Identifying and Remediating Potential Conflicts between Denver's Sanitary and Storm Sewer Systems:

Supporting the Mayor's Water Quality Initiative

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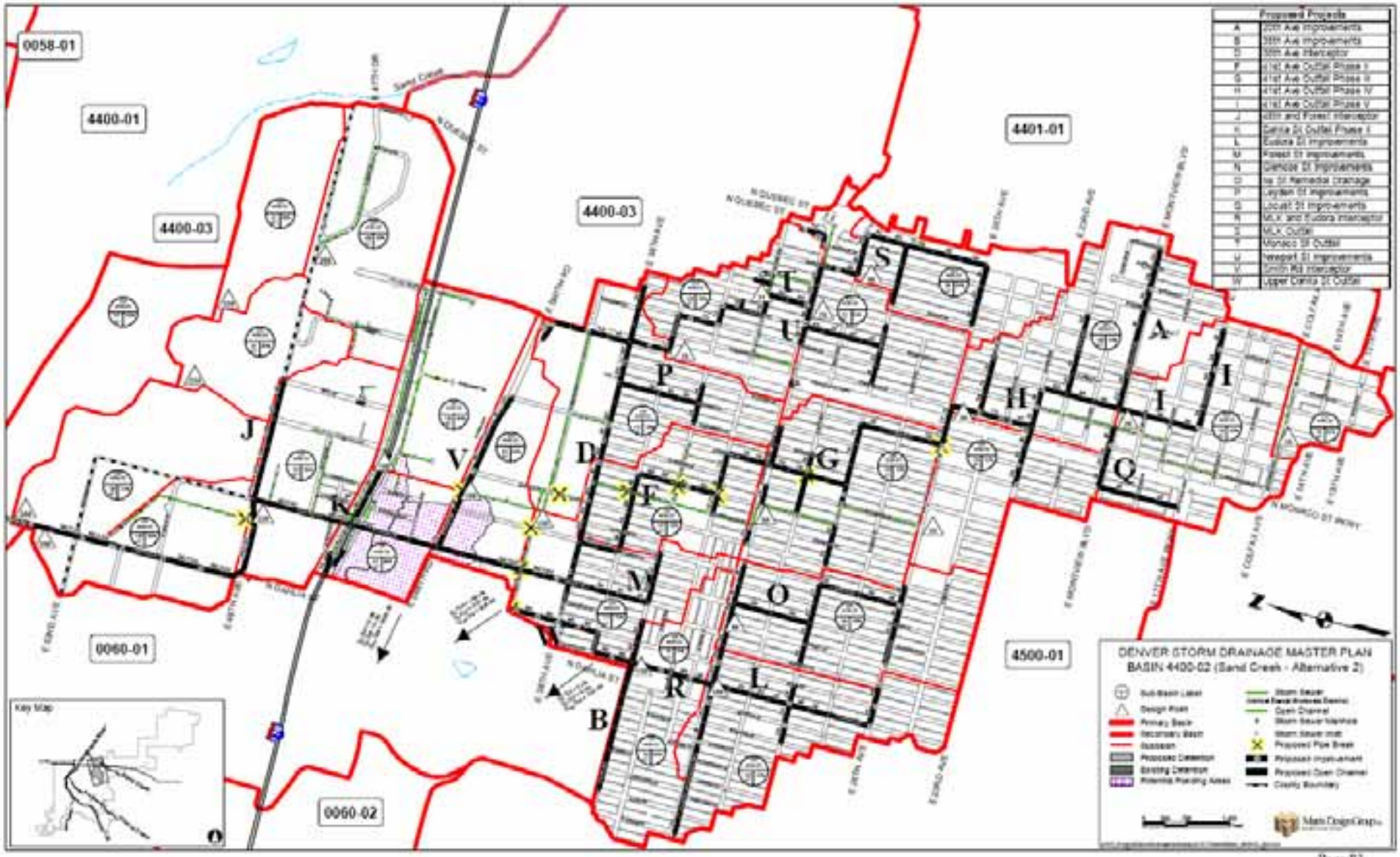
Presentation Overview

- Context/Background
- Network and Spatial Analysis
- Implementation and Use
- Future Work

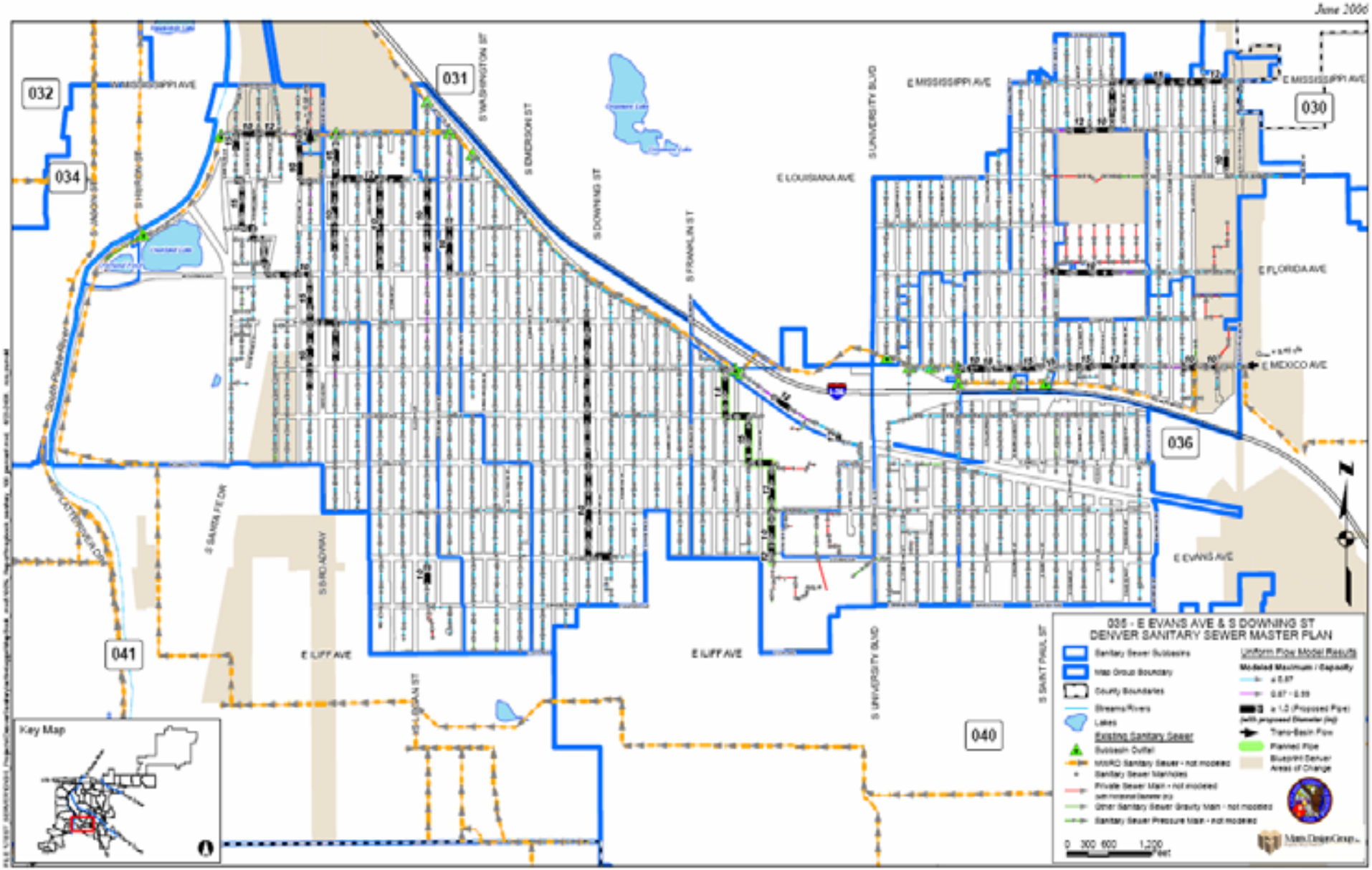
Business Drivers

- Mayor's Water Quality Initiative, part of the "Greenprint Denver" project.
- Sanitary and Storm Master Planning.
- CityWorks work order system.
- Aging infrastructure.
- Water Quality permitting.

Storm Sewer Master Plan



Sanitary Sewer Master Plan



GIS Layer Background

- Starting Point: ESRI Wastewater GeoDB Model
- Customization: Feature classes and subtypes
- Conversion:
  - 310K edges and 338K junctions = 648K features!
  - 68K other features and 252K pieces of Annotation
  - Contracted to a conversion vendor, in-house QC
  - Took 1 year to complete
  - Geometric Network used to provide connectivity

Denver Sewer/Stormwater UML Model

PWWMD_Storm_Facility

Annotation Layers:

PWWMD_INF_STMMAINMISC_T
PWWMD_INF_STMMAINREHAB_T
PWWMD_INF_STMGRAVPIPEINFO_T
PWWMD_INF_STMPRPIPEINFO_T
PWWMD_INF_STMGRAVUPINVERT_T
PWWMD_INF_STMPRUPINVERT_T
PWWMD_INF_STMGRAVUPDWNINVERT_T
PWWMD_INF_STMPRUPDWNINVERT_T
PWWMD_INF_STMTAPMISC_T

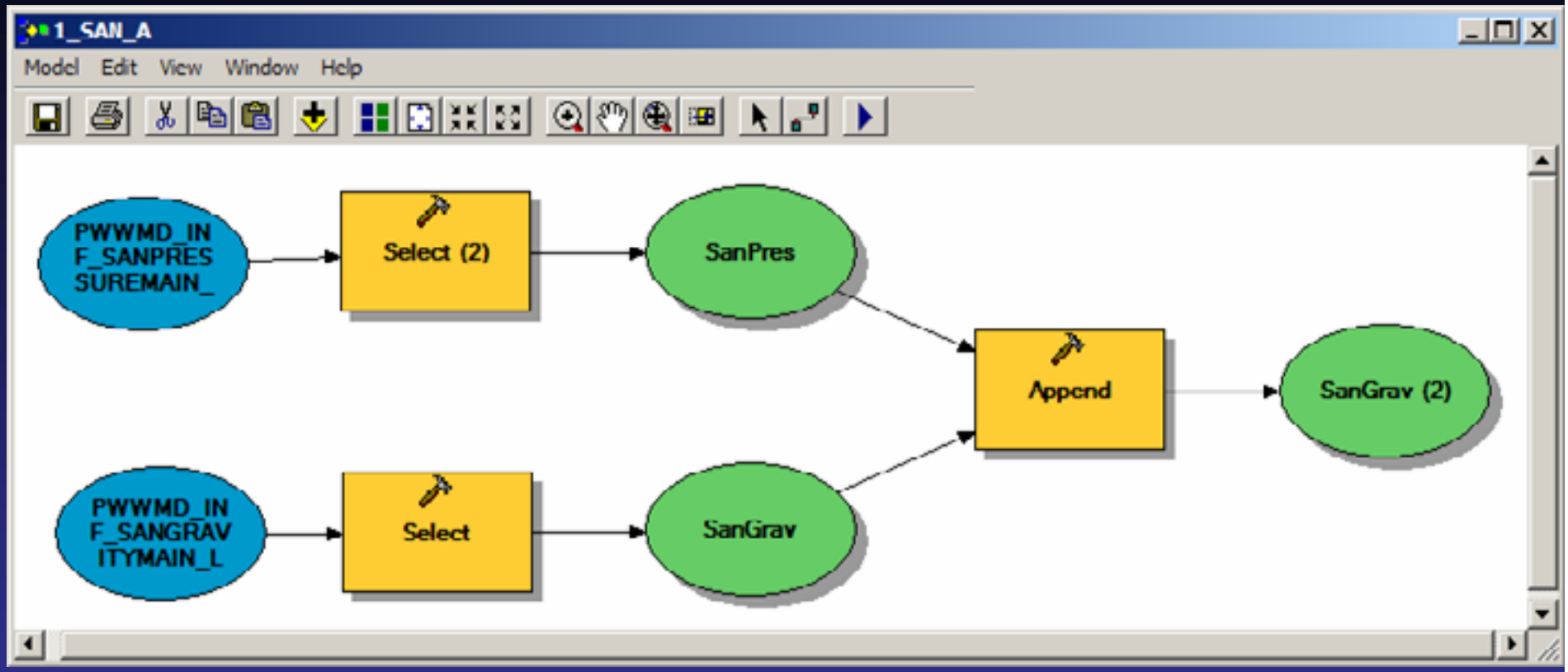
Network Analysis

- Network traces to verify connectivity
  - Flip arcs digitized opposite of flow direction
  - Snap arcs/edges to junctions where needed
  - ID abandoned facilities not coded as such
  - Assign each main to surface water outfall
- Intersection of Sanitary and Storm Mains
- Risk rating of intersections based on Z
- Development of an intersection layer

Intersection Model

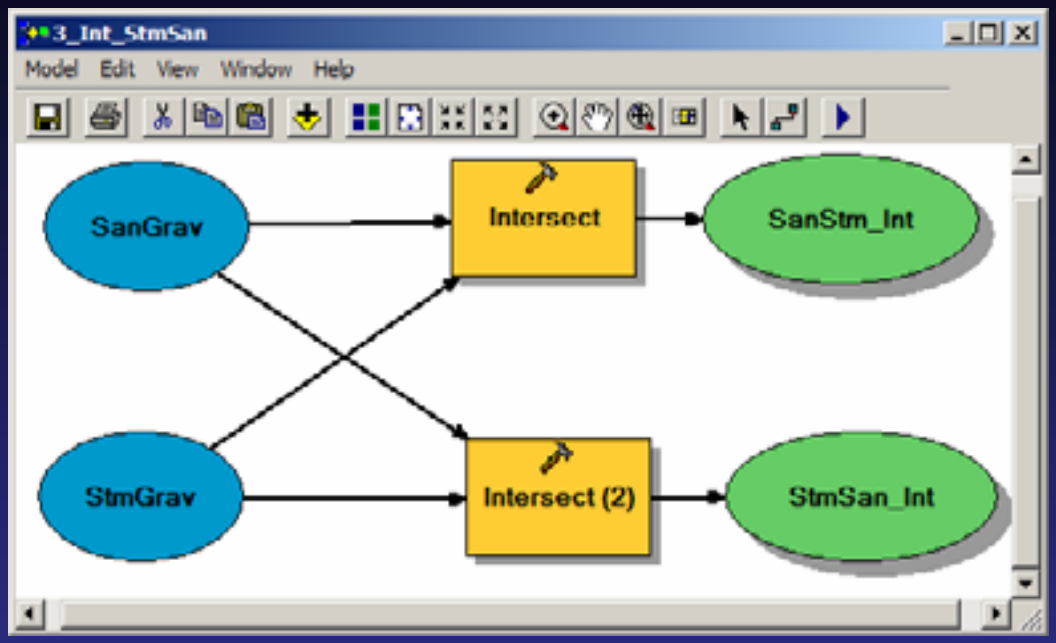
- Preprocessing - Need 3 of 4 data items:
  - Upstream invert elevation
  - Downstream invert elevation
  - Pipe slope
  - Pipe length
  - 4th can be calculated from other 3

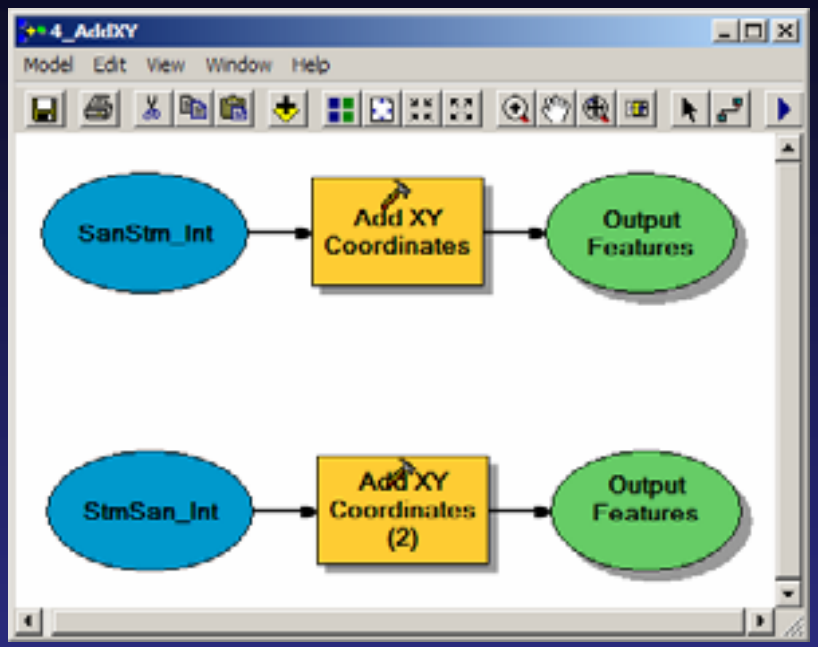
Geoprocessing – Subsetting



- SanPres_Select: [OWNER] = 'DPUB'
- SanGrav_Select: ([OWNER] = 'DPUB') AND ([LIFECYCLESTATUS] = 'Active') AND ([UNITTYPE] = 'Collector' OR [UNITTYPE]= 'Interceptor'
- Similar logic to subset Storm Pressure/Gravity mains

Geoprocessing – Overlay





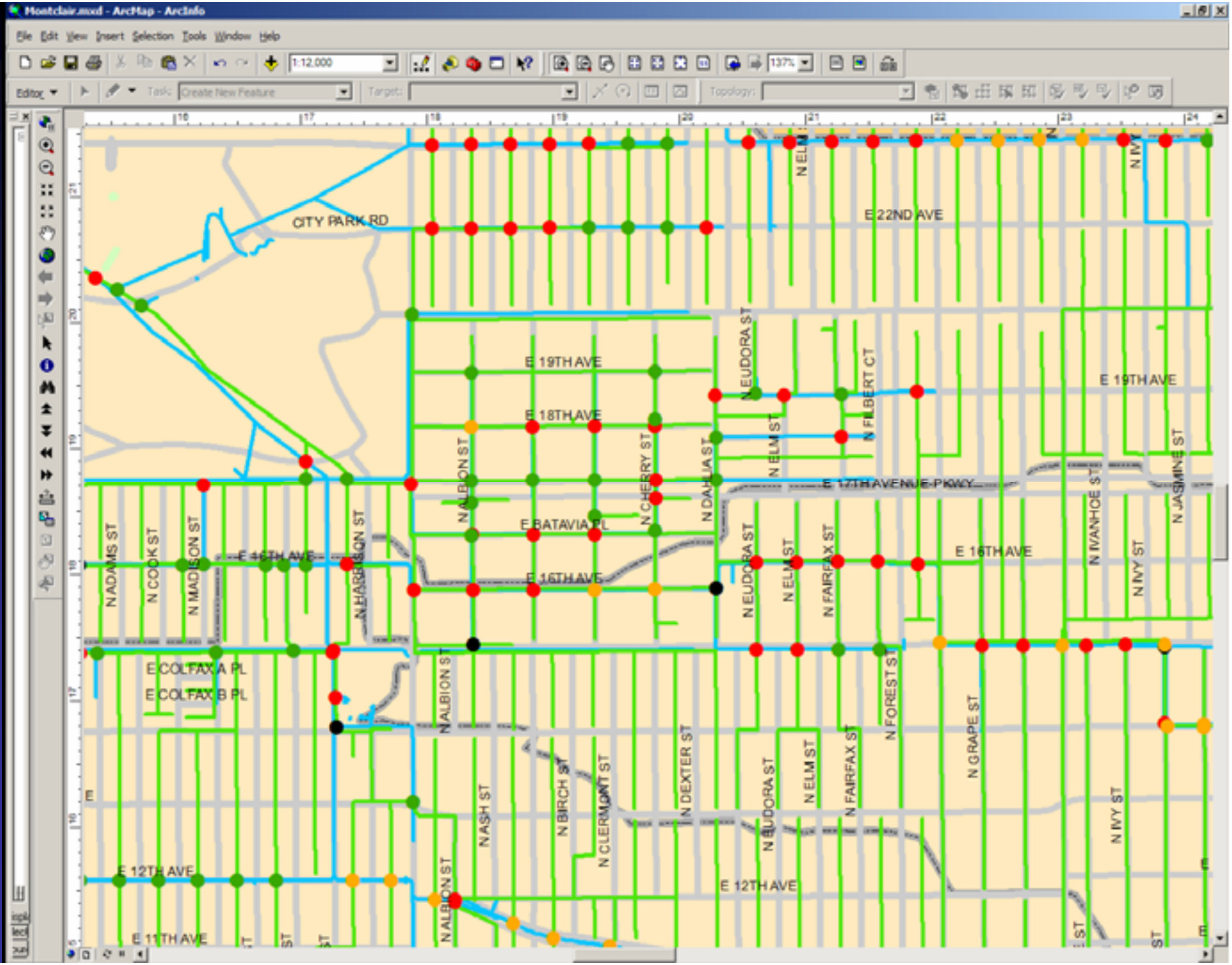
- Intersect order results in slightly different results, so it is done twice. Doing overlay both ways (Stm intersect San, San Intersect Stm), appending, and selecting the superset assures all San-Stm intersections are captured.
- Add x-y coordinates for conversion to tabular form and use of the location as a relational key

Tabular Postprocessing

- The two intersect results feature classes are appended into a new table (object class).
- Then, a summary, make table query is used to eliminate duplicate results and place unique locations into a new table.
- ArcMap is then used to convert these rows into an XY event class. The features in this are pasted into an empty template for the intersection feature class.

Relative Elevation Calculation

- Main elevations are calculated at intersections.
- The relative elevations are classified:
  - Sanitary over storm (potentially bad)
  - Sanitary even with storm (potentially VERY bad)
  - Sanitary below storm (All clear!)
- Relative elevations account for pipe diameters.
- “Even” means the bottom of one pipe is within 1 foot of the top of the other.
- These are potential penetrations of storm mains by sanitary mains, the worst possible case!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Editor
Task: Create New Feature
Target:
Topology:
CITY PARK RD
E 22ND AVE
E 19TH AVE
E 18TH AVE
E 17TH AVENUE PKWY
E BATAVIA PL
E 16TH AVE
E 12TH AVE
E 11TH AVE
E COLFAX A PL
E COLFAX B PL
N ADAMS ST
N COOK ST
N MADISON ST
N HARRISON ST
N ALBION ST
N CHERRY ST
N DAHLIA ST
N EUDORA ST
N ELM ST
N FILBERT CT
N FAIRFAX ST
N FOREST ST
N GRAPE ST
N IVANHOE ST
N IVY ST
N JASMINE ST
N ASH ST
N BIRCH ST
N CLERMONT ST
N DEXTER ST

Implementation and Use

- Investigation Priorities.
- Work Order Development.
- Field Inspection Protocols.
- Environmental Reporting.

Investigation Priorities

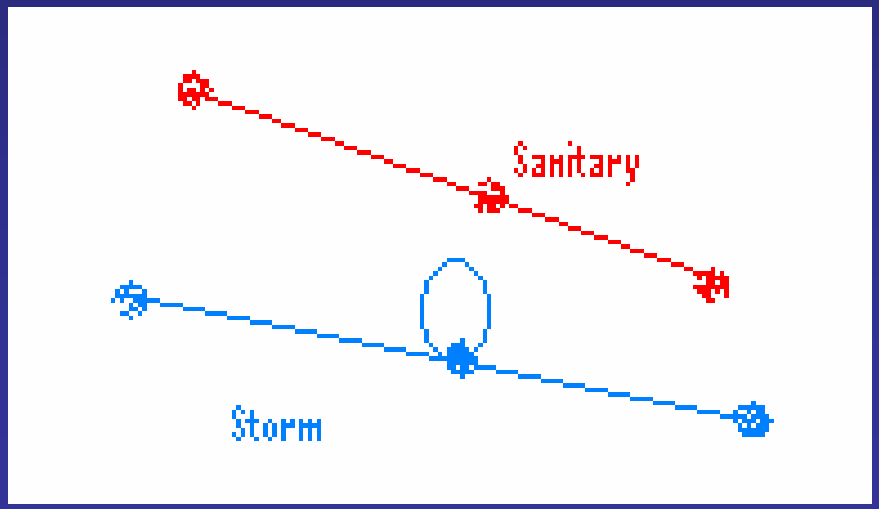
- Top Priority: Potential penetrations of Storm by Sanitary.
- Second Priority: Sanitary over Storm.
- No work required for Storm over Sanitary.

Work Order Development

- Sewer Facility GeoDatabase used as “assets” by Azteca CityWorks.
- Work orders are generated for even and above cases using standard inspection protocols.
- Work order tracking.
- Generation of child work orders where slip lining, repair or replacement are required.

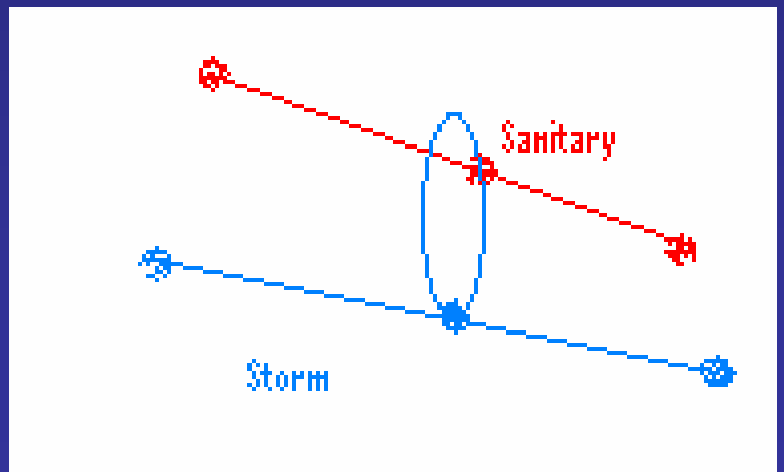
Field Inspection Protocols

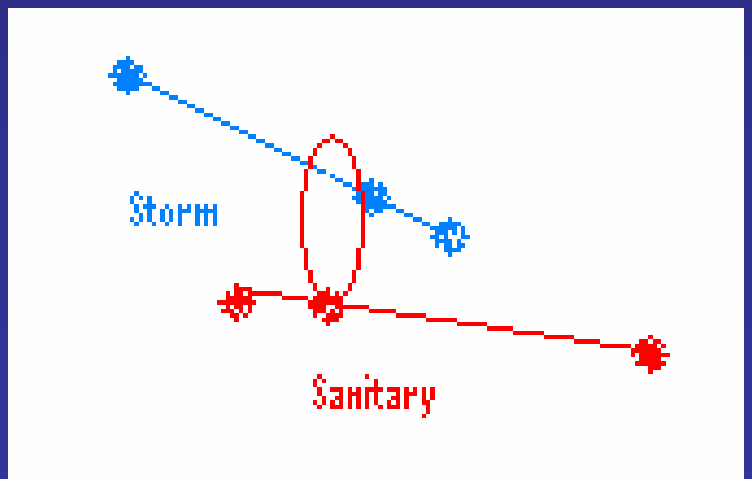
- Sanitary over storm:
  - TV Inspect both intersecting mains.
  - Pressure test and seal sanitary joints if needed.



Field Inspection Protocols

- Potential Penetrations:
  - TV Inspect both intersecting mains.
  - If a penetration is observed, add a child work order for additional work to be completed later.
  - If there is no penetration, pressure test and seal sanitary joints if needed.





Environmental Reporting

- Reports are generated for State and Federal regulatory agencies.
- Internal administrative reports:
  - Current and future workload/assignments.
  - Maintenance and administrative costs.
  - Water quality improvement.

Future Work

- Articulation of the drainage network by addition of missing surface features such as ditches, gulches and streams.
- Development of a GIS model for parallel sanitary and storm facilities:
  - Within 5’ buffer distance.
  - Risk rated (Relative elevation).
- Non-point source pollutant modeling, including sample analysis of storm water runoff.

Conclusion

- GIS Rocks for spatial water quality analysis.
- GIS is not just for mapping – lots of substantive modeling and analysis.
- Improving response time for environmental concerns.
- Doing a better job of managing analytical and remediation data while improving water quality and enhancing reports.
- Delivering on the Mayor's campaign promises to improve water quality in the South Platte River and Cherry Creek.

For further information:

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