NWWC 2025

Victoria, BC

Prioritizing Water Infrastructure with Artificial Intelligence

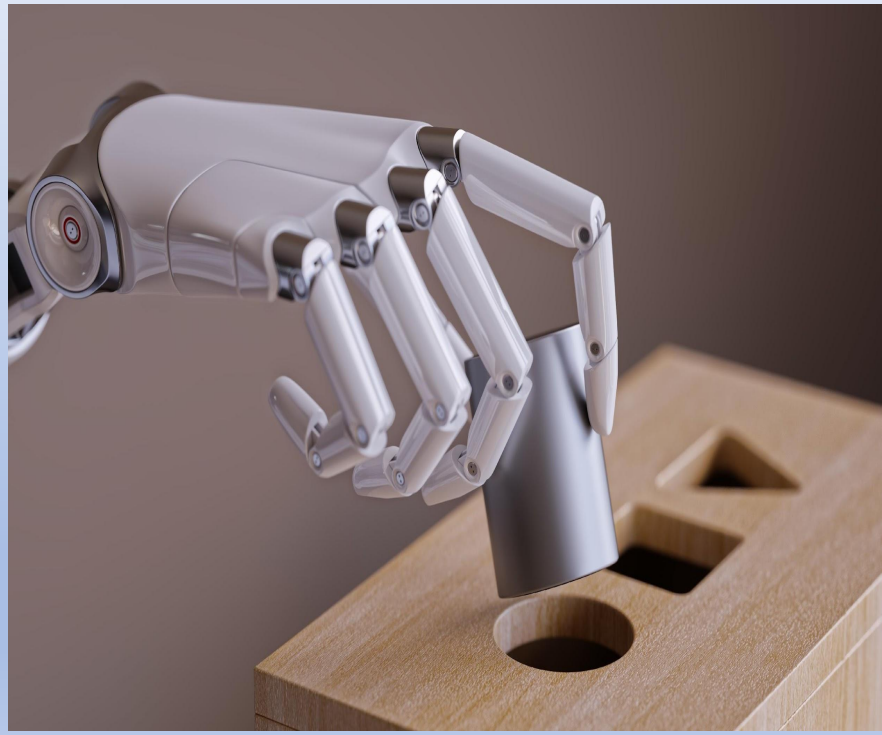
Dan Hack | Itron & VODA.ai

Topics for Prioritizing Water Infrastructure with Artificial Intelligence

1. What is Artificial Intelligence & Machine Learning and why do we care?
2. Is AI/ML superior for determining Likelihood-of-Failure (LOF)?
3. Who can benefit & how?
4. Process – what are the steps?
5. Planning Demonstration

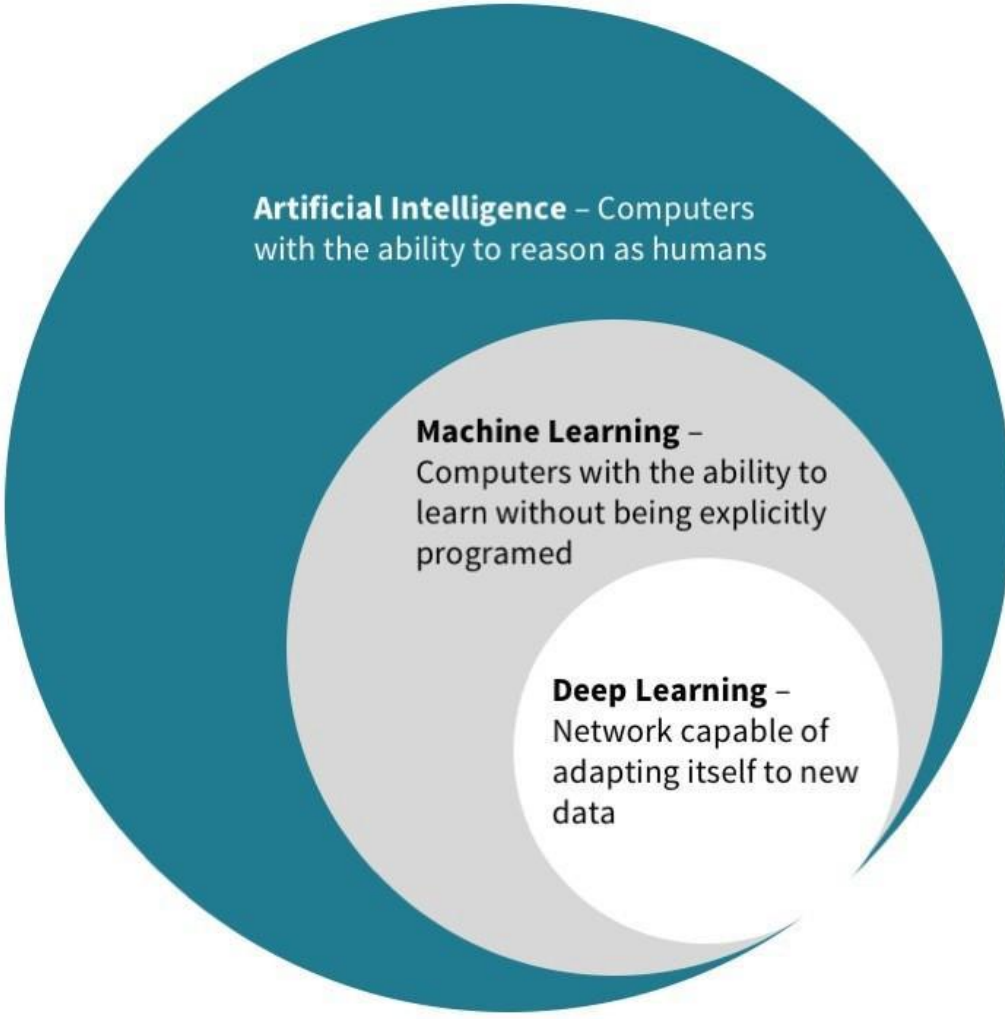
“Artificial Intelligence” (AI)

- Coined at Dartmouth College in 1956
- Machines acting rationally (like most people)
- Machine Learning (ML), subset of AI, models/algorithms for improving outcomes

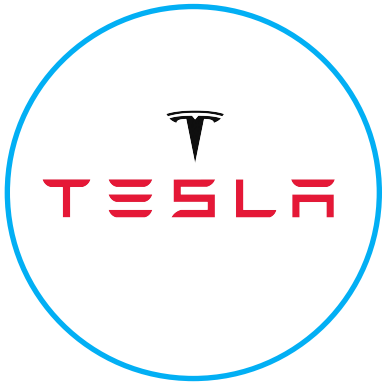


Why Machine Learning?

- Increased computing power
- Access to more data
  - Volume
  - Variety
  - Velocity
- New research



AI & ML Driving Successful Companies



It helps reduce risks, improve results

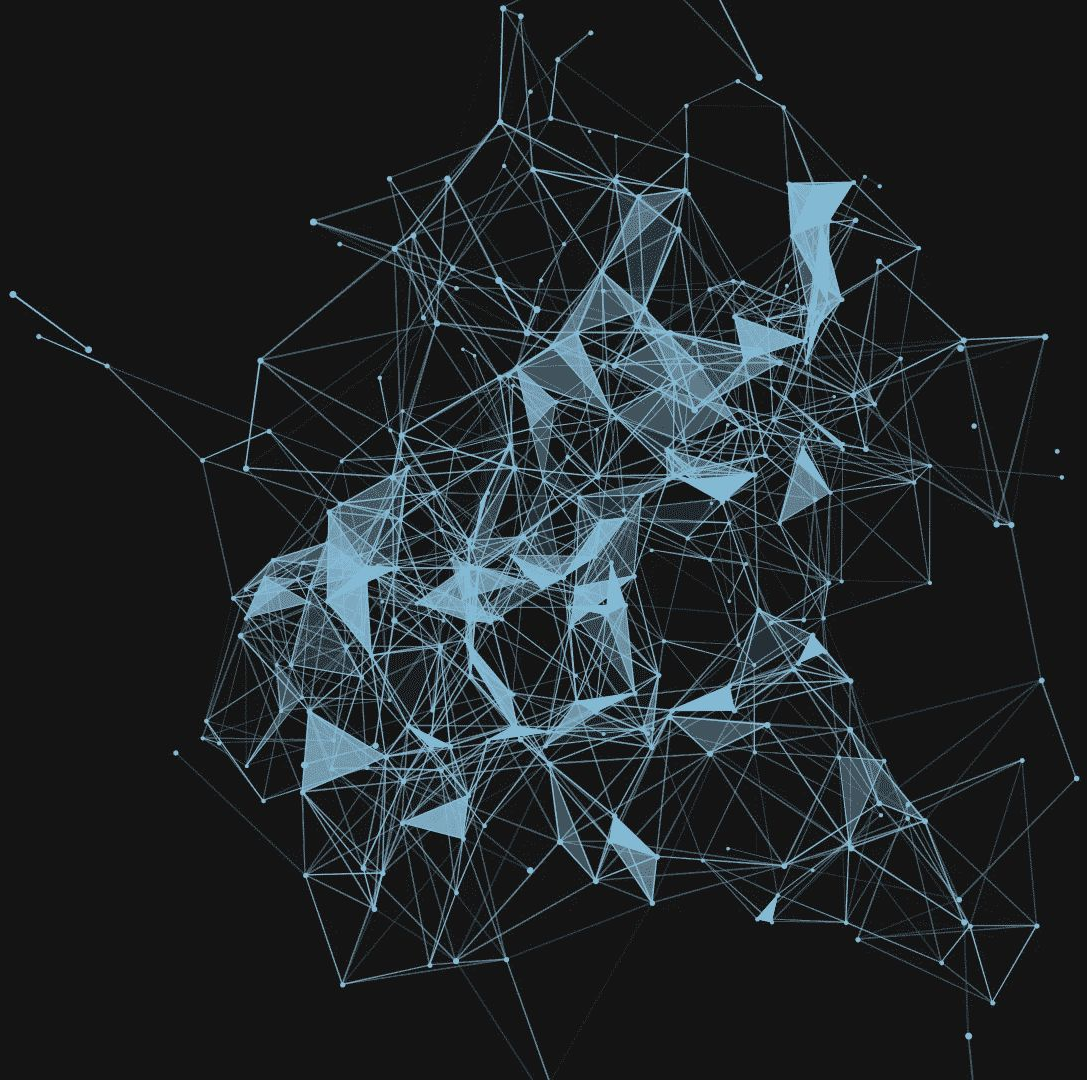
OK…So how is AI/ML relevant for Water & Wastewater utilities?

Reactive

CHALLENGE

Allocating resources
on the right pipes

AI/ML Modeling



Water Failure Predictions

Wastewater Incident Predictions

Service Lines

Wastewater Condition Assessment

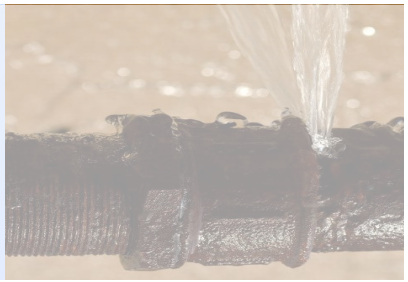
Lead Pipe Finder

Laterals

Water Failure Predictions

Wastewater Incident Predictions

Service Lines



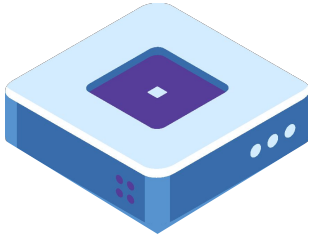
Wastewater Condition Assessment

Lead Pipe Finder

Laterals

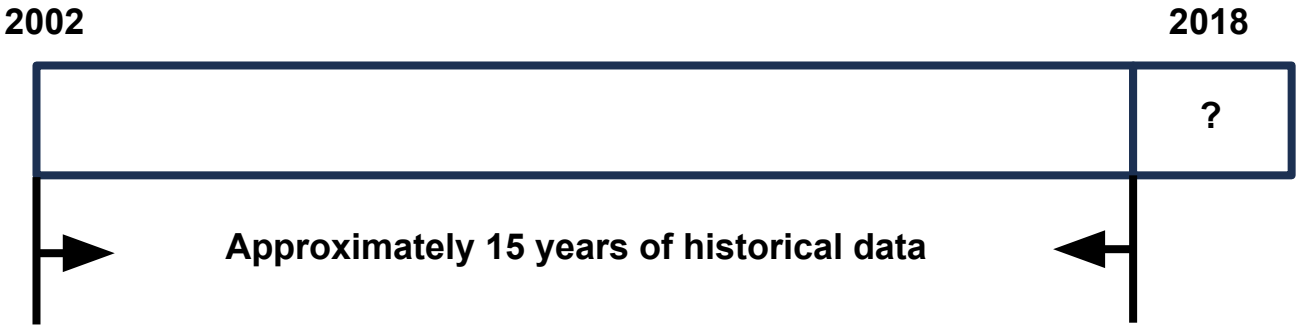
8,000 km of Pipe
260,000 Pipe Segments

Proof-of-Concept Approach



UTILITY DATA

- GIS
- Asset Data (Diameter, Material, Age)
- Failure History (Breaks & Leaks)



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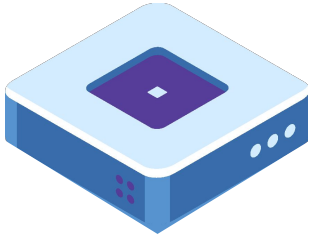

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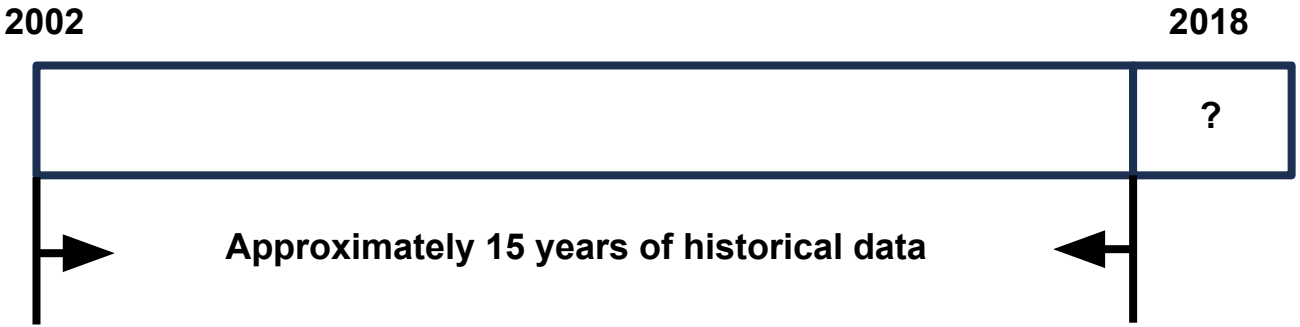
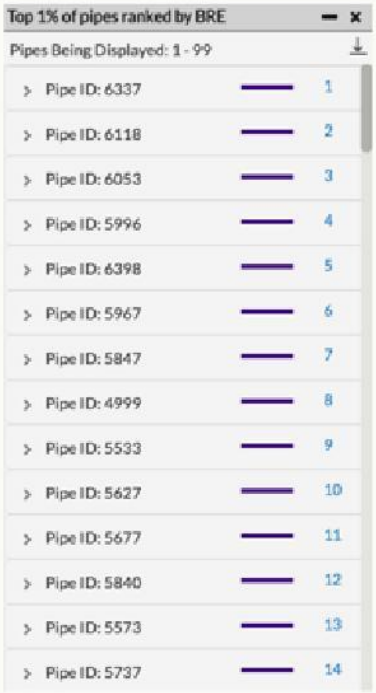
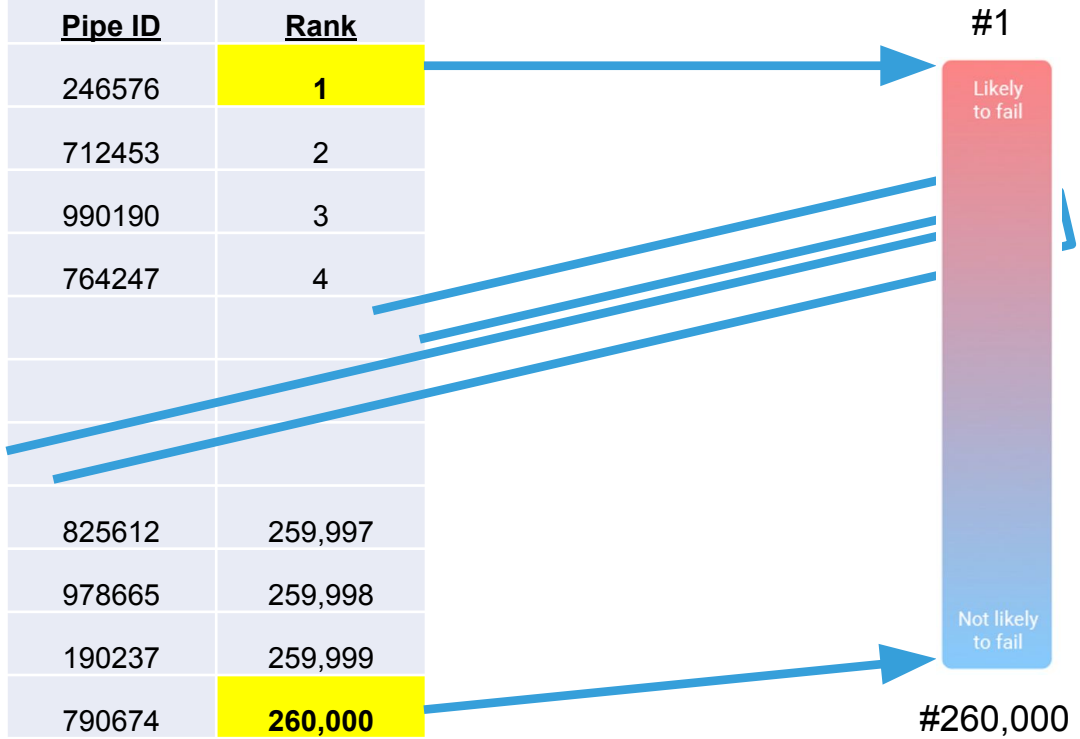




Proof-of-Concept Results - Comparing Methods (Potable)

AI/ML Results

Pipe ID	Rank
246576	**1**
712453	2
990190	3
764247	4
825612	259,997
978665	259,998
190237	259,999
790674	**260,000**



Proof-of-Concept Results - Comparing Methods (Potable)

Prior Failures

Age

AI/ML Results

Proof-of-Concept Results - Comparing Methods (Potable)

Prior Failures

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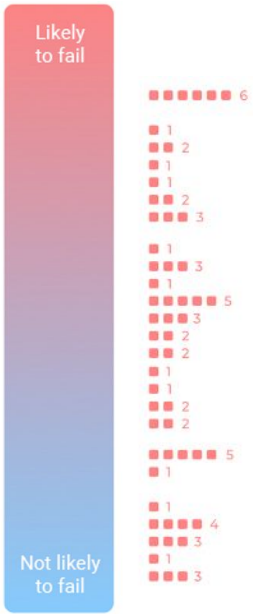
AI/ML Results



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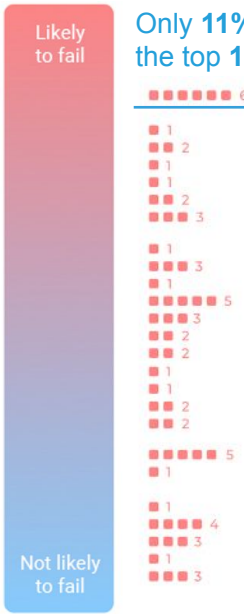

Only **11%** are in the top **1%**

Age

AI/ML Results

Proof-of-Concept Results - Comparing Methods (Potable)

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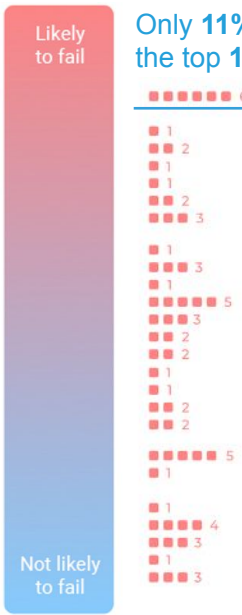

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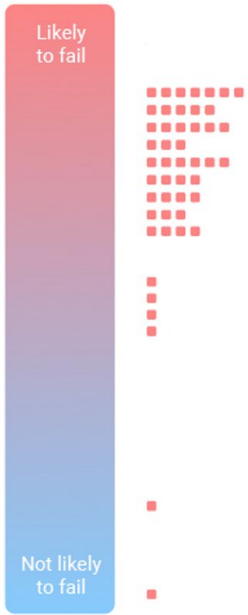

AI/ML Results

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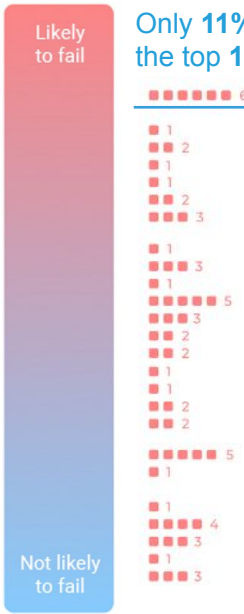
Prior Failures



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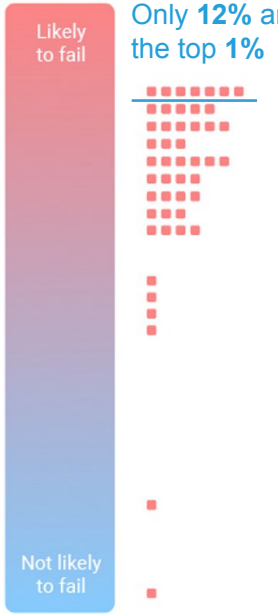
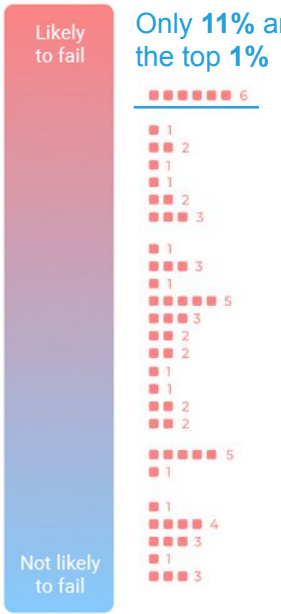


Only **12%** are in the top **1%**

AI/ML Results

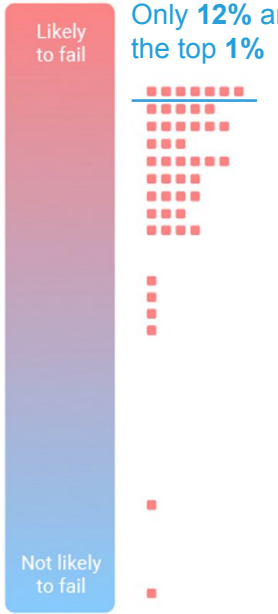
Proof-of-Concept Results - Comparing Methods (Potable)

Prior Failures



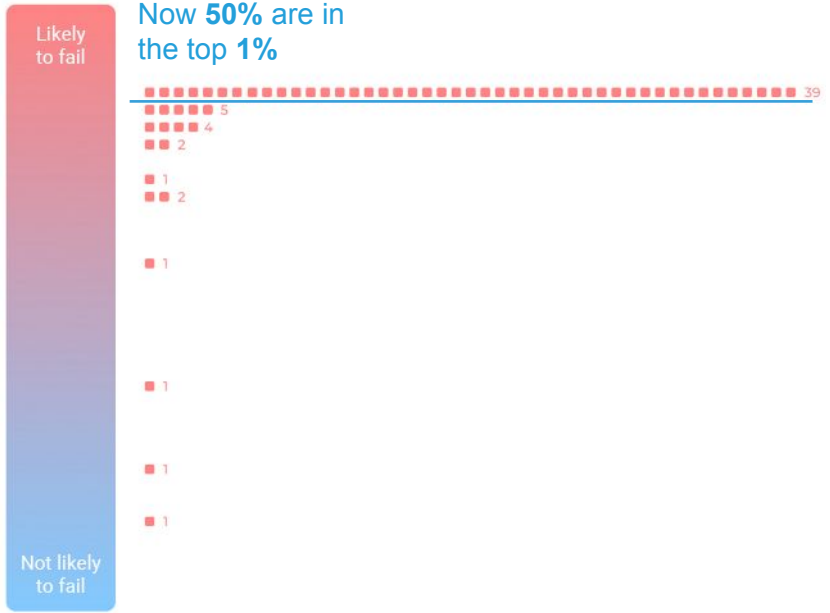
Only **11%** are in the top **1%**

Age



Only **12%** are in the top **1%**

AI/ML Results



Now **50%** are in the top **1%**

TUCSON WATER

A proud part of the City of Tucson

6,400 km of Pipe
150,000 Pipe Segments

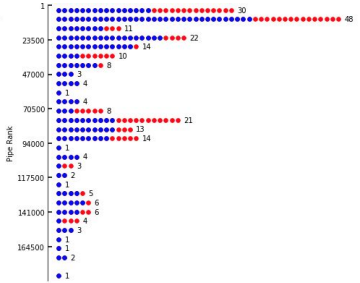
AI/ML found 200% more failures than using traditional methods

50% had no prior failures!

Looking for the Bull's Eye

Prior Failures

Age



AI/ML Results

■ = Failures on Pipes with No Prior Breaks

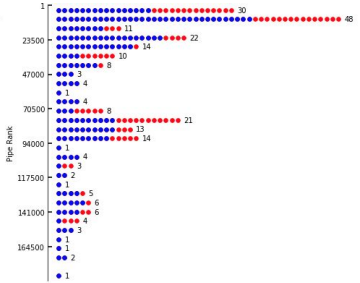
■ = Failures on Pipes with Prior Breaks

AI/ML predicted nearly twice as many failures as the prior break model and 50% were pipes that had never failed before

Looking for the Bull's Eye

Prior Failures

Age



AI/ML Results

■ = Failures on Pipes with No Prior Breaks

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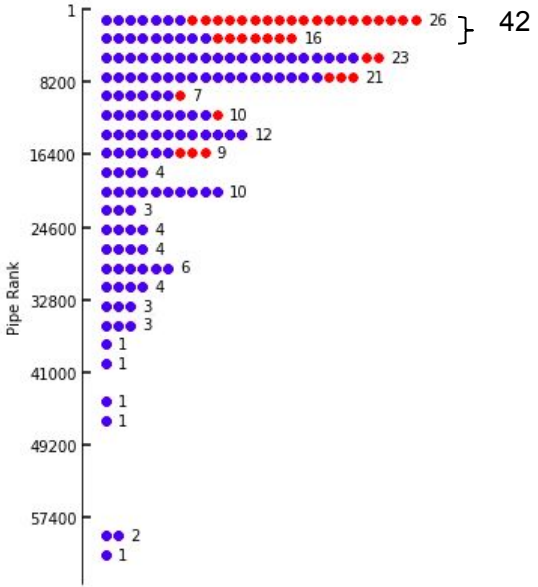
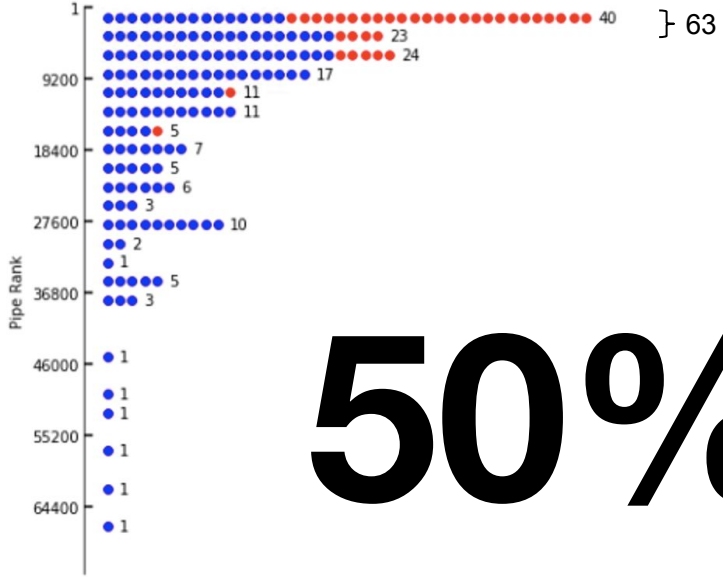
Machine Learning Results*

AEC Company



AI/ML Results

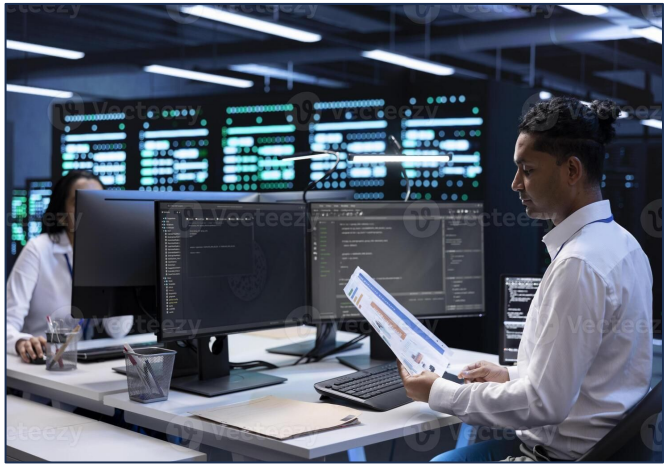


50%

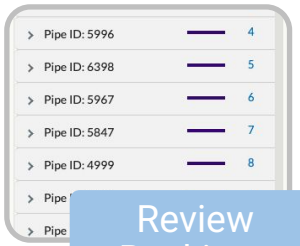
*AWWA Virtual Summit - Water Quality & Infrastructure
Evolution of Water Main Replacement Planning Toward Machine Learning
Len Sekular | Arcadis | December 8 – 10, 2020

Operations

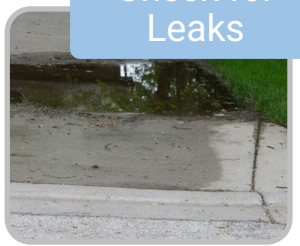
Planning



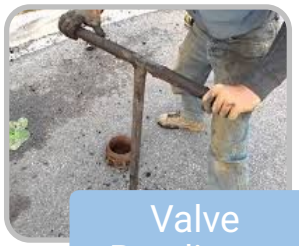
Operations SOP for AI generated LOF



Review Rankings



Check for Leaks



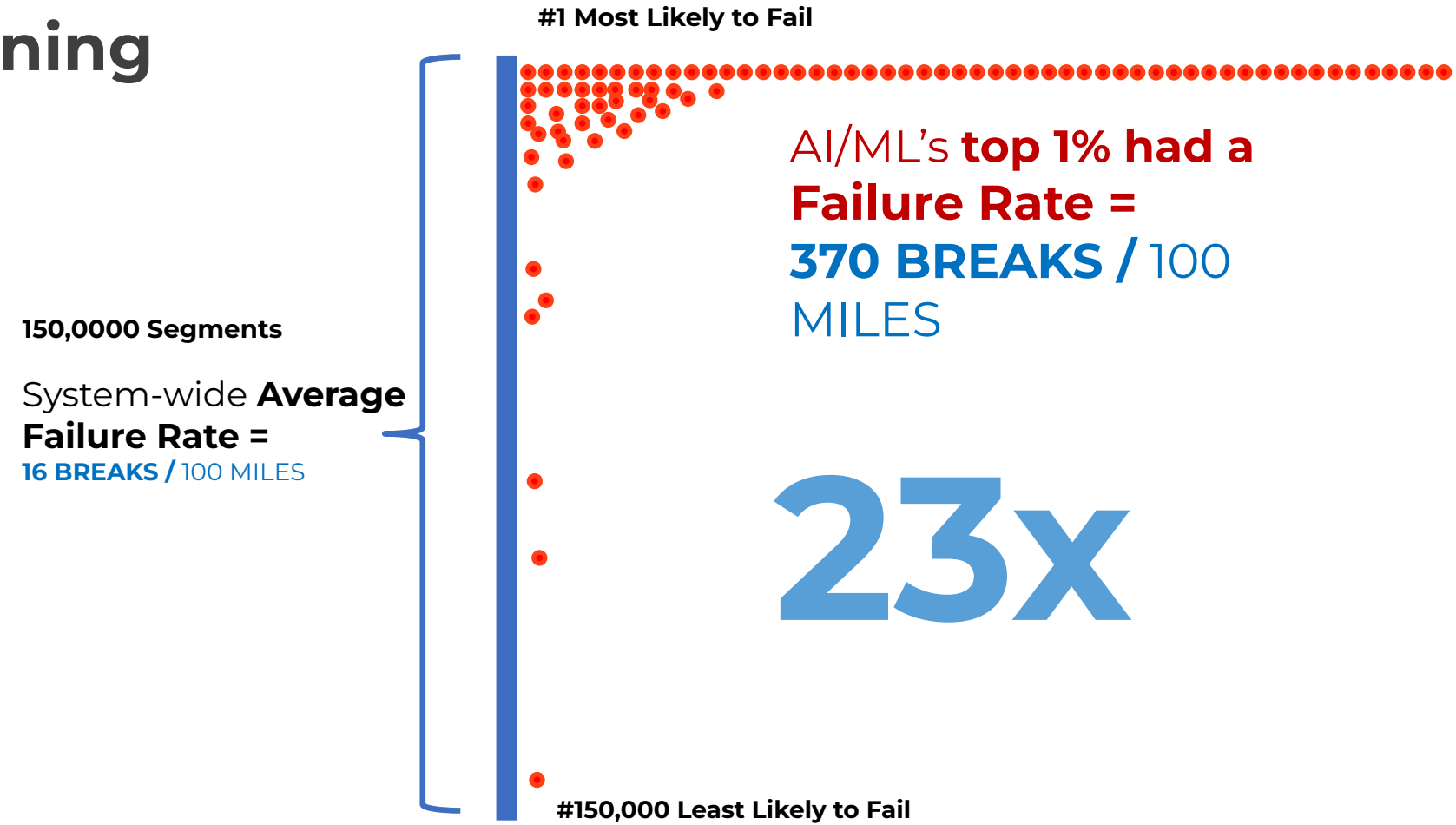
Valve Readiness

Material Availability

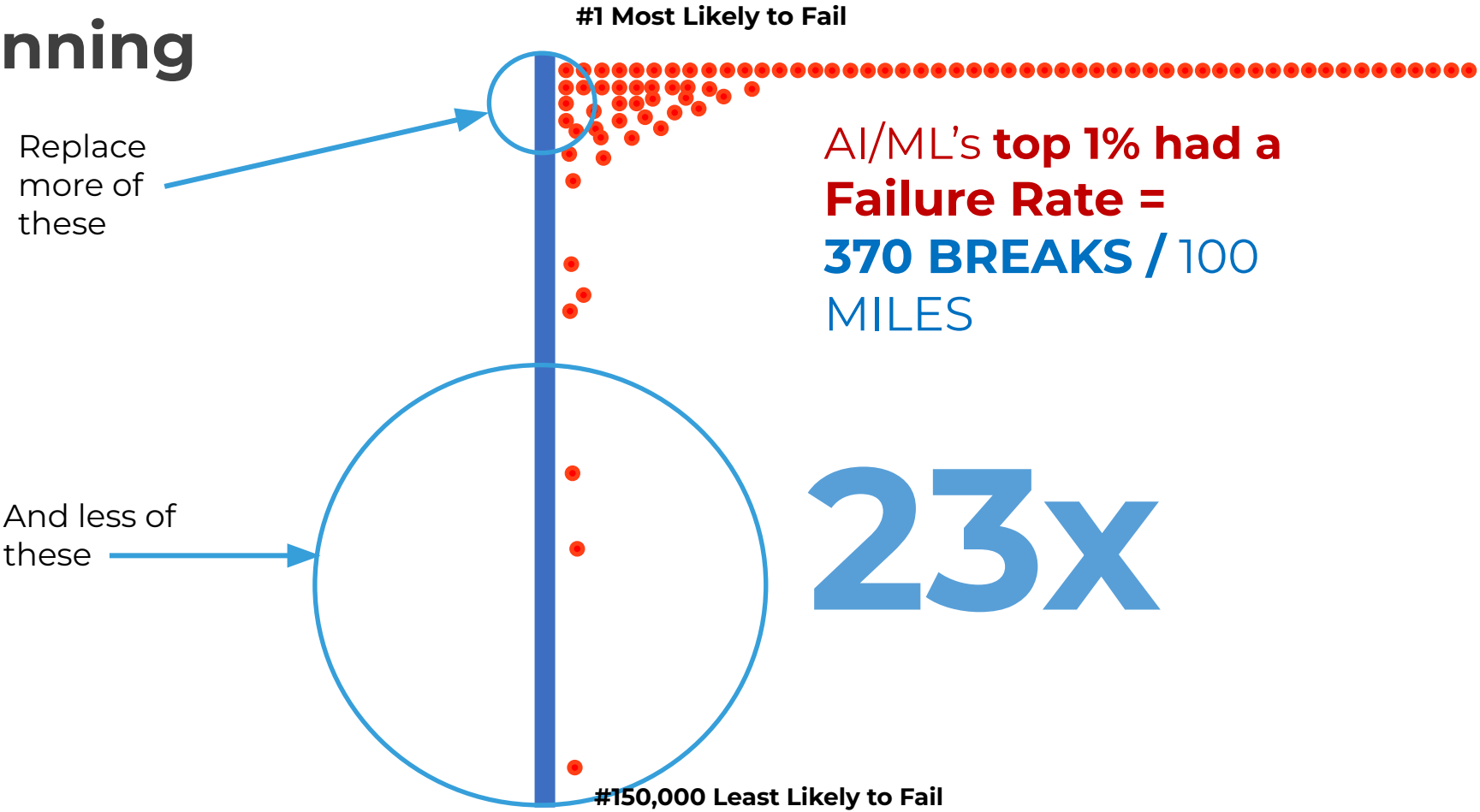
Faster Repairs

Planning – AI targeting for replacement

Planning


#1 Most Likely to Fail
AI/ML's top 1% had a Failure Rate = 370 BREAKS / 100 MILES
150,0000 Segments
System-wide Average Failure Rate = 16 BREAKS / 100 MILES
23x
#150,000 Least Likely to Fail

Planning

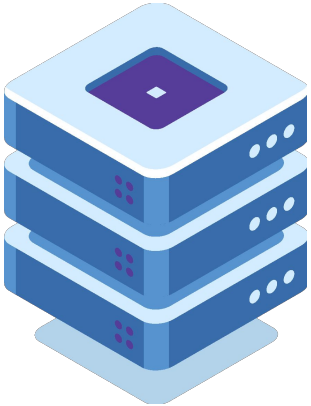

#1 Most Likely to Fail
Replace more of these
AI/ML's top 1% had a Failure Rate = 370 BREAKS / 100 MILES
And less of these
23x
#150,000 Least Likely to Fail

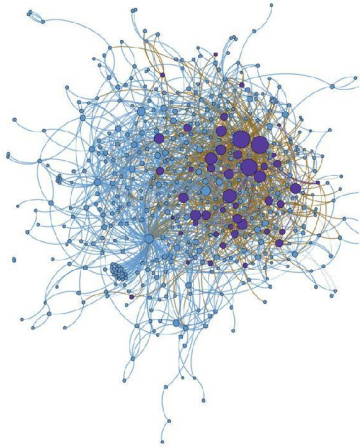
How it Works

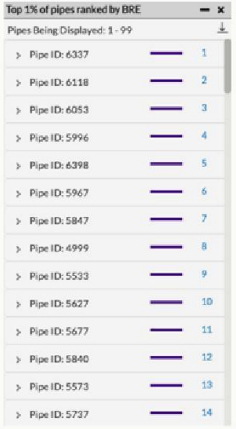
Utility

Public

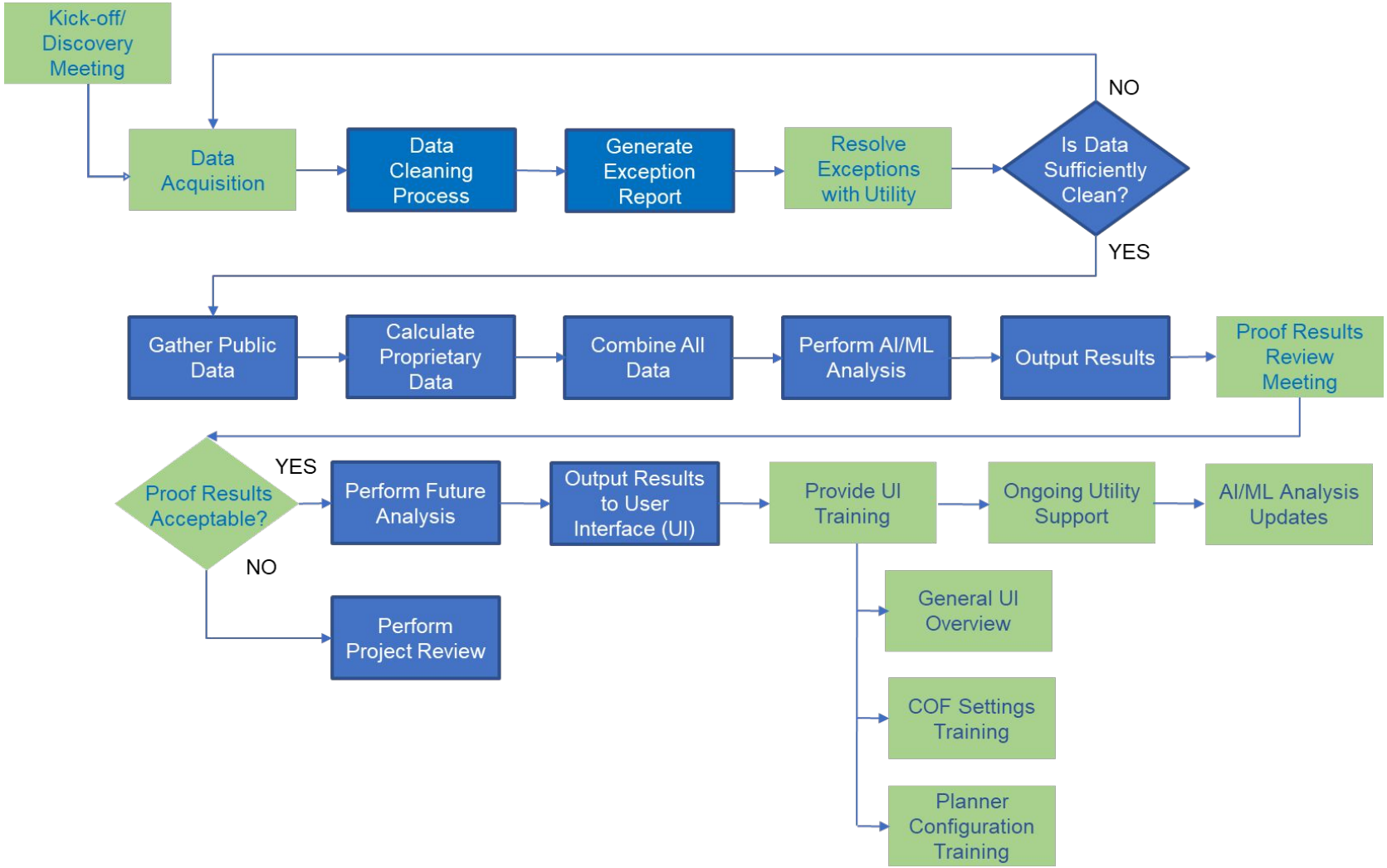
Proprietary







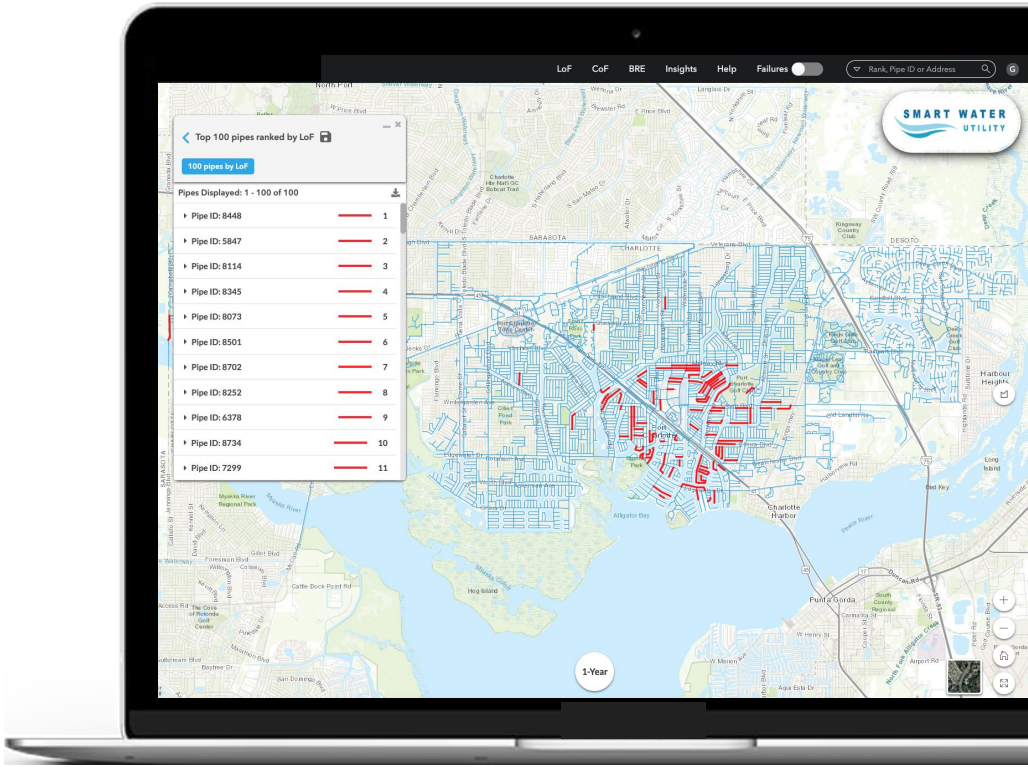
DATA COLLECTION AND CLEAN UP → **AI/ML Model LEARNS** → **PIPE RANKING**


Kick-off/ Discovery Meeting
Data Acquisition
Data Cleaning Process
Generate Exception Report
Resolve Exceptions with Utility
Is Data Sufficiently Clean?
NO
YES
Gather Public Data
Calculate Proprietary Data
Combine All Data
Perform AI/ML Analysis
Output Results
Proof Results Review Meeting
Proof Results Acceptable?
YES
NO
Perform Future Analysis
Output Results to User Interface (UI)
Provide UI Training
Ongoing Utility Support
AI/ML Analysis Updates
Perform Project Review
General UI Overview
COF Settings Training
Planner Configuration Training

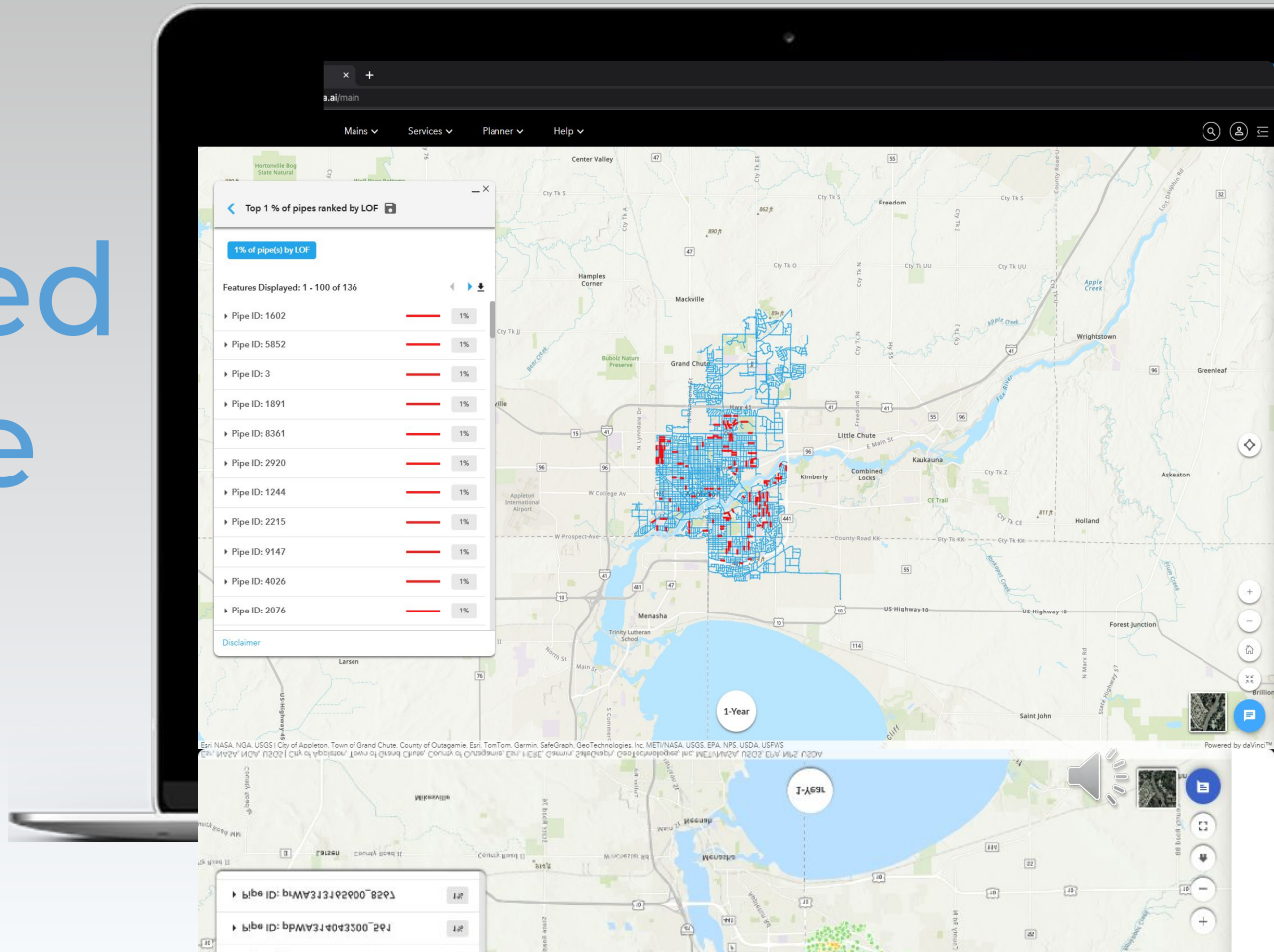
TARGETED CAPITAL AND O&M SPEND

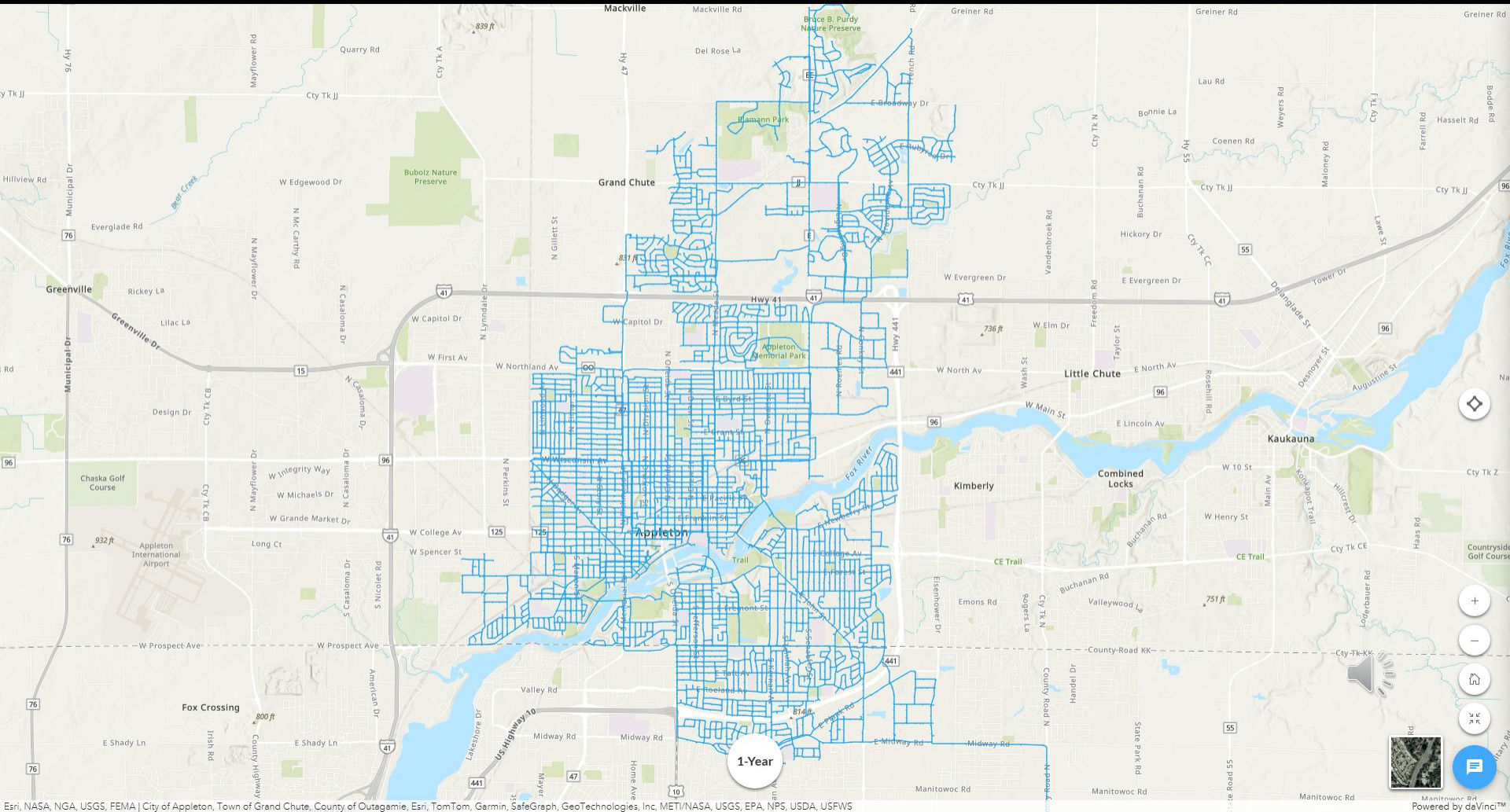
- Targeted Leak Detection & Monitoring
- Targeted Valve Maintenance
- Targeted Replacement & Renewal
- Remaining Useful Life
- Faster Repairs & Reduce Risk

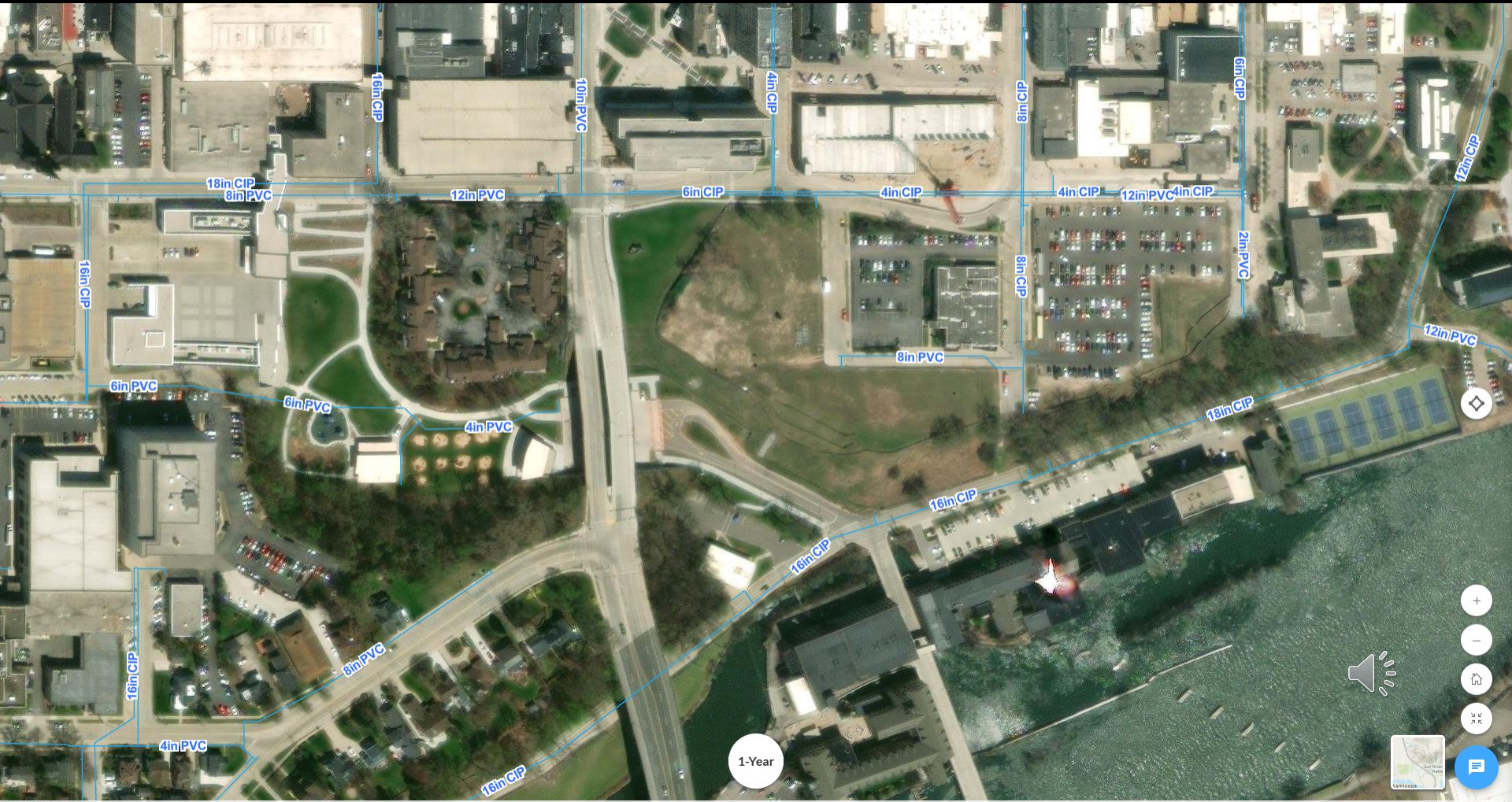
Example/ Demo

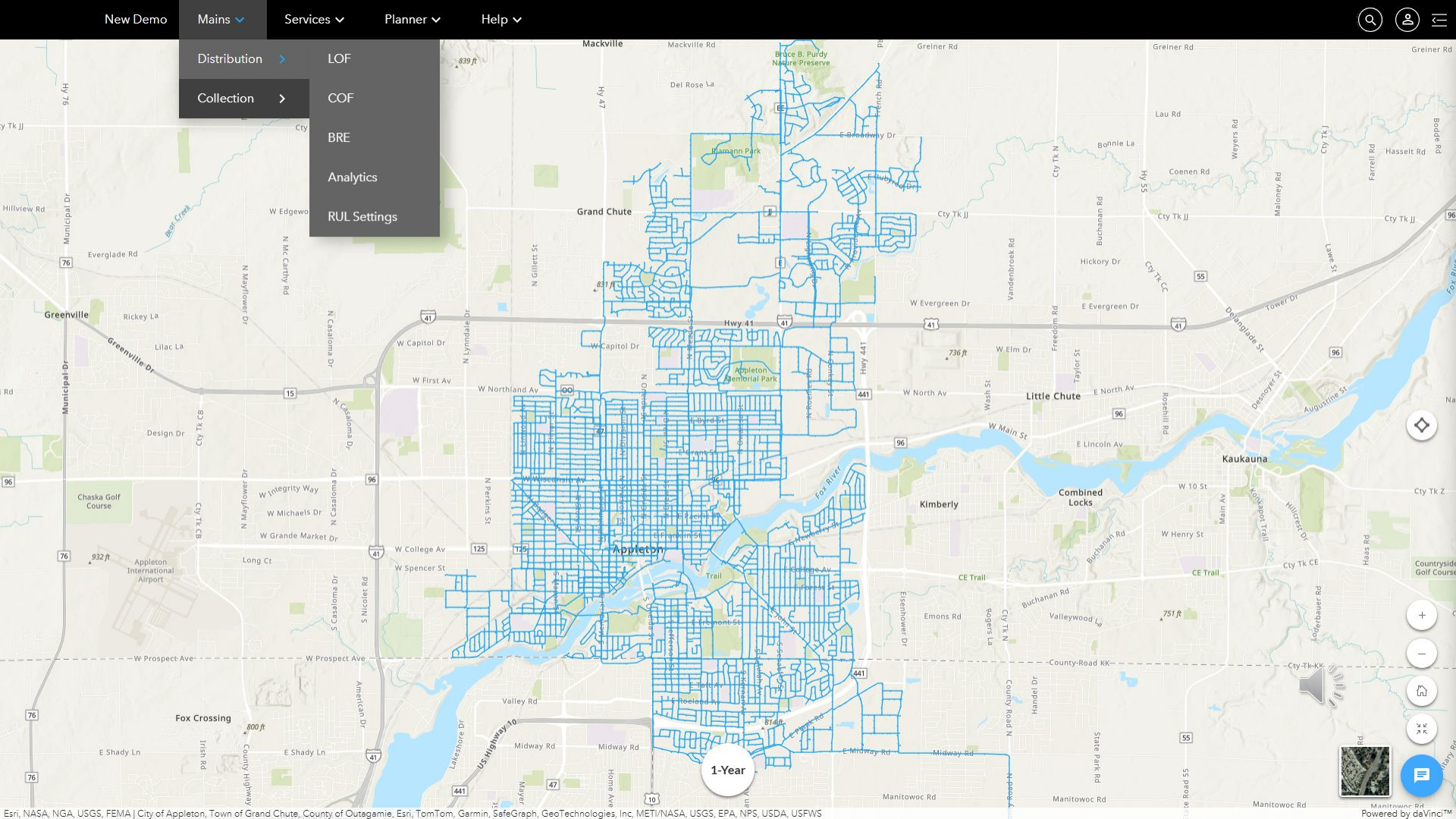


Web-based Interface






New Demo
Mains
Services
Planner
Help
16in CIP
10in PVC
4in CIP
8in CIP
6in CIP
12in CIP
18in CIP
8in PVC
12in PVC
6in CIP
4in CIP
4in CIP
12in PVC
4in CIP
16in CIP
2in PVC
8in CIP
8in PVC
12in PVC
6in PVC
6in PVC
4in PVC
18in CIP
16in CIP
16in CIP
8in PVC
16in CIP
4in PVC
16in CIP
1-Year
Maxar, Microsoft
Powered by daVinci™


New Demo
Mains
Services
Planner
Help
Distribution
Collection
LOF
COF
BRE
Analytics
RUL Settings
Mackville
Grand Chute
Greenville
Hwy 41
Little Chute
Kaukauna
Kimberly
Combined Locks
Appleton
Fox Crossing
1-Year
Esri, NASA, NGA, USGS, FEMA | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
Powered by daVinci™

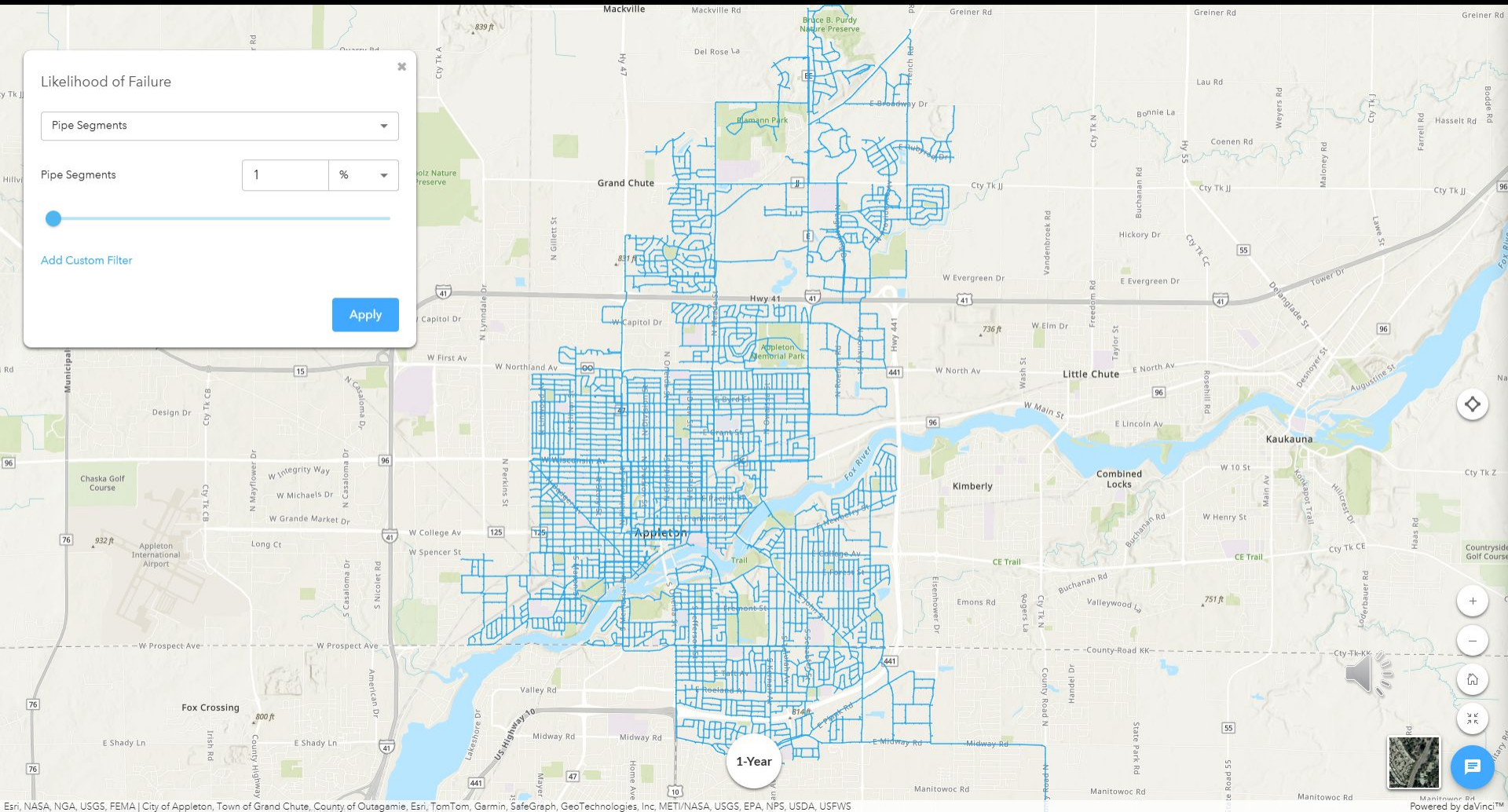
Likelihood of Failure

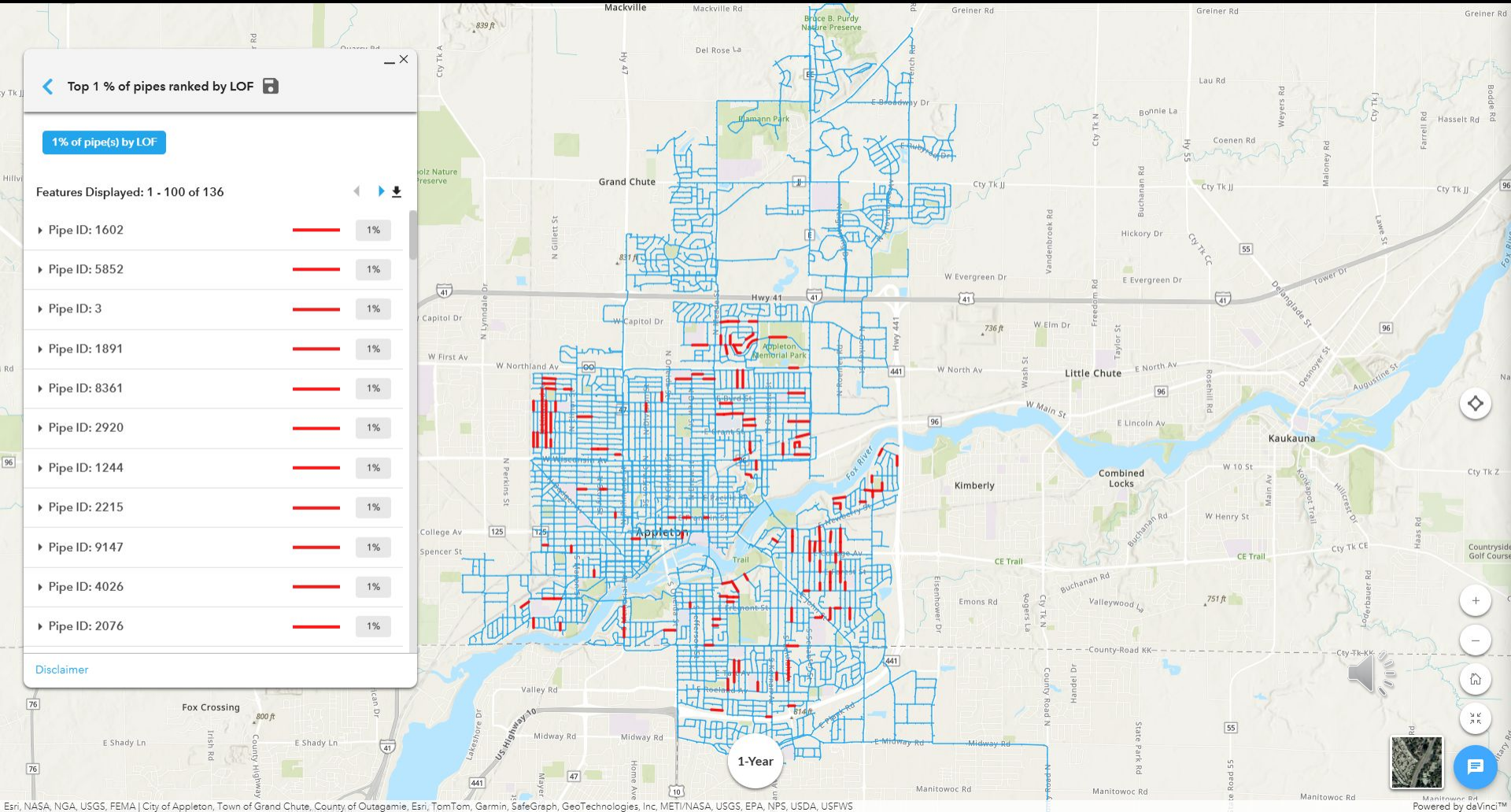
Pipe Segments

Pipe Segments 1 %

Add Custom Filter

Apply





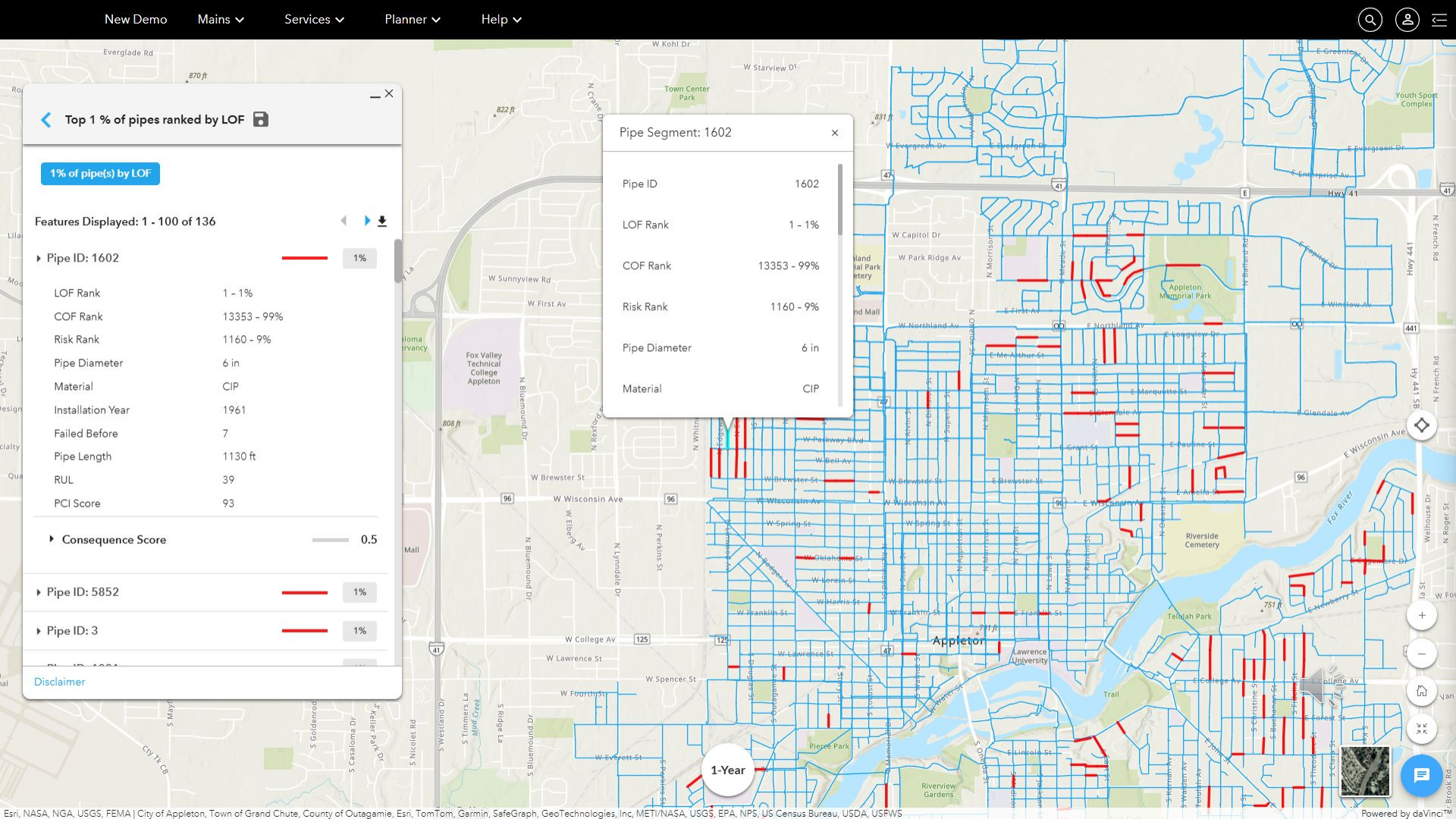
Top 1 % of pipes ranked by LOF

1% of pipe(s) by LOF

Features Displayed: 1 - 100 of 136

Pipe ID: 1602	1%
Pipe ID: 5852	1%
Pipe ID: 3	1%
Pipe ID: 1891	1%
Pipe ID: 8361	1%
Pipe ID: 2920	1%
Pipe ID: 1244	1%
Pipe ID: 2215	1%
Pipe ID: 9147	1%
Pipe ID: 4026	1%
Pipe ID: 2076	1%

Disclaimer


New Demo
Mains
Services
Planner
Help
Top 1 % of pipes ranked by LOF
1% of pipe(s) by LOF
Features Displayed: 1 - 100 of 136
Pipe ID: 1602
1%
LOF Rank 1 - 1%
COF Rank 13353 - 99%
Risk Rank 1160 - 9%
Pipe Diameter 6 in
Material CIP
Installation Year 1961
Failed Before 7
Pipe Length 1130 ft
RUL 39
PCI Score 93
Consequence Score
0.5
Pipe ID: 5852
1%
Pipe ID: 3
1%
Disclaimer
Pipe Segment: 1602
Pipe ID 1602
LOF Rank 1 - 1%
COF Rank 13353 - 99%
Risk Rank 1160 - 9%
Pipe Diameter 6 in
Material CIP
1-Year
Appleton
Esri, NASA, NGA, USGS, FEMA | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
Powered by daVinci™

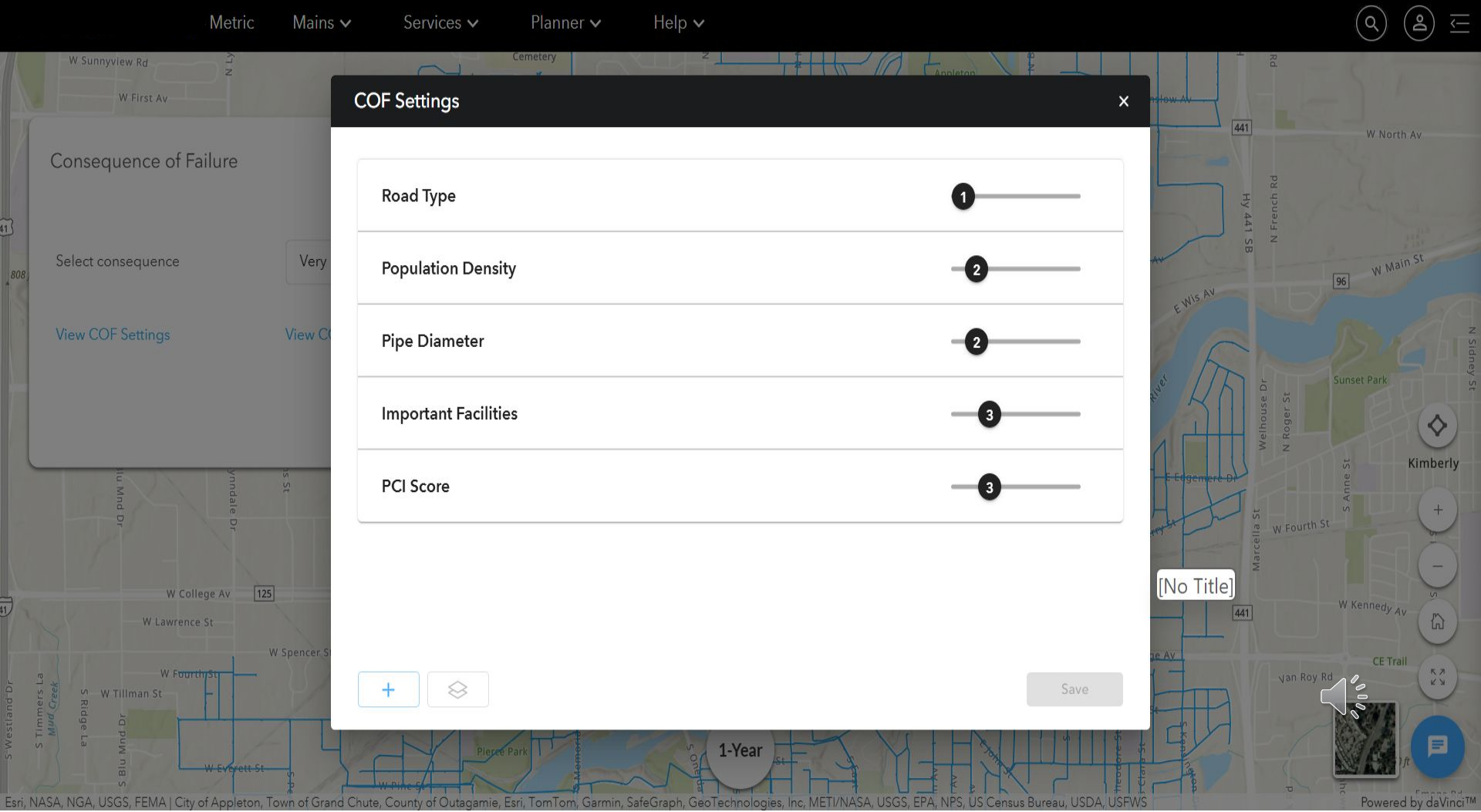
Consequence of Failure

Select consequence: Very High

- **Very High**
- High
- Medium
- Low
- Very Low

View COF Settings

1-Year


Metric
Mains
Services
Planner
Help
COF Settings
Road Type
1
Population Density
2
Pipe Diameter
2
Important Facilities
3
PCI Score
3
Save
Consequence of Failure
Select consequence
Very
View COF Settings
[No Title]
1-Year
Kimberly
Sunset Park
Pierce Park
CE Trail
Esri, NASA, NGA, USGS, FEMA | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
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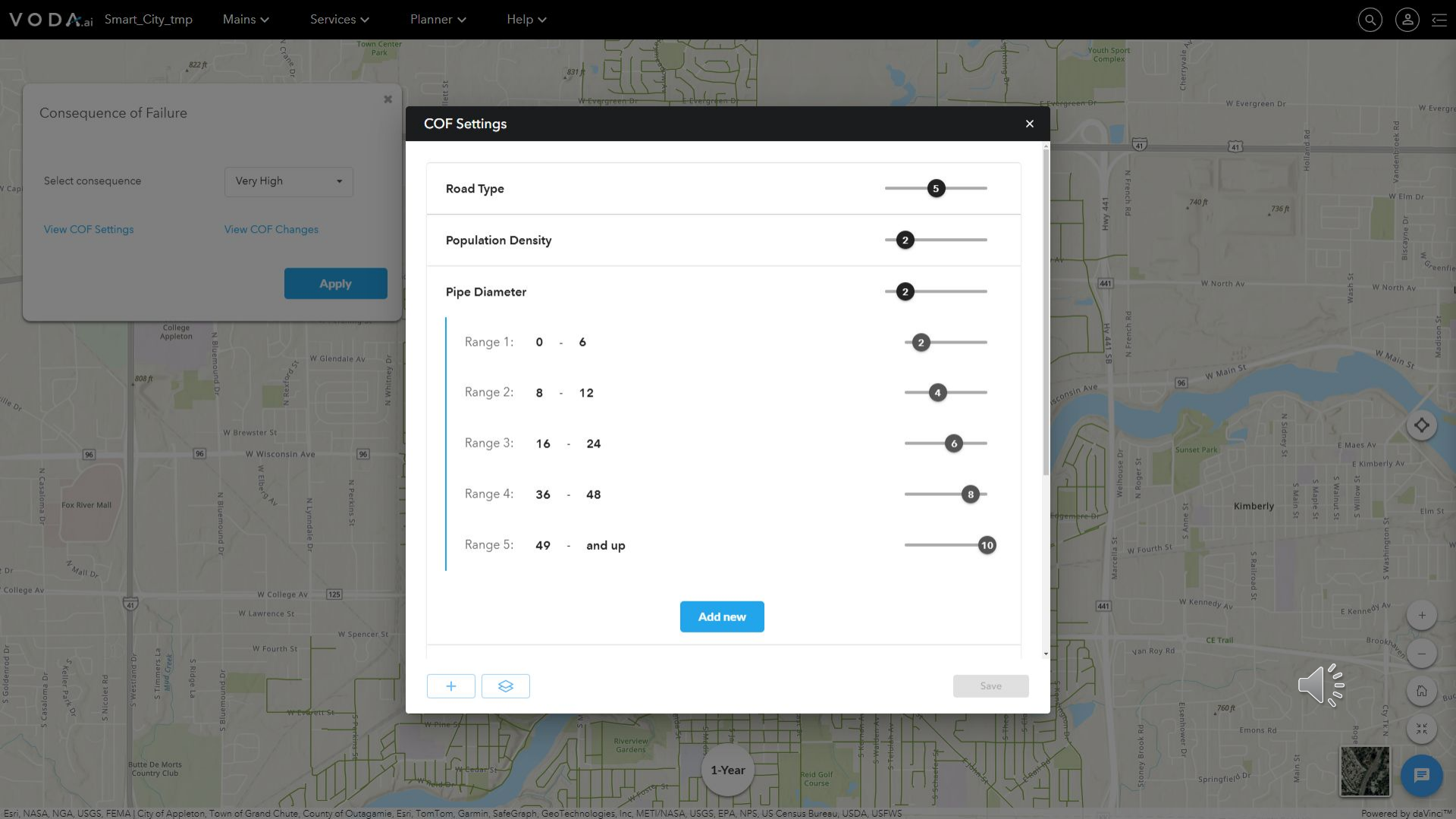
VODA.ai
Smart_City_tmp
Mains
Services
Planner
Help
Consequence of Failure
Select consequence
Very High
View COF Settings
View COF Changes
Apply
COF Settings
Road Type
5
Population Density
2
Pipe Diameter
2
Range 1: 0 - 6
2
Range 2: 8 - 12
4
Range 3: 16 - 24
6
Range 4: 36 - 48
8
Range 5: 49 - and up
10
Add new
Save
1-Year
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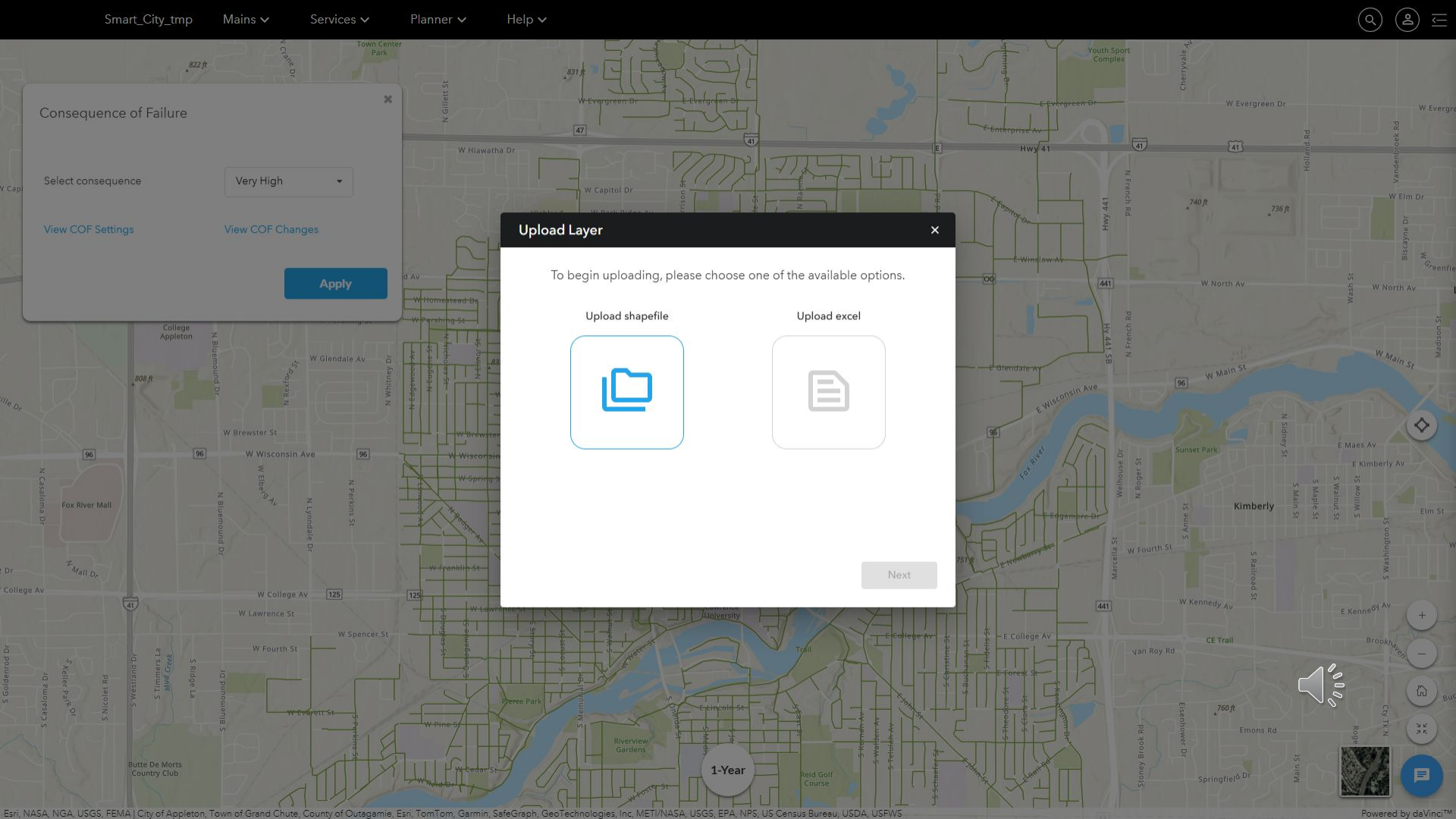
Smart_City_tmp
Mains
Services
Planner
Help
Consequence of Failure
Select consequence
Very High
View COF Settings
View COF Changes
Apply
Upload Layer
To begin uploading, please choose one of the available options.
Upload shapefile
Upload excel
Next
1-Year
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Top 1 % of pipes ranked by BRE

1% of pipe(s) by BRE

Features Displayed: 1 - 100 of 136

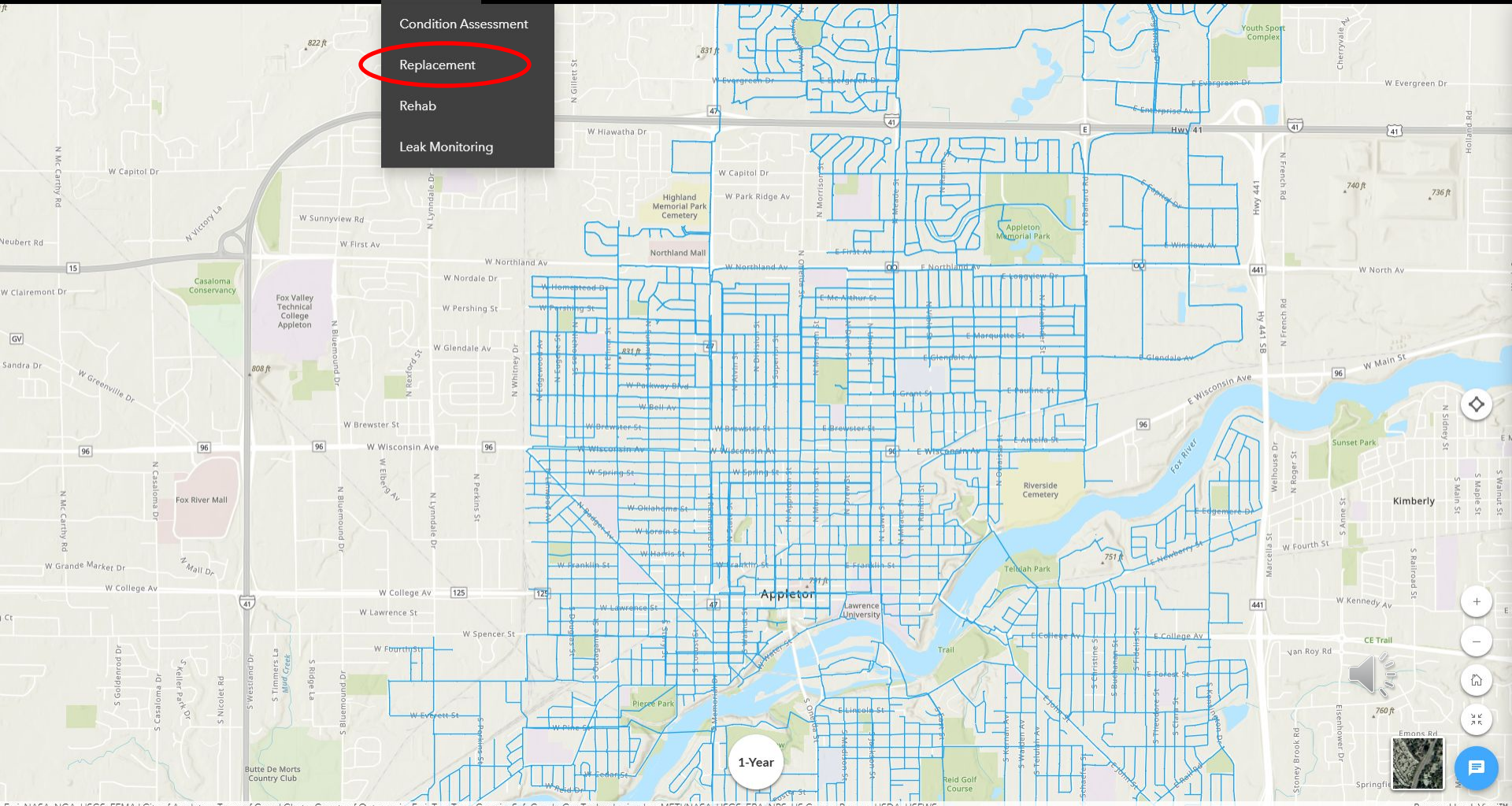
Pipe ID: 3		1%
Pipe ID: 2076		1%
Pipe ID: 2075		1%
Pipe ID: 615		1%
Pipe ID: 1		1%
Pipe ID: 6		1%
Pipe ID: 2043		1%
Pipe ID: 2044		1%
Pipe ID: 5840		1%
Pipe ID: 617		1%
Pipe ID: 493		1%

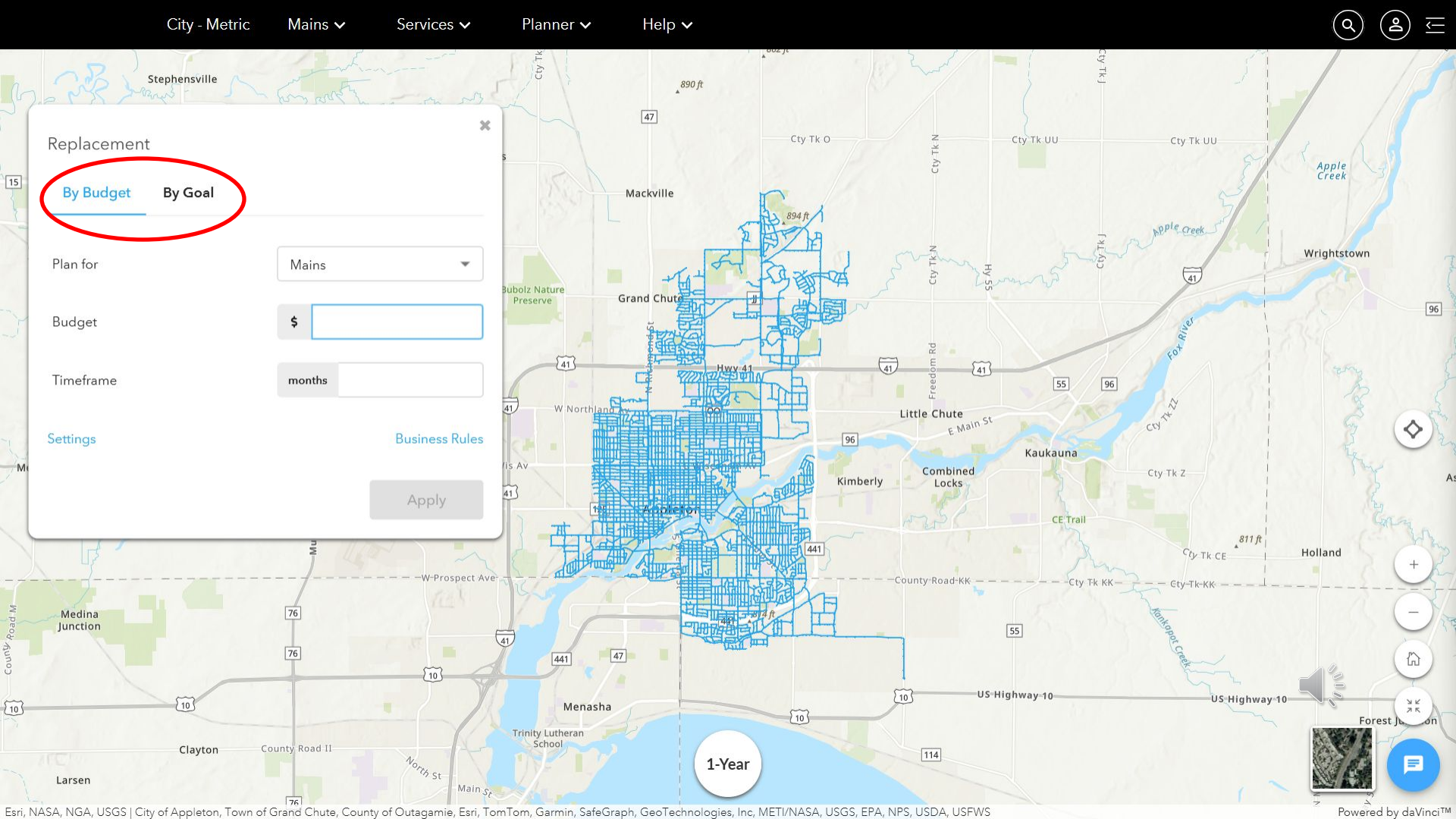
Disclaimer

1-Year

New Demo | Mains | Services | Planner | Help

- Condition Assessment
- Replacement
- Rehab
- Leak Monitoring




City - Metric
Mains
Services
Planner
Help
Replacement
By Budget
By Goal
Plan for
Mains
Budget
$
Timeframe
months
Settings
Business Rules
Apply
1-Year
Stephensville
Mackville
Grand Chute
Hwy 41
Little Chute
Kaukauna
Kimberly
Combined Locks
Wrightstown
Holland
Menasha
Medina Junction
Clayton
Larsen
US Highway 10
Fox River
Apple Creek
Bubolz Nature Preserve
CE Trail
Trinity Lutheran School
Esri, NASA, NGA, USGS | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
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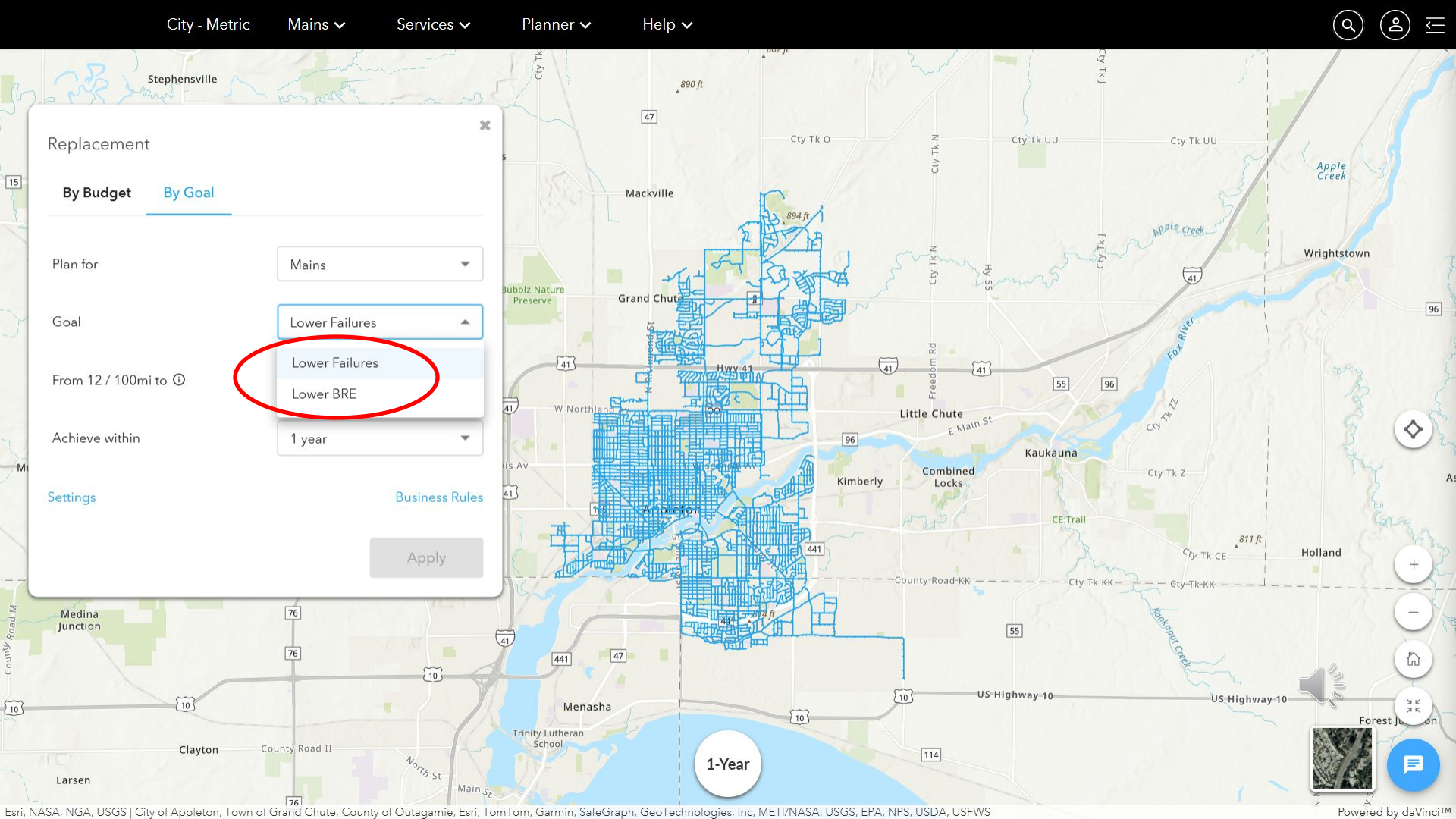
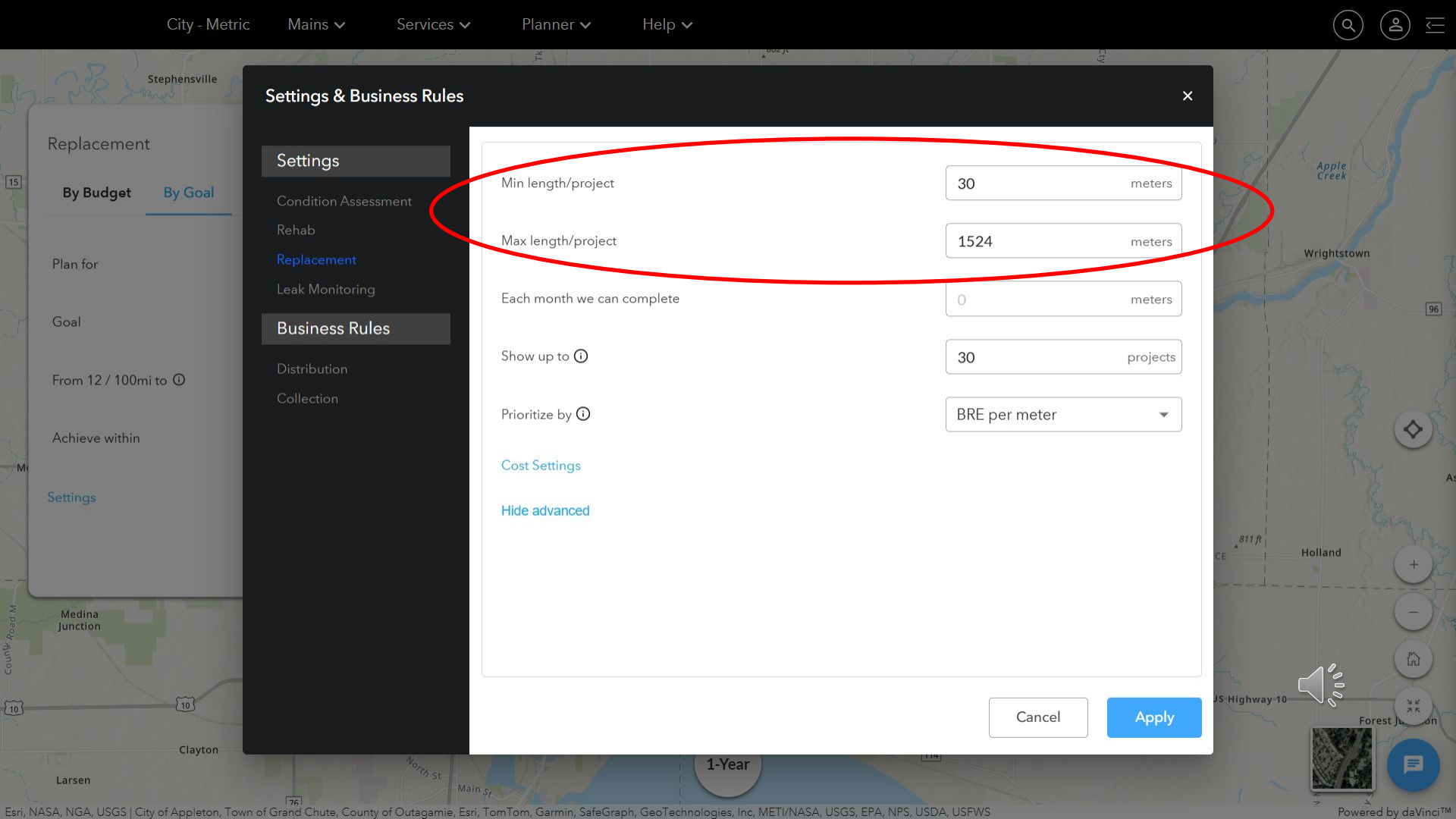

City - Metric
Mains
Services
Planner
Help
Replacement
By Budget
By Goal
Plan for
Mains
Goal
Lower Failures
Lower Failures
Lower BRE
From 12 / 100mi to
Achieve within
1 year
Settings
Business Rules
Apply
1-Year
Stephensville
Mackville
Grand Chute
Little Chute
Kaukauna
Kimberly
Combined Locks
Wrightstown
Holland
Medina Junction
Menasha
Clayton
Larsen
Bubolz Nature Preserve
Trinity Lutheran School
Apple Creek
Fox River
CE Trail
US Highway 10
County Road KK
Hwy 41
Esri, NASA, NGA, USGS | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
Powered by daVinci™


City - Metric
Mains
Services
Planner
Help
Settings & Business Rules
Settings
Condition Assessment
Rehab
Replacement
Leak Monitoring
Business Rules
Distribution
Collection
Min length/project
30
meters
Max length/project
1524
meters
Each month we can complete
0
meters
Show up to
30
projects
Prioritize by
BRE per meter
Cost Settings
Hide advanced
Cancel
Apply
Replacement
By Budget
By Goal
Plan for
Goal
From 12 / 100mi to
Achieve within
Settings
Stephensville
Medina Junction
Clayton
Larsen
Wrightstown
Holland
Apple Creek
1-Year
Esri, NASA, NGA, USGS | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
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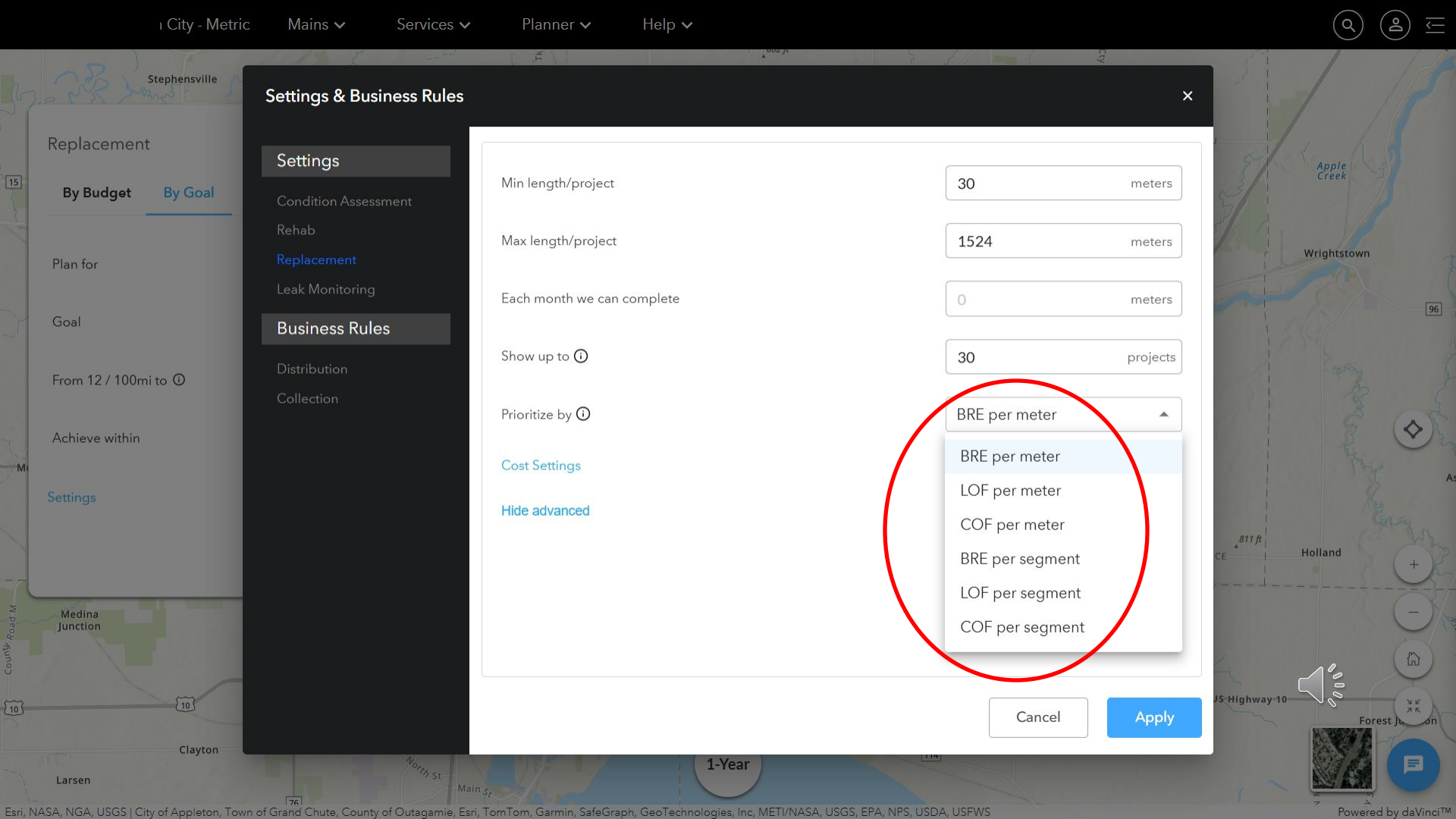
City - Metric
Mains
Services
Planner
Help
Settings & Business Rules
Settings
Condition Assessment
Rehab
Replacement
Leak Monitoring
Business Rules
Distribution
Collection
Min length/project
30
meters
Max length/project
1524
meters
Each month we can complete
0
meters
Show up to
30
projects
Prioritize by
BRE per meter
Cost Settings
Hide advanced
BRE per meter
LOF per meter
COF per meter
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LOF per segment
COF per segment
Cancel
Apply
Replacement
By Budget
By Goal
Plan for
Goal
From 12 / 100mi to
Achieve within
Settings
Stephensville
Medina Junction
Clayton
Larsen
Wrightstown
Holland
Apple Creek
1-Year
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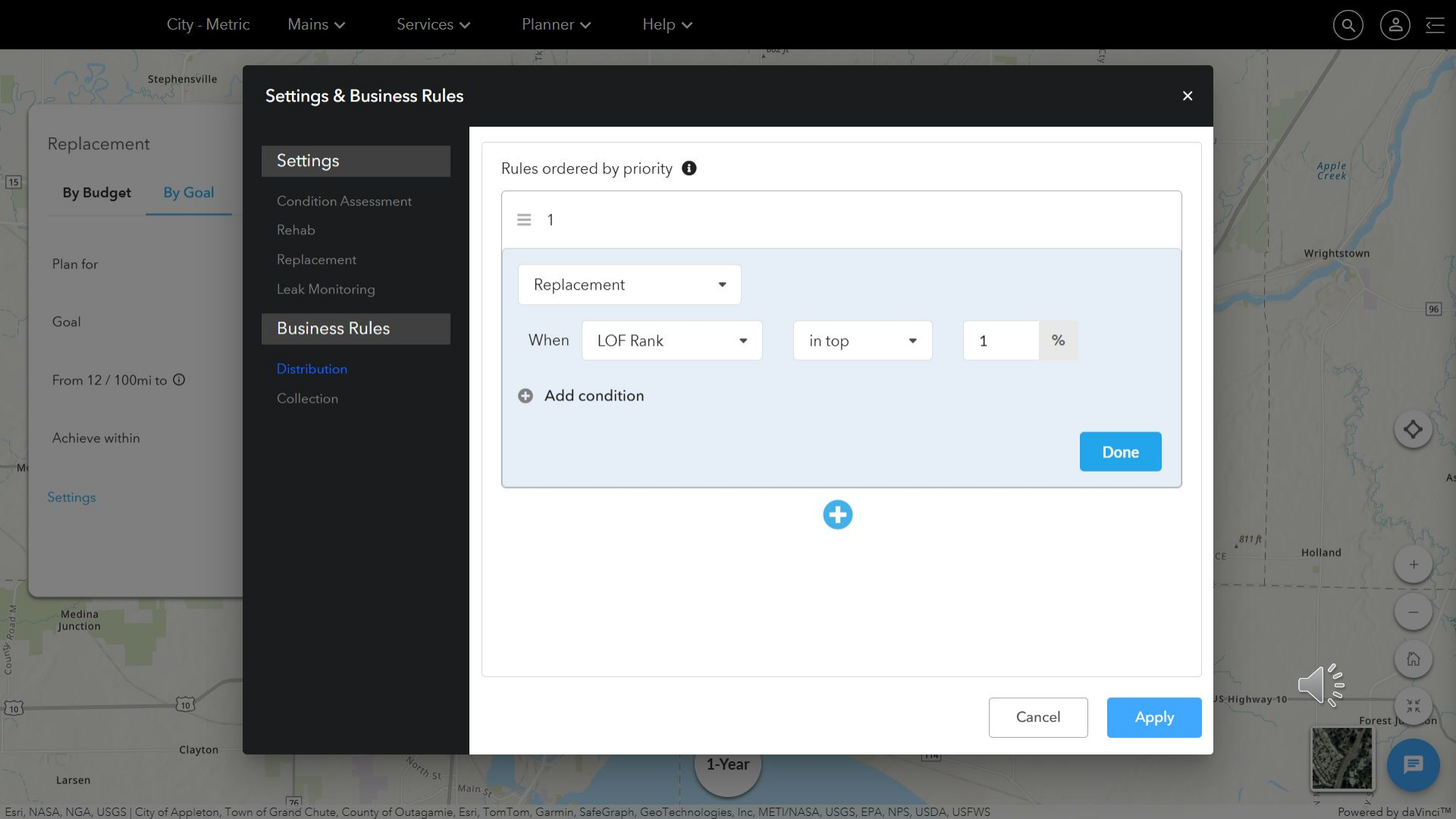
City - Metric
Mains
Services
Planner
Help
Settings & Business Rules
Settings
Condition Assessment
Rehab
Replacement
Leak Monitoring
Business Rules
Distribution
Collection
Rules ordered by priority
1
Replacement
When
LOF Rank
in top
1
%
Add condition
Done
Cancel
Apply
Replacement
By Budget
By Goal
Plan for
Goal
From 12 / 100mi to
Achieve within
Settings
Stephensville
Wrightstown
Holland
Medina Junction
Clayton
Larsen
1-Year
Esri, NASA, NGA, USGS | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS
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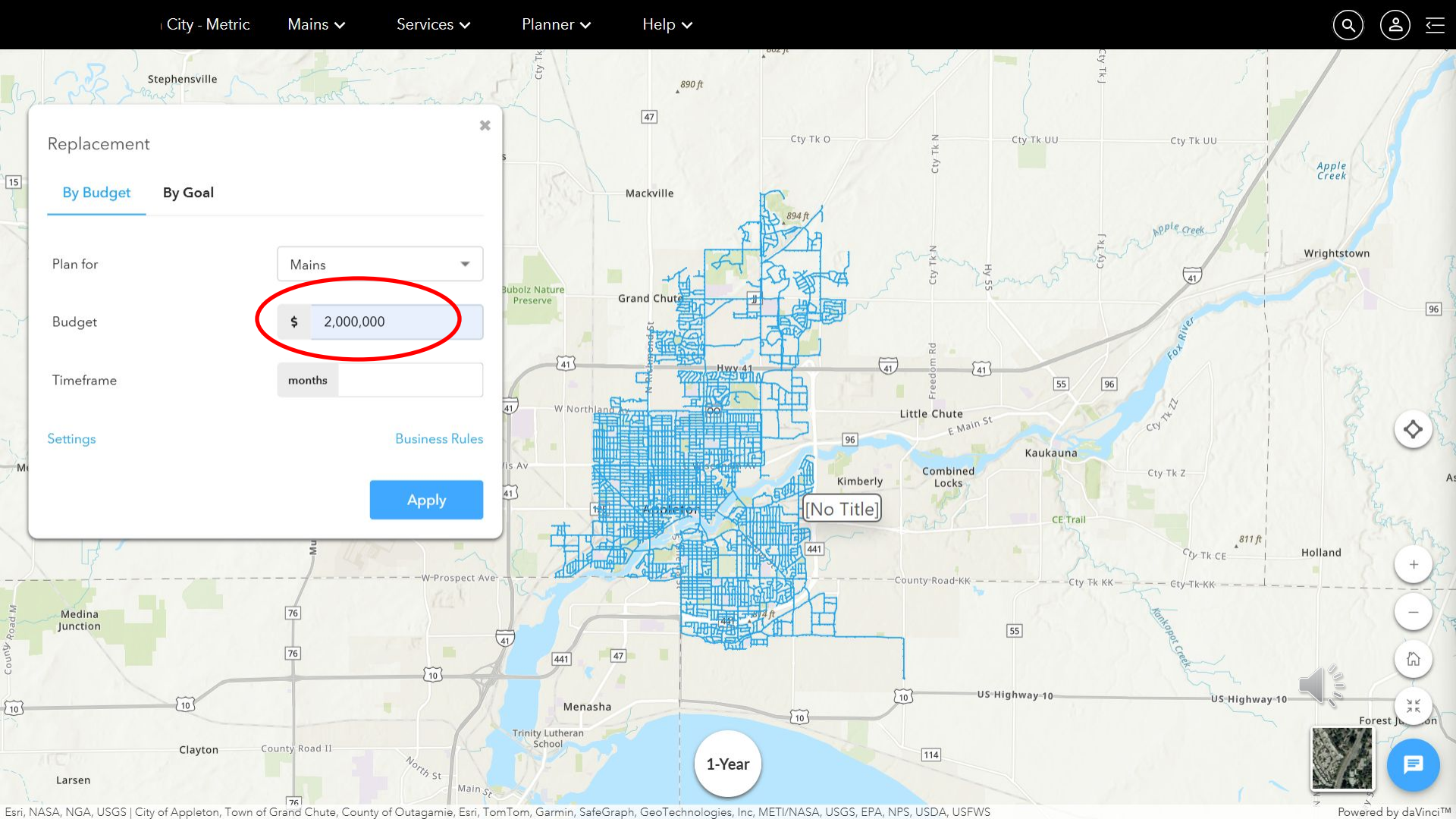
City - Metric
Mains
Services
Planner
Help
Replacement
By Budget
By Goal
Plan for
Mains
Budget
$
2,000,000
Timeframe
months
Settings
Business Rules
Apply
[No Title]
1-Year
Stephensville
Mackville
Grand Chute
Little Chute
Kaukauna
Kimberly
Combined Locks
Wrightstown
Holland
Menasha
Medina Junction
Clayton
Larsen
Hwy 41
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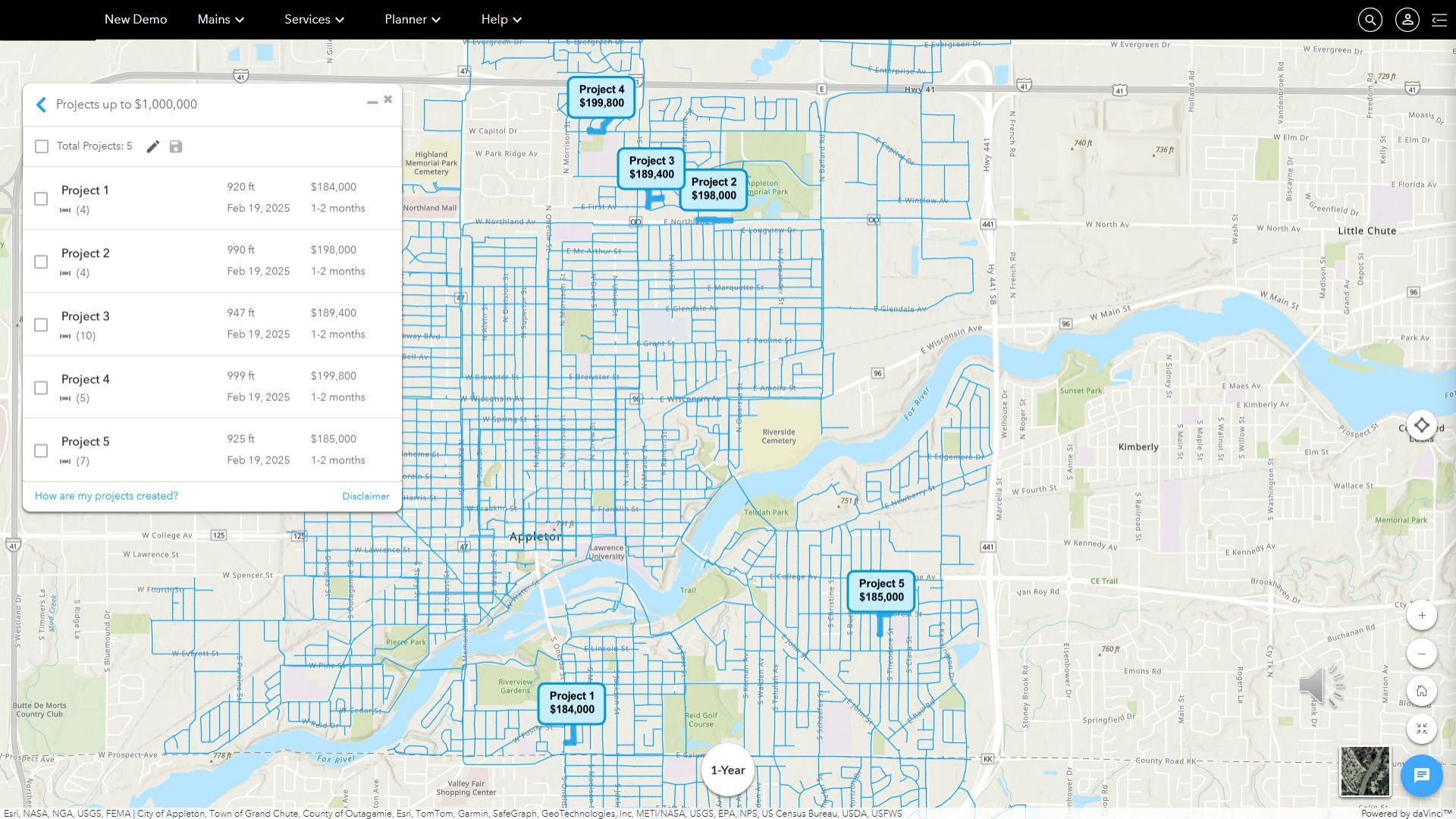
New Demo
Mains
Services
Planner
Help
Projects up to $1,000,000
Total Projects: 5
Project 1 (4) 920 ft Feb 19, 2025 $184,000 1-2 months
Project 2 (4) 990 ft Feb 19, 2025 $198,000 1-2 months
Project 3 (10) 947 ft Feb 19, 2025 $189,400 1-2 months
Project 4 (5) 999 ft Feb 19, 2025 $199,800 1-2 months
Project 5 (7) 925 ft Feb 19, 2025 $185,000 1-2 months
How are my projects created?
Disclaimer
Project 4 $199,800
Project 3 $189,400
Project 2 $198,000
Project 5 $185,000
Project 1 $184,000
1-Year
Appleton
Kimberly
Little Chute
Esri, NASA, NGA, USGS, FEMA | City of Appleton, Town of Grand Chute, County of Outagamie, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS
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Projects up to $3,000,000

Total Projects: 3 Saved Projects

Project 1 (15)	4,946 ft	$1,146,383	
	Feb 07, 2025	2-3 months	

1	Pipe ID: SAN02137
2	Pipe ID: SAN02135
3	Pipe ID: SAN02132
4	Pipe ID: SAN02133
5	Pipe ID: SAN02125
6	Pipe ID: SAN02139
7	Pipe ID: SAN02136
8	Pipe ID: SAN02130
9	Pipe ID: SAN02142
10	Pipe ID: SAN02131
11	Pipe ID: SAN02124
12	Pipe ID: SAN02150
13	Pipe ID: SAN02140

How are my projects created? Disclaimer

Project 1
$1,146,383

1-Year

Projects up to $3,000,000

Total Projects: 3 Saved Projects

Project 1 (15)	4,946 ft Feb 07, 2025	$1,146,383 2-3 months

1 Pipe ID: SAN02137
2 Pipe ID: SAN02135
3 Pipe ID: SAN02132
4 Pipe ID: SAN02133
5 Pipe ID: SAN02125
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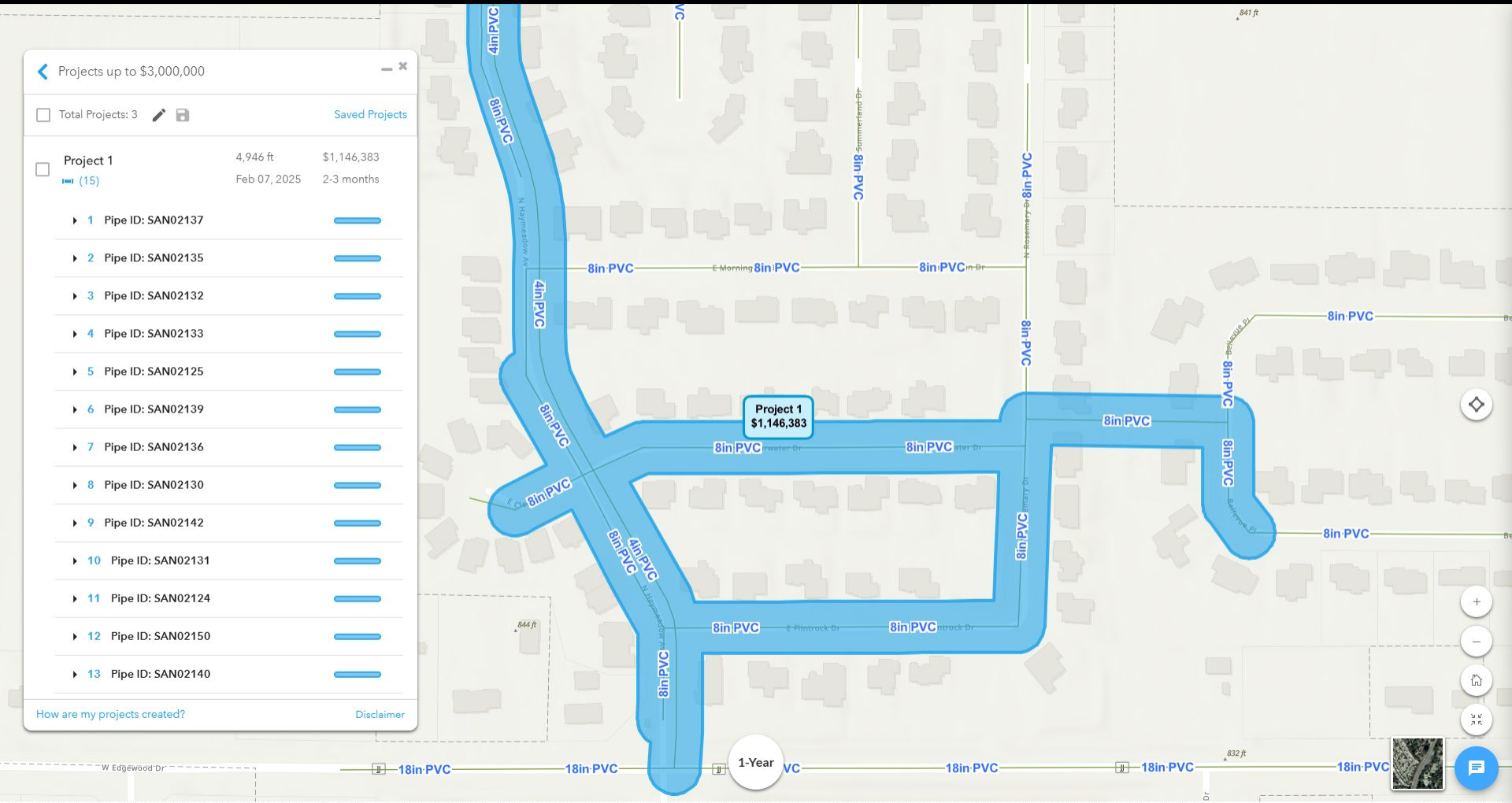
7 Pipe ID: SAN02136
8 Pipe ID: SAN02130
9 Pipe ID: SAN02142
10 Pipe ID: SAN02131
11 Pipe ID: SAN02124
12 Pipe ID: SAN02150
13 Pipe ID: SAN02140

How are my projects created? Disclaimer



NWWC 2025

Victoria, BC

Prioritizing Water Infrastructure with Artificial Intelligence

Dan Hack | Itron & VODA.ai

NWWC
2025

Prioritizing Water Infrastructure Artificial Intelligence

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