Risk Management Issues Incorporated in Asset Management Practices

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Pre-Conference Seminar

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Common Statements Overheard

- We have about 500 main breaks a year
- Our CIP Budget was just lowered significantly
- We do not have enough money to fix the problems we currently have

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Current Situation

- 240,000 water main breaks/yr in USA
- January, 2009 – WSSC had 611 water breaks
- Midwest breaks increased from 250/yr to 2,200/yr over 19 years
- Baltimore, MD in 2003 had 1,190 main breaks: more than 3 per day
- Houston, TX has one main break every 51 minutes
- 2005 study correlated diarrhea with low water pressure events
- USGS estimates 1.7 trillion gallons of water lost/yr, at a cost of $2.6 Billion

In Many Systems, Risk is Increasing

- System is in worse condition than 20 years ago
- Main breaks are increasing
- Funding is limited
- CIP is very reactionary

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How is Risk Defined?

- Function of:
  - Likelihood of pipe failure
  - Consequence of pipe failure

Risk Classification		Consequence of Failure				
		1	2	3	4	5
Likelihood of Failure	1	Negligible	Negligible	Low	Medium	High
	2	Negligible	Negligible	Low	Medium	High
	3	Negligible	Low	Low	High	High
	4	Low	Low	Medium	High	Extreme
	5	Medium	Medium	High	Extreme	Extreme

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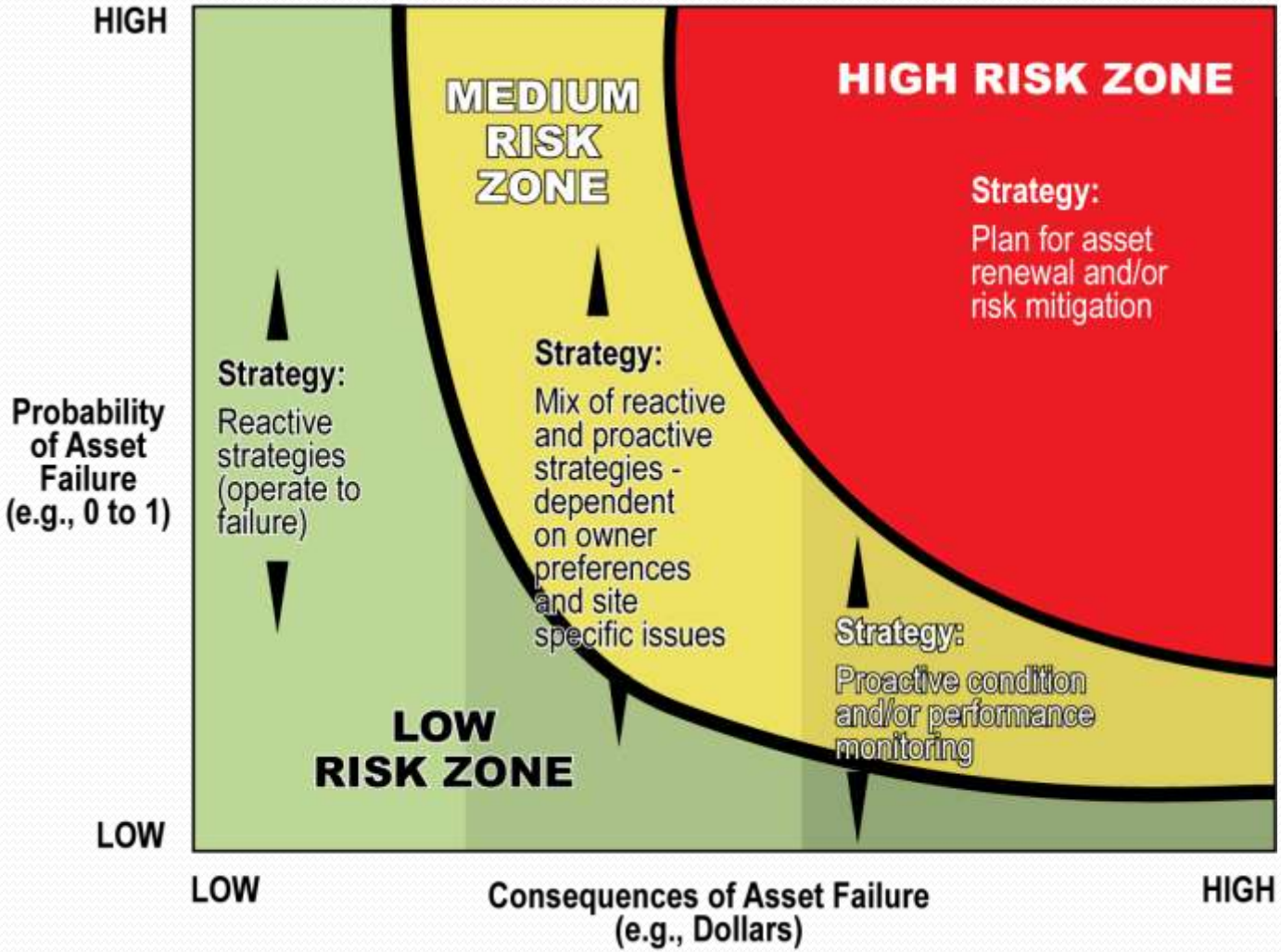
Risk Matrix Determines Inspection and Renewal Priority



Consequences of Failure

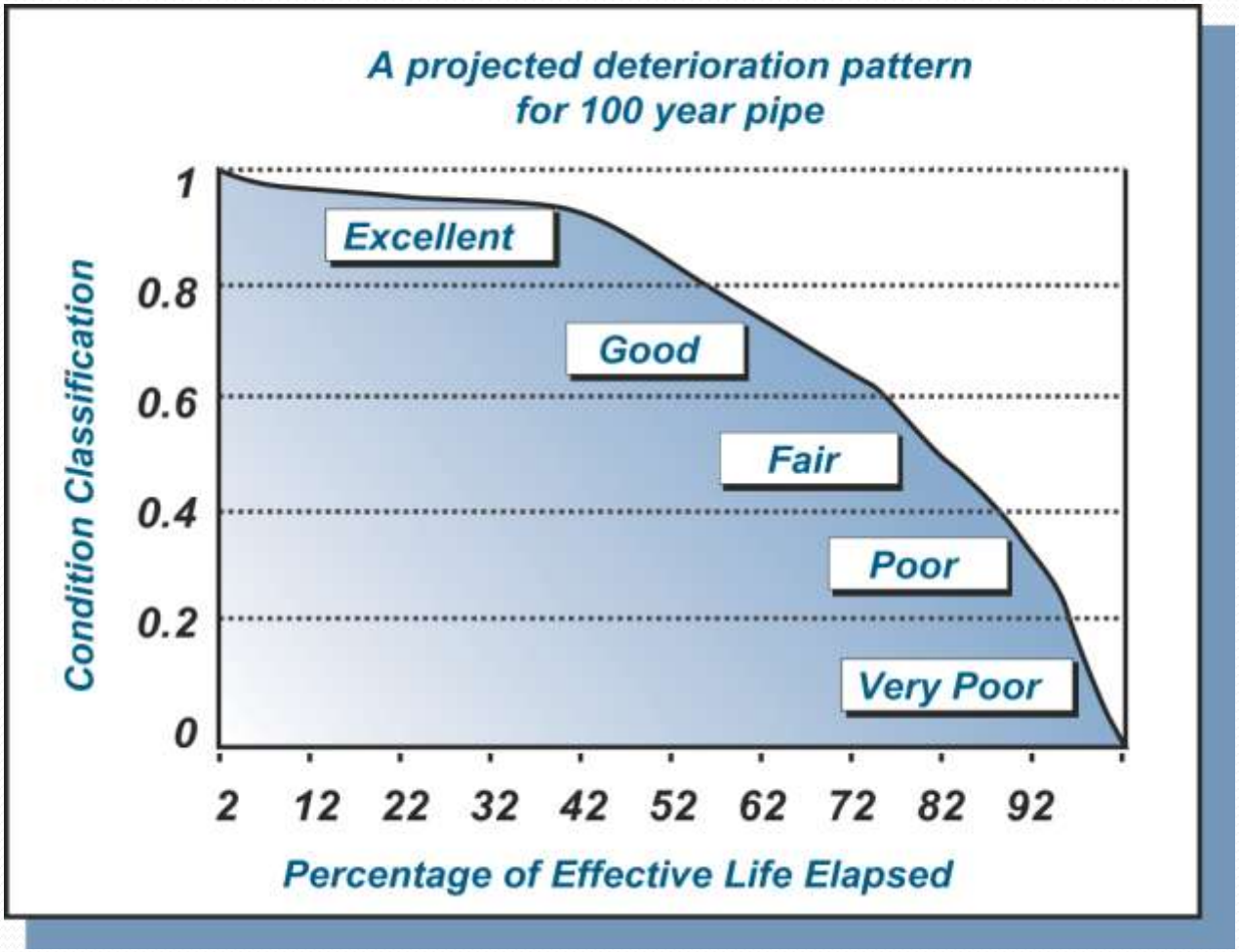
Likelihood of Failure

Infrastructure Failures

Infrastructure Failures

Sample Pipe Deterioration Curve

Pipes do not deteriorate at a constant rate



Variables:

Material,

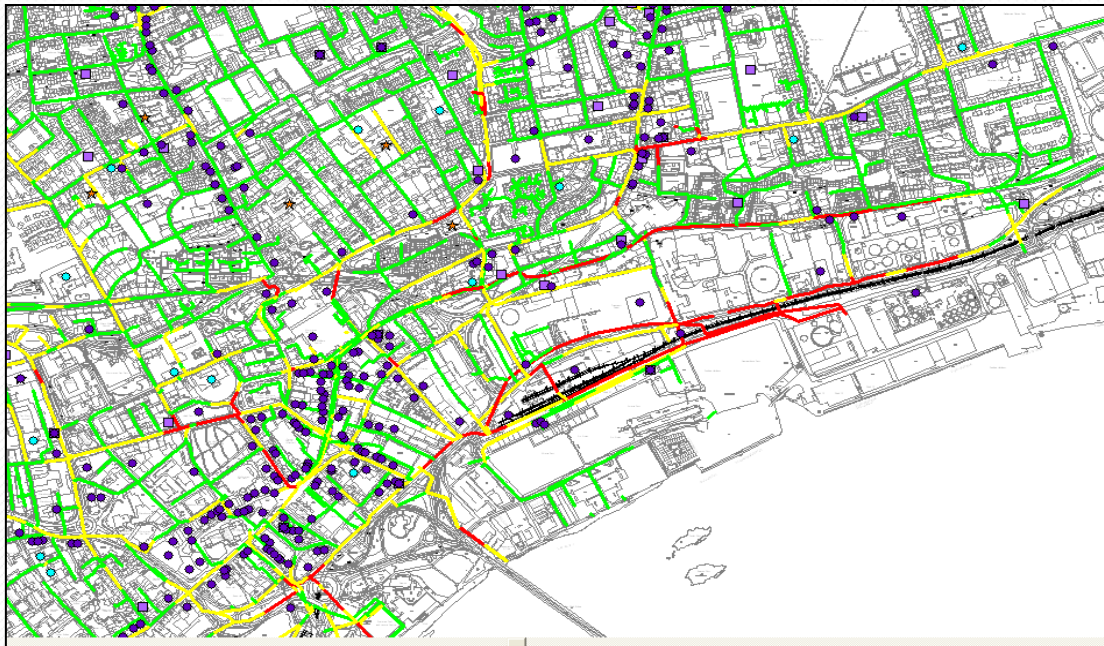
Environment:

- Soil condition
- Wrapping/Lining
- External Loading
- Excavation Activity
- Corrosion Protection
- Pipe Depth
- Pipe Pressure
- …

Risk Analysis Drives Capital Actions

- Integrate programs for enhanced decisions:
  - Hydraulic Model
  - GIS
  - Asset Management
  - Customer Databases
- Determine timelines
- Estimate budgets
- Use to attain additional funding

Risk Class	Capital Action
Extreme	Renew or Replace within 1 year
High	Renew or Replace within 5 years
Medium	Renew or Replace within 10 years
Low	Do Nothing
Negligible	Do Nothing



Bottom Line

The “find and fix” or purely reactive rehabilitation strategies are neither practical or fiscally feasible.

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What Has Been Done?

- Engineering firms develop one-off, proprietary solutions (excel, access, GIS, etc.)
- Difficult for clients to use / limited training
- No upgrade path
- No $$ vehicle for updates
- Original author(s) may leave, be promoted, or otherwise unavailable

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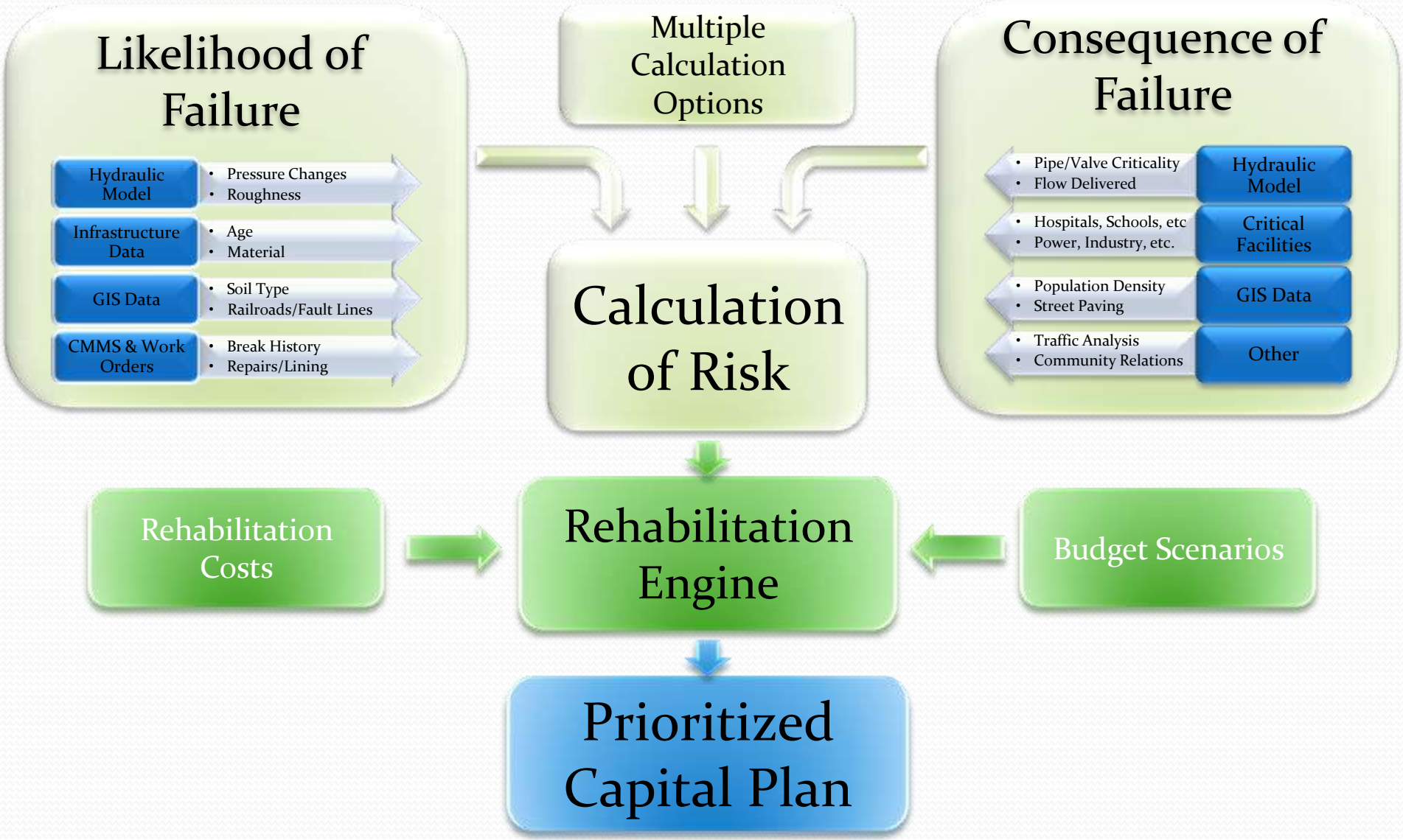
Risk-Based Planning: New Focus

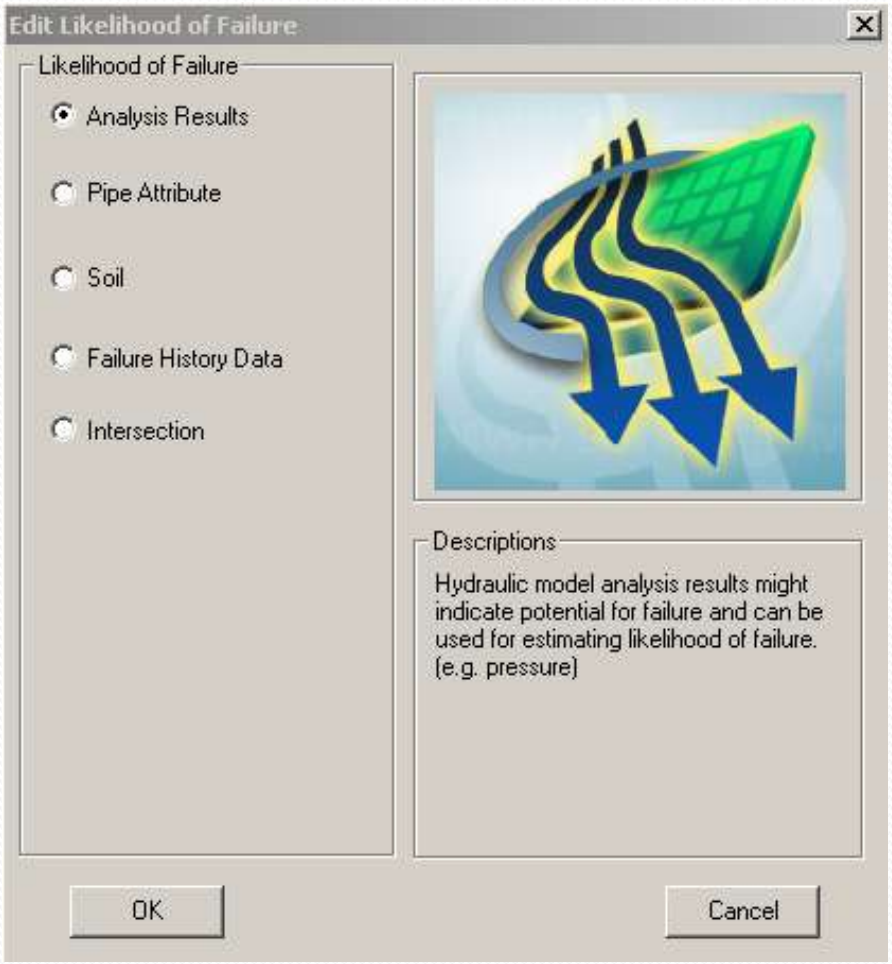
Historical Approach to Renewal Planning	
Backward Looking	• Budget Based on Last Year • Little knowledge of system risks
Reactive	• Projects determined as problems arise during the year
Budget Constrained	• Do as many projects as you can afford each year
Ignores asset and system risks	• Money is spent but overall risk may not have been reduced much

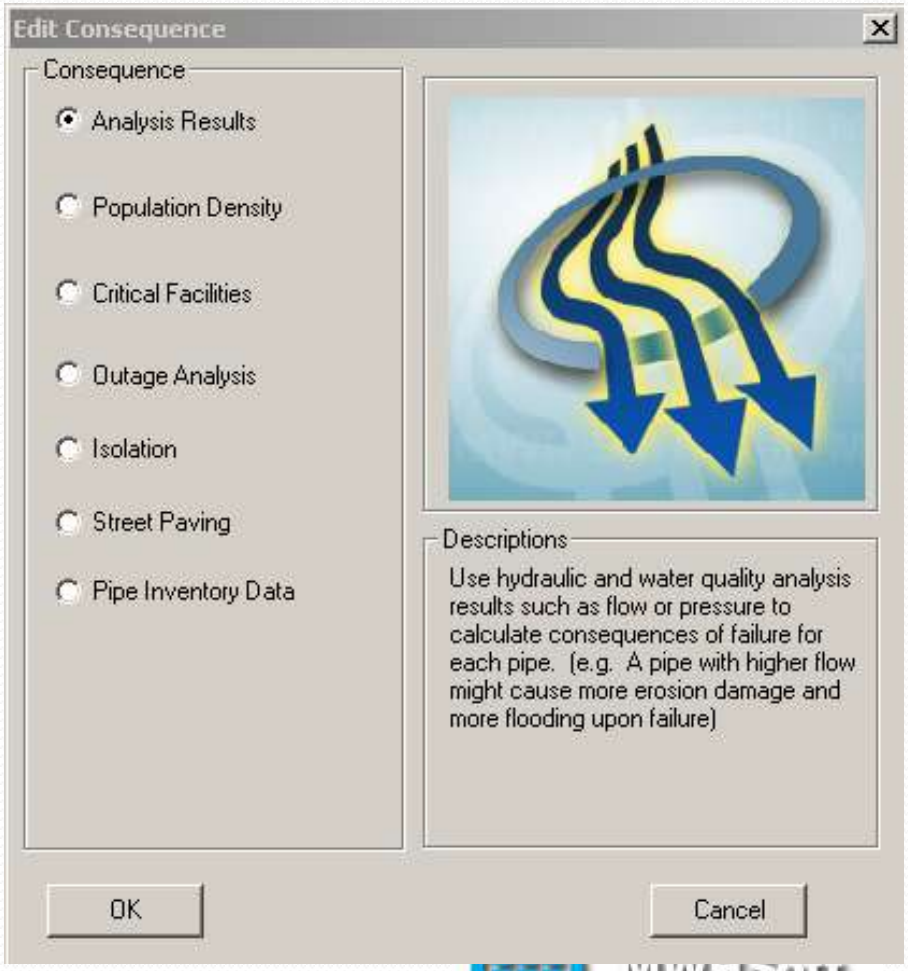
Risk-Based Renewal Planning	
Forward Looking	• Based on asset risk scores throughout system and long term forecasts of risk and cost
Proactive	• High risk assets slotted for renewal before failure occurs
Risk or Budget Constrained	• Budget could be determined based on agreed risk targets for system
Focused on risk management	• High risk assets addressed first • Budget may rise or fall to meet risk targets

CapPlan Work Flow Diagram

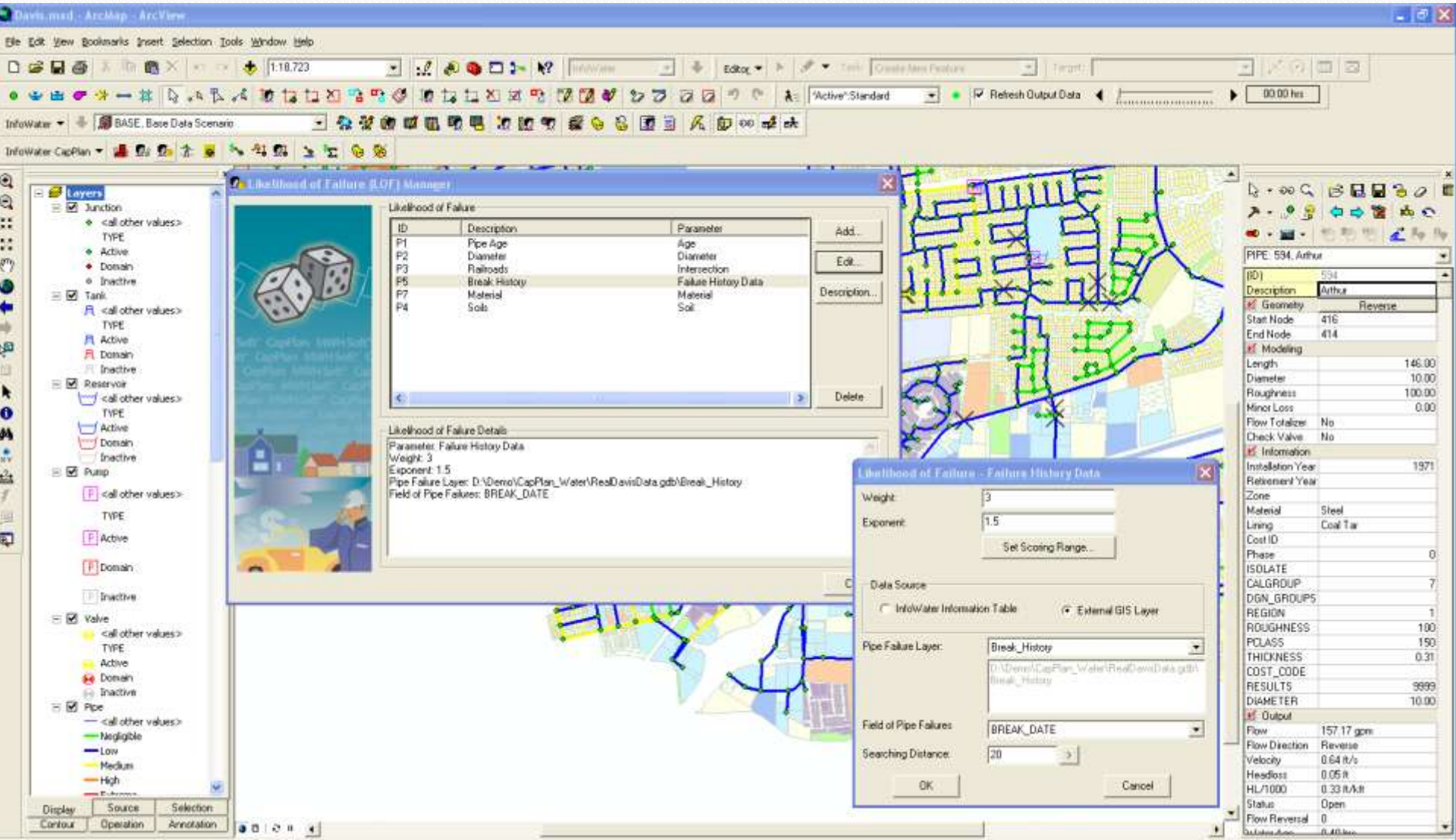


Likelihoods & Consequences

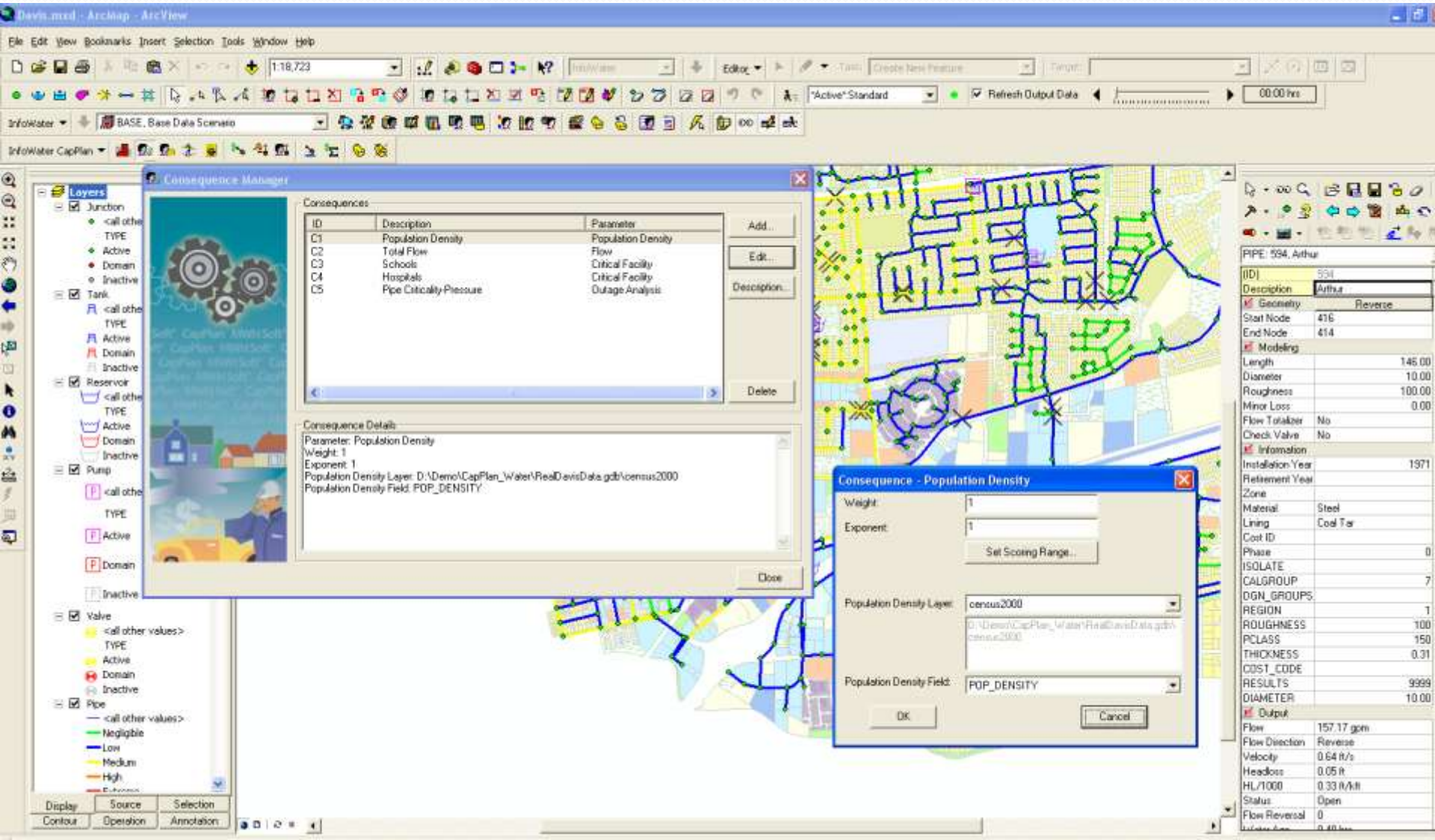


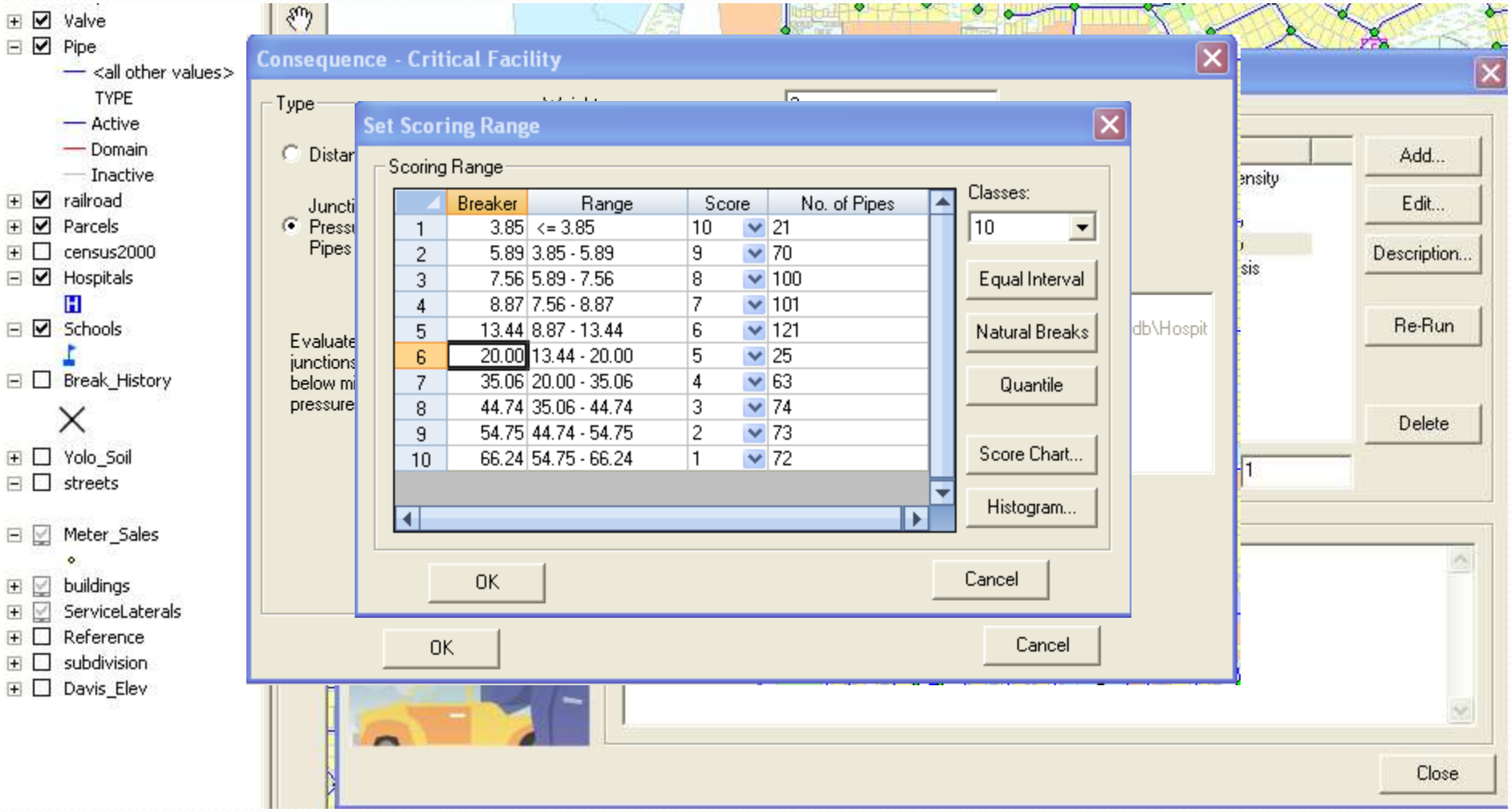


Likelihood of Failure



Consequence of Failure




Valve
Pipe
<all other values>
TYPE
Active
Domain
Inactive
railroad
Parcels
census2000
Hospitals
Schools
Break_History
Yolo_Soil
streets
Meter_Sales
buildings
ServiceLaterals
Reference
subdivision
Davis_Elev
Consequence - Critical Facility
Type
Set Scoring Range
Scoring Range
Breaker
Range
Score
No. of Pipes
1 3.85 <= 3.85 10 21
2 5.89 3.85 - 5.89 9 70
3 7.56 5.89 - 7.56 8 100
4 8.87 7.56 - 8.87 7 101
5 13.44 8.87 - 13.44 6 121
6 20.00 13.44 - 20.00 5 25
7 35.06 20.00 - 35.06 4 63
8 44.74 35.06 - 44.74 3 74
9 54.75 44.74 - 54.75 2 73
10 66.24 54.75 - 66.24 1 72
Classes:
10
Equal Interval
Natural Breaks
Quantile
Score Chart...
Histogram...
OK
Cancel
OK
Cancel
Add...
Edit...
Description...
Re-Run
Delete
Close

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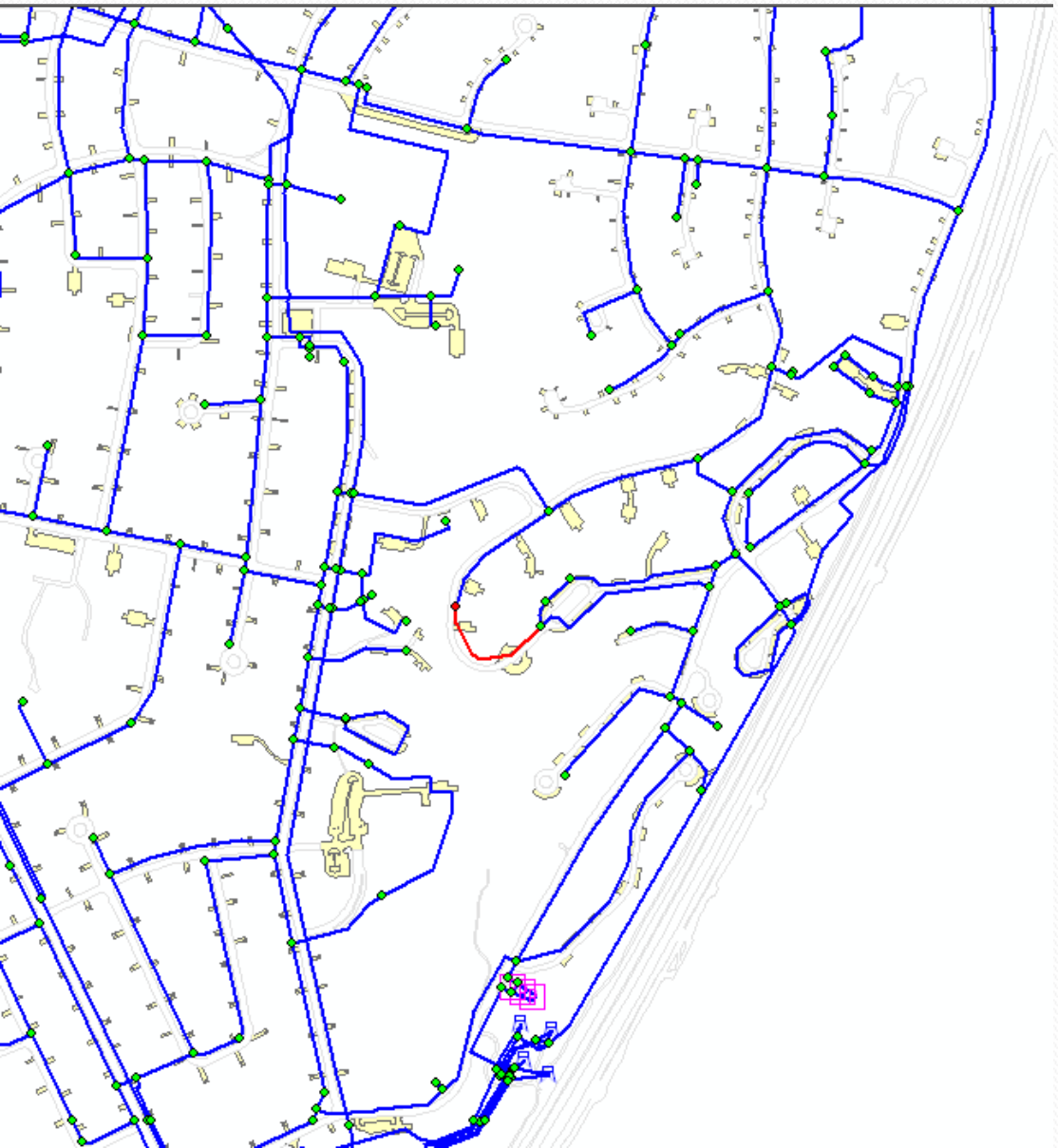
Key Trends

- Moving to an Asset Management "Model"
  - Repeatable and defensible
  - Presents multiple options
  - Facilitates a pilot analysis
  - Can grow and change with you
  - Better leverages existing IT Investments
  - Yet another reason to keep data accurate
- Larger and Larger Data Sets
  - Store multiple versions of data
  - "All Pipe" models
- Geospatial analysis
  - Maps speed analysis and methodology development
  - Makes hydraulic modeling integration easier

Outage Analysis



- Evaluate each pipe

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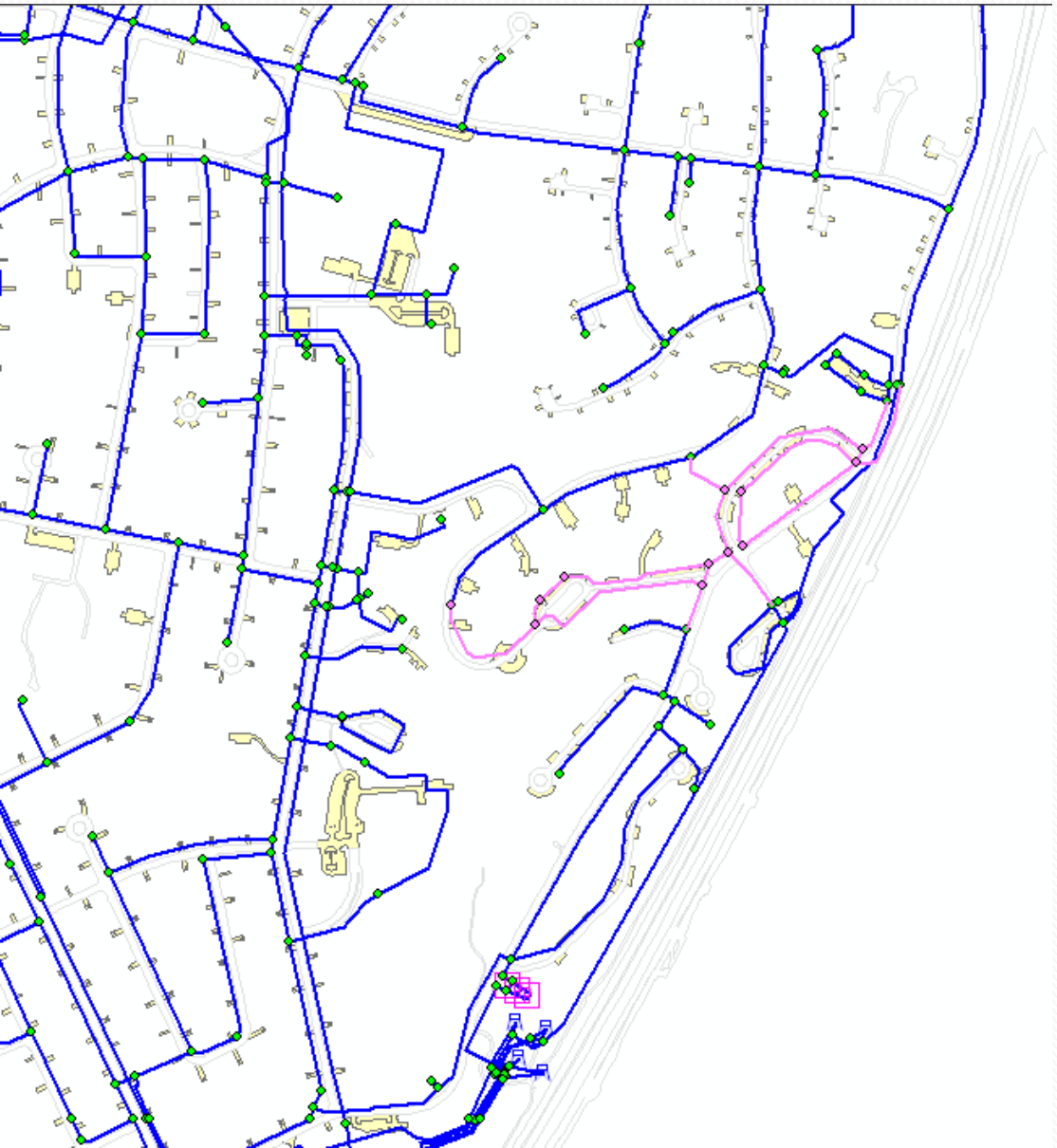
Outage Analysis



- Evaluate each pipe
- ID u/s pipes/valves

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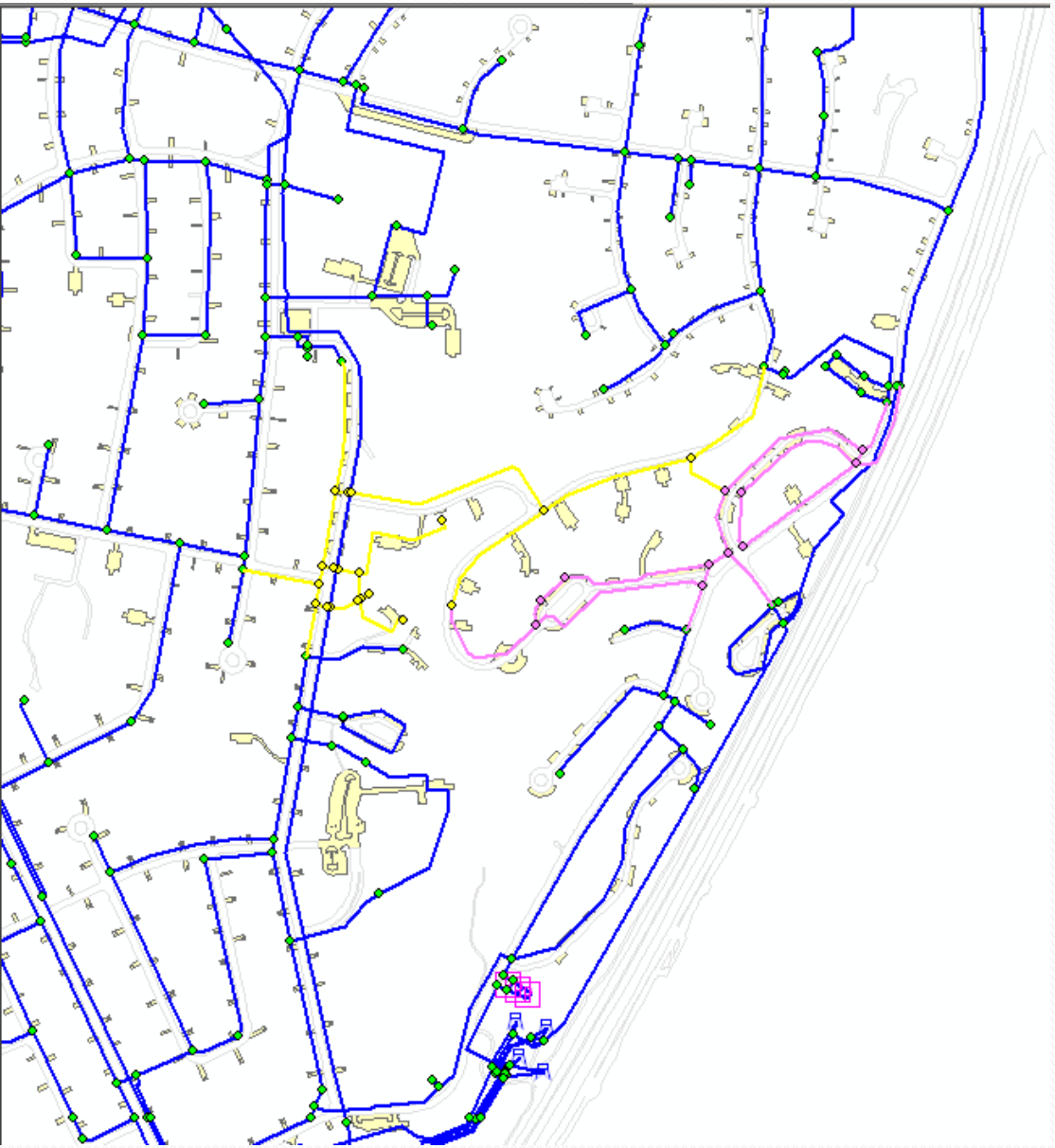
Outage Analysis



- Evaluate each pipe
- ID u/s pipes/valves
- ID d/s pipes/valves

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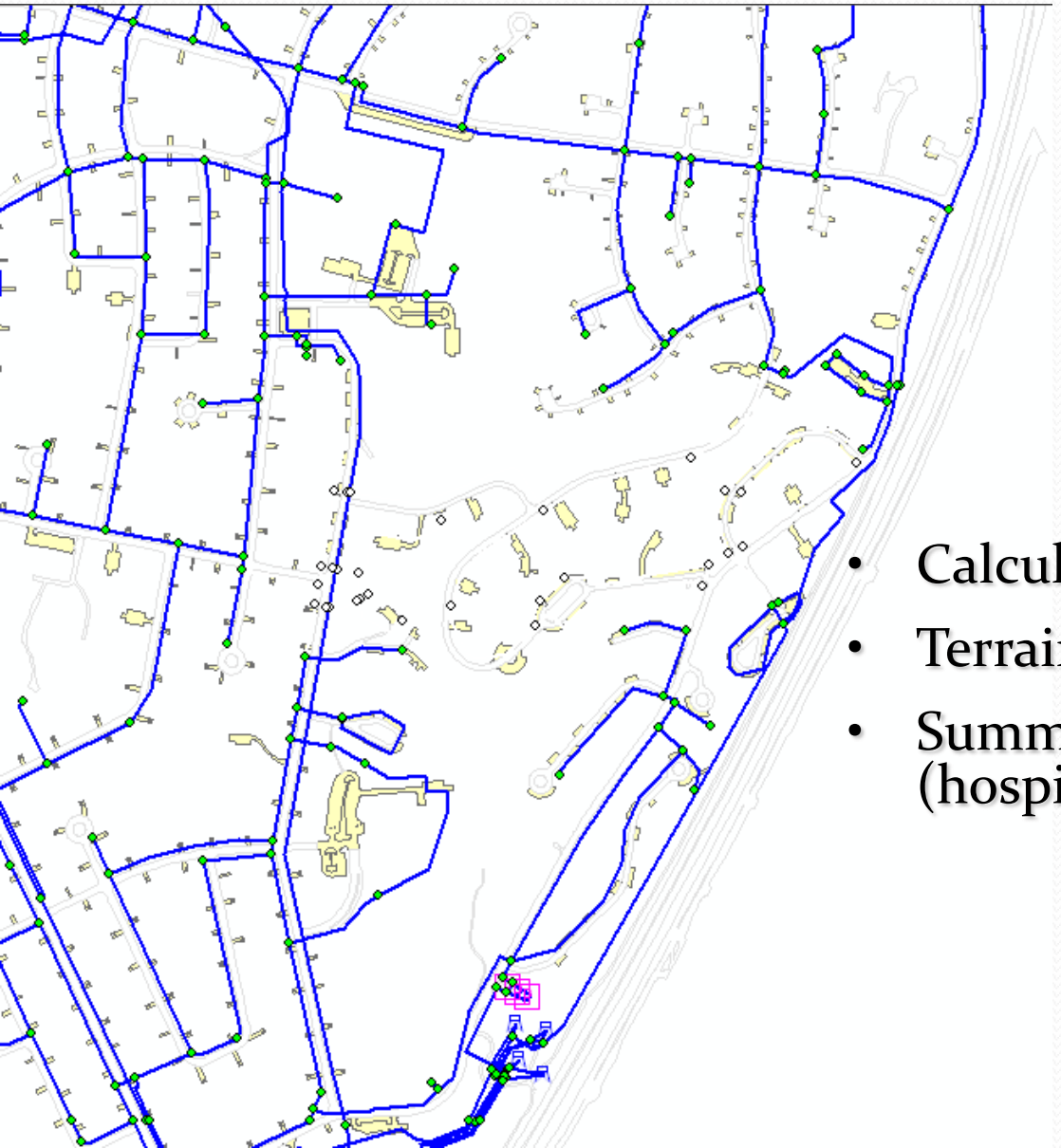
Outage Analysis



- Evaluate each pipe
- ID u/s valves
- ID d/s valves
- Remove elements

- Calculate Water Volume - burst (cf)
- Terrain Model – determine flooding
- Summary of critical outages (hospitals, critical care, schools, etc.)

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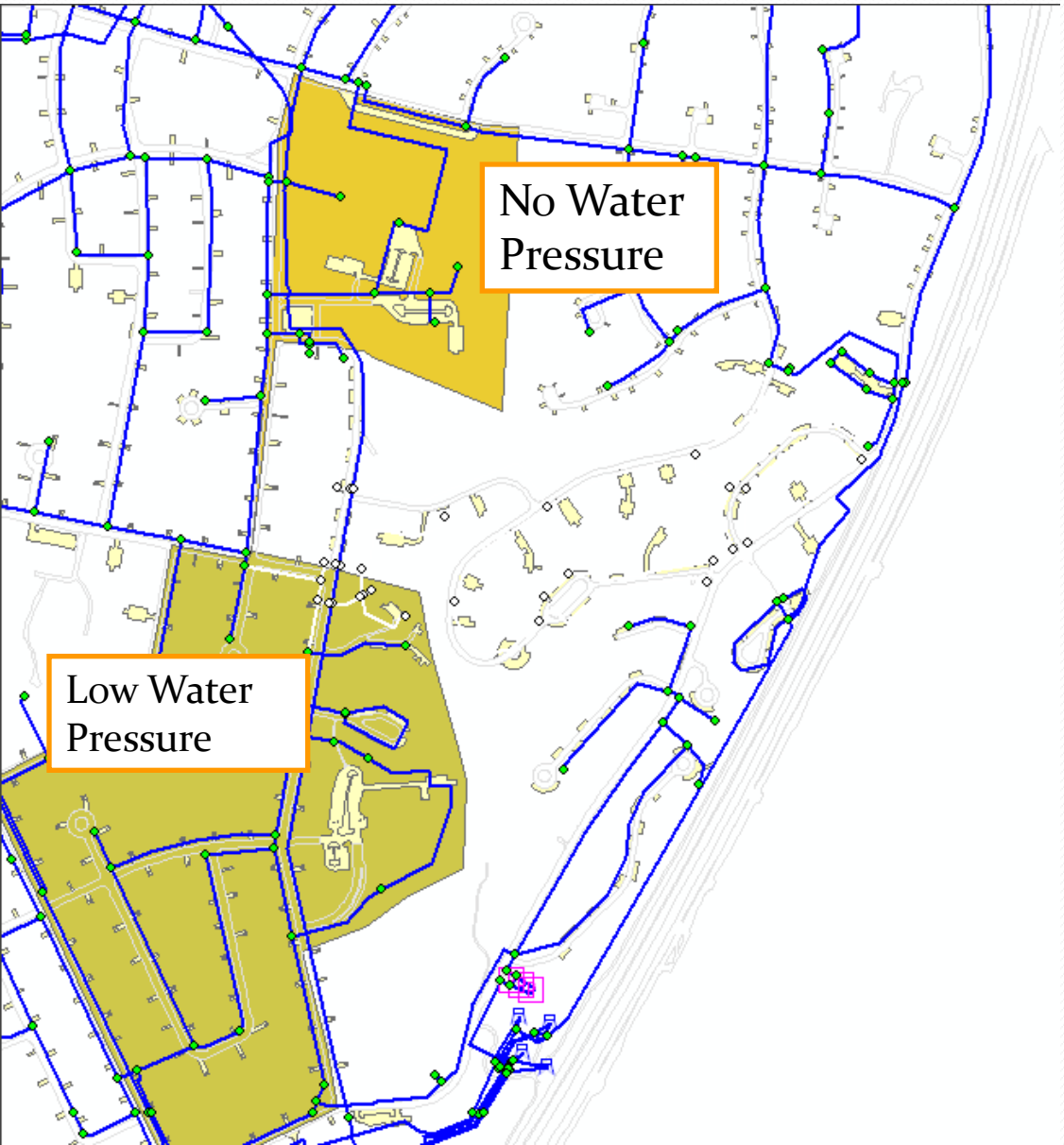
Outage Analysis



- Evaluate each pipe
- ID u/s valves
- ID d/s valves
- Remove elements
- Find pressure problems

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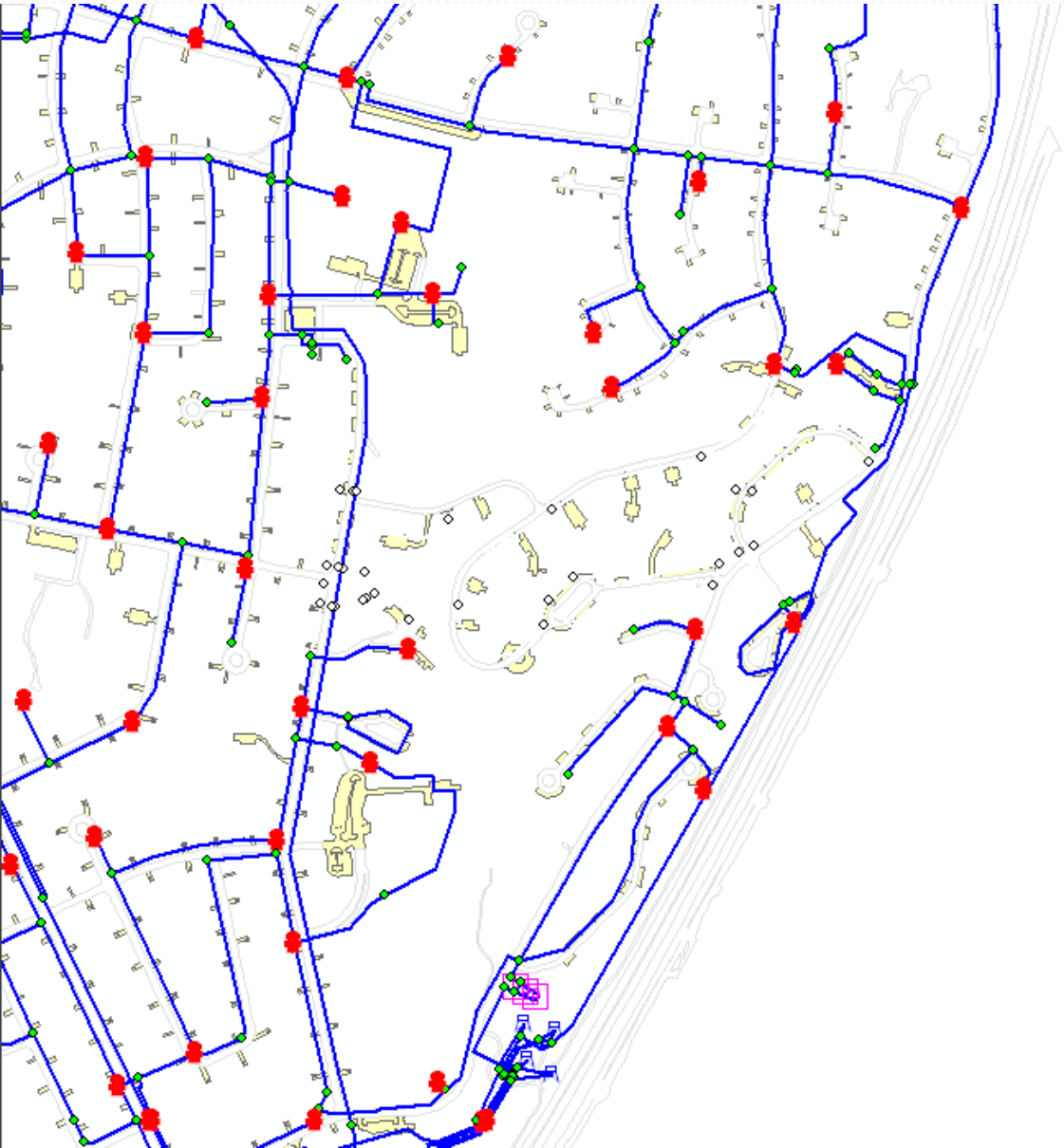
Outage Analysis



- Evaluate each pipe
- ID u/s valves
- ID d/s valves
- Remove elements
- Find pressure problems
- Evaluate reduced fire fighting capabilities

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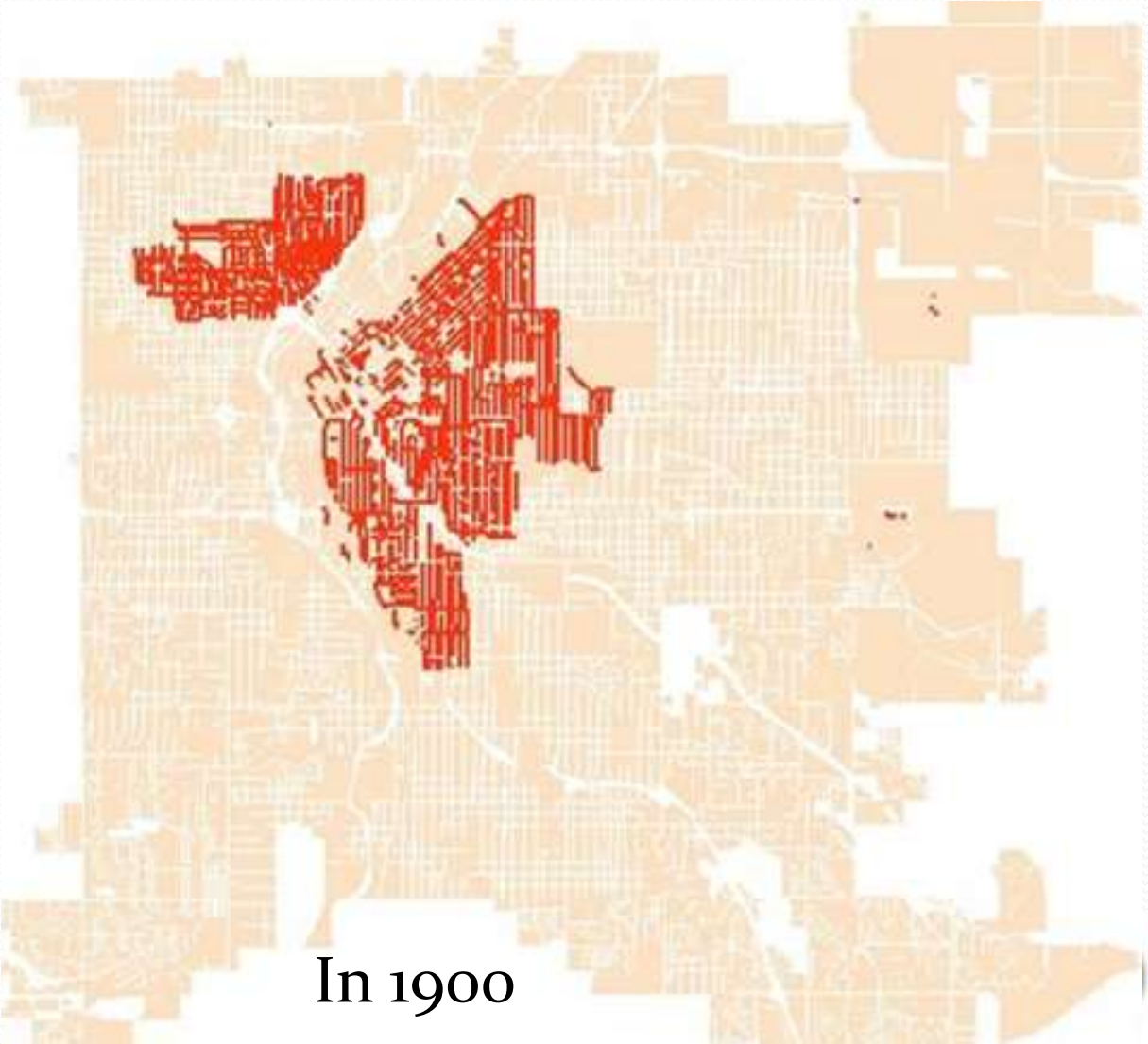
Denver Water Example

The Growth of Denver Water



Reasons for using CapPlan

- Prioritize rehabilitation
- Understand system risk
- CIP funding analysis
- Use an off-the-shelf tool that can be maintained and updated internally
- Transmission and distribution mains analysed separately

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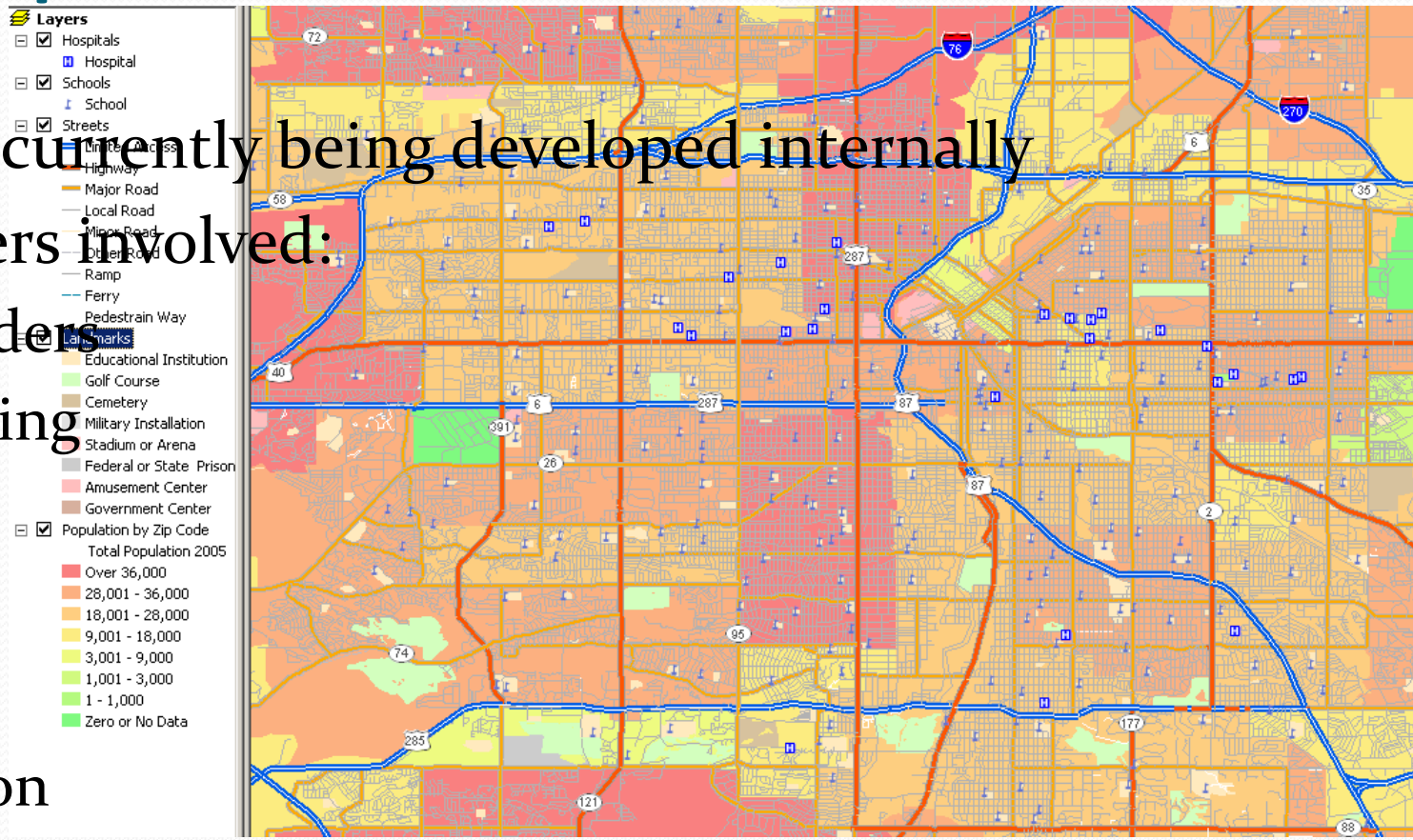
Consequence

- Weighting currently being developed internally
- Many players involved:
  - Stakeholders
  - Engineering
  - Planning



- Criteria:
  - Population
  - Location / Critical Facilities
  - Traffic
  - ???

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Likelihood

- Weighting factors currently being developed with help of outside firm
- Likelihood analysis will be performed internally
- Criteria:
  - Pipe age
  - Pipe material
  - ???

ID (Char)	Year of Installation (Int)	Zone (Char)	Material (Char)
2152	1951	3	DI
914	1951	3	DI
916	1951	3	DI
896	1951	3	DI
910	1951	3	DI
1954	1951	3	DI
918	1951	3	DI
972	1971	3	AC
1502	1971	2	AC
592	1971	1	AC
824	1971	3	AC
1504	1971	2	AC
524	1971	1	AC
1334	1971	3	AC
2416	1972	4	AC
2420	1972	4	AC

Experience to Date

- Data quality is important to consider
- Analysis of current procedures for data collection and storage
- CapPlan is easy to use
- Sensitivity of consequence of failure criteria
- Sensitivity of likelihood of failure criteria

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Departments Benefiting from the Project

- Engineering
- Planning
- Asset Management
- Field Services

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Capital Savings

- Quickly prioritize projects
- Utilize all available data for enhanced project phasing
- Enhance data collection procedures
- Reduction in pipe failures with high consequence
- Capital plan maintained instead of re-created

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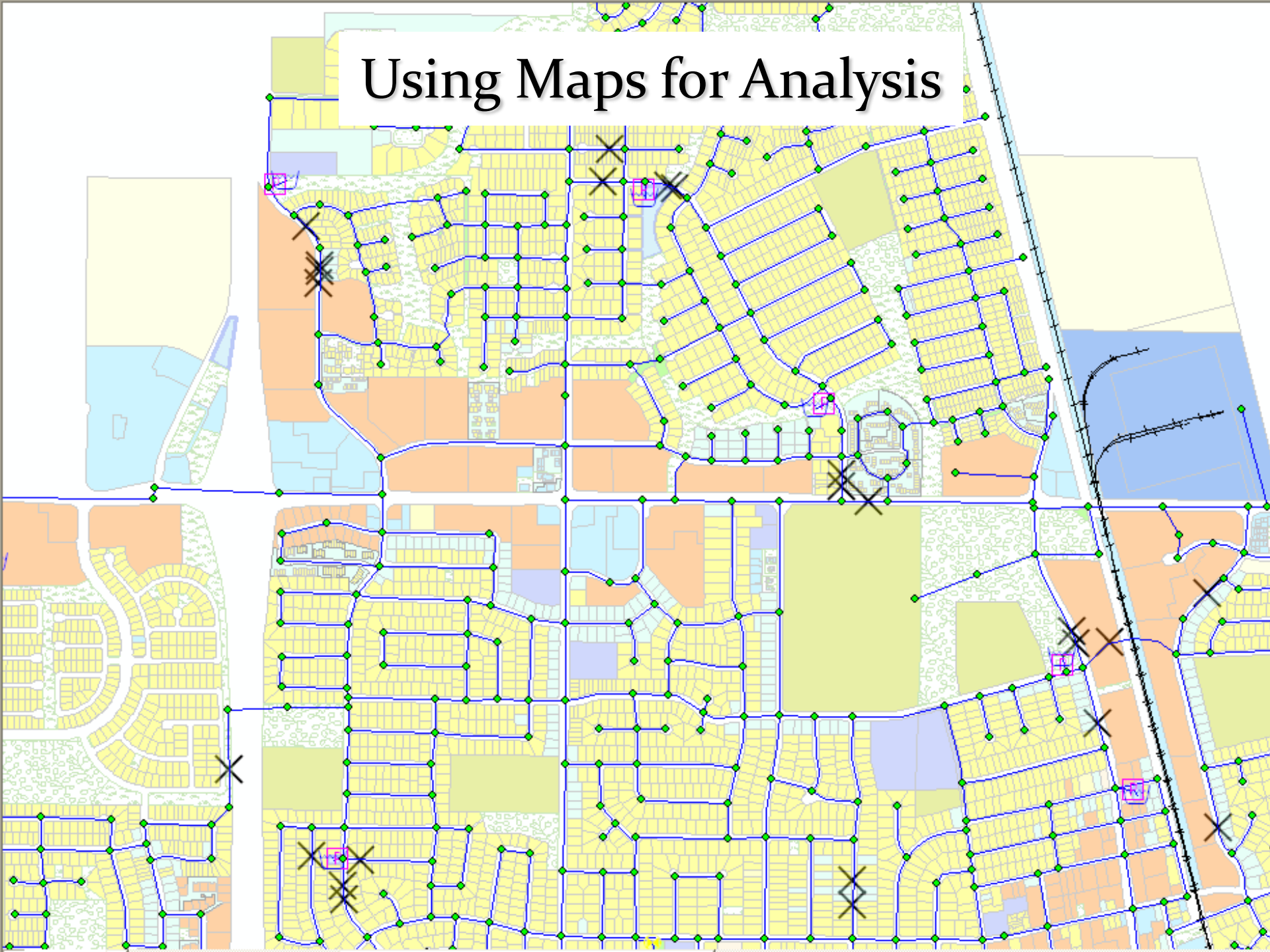
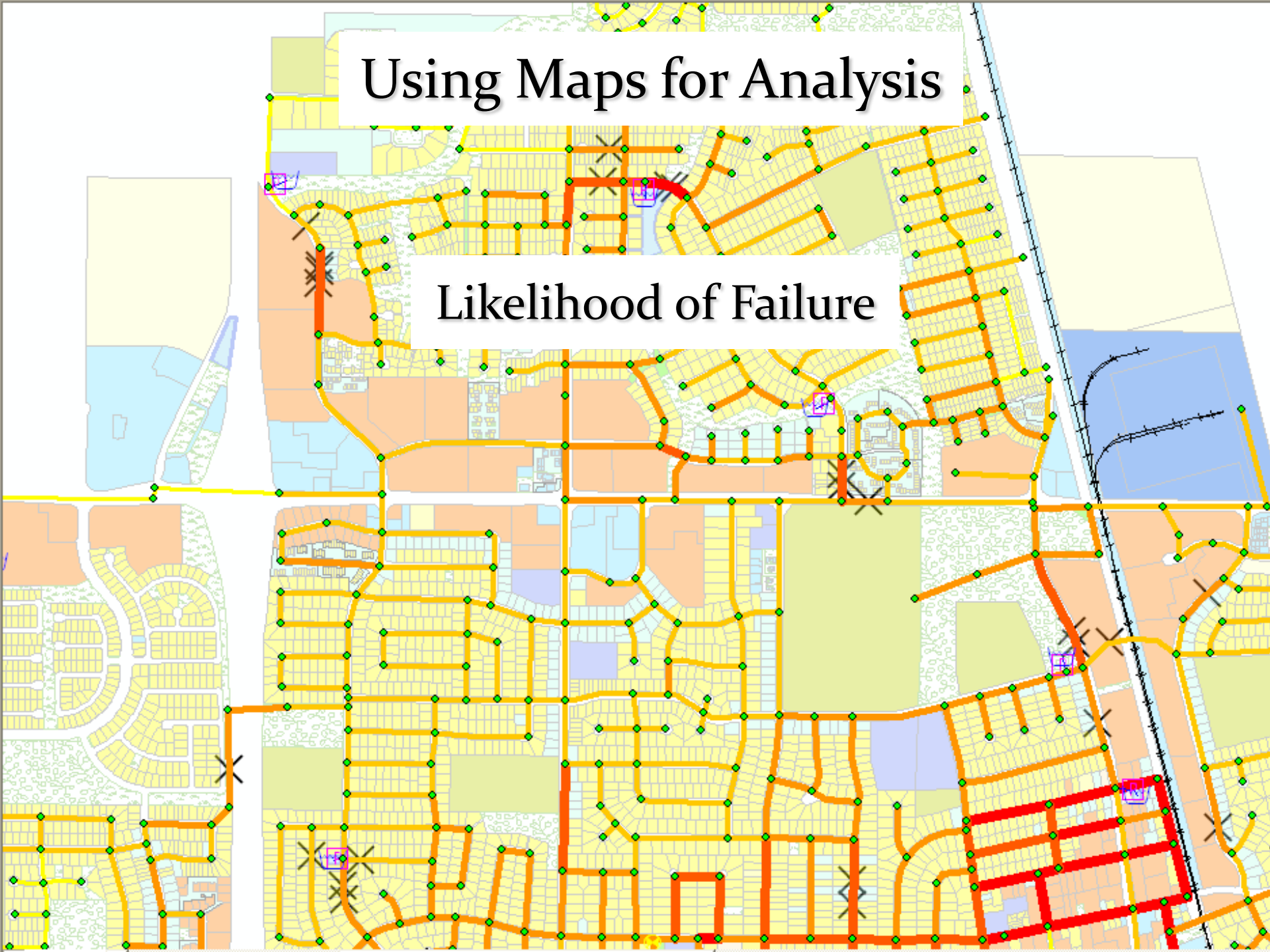
Using Maps for Analysis



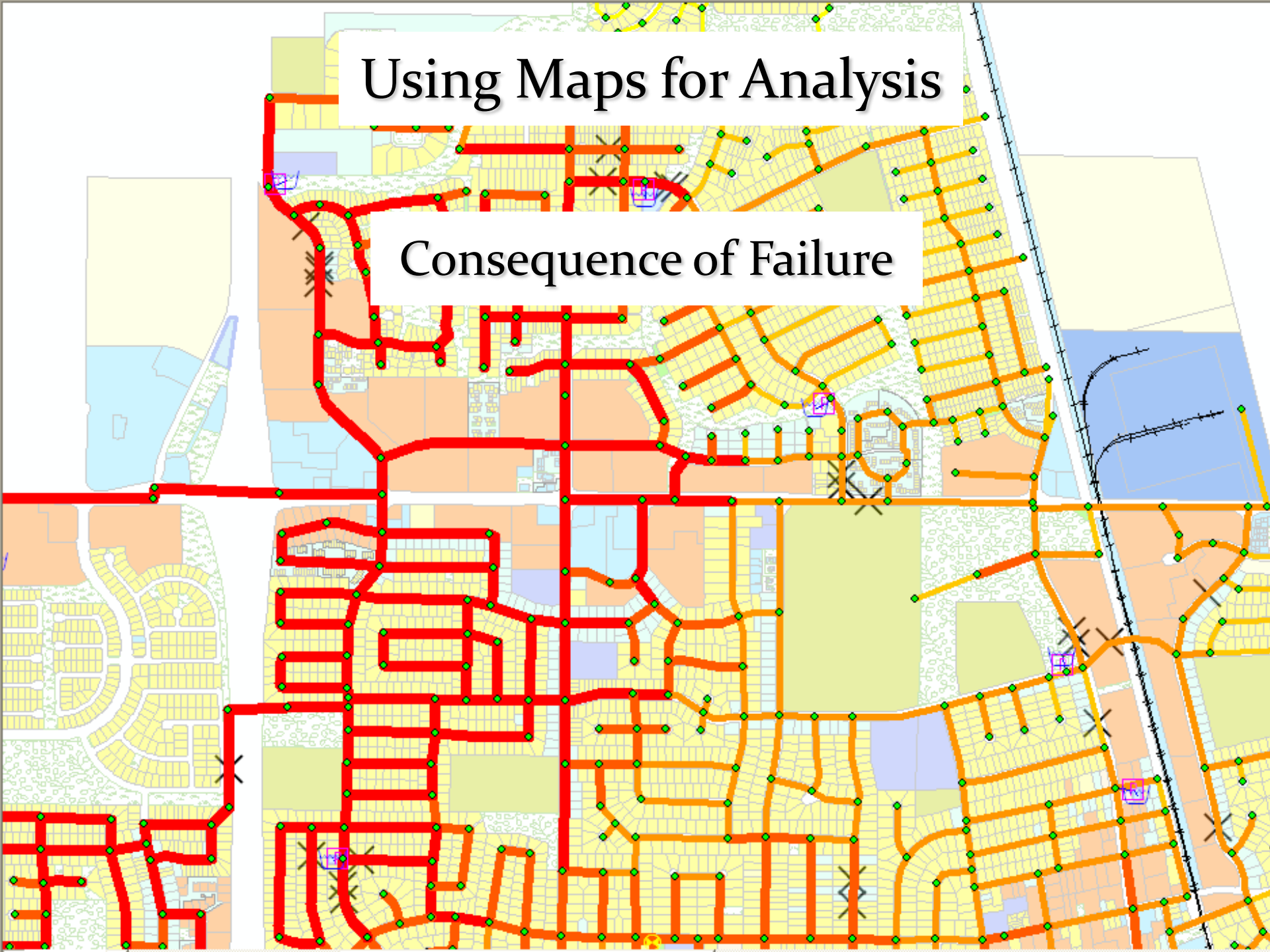
Using Maps for Analysis

Likelihood of Failure



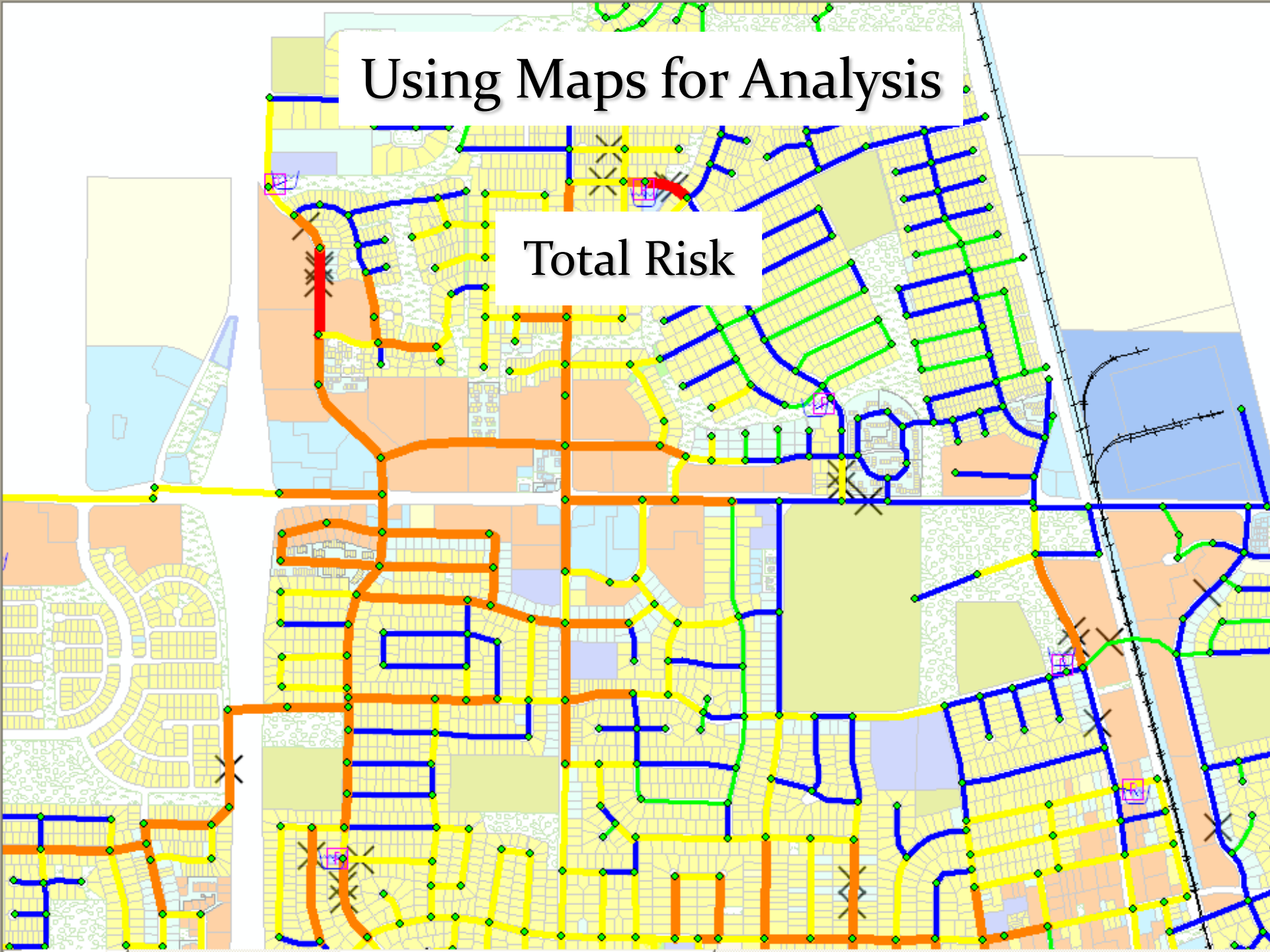
Using Maps for Analysis

Consequence of Failure

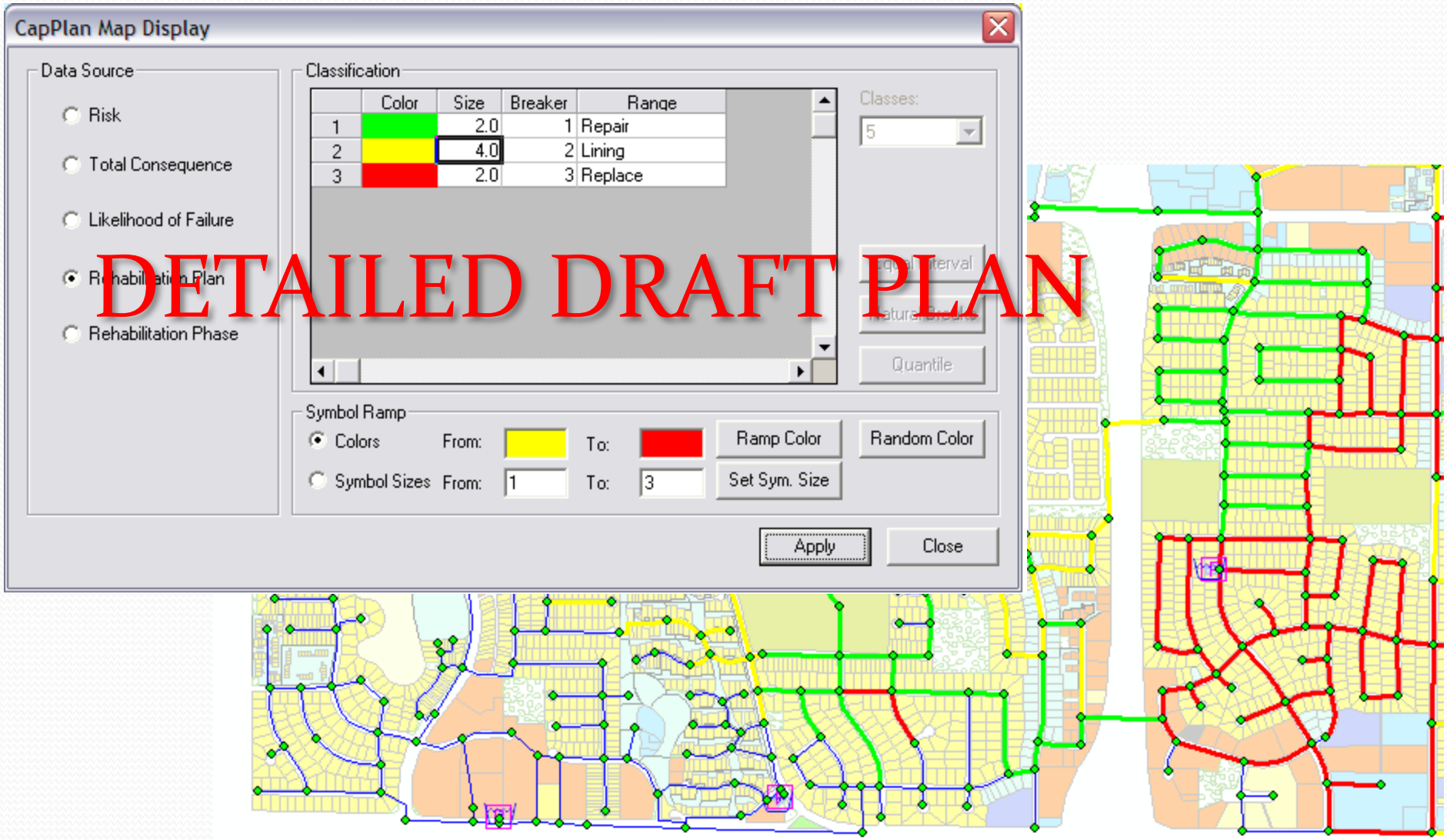


Using Maps for Analysis

Total Risk

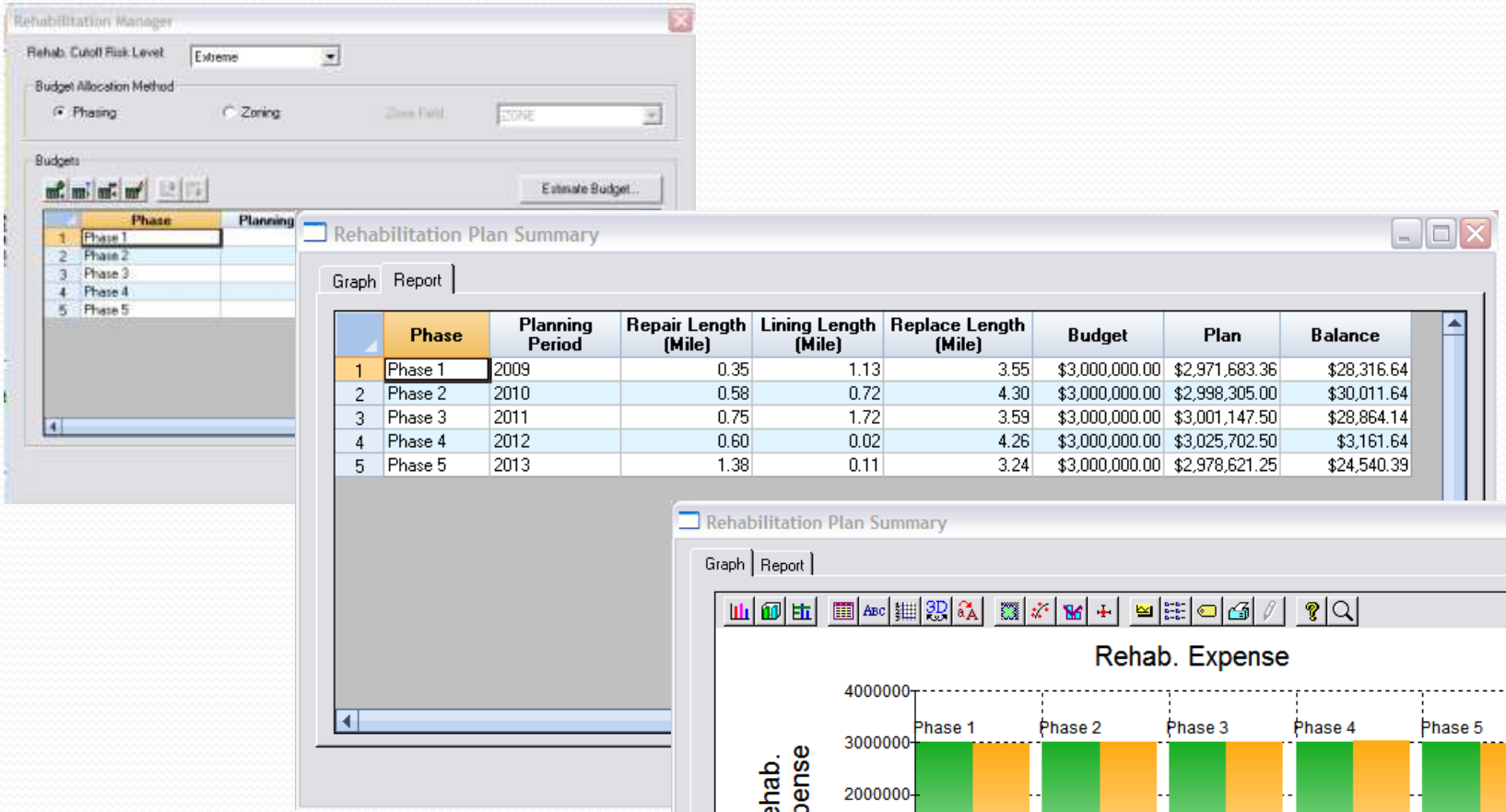


CapPlan Output



DETAILED DRAFT PLAN

Limited Funding



	Phase	Planning Period	Repair Length (Mile)	Lining Length (Mile)	Replace Length (Mile)	Budget	Plan	Balance
1	Phase 1	2009	0.35	1.13	3.55	$3,000,000.00	$2,971,683.36	$28,316.64
2	Phase 2	2010	0.58	0.72	4.30	$3,000,000.00	$2,998,305.00	$30,011.64
3	Phase 3	2011	0.75	1.72	3.59	$3,000,000.00	$3,001,147.50	$28,864.14
4	Phase 4	2012	0.60	0.02	4.26	$3,000,000.00	$3,025,702.50	$3,161.64
5	Phase 5	2013	1.38	0.11	3.24	$3,000,000.00	$2,978,621.25	$24,540.39

Pipe Rehabilitation Plan

Pipe Rehabilitation Plan

Close

	Pipe ID	Phase	Action	Rehab. Year	Cost	Comments
1	9010	1	LINING	2009	$129,888.36	
2	2334	1	REPAIR	2009	$85,320.00	
3	1954	1	LINING	2009	$32,805.00	
4	2094	1	REPLACE with Steel	2009	$60,307.50	
5	2278	1	REPAIR	2009	$83,640.00	
6	2116	1	REPLACE with Steel	2009	$61,327.50	
7	P17	1	REPLACE with Steel	2009	$10,837.50	
8	840	1	LINING	2009	$20,017.50	
9	842	1	LINING	2009	$18,296.25	
10	846	1	LINING	2009	$42,138.75	
11	844	1	LINING	2009	$30,918.75	
12	2066	1	LINING	2009	$9,825.00	
13	2330	1	REPLACE with Steel	2009	$142,035.00	
14	2280	1	REPLACE with Steel	2009	$112,327.50	
15	905	1	REPLACE with PVC	2009	$16,590.00	
16	2120	1	REPLACE with Steel	2009	$22,185.00	
17	2328	1	REPLACE with Steel	2009	$16,320.00	
18	896	1	LINING	2009	$16,485.00	
19	2172	1	REPLACE with Steel	2009	$21,165.00	
20	918	1	LINING	2009	$58,586.25	

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Thoughts

- Guarantee: Your water system will fail…Eventually
- Rule of thumb is $1M/mile to install pipe. One City block ($100,000) is enough for software and first cut at a plan
- $$ from existing pipe replacement budgets can be used to develop a prioritized plan
- Treated water is delivered to customers at (USA average) ~1¢/gallon
- Current rates are too low to replace existing infrastructure
- Long-term plan budget ($$) can justify a rate increase

More Thoughts

- If infrastructure is not failing yet, we still need the plan to justify a gradual rate increase so customers are not hit with double/triple rates when pipes do start to fail
- There's no such thing as "not enough data to start"
- It's better to be proactive than reactive. Reactive means:
  - Massive overtime (higher costs)
  - Bad PR
  - Customers out of water
  - Boil water orders
  - More. . .

Questions ?

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