ADVANCED DEM APPLICATION TO ENHANCE STORMWATER MODELING

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- H&H modeling
- WW Master Planning
- SSOs and CSOs Mitigation
- RDII Source Reduction Program
- Green Infrastructure Program


Agenda

- Integrated Plan Objectives
- Modeling at the Source
- Newton-Bedford Case Study
- Green Infrastructure Program

Integrated Plan Objective

Sanitary System:

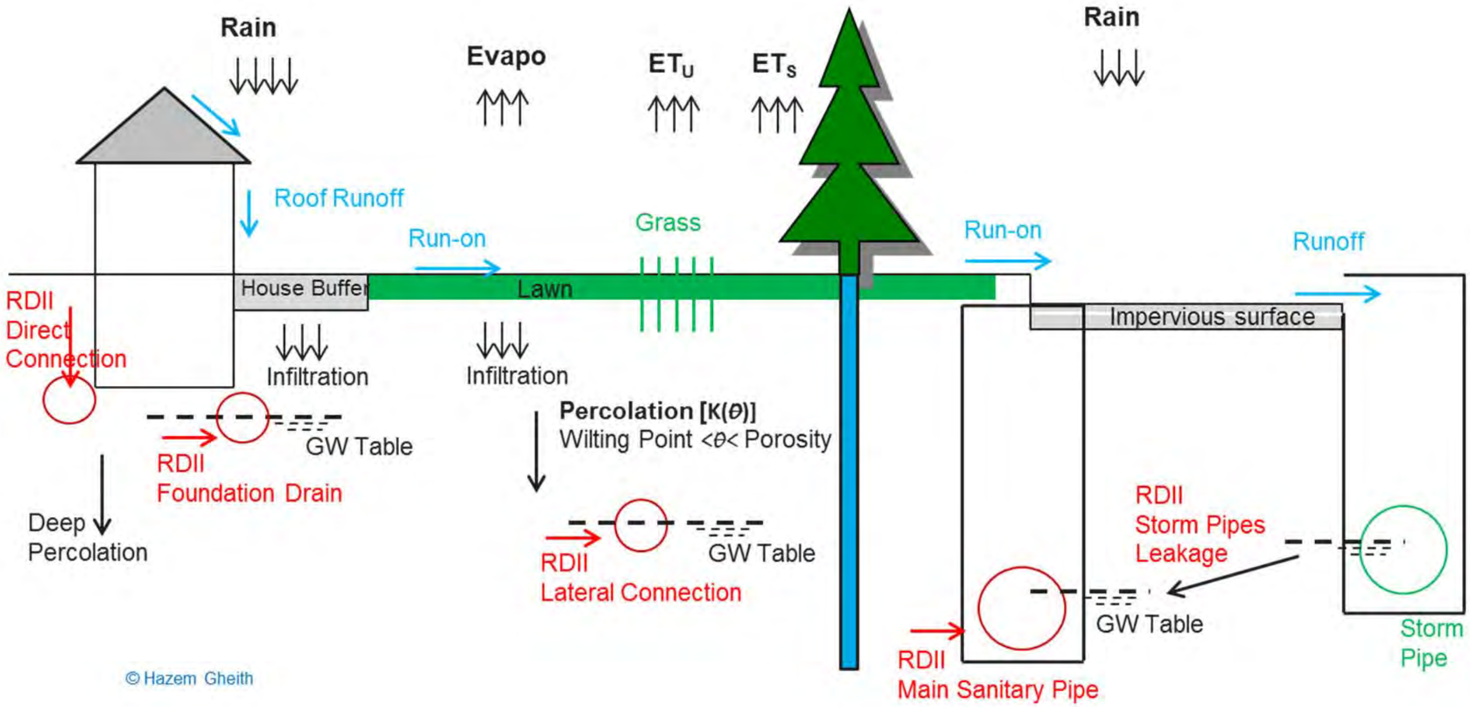
- Mitigate sewage overflowing to receiving waters, by reducing excessive rain driven inflow and infiltration (RDII)
  - Roof Redirection
  - Storm Sump Pump

Stormwater System:

- Reduce pollution to the receiving waters and mitigate backups and flooding deficiencies
  - Green Infrastructure (GI)

Detailed resolution calculations are needed for an educated Integrated Plan

Runoff and RDII Sources



Green Infrastructures in Urban Setting

- Suitable sites are limited
- Planning large scale GI program requires careful consideration on runoff calculation

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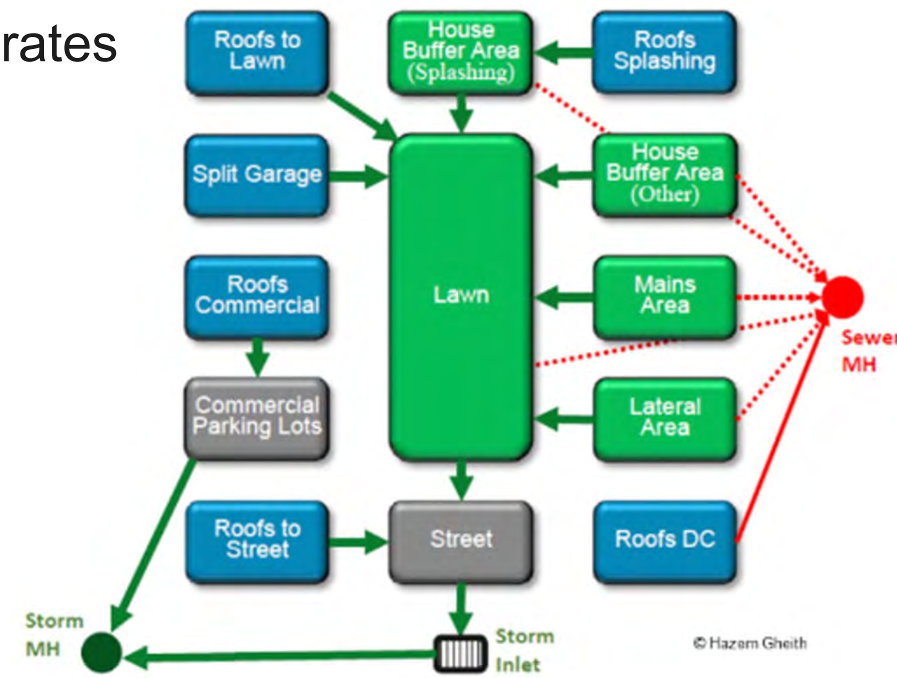
ARCADIS Design & Consultancy for natural and built assets

Modeling Approach

- Use wealth of available GIS data
  - DEM
  - Streets
  - Buildings
  - Sewers
- Delineate runoff catchments
  - GI, Storm Inlets, or Manhole Resolution
- Split sub-sewersheds into the independent hydrologic features (subareas)

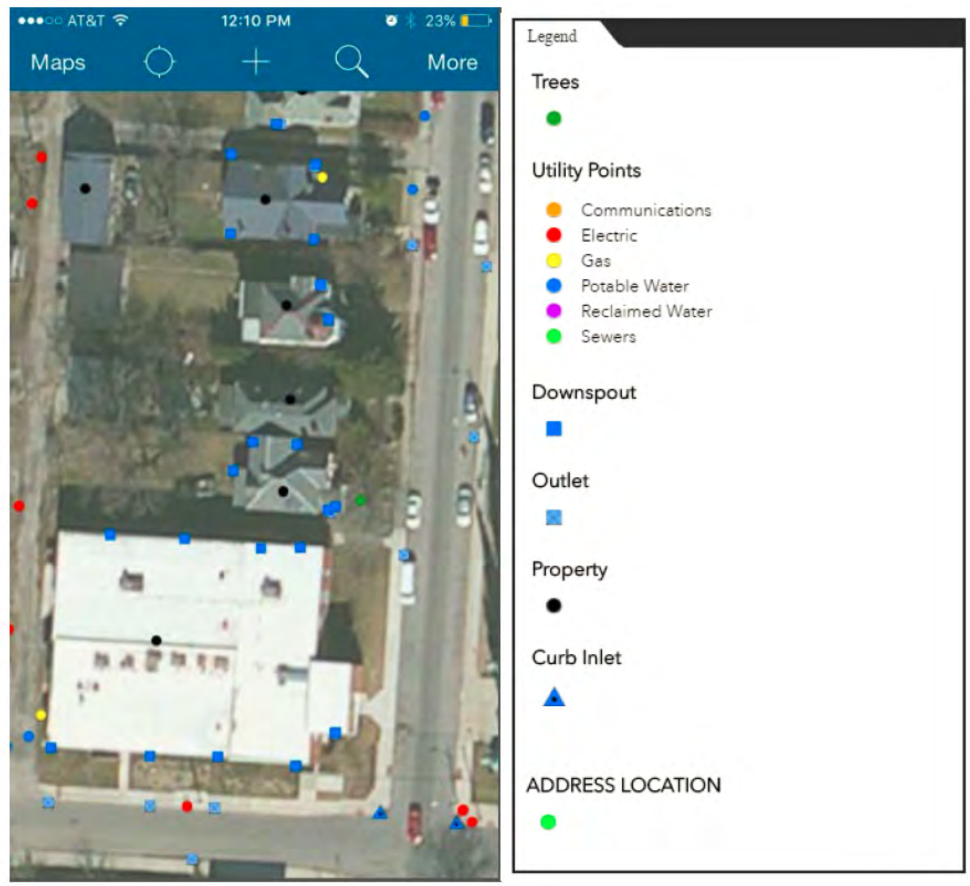
Integrated Plan Model Setup

- One model platform that integrates sanitary and storm systems
- Suitable for Integrated Plan planning
- Programs since 2012
  - Columbus (SWMM)
  - Cincinnati (SWMM)
  - Indianapolis (ICM)
  - Buffalo (SWMM)
  - DC Water (SWMM)
  - Ft Wayne (SWMM)
  - City of Westfield (ICM)
  - City of Marysville (SWMM)



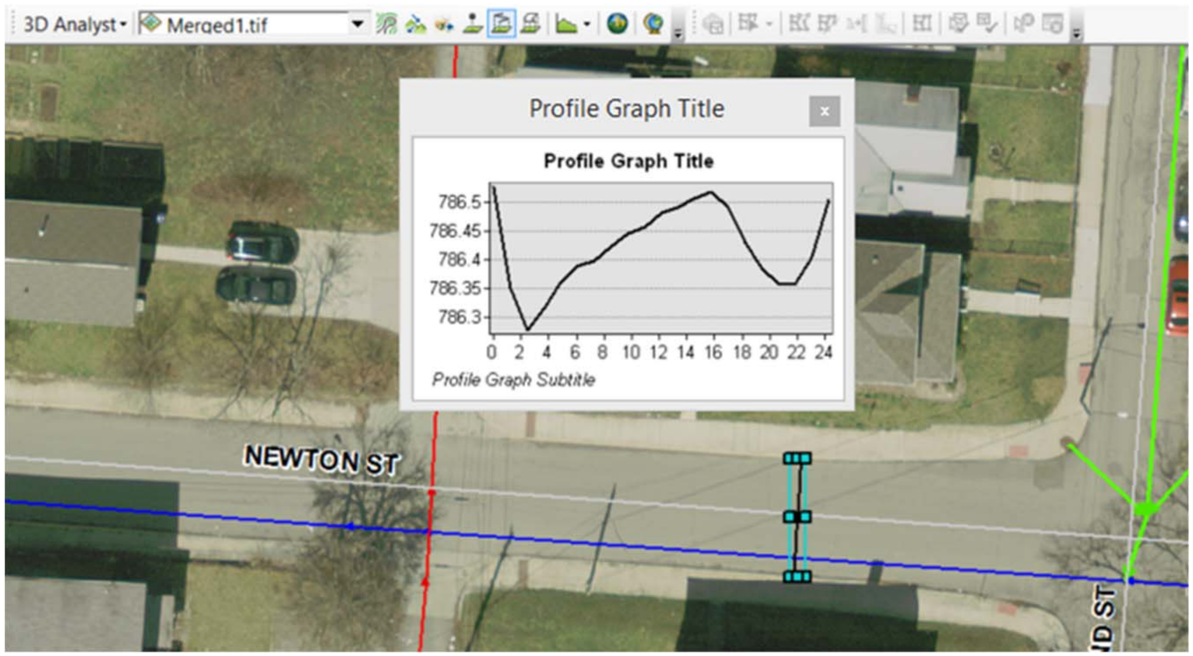
Field Data Collection

Discharge Locations	Quantity	Distribution of Outlets (%)
Within 6' of Home Perimeter	1329	57%
Greater than 6' of House Perimeter – Lawn	127	6%
Greater than 6' of House Perimeter – Street/Curb Cut	220	10%
In-Ground (Discharge Location Unknown)	626	27%
TOTAL:	**2302**	**100%**



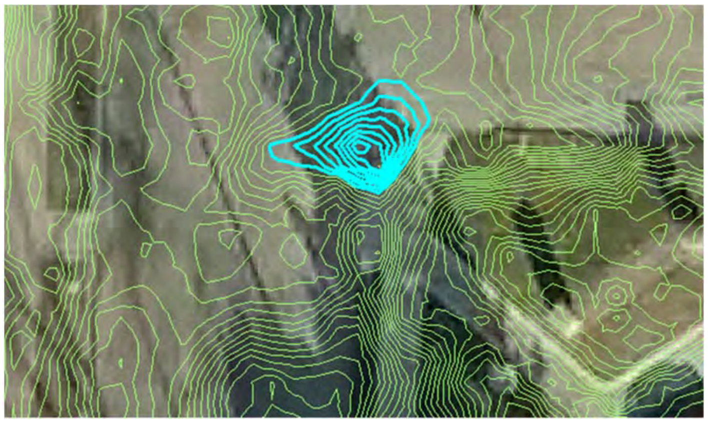
Surface Hydraulics - Street Channel

Calculate Street profile using LiDAR and ArcGIS 3D Analyst



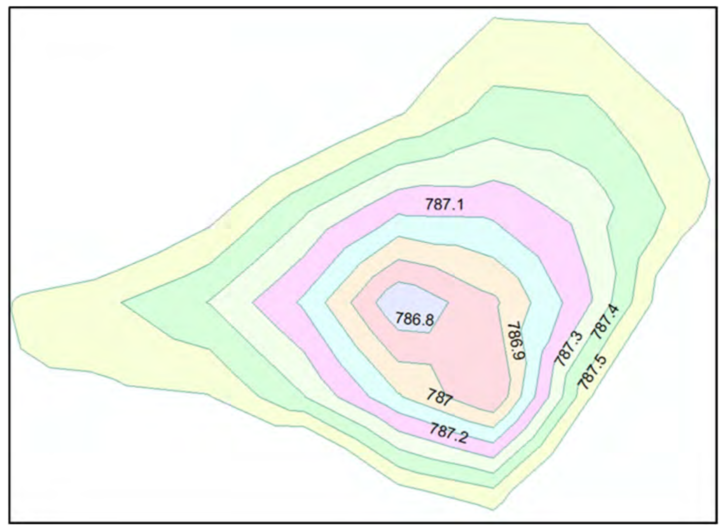
Sink Analysis for Depression Storages

Depression Storage Curves



FID	Shape	Id	Elevation	area
0	Polygon	46699	786.8	1.7
2	Polygon	46719	786.9	10.2
1	Polygon	46719	787	18.6
4	Polygon	46720	787.1	28.8
3	Polygon	46720	787.2	43.4
5	Polygon	46720	787.3	61.8
6	Polygon	46720	787.4	87.1
7	Polygon	46741	787.5	126.6

Automate depth-storage curve generation



Storm Inlets

- Include storm inlets limitation by survey, google maps, or estimate effectiveness through flow meters calibration
- Critical for representing street runoff, flooding and storm/combined sewers backups

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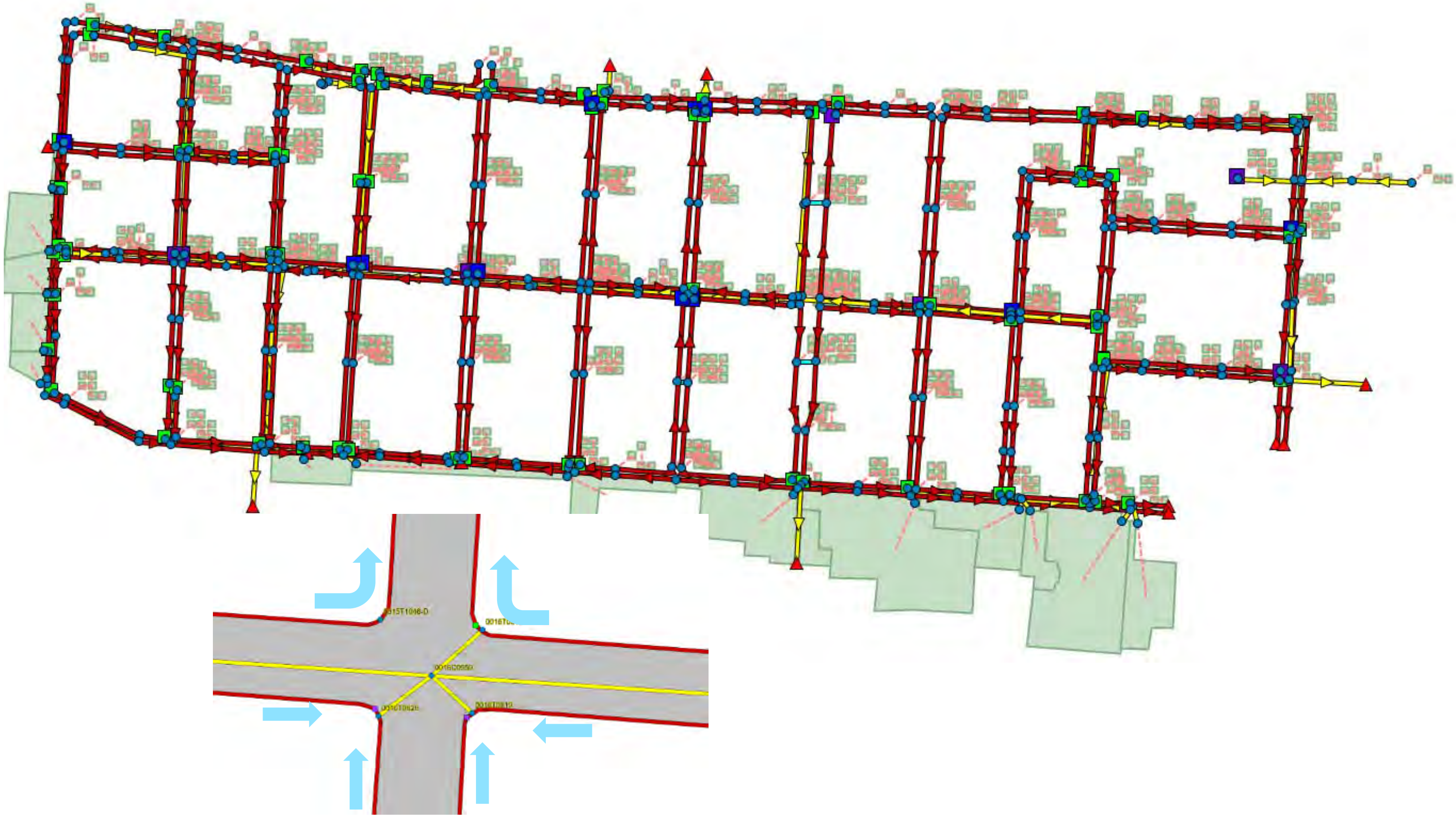
Case Study – Blueprint Columbus

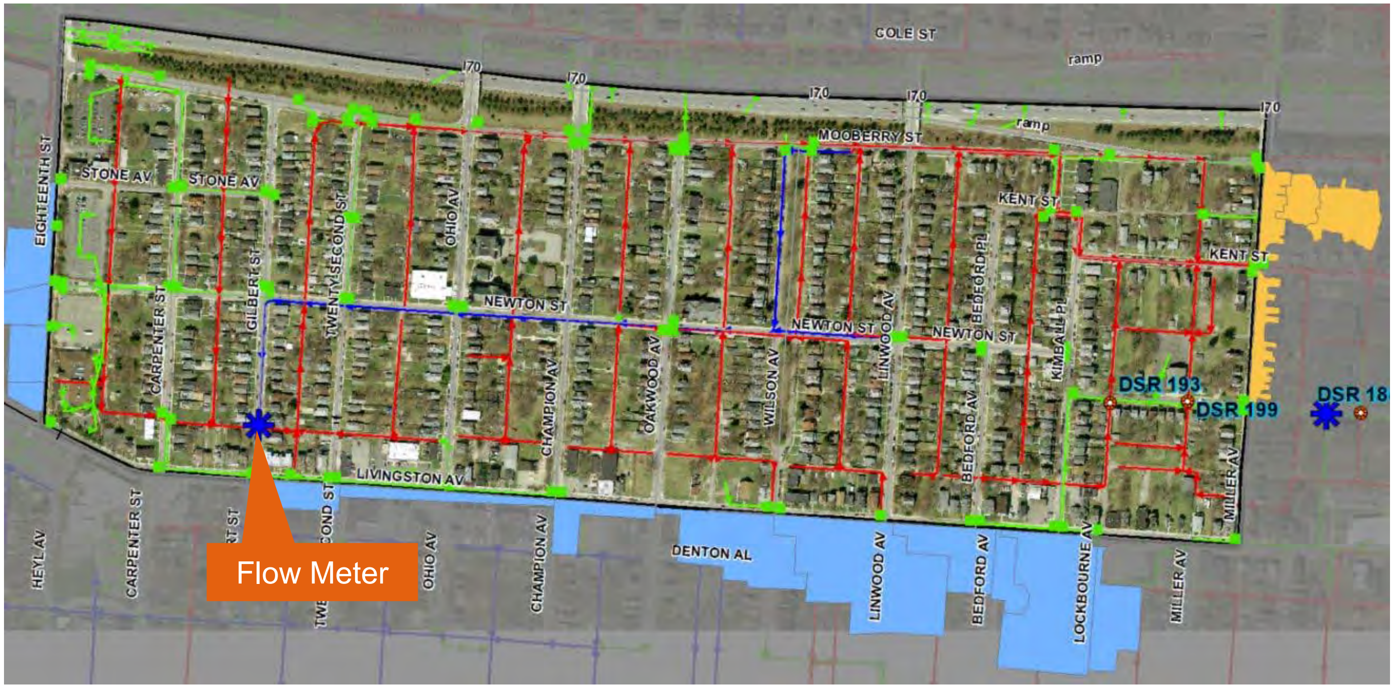
- Runoff catchment delineation per storm inlet
- LiDAR, Streets, Buildings, and downspouts condition survey used to generate the subareas

Model Overview



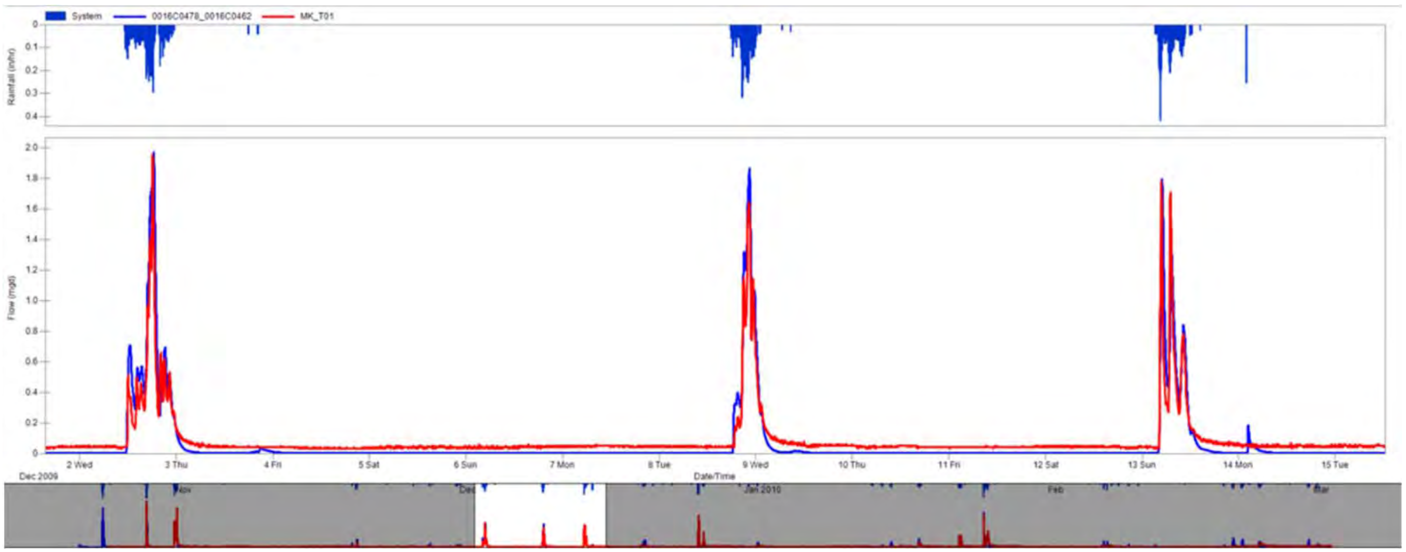
Model Platform Flow Prediction Quality

Flow monitoring data available October 2009 – February 2010

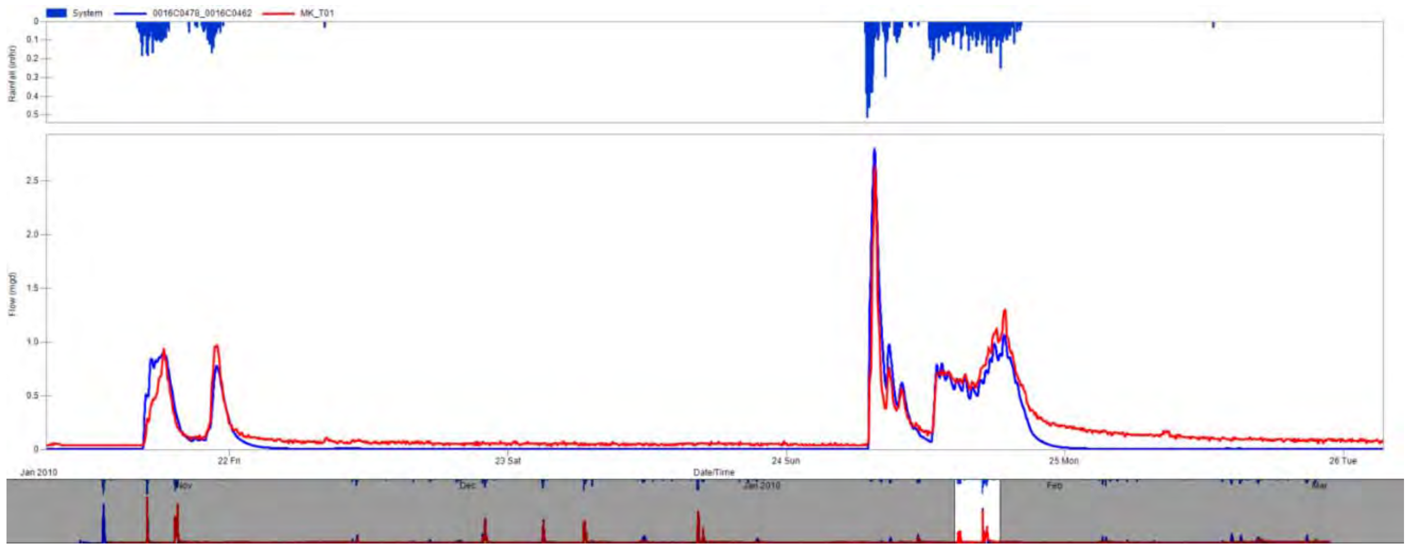


October 2009 Events

December 2009 Events



January 2010 Events



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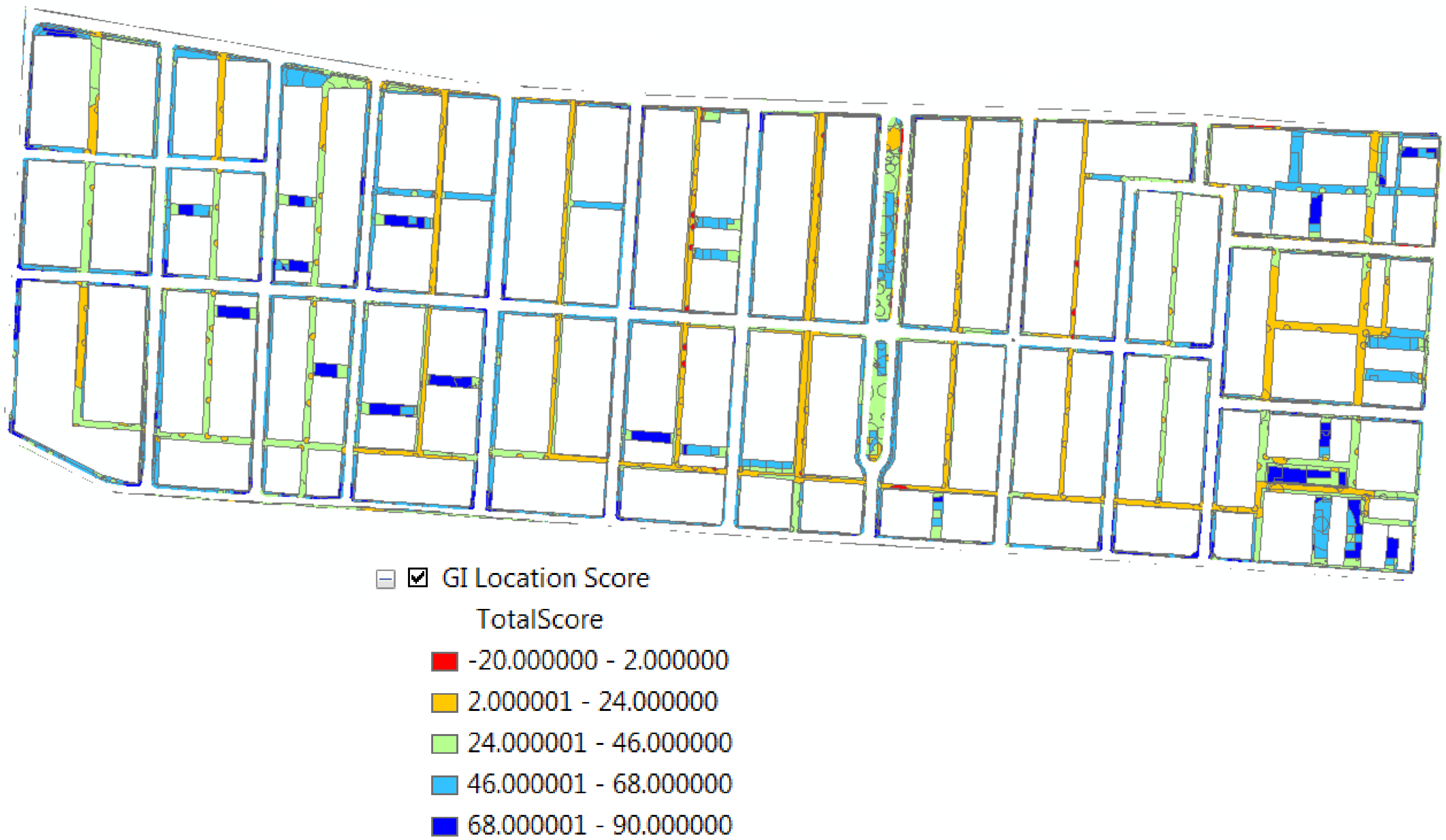
GI Program Objectives

- Water Quality, 20% TSS removal (typical year)
- Water Quantity, manage 20% of 0.75” rainfall on the GI contributing area
- Mitigate negative impact resulting from RDII reduction,
  - No additional storm water surface spreading
  - No flow increase to downstream sewers

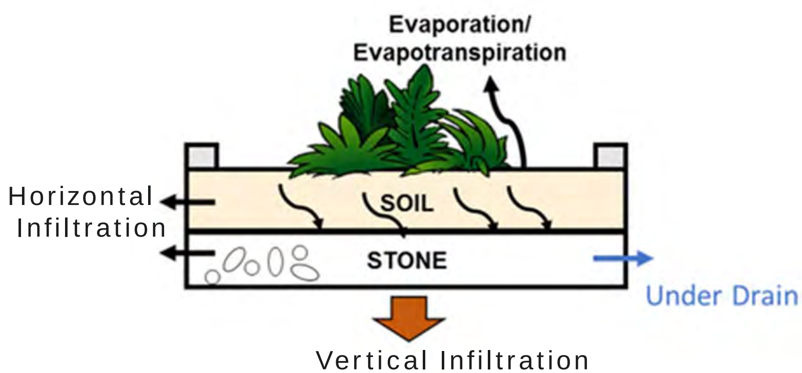
Continuum of Favorable Sites for GI

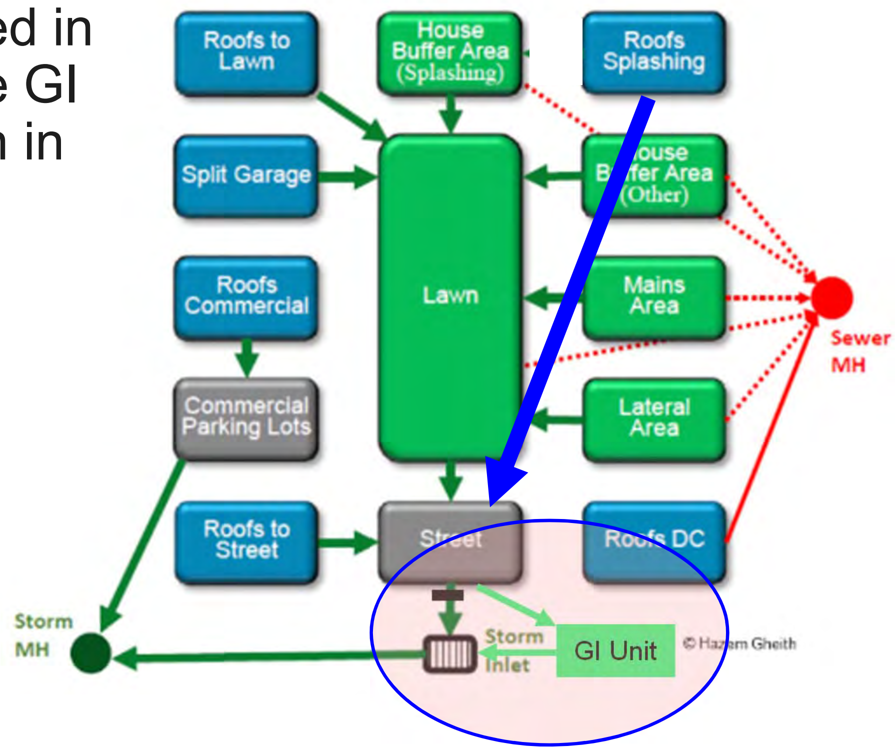


GI Sites and Types

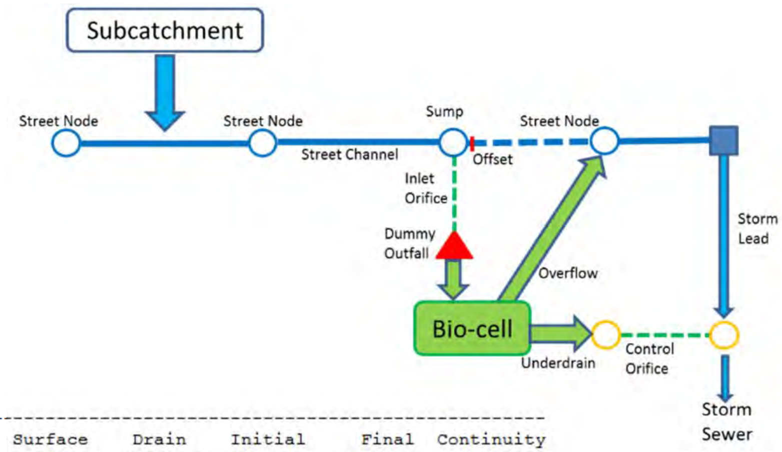
Model Setup – Add Green Infrastructures

- GI unit can be placed/defined in the H/H Model based on the GI type and placement location in the catchment





Modeling GI Units



LID Performance Summary

Subcatchment	LID Control	Total Inflow in	Evap Loss in	Infil Loss in	Surface Outflow in	Drain Outflow in	Initial Storage in	Final Storage in	Continuity Error %
1	BR_1	3080.44	22.11	83.30	1690.39	1278.67	0.84	6.87	-0.00
100	BR_100	5399.90	28.73	80.08	3992.53	1290.29	0.84	9.23	-0.00
101	BR_101	2195.28	17.42	81.42	1213.41	879.64	0.84	4.27	-0.00
102	BR_102	5828.53	26.40	81.63	4238.11	1473.91	0.84	9.61	-0.01
104	BR_104	1529.03	25.72	76.50	909.97	513.40	0.84	4.31	-0.00
107	BR_107	3411.76	29.09	80.30	2087.50	1208.41	0.84	7.39	-0.00
109	BR_109	4795.83	23.77	81.35	3374.12	1307.99	0.84	9.56	-0.00
110	BR_110	4976.12	19.63	83.14	3531.77	1333.82	0.84	8.72	-0.00
111	BR_111	1295.84	17.07	81.44	330.99	862.25	0.84	4.98	-0.00
112	BR_112	0.00	0.00	0.00	0.00	0.00	0.84	0.84	0.00
113	BR_113	6104.18	11.57	85.76	4441.52	1555.93	0.84	10.56	-0.01
116	BR_116	2193.18	15.68	81.40	1003.03	1087.26	0.84	6.74	-0.00
117	BR_117	628.13	24.08	74.85	156.94	369.42	0.84	3.71	-0.01
118	BR_118	1692.73	18.90	79.83	778.68	811.30	0.84	4.94	-0.00
119	PP	293.56	3.94	83.69	25.88	174.39	0.00	5.65	-0.00
121	PP	454.57	4.00	86.35	74.06	283.53	0.00	6.62	-0.00
122	PP	126.68	3.84	81.74	0.00	35.50	0.00	5.60	-0.00

GI Performance in TY

GI Unit	GI Footprint (SF)	Total Inflow Volume (CF)	Overflow Volume (CF)	Captured Volume (MG)	% Captured Volume	Captured Volume CF /Footprint SF
1	41.60	39,357	34,092	5,265	13%	127
2	69.61	72,270	60,219	12,051	17%	173
3	49.61	29,891	23,315	6,575	22%	133
4	72.57	58,006	48,269	9,737	17%	134
5	55.80	42,742	35,665	7,077	17%	127
6	89.60	16,153	7,703	8,450	52%	94
7	37.59	11,456	7,308	4,148	36%	110
8	121.31	12,002	4,985	7,017	58%	58
9	89.34	27,309	18,220	9,089	33%	102
10	89.34	19,592	12,442	7,150	36%	80
11	33.76	36,669	31,764	4,906	13%	145
12	67.87	21,457	16,951	4,507	21%	66
13	117.87	17,987	12,028	5,960	33%	51
14	117.87	17,786	10,298	7,489	42%	64
15	41.64	31,737	23,495	8,242	26%	198

Lessons Learned

- The detailed surfacing modeling platform allows for educated GI planning, siting and sizing.
- TSS removal objective is the dominant factor on GI footprint
- Water quantity reduction objective is the dominant factor on storage capacity
- Engineered soil media permeability is the limiting factor for fully utilizing the GI storage
- Stone column or standing pipe improves GI storage utilization


Thank You
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Imagine the result