural Repairs (Prioritize / Cost)
 - Major Sources of I&I (Prioritize / Cost)
 - Minor Sources of I&I (Prioritize / Cost)



Typical Sewer Main Defects

- Protruding Lateral Connections
- Broken Pipe
- Sags
- Misalignment
- Separated Joints



Dye Testing

- Verification of suspect sources
 - Roof leaders
 - Storm Inlets
 - Unknown pipes



Now That We've Found The Problem....

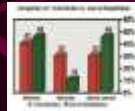
- How do we fix it?
 - Dig and Replace
 - Costly, inconvenient, but sometimes necessary
- Trenchless Rehabilitation
 - "No-dig" Option
 - Temporary or Permanent Fix?

Main Line Replacement versus Rehabilitation

- Condition of existing pipe / manholes / lateral piping
- Constructability of new pipe
- Number of laterals
- Restoration / Permitting Requirements
- Job Size and Number of Contractors

Manhole Rehabilitation

- "Low-Lying Fruit"
- Cost-Effective
- Grouting
- Cementitious vs Epoxy Sprays
 - Selection Criteria
- Chimney Seal



Manhole Rehabilitation Process



H2S Damage

- Usually localized near force main discharge points
- Rehabilitation of H2S prone structures is expensive



Importance of Post-CCTV

- Installation Inspection
- Post-CCTV Verification



Cured-In-Place Sectional Repair

- "Surgical Approach"
- Cost-Effective
- 2'-20' Repairs



Cured-In-Place Sectional Repair



Large Diameter Pipe Repair



Lateral Rehabilitation

- Laterals rehabilitation have been given less attention in the past due to:
 - Lack of adequate inspection for small diameter lines
 - Lack of adequate rehabilitation methods for small diameter lines
 - Complex issues of ownership and maintenance
 - Transitions from 4 to 6-inches
 - Bends
- Usually up to 45 degree with liners.

Other Solutions

- Pipe Bursting
 - Need to re-connect laterals
- Slip-Lining
 - Grout the annular space
- Lateral Lining

Contracting

- Identify Budget – Select Rehabilitation
- Clarify Scope
 - Access, traffic control, bypass pumping, dump site, light / heavy cleaning, water source, completion timeframe, wet weather, certified operator, deliverables
- Avoid “Sole-Sourcing”
- Economies of Scale

3rd Party New Construction Testing

- Flush and CCTV New Pipes
- Mandrill / Laser Profile
- Pressure Testing
- Vacuum Test Manholes



Good Practices

- Public notification of flushing / smoke test
 - Document laterals with issues, for future notifications
- Identify sags, severe offsets, roots
- CCTV New Construction Pipes
- Pump Station Grit Removal / Vacuuming

PART 3 - RESOURCES AND BUDGETS

Resources and Budget

- Budget Process
- Rate Setting, Budgetary Policies and Financial History
- Historical Rate Review
- Operating and Maintenance Expense
- Capital Improvement Program Overview
- Capital Improvement Plan

Selecting the right method

- What are the problems to be addressed?
- What methods can remedy the problems identified?
- Does the method provide a short or long term solution?
- Does the method go beyond just solving the problem identified and is there an added benefit?

No more I&I Problem?

"I did I&I work five years ago and I still have a problem!"



The reduction and control of I&I should be considered a part of your disciplined, long-term monitoring and maintenance program.
– NOT A ONE TIME FIX. IT'S A PROGRAM NOT A PROJECT.

Post-Rehab Flow Data

- Did it work?
 - Pre- and post rehab evaluation
 - Are the flows down?
 - Monitor peaks
 - Monitor duration



Meaningful Conversation with your Board

What is needed now versus what can be budgeted in the future?

Operator Certification Act

Importance of advocating for what is right / needed

Finding ways to help your board see and understand

Justifying why you need them to fund collection system maintenance

The Cost of Waiting

Proactive versus Reactive

Questions

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- Robb Kalbach
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REVIEW / QUIZ