Agenda

• Background
• The Challenge
• Alternatives Analysis Approach
• Results
• Summary
BACKGROUND
Background - Location
Background

- **Area**
  - 3,800 ac. (6 mi²)
  - City of Columbus (84%)
  - Clinton Twp (15%)
  - Mifflin Twp (1%)
- **DSRs** (Designed Sanitary Reliefs=SSOs) = 9
- **Sanitary Sewer Outlets** = 10
- **467,000 feet of sanitary sewers**
- **Sewer Age**
  - Oldest pipes are pre-1920s
  - 45% constructed in 1940s and 1950s
Background

- **Topography**
  - Flat
  - Slope from NW to SE towards ACT
- **Multiple Landuses**
  - Mostly Residential
  - Residential + Commercial + Vacant > 95%

NWAC Landuse

<table>
<thead>
<tr>
<th>Landuse</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Residential</td>
<td>86%</td>
</tr>
<tr>
<td>Commercial</td>
<td>3%</td>
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<tr>
<td>Industrial</td>
<td>2%</td>
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<tr>
<td>Vacant</td>
<td>1%</td>
</tr>
<tr>
<td>Exempt</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>7%</td>
</tr>
</tbody>
</table>

Legend

Topography

- High: 916.4
- Low: 742.86

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THE CHALLENGE
Challenge

- 1 study area
- 42 meter-basins
- 21 target areas
- Complex hydraulics
  - Relief sewers
  - Cross connections
  - Wet-weather overflow weirs
  - Backwater conditions from downstream trunk sewer
Challenge - Historical

- **DSRs**
  - 9 DSRs
  - Concentrated in central area
  - Typically activate at 1-year storm

- **Historical WIBs (2003 – 2011)**
  - 1,345 total WIB complaints
  - 939 parcels reporting WIBs
  - 687 1-time complaints
  - 238 repeat complaints 2-4 times
  - 11 repeat complaints 5-7 times
  - 3 repeat complaints 8-10 times

**Legend**
- Project Area Boundary
- Existing Sanitary Sewer
- Woodland Avenue Trunk Sewer
- Clinton Township
- Mifflin Township

**Repeated WIBs**
- 8 - 10 complaints (3)
- 5 - 7 complaints (11)
- 2 - 4 complaints (238)
- 1 complaint (687)
Challenge - Model Status Quo
10-Year LOS

- PWIBs
  - 2,012
- DSR Activations
  - 339; 1.04 MG
  - 305; 0.38 MG
  - 306; 0.34 MG
  - 315; 0.24 MG
  - 307; 0.12 MG
  - 312; 0.12 MG
  - 279; 0.00 MG
  - 314; 0.00 MG
  - 317; 0.00 MG
THE ALTERNATIVES ANALYSIS APPROACH
General Alternatives Analysis Approach

- Multi-tiered approach
  - Screening analysis
  - Hybrid analysis
  - Cost-benefit analysis
General Alternatives Analysis Approach

Define Existing Conditions and Identify Problem Areas

Alternative Analysis

Identify and Prioritize Options

Technology Screening

Hybrid Analysis

Triple Bottom Line Analysis

Recommendations

Screening

Refinement

DSRs
WIBs
Allowable Surcharge

Capacity Enhancement
Storage
I/I Reduction
Diversion
Client preference / cost

System-Wide
Regional (trunk)
Local

30-Year Runs
Estimates of DSRs and WIBs
Alternative Refinement

Cost-Benefit

Constructability

Define Existing Conditions and Identify Problem Areas

Alternative Analysis

Identify and Prioritize Options

Technology Screening

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DSRs
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System-Wide
Regional (trunk)
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30-Year Runs
Estimates of DSRs and WIBs
Alternative Refinement

Cost-Benefit

Constructability
Alternatives Analysis - Screening

- Prioritization of technologies
  - Conveyance capacity (upsize pipes, new pipes, pumping)
  - Storage capacity (off-line/in-line tanks)
  - System optimization (weirs, real-time control)
  - Source control (I/I reduction)
  - Treatment

- System-wide application
  - Conveyance enhancements (pipe upsizing only)
  - Storage
  - I/I reduction

- Regional vs. local areas
Alternatives Analysis - Screening
Alternatives Analysis
Regional vs. Local

- Trunk Sewer = regional system
- Everything else = local system
Alternatives Analysis
System-wide Conveyance

- Upsizing pipes only
- Meets project area LOS
- Free outfalls (but passes the problem downstream)
- Needs refined:
  - Relief vs. Upsize
  - Provide outfall control with additional storage facilities
Alternatives Analysis
System-wide Storage

- 3 to avoid upsizing trunk sewer
  - SU1 = 6 MG
  - SU2 = 2 MG
  - SU3 = 3 MG
  - Total Storage = 11 MG
- 3 in local areas
- Still problems in local areas
- Stop here!
Alternatives Analysis
System-wide
I/I Reduction

- ~ 50-60% reduction
- Feasible?
Alternatives Analysis
System-wide
System Optimization

- 4 wet-weather flow weirs
- Evaluated individually, then in combinations
- Partial lowering of weirs, then complete removal of weirs
- Helps most of trunk sewer
- Does not help local areas
Alternatives Analysis - Hybrid
CONVEYANCE/STORAGE/WEIRS
Alternatives Analysis-hybrid Conveyance, Storage, Weirs

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 34,449 LF (6.52 mi.)
    - 565 LF less than Conveyance Only
    - 8” – 24” Diameter Pipe
  - Storage Improvements
    - SX1: 3.0 MG
  - Zero PWIBs
  - Zero DSR Activations
Alternatives Analysis-hybrid Conveyance, Weirs

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 35,014 LF (6.63 mi.)
    - 8” – 24” Diameter Pipe
  - Storage Improvements
    - 0 MG Total
  - Zero PWIBs
  - Zero DSR Activations
Alternatives Analysis – hybrid Conveyance, I/I Reduction, weirs

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 31,120 LF (5.89 mi.)
    - 3,894 LF less than Conveyance Only
    - 8” – 24” Diameter Pipe
  - **Targeted 40% I/I Reduction**
    - 1,914 Grouted Taps
    - 1,157 Top Hats
    - 1,228 Downspout Redirection
    - 137,278 LF Lining
  - Zero PWIBs
  - Zero DSR Activations
Alternatives Analysis
Targeted I/I Reduction

- 24% of study area targeted
- Elements
  - Mainline Lining
  - Grouted Taps
  - Top Hats
  - Downspout and/or Sump Pump Redirection
- I/I Reduction vs. PWIB Analysis
  - Knee of curve at 50% reduction
  - Comprehensive I/I reduction program goal of 40% to make it achievable
Alternatives Analysis - Costing
Alternatives Analysis
Short List of Improvements

• WWMP
  1. As documented (2005)
  2. Modified (2011)

• Pipe Upsizing Only
  3. DSR control
  4. DSR and PWIB control

• Conveyance Suite
  5. Conveyance Only
  6. Conveyance and Storage
  7. Conveyance and Targeted 40% I/I Reduction
  8. Conveyance, Storage, and Targeted 40% I/I Reduction
WWMP (2005)

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 6,731 LF (1.27 mi.)
    - 8” – 18” Diameter Pipe
  - Storage Improvements
    - 0 MG Total
  - PWIBs
    - 1,742
  - DSRs
    - 1.16 MG from 5 activations

**30-Year Life-Cycle**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>DSR/PWIB Benefit</td>
<td>$ 60.8 million</td>
</tr>
<tr>
<td>Risk Cost Avoided</td>
<td>($1 thousand)</td>
</tr>
<tr>
<td>Total Benefit</td>
<td>$ 60.8 million</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>$ 4.97 million</td>
</tr>
<tr>
<td>B/C ratio</td>
<td>12</td>
</tr>
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</table>
MODIFIED WWMP

Modified to Meet 10-Year LOS
Modified WWMP

- 10-Year Level-of-Service
  - Conveyance Improvements
    - **13,201 LF (2.50 mi.)**
    - 8” – 18” Diameter Pipe
  - Storage Improvements
    - **0 MG Total**
    - **1,555**
  - Zero DSR Activations

### 30-Year Life-Cycle

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>DSR/PWIB Benefit</td>
<td>$121.4 million</td>
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<tr>
<td>Risk Cost Avoided</td>
<td>$0.9 million</td>
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<td><strong>Total Benefit</strong></td>
<td><strong>$122.3 million</strong></td>
</tr>
<tr>
<td>Capital Cost</td>
<td>$9.98 million</td>
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<tr>
<td><strong>B/C ratio</strong></td>
<td><strong>12</strong></td>
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</tbody>
</table>

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**Risk Cost Avoided**

$0.9 million

**Total Benefit**

$122.3 million

**Capital Cost**

$9.98 million

**B/C ratio**

12
PIPE UPSIZING FOR DSR CONTROL

In Lieu of WWMP
Pipe Upsizing for DSR Control

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 29,186 LF (5.53 mi)
    - 12” – 30” Diameter Pipe
  - Storage Improvements
    - 0 MG Total
- PWIBs
  - 1,694
- Zero DSR Activations

### 30-Year Life-Cycle

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<table>
<thead>
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</thead>
<tbody>
<tr>
<td>DSR/PWIB Benefit</td>
<td>$82.7 million</td>
</tr>
<tr>
<td>Risk Cost Avoided</td>
<td>$6.6 million</td>
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<tr>
<td>Total Benefit</td>
<td>$89.3 million</td>
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<td>Capital Cost</td>
<td>$32.5 million</td>
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<td>B/C ratio</td>
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Legend
- Project Area Boundary
- Existing Sanitary Sewer
- Flooded Manhole
- Flow Meter
- BW_AL_0647
- Major Roads
- Name
- Outfalls
  - Sanitary Outfall
  - Proposed Improvements
  - Replacement
- DSR
  - No Flow
  - PWIB
- Project Dry Basement (PDB)
  - Installed PDB (82)
  - Water In Basement (WIB)
  - Potential WIB (1,694)
PIPE UPSIZING FOR DSR AND PWIB CONTROL

In Lieu of WWMP
Pipe Upsizing for DSR and PWIB Control

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 92,918 LF (17.60 mi.)
    - 12” – 42” Diameter Pipe
  - Storage Improvements
    - 0 MG Total
  - Zero PWIBs
  - Zero DSR Activations

<table>
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<tbody>
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<td>DSR/PWIB Benefit</td>
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NWAC TPM #26
CONVEYANCE IMPROVEMENTS
Conveyance Only

• 10-Year Level-of-Service
  – Conveyance Improvements
    • 35,014 LF (6.63 mi.)
    • 8” – 24” Diameter Pipe
  – Storage Improvements
    • 0 MG Total
  – Zero PWIBs
  – Zero DSR Activations

30-Year Life-Cycle

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>DSR/PWIB Benefit</td>
<td>$ 668.7 million</td>
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<tr>
<td>Risk Cost Avoided</td>
<td>$ 2.93 million</td>
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<tr>
<td>Total Benefit</td>
<td>$ 671.7 million</td>
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<tr>
<td>Capital Cost</td>
<td>$ 28.2 million</td>
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<td>B/C ratio</td>
<td>24</td>
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Legend
- Project Area Boundary
- Existing Sanitary Sewer
- Flow Meter
- Major Roads
- Name
- Outfalls
- Sanitary Outfall
- Proposed Improvements
- Relief
- Replacement
- DSR
- No Flow
- ** DSR
- Project Dry Basement (PDB)
- Installed PDB (82)
- Recommended PDB (71)
- Pipe Abandoned/Removed
- Weir Removed

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CONVEYANCE AND STORAGE
Conveyance and Storage

• 10-Year Level-of-Service
  – Conveyance Improvements
    • 34,449 LF (6.52 mi.)
    • 565 LF less than Conveyance Only
    • 8” – 24” Diameter Pipe
  – Storage Improvements
    • SX1: 3.0 MG
  – Zero PWIBs
  – Zero DSR Activations

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CONVEYANCE AND I/I REDUCTION

Targeted 40% I/I Reduction
Conveyance and Targeted 40% I/I Reduction

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 31,120 LF (5.89 mi.)
    - 3,894 LF less than Conveyance Only
    - 8” – 24” Diameter Pipe
  - Targeted 40% I/I Reduction
    - 1,914 Grouted Taps
    - 1,157 Top Hats
    - 1,228 Downspout Redirection
    - 137,278 LF Lining
  - Zero PWIBs
  - Zero DSR Activations

### 30-Year Life-Cycle

<table>
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<th>Value</th>
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<tbody>
<tr>
<td>DSR/PWIB Benefit</td>
<td>$692.6 million</td>
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<tr>
<td>Risk Cost Avoided</td>
<td>$33.6 million</td>
</tr>
<tr>
<td>Total Benefit</td>
<td>$726.2 million</td>
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<tr>
<td>Capital Cost</td>
<td>$39.9 million</td>
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<td>B/C ratio</td>
<td>18</td>
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</table>

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CONVEYANCE, STORAGE, AND I/I REDUCTION

Targeted 40% I/I Reduction
Conveyance, Storage, and Targeted 40% I/I Reduction

- 10-Year Level-of-Service
  - Conveyance Improvements
    - 30,485 LF (5.77 mi.)
    - 4,529 LF less than Conveyance Only
    - 8 – 24” diameter pipe
  - Storage Improvements
    - SX1: 2.25 MG
  - Targeted 40% I/I Reduction
    - 1,914 Grouted Taps
    - 1,157 Top Hats
    - 1,228 Downspout Redirection
    - 137,278 LF Lining
  - Zero PWIBs
  - Zero DSR Activations

30-Year Life-Cycle

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<td>DSR/PWIB Benefit</td>
<td>$ 692.7 million</td>
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<tr>
<td>Risk Cost Avoided</td>
<td>$ 33.6 million</td>
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<tr>
<td>Total Benefit</td>
<td>$ 726.2 million</td>
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<tr>
<td>Capital Cost</td>
<td>$ 56.6 million</td>
</tr>
<tr>
<td>B/C ratio</td>
<td>13</td>
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Legend
- Project Area Boundary
- Existing Sanitary Sewer
- Flow Meter
- Project Dry Basement (PDB)
- Installed PDB (82)
- Recommended PDB (81)
- Major Roads
- Name
- Outfalls
- Sanitary Outfall
- Proposed Improvements
  - Relief
  - Replacement
  - Storage Unit
  - Targeted 40% I/I Reduction
  - DSR
  - No Flow
  - ### DSR

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RESULTS
Results

- For DSR control (10-yr LOS)
  - Pipe upsizing + relief sewers (Modified WWMP)
  - ~ $10 million
  - B/C = 12

- For DSR and PWIB control (10-yr LOS)
  - Additional pipe upsizing + relief sewers
  - ~ $28 million
  - B/C = 24
SUMMARY
Summary

- Multi-tiered approach allows team to bound range of potential solutions and efficiently narrow down to the optimal, cost-beneficial recommendations
- Spend time planning ahead of diving in
- Methodical approach helps to be efficient
QUESTIONS/DISCUSSION

Northwest Alum Creek