Portland Green Infrastructure Analysis

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Abstract

As Portland, OR remains a leader in sustainable stormwater management, green infrastructure (GI) facilities are increasing in number. These designs are widely accepted as providing a broad array of socio-ecological benefits in urban environments, extending well beyond their stormwater control capabilities. However, as facilities are required, the question arises as to whether or not they are constructed in areas physically conducive to high functionality. One indicator of this can be derived from whether the facilities are located within areas of high stormwater accumulation, or flowpaths. To explore this concept, this study identifies the proportion of GI facilities with potential to intercept stormwater flow within two areas of Portland, OR, distinct in their opposing slope characteristics. The proportion values were determined by calculating a binary response of GI facility presence within the proximity of a flowpath. GIS tools are used to assess this relationship, as well as to represent the effect of manipulated parameters on the outcome of results. It was determined that in areas with mean slopes of 0.29% and 0.93%, GI facilities are located within 3 meters of a flowpath 37% and 38% of the time, respectively. Additionally, different modeling techniques which increase the impact of GI on stormwater flow yield similar results, indicating that GI placement is not more likely to intercept stormwater in varying topography within the city. These findings suggest that a substantial percentage of GI facilities are located in areas of high stormwater flow potential, a result which a more detailed modeling technique should confirm.

Keywords: Stormwater, Green Infrastructure, Hydrology, Flow Accumulation, GIS, Sustainability

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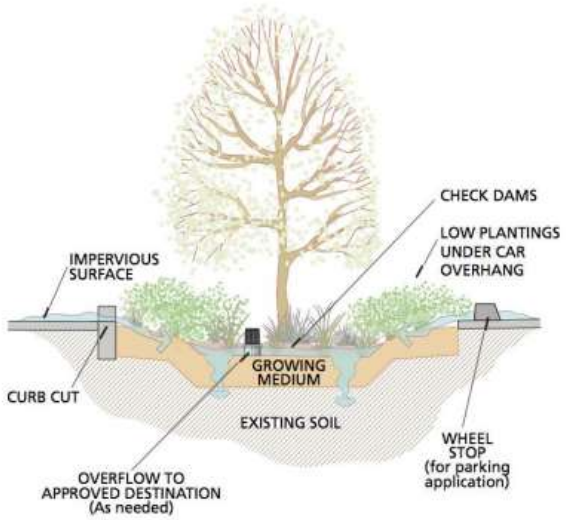
Green Infrastructure Background

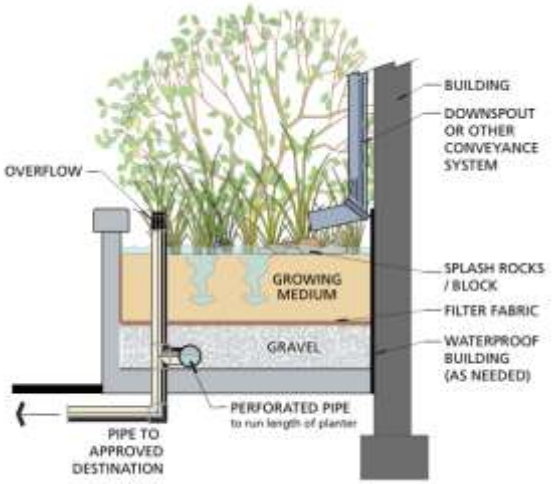
Storm Drain

- Grey Infrastructure – moves urban stormwater away
  - Major cause of urban water pollution
- Green Infrastructure – reduces and treats stormwater at source
  - Environmental, Social, and Economic benefits
  - Uses vegetation, soils and other practices to restore or mimic natural filtration processes
- Key component of Portland's storm water management plan

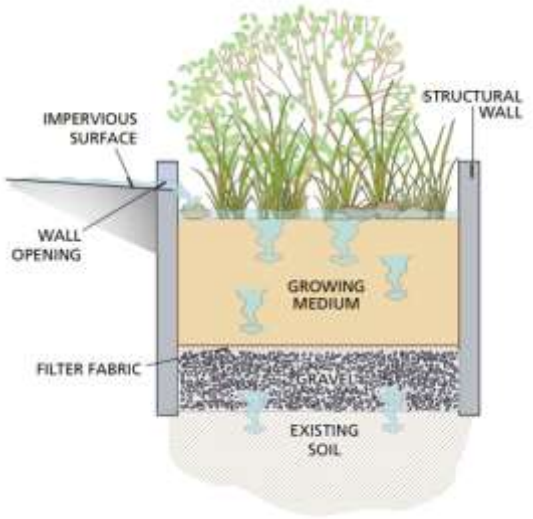
Vegetated Infiltration Basins



Bioswales



Flow-through Planters



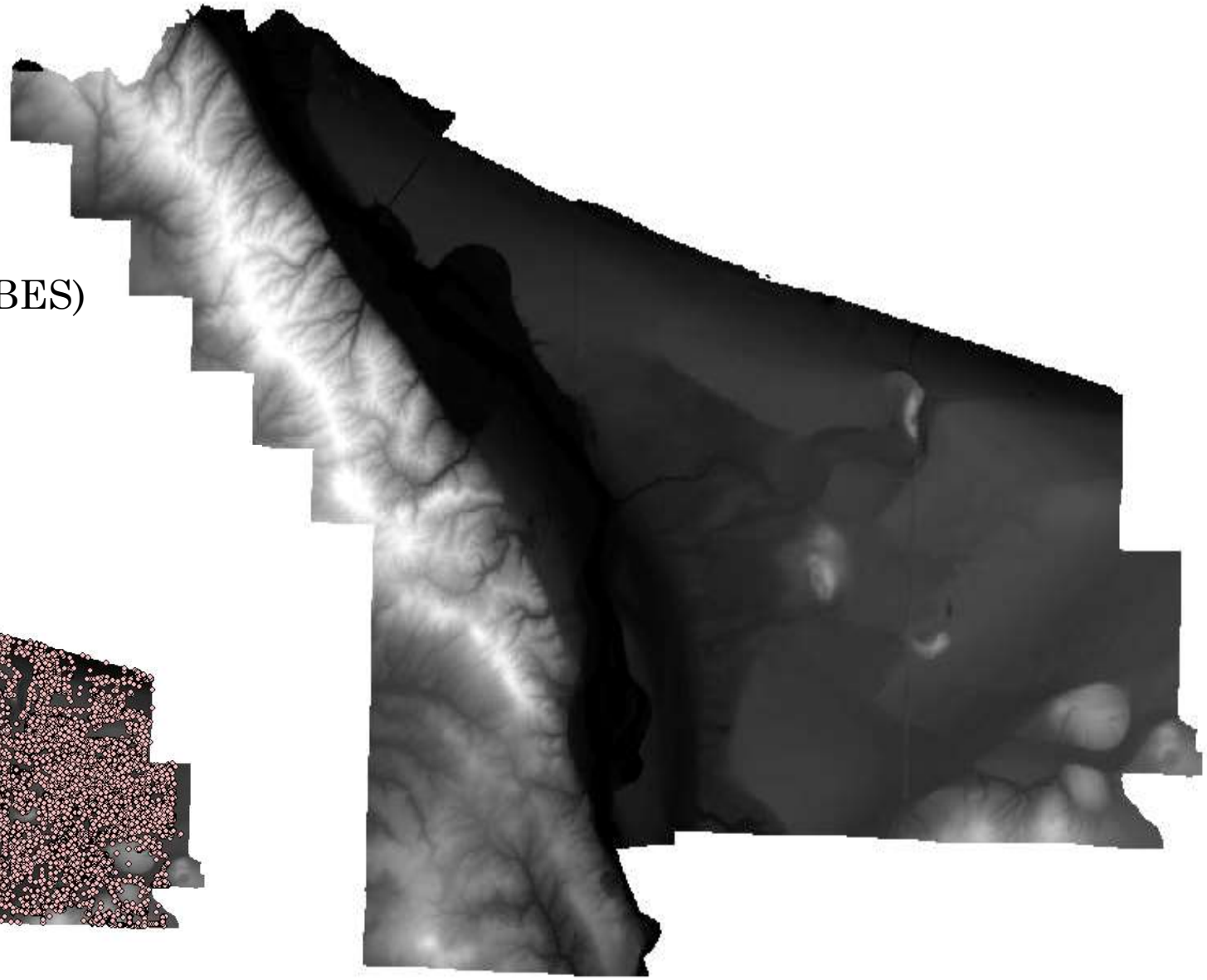
Infiltration Planters

Research Question

- What percent of Green Infrastructure (GI) facilities are effectively placed to receive stormwater flow?

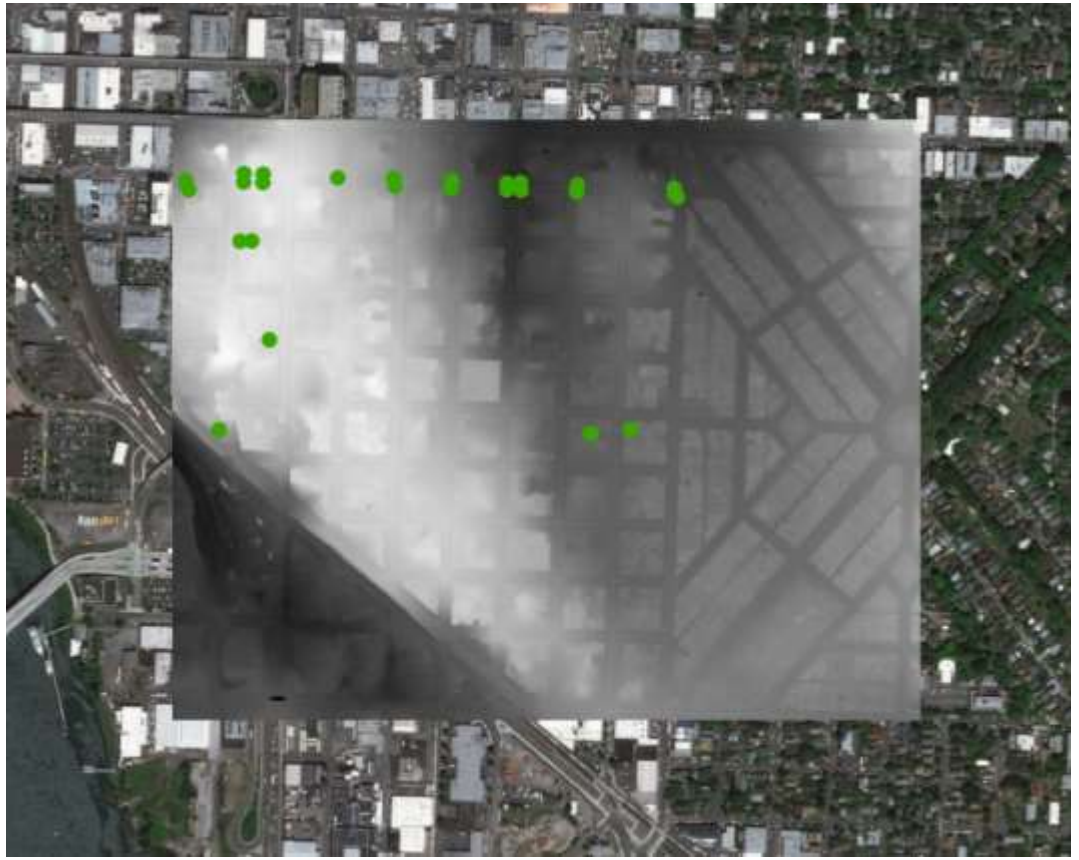
Data Sets Used

- High Resolution DEM (RLIS)
- Portland Green Infrastructure (BES)
- Census Data (ACS)



Study Area 1 – Census Tract 1102

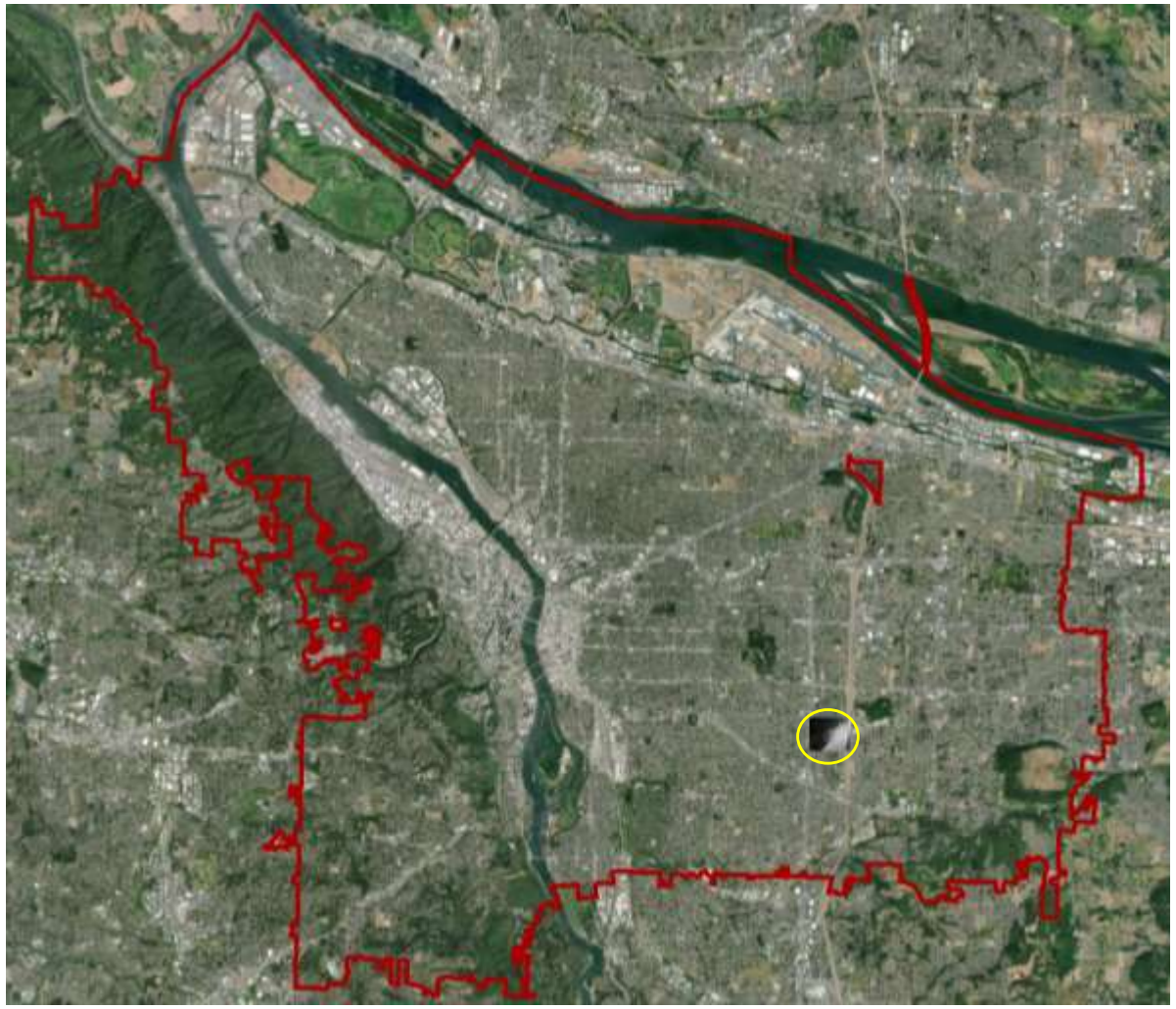
Lower Slope

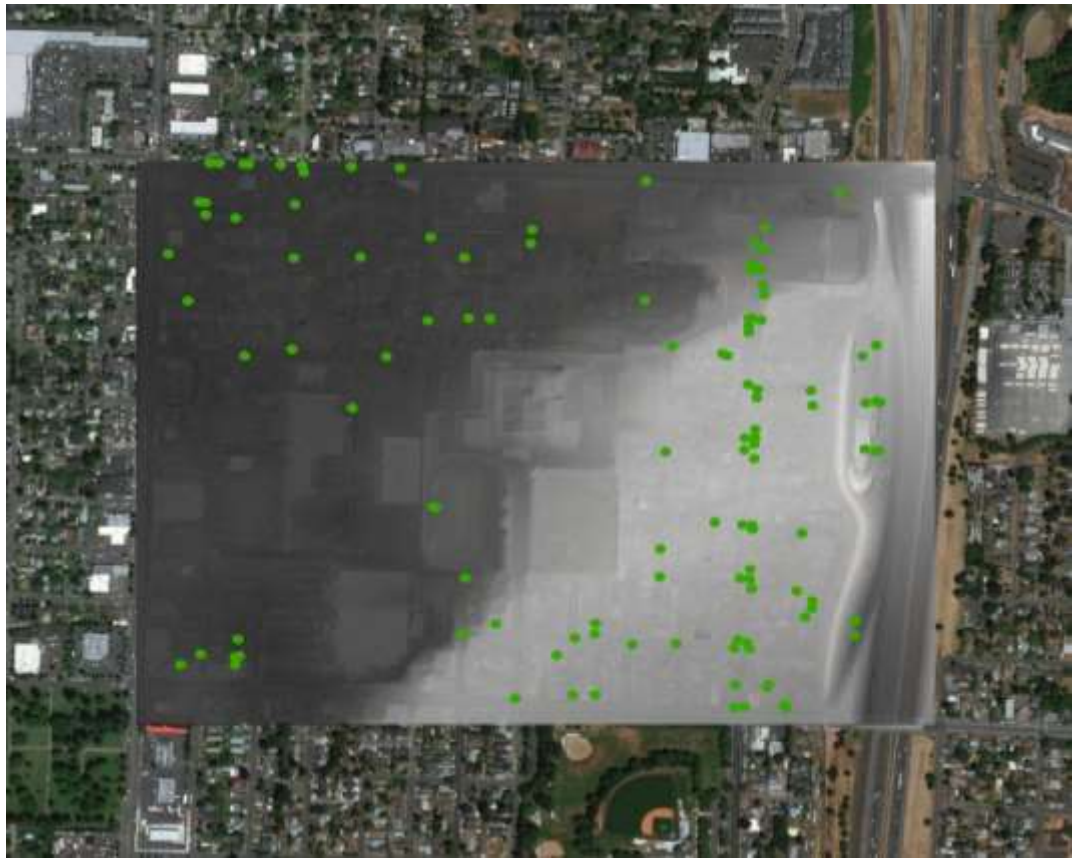


Green Infrastructure Facilities: 27

Study Area 2 – Census Tract 8301

Higher Slope





Green Infrastructure Facilities: 130

Methods

Simple

- Initial raster manipulation
  - Extract values to points (GI)
  - Point to raster

GI as 5-foot sinks

  - Null values = 0,
    - Con(IsNull("inputraster"),0,"inputraster")
  - Everything else = 5
    - Con(inputraster>0,5,0)

Weighted

  - Weight GI raster as -100
    - Reclassify Tool
  - Subtract GI raster from DEM Fill

DEM w/ 5-foot GI Sinks

Methods

- Flow direction
- Flow accumulation
- Select cells with flow accumulation > 2,000
- Convert to polyline
- Intersect GI (3m buffer of points) with

  flow lines (polyline)

Simple

GI as 5-foot sinks

Weighted

Table

intersect1

Gen_Type	ACWA_ID	ACWA_Type
GREEN STREET FACILITY	5	Swales - Vegetated Filter Strips
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GREEN STREET FACILITY	5	Swales - Vegetated Filter Strips
CHANNEL - WATER QUALITY SWALE	5	Swales - Vegetated Filter Strips
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SEDIMENTATION MANHOLE	7	Sediment Manhole
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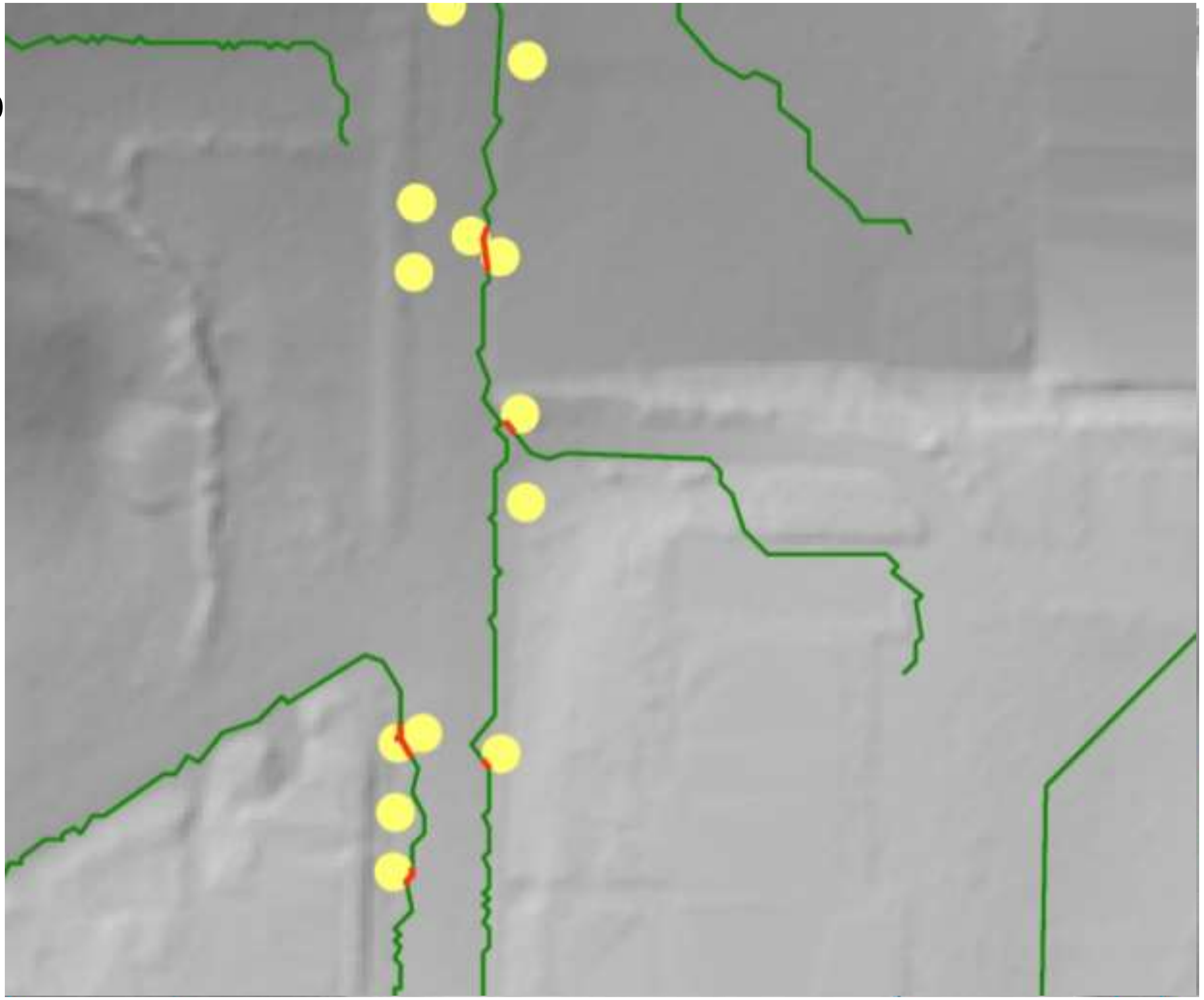
1 (0 out of 49 Selected)



Flow Lines and 3m GI Buffers Intersections

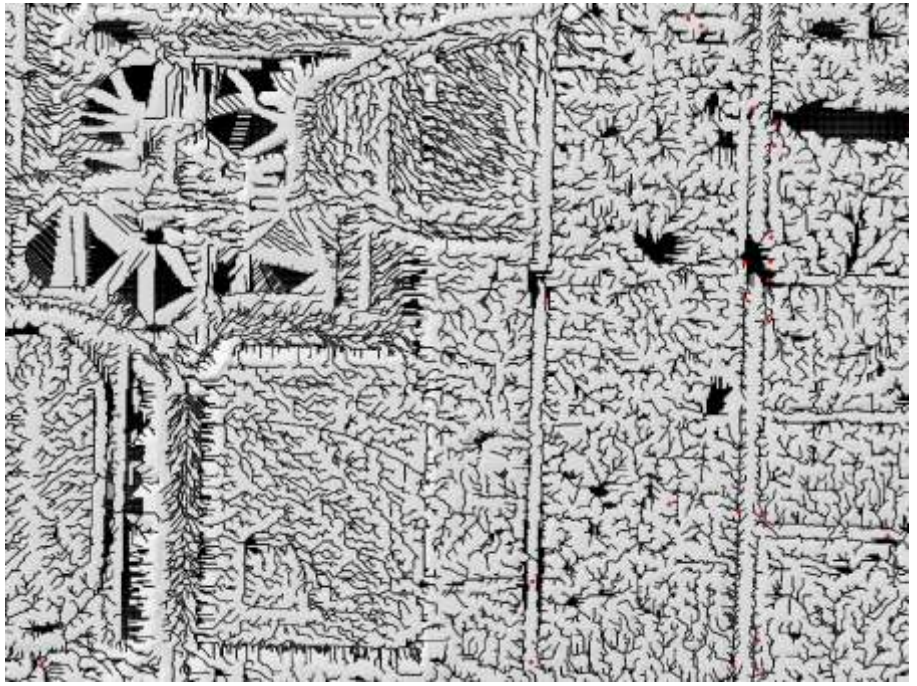
Results

Census Tract	Total Number of GI Facilities	GI Facilities that intersect flow lines (Simple)	% of GI Facilities that intersect flow lines (Simple)	GI Facilities that intersect flow lines (Weighted)	% of GI Facilities that intersect flow lines (Weighted)	GI Facilities that intersect flow lines (5-foot GI Sink)	% of GI Facilities that intersect flow lines (5-foot GI Sink)
1102	27	10	37%	10	37%	10	37%
8301	130	49	38%	49	38%	47	36%

- No significant difference based on slope characteristics.
- Only about 1/3 of GI facilities are located within 3 meters of a flowpath.

Discussion

- Two extreme scenarios
  - No change to Raster (Simple)
  - No Data
- Two middle ground scenarios
  - 5-foot GI Sink
  - Weighted
- Further Research
  - Run on entire city
  - Different flow accumulation threshold
  - Find and use actual stormwater flow values
- Lessons Learned
  - Lower resolution DEM would be more effective
  - Limited by analyzing small study areas
  - Build a model
  - Use a geodatabase
  - All facilities in polygon form



Resources

- Environmental Protection Agency: https://www.epa.gov/green-infrastructure/what-green-infrastructure
- Portland Bureau of Environmental Services: https://www.portlandoregon.gov/bes/article/129057
- Census Tract Data: RLIS (2011-2015 Estimates)
- Green Infrastructure: Bureau of Environmental Services
- High Resolution DEM: RLIS