ESRI UC 2017

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The City of Tacoma's GIS-Centric Wastewater Asset Performance Modeling Approach

Innovyze®

Tacoma's Sanitary Sewer – Upfront Information

- Tacoma is located within Puget Sound on Commencement Bay
- Over 90,000 Customers
- 2 Treatment Plants:
  - Central WW Treatment Plant
  - North End WW Treatment Plant
- ~ 700 miles of pipe, some of which are 120 years in age
- Size 6-inch to 66-inch

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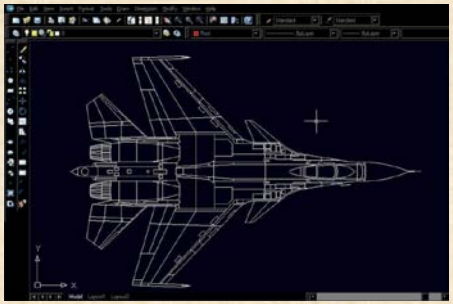
Tacoma's Sanitary Sewer – GIS History

- Sanitary GIS History
  - AutoCAD—Oracle database (1990s-2014)

GREAT FOR…



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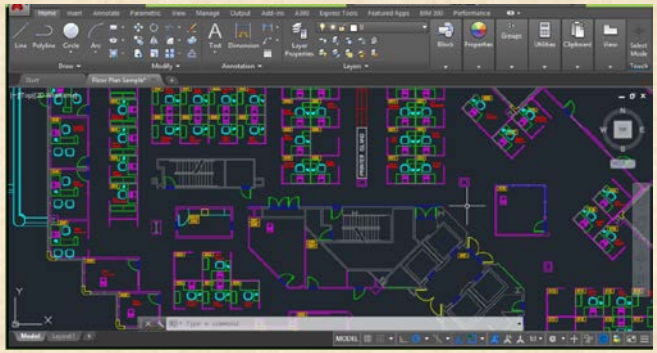

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Tacoma's Sanitary Sewer – GIS History

- Sanitary GIS History
  - 2014 - the move to:

  - ESRI—Oracle database (2014-2015)
  - ESRI—SQL database with LGIM structure (2015-present)

Tacoma's Sanitary Sewer – Asset Management

- Asset Management History
  - Historically separate programs for each utility
  - Early to Mid-2000s started the formal asset management program for sanitary
  - Manually evaluated each pipe for LOF and COF to develop a risk, lots of spreadsheet
  - Searching for software to make this process faster and easier
  - **Mid 2014 Environmental Services consolidated into one Asset Management Group**
  - 3/2015 Request for Proposal for "Linear Asset Management Software"
  - 8/2015 Contract completed
  - 12/2015 Training

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Tacoma's planning challenges

aging assets

- How much renewal does my utility really need? And when?

budgeting

- What's too much? What's too little?

sewer capacity

- Why did the pipe fail?
- Was it planned to be replaced soon?

rate increase

- How to justify rate increases to stakeholders?

aging workforce

- Can we capture knowledge from retiring operations staff?

Traditional Capital Improvement Plan (CIP)

- Challenges
  - "Black Box" – not very defensible or repeatable
    - **Complex, customized spreadsheets**
    - Manual integration to GIS
    - Hydraulic modeling based
    - Human interpretation
  - Hard to quickly decipher, visualize, and share the results
    - Not intuitive
  - Not easy to integrate with existing data (CMMS, GIS, etc.)
  - Difficult (time consuming and costly) to maintain

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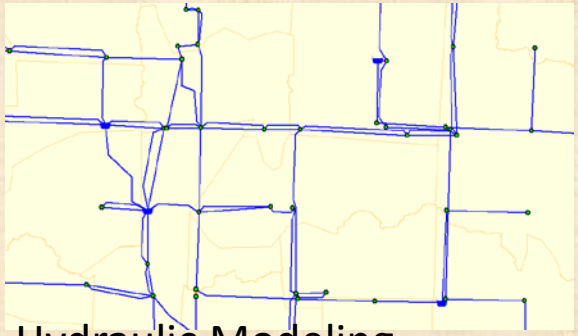
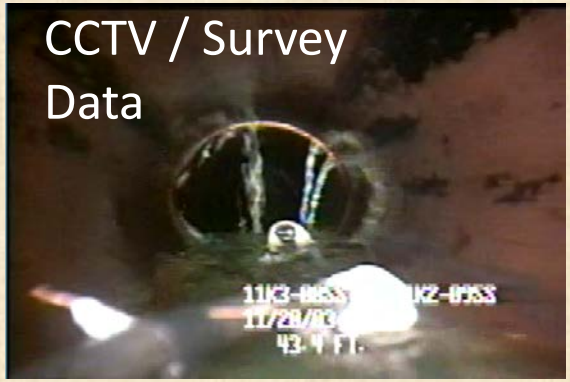
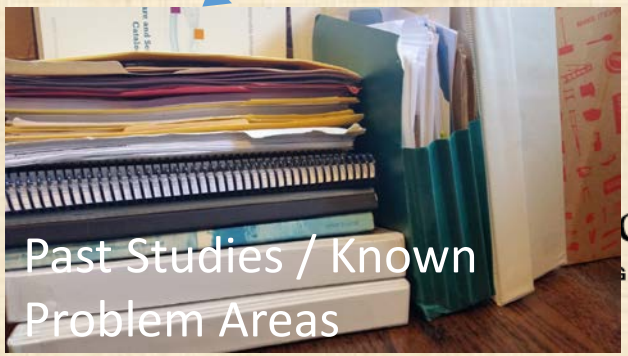
Traditional Planning Efforts



Sewer Rehab





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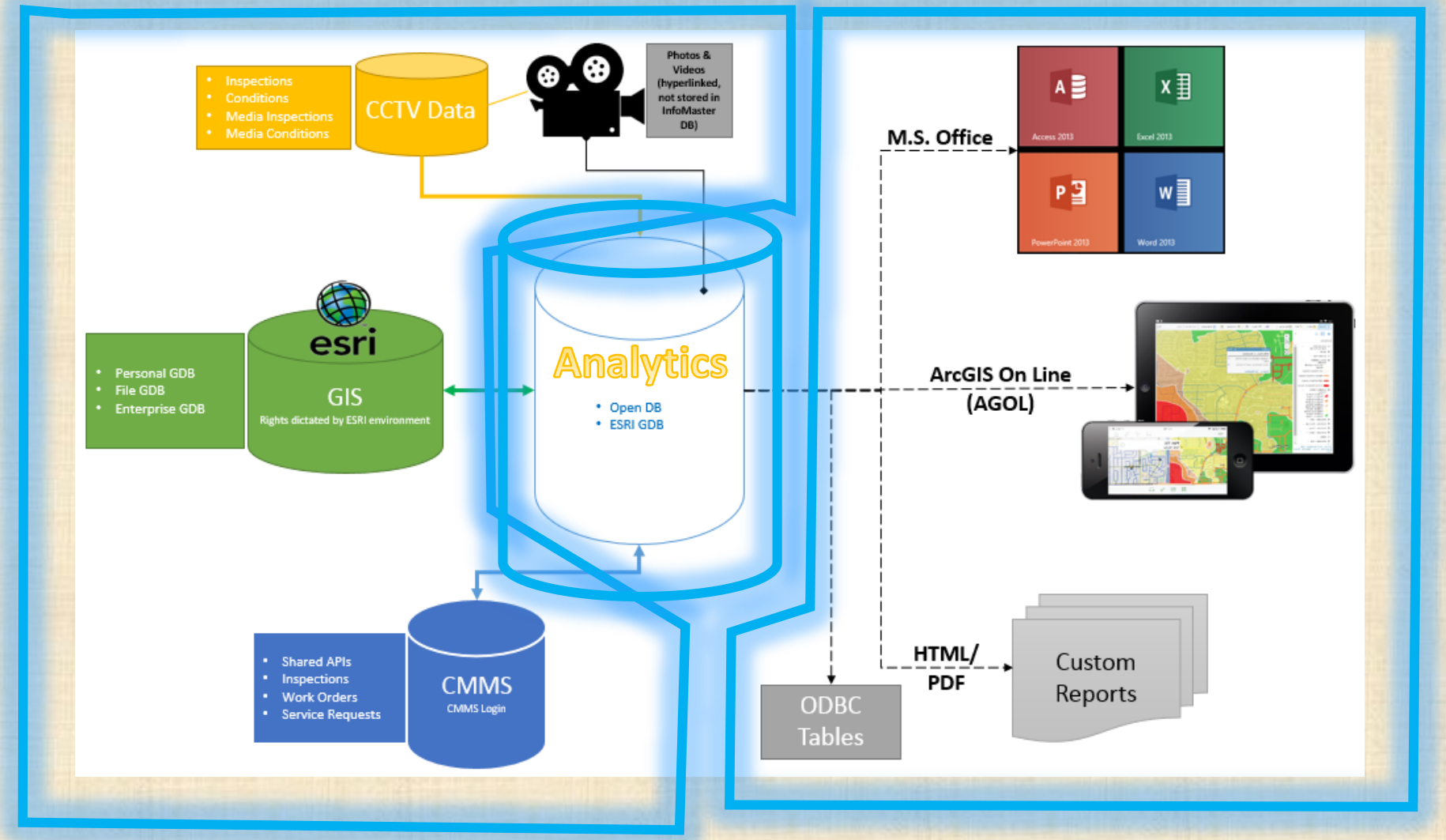

Data Inputs | Analytics | Outputs

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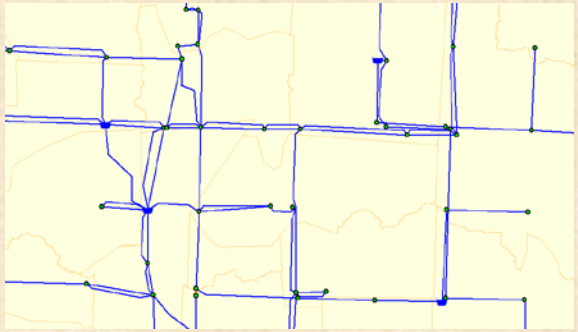
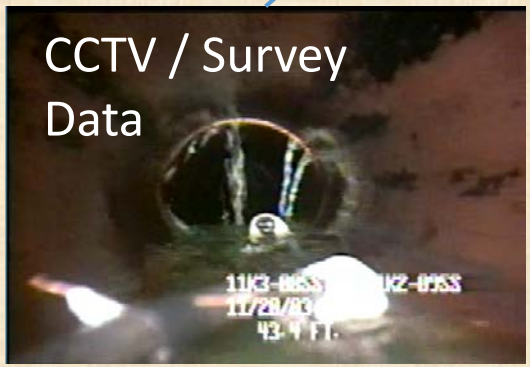
GIS Based Effort



Hydraulic Modeling

Sewer Rehab

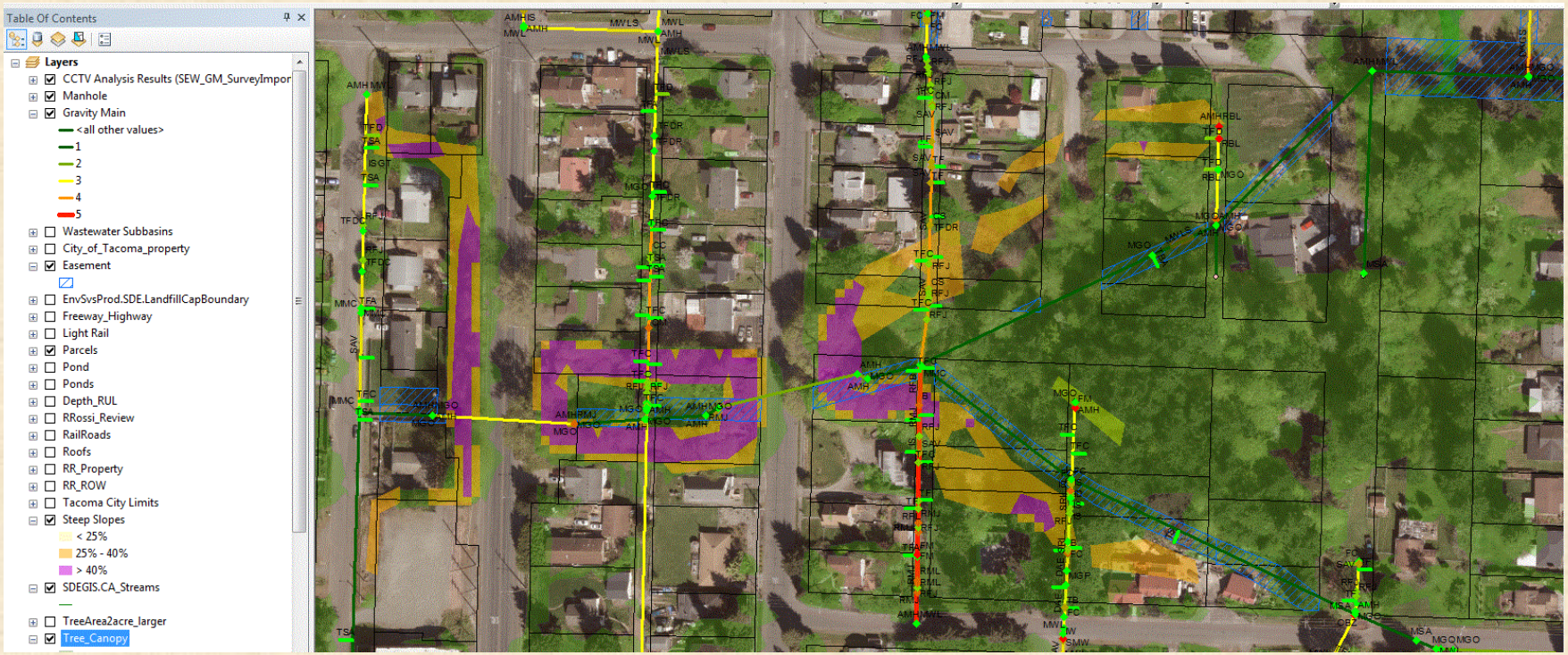


Data Inputs

Analytics

Outputs

GIS Data



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Analytics

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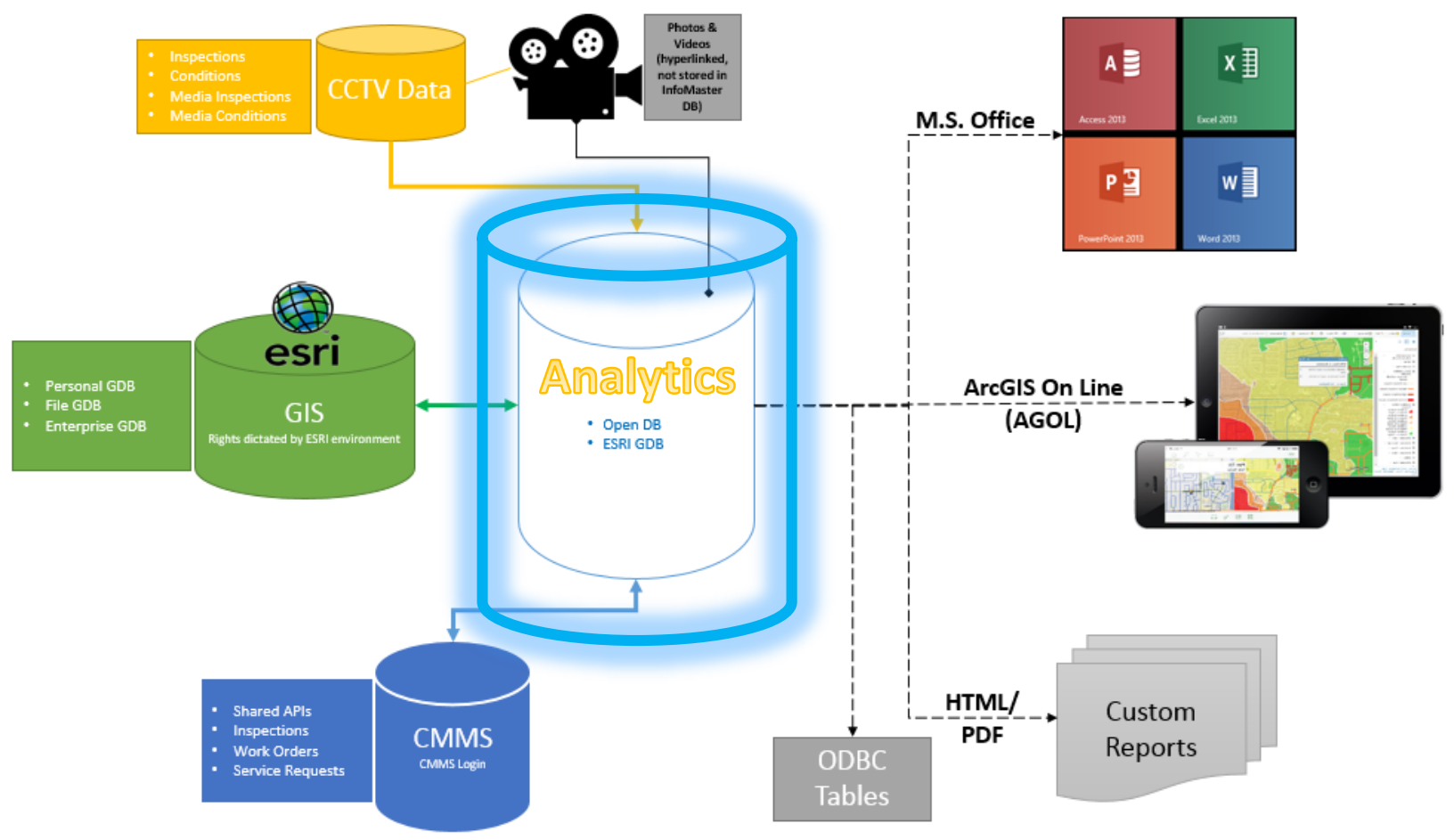

Data Inputs

Analytics

Outputs

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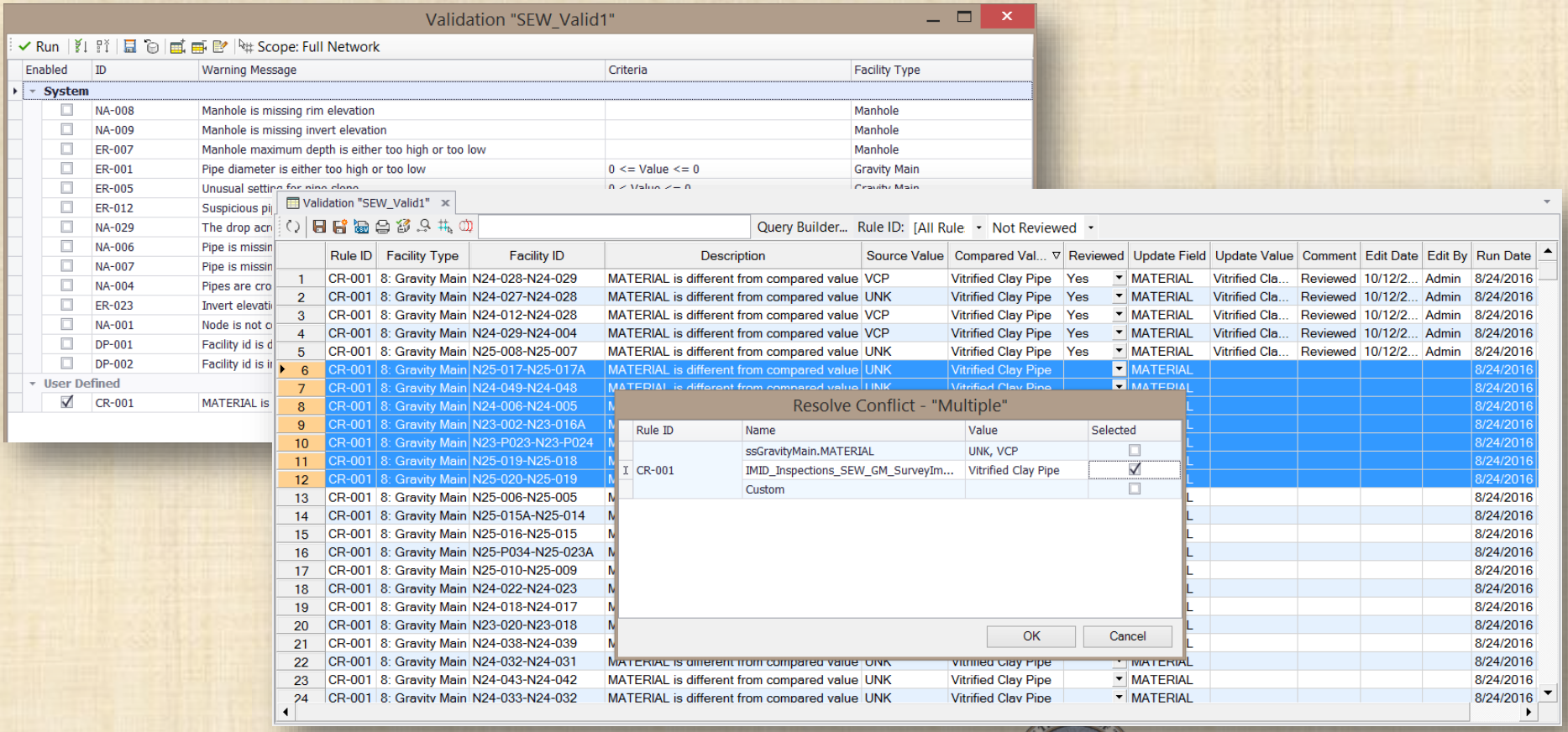
Data Validation



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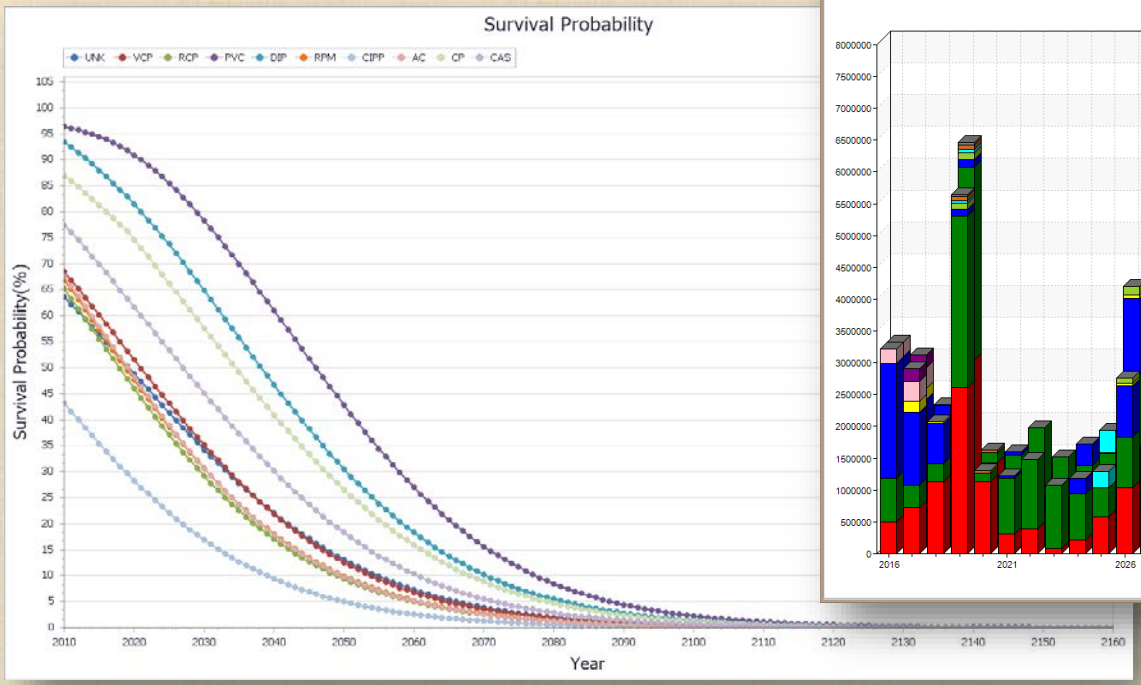
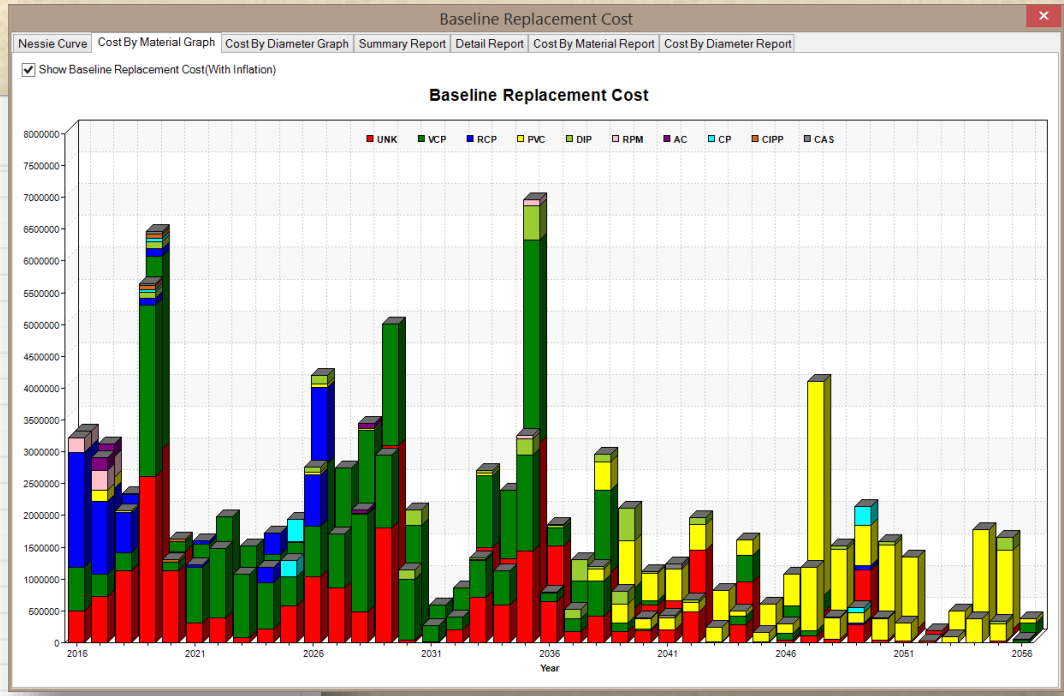
Baseline Replacement Costs





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CCTV Data and Draft Rehab

Gravity Main Defect Code

Query Builder... Survey Standard: NASSCO's PACP

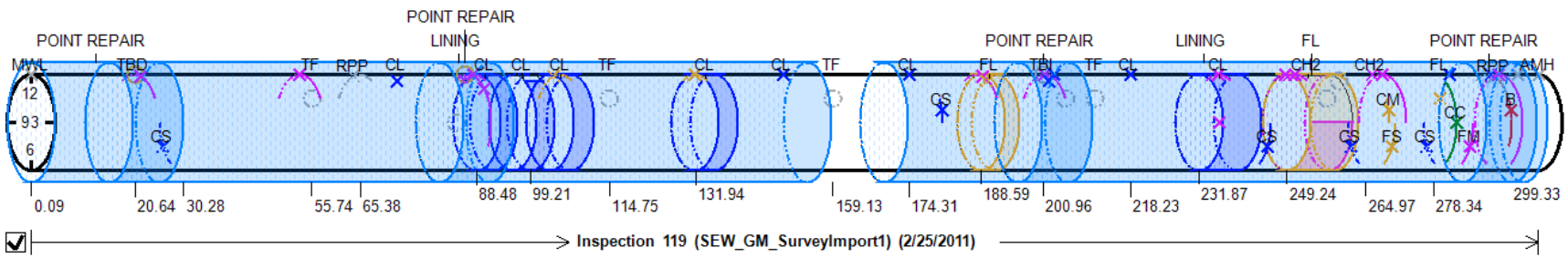
	Defect Code	Default Score	Type	Description	Rehab. Method	Alternative Method	Comments	Clock Po
91	HVV	5	MISCELLANEOUS	Hole Void Visible	POINT REPAIR	POINT REPAIR		
92	ID	3	MISCELLANEOUS	Infil Dripper	LINING	POINT REPAIR		
93	IG	5	MISCELLANEOUS	Infil Gusher	LINING	POINT REPAIR		
94	IR	4	SERVICE	Infil Runner	LINING	POINT REPAIR		
95	IS	0	SERVICE	Infil Stain	LINING	POINT REPAIR		

Condition Assessment - Gravity Main 'N24-027-N24-028'

Survey Import SEW_GM_SurveyImport1 CapPlan Result SEW_RehabPlan1

Defects Connections Continuous Draft Rehab. Final Rehab. Score Filter: 0 1 2 3 4 5

Upstream Manhole 'N24-027' Downstream Manhole 'N24-028'



122	LFCS	3	MISCELLANEOUS	Lining Failure Connection Cut Sh	POINT REPAIR	POINT REPAIR		
123	LFD	3	MISCELLANEOUS	Lining Failure Detached	POINT REPAIR	POINT REPAIR		
124	LFDC	2	MISCELLANEOUS	Lining Failure Discoloration				
125	LFDE	3	MISCELLANEOUS	Lining Failure Defective End	POINT REPAIR	POINT REPAIR		
126	LFDL	3	MISCELLANEOUS	Lining Failure Delaminating	POINT REPAIR	POINT REPAIR		
127	LFOC	3	MISCELLANEOUS	Lining Failure Overcut Connectio	POINT REPAIR	POINT REPAIR		
128	LFPH	3	MISCELLANEOUS	Lining Failure Pinhole	POINT REPAIR	POINT REPAIR		
129	LFRS	3		Lining Failure Resin slug				

Data Inputs

Analytics

Outputs

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Tacoma's Consequence of Failure Approach

- Consequence of Failure (COF)
  - SEW_COF1, Diameter
  - SEW_COF3, Street Type
  - SEW_COF11, Street Condition
  - SEW_COF5, Wetlands
  - SEW_COF6_1, Don't use (easement)
  - SEW_COF6_2, Don't use (parcel)
  - SEW_COF6, Easements
  - SEW_COF8, Building
  - SEW_COF2, Depth
  - SEW_COF9, Landfill Cap
  - SEW_COF10, Pipe Function
  - SEW_COF12, Pavement Index
  - SEW_COF13, Highway_Freeway
  - SEW_COF7_1, Don't use (DistanceSlope)
  - SEW_COF7_2, Don't Use (%slope)
  - SEW_COF7_3, Don't use (distanceTree Canopy)
  - SEW_COF7, Steep Slope
  - SEW_COF7_4, Don't use (paved street)
  - SEW_COF14_1, Don't use (RR_ROW)
  - SEW_COF14_2, Don't use (RR_Parcel)
  - SEW_COF14_3, Don't use (30ft from RR CL)
  - SEW_COF14, RR
  - SEW_COF5_1, Don't use - 300 ft buffer
  - SEW_COF5_2, Don't use - Wetland buffer by Category I 200 ft
  - SEW_COF5_3, Don't use - Wetland buffer by Category II 150 ft
  - SEW_COF5_4, Don't use - Wetland buffer by category III 75 ft
  - SEW_COF5_5, Don't use - Wetland buffer by category IV 50 ft
  - SEW_COF15, Stream
  - SEW_COF6_3, Don't use - COT Property
  - SEW_COF16, Ponds
  - SEW_COF8_1, Don't Use - Building Size
  - SEW_COF8_2, Don't use - Distance from Building
  - SEW_COF17, 2017 Street Project

Category

- (●) Pipe Attribute
- ( ) Inspection
- ( ) Population Density
- ( ) Work Order
- ( ) Critical Facilities
- ( ) Pipe Inventory
- ( ) Intersection
- ( ) Multi-Parameter
- ( ) Pavement

Description

Use Pipe attributes to estimate the consequence of failure. (e.g. Age, Material)

Data Inputs → Analytics → Outputs

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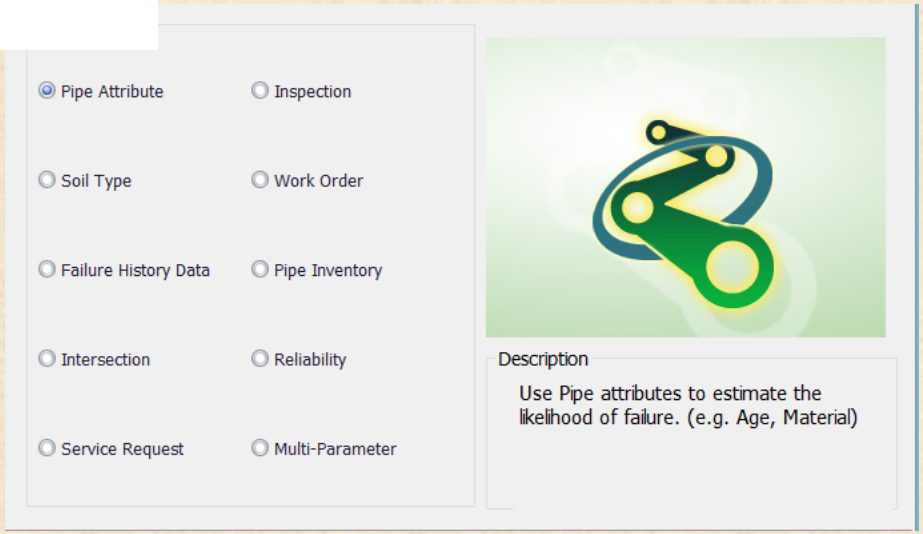
Tacoma's Likelihood of Failure Approach

- Likelihood of Failure (LOF)
  - SEW_LOF3, Reliability of Asset
  - SEW_LOF1, Remaining Useful Life
  - SEW_LOF2, Condition
  - SEW_LOF4, flat concrete mains
  - SEW_LOF4_1, Don't use (flat mains)
  - SEW_LOF4_2, Don't Use (Concrete mains)
  - SEW_LOF4_3, Pipe Function
- Risk



Data Inputs

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Risk Analysis and Prioritization

Likelihood of Failure

- Hydraulic Model
  - Pressure Changes
  - Roughness
- Infrastructure Data
  - Age
  - Material
- GIS Data
  - Soil Type
  - Railroads/Fault Lines
- CMMS & Work Orders
  - Break History
  - Repairs/Lining

Calculation of Risk

Consequence of Failure

- Hydraulic Model results
  - Pipe/Valve Criticality
  - Flow Delivered
- Critical Facilities
  - Hospitals, Schools, etc
  - Power, Industry, etc.
- GIS Data
  - Population Density
  - Street Paving
- Other
  - Traffic Analysis
  - Community Relations

Risk Class	Capital Action
Extreme	High Priority in CIP / Yearly Operational Frequency
High	Standard Priority in CIP / Biannual Operational Frequency
Medium	Low Priority in CIP / 1 in 5 Years Operational Frequency
Low	1 in 10 Years Operational Frequency
Negligible	Wait for a problem to arise

Data Inputs → Analytics → Outputs

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Repeatable Risk Analysis

Consequence of Failures

		ID	Weight	Exponent	Category	Parameter	Description
1	☑	SEW_COF1	1.00	1.00	Pipe Attribute	Diameter	Diameter
2	☑	SEW_COF2	1.00	1.00	Critical Facilities	Critical Facilities - Hosp	Proximity to Fire Stations
3	☑	SEW_COF3	1.00	1.00	Critical Facilities	Critical Facilities - parks	Proximity to Parks
4	☑	SEW_COF4	1.00	1.00	Critical Facilities	Critical Facilities - Police	Proximity to Police Stations
5	☑	SEW_COF5	1.00	1.00	Intersection	Intersection - FEMAFloodZone	FEMA Flood Zone
6	☑	SEW_COF6	1.00	1.00	Critical Facilities	Critical Facilities - Buildings	Buried under Building
7	☐	Sum of Vertical Asset	1.00	1.00		Sum of Vertical Asset COF	Sum of Vertical Asset COF
8	☐	Max of Vertical Asset	1.00	1.00		Max of Vertical Asset COF	Max of Vertical Asset COF
9	☐	Avg of Vertical Asset	1.00	1.00		Avg of Vertical Asset COF	Avg of Vertical Asset COF
10	☐	Median of Vertical Asset	1.00	1.00		Median of Vertical Asset COF	Median of Vertical Asset COF
11	☐	Mode of Vertical Asset	1.00			Vertical Asset COF	Mode of Vertical Asset COF

Facility Scope

- (●) Full Network
- ( ) Selection
- ( ) Zone

Likelihood of Failures

		ID	Weight	E		Parameter	Description
1	☑	SEW_LOF1	1.00				Material
2	☑	SEW_LOF2	1.00		1.00	Pipe Attribute InstallDate	Pipe Age
3	☑	SEW_LOF3	1.00		1.00	Intersection Intersection - Railroad	Proximity to Rail Roads
4	☐	Sum of Vertical Asset	1.00		1.00	Sum of Vertical Asset LOF	Sum of Vertical Asset LOF
5	☐	Max of Vertical Asset	1.00		1.00	Max of Vertical Asset LOF	Max of Vertical Asset LOF
6	☐	Avg of Vertical Asset	1.00		1.00	Avg of Vertical Asset LOF	Avg of Vertical Asset LOF
7	☐	Median of Vertical Asset	1.00		1.00	Median of Vertical Asset LOF	Median of Vertical Asset LOF
8	☐	Mode of Vertical Asset	1.00		1.00	Mode of Vertical Asset LOF	Mode of Vertical Asset LOF

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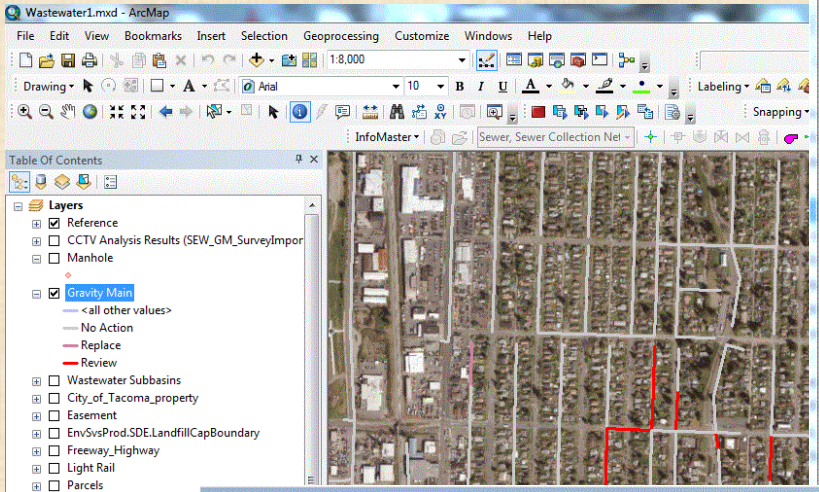
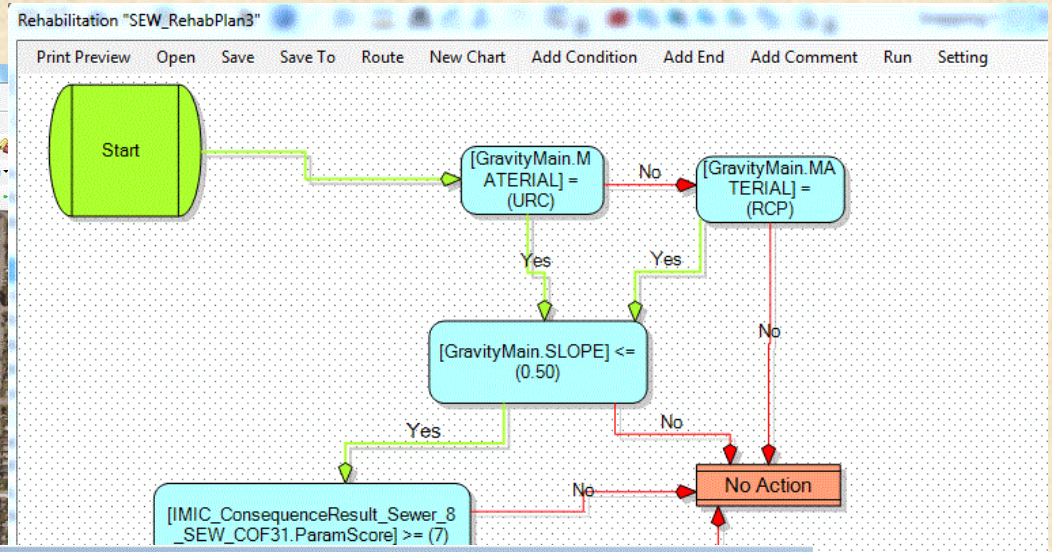
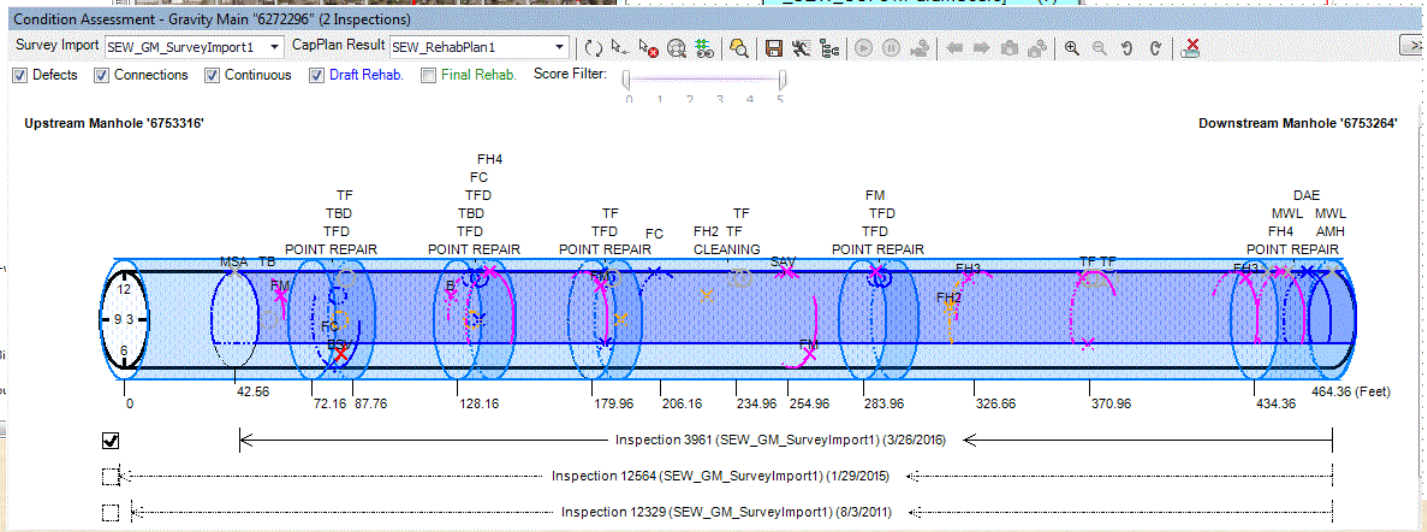
Rehab Planning







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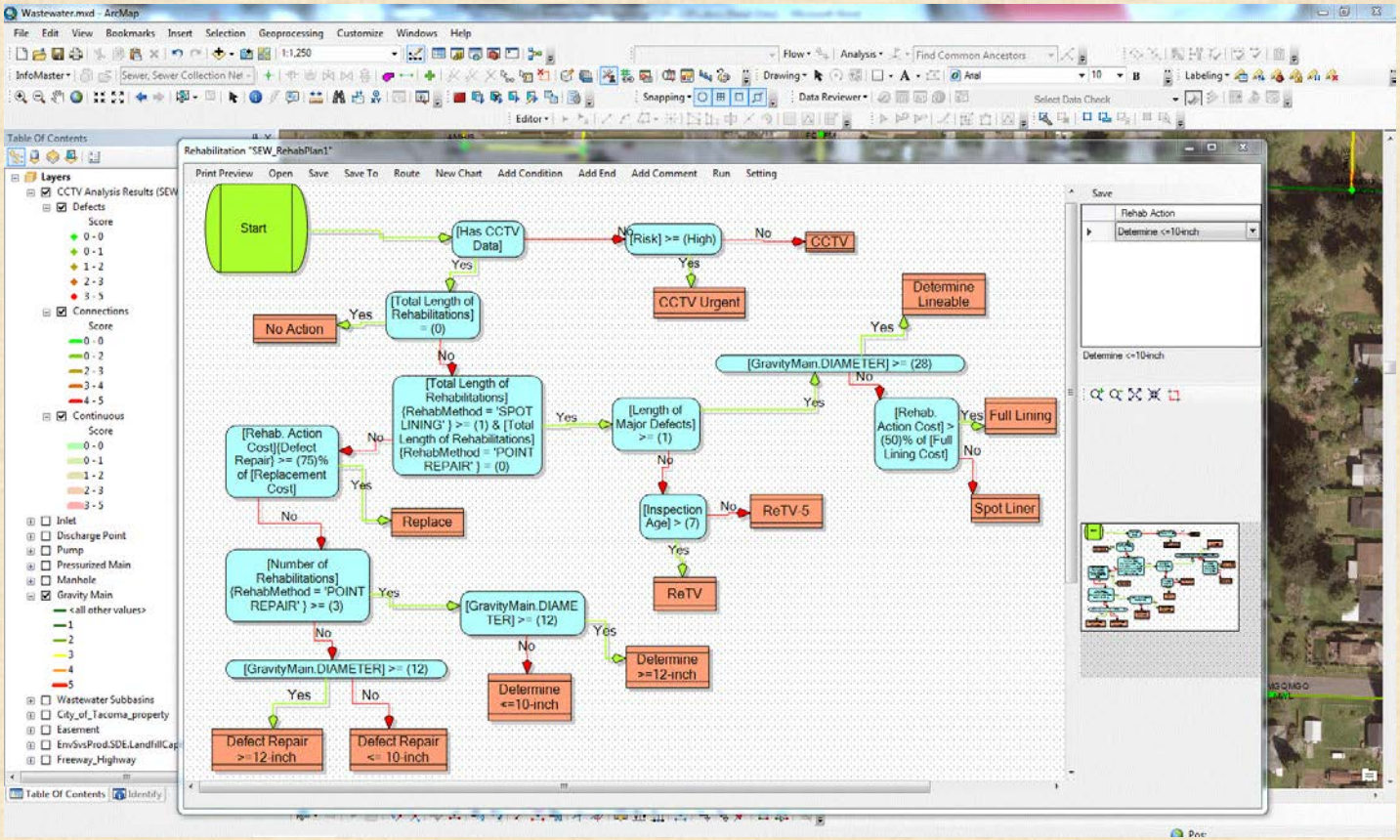
Rehabilitation & Budgeting Engine

Rehabilitation Plans …Is it lineable? “To Re-TV, or NOT to Re-TV”



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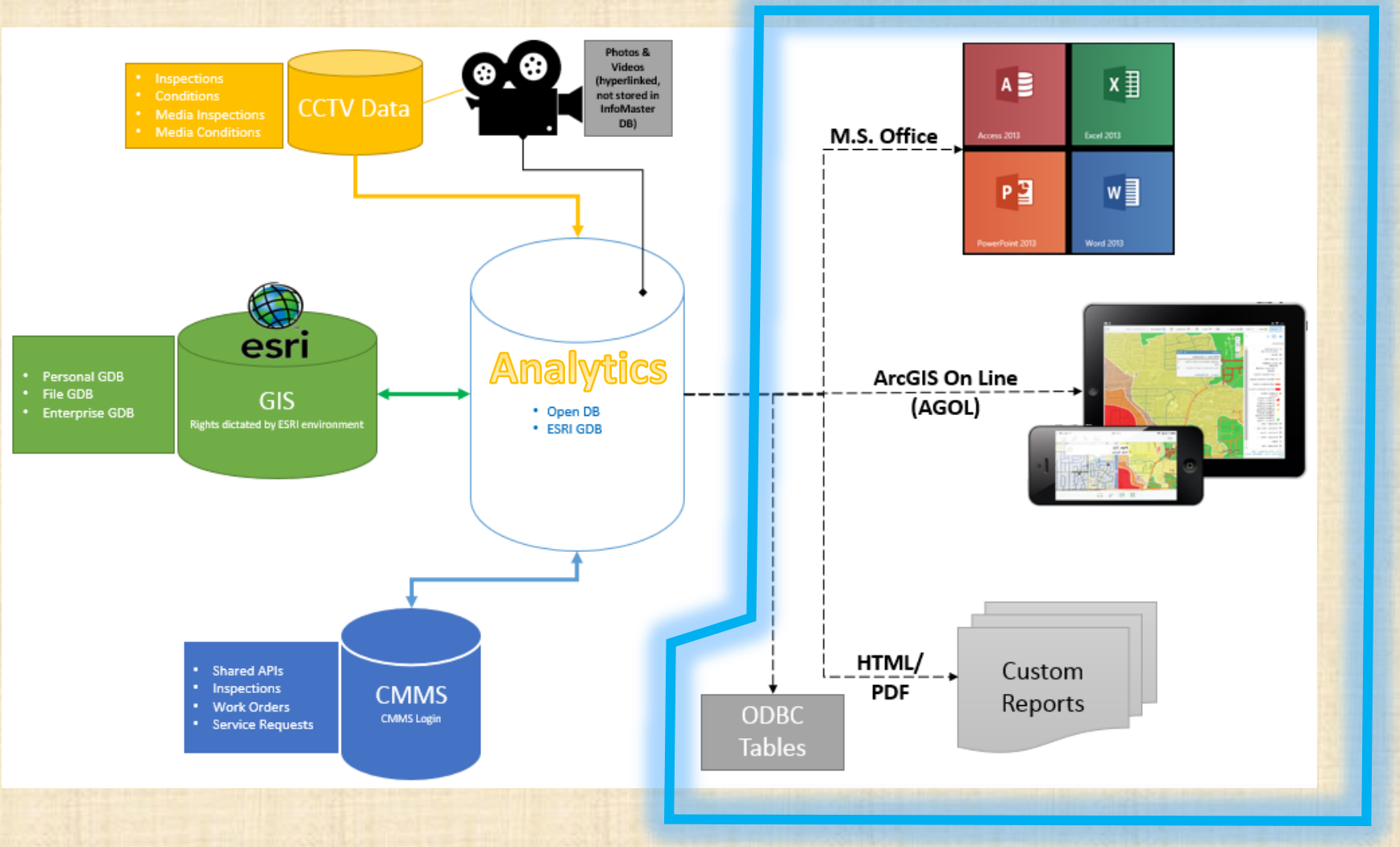

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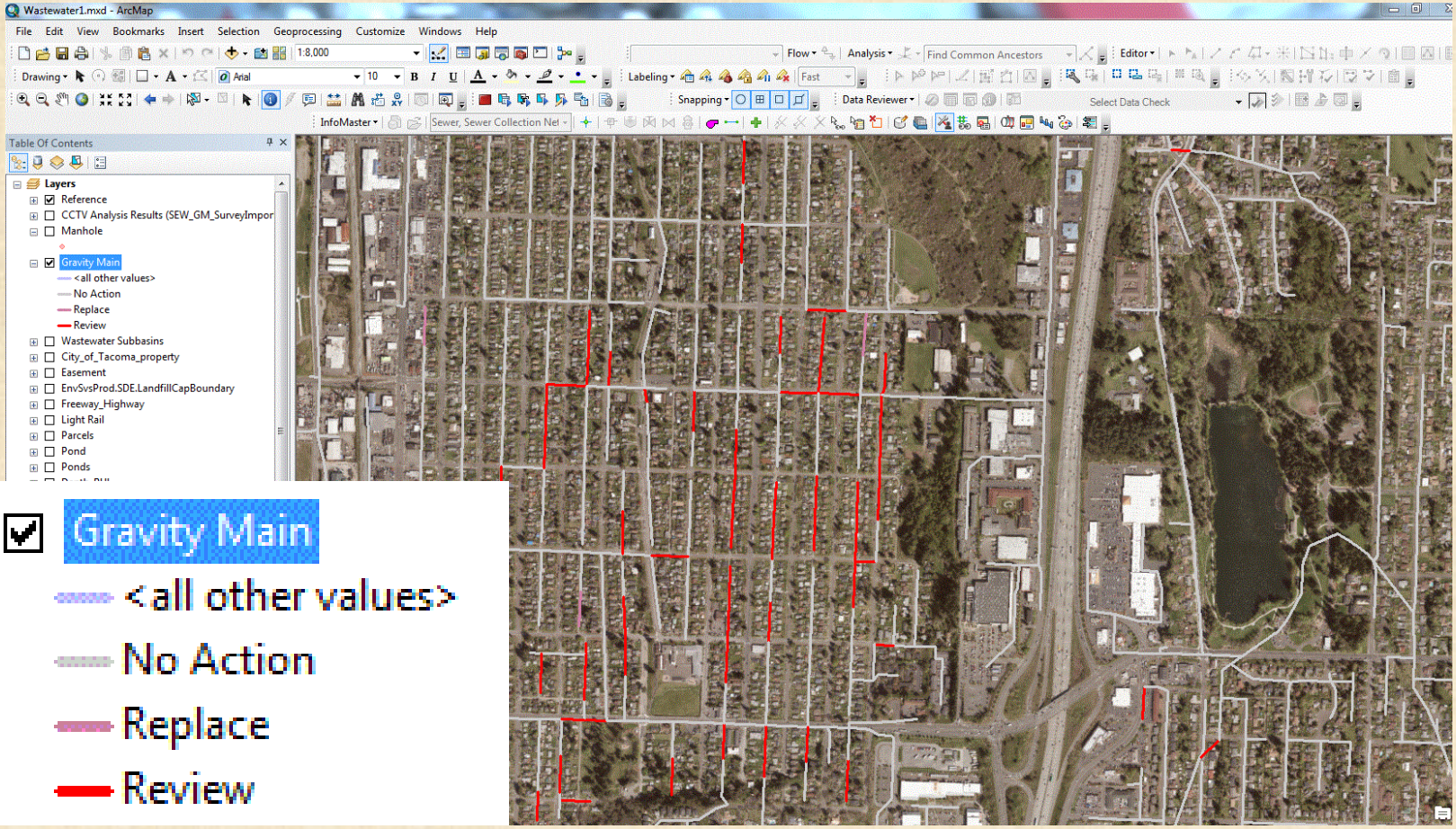
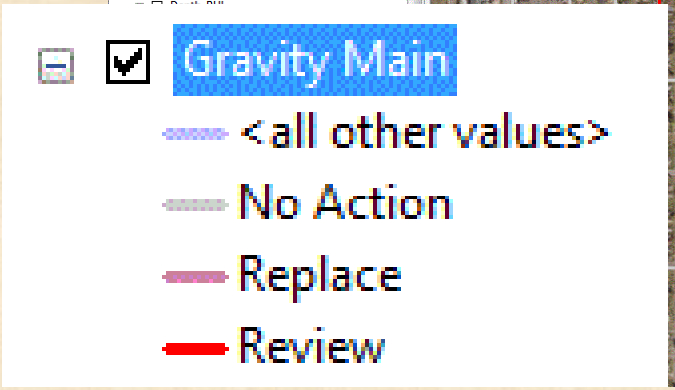
Spatial Viewing of Results





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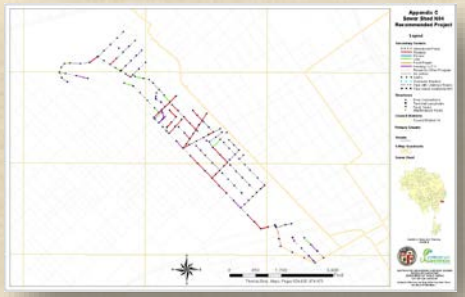
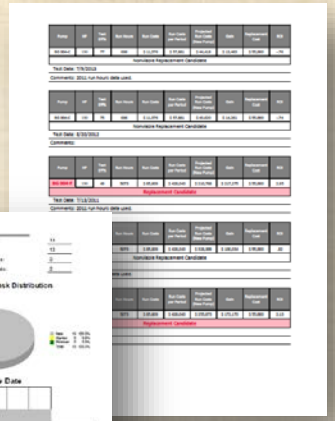
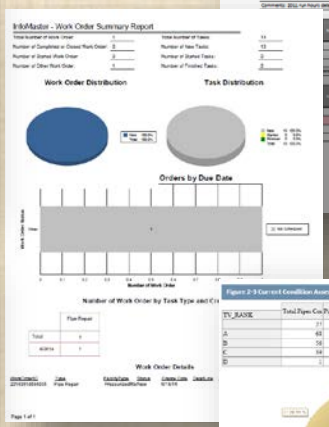
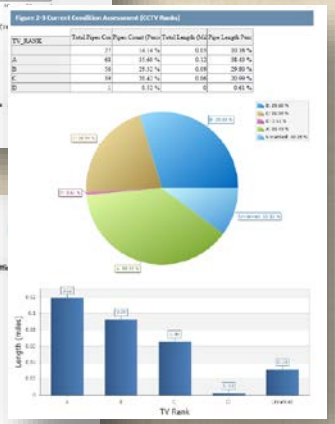
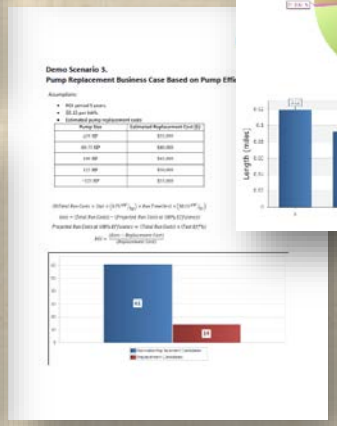
Reporting

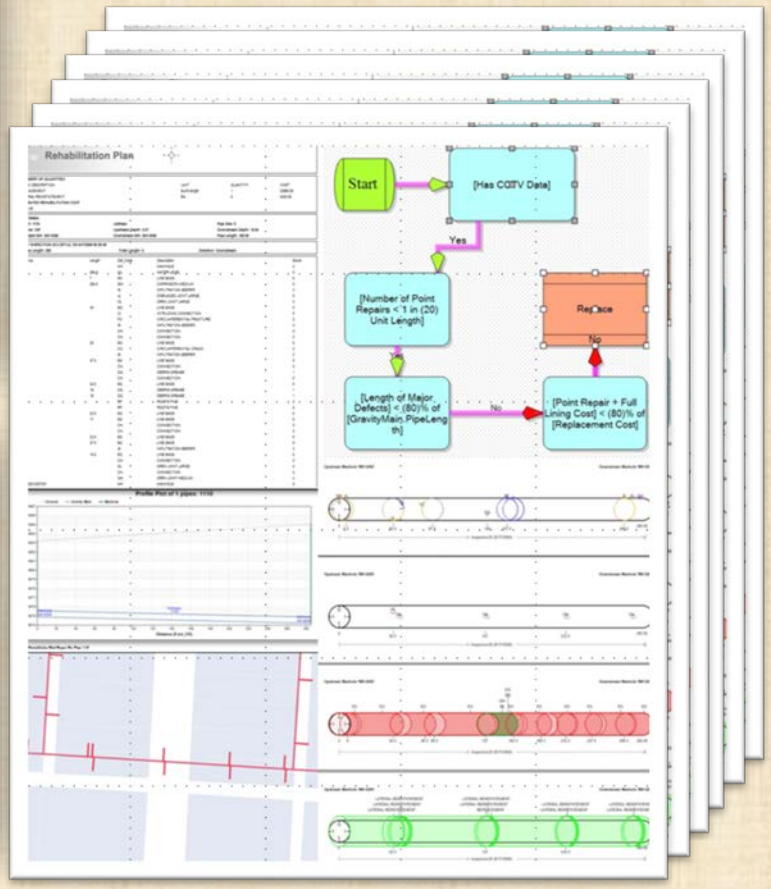












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Analytics

Outputs

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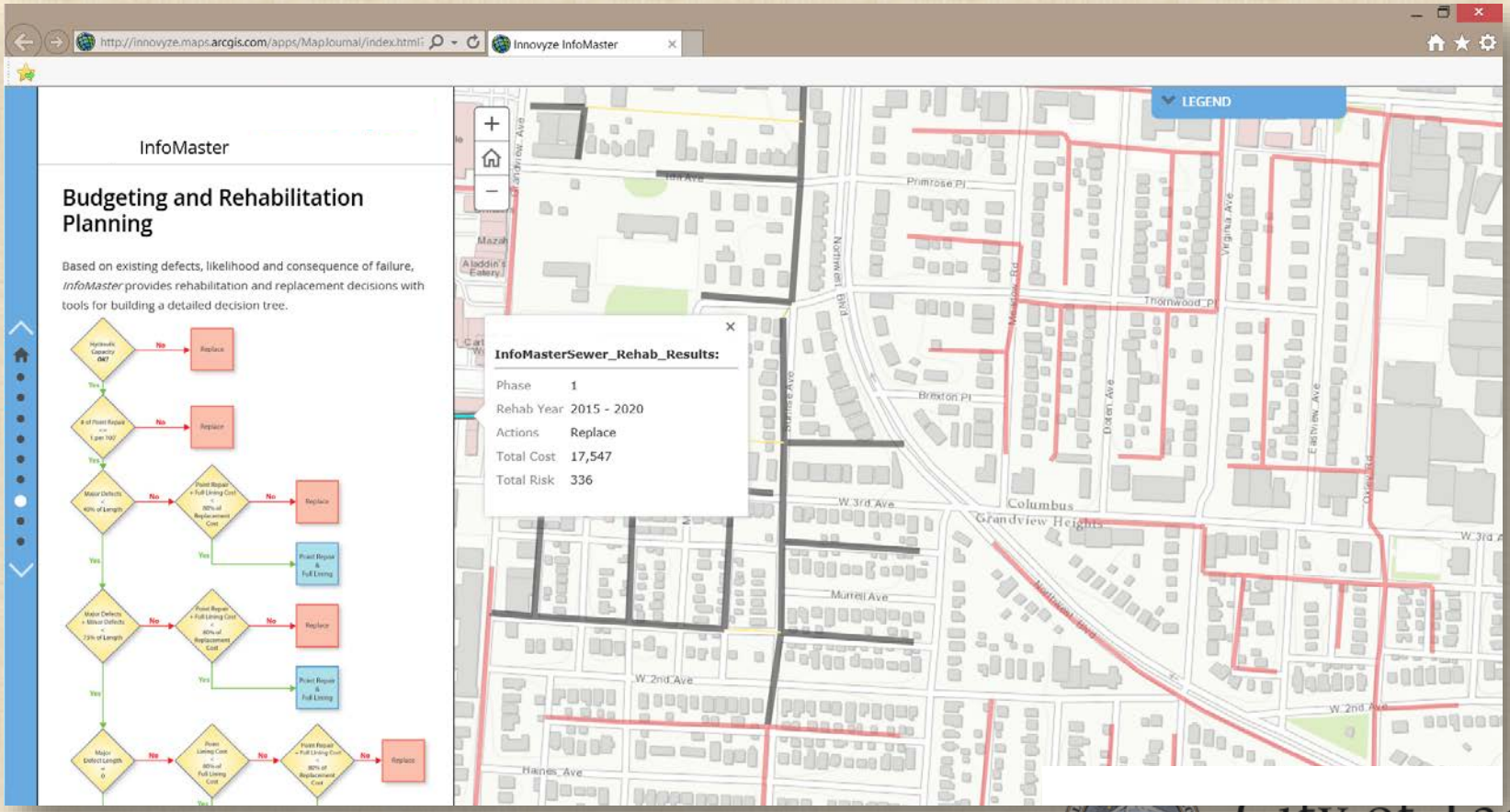
Results in GIS



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Developing an Approach for your Utility

- Build on a good GIS base
  - Good asset data (material & age)
  - Spatial data sets
- Add asset management & historical data
  - Type and number of breaks and leaks
  - Link between work activity and affected assets
- Identify risk and performance factors
  - Where failure will impact service?
  - What do you and your customers worry most about?
- Feed back data to asset database (GIS)
  - Internal procedures
  - Leverage existing and new computer technology

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Thanks For Joining Us!!!

Teresa Dressler, P.E.
City of Tacoma, Environmental Services
Science & Engineering
tdressle@cityoftacoma.org

Greg Brazeau, P.E.
Client Service Manager
Innovyze
Greg.Brazeau@Innovyze.com

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