Presentation Overview

- Project Background
  - Drivers
- Enhanced Inventory Database
- Capacity Level of Service Analysis
  - System Wide H&H Modeling
- Asset Management Decision Support
- Summary
  - Program Going Forward
Project Background

- **Gwinnett County, GA**
  - Metro Atlanta
  - 437 Square Miles
  - Population 800,000

- **Stormwater Management**
  - Stormwater Utility Funded
    - Implemented in 2006
    - $34M Annual Revenues ($2.46/100 sf)
  - Aging Stormwater Infrastructure
    - ~1,300 Miles County-Maintained Pipe
      - ~1,000 Miles Corrugated Steel
      - ~500 Miles > 20 Years Old
    - ~80,000 Drainage Structures
Project Background

- **C&M Practices**
  - SOP for Rehab/Replacement of Failed Pipe
    - CIPP or Replace Like Size with HDPE or RCP
    - 18” min
  - **Existing Conditions Capacity LOS Unknown**
    - Hydraulic Impacts of Rehab/Replacement Unknown
      - Does the existing system meet desired LOS?
      - What upgrades are needed to meet desired LOS?
  - H&H analysis on select systems where history of flooding exists
    - At discretion of Division based on site specific concerns
  - Resource Issue - Manpower and Funding
Project Background

- **Active Asset Management Program**
  - Stormwater Inventory Database
    - Pipes, Structures, Ditches
    - Basic Data – type, size, material, etc...
    - X&Y; No Z
  - Strategic Asset Management Plan
    - Identifies Critical Infrastructure
    - Capacity LOS potential score for ranking (unused)
- **Bridge/Culvert CIPs**
  - Floodplain Management Program
    - Floodplain modeled and mapped up to 100-acre point
    - ~400 miles detailed study streams
    - ~400 miles limited detailed study streams
  - ~600 County Maintained Bridge/Culvert CIPs identified
- **Next Step to Analyze Remaining Pipe Infrastructure**
Enhanced Inventory Database

- **Pilot Study – Level Creek (2011)**
  - 9 square miles
    - ~20% Impervious (Suburban)
  - Pipes Upstream of 100-acre Floodplain
    - Developed Scope of Study
      - Provided to Surveyors for Measure Downs
      - All pipe ends except for end sections
    - 1,600 Pipe Segments
      - 22 miles County-Maintained Pipe
      - 2 miles non County-Maintained Pipe
Enhanced Inventory Database

- **Invert Estimation**
  - Assign Ground Elevation to Pipe Ends and Structures
  - Subtract Measure Down Value from Ground Elevation
    - Ground = Invert at End Sections
  - Lowest Pipe Invert at Structure = Structure Invert

- **Pipe Depth**
  - Every 1-ft along pipe length
  - Min, Max, and Avg Depth
  - Create JPGs of Pipe Profiles
    - Hyperlinked to each pipe by Facility ID
Enhanced Inventory Database

- Easement Needs
  - On Pipes only
  - Dependent on Maximum Top Trench Width
    - Typically varies along the pipe
    - Span + 6' +2*Max Depth
  - Permanent
    - Max Top Trench Width
      - Rounded up to next 5’ increment, 20’ min
  - Temporary Construction
    - 15’ buffer each side of Perm. Esmt.
- Developed Easement Polygons
  - Clipped at R/W
Enhanced Inventory Database

- Trench Area Polygons
  - Utilized Pipe Depth Analysis Output
  - Open Cut Trench Area Along Pipe
  - Simple Conical Shape for Structures

- Critical Infrastructure
  - Intersect with Building and Transportation Polygons

- Cost Estimation Planning
Capacity Level of Service Analysis

- H&H analysis of all Pipe Infrastructure Upstream of 100-acre Floodplain
  - 22 miles County-Maintained Pipe
  - 2 miles Hydraulically Connected non County-Maintained Pipe

- Dynamic rainfall-runoff simulation model
  - EPA SWMM5 engine (PCSWMM)
    - Urban drainage system modeling
  - ArcGIS interface
  - Time varying rainfall
    - Model synthetic or observed storms
  - Route hydrograph through the system
Capacity Level of Service Analysis: Sub-Catchments

- Terrain processing tool to develop flow lines from DEM created from Terrain
  - Flow accumulation concept with 0.06 acre threshold
- Delineate sub-catchments for each inlet
  - Consideration for roadway drainage characteristics
- Longest flow path determination
  - Max lengths from multiple flow paths averaged
  - Used to determine sub-catchment average % slope
Capacity Level of Service Analysis: Sub-Catchments

- % Impervious
  - Impervious Coverage intersected with sub-catchments

- Curve Number Generation
  - Land Cover
    - Impervious
    - Woods
    - Open Space (lawn)
    - Open Water
  - Soils Data
  - CN for every SF in watershed
Capacity Level of Service Analysis: System Setup

- Import Pipe and Structure Data from Enhanced Inventory DB
  - Structures
    - Type
    - Rim and Invert Elevations
  - Pipe
    - Size
    - Material
      - Manning’s ‘n’ values
    - Invert Elevations
    - Length
  - Ditches/Channels/Streams
    - Connectivity from upstream to downstream limits
    - Assumed typical sections for roadway ditches
    - Transects from terrain for streams and channels
  - Facility ID
    - Pipe, channel, and structure association
    - Sub-catchment and inlet association
- Assign additional parameters
  - Ponded areas, Loss Coefficients, etc.
Capacity Level of Service Analysis: Model Setup

- **Rainfall**
  - SCS Type II Distribution
  - Duration
    - Shorter duration storms tend to be more critical
      - Critical duration discussed but single duration preferred
    - Rational Method generally accepted methodology for pipe system design
      - Select duration that generated similar peak flows
      - Sample sub-catchments in developed area
    - 12-hour storm duration

Peak Runoff Comparison

- 6hrs design storm (4.74 in)
- Rational Method
- 12hrs design storm (5.64 in)
Capacity Level of Service Analysis: Modeling

- Runoff
  - Subcatchments
    - Nonlinear reservoir routing
  - Inflows
    - Precipitation
    - Designated upstream subcatchments.
  - Outflows
    - Infiltration
    - Evaporation
    - Surface runoff
  - Subcatchment "reservoir" capacity
    - Maximum depression storage, \( d_p \)
  - Surface runoff per unit area, \( Q \)
    - \( d > d_p \)

- Dynamic Wave Routing
  - Most Accurate
    - Solves complete Saint-Venant Equations
  - Accounts for flow in pipes and channels and water levels in structures.
    - Channel storage, backwater, entrance/exit losses, etc…
Capacity Level of Service Analysis: Modeling

- Determined Existing Capacity LOS
  - System Wide Model
  - Each pipe segment
    - 1,295 County Maintained Pipes
  - Storm Return Period (Event) Based
  - HGL contained below ground for closed systems
  - Road overtopping for culverts
  - Results
    - 101 pipes 2-yr event or less LOS
    - 128 pipes 5- or 10-yr event LOS
    - 1,066 pipes 25-yr or greater LOS
Capacity Level of Service Analysis: Modeling

- **Rehabilitation/Replacement Scenarios**
  - **System-wide Model Scenarios**
    - Not segment specific
  - **Cured-in-Place Pipe Rehabilitation (CIPP)**
    - All County-maintained CSP
      - No improvements to non-County
    - Improved hydraulics
      - Maintain pipe diameter (lining negligible)
      - Improved Manning’s ‘n’ (0.015)
  - Determine LOS for this Scenario
- **Results**
  - 53 pipes 2-yr event or less LOS
  - 89 pipes 5- or 10-yr event LOS
  - 1,153 pipes 25-yr or greater LOS
Capacity Level of Service Analysis: Modeling

- Rehabilitation/Replacement Scenarios
  - System-wide Model Scenarios
    - Not segment specific
  - Replace like-size HDPE or RCP
    - All County-maintained CSP
      - Replace with 18” min diameter
      - Replace arch with equivalent round
      - Match downstream regardless of Ownership
    - Improved hydraulics
      - Improved Manning’s ‘n’ (0.015)
  - Limitations on HDPE
    - Size, Cover, Under Roads
  - Determine LOS for this Scenario
  - Results
    - 50 pipes 2-yr event or less LOS
    - 88 pipes 5- or 10-yr event LOS
    - 1,157 pipes 25-yr or greater LOS
Capacity Level of Service Analysis: Modeling

- Rehabilitation/Replacement Scenarios
  - System-wide Model Scenarios
    - Not segment specific
  - Replace with HDPE or RCP to meet desired LOS
    - Pipes not meeting desired LOS from CIPP/Replace Like Size Scenarios
      - 18” min. diameter
      - Replace arch with equiv. round
  - Closed, Lateral, and Longitudinal Pipes
    - 25-yr Storm LOS
  - Culverts
    - 100-yr Storm LOS
  - Pipe Diameter Upgrades
    - Match diameter downstream regardless of Ownership
  - Limitations on HDPE
Asset Management Decision Support

- Asset Management Decision Support
  - Rehab/Replacement Scenarios
  - What’s the pipe’s existing LOS?
  - What’s the LOS if lined (CIPP)?
    - What does that cost?
  - What’s the LOS if replace like size with HDPE or RCP (18” min)?
    - Same as CIPP except where pipe diameter < 18”
    - What does that cost?
  - What do we need to do meet the desired LOS
    - What does that cost?

- Leverage DB, GIS, and Models
  - Estimate of Quantities
  - Develop Accurate Planning Cost Estimates
Asset Management Decision Support - Quantities

- **Enhanced Inventory Database**
  - Pipe Size, Material, Length
    - Replacement Pipe, CIPP
    - Remove Pipe, Silt Fence, Inversion Setup, Clean Pipe
  - Pipe depth along profile
    - Depth to Top of Pipe
    - Backfill
  - Structure Type, Depth
    - Replacement Structure
    - Remove Structure, Silt Fence

- **GIS Data**
  - Transportation Polygons
    - Roadway, Sidewalk, Driveway Feature Classes
  - Barrier Feature Class
    - Fence
  - Trench Area Polygons
    - Street Cut, Driveway, Sidewalk Removal and Replacement
    - Remainder - Sod
    - Fence Removal and Replacement

- **Populate Database with Quantities**
Asset Management Decision Support – Unit Costs

• Unit Cost Database
  – Annual Contractor Prices
  – GDOT Item Mean Summary
  – Engineering Judgment
    • Logical Incremental Price Increases
  – Rolled Up Specific Items into One
    • GP1, GP2 CBs as simple CB
  – Unit Conversion for Specific Items
    • RCB from CY to LF
  – Contingency to Unit Price
    • Incidentals not captured in GIS
Asset Management Decision Support – CIP Tool

- GCSWM Stormwater System CIP Tool
  - ESRI ArcGIS and Microsoft Excel

ArcGIS
- Inventory & Rehabilitation/Replacement Info Database

ArcGIS
- Select conduits/structures
- Select rehabilitation/replacement scenarios

Excel
- Cost breakdown for each conduit/structure under each scenario
- Cost roll-up for each scenario
- Cost comparison between scenarios

Excel
- Unit Costs Database
Asset Management Decision Support – CIP Tool

- Rehabilitation/Replacement Scenario for Pipe

- CIPP
  - Use existing conduit shape and size
  - Shape
    - Rectangular: Use like size RCB solution
    - Elliptical Arch: Calculate equivalent diameter
    - Round: Match with available CIPP size

- Like size RCP/RCB
  - Use existing conduit shape and size
  - Shape
    - Elliptical Arch: Calculate equivalent diameter
    - Round Rectangular: Match with available manufacturing size

- Like size HDPE
  - Under road: Yes
    - Avg depth > 20': Yes
      - Use existing conduit shape and size
      - Shape
        - Rectangular: Calculate equivalent diameter
        - Elliptical Arch: Match with available manufacturing size
        - Diameter > 60°: Yes
      - No
        - Use standard sizes in model
  - No
    - Under road: Yes
      - Avg depth > 20': Yes
      - Diameter > 60°: Yes
        - Use upgraded size RCP/RCB solution
      - No
        - Use standard sizes in model
  - No
    - Under road: Yes
      - Avg depth > 20': Yes
        - Use upgraded size RCP/RCB solution
      - No
        - Use standard sizes in model
Asset Management Decision Support – CIP Tool

- Replacement Scenario for Structures
Asset Management Decision Support – CIP Tool
Summary

• Asset Management Decision Support Tool
  – Enhanced DB and GIS Data
  – Model Results
  – Accurate Planning Level Cost Estimates
  – Assist in Rehab/Replacement Decisions
• Sustainable Models
  – New Inventory
  – Replaced/Rehabbed Inventory
  – Updated H&H
    • Land Cover Changes
  – Unit Prices/Quantities

SW System Assessment Program
  - SW System Assessment Studies / Updates
  - New Development / GCDOT Improvements
  - CIP Designs / C&M List/GBA
  - Bid/Annual Contractor Improvements
Summary

Going Forward

- Focus on SW Infrastructure
- Watershed Studies
  - Survey Measure Downs
    - All Watersheds Completed based on 2011 Inventory
  - System Assessment
    - 5 Watersheds Complete (over 160 miles pipe)
    - 3 Watersheds Under Study for 2013
    - 9 Watersheds 2014 - TBD
- CIP Tool / DB Development
  - Revise to incorporate Bridge / Culvert CIPs in 2013
- DB / Model Maintenance

Other Potential Applications

- Emergency Preparedness
- Pollutant Loading
- LID / Green Infrastructure Planning
- Forensics
Questions

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