

Using GIS to Assess Water Main Risk & to Develop Capital Projects

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CITY OF
Vancouver
WASHINGTON

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Presentation Summary

- Discuss historic/current approach to assessing water main risk.
- Discuss new approach to assessing water main risk.
- Demo of BETA tool

Historical Capital Prioritization Approach



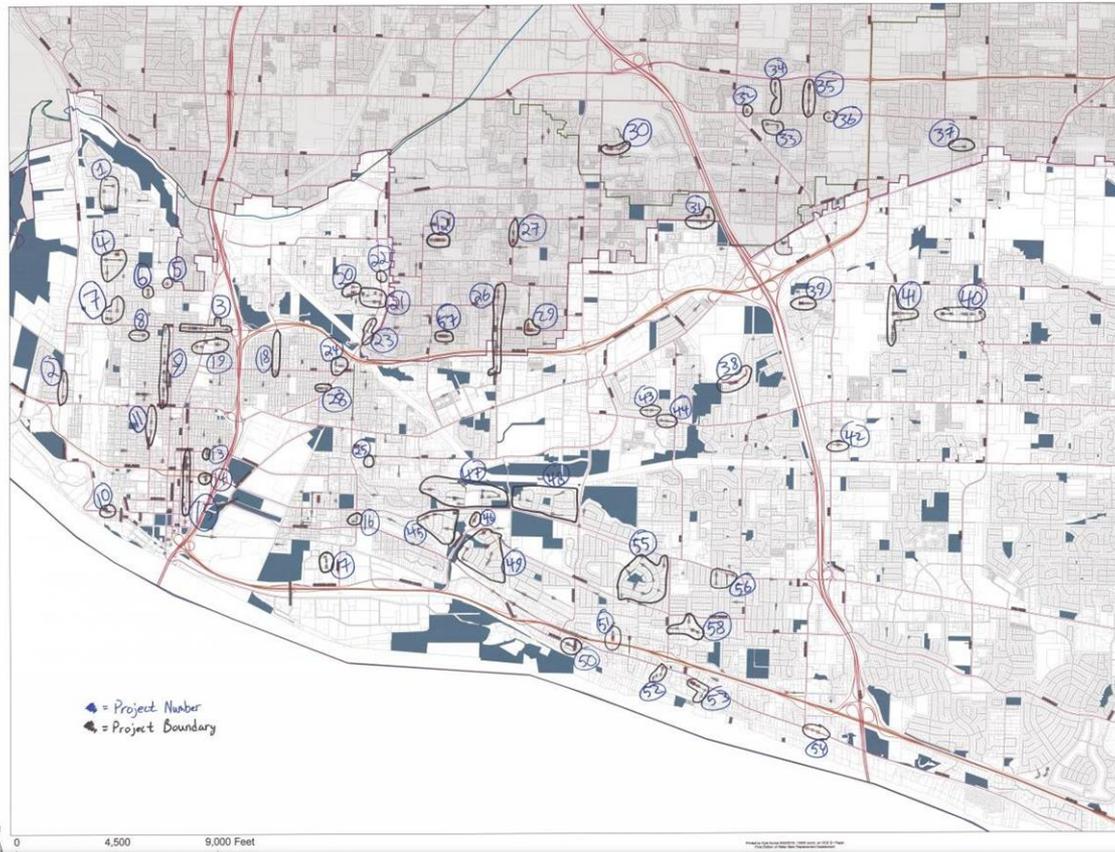
We need to do the 16th St. Project first...

Man, I hate working with engineers...

Historic Approach – Summary

- 2010 Finance and AM group formed
- 2012 Risk Matrix using Likelihood of Failure (LoF) & Consequence of Failure (CoF)
- 2016 intern project

Historic Approach – Sample Data: Proj Map



Historic Approach – Sample Data: Proj Map

NE 45th ST
& NE 44th ST

10 Leaks
6" OD
2" GALV

2200 LF
1960-1969

WO70W.WO2879
WO2247.WO2548
WO4139



- Comp/FF none
- Street Type Residential & Arterial
- Residential Services 36
- Multi-Family Services 3
- Commercial Industrial Services 0
- Govt. Other Services 1



0 80 Feet

pg. 23

Comments:

21

Historic Approach – Sample Data: Proj Map

Project Number	Name	# Of Leaks	Size of Pipe	Type of Pipe	Project LF	Year	Pipe Project Numbers	Comp/FF Project	Residential Services	Multi-Family Services	Commercial & Industrial Services
1	NE 58th to 62nd ST	5	6,4	OD	3200	1948-1966	WO425, WO754, WO514, WO503	D-5	44	0	0
2	Fruit Valley & W 28th ST	2	6	CI	1200	1950	WO694, WO579	T-9	8	6	2
3	39th ST & Main ST	12	8,8,2	MATH,CI,GALV	2800	1911-1918	?	none	30	5	10
4	NW 49th ST & NW Cherry ST	6	6,4	OD,CI	3700	1943-1955	WO271, WO597, WO649, WO337, WO341,WO360	none	53	0	0
5	NW Daniels ST & NW 46th ST	1	2	CI	150	1949	WO564	none	3	0	0
6	NW Grant ST & NW 45th ST	2	6	CI	800	1940-1956	WO809, WO138	none	16	0	0
7	NW Lavina ST & NW 41st ST	5	6,2,4,2	GALV,CI	2600	1915-1952	WO199, WO685, WO671,	D-11	43	0	0
8	W 38th ST & Columbia AVE	2	2	GALV	1600	1913	?	none	36	2	0
9	Daniels ST	15	4	MATH,OD	4200	1911-1940	?	D-12	37	2	0
10	W 8th ST & Hill ST	2	12	AC	300	1940	WO220	none	0	0	1
11	Franklin ST & 21st ST	2	8,6	CI	1400	1967	WO3597, WO4175	none	26	0	0
12	NE 54th ST & NE 40th AVE	7	6	OD	1200	1961	WO2646	none	21	0	0
13	E ST & E McLoughlin RD	1	6	MATH	300	1911	?	none	1	1	1
14	E ST & E 13th ST	4	6,4	OD,MATH	1400	1911-1954	WO54, WO784	none	0	1	3
15	Broadway	6	12,6	MATH	2300	1912-1915	?	none	0	0	20
16	E 8th ST & Grand BLVD	2	6,4	CI	1500	1953	WO771	none	7	1	9
17	Y ST & E 1st ST	3	6	OD,CI	1500	1947-1953	WO755, WO446	none	0	0	5
18	P ST & E 33rd ST	1	10	CI	1350	1940	WO139	none	25	5	0
19	E 36th ST & Main ST	4	6,4	CI,MATH	1800	1928-1959	WO175, WO158, WO1930	none	23	0	3
20	NE 46th ST & NE 28th AVE	5	2	GALV	800	1963-1969	WO3481, WO10347, WO10703	none	18	0	0
21	NE 45th ST & NE 44th ST	10	6,2	OD,GALV	2200	1960-1966	WO70W, WO2879, WO2247, WO2548	none	36	3	0
22	NE Saint James RD & NE 49th ST	2	6	OD	300	1955	WO710	none	3	0	2
23	NE Saint James RD & NE Cherry RD	3	6	OD	1300	1960-1966	WO4139, WO 2177	none	9	0	0
24	E 33rd ST & NE Saint James RD	4	6	CI,OD	1500	1938-1961	WO78, WO2582, WO22	none	15	4	8
25	Murton ST	2	2	GALV	250	1965	WO26W	none	0	6	0
26	NE Stapleton RD	8	10,6	OD	4300	1953-1963	WO759, WO3149, WO1369	none	49	4	0

Historic Approach - Sample Data: Proj. Report Card

Project Number	Project Name:	SE Northgate AVE & SE 95th AVE										Family	Commercial & Industrial Services		
1	NE 58th	Project Number:	56											0	
Consequence of Failure															
2	Fruit Valley	Pipe Segment 1	Pipe Size (in.)	Score	Pipe Type	Score	LF	Street Type	Score	Sum	Percent (%)	Weighted Sum	2		
3	39th	Pipe Segment 2	6	0	OD	0	625	RESIDENTIAL	0	0	24%	0.00			
4	NW 49th	Pipe Segment 3	4	0	OD	0	1950	RESIDENTIAL	0	0	76%	0.00	10		
5	NW Daniel	Pipe Segment 4	N/A	0	N/A	0	N/A	N/A	0	0	N/A	N/A	0		
6	NW Grand	Pipe Segment 5	N/A	0	N/A	0	N/A	N/A	0	0	N/A	N/A	0		
7	NW Lavin	Pipe Segment 6	N/A	0	N/A	0	N/A	N/A	0	0	N/A	N/A	0		
8	W 38th ST	Pipe Segment 7	N/A	0	N/A	0	N/A	N/A	0	0	N/A	N/A	0		
		Total	-	-	-	-	2575	-	-	-	-	0.00			
Likelihood of Failure															
9	D	Services											0		
		#SF	#MF	#COMM	#School	#Industrial	#Medical	Total							
10	W 8th	#Services	37	1	0	0	0	0	38				0		
11	Franklin	Weight	0	1	-	-	-	-	1				1		
12	NE 54th	Fire Flow?	NO										0		
13	E ST & E	Weight	0										0		
		#LF/SVC													
14	E ST	Linear Feet / SVC	67.76										2		
		Weight	2										2		
											Consequence Sum	3.00	3		
15	B												20		
16	E 8th St	Pipe Segment 1	Pipe Size (in.)	Score	Pipe Type	Score	LF	Leaks	Score	Year	Score	Sum	Percent (%)	Weighted Sum	9
17	Y St	Pipe Segment 2	6	0	OD	1	625	2	5	1954	1	7	24%	1.70	
18	P St	Pipe Segment 3	4	0	OD	1	1950	1	1	1954	1	3	76%	2.27	
19	E 36th	Pipe Segment 4	N/A	0	N/A	0	N/A	N/A	0	N/A	0	0	N/A	N/A	
20	NE 46th	Pipe Segment 5	N/A	0	N/A	0	N/A	N/A	0	N/A	0	0	N/A	N/A	
21	NE 45th	Pipe Segment 6	N/A	0	N/A	0	N/A	N/A	0	N/A	0	0	N/A	N/A	
22	NE Saint James	Pipe Segment 7	N/A	0	N/A	0	N/A	N/A	0	N/A	0	0	N/A	N/A	
		Total	-	-	-	-	2575	3	-	-	-	-	-	3.97	
22	NE Saint James												2		
23	NE Saint James												0		
24	E 33rd ST &												8		
25	N												9		
26	NE S												0		
												Estimated Project Cost	\$ 478,950.35		
												Results	Raw	Scaled	
												Consequence	= 3.0	2	
												Condition	= 4.0	2	

Historic Approach – Pro's & Con's

Disadvantages

- Labor Intensive/Time Consuming
- Only looking at pipes with leaks.
- Lack flexibility / Not easy to add/consider additional LoF and CoF criteria.

Not a Long-term needs evaluation

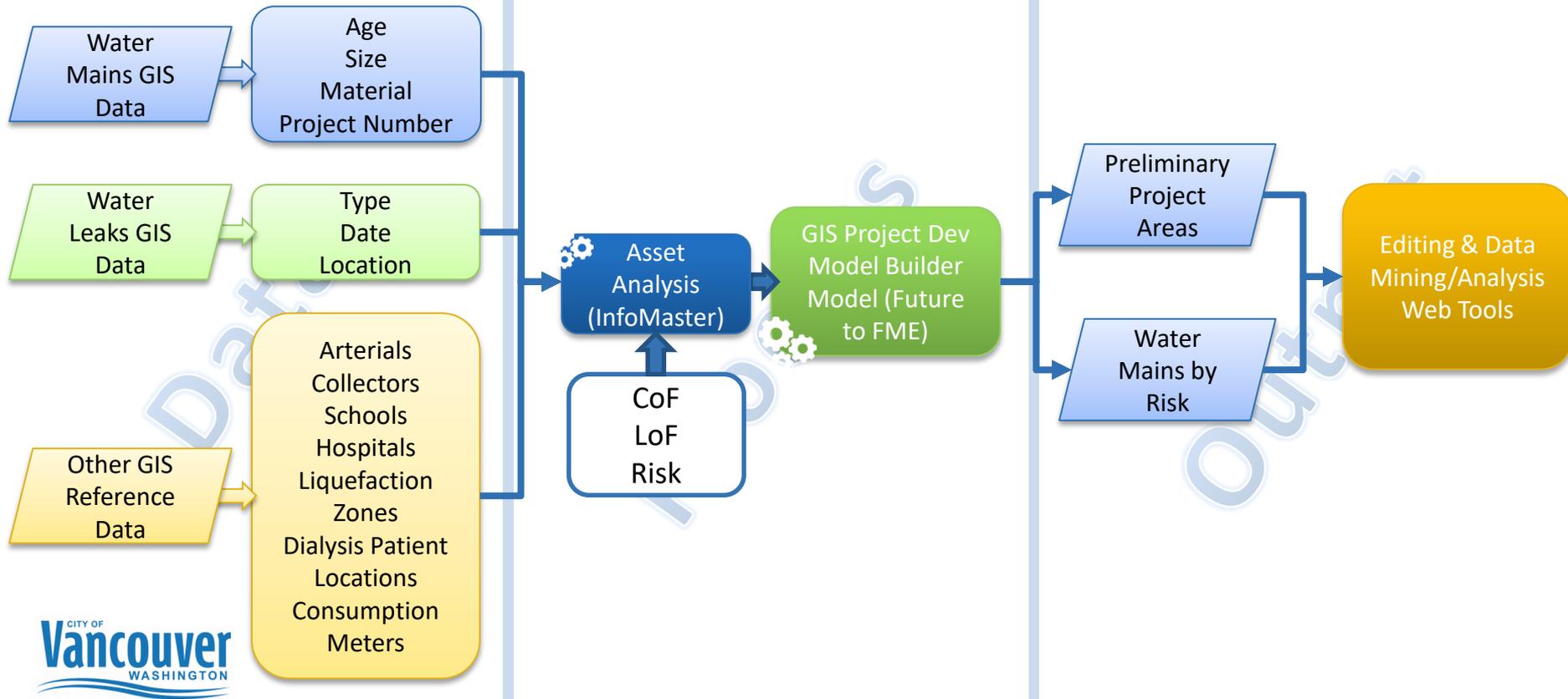
Advantages

- Comprehensive reporting (Excel).
- Thorough/Effective
- Has worked for several years – staff familiar with process.

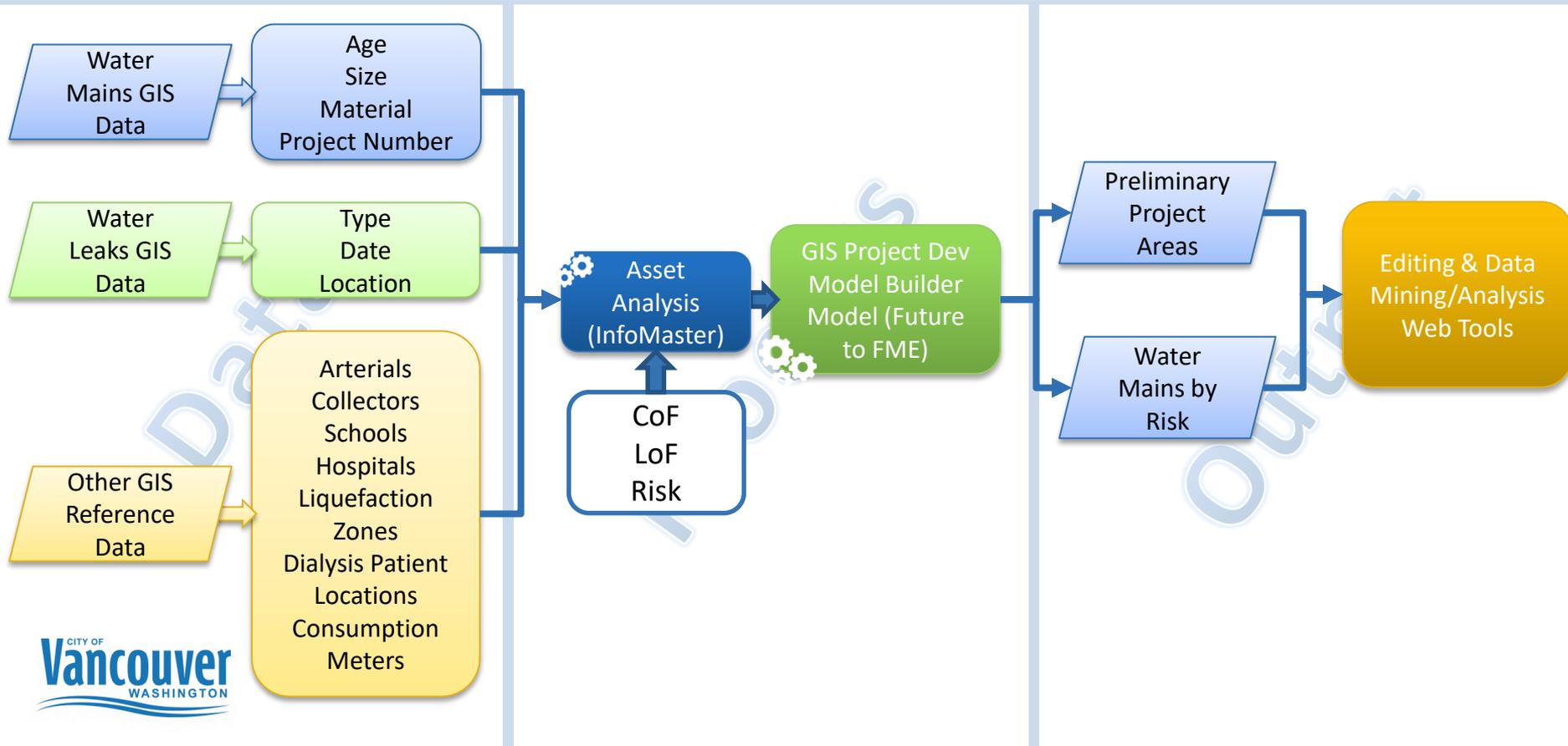
New Approach Goals – Desired Improvements

- Intuitive tool that will allow end users to mine / search and discover asset data as it relates to risk.
- Increase efficiency...
- Reduce manual review by adding automation
- Repeatable / consistent process and results.
- Add flexibility

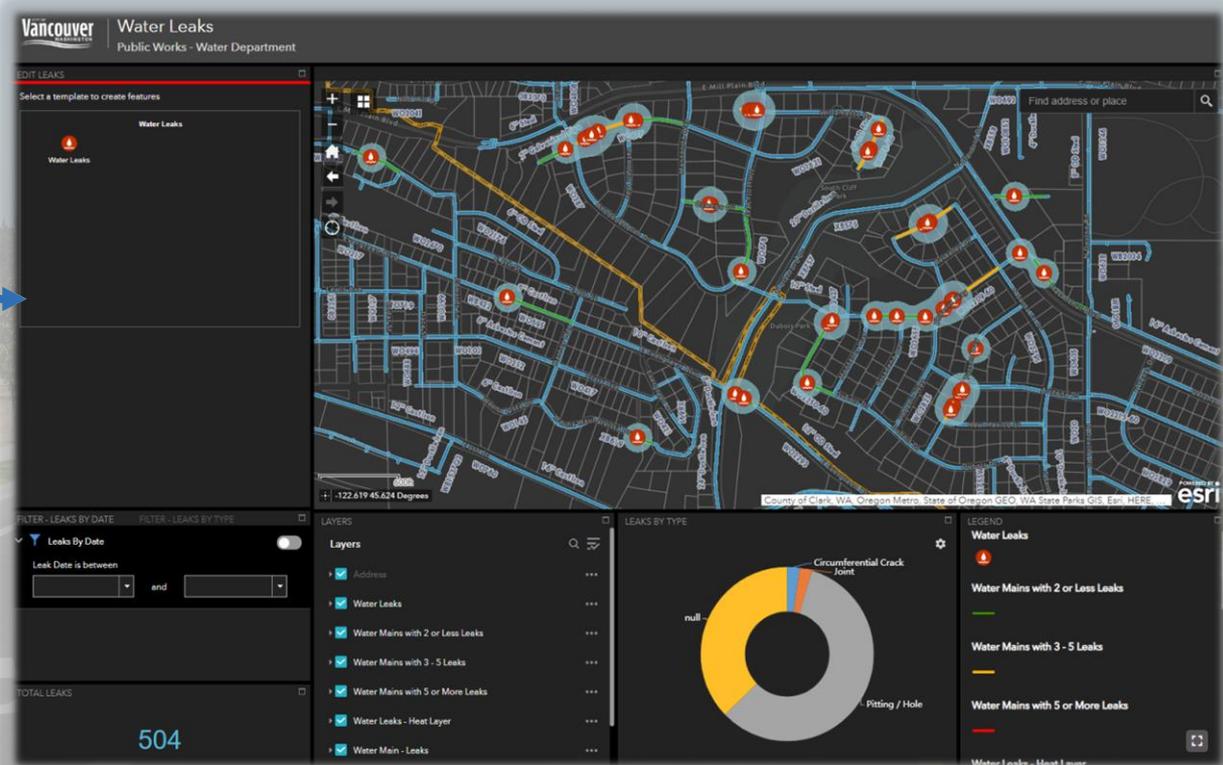
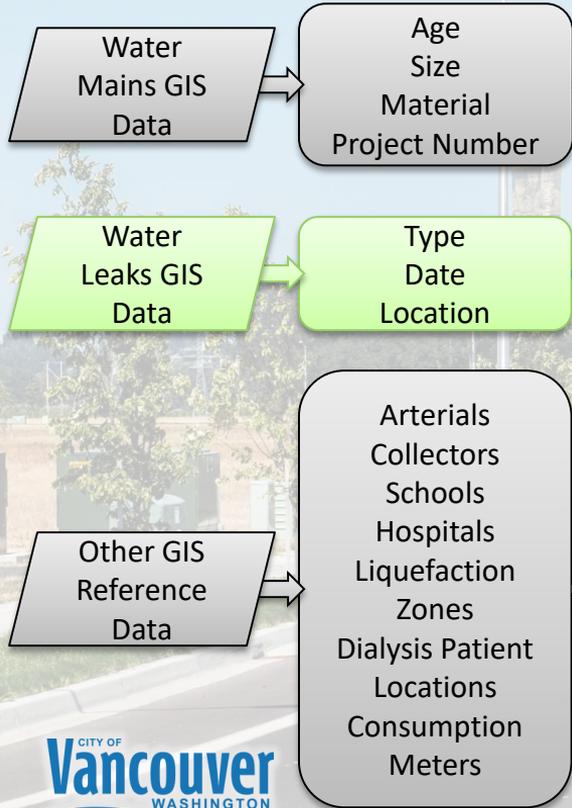
Modified GIS Approach – Requirements



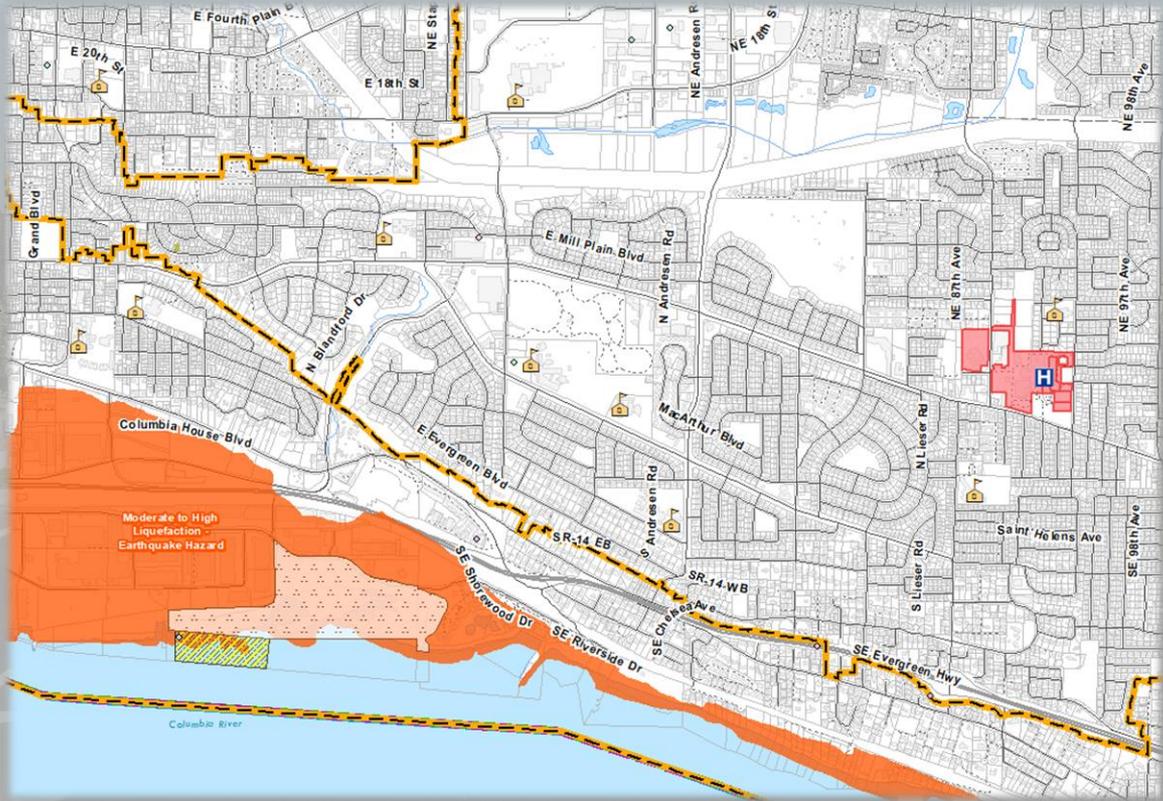
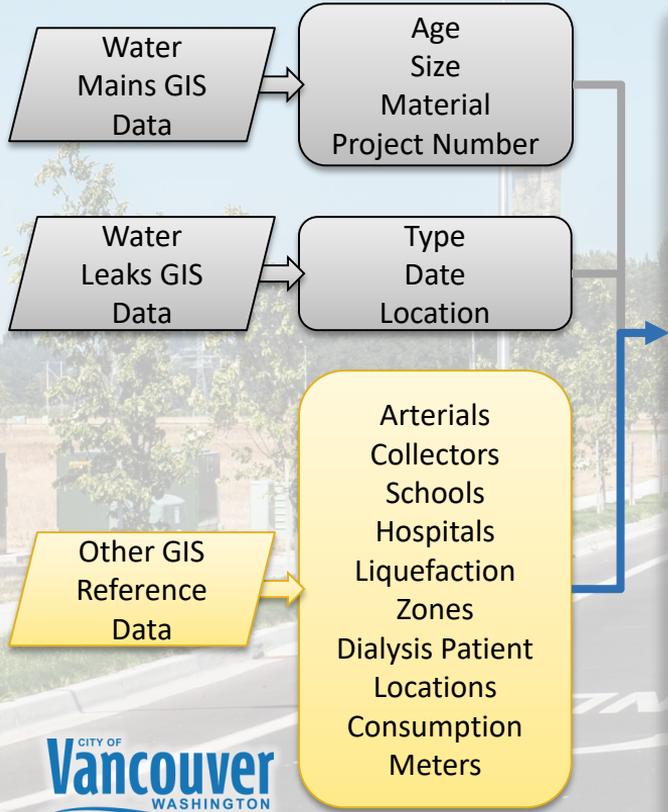
GIS Approach – Water Mains GIS Data



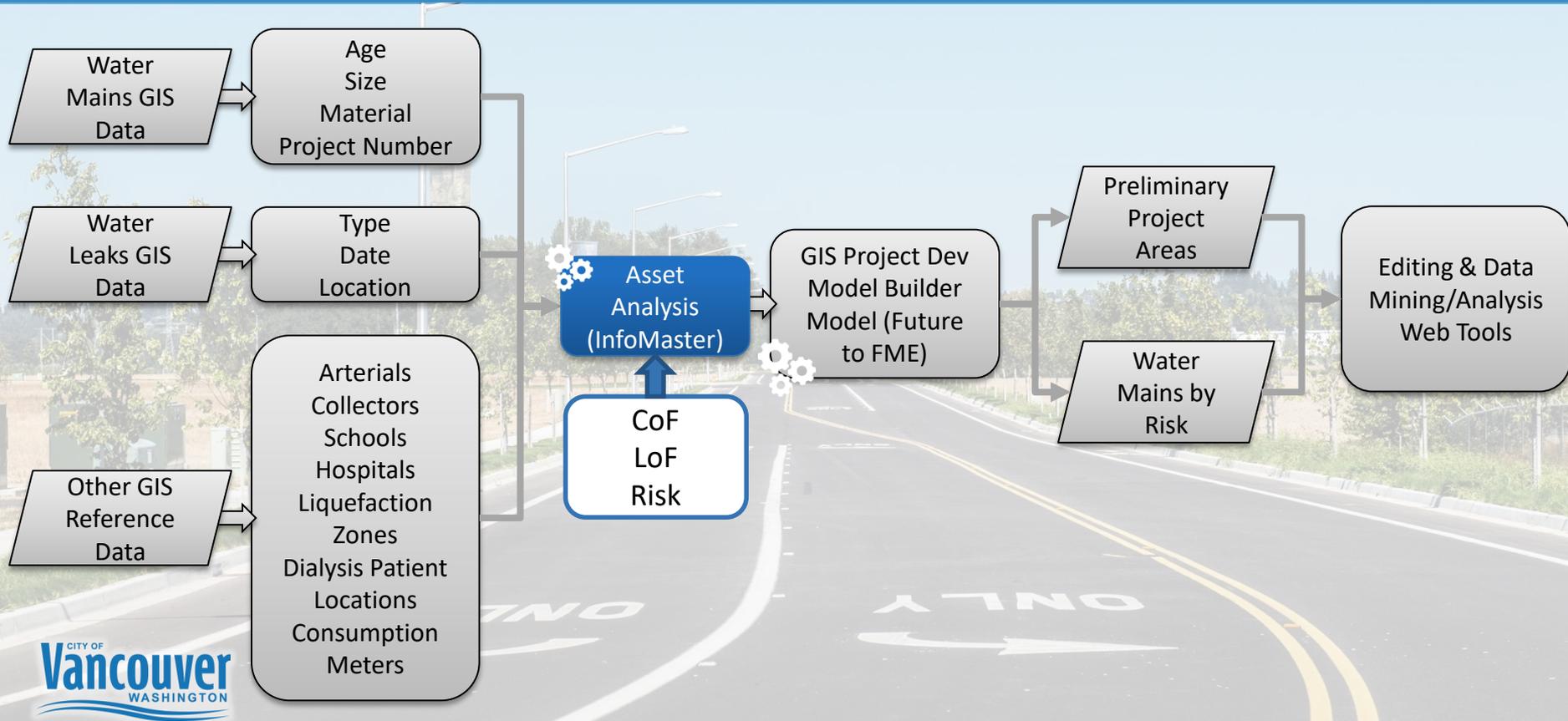
GIS Approach – Water Leaks GIS Data



GIS Approach – Other GIS Reference Data



GIS Approach – Asset Analysis (InfoMaster)



GIS Approach – Asset Analysis Recipe (InfoMaster)

Consequence of Failure (CoF)

- Consequence of Failure (COF)
- wMain_CO1, Pipe Size
- wMain_CO2, Pipe Material
- wMain_CO3, Install Year
- wMain_CO4, Leaks/LF
- wMain_CO5, Liquefaction
- wMain_CO6, Laterals/
- wMain_CO7, Cast Iron 1938-1945
- wMain_CO8, Leaks/LF(2 Leaks or Greater)
- wMain_CO9, CI_1938_1941
- wMain_CO10, Test
- wMain_CO11, Test

Asset
Analysis
(InfoMaster)

CoF
LoF
Risk

Likelihood of Failure (LoF)

- Likelihood of Failure (LOF)
- wMain_LOF1, Pipe Size
- wMain_LOF2, Pipe Material
- wMain_LOF3, Install Year
- wMain_LOF4, Leaks/LF
- wMain_LOF5, Liquefaction
- wMain_LOF6, Cast Iron 1938-1945
- wMains_LOF4a, Leaks/LF(2 Leaks or Greater)
- wMain_LOF_Test, CI_1938_1941

X

GIS Approach – Asset Analysis Recipe (InfoMaster)

Consequence of Failure

- Consequence of Failure
- wMain_COF1, Pipe
- wMain_COF2, Pipe
- wMain_COF3, Dea
- wMain_COF4, Arte
- wMain_COF5, High
- wMain_COF6, Late
- wMain_COF7, Con
- wMain_COF8, Con
- wMain_COF9, Sch
- wMain_COF10, Ho
- wMain_COF11, Dis

Scoring Range

Score Method

Scoring Range

Score Method

Score Method

Score Method

Score Method

Breaker	Range	Score	No.	Length (Miles)
1916.0101	<= 1916.0101	3	244	4.13
1941.0101	1916.0101 - 1941.0101	2	737	16.40
1966.0101	1941.0101 - 1966.0101	1	5851	144.23
2018.0412	1966.0101 - 2018.0412	0	54753	854.52
[blank value]		0	2447	24.74

Score Method

Range

Unique Values

Classes: 4

Equal Interval

Natural Breaks

Quantile

Score Chart

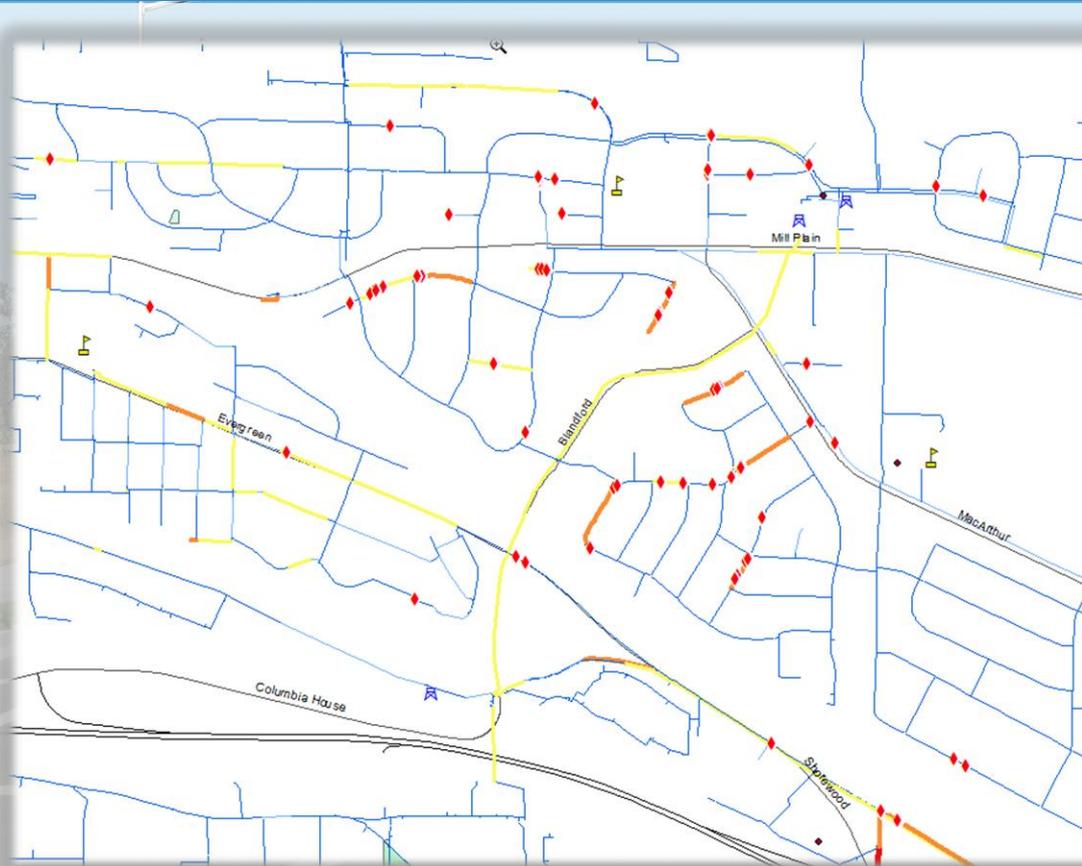
Histogram

GIS Approach – Asset Analysis Result (InfoMaster)

InfoMaster Risk Result Layer

Water Mains By Risk Grading

- 1 - Negligible Risk
- 2 - Low Risk
- 3 - Medium Risk
- 4 - High Risk
- 5 - Extreme Risk



- Facility Analysis
 - Pressurized Main CapPlan
 - Consequence of Failure (COF)
 - wMain_COF1, Pipe Size
 - wMain_COF2, Pipe Material
 - wMain_COF3, Dead Ends/Redundancy
 - wMain_COF4, Arterials
 - wMain_COF5, Highways
 - wMain_COF6, Laterals/LF
 - wMain_COF7, Consumption/Pipe(with meters only)
 - wMain_COF8, Consumption/Pipe(All Pipes)
 - wMain_COF9, Schools
 - wMain_COF10, Hospitals
 - wMain_COF11, Dialysis Patients
 - Likelihood of Failure (LOF)
 - wMain_LOF1, Pipe Size
 - wMain_LOF2, Pipe Material
 - wMain_LOF3, Install Year
 - wMain_LOF4, Leaks/LF
 - wMain_LOF5, Liquefaction
 - wMain_LOF6, Cast Iron 1938-1945
 - wMains_LOF4a, Leaks/LF(2 Leaks or Greater)
 - wMain_LOF_Test, CI_1938_1941
 - Risk
 - wMain_Risk_1
 - wMain_Risk_2
 - wMain_Risk_3
 - wMain_Risk_4
 - wMain_Risk_5
 - wMain_Risk_6
 - Reliability Analysis
 - Cohort Reliability Analysis
 - Regression Reliability Analysis
 - WAT_FD1, New Failure/Deterioration Model
 - Rehabilitation Plan
 - wRehabPlan_1
 - Example_DC
 - Hydrant CapPlan
 - Consequence of Failure (COF)
 - Likelihood of Failure (LOF)
 - Risk
 - System Valve CapPlan
 - Consequence of Failure (COF)
 - Likelihood of Failure (LOF)

GIS Approach – Asset Analysis Result (InfoMaster)

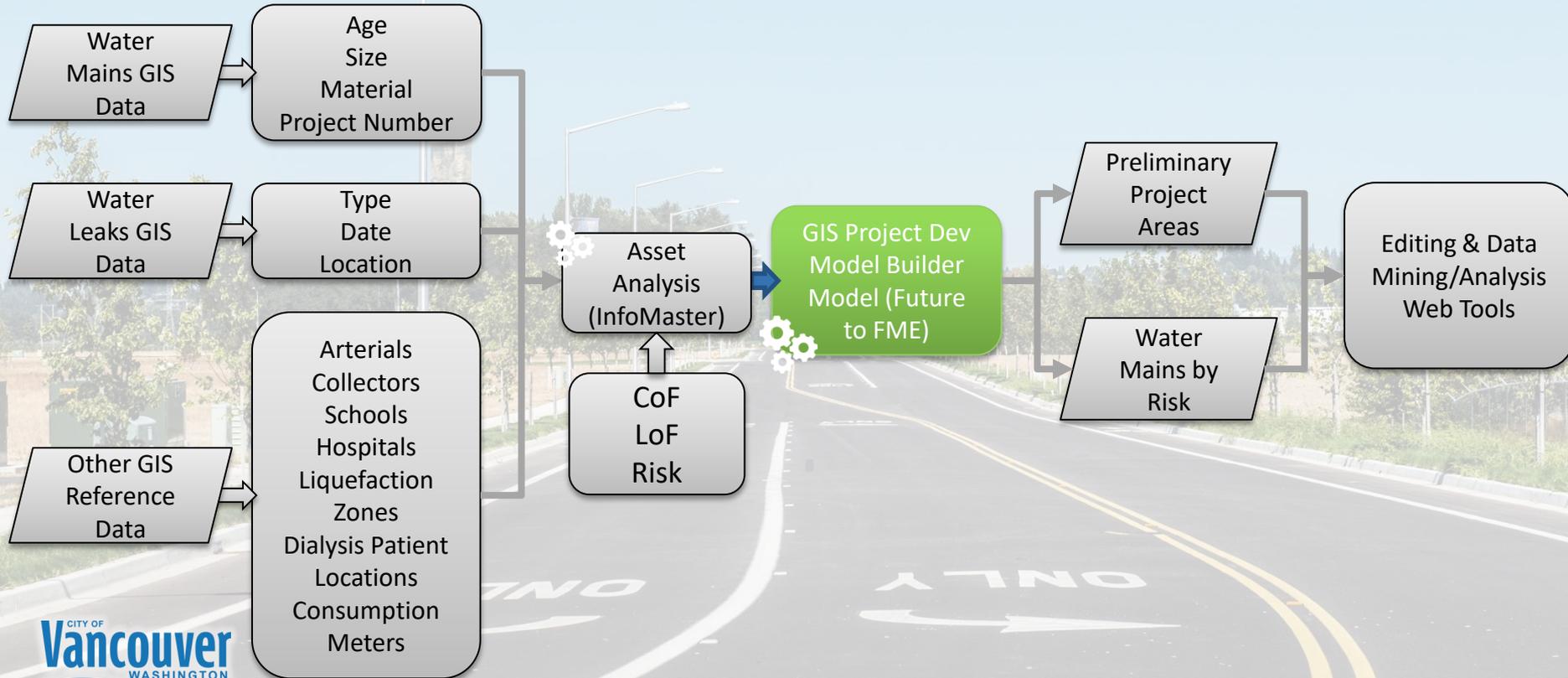
InfoMaster Risk Result Layer

Water Mains By Risk Grading

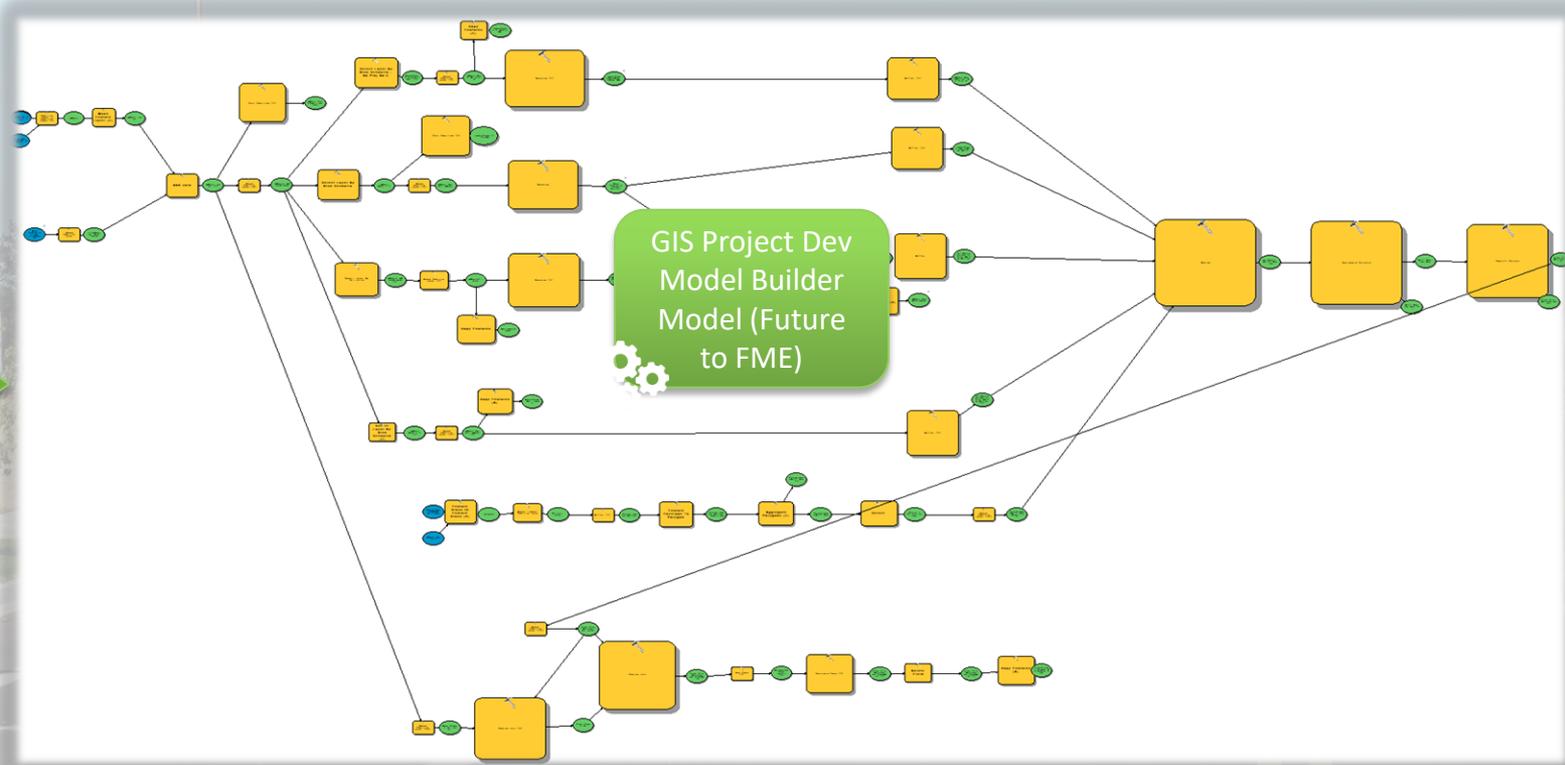
- 1 - Negligible Risk
- 2 - Low Risk
- 3 - Medium Risk
- 4 - High Risk
- 5 - Extreme Risk



GIS Approach – Creation of Project Boundaries



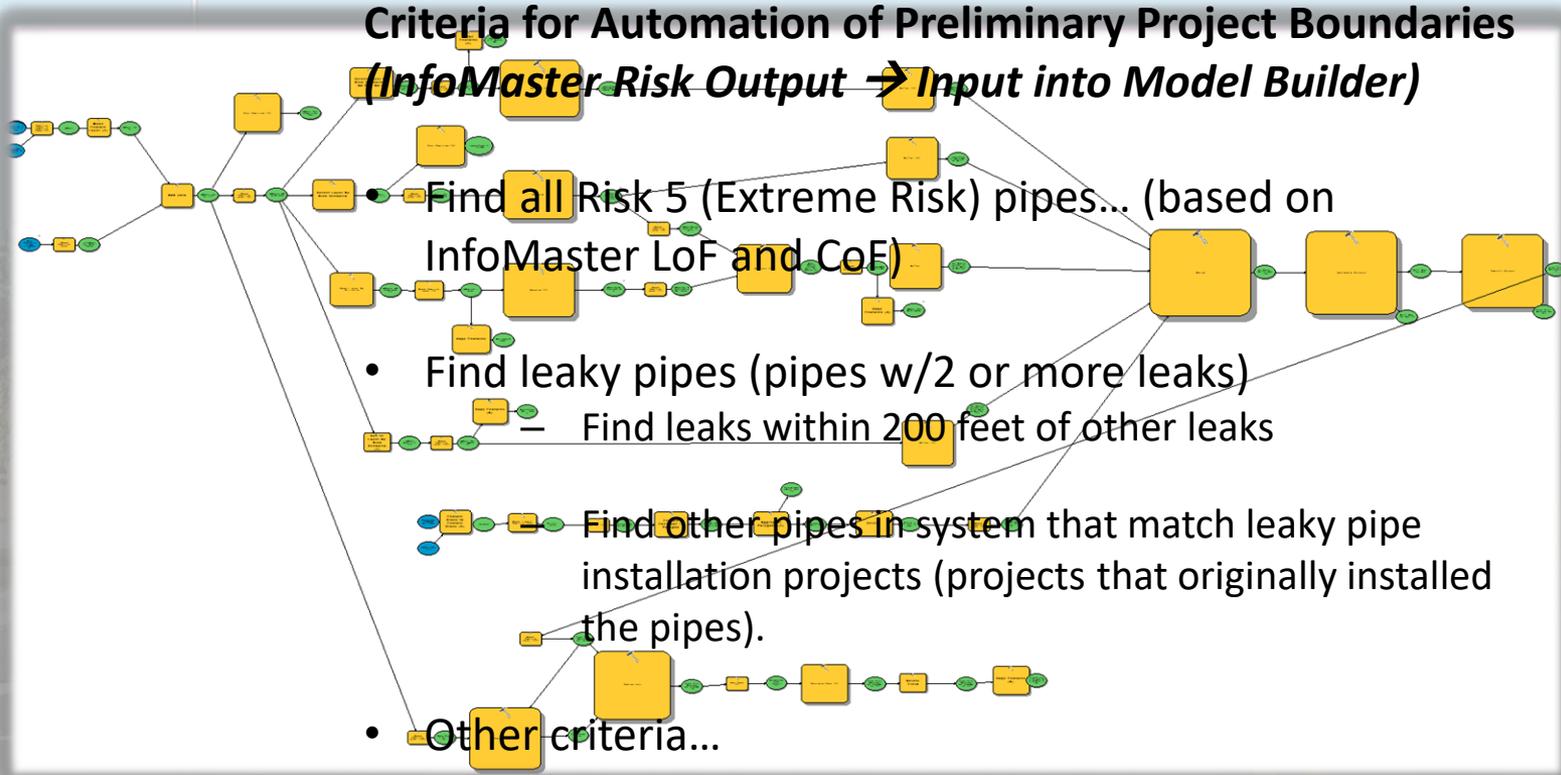
GIS Approach – Creation of Project Boundaries



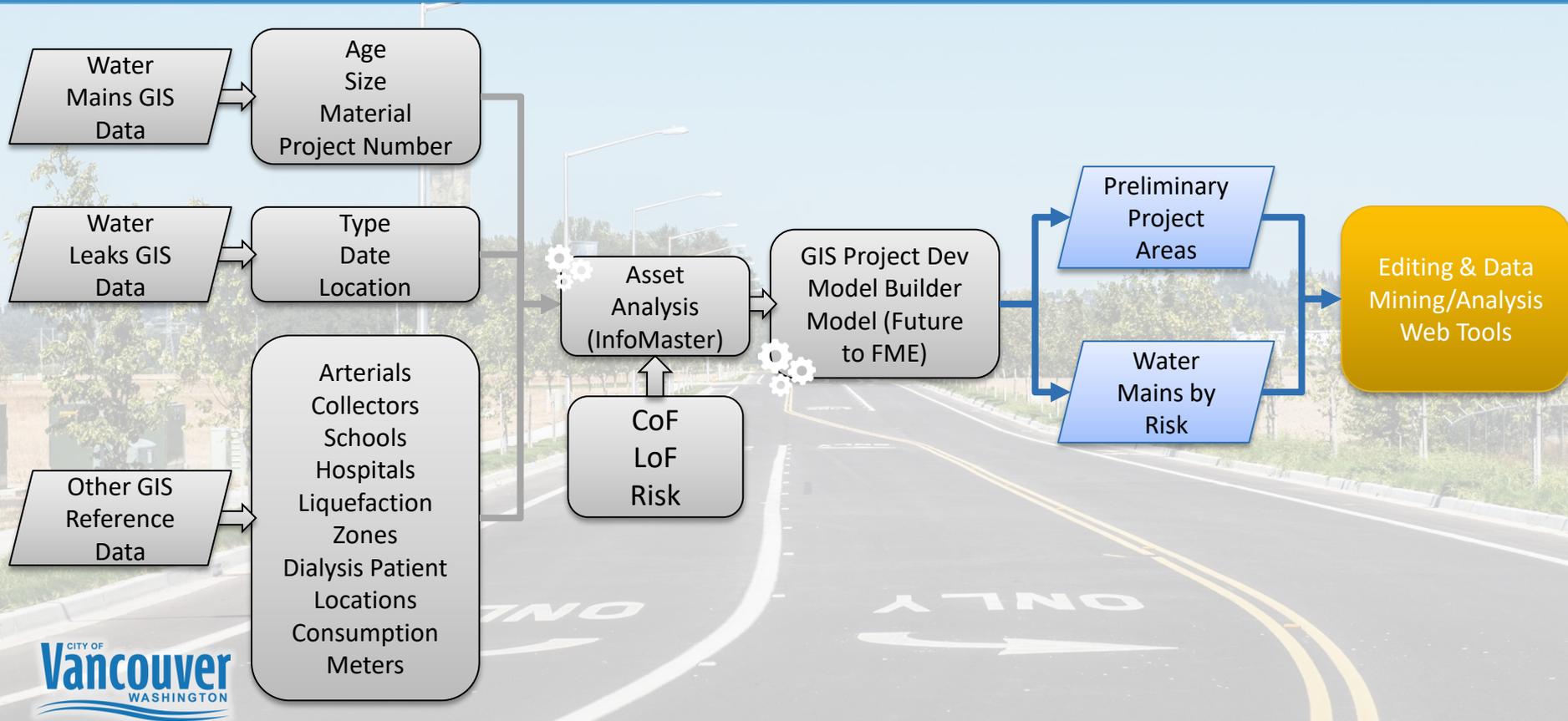
GIS Approach – Creation of Project Boundaries

Criteria for Automation of Preliminary Project Boundaries

(InfoMaster Risk Output → Input into Model Builder)



GIS Approach – CIP Project Analysis & Review



GIS Approach – Creation of Project Boundaries

Access pertinent tools from one web application.

Prioritized List of Project

Project Map

Project and Pipe Statistics

Cost Summaries

Pipe Summaries

Pipe Detail



Vancouver Water Risk Analysis & Capital Improvement Planning

Water CIP Project Analysis
Water CIP Project Areas (Edit)
Water Leaks

65 Projects by Risk Priority

Broadway St in Esther Short Neighborhood Project ID: 11 Risk Index: 0.21
NE 53rd St in East Minnehaha Neighborhood Project ID: 20 Risk Index: 0.18
E 37th St in Lincoln Neighborhood Project ID: 4 Risk Index: 0.17
E Frontage Rd in Rose Village Neighborhood Project ID: 40 Risk Index: 0.17
E 39th St in Lincoln Neighborhood Project ID: 5 Risk Index: 0.15
NE Saint James Rd in West Minnehaha Neighborhood Project ID: 46 Risk Index: 0.15
W 8th St in Esther Short Neighborhood Project ID: 45 Risk Index: 0.15
E 13th St in Esther Short Neighborhood Project ID: 32 Risk Index: 0.14

[Project List](#) | [Map Legend](#)

Replacement Cost Est. \$20k	Upsize Cost Est. \$82k
2 Leak Water Meters 8	0.2 Miles of Main 877 Feet of Main
829.3 Miles of Distribution Main	200.8 Miles of Transmission Main

Pipe Detail

296.05 feet of 2" GALV; Installed in 1945
Installed with Project Number: 000000
Project Name:
Estimated Replacement Cost: \$0.00 (\$0.00/foot cost)
Estimated Upsize Cost: \$34,490.21 (\$116.50/foot cost)

Asset Risk Analysis

Consequences of Failure (COF)	
COF Type	COF Score
Pipe Size	0.00
Pipe Material	0.00
Proximity to Arterials	0.00
Proximity to Highways	0.00
Laterals per Lineal Foot	3.00

Replacement Costs

Upsize Costs

Water Mains - By Diameter

Water Mains - By Year Installed

Water Mains - By Diameter

GIS Approach – Creation of Project Boundaries

Project List

Edit Attributes

Reshape/Cut Projects

Create New Projects

The screenshot displays a web-based GIS application interface. At the top, the title is "Vancouver Water Risk Analysis & Capital Improvement Planning". Below the title are three tabs: "Water CIP Project Analysis", "Water CIP Project Areas (Edit)", and "Water Leaks". The "Water CIP Project Areas (Edit)" tab is active. On the left side, there is a "Project List" panel with a scrollable list of project entries. Each entry includes a purple square icon, a project name, a project neighborhood, and a risk index. The main area is a map showing a street grid with several project areas highlighted in purple. A search bar at the top of the map area contains the text "Find address or place". A pop-up window titled "Preliminary Project Areas - By Risk: 20" is open over the map, displaying details for a specific project: Project Name: NE 53rd St, Description: East Minnehaha, Project Area ID: 20, Priority: 20, Status: Auto Generated, Date Reviewed: (blank), Last Update: (blank), Total Asset Cost: (blank), and Gross Project Cost: (blank). The map also shows a scale bar and a coordinate indicator at the bottom: "122.618 45.668 Degree". The Vancouver logo is visible in the bottom right corner of the map area.

Vancouver Water Capital Project Boundary Edits

with Web AppBuilder for ArcGIS

Find address or place

Project List

- Project Name: E 20th St - Project Neighborhood: Rose Village - Risk Index: 0.07
- Project Name: E 33rd St - Project Neighborhood: Rose Village - Risk Index: 0.09
- Project Name: E 37th St - Project Neighborhood: Lincoln - Risk Index: 0.17
- Project Name: E 39th St - Project Neighborhood: Lincoln - Risk Index: 0.13
- Project Name: E 9th St - Project Neighborhood: Hudsons Bay - Risk Index: 0.11
- Project Name: E Frontage Rd - Project Neighborhood: Rose Village - Risk Index: 0.17
- Project Name: G St - Project Neighborhood: Shumway - Risk Index: 0.05
- Project Name: G St - Project Neighborhood: Armade - Risk Index: 0.06
- Project Name: Main St - Project Neighborhood: Lincoln - Risk Index: 0.08
- Project Name: - Project Neighborhood: Maple Tree - Risk Index: 0.08
- Project Name: NE 103rd Ave - Project Neighborhood: Oakbrook - Risk Index: 0.02
- Project Name: NE 107th Ave - Project Neighborhood: Sunnyside - Risk Index: 0.04
- Project Name: NE 112th Ave - Project Neighborhood: Landover-Sharmel - Risk Index: 0.05
- Project Name: NE 122nd Ave - Project Neighborhood: Image - Risk Index: 0.03
- Project Name: NE 131st Ave - Project Neighborhood: Sifen - Risk Index: 0.04
- Project Name: NE 18th St - Project Neighborhood: Landover-Sharmel - Risk Index: 0.04
- Project Name: NE 39th Ave - Project Neighborhood: Truman - Risk Index: 0.06
- Project Name: NE 39th St - Project Neighborhood: Truman - Risk Index: 0.08
- Project Name: NE 44th St - Project Neighborhood: North Image - Risk Index: 0.05
- Project Name: NE 45th St - Project Neighborhood: Kevanna Park - Risk Index: 0.03
- Project Name: NE 53rd St - Project Neighborhood: East Minnehaha - Risk Index: 0.18
- Project Name: NE 54th Ave - Project Neighborhood: Bagley Downs - Risk Index: 0.05
- Project Name: NE 50th St - Project Neighborhood: East Minnehaha - Risk Index: 0.05
- Project Name: NE 58th St - Project Neighborhood: West Minnehaha - Risk Index: 0.07
- Project Name: NE 58th St - Project Neighborhood: VanMei - Risk Index: 0.04
- Project Name: NE 75th St - Project Neighborhood: ...

Preliminary Project Areas - By Risk: 20

ProjectName	NE 53rd St
Description	East Minnehaha
Project Area ID	20
Priority	20
Status	Auto Generated
Date Reviewed	
Last Update	
Total Asset Cost	
Gross Project Cost	

Edited by DURSHPEE on Thursday at 2:31 PM

Zoom to

122.618 45.668 Degree

Esri, NASA, NGA, USGS, FEMA | County of Clark, WA, Oregon Metro, State of Oregon GEO, WA State Parks GIS, Esri

What's Next?

- Complete developing workflow / dataflow – allowing project managers to update boundaries.
- Incorporate modified / approved boundaries to flow into CIP document development process.
- Continue refining methodology for automation of project areas.

What's Next?

- Continue to refine LoF / CoF / Risk Criteria
- Develop better project costing (area specific costing)
- Continual incremental process improvements.

Questions and Discussion

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