Stormwater System Plan
Water Quality Risk Assessment

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01.

Project Description

Project Description

- Goal: Develop a plan to guide investment in Portland's stormwater system over the next 30 years.

- Context: Portland just finished a $1.4B project to control sewer overflows and manage stormwater in the central portions of the city. The next phase of stormwater investments will focus on the surface streams and stormwater infrastructure outside the combined sewer area.

- Approach: An asset-based prioritization, focused on identifying risk and then evaluating options to reduce risk. Rely on existing asset inventories and available terrain and landuse data sets.

Project Description

Outcomes: Stormwater flow and volume estimates and annual pollutant load estimates for all stormwater assets in the city inventory

- ~100,000 stormwater pipes and culverts
- ~10,000 mapped stream segments
- ~70,000 inlets / catchbasins
- ~20,000 stormwater treatment facilities
- 3’ grid cell digital elevation model, 600,000,000 cells

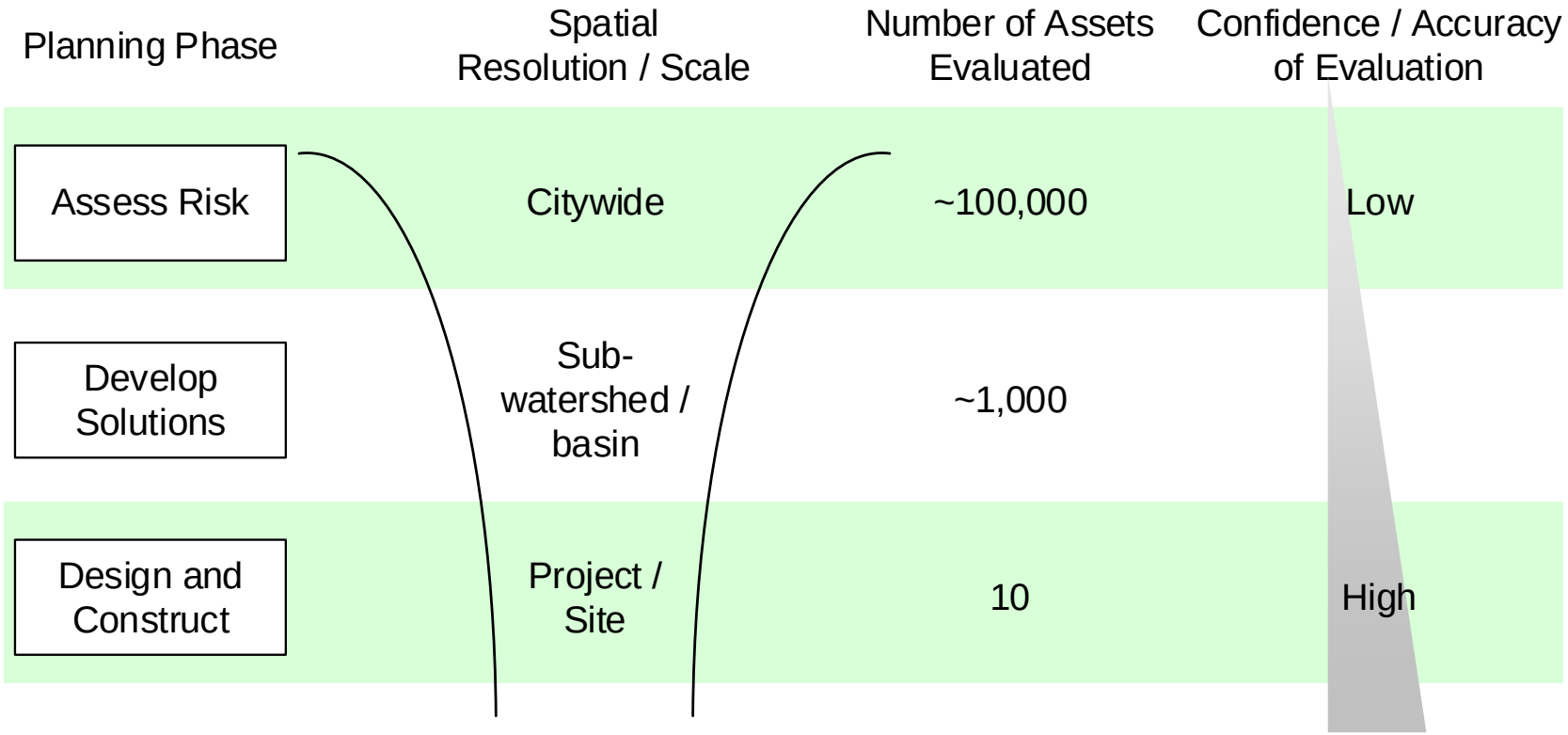
Project Description

Challenges:

- Incomplete asset inventory
- Spatial inaccuracies in inventory
- Corrections being made constantly
- Large data sources

Strategic Commitments	Stormwater Services
Stormwater is managed to meet regulations in a watershed context to achieve:	*Services delivered to the customer - What we manage to reduce risk & improve conditions:*
protection of public health and property and improvement of public safety	• sanitary sewage releases • erosion and landslide hazards • localized/nuisance flooding • **groundwater contamination**
protection of biological communities and improvement of ecological function	• loss of habitat • **contamination of surface water and sediment** • disruption to hydrologic cycle
support of community needs	• deficiencies that impede community improvements

Asset Management and Risk Assessment



Asset Management and Risk Assessment

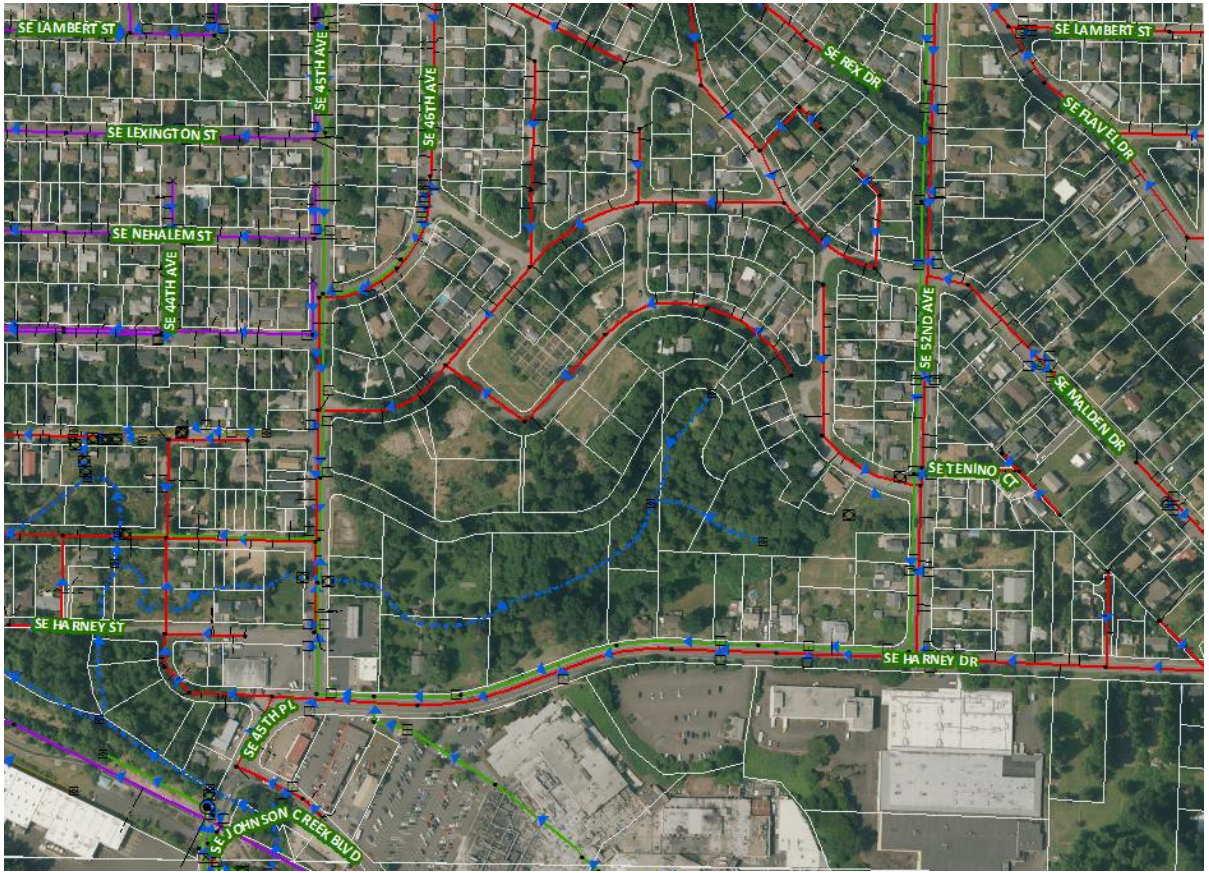
$$\boldsymbol{Risk = Consequence\ of\ Failure * Likelihood\ of\ Failure}$$

- Risk of a pollutant washing in to a receiving water
  - Likelihood: How much pollution washes off a given surface?
  - Consequence: How susceptible is a receiving water to that pollutant?
  - Assign scores to likelihood and consequence, and calculate the relative water quality risk.

02.

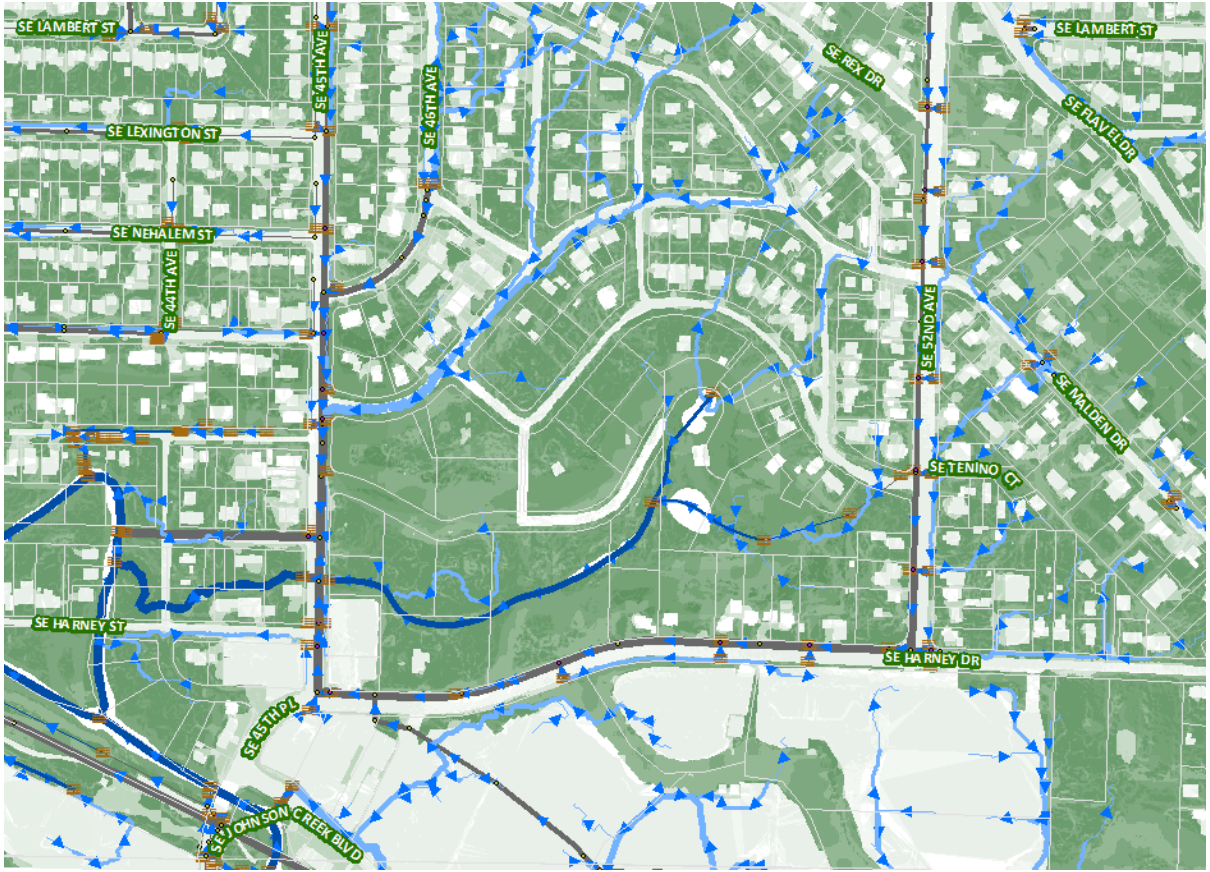
Maps and Data Source

Asset Inventory Base Layers

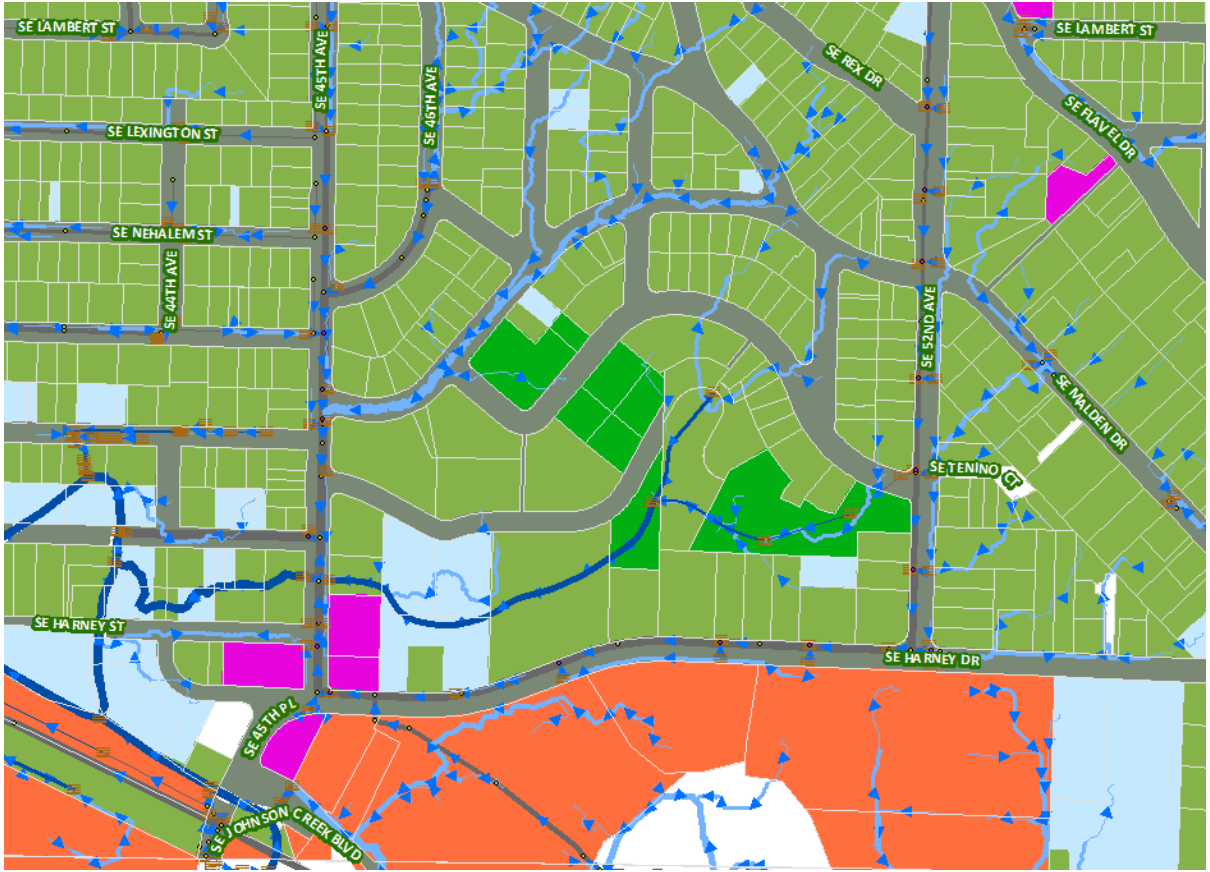


Supplement the Base Inventory

Estimating Volume and Flow Rate



Landuse Classification



03.

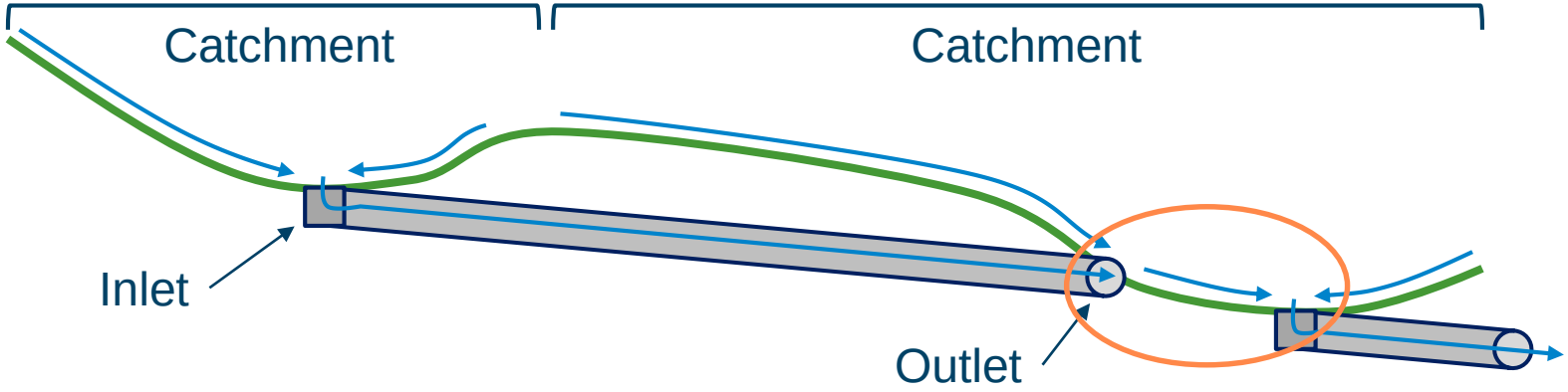
Process Details

Overview

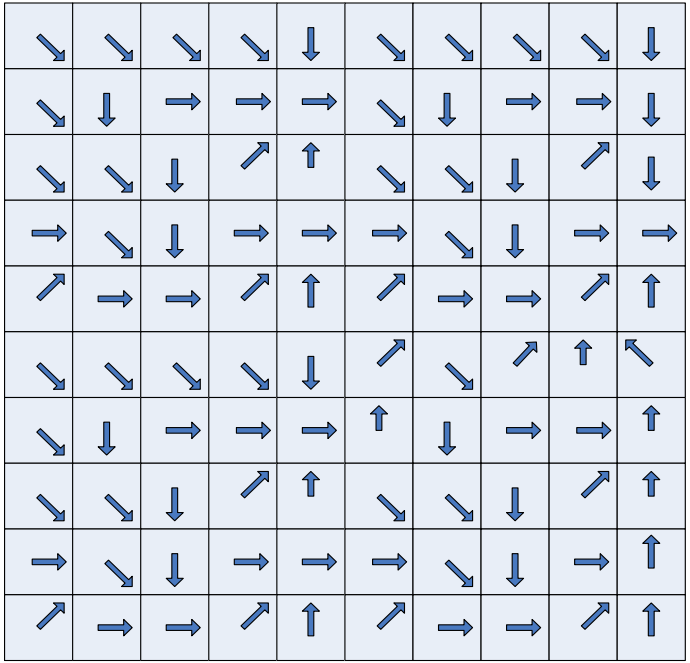
- Framework
  - Extract flow paths above and below ground
  - Flow accumulation and “decumulation”
- Two worlds combined
  - Raster: Above ground hydrology
  - Vector: Below ground infrastructure
  - Combined: Geometric network of stormwater flows

Linking Surface and Subsurface

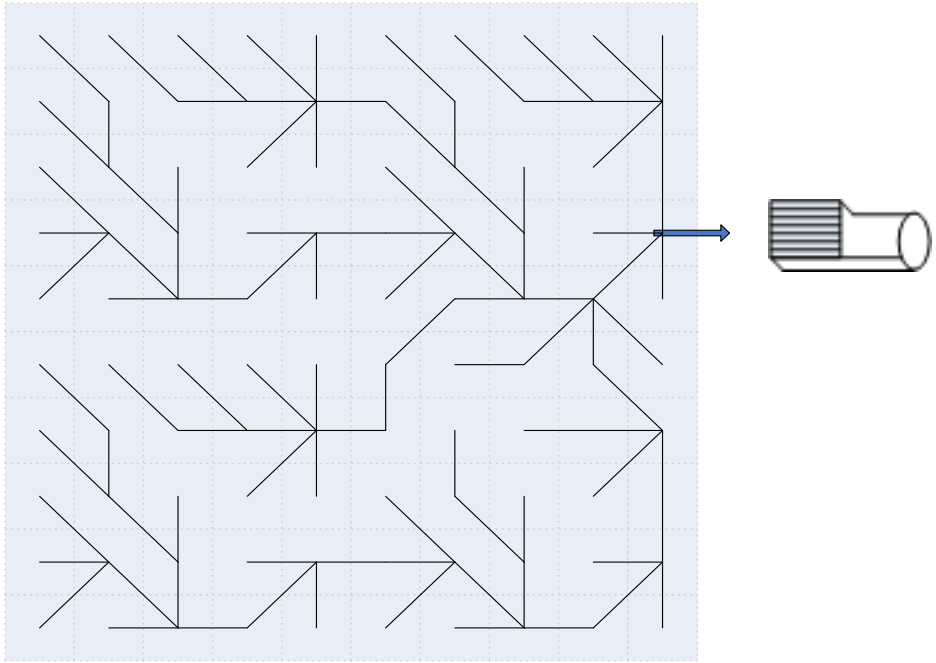
- Trace surface flow along paths of steepest descent
- Linking of overland and underground flow: Inlets and Outlets
- Each *inlet* has a *catchment* area.
- *Outlets* flow into the catchment of another inlet or out of the system.



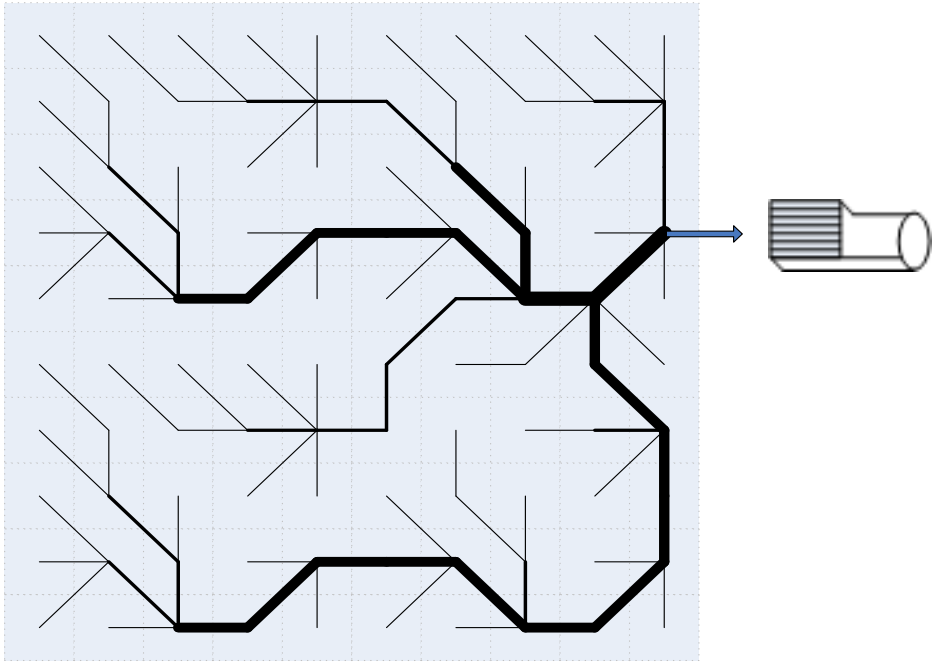
Flow Accumulation - Surface



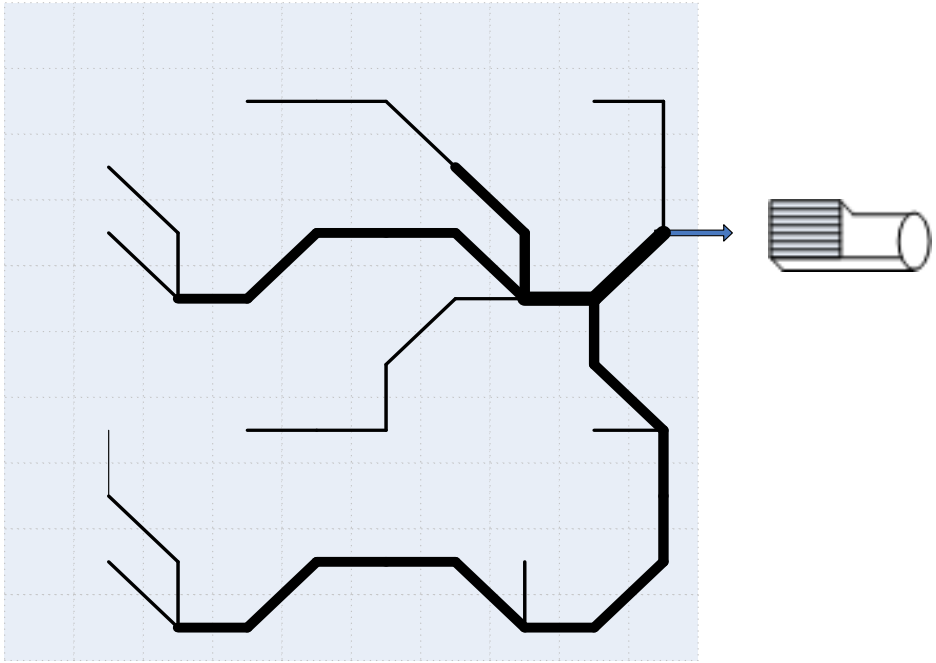
Flow Accumulation - Surface



Flow Accumulation - Surface

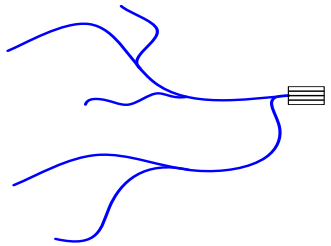


Flow Accumulation - Surface



Flow Accumulation: Surface

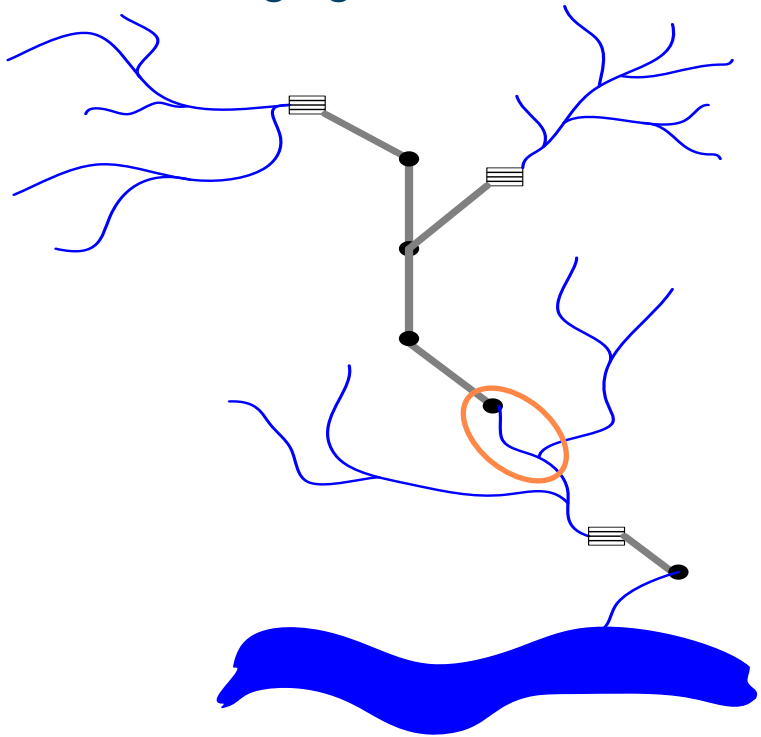
Zooming out a bit more…



Note the gridded nature of the data starts to become obscured as we zoom out

Linking Surface and Subsurface

We can combine that surface channel identification and tracing algorithms with a pipe network tracing algorithm



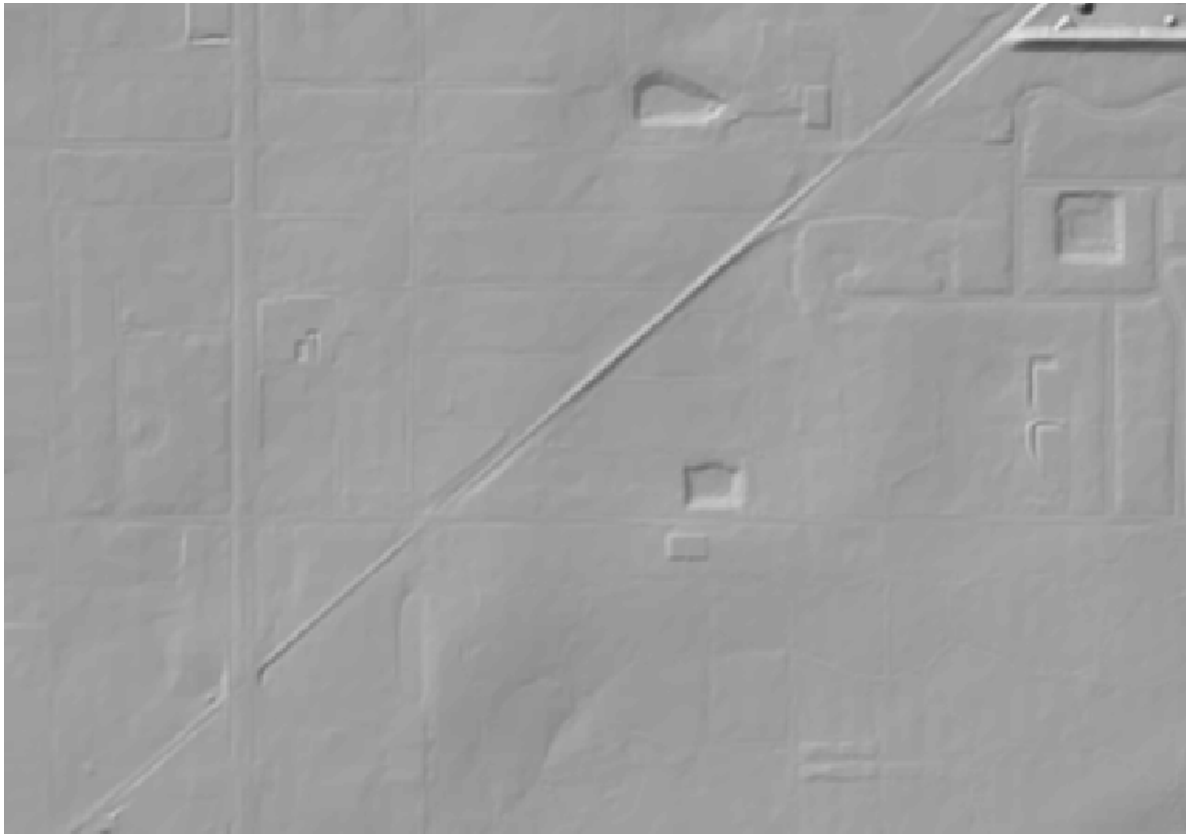
Filling of DEM

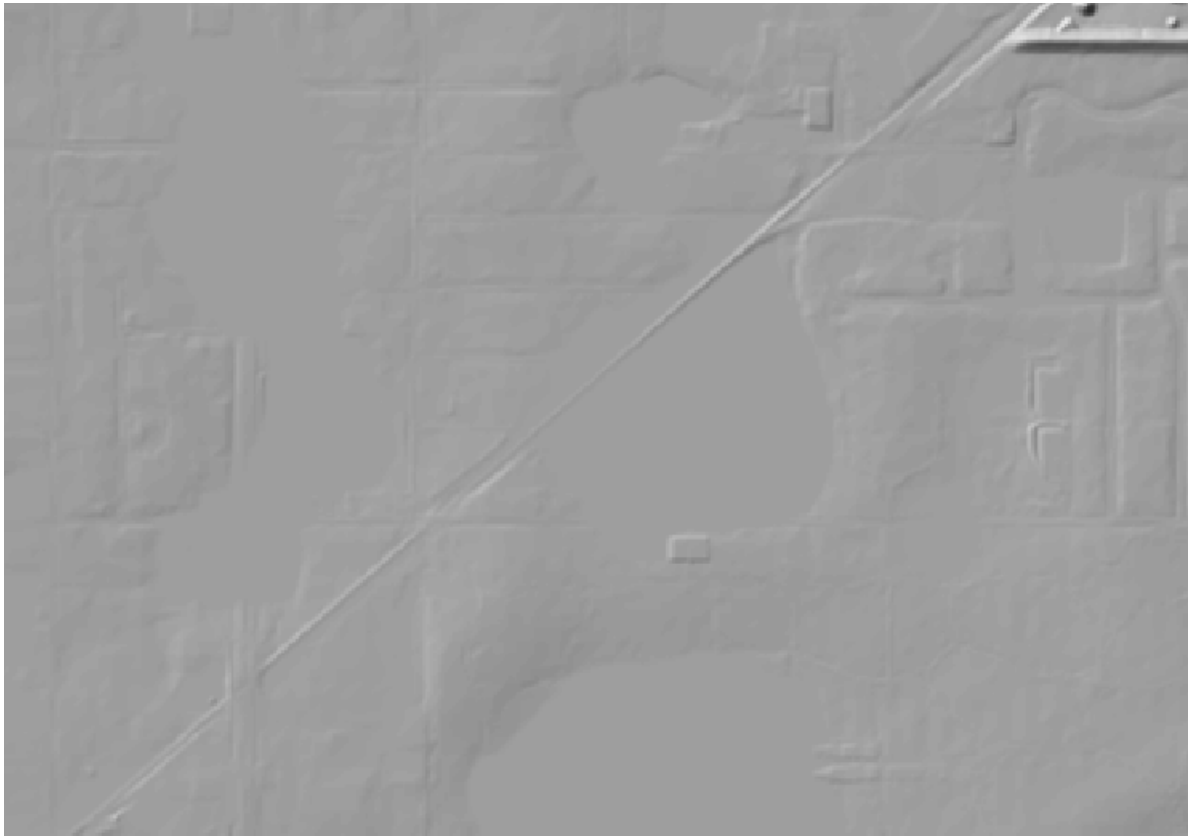
Goal:

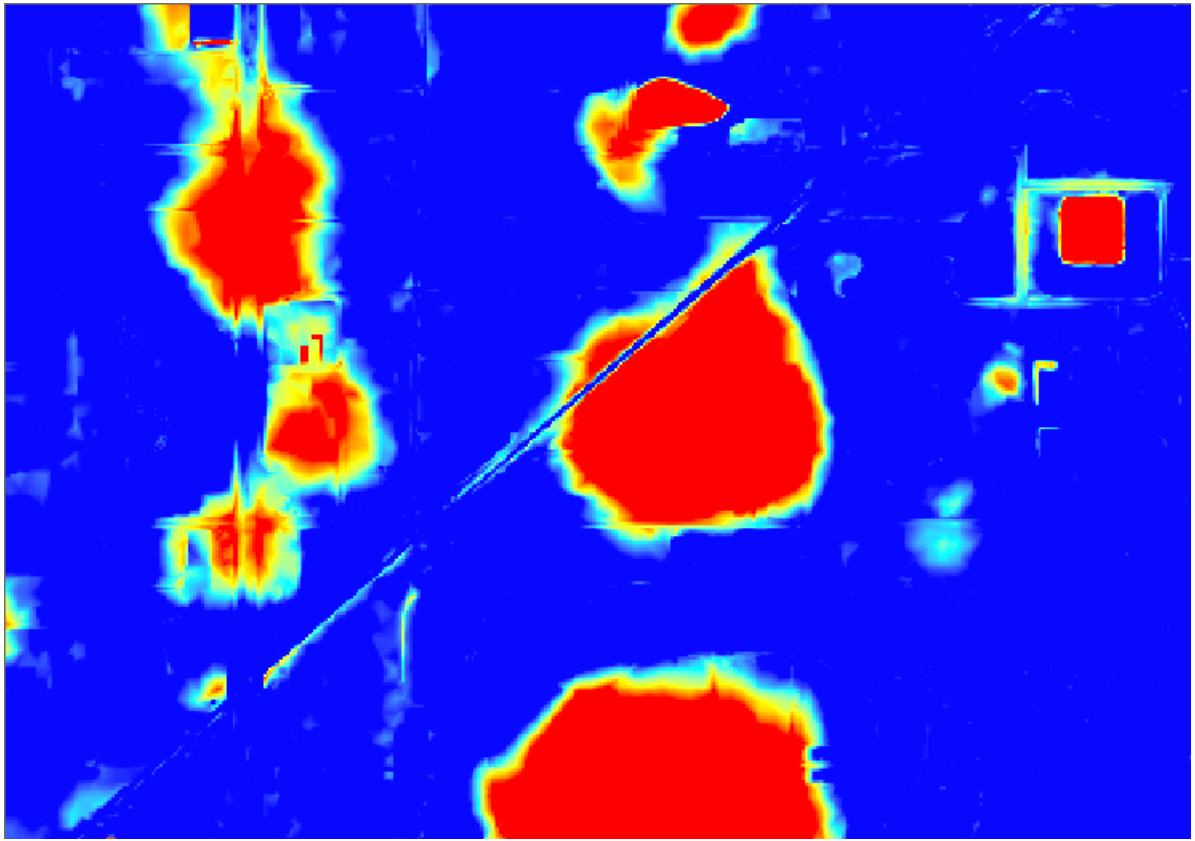
- Prevent filling of sinks which are “true” sinks.
- Allow filling for other anomalies.
- Stop flow paths at inlets.

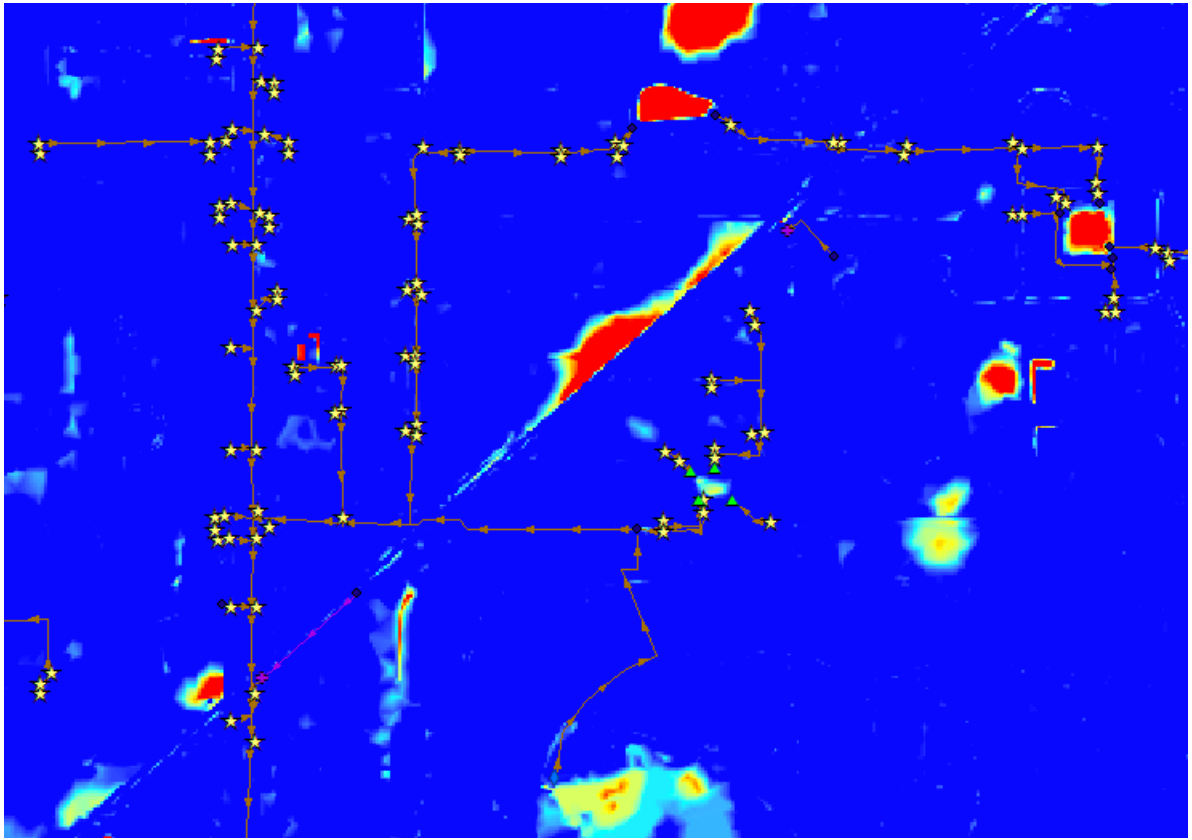
Solution:

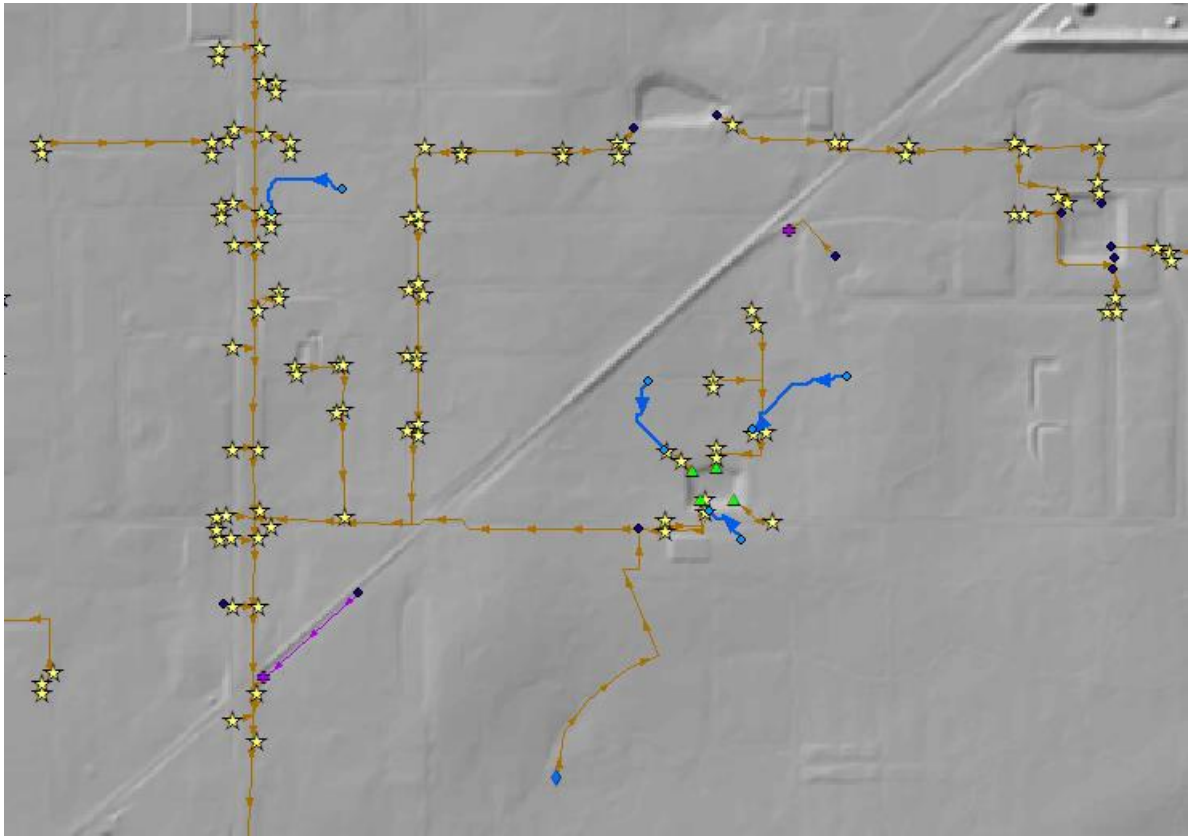
- Punch “holes” into the DEM.
- Set location of inlets to “No Data”.











Water Quality Load Accumulation

- Tracking of multiple pollutants using landuse loading values.
  - TSS, TP, BOD, E Coli, PbD
- Accumulation of loads through system.
- Reduction of loads through Pollution Reduction Facilities.
  - Concentration based
  - Flow volume reduction
  - No increase in loads

Results

- Volume and flow rate estimates
- Load and concentration estimates for every asset in the system
  - Pipes, ditches, culverts, streams can all be queried to determine water quality risk
  - Sumps, swales, filters, can all be queried to determine total load reduction
- Classification system defining susceptibility of an asset to a pollutant

Total Risk Maps

Implementation

- Technologies:
  - ArcGIS (ArcObjects/Geoprocessing)
  - Custom Code (Eclipse Public License – Google Code)
  - TauDEM (David Tarboton, Utah State University)
- Languages:
  - C#, Python
- Automated Build:
  - Windows Batch, Windows Scheduler

Thank you

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Source Code: https://code.google.com/p/besasm-swsp/
TauDEM: http://hydrology.usu.edu/taudem/taudem5/index.html