

GIS, Hydrologic/Hydraulic Modeling – The Letort Spring Run Collaborative Stormwater Management Project

Water Resource Center
Southwestern Pennsylvania Commission

NEWELL TERESKA & MACKAY
ENGINEERING

March 23, 2021

SKELLY AND LOY
ENGINEERING-ENVIRONMENTAL
CONSULTANTS

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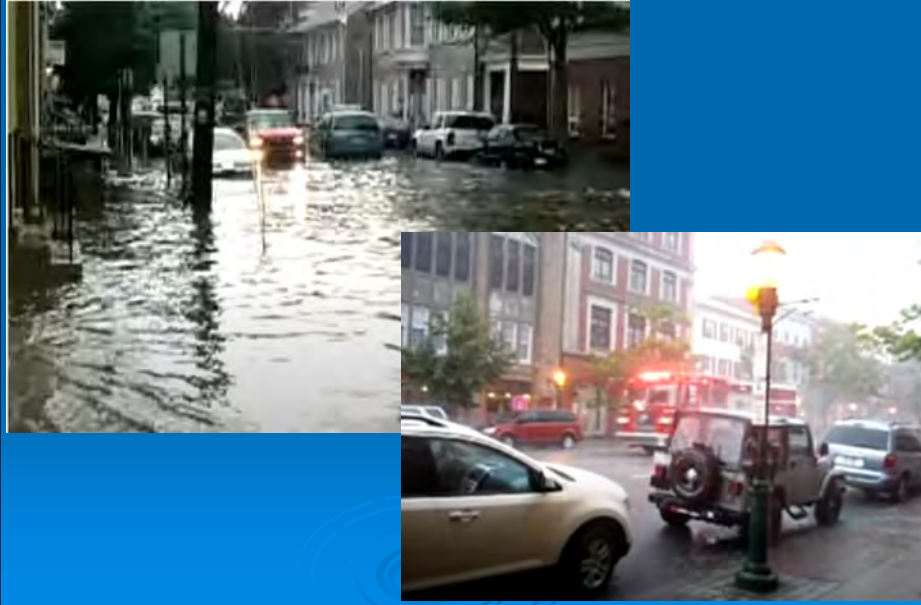
Agenda

- Project Overview
- Purpose
- Project Analysis
- Results
- Funding



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Flooding - May 14, 2010



3

Flooding - July 11, 2012



4

Flooding – October 11, 2013

Storm Sewer Surcharge or Stream Overbank Flow Causing Flooding



Storm Sewer Surcharge

October 11, 2013 4:10 PM
Intensity: 0.22 inches/hour
Total Rainfall : 3.90 inches



Letort Spr. Run Overbank Flooding

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Participation Benefits

The "Tool"

Solutions beyond Act 167

Municipal/Facility Asset Management

Regional Tourism/Quality of Life

Collaborative Model

MS4/Regulatory Compliance

Reduction in Municipal/Facility Operating Costs

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Project Phases

PHASE 1

Establish a cohesive and Committed Stakeholders Collaborative



Attractive to funding Agencies

Cost Savings through elimination of duplicative efforts

Essential for cross-boundary cooperation





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Current Activities

PHASE 2

Engineering and Assessment

The image shows an aerial map of a region with various colored overlays representing GIS data. Four callout boxes are overlaid on the map, each with a circular icon and text:

-  Build Study-Area GIS "Tool"
-  Engineering Assessment: Region Specific BMP Solutions
-  Stakeholders Assessment Review Meeting
-  Implementation Plan Report

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Future Phases

- Letort Spring Run Stormwater BMP Construction
- Expansion to Additional Areas
- Re-evaluation and Refinement of Sustainable Approach




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PHASE 1 FINDINGS

-  Stormwater Flooding/Drainage Problems
-  Water Quality Issues
-  Future Regulatory Compliance Preparations
-  Need for Mapping Tools (GIS/CADD)
-  Anticipated Collaborative Cost Savings

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Working Together



The Collaborative Successfully Applied for \$75,000 DCED Grant

- Create GIS Collection Tool
- Create GIS Database
- Provide Instruction for Municipal Staff in Use of Tool and Database

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GIS Tool

- Web-based application allows for “Real Time” Data Collection
- Input, View and Edit from Desktop Station or Mobile Device
- Built-in applications with pull-down menus for quick data entry and minimal errors

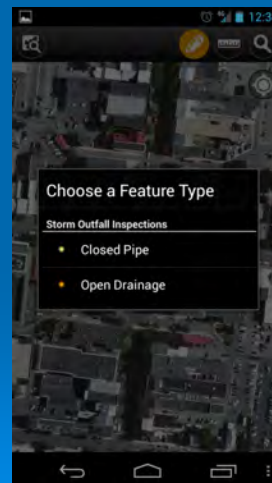
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Sample: Mobile MS-4 Data Collection

Find Location

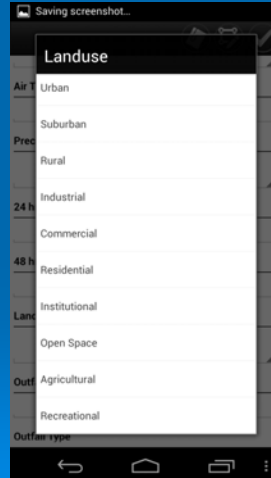


Choose Outfall Type



14

Sample: Mobile MS-4 Data Collection Fields Matching DEP Form *: Land Use Pull Down



* Outfall Reconnaissance Inventory/ Sample Collection Field Sheet

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Sample: Mobile MS-4 Data Collection Clarity Pull Down



- Attach Pictures, Notes, PDFs
- Immediately uploaded to the Web for viewing and editing
- User controls viewing and editing permission
- Applications with same easy-to-use format:
 - **Infrastructure:** Signs, Utility Poles, Street Lights and Traffic Signals
 - **Stormwater Collection and Conveyance:** Inlets Manholes, Fittings Valves, Culverts, Pipes, etc.
 - **Citizen Request Forms:** Potholes, Graffiti, Service Repairs, Complaints, Other
 - **Inspections:** MS-4, Storm Water, Sanitary Sewer, Water , Poles, Signs
 - **Emergency Operations:** Damage Assessments, Incidents, Accidents, Shelters, Evacuation routes, etc.

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Stormwater Model

Pre-modeling Effort

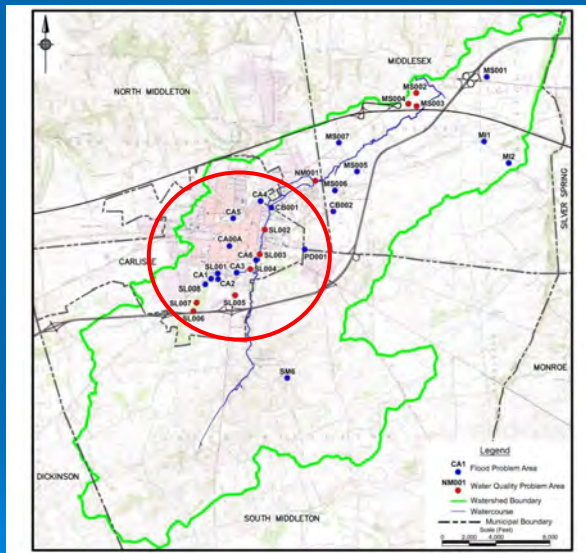
- Identify Flood Areas
- Acquire Existing Infrastructure Mapping
- Supplement with field collected data
- Acquire Land Cover, Soils and Topography
- Synthesize to GIS Base Map

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Problem Areas – Data Collection

ArcGIS

- Flooding
- Water Quality Problem



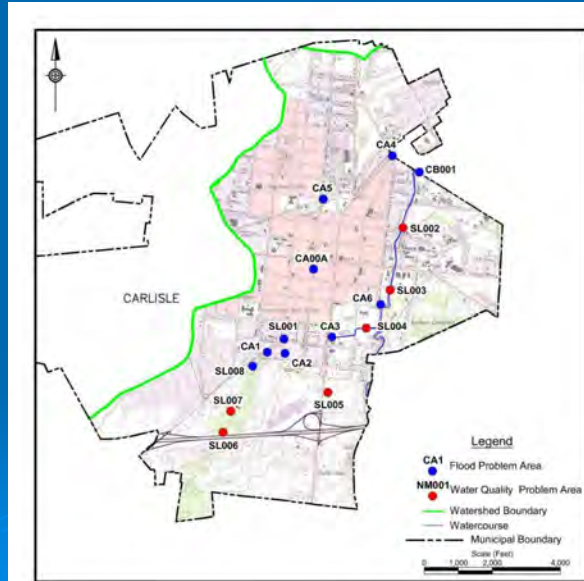
18

Modeling Focus on Region's Flooding

ArcGIS

- Carlisle Borough has the highest concentration of flooding impacts

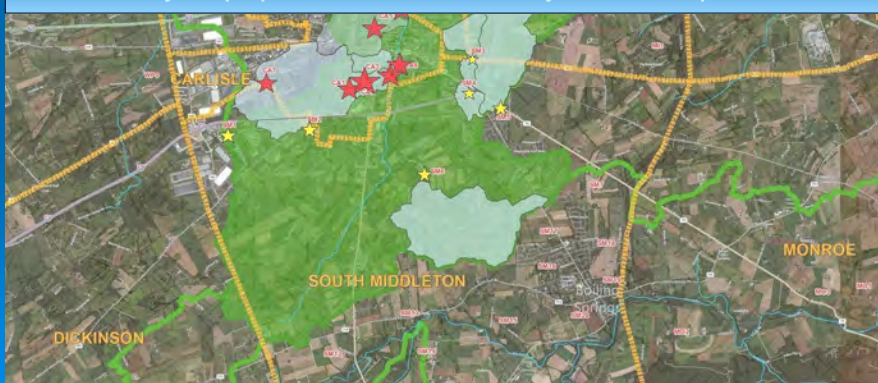
- Flooding
- Water Quality Problem



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Focus on Region's Flooding

- Carlisle Borough has the highest concentration of areas that flood
- The most severe safety and damage impacts from flooding are encountered in Carlisle Borough due to density of population and intensity of development



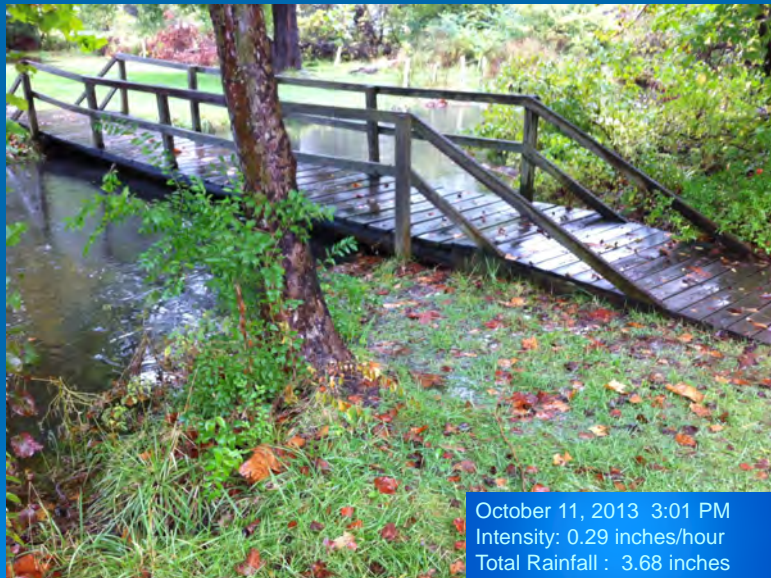
20

Bridge over Molly Grub



21

Bridge over Molly Grub



October 11, 2013 3:01 PM
Intensity: 0.29 inches/hour
Total Rainfall : 3.68 inches

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Channels – Little Capacity

By: PAD/RCB	Date: 05/22/14 & 01/16/14	Sheet No.: 1 of 6
Project Name: Letort Run H&H	Project No.: 11023.02	




Photo #1
Letort Spring Run

Note: Looking upstream (south) from walking bridge connecting Letort Park to E South Street.

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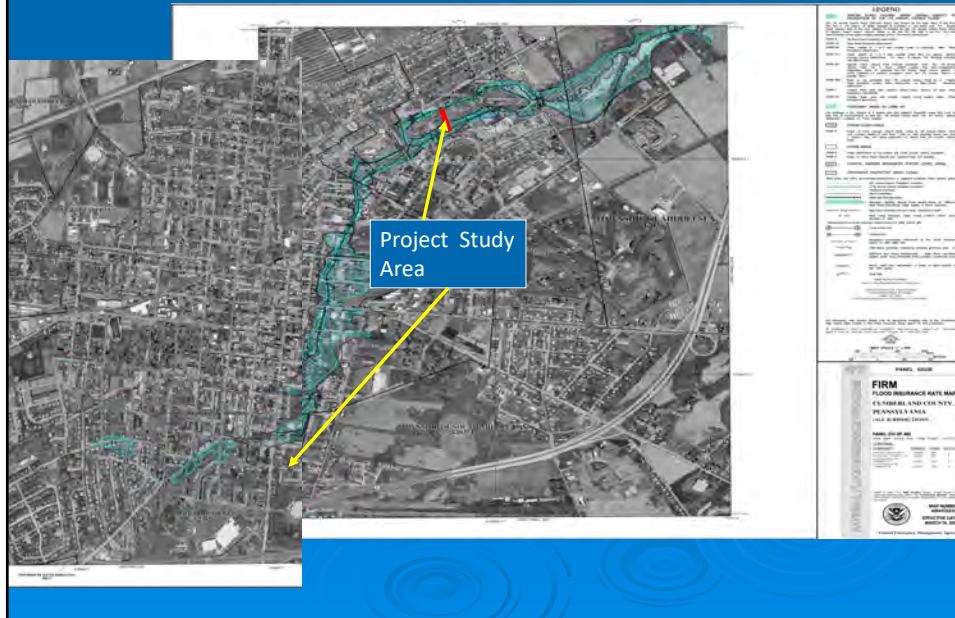
Bridges



Property	Value
Name	RBldgedHighSt24234
Inlet Node	L24316
Outlet Node	L24234HighSt
Description	
Tags	
Shape	RECT_CLOSED
Max. Depth	4.1
Length	82
Roughness	0.012
Inlet Offset	0
Outlet Offset	0
Inlet Flow	0
Maximum Flow	0
Entry Loss Coeff.	0.5
Exit Loss Coeff.	1.0
Avg. Loss Coeff.	0
Flag Code	IND
Culvert Code	9

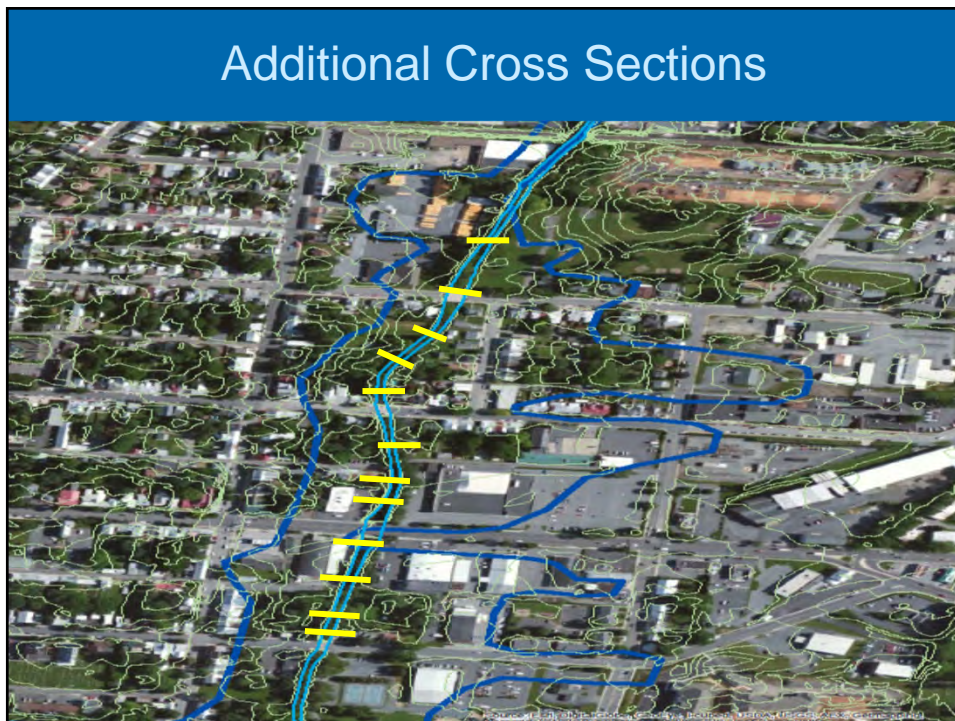
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FEMA FIRM – Letort Spring Run Project Study Area

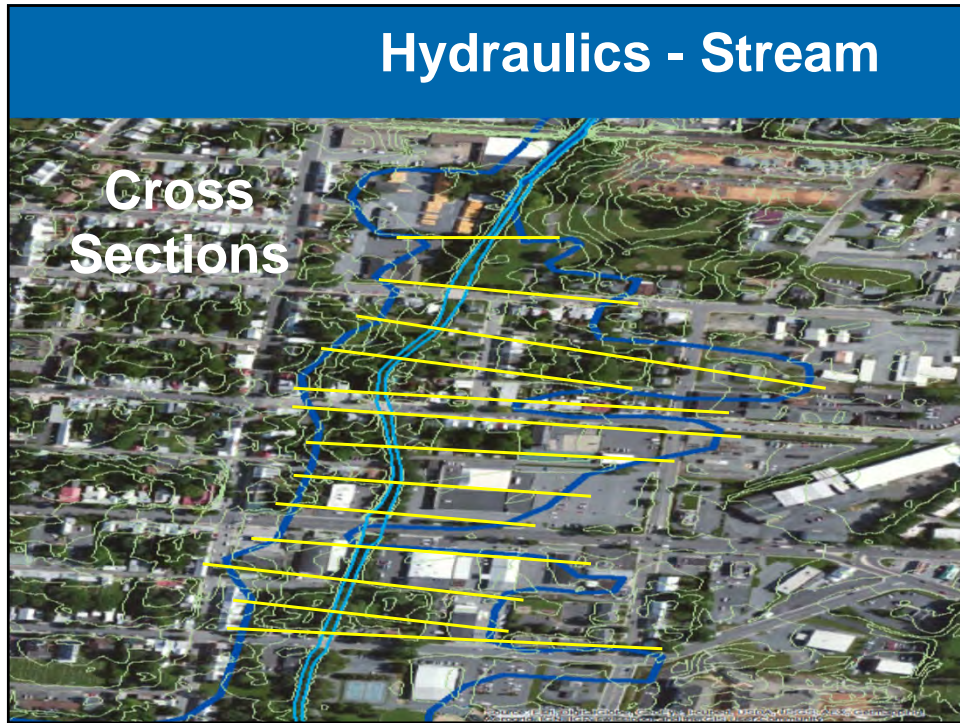


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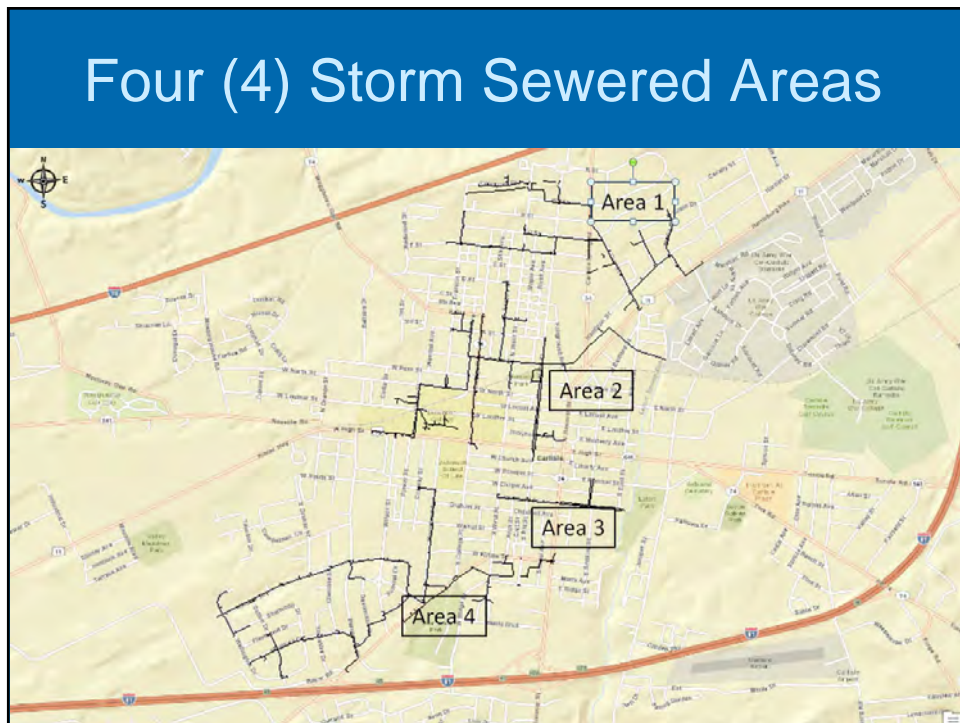
Additional Cross Sections



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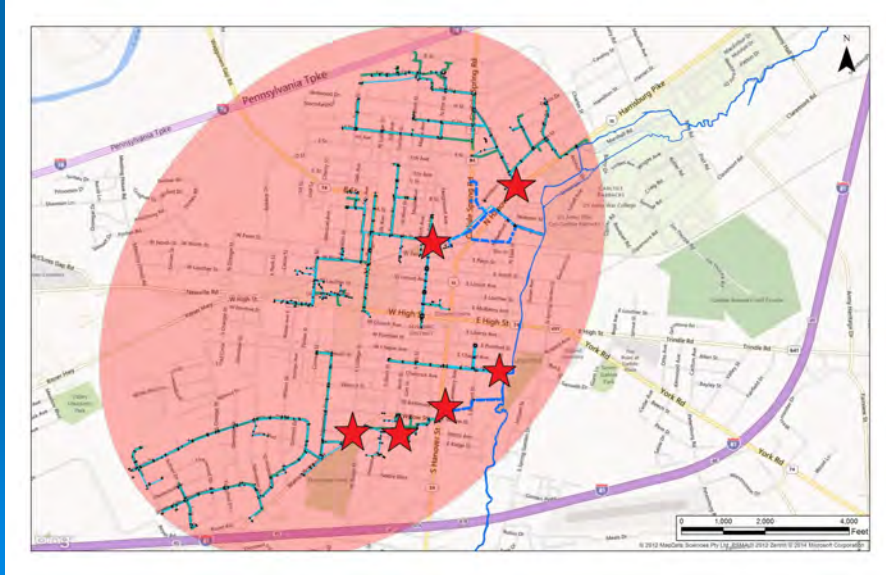


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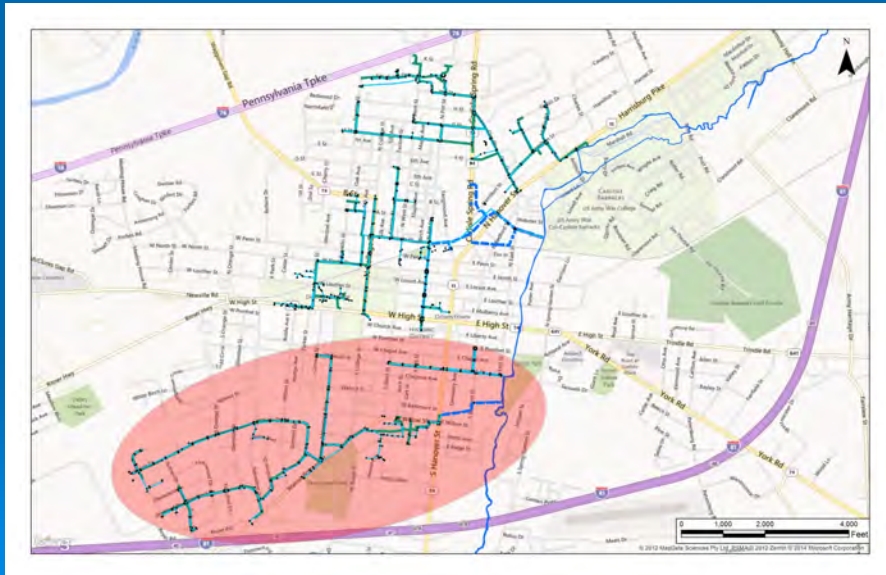
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Carlisle Stormsewer Survey



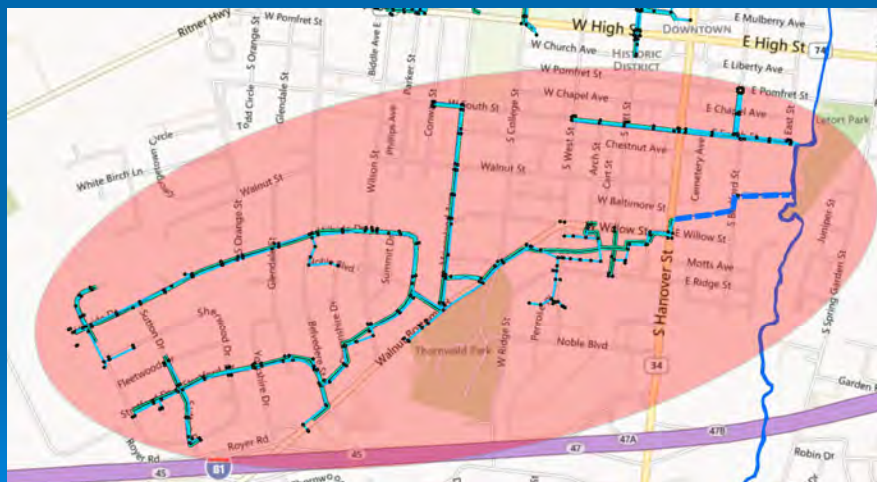
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Carlisle Detailed Study Area



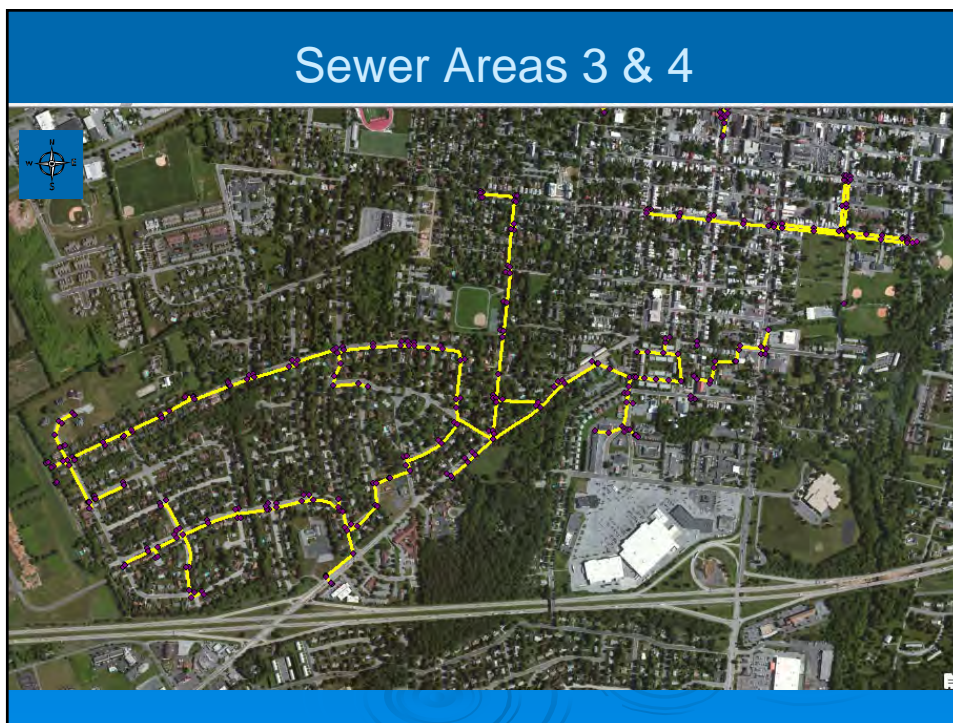
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Carlisle Detailed Study Area

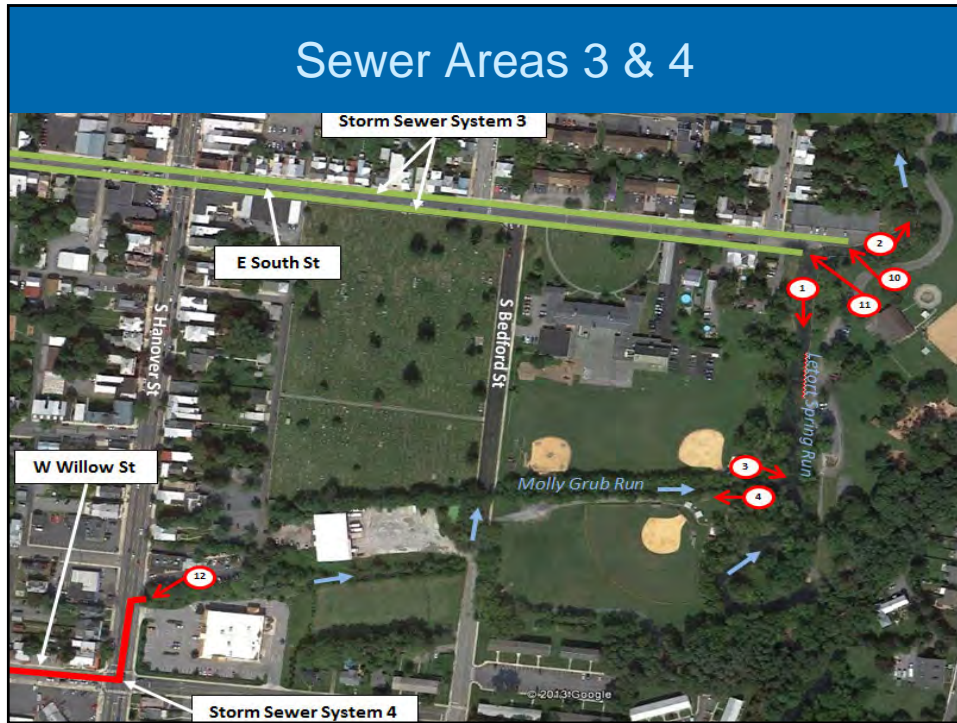


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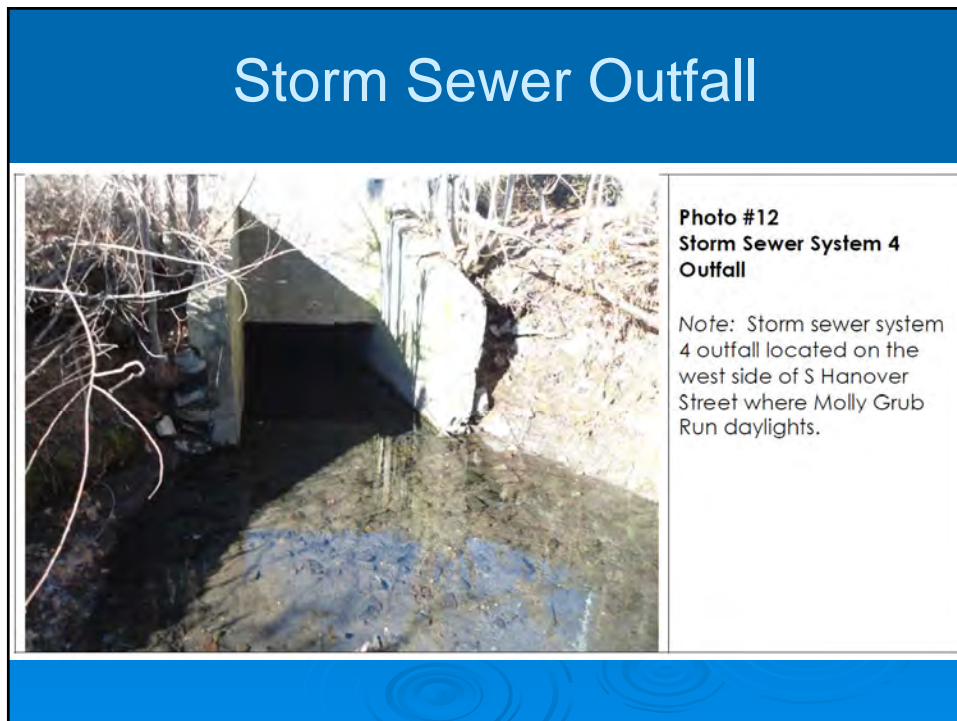
Sewer Areas 3 & 4



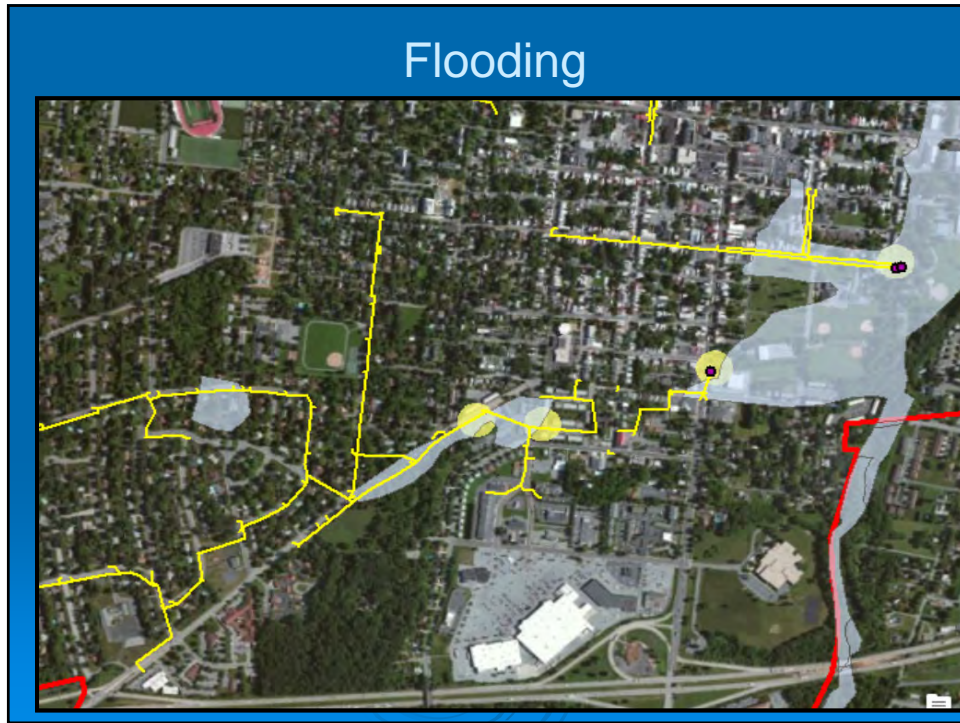
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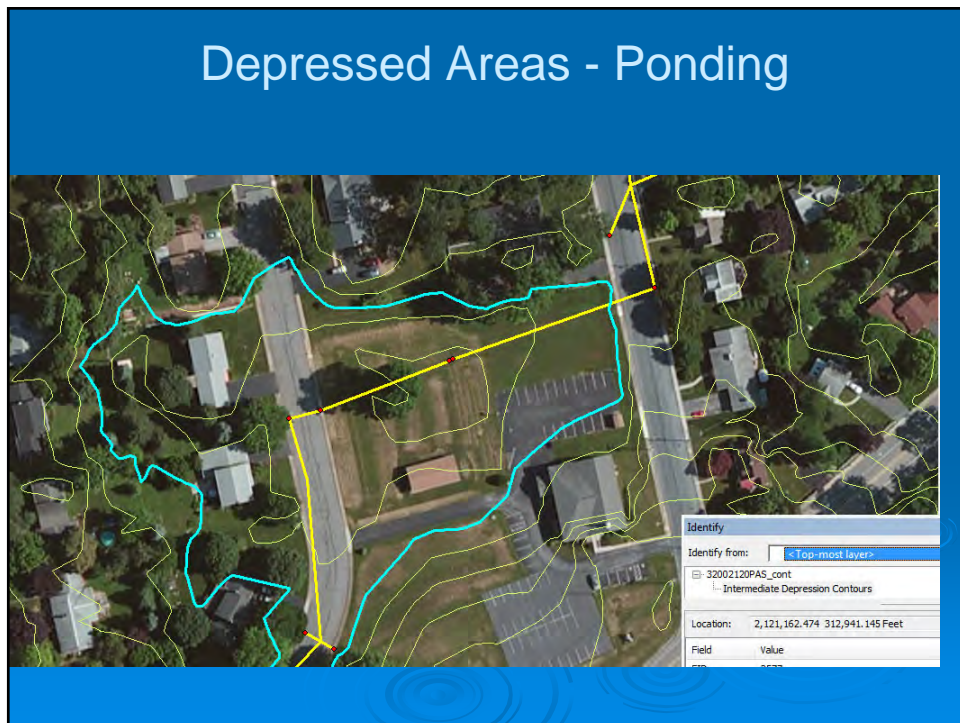
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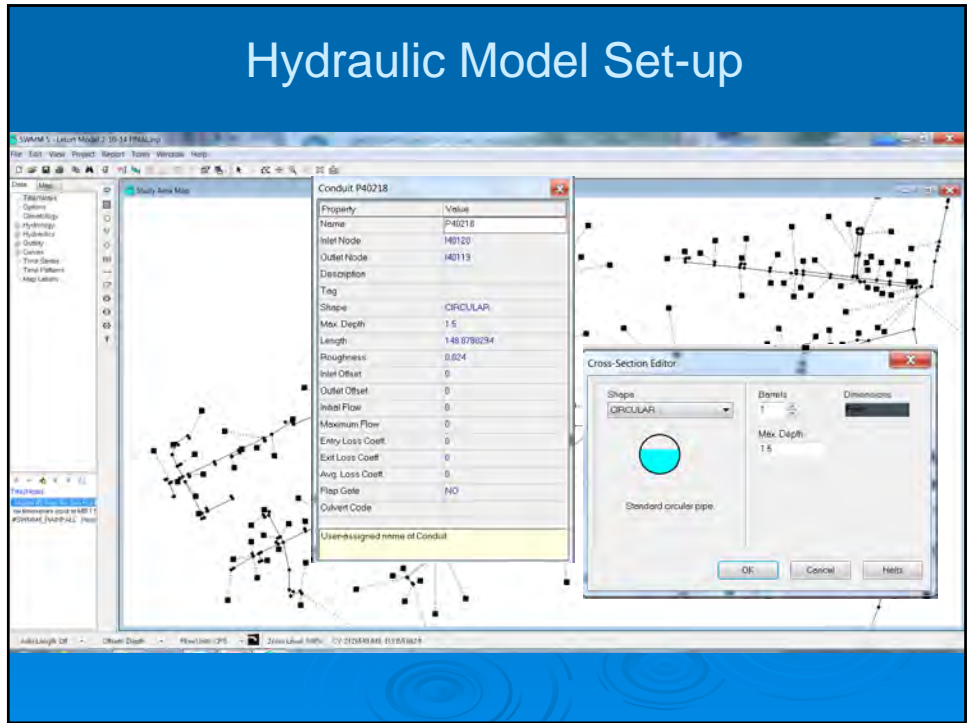
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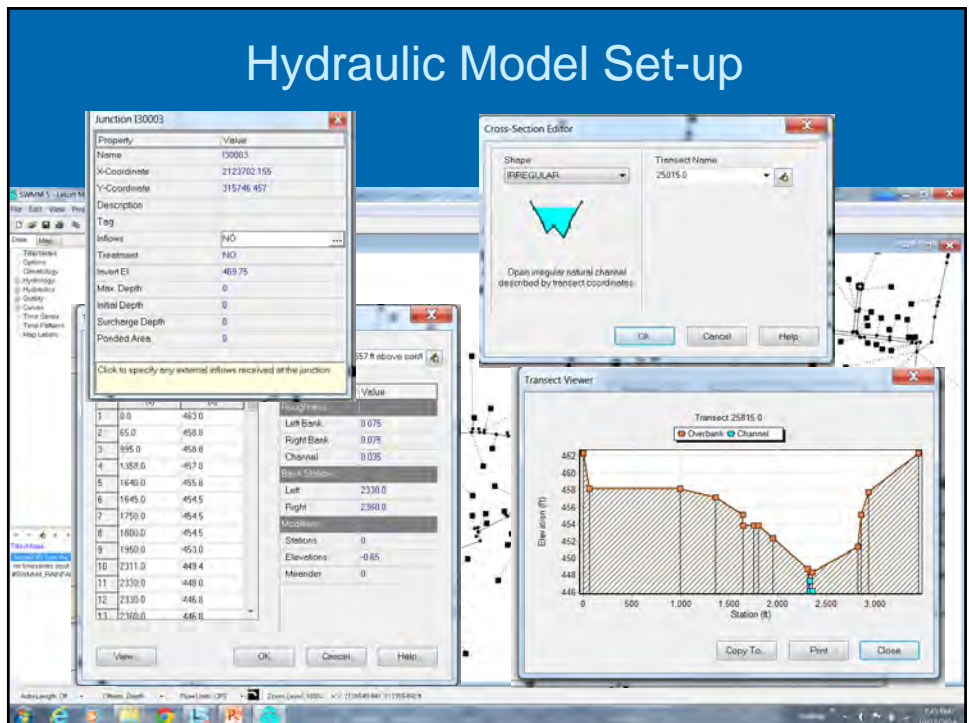
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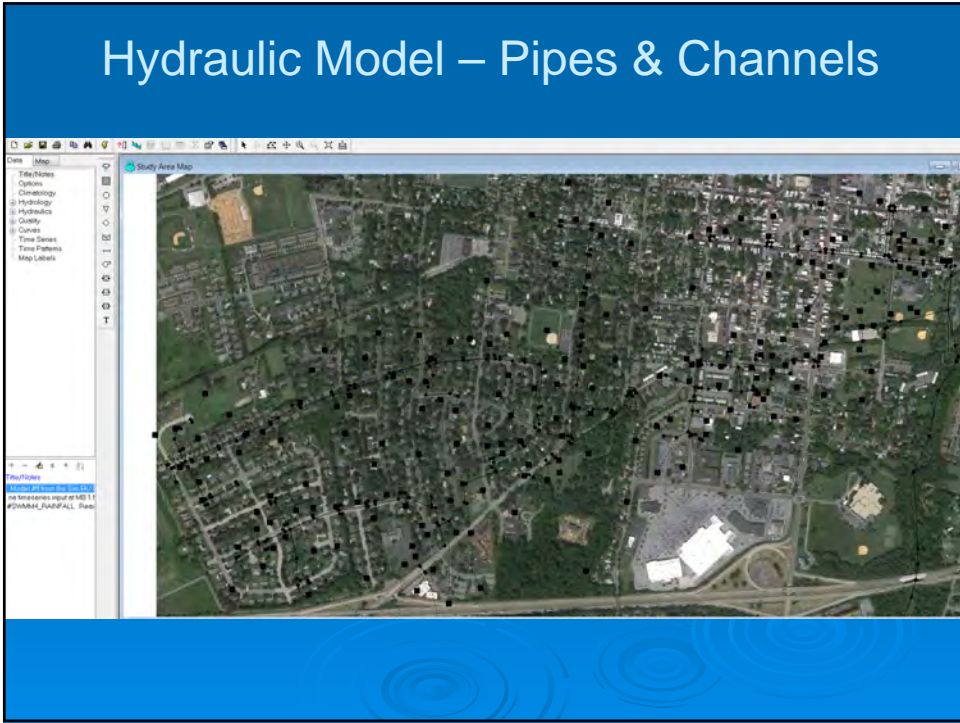
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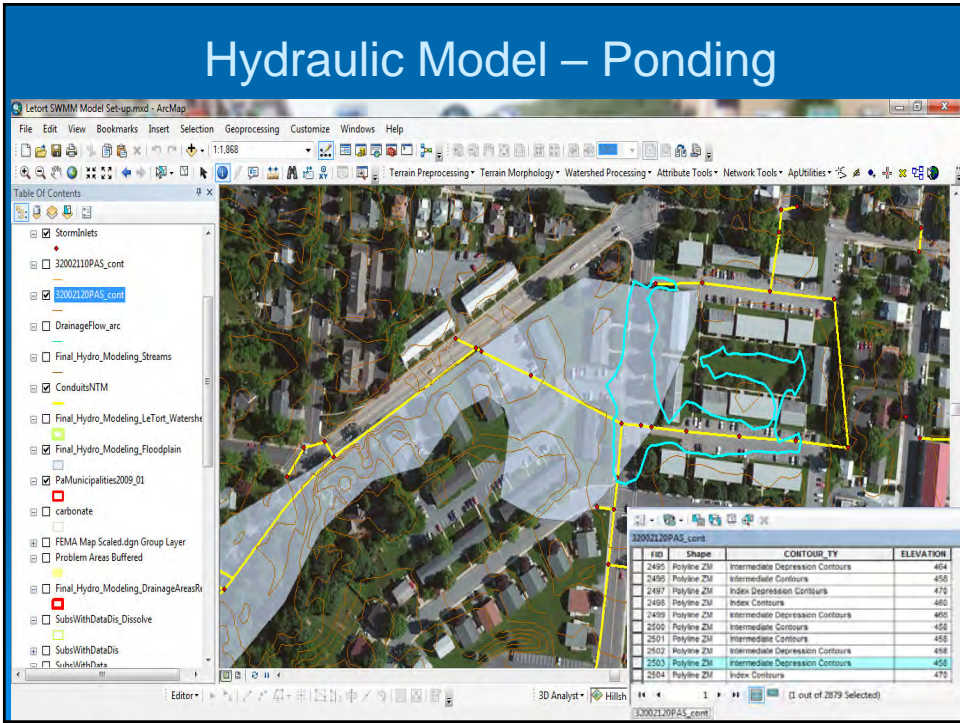
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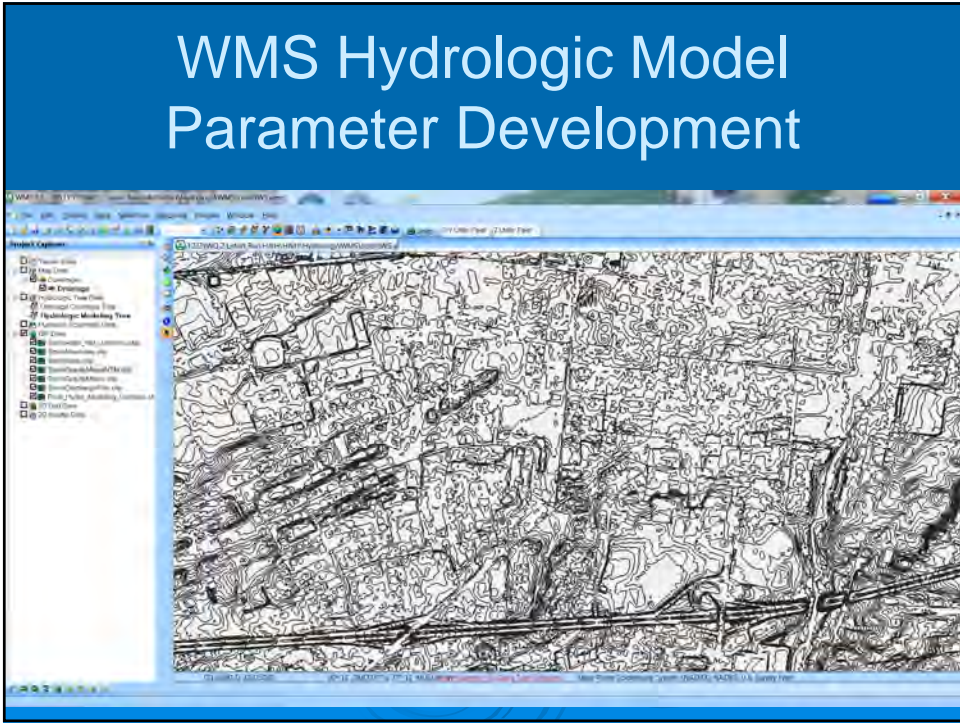
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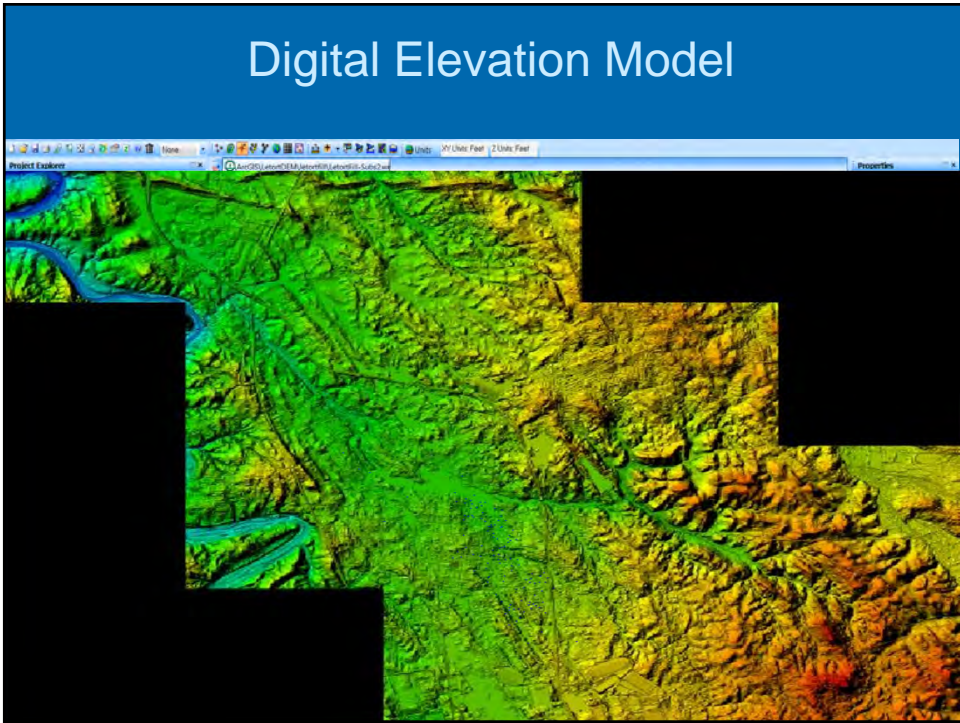
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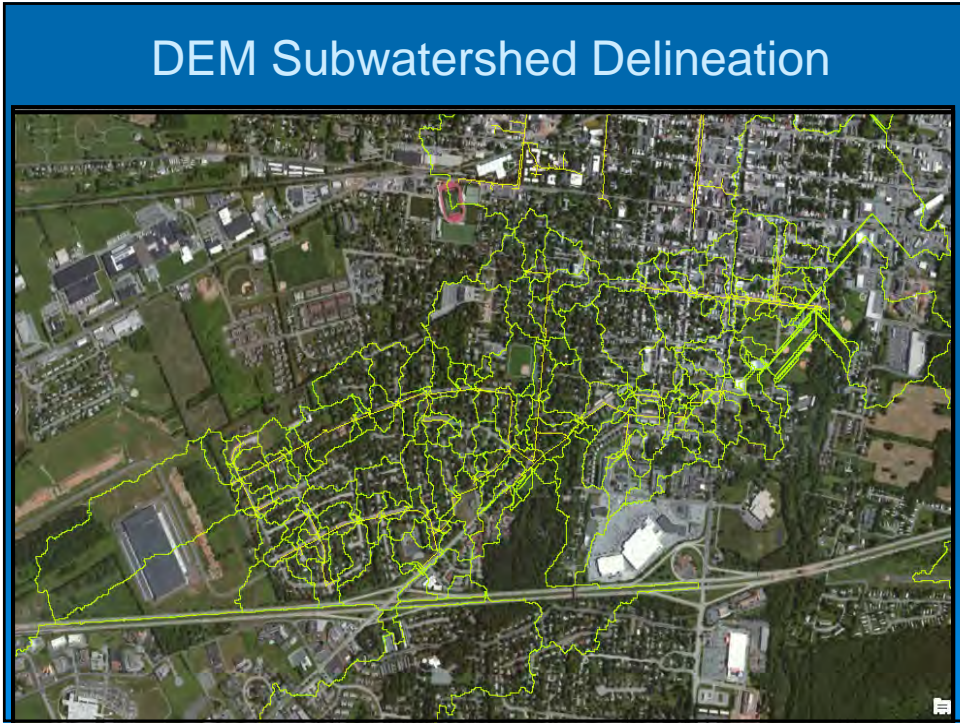
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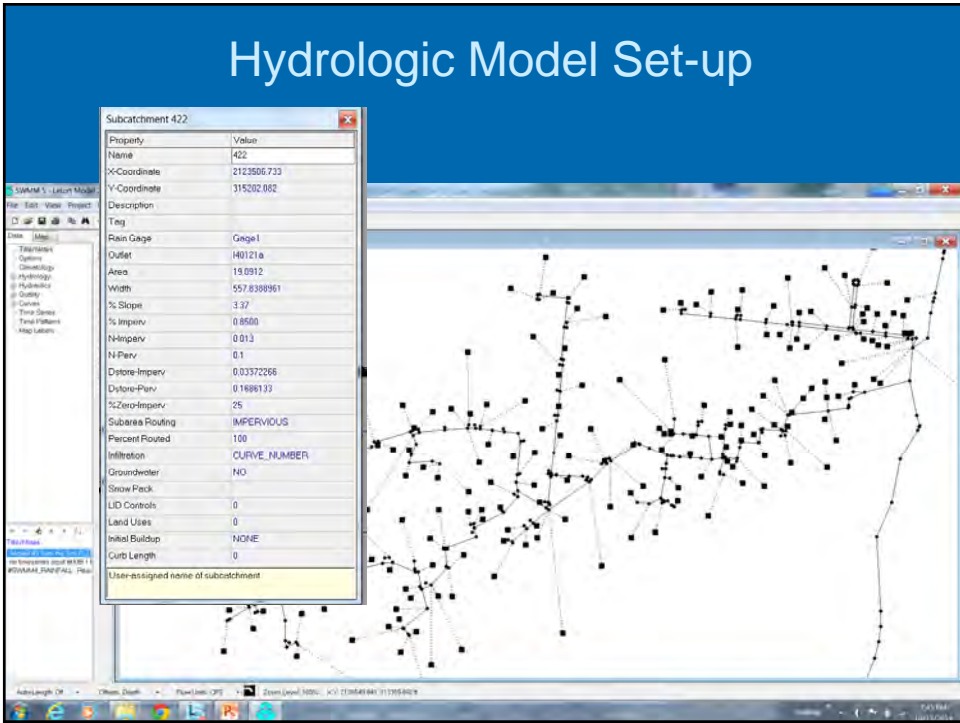
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2006 USGS NLCD

Data Service Options

Web Services Catalog

3 Cover Europe (300 m Resolution) NLCD 2006 (US National Land Cover Database) (30m Resolution) World Imagery

IMPORTANT NOTE: These data sources are on external servers that we have no control over. The data may draw/report very slowly or become unavailable at any time. We have no control over this.

Help... Advanced... OK Cancel

NLCD Land Cover Classification Legend

- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only

Scale Information: Scale ~ 1:14,922,914

Display: Places (Names), Transportation, Boundaries, Layer Extent, Hydrography, Land Cover, Elevation

Downloads: You have a popup blocker enabled. This means some functionality but this is a very limited space for displaying results.

45

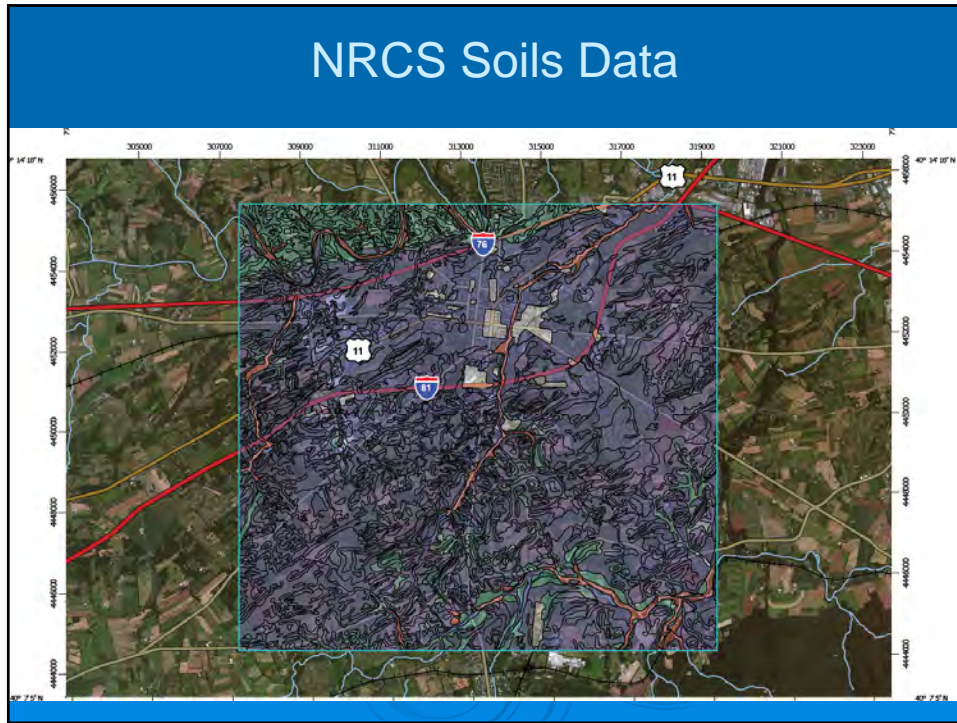
2006 USGS NLCD

Project Explorer

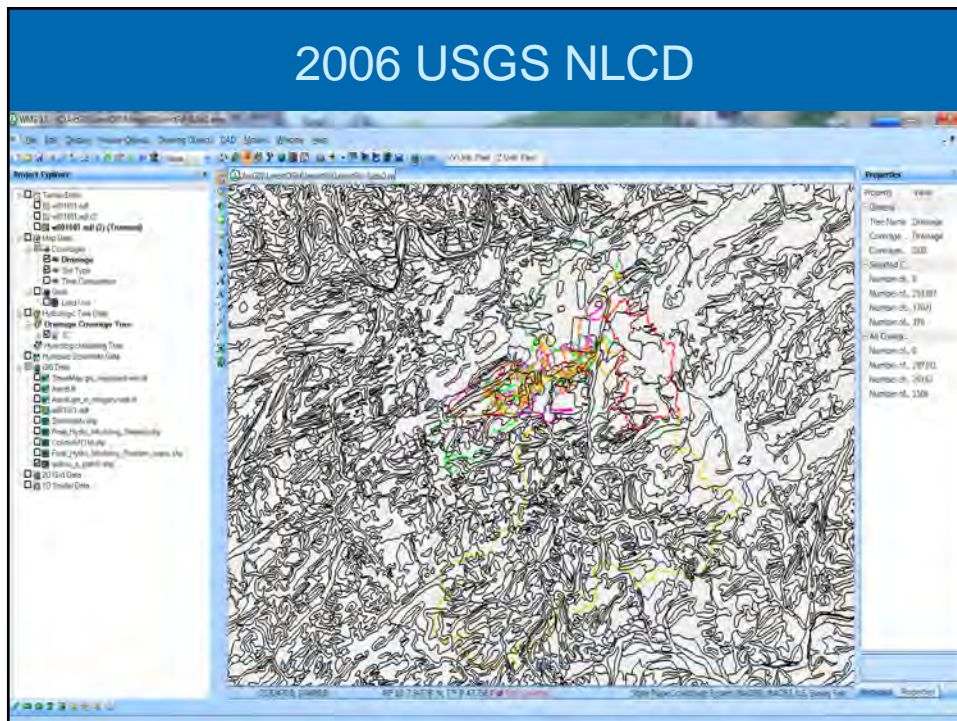
- 0 21 Developed - Open Space
- 0 23 Developed - High Intensity
- 0 41 Deciduous Forest Land
- 0 81 Pasture - Hay
- 0 90 Woody Wetlands

Properties: Property Value, General, Tree Name Land Use

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Hydrologic Model Parameters

The screenshot displays a software window titled "Subcatchment 422" with a list of properties and values. To the right is a network diagram showing a complex web of lines and nodes representing a hydrologic network.

Property	Value
Name	422
X-Coordinate	2123506.733
Y-Coordinate	315202.062
Description	
Tag	
Rain Gage	Gage1
Outlet	140121a
Area	15.0912
Width	557.8388961
% Slope	3.37
% Imperv	0.8500
N-Imperv	0.013
N-Perv	0.1
Dstore-Imperv	0.03372266
Dstore-Perv	0.1686133
%Zero-Imperv	25
Subarea Routing	IMPERVIOUS
Percent Routed	100
Infiltration	CURVE_NUMBER
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0
User-assigned name of subcatchment	

Below the network diagram is a legend with the following entries:

- 11, "Open water", 100,100,100,100
- 12, "Perennial Ice-Snow", 0,0,0,0
- 21, "Developed - Open Space", 49,69,79,84
- 22, "Developed - Low Intensity", 54,70,80,85
- 23, "Developed - Medium Intensity", 69,80,87,90
- 24, "Developed - High Intensity", 89,92,94,95
- 31, "Barren Land - Rock-sand-Clay", 77,86,91,94
- 41, "Deciduous Forest Land", 36,60,73,79
- 42, "Evergreen Forest Land", 36,60,73,79
- 43, "Mixed Forest Land", 36,60,73,79
- 51, "Dwarf Shrub", 35,56,70,77
- 52, "Shrub-Shrub", 35,56,70,77
- 71, "Grassland-Herbaceous", 49,69,79,84
- 72, "Sedges/herbaceous", 49,69,79,84
- 73, "Lichens", 49,69,79,84
- 74, "Moss", 49,69,79,84
- 81, "Pasture - Hay", 49,69,79,84
- 82, "Cultivated row crops", 67,78,85,89
- 90, "woody wetlands", 36,60,73,79
- 95, "Emergent herbaceous wetlands", 49,69,79,84

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EPA SWMM5 Hydrologic/Hydraulic Model Set-up

The screenshot shows the EPA SWMM5 software interface with several windows open. The "Junction Editor" window is in the foreground, showing properties for Junction 130003. The "Cross-Section Editor" window shows an irregular channel shape. The "Transect Editor" window displays a table of station and elevation data, and the "Transect Viewer" window shows a graph of elevation versus station.

Junction Editor (Junction 130003):

Property	Value
Name	130003
X-Coordinate	2123702.155
Y-Coordinate	315746.457
Description	
Tag	
Flow	NO
Transmiss	NO
Invert EI	463.75
Max. Depth	0
Initial Depth	0
Surcharge Depth	0
Ponded Av	

Transect Editor (Transect 25815.0):

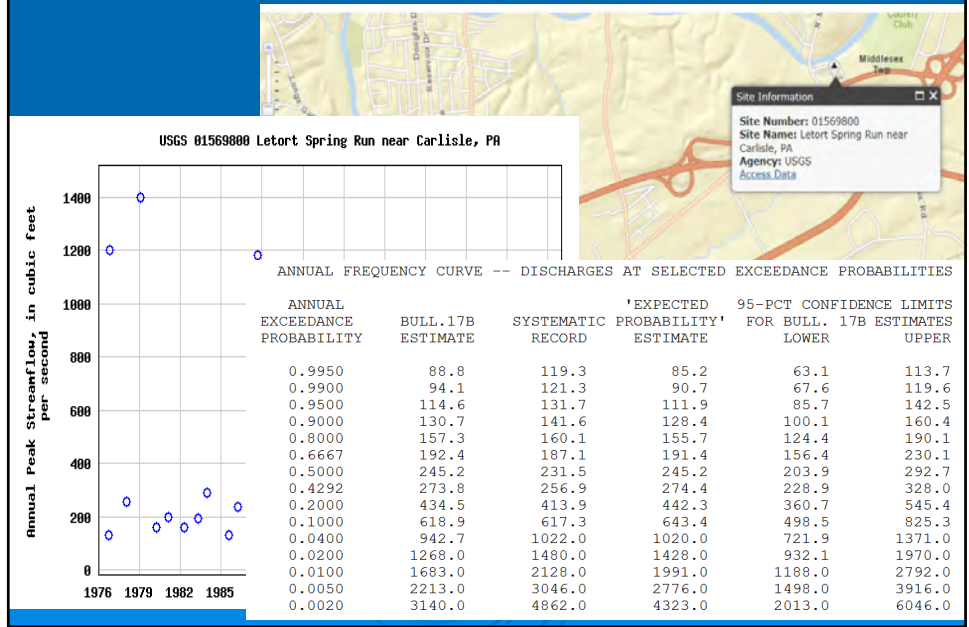
Station (ft)	Elevation (ft)	
1	0.0	463.0
2	55.0	458.8
3	595.0	458.6
4	1388.0	457.8
5	1640.0	455.8
6	1645.0	454.5
7	1750.0	454.5
8	1800.0	454.5
9	1950.0	453.0
10	2111.0	449.4
11	2150.0	448.0
12	2135.0	446.6
13	2190.0	446.6

Transect Viewer (Transect 25815.0):

Property	Value
Discrim	
Left Bank	0.075
Right Bank	0.075
Channel	0.035
Bank Slope	
Left	2330.0
Right	2360.0
Midstream	
Stations	0
Elevations	-0.65
Meander	0

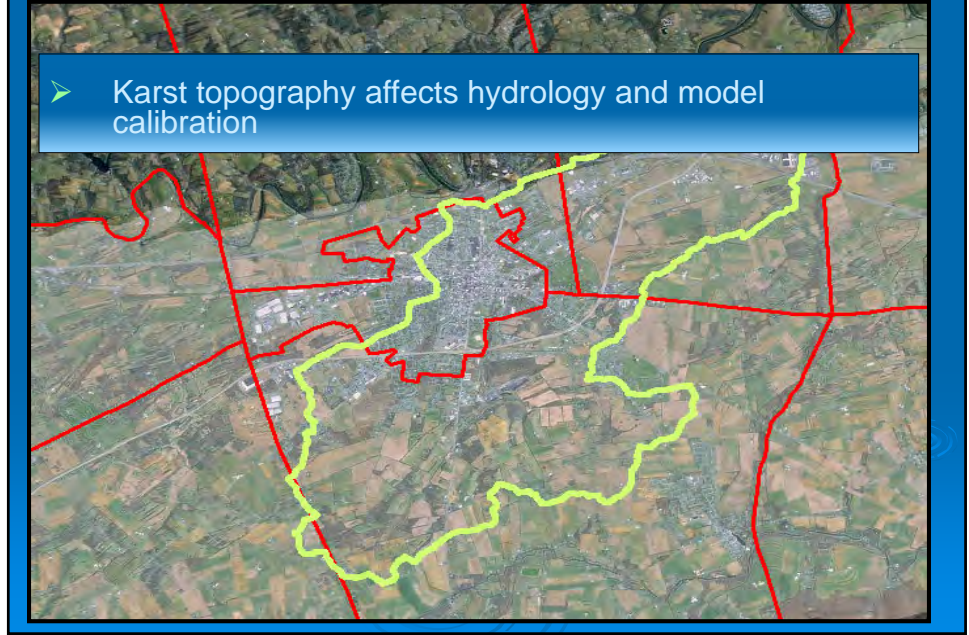
50

Stream Gage - Calibration



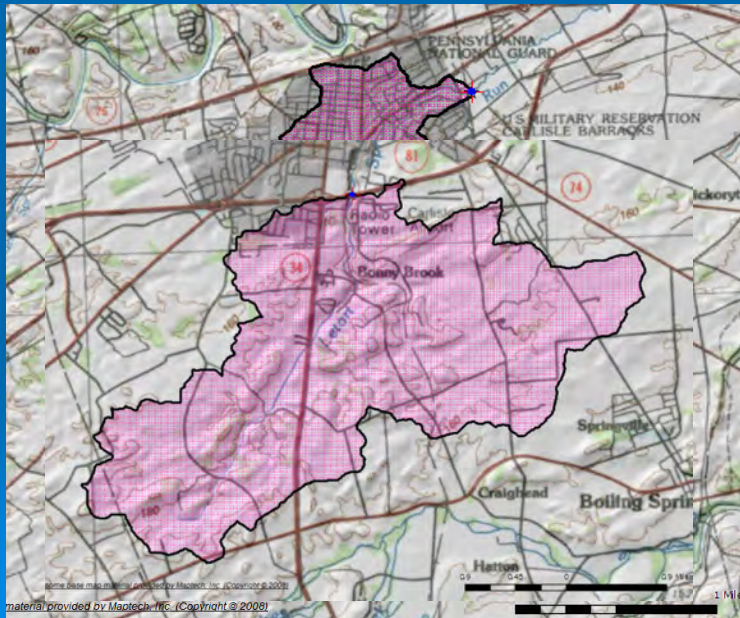
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Karst Topography



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StreamStats Regression Equations



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StreamStats Regression Equations

Parameter	Value
Area in square miles	14.65
Mean Basin Elevation in feet	516.3
Unadjusted basin slope, in degrees	2.5
Adjusted basin slope, in degrees	2.3
Total stream length in miles	7.61
Stream density (miles/square mile)	0.52
Percent of area covered by lakes, ponds, reservoirs and wetlands	0.3
Percent of area covered by carbonate bedrock	100.0
Percent of area covered by glacial activity	0.0
Depth to rock in feet	5.7
Mean annual precipitation in inches	39.0
Maximum Daily Temperature in degrees F	62.0
Percent of area covered by forest	9.0
Percentage of impervious area determined from NLCD 2001 impervious dataset	14.8
Percent of area covered by urban land according to an enhanced version of NLCD 1992	24.4
Percentage of urban land cover determined from NLCD 2001 land cover dataset	37.8
Drainage quality index from STATSGO	3.2
X coordinate of the centroid, in map projection, meters	68924.2
Y coordinate of the centroid, in map projection, meters	130956.5
X coordinate of the outlet, in map projection, meters	70965.0
Y coordinate of the outlet, in map projection, meters	135155.0
Longitude of the outlet, in decimal degrees	-77.16629



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StreamStats Regression Equations

Streamstats Ungaged Site Report

Date: Fri Nov 15 2013 05:48:03 Mountain Standard Time
 Site Location: Pennsylvania
 NAD27 Latitude: 40.2144 (40 12 52)
 NAD27 Longitude: -77.1666 (-77 09 60)
 NAD83 Latitude: 40.2145 (40 12 52)
 NAD83 Longitude: -77.1663 (-77 09 59)
 Drainage Area: 14.65 mi2
 Percent Urban: 37.8 %
 Percent Impervious: 14.8 %

Peak Flow Basin Characteristics

100% Peak Flow Region 3 (14.7 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	14.7	1.44	1610
Mean Basin Elevation (feet)	516.3	457	2150
Percent Carbonate (percent)	100.0 (above max value 99)	0	99
Percent Urban (percent)	24.4	0	64
Percent Storage (percent)	0.3	0	22.6

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Peak Flow Streamflow Statistics

Statistic	Flow (ft ³ /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	255		3		
PK5	510		5		
PK10	753		7		
PK50	1470		11		
PK100	1870		11		
PK500	3070		11		

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Calibration

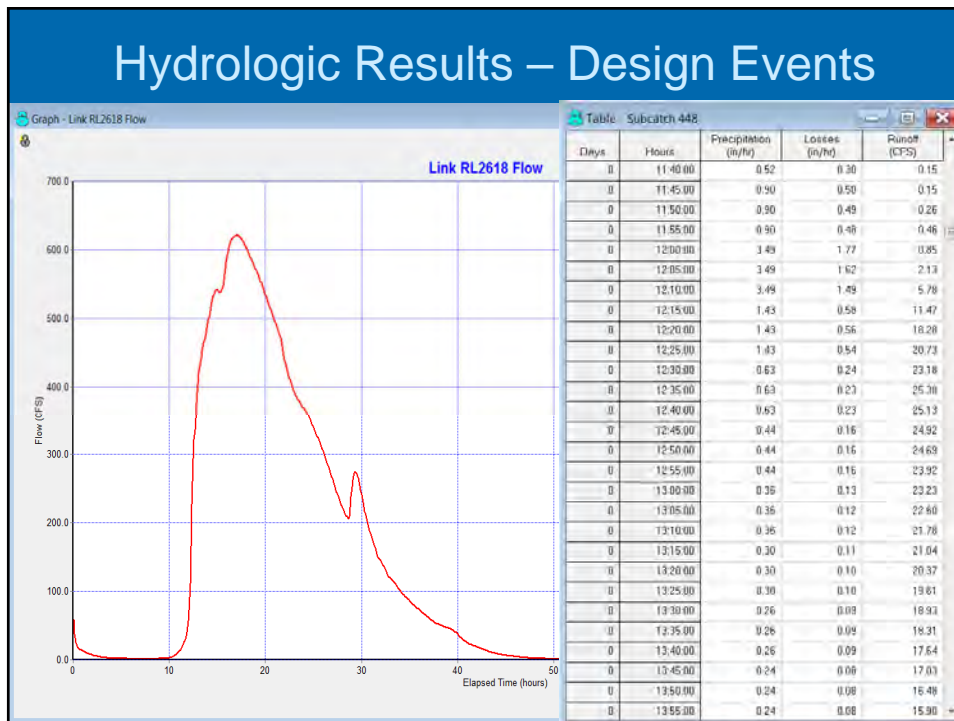
Location / SWMM Parameter	Letort Spring Run just US of Area 4 Letort to I-81
Data / Method	Table - Link R26220
DA GIS (SM)	8.28
DA SS (SM)	8.41
DA FIS (SM)	10
Baseflow (Init. Flow)	8.41
Sub/Conduit	364
SWMM 1st Try	894.54
Calibrated Values	711.08
Streamstats (5102)	480
Act 167 HMS	838
PeakFQ LPIII	296
FEMA FIS	270
PekFQ Weibul Plot	502

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Calibration

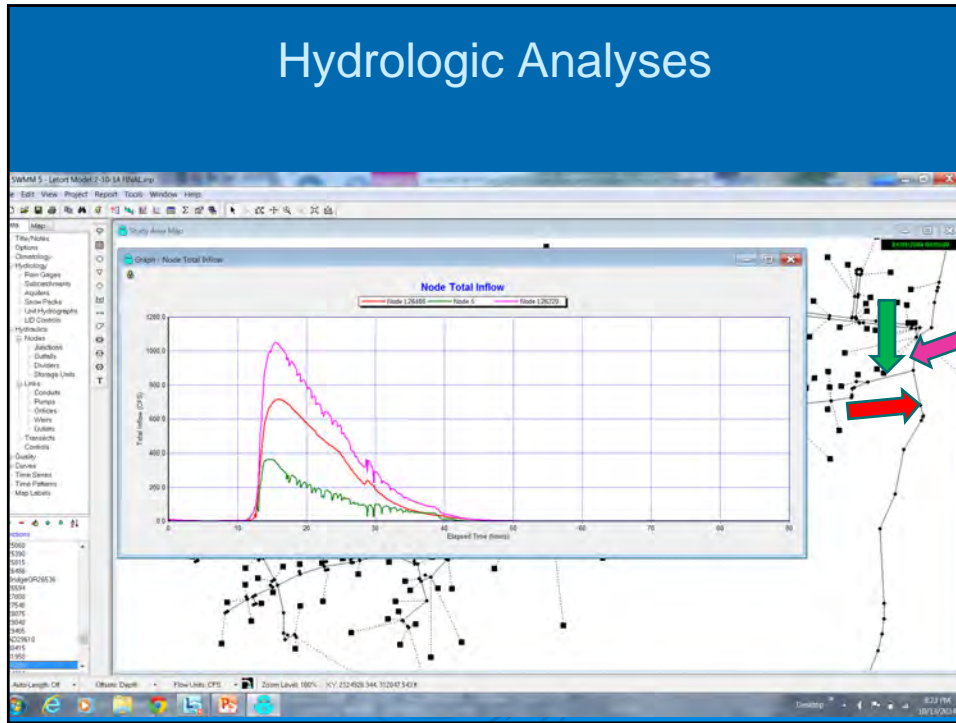
HMS data (From US to DS)	Calibrated						Combined Areas
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
Act 167 HMS Sub							
LSR_08	215	430	663	1089	1522	2067	
LSR_09	116	224	340	553	771	1048	
J-LSR-01 (US of I-81) Comb	278	547	838	1370	1915	2606	LS 8,9
LSR-06 (I-81)	58	118	185	309	438	602	
J-LSR-02 (I-81) Comb +6,7	363	711	1085	1772	2478	3376	LS 6,7,8,9
LSR_07	91	167	249	397	550	744	
LSR_04 (DS Limit Study)	186	325	467	719	969	1280	
J-LSR-03 (DS Limit Study) Comb	526	989	1462	2319	3192	4288	LS 4,6,7,8,9
PeakFQ values Transposed	178	338	508	810	1091	1504	
J-LSR-04 Confluence - Stream gage	632	1180	1746	2773	3851	5212	
PeakFQ values	245	435	619	943	1268	1683	

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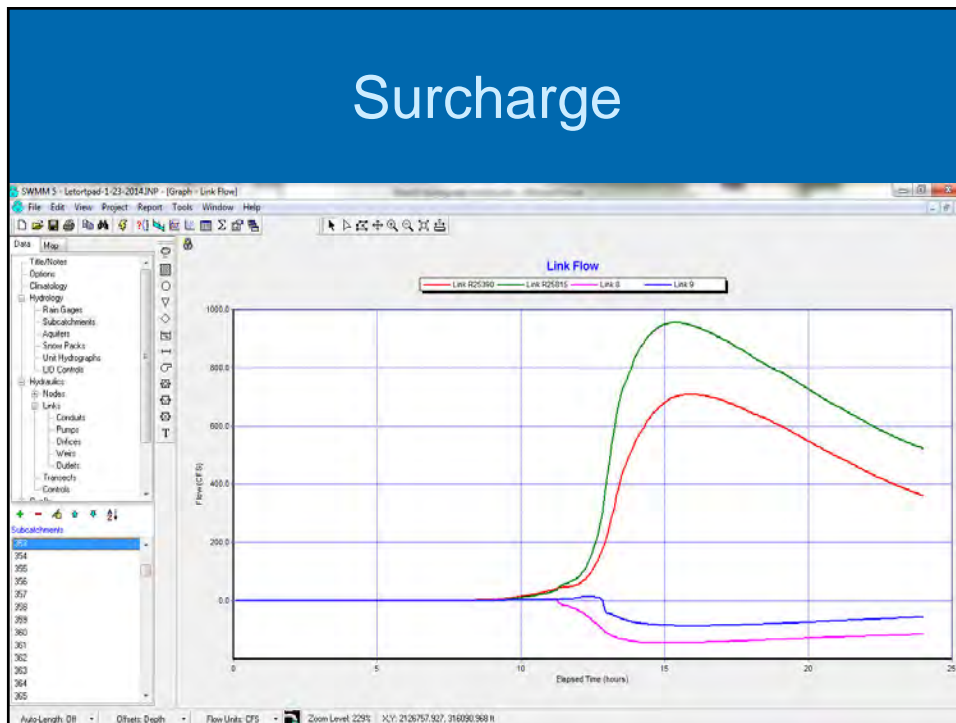
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Hydrologic Analyses



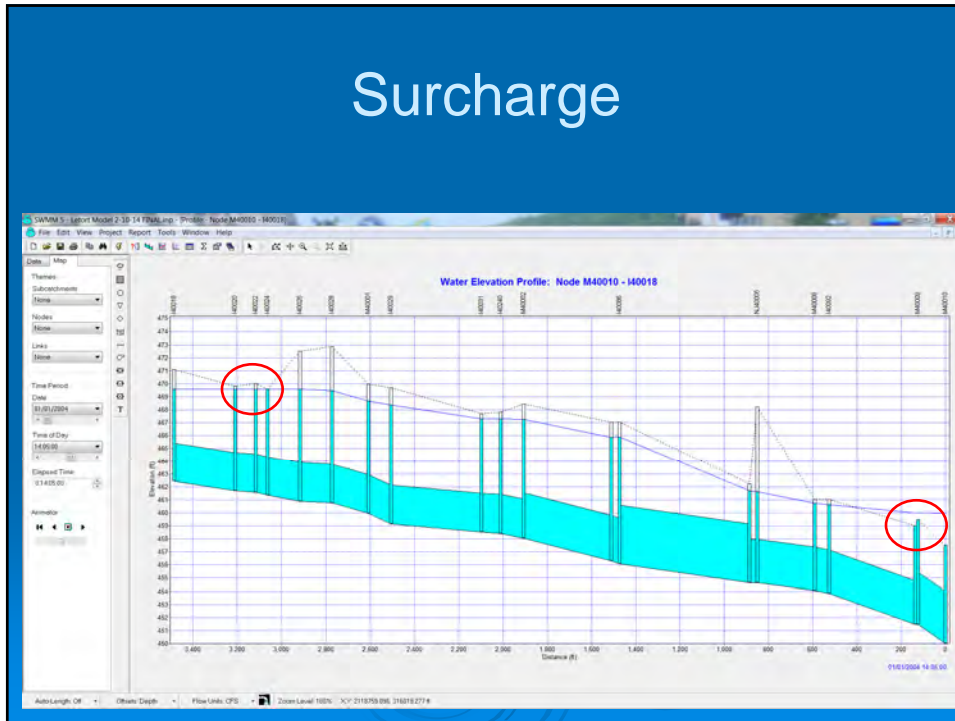
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Surcharge



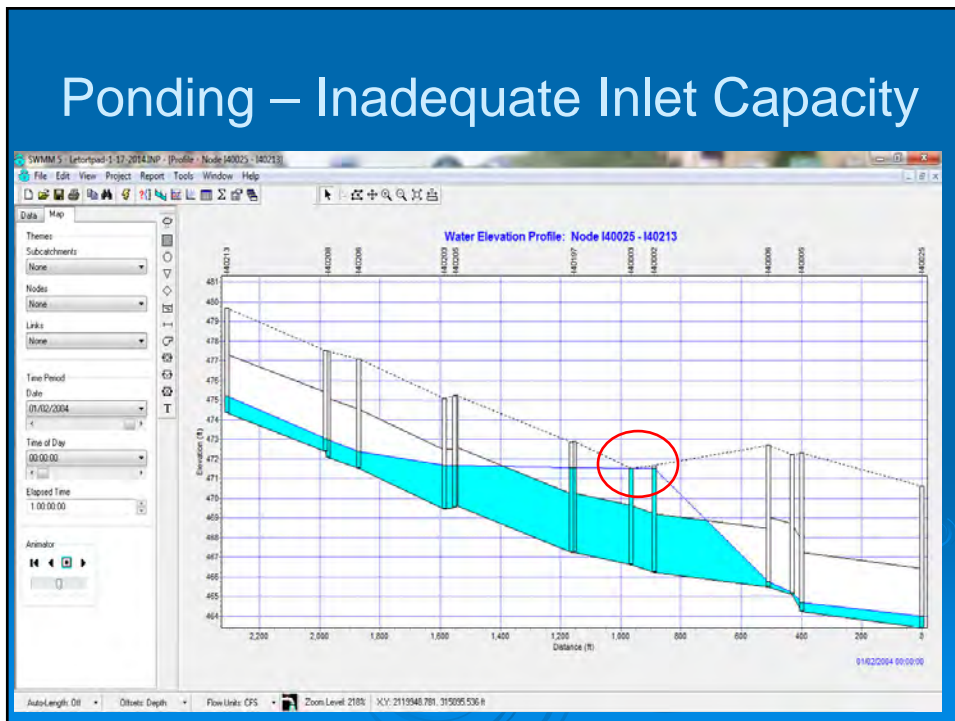
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Surcharge



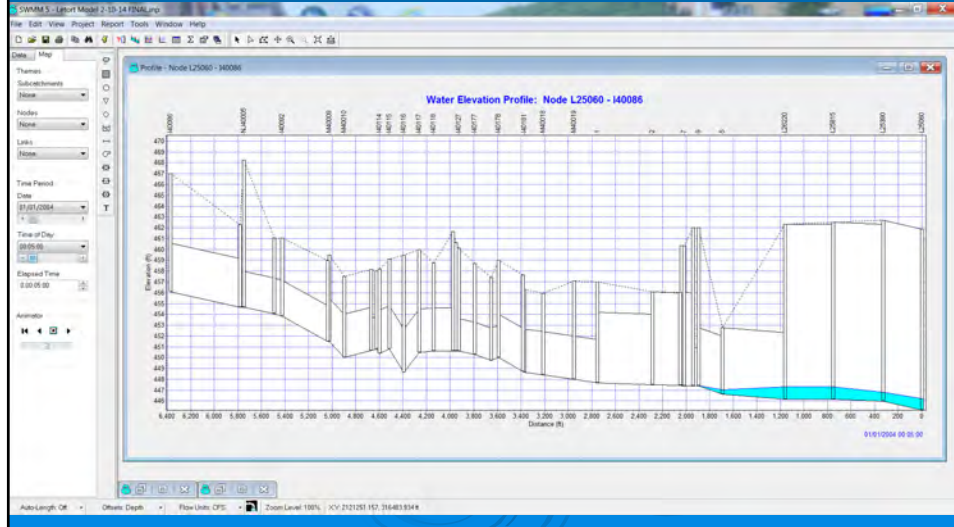
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Ponding – Inadequate Inlet Capacity



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Animation Aids Timing Analysis



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Preliminary Modeling Observations

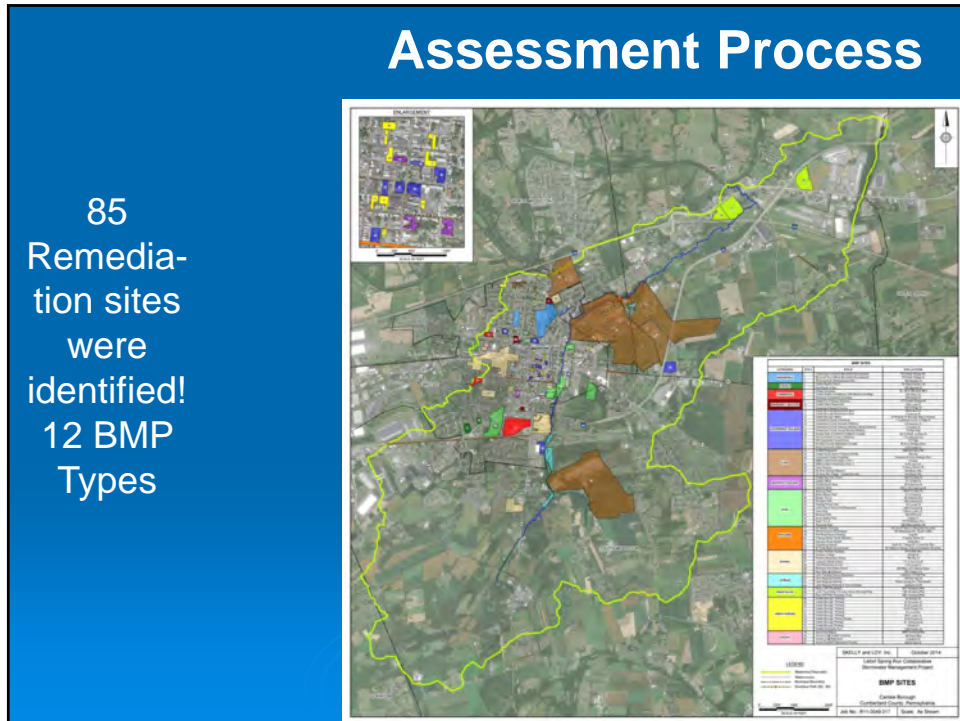
2-Stage flooding

- Surface runoff overwhelms the system, then subsides
- Letort crest backflows and causes a second inundation

Volume control BMPs spread throughout study area most effectively resolve flooding

A combination of rate control, volume control, conveyance upgrades and floodplain restoration is indicated

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Excerpt from BMP Map Legend

BMP SITES			
CATEGORIES	SITE #	SITE ID	SITE LOCATION
BROWNFIELD	1	Carlisle Auto Industries (Brownfield Development)	50 Carlisle Springs Rd
	2	RE Invest Tire & Wheel (Brownfield Development)	515 North College St
	3	TE Connectivity Redevelopment Site	759 Hamilton St
CHURCH	4	Carlisle Baptist Church	701 Walnut Bottom Rd
	5	First Church of God	705 Glendale St
COMMERCIAL	6	Carlisle Commons	10, 100 & 260 Noble Blvd
	7	Carlisle Health and Wellness (AKA Medical Arts Bldg)	220 Wilson St
	8	Downtown Construction Company	320 Cherry St
EMERGENCY SERVICES	9	Carlisle Fire & Rescue Services	177 Carlisle Springs Rd
	10	Carlisle Police Department	240 Lincoln St
	11	Cumberland Goodwill Fire Co.	102 W Ridge St
	12	Carlisle Borough Maintenance Shed	228 N West St

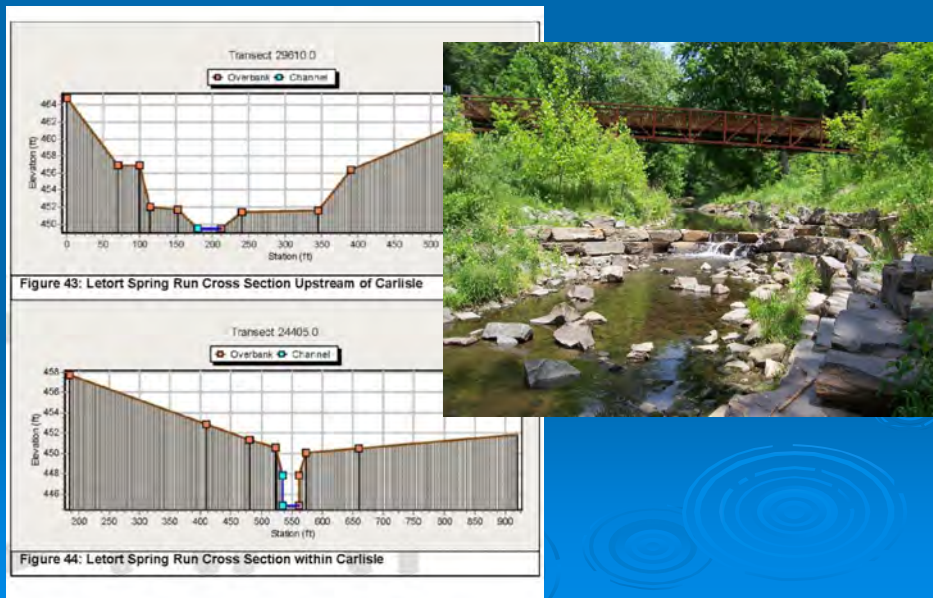
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BMP No. 1- Source Area Samples



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BMP No. 2- Floodplain Restoration

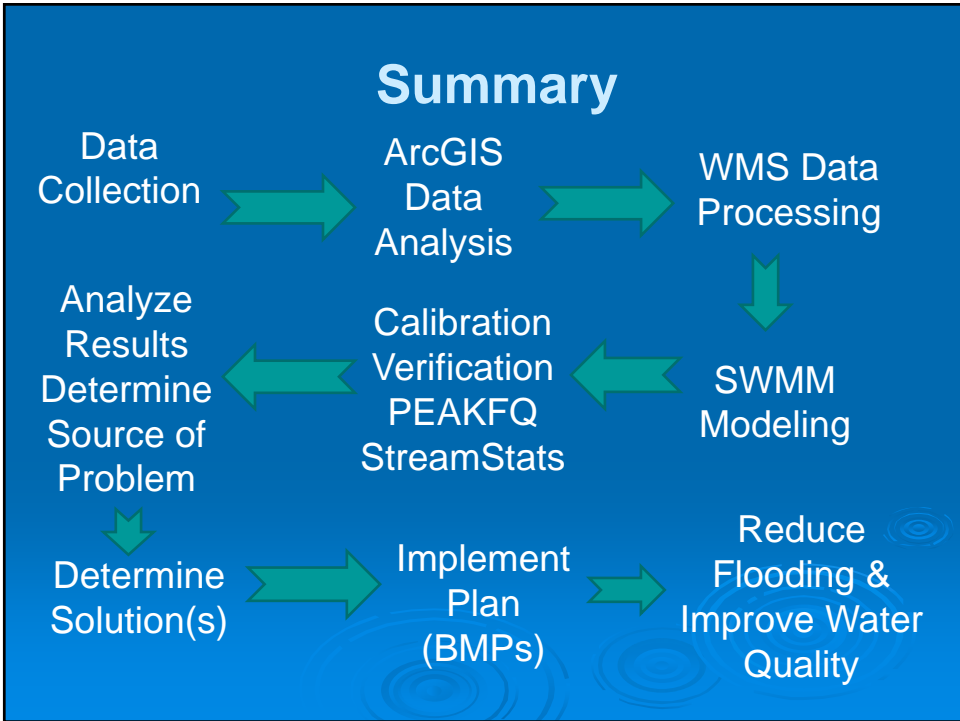


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BMP No. 8 – Policy & Programmatic Initiatives Samples

The images illustrate various BMP initiatives for Chesapeake Bay drainage. The first image shows a storm drain with a concrete curb and a sign that reads "CHESAPEAKE BAY DRAINAGE". The second image shows a person using a green brush to clean a storm drain. The third image shows a circular sign with a crab logo and the text "DO NOT DUMP" and "DRAINS TO CHESAPEAKE BAY".

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Letort Spring Run Collaborative Funding:

Penn DOT Support

- Phase 1 & Phase 2 Funding
- Involvement throughout project

PA DEP Support

- Phase 2 Funding
- Phase 1 Project Involvement

PA DCED Support

- Grant for GIS Database

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Funding: Sources

PA DCED	US EPA
PA DCNR	US Army Corps of Engineers
PA DEP	US Housing and Urban Development
PennDOT	National Fish and Wildlife
PennVEST	Chesapeake Bay Foundation
PA Public Utility Commission	Chesapeake Bay Trust
PA Fish and Boat Commission	Land Trust and Conservancies
Commonwealth Financing Assoc	Endowments
League of Women Voters	Users Fees
	General Funds

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Funding: Opportunities

A Guide to State Funding Opportunities for Conservation, Recreation and Preservation Projects

FINDING THE green!

Compiled by the Pennsylvania Growing Greener Coalition

<http://pagrowinggreener.org/wp-content/uploads/2014/02/Finding-the-Green-LR.pdf>

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