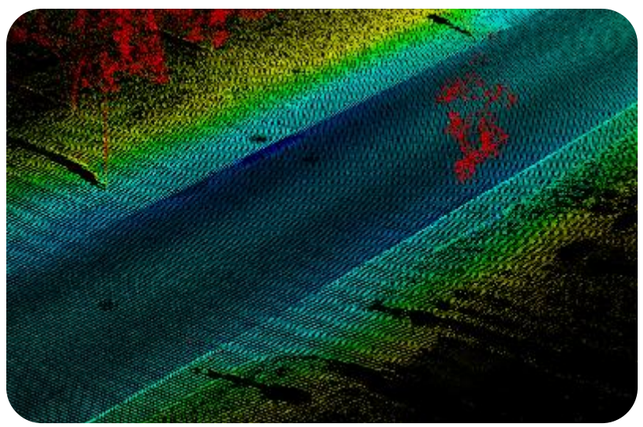
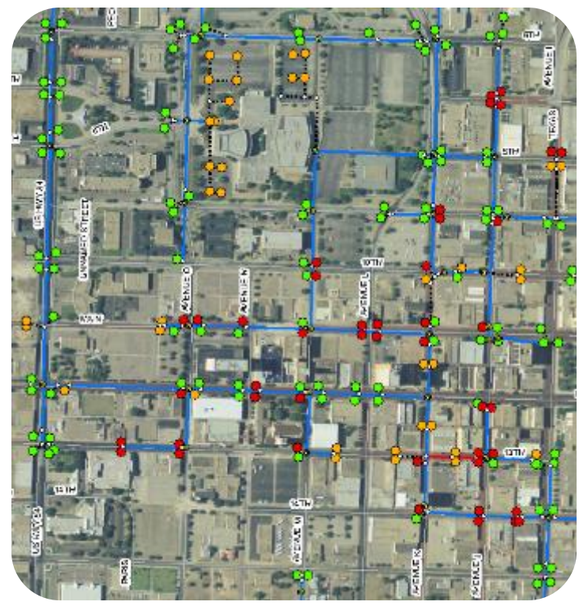
City of San Antonio

Utilizing Advanced Technologies for Stormwater System Mapping and Condition Assessments





Prepared for:
2017 ESRI Users Conference

Prepared by
Noelle Gaspard, PE, GISP, CFM

July 12,2017

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Agenda

- Stormwater Management Purpose
- City of San Antonio Stormwater Inventory Project
- Advanced Technologies
  - *Data Collection:* Mobile LiDAR
  - *Condition Assessment:* 360° Manhole Inspection with IBAK Panoramo
  - *Defect Analysis:* InfoMaster Sewer
- Questions

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Stormwater Management

- Stormwater management is a major and growing challenge nationwide.

- Stormwater pollution, aging infrastructure, flooding and other issues impose serious impacts on public safety, water quality, public health and local economies.

- As communities continue to grow, the need to develop a **comprehensive and effective stormwater management program** increases

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Stormwater Management

- Many communities have a stormwater system, however:
  - They do not have a comprehensive understanding of where their storm assets are located
  - The condition of the existing system largely unknown
  - Reactive vs. Proactive approach to stormwater management
  - Unable to fund stormwater improvements
- First step is to develop a **Stormwater Asset Management Plan**

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CITY OF SAN ANTONIO

STORMWATER PROJECT CASE STUDY

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COSA Stormwater Project Purpose

Portions of the City of San Antonio storm sewer system are approaching 100 years old and a City-wide understanding of **where the storm assets are located** is incomplete.

Additionally, the **condition of the existing pipes** is largely unknown and the City would like to tie all condition assessment data to into the City of San Antonio's GIS and Cartegraph system.

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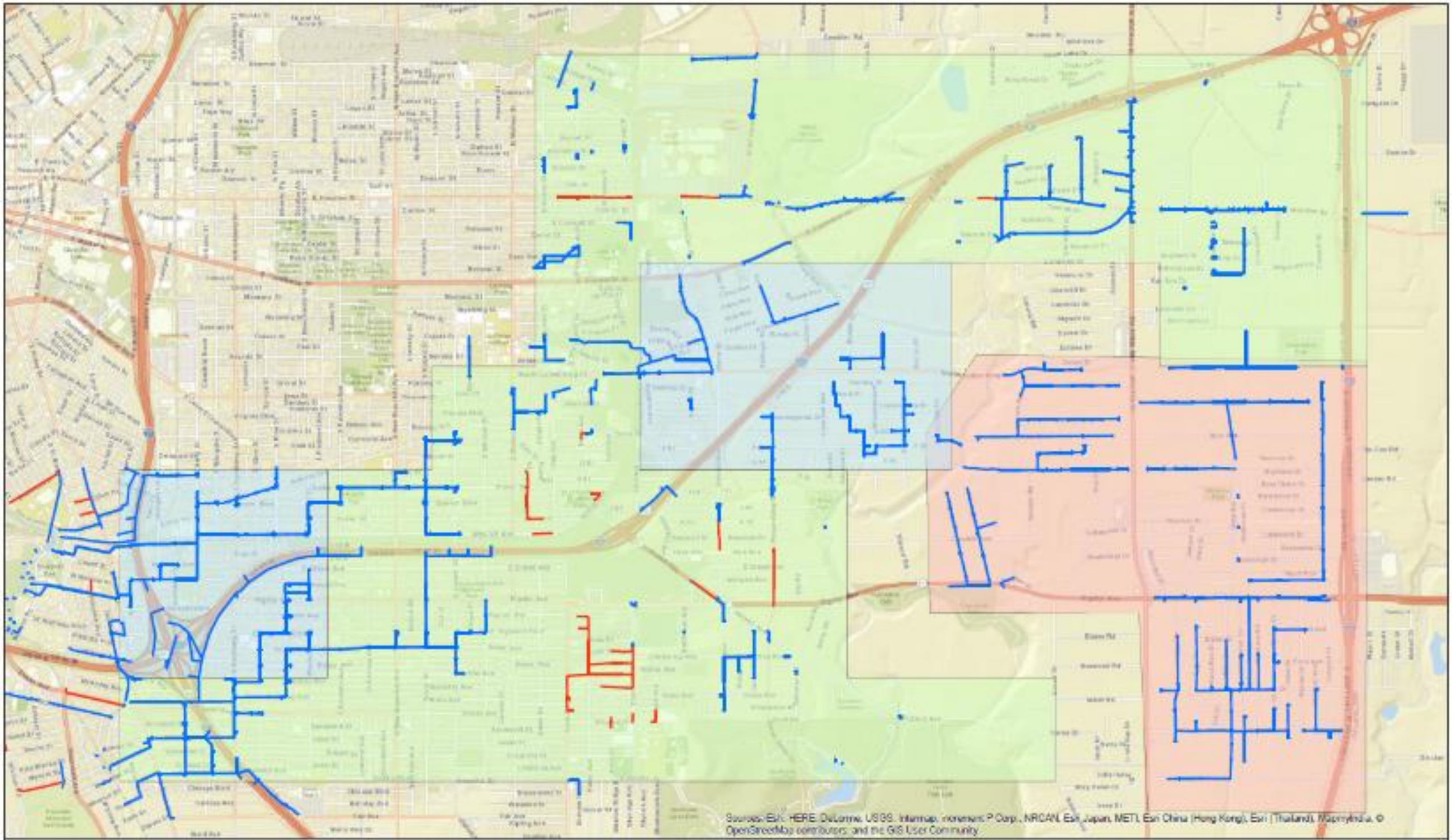

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The Choice for Collection System Solutions

Storm Pipe

Assumed Storm Pipe

2017 Study Area

2016 Study Area

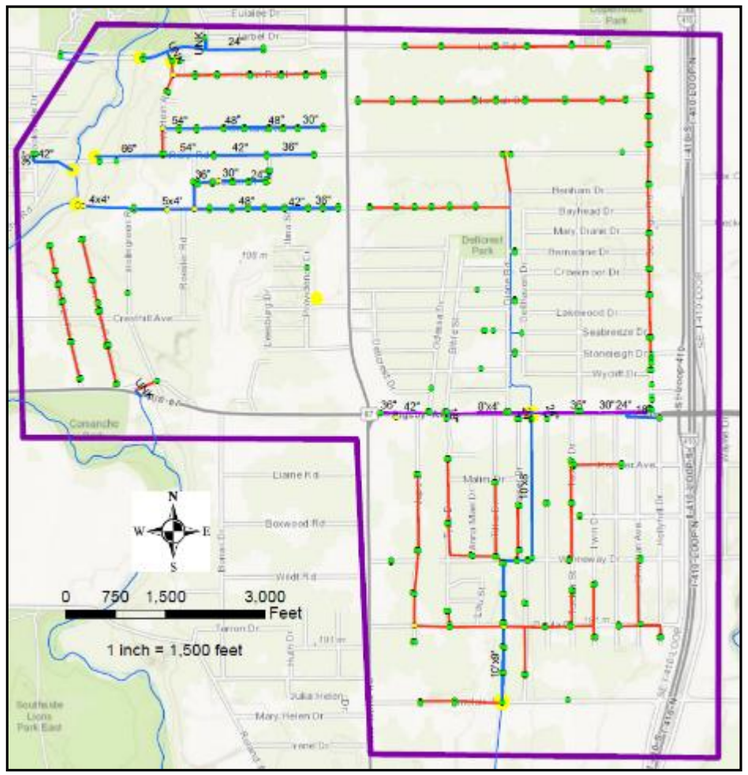
2015 Study Area

Stormwater Mapping, CCTV and Condition Assessment - Year 3
City of San Antonio
18-2872-02
February 2017

COSA Stormwater – Pilot Project

Project Objective: Conduct mapping and video inspection of the storm sewer infrastructure

- Develop Stormwater GIS database structure
- Perform field survey, CCTV and Condition Assessment
- Integrate all project deliverables into a comprehensive GIS Database, PipeLogix database and Cartegraph system



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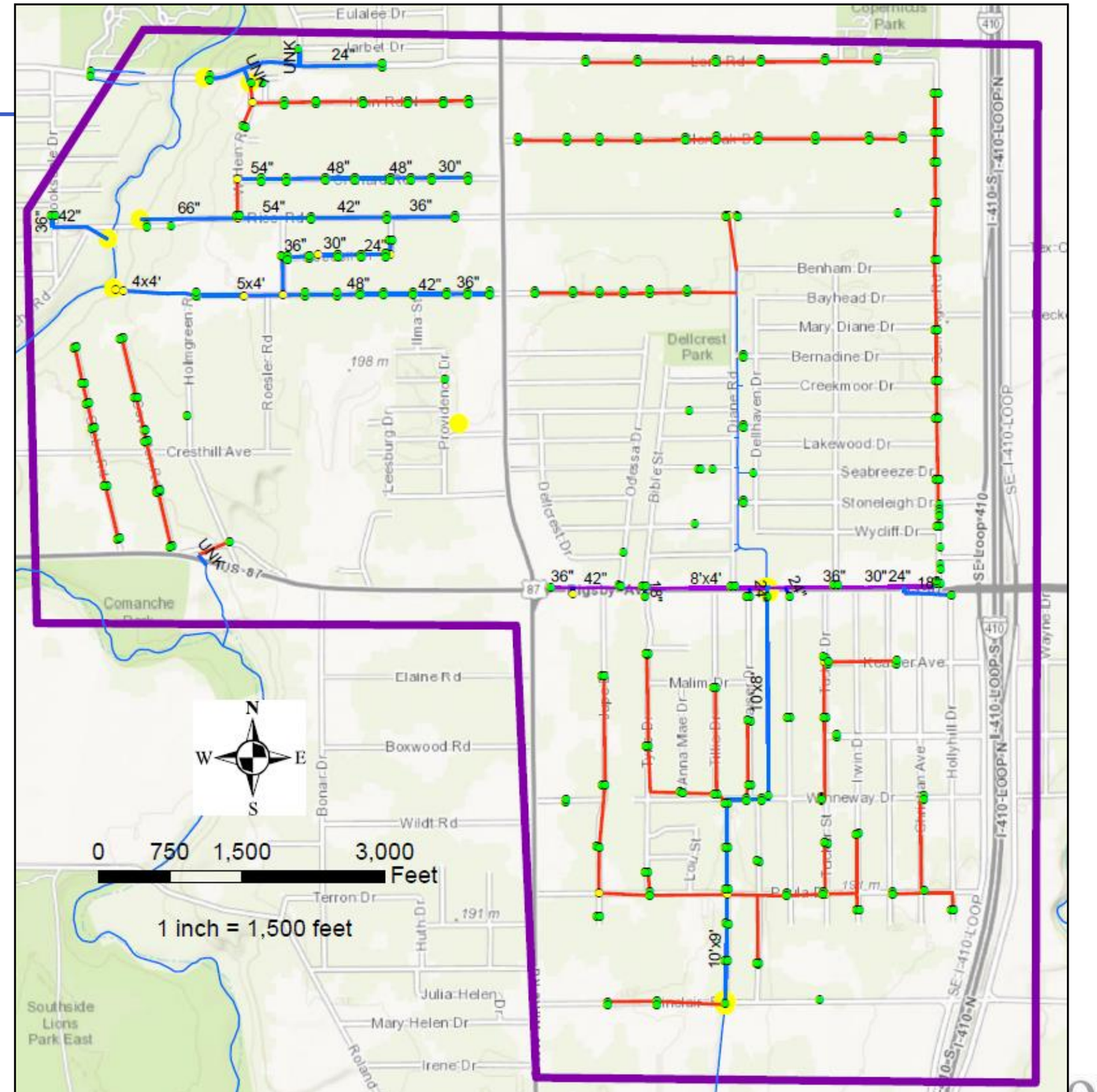
Pilot Area

- Storm Sewer – 30,000 lf
- Inlets – 260
- Manholes – 100

COSA Stormwater

- COSA GIS Pipe
- Suspected Pipe
- Inlets
- Manholes
- RJN Proposed Pilot Area

COSA GIS Pipe	30,000
Suspected Pipe	42,000
TOTAL	72,000



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COSA Stormwater – Pilot Project

Challenges: Project RFQ was released February 2105, RJN was selected in early May and the project was approved by Council late May 2015. The full project had to be completed by the end of the 2015 Fiscal Year (September 2015)

- The existing storm GIS layers from the City were incomplete and many assets were not mapped or missing attribute information
- The accelerated timeline of 5 months, required efficient data collection and analysis procedures to complete the project within the outlined schedule

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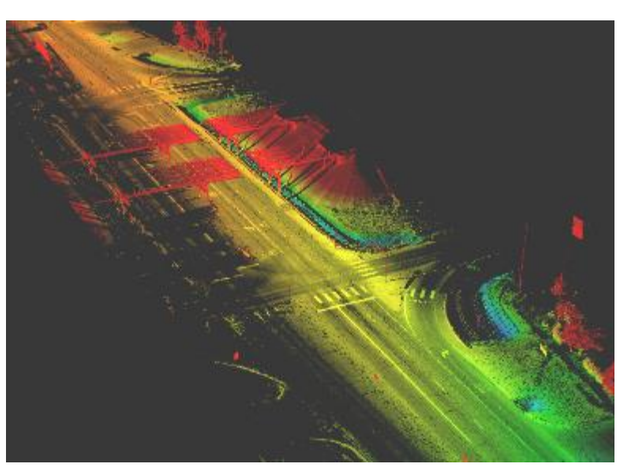
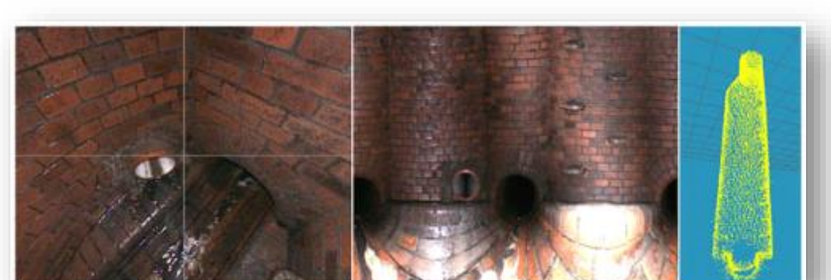
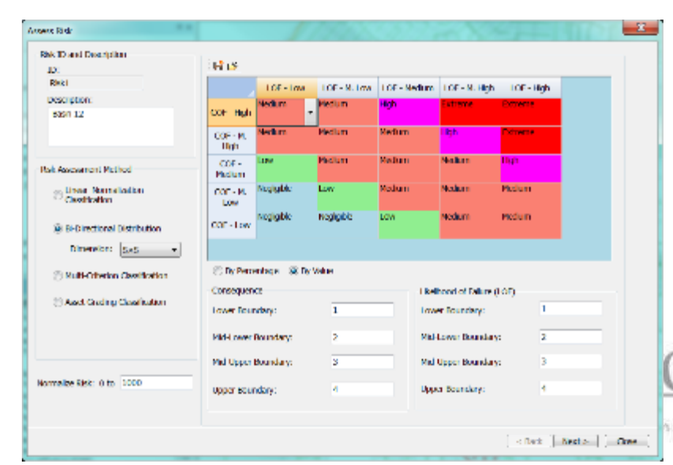
COSA Stormwater – Pilot Project

Solutions: Project utilized multiple advanced technologies and software programs throughout each phase of the project to efficiently map and analyze the stormwater system, including:

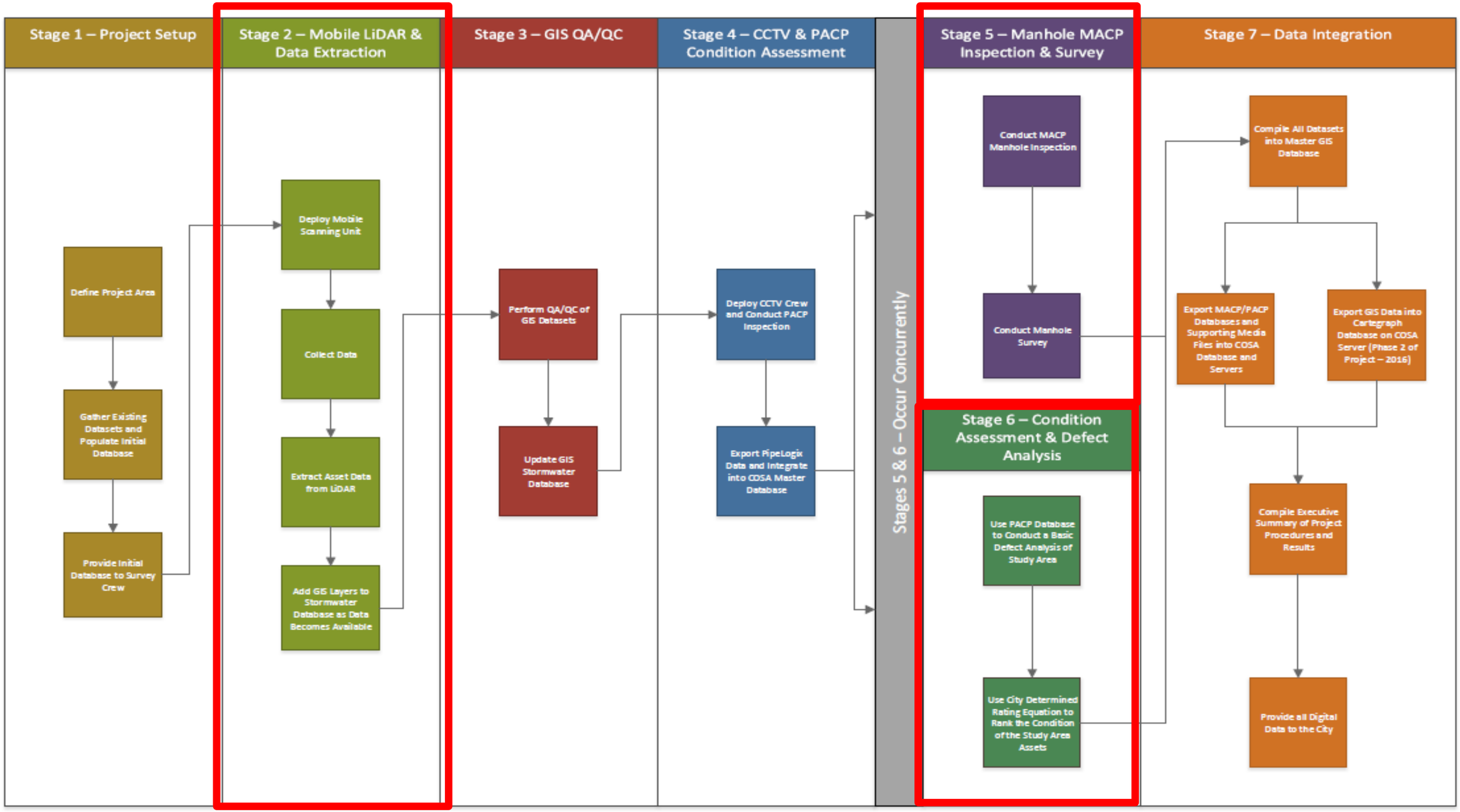
- Mobile LiDAR
- 360° Manhole Inspection with IBAK Panoramo
- InfoMaster Sewer







City of San Antonio – Stormwater System Televising, Mapping and Condition Assessment Project Workflow



Project Workflow

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Advanced Technologies

- *Data Collection:* Mobile LiDAR
- *Condition Assessment:* 360° Manhole Inspection with IBAK Panoramo
- *Defect Analysis:* InfoMaster Sewer

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DATA COLLECTION

MOBILE LIDAR

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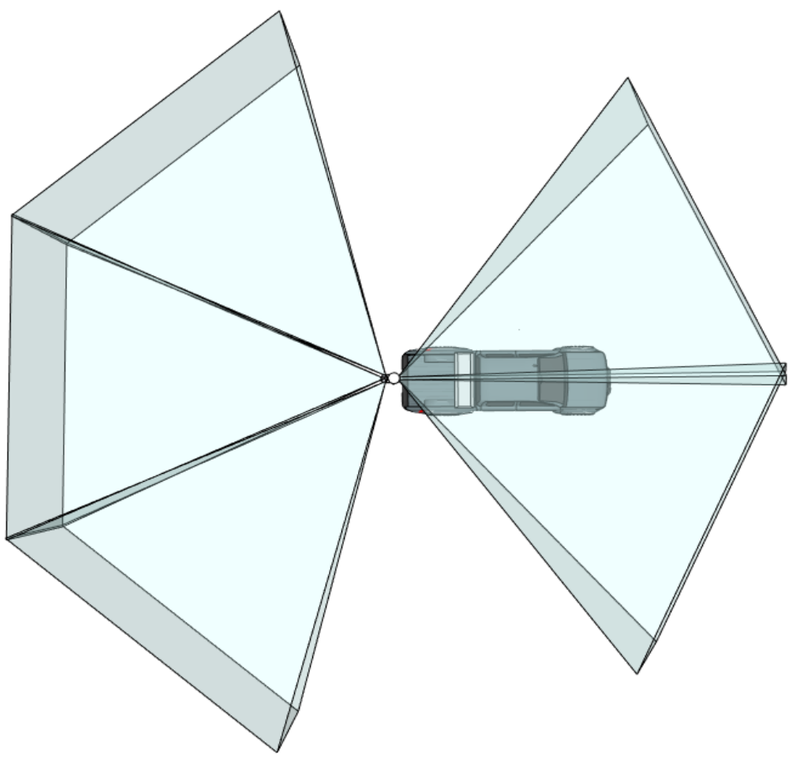
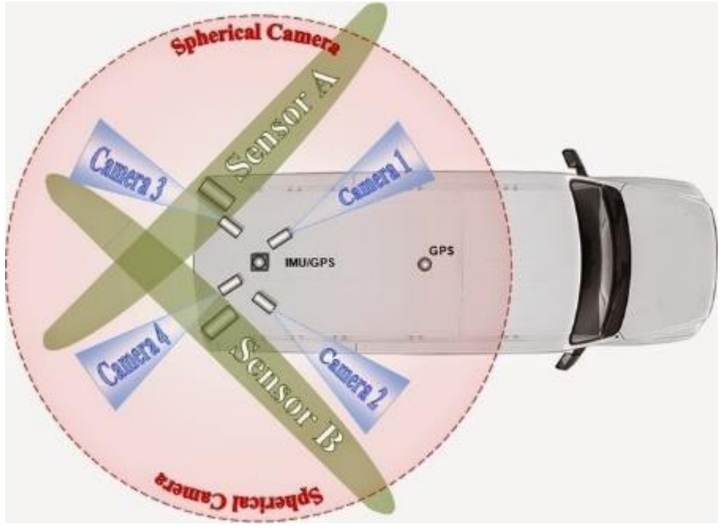
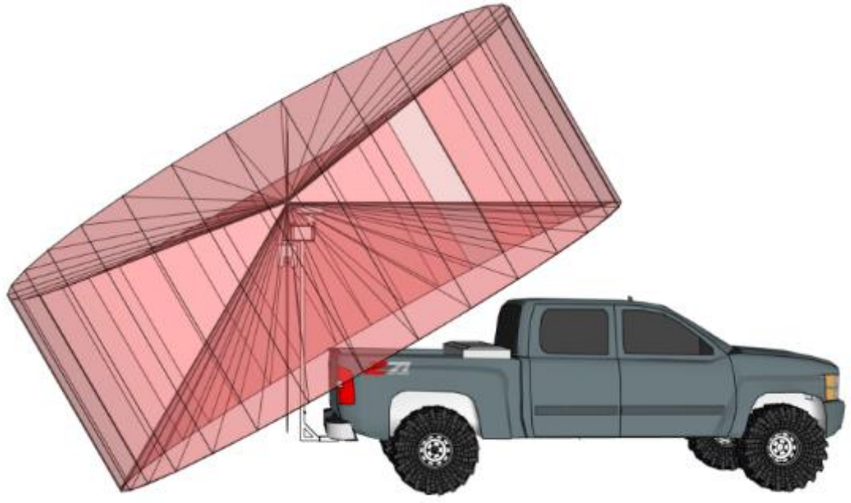
What is Mobile LiDAR?

Mobile Mapping System

- **Li**ght **D**etecting **A**nd **R**anging
- A vehicular based imaging and LiDAR data collection system
- 200,000 points collected per second







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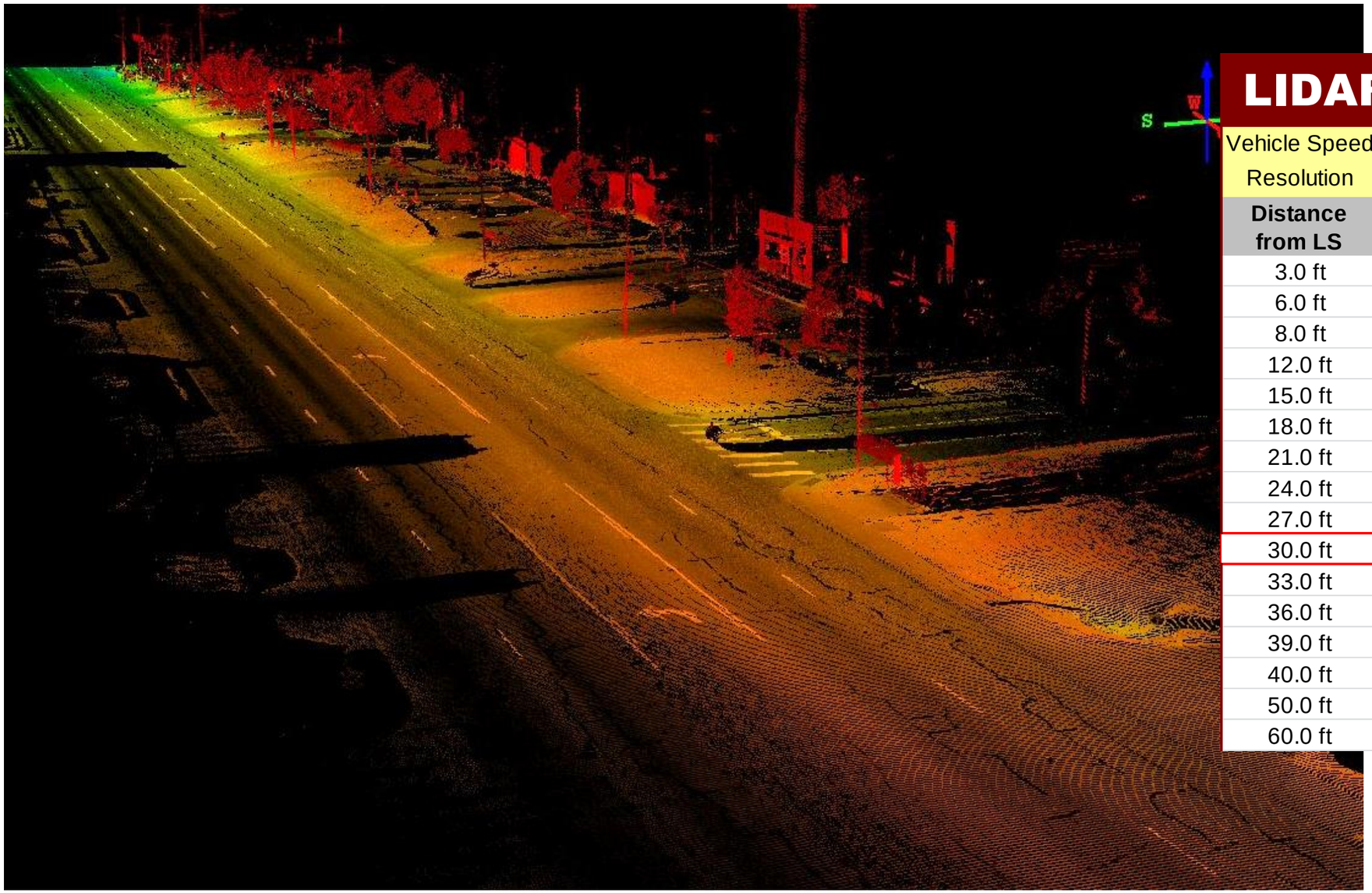
Mobile LiDAR Point Cloud



LIDAR USA MOBILE SCAN

Vehicle Speed	30	mph		
Resolution	1/1			
Distance from LS	**Perp. To Travel**	**Parral. To Travel**	**Perp. To Travel**	**Parral. To Travel**
3.0 ft	0.0009 ft.	0.4536 ft.	0.011 "	5.443 "
6.0 ft	0.0019 ft.	0.4536 ft.	0.023 "	5.443 "
8.0 ft	0.0025 ft.	0.4536 ft.	0.030 "	5.443 "
12.0 ft	0.0038 ft.	0.4536 ft.	0.045 "	5.443 "
15.0 ft	0.0047 ft.	0.4536 ft.	0.057 "	5.443 "
18.0 ft	0.0057 ft.	0.4536 ft.	0.068 "	5.443 "
21.0 ft	0.0066 ft.	0.4536 ft.	0.079 "	5.443 "
24.0 ft	0.0075 ft.	0.4536 ft.	0.090 "	5.443 "
27.0 ft	0.0085 ft.	0.4536 ft.	0.102 "	5.443 "
30.0 ft	0.0094 ft.	0.4536 ft.	0.113 "	5.443 "
33.0 ft	0.0104 ft.	0.4536 ft.	0.124 "	5.443 "
36.0 ft	0.0113 ft.	0.4536 ft.	0.136 "	5.443 "
39.0 ft	0.0123 ft.	0.4536 ft.	0.147 "	5.443 "
40.0 ft	0.0126 ft.	0.4536 ft.	0.151 "	5.443 "
50.0 ft	0.0157 ft.	0.4536 ft.	0.188 "	5.443 "
60.0 ft	0.0188 ft.	0.4536 ft.	0.226 "	5.443 "

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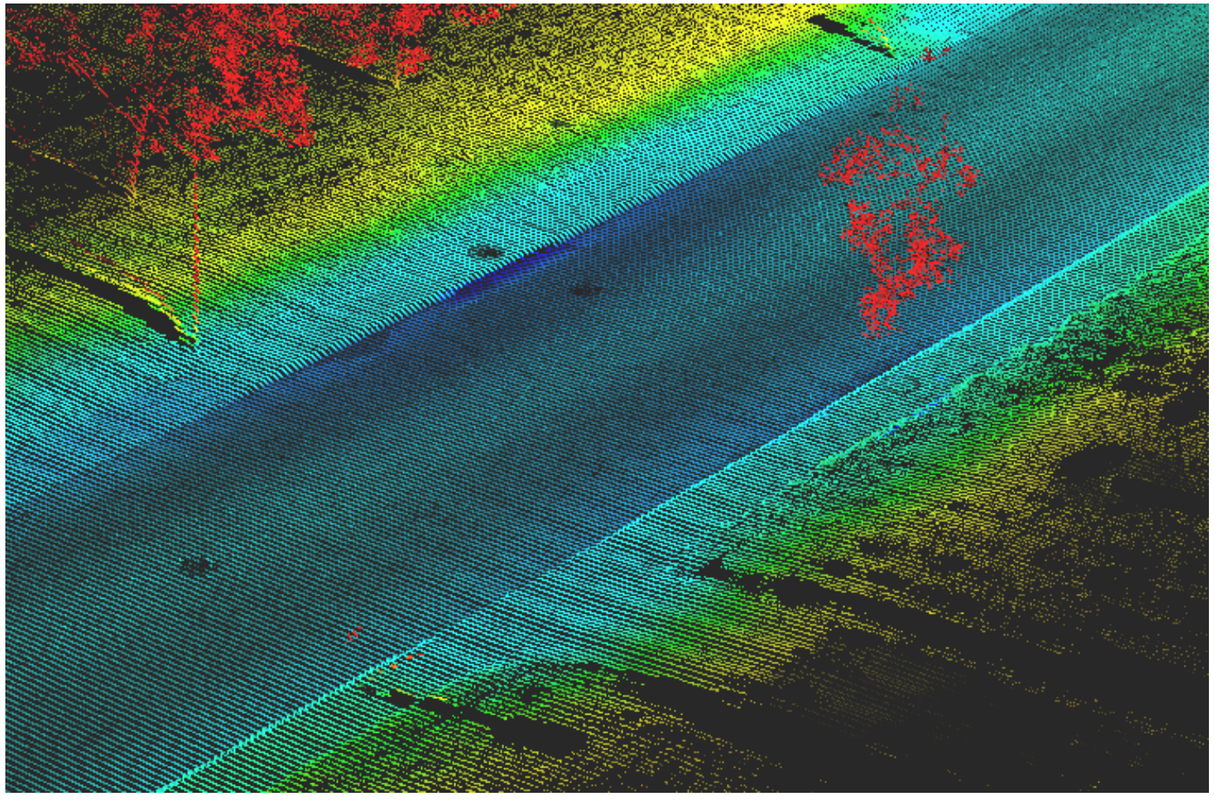
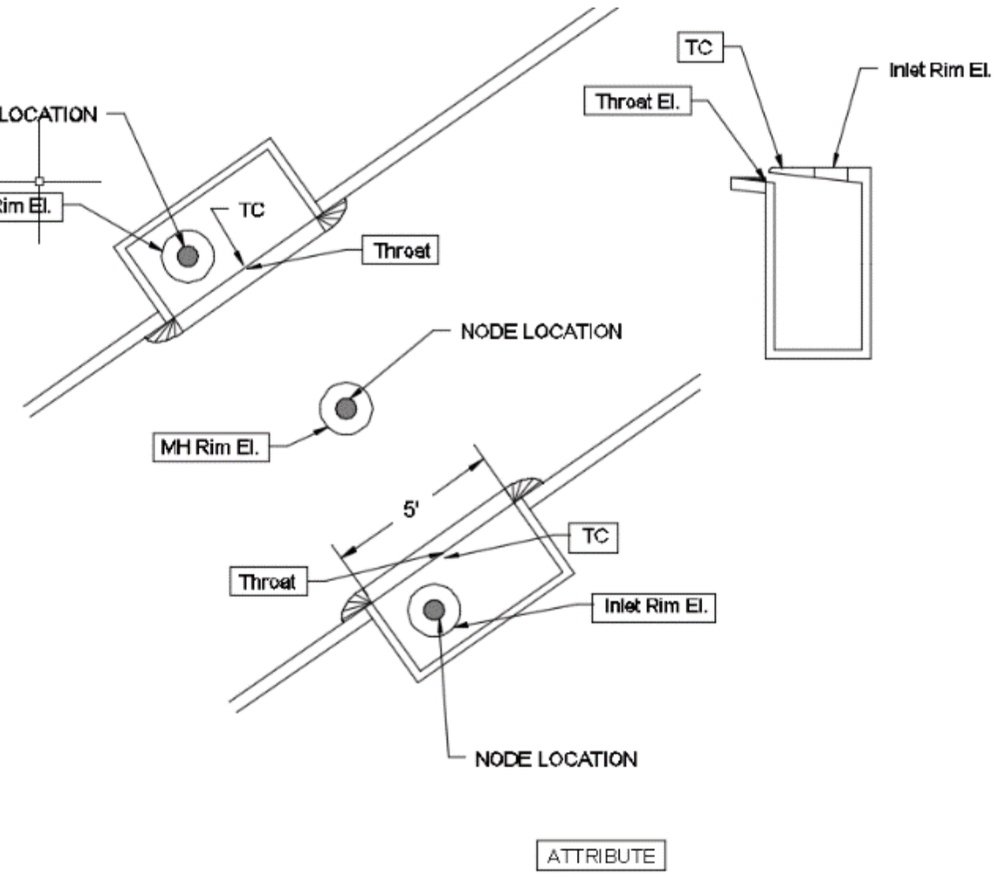
Mobile LiDAR Data Extraction

- Extract Inlets and Manholes from Mobile LiDAR Point Cloud
  - Inlet Manhole Lid Elevation
  - Inlet Throat Elevation
  - Inlet Top of Curb Elevation





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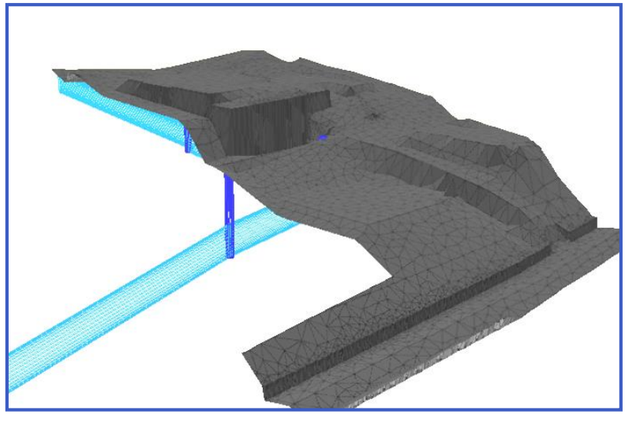
Mobile LiDAR Benefits

- Capture accurate geo-referenced imagery and LiDAR point cloud safely
- Survey Grade Accuracy
- Reduced field time
  - COSA Project – **collected 54 street miles of data in 1 day**
- Produce higher quality data than traditional asset surveys
- Cost Effective
- Can be used for future 2D Hydraulic modeling



MANHOLE CONDITION ASSESSMENT

IBAK PANORAMO SI

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360° Panoramic Manhole Inspections

- RJN Purchased and began using the IBAK Panoramo in April 2016.
- Allows for quick, accurate and detailed MACP surveys of each structure.
- This mobile system captures a complete 360° perspective record of the inside of the structure

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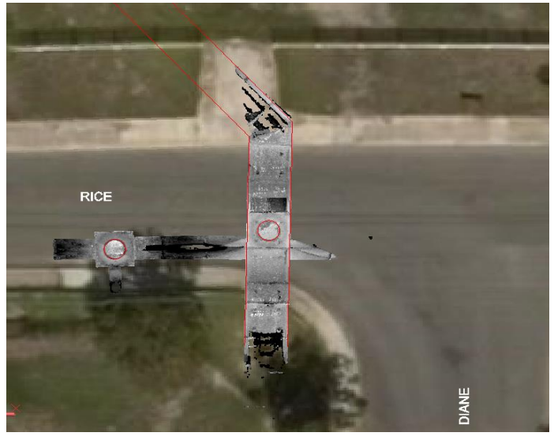
360° Panoramic Manhole Inspections

- **Panoramic view** of the manhole

360° Manhole Survey Benefits

- Capture accurate inspection information safely
- MACP Inspection defect coding
- Produce higher quality data than traditional asset surveys
- More efficient data collection equates to cost savings
- Locate unknown line connections and laterals



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DEFECT ANALYSIS

INFOMASTER SEWER

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InfoMaster Sewer Defect Analysis

CCTV video inspection was completed for approximately 70,000 linear feet of stormwater pipe within the Pilot Area. All observations were coded using the most recent version of the NASSCO PACP guidelines.

- Identification of **condition of the sewer**.
- Identification of any **connections from storm laterals** (catch basins and inlets)
- Identification of any **defects** which are cost-effective to repair.
- Identification of **maintenance issues** such as debris, grease, and roots

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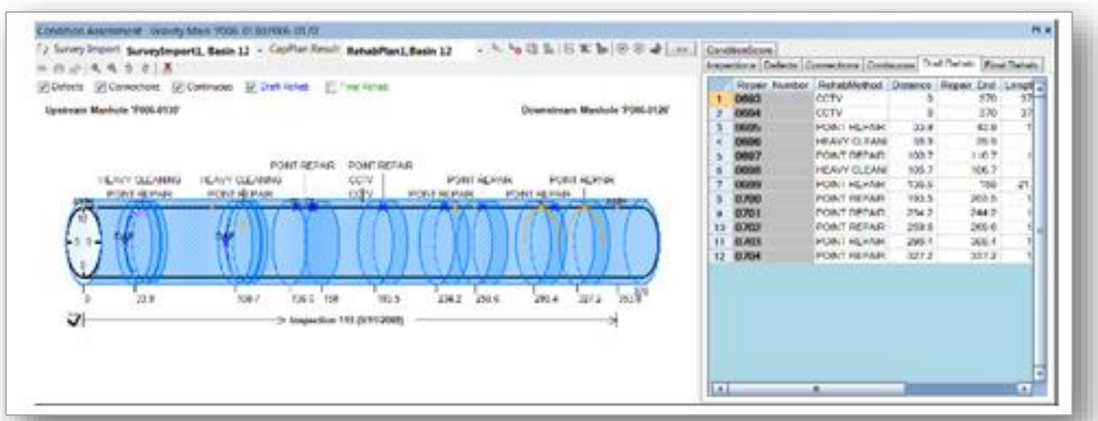
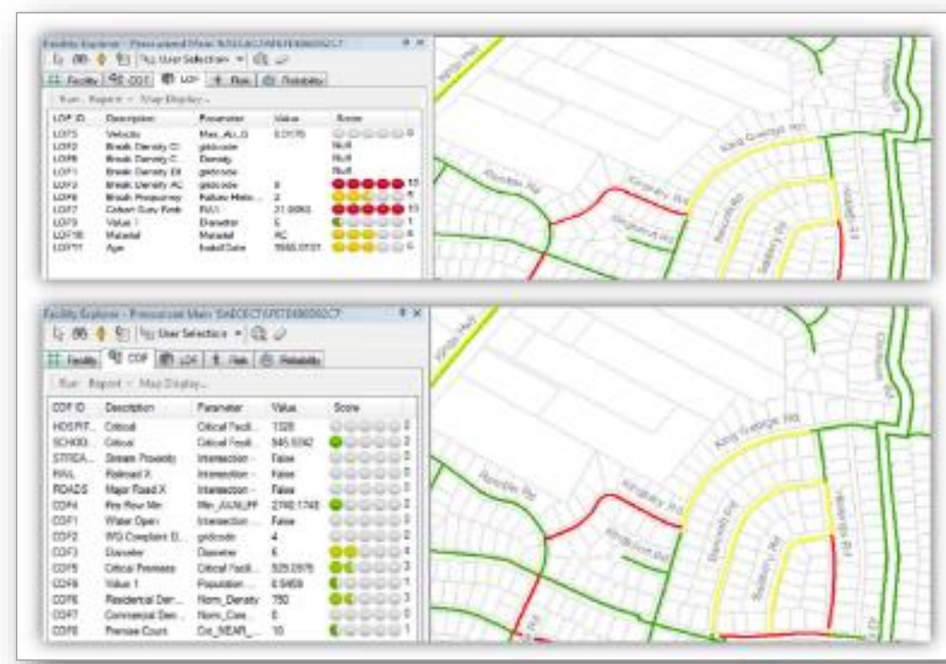
InfoMaster Sewer Defect Analysis

- **InfoMaster** is a decision support tool that uses user defined asset data and field investigation data along with analysis tools to prioritize assets and determine condition assessment rehabilitation decisions for an entire system.





InfoMaster Decision Process

Data Wizard	Data Wizard does a quality check of the data, scores defects, and develops a draft rehabilitation plan
Consequence of Failure (COF)	Consequence of Failure of an asset based on parameters set by user
Likelihood of Failure (LOF)	Likelihood of Failure of an asset based on parameters set by user
Risk	Customizable Matrix of the Consequence of Failure to the Likelihood of Failure
Rehabilitation Plan	Rehabilitation Plan for the Asset

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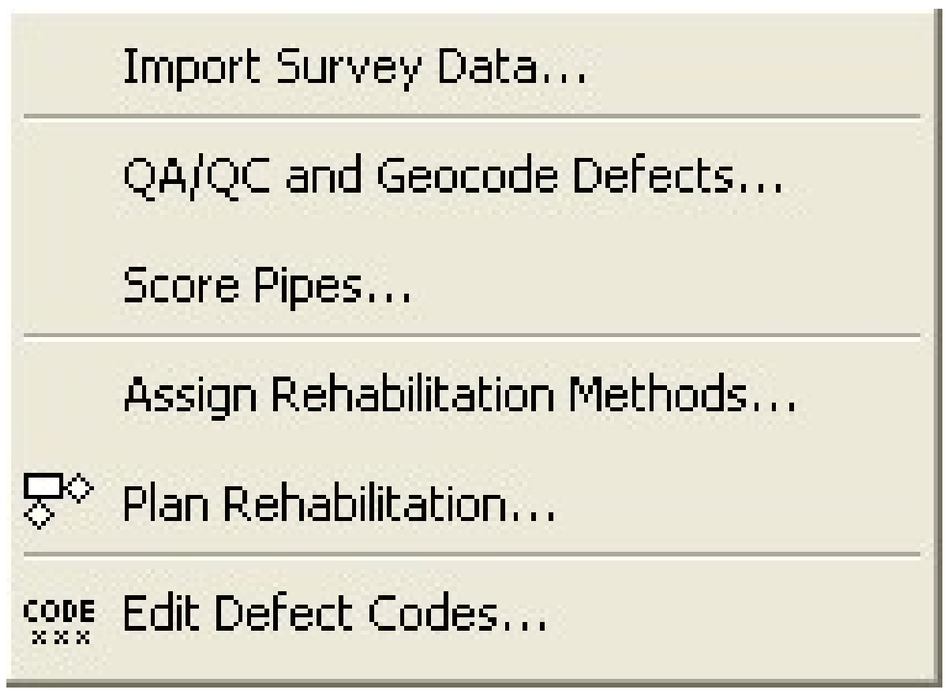
CCTV QA/QC and Geocode Defects



- Simplified CCTV import
- Streamlined CCTV QA/QC and geocode
  - Performed in one step
  - Checks for continuous defects that are not closed
- Enhanced QA/QC
- Pre-loaded with all the PACP defect codes

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GIS Validation Errors

- E.g. Missing MH, Missing Pipe, Pipe Length Errors, etc.

Validation "SEW_Valid1"

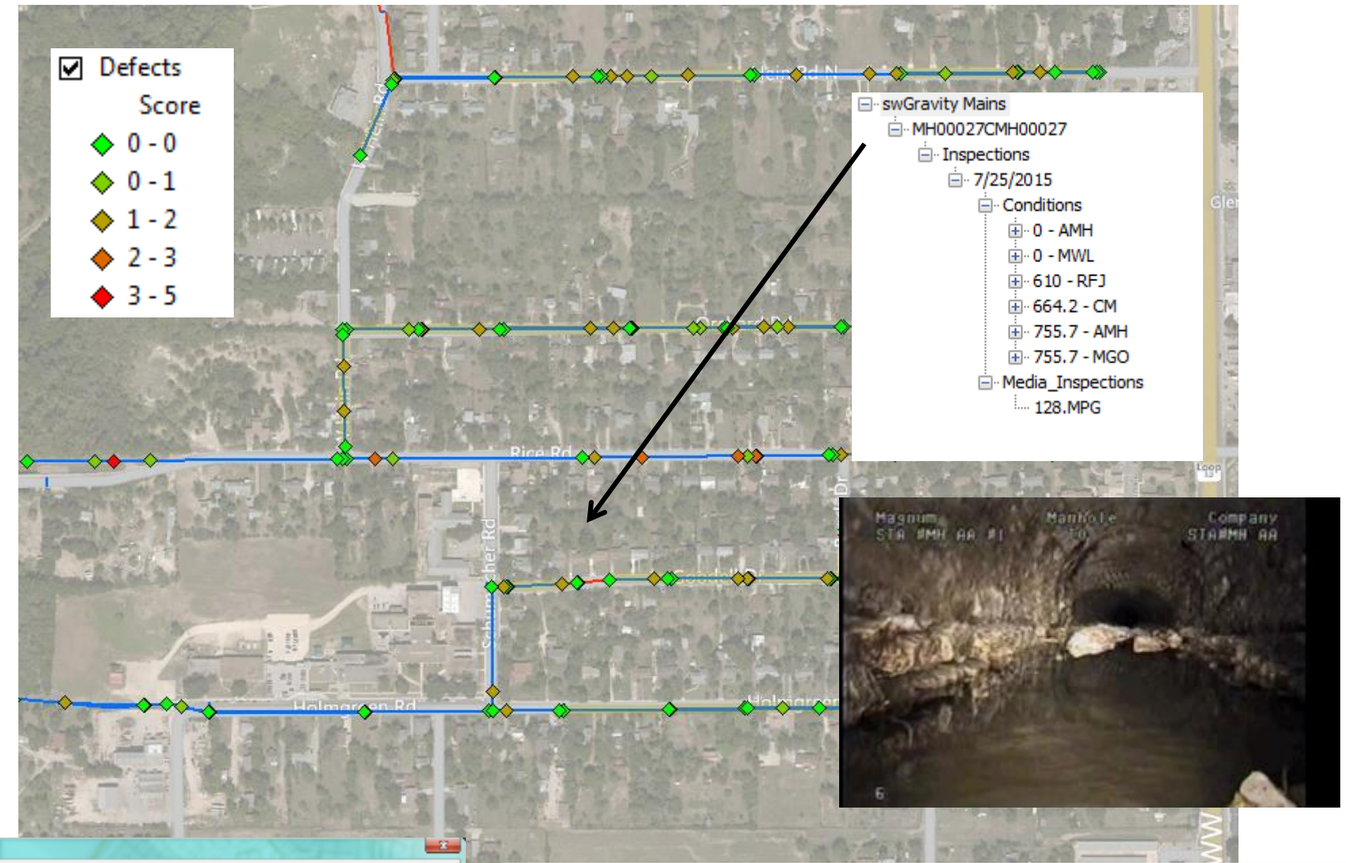
Run | Scope: Full Network

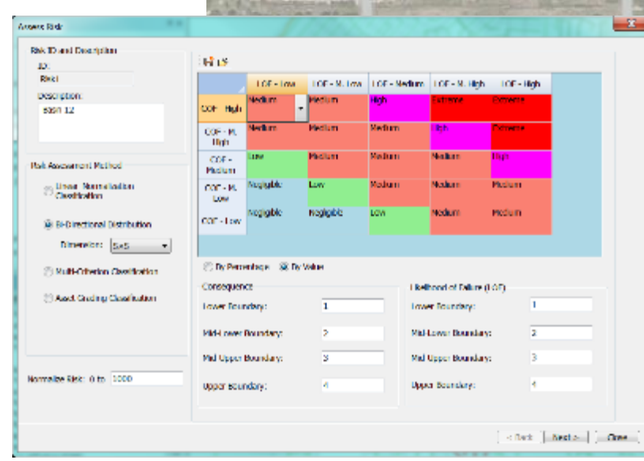
Enabled	ID	Warning Message	Criteria	Facility Type
System				
☐	NA-008	Manhole is missing rim elevation		Manhole
☐	NA-009	Manhole is missing invert elevation		Manhole
☐	ER-007	Manhole maximum depth is either too high or too low		Manhole
☐	ER-001	Pipe diameter is either too high or too low	0.25 <= Value <= 10	Gravity Main
☐	ER-005	Unusual setting for pipe slope	0 < Value <= 0.02	Gravity Main
☐	ER-012	Suspicious pipe length (it may have lots of bends or is shorter th...	nodal distance - 0 <= Value <= nodal...	Gravity Main
☐	NA-029	The drop across the pipe cannot exceed it's length		Gravity Main
☐	NA-006	Pipe is missing US Node		Gravity Main
☐	NA-007	Pipe is missing DS Node		Gravity Main
☐	NA-004	Pipes are crossing/intersecting each other		Gravity Main
☐	ER-023	Invert elevation of outgoing pipe is higher than that of incoming...		Manhole
☐	NA-001	Node is not connected to any link		Manhole
☐	DP-001	Facility id is duplicated		All Facility Types
☐	DP-002	Facility id is invalid		All Facility Types

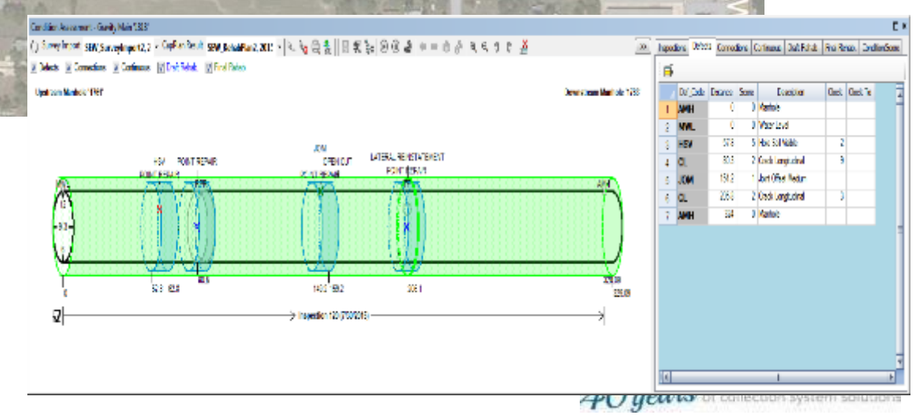
InfoMaster Sewer Defect Analysis

After completing the PACP coding of all defects, the tabular condition assessment data was brought into InfoMaster Sewer and GIS for analysis

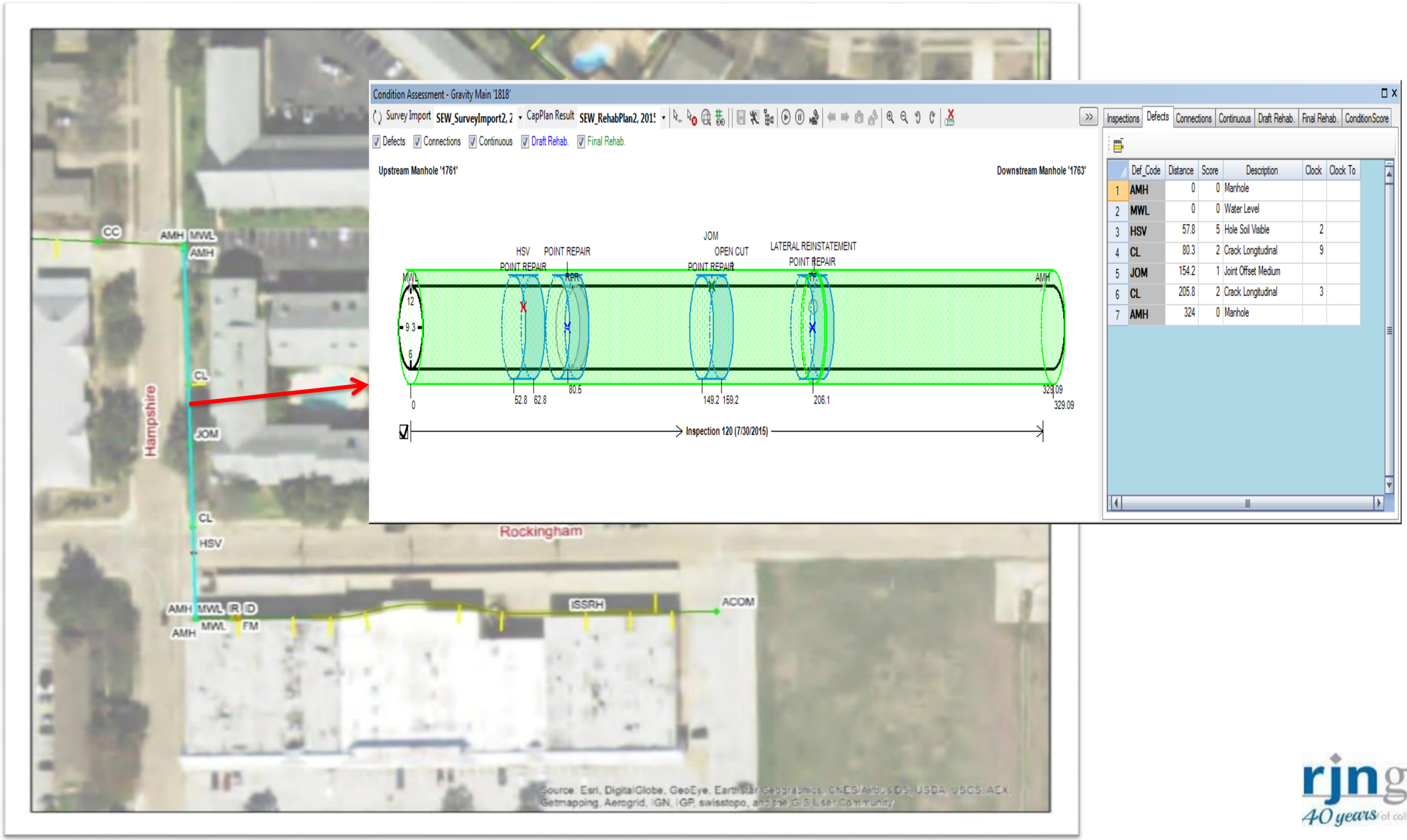
- Spatially linked with the GIS
- Visual representation of PACP defects shown geographically along the asset line
- GIS-linked defect images and CCTV videos inspections
- Simplified access to CCTV videos through the GIS interface







InfoMaster Sewer Defect Analysis



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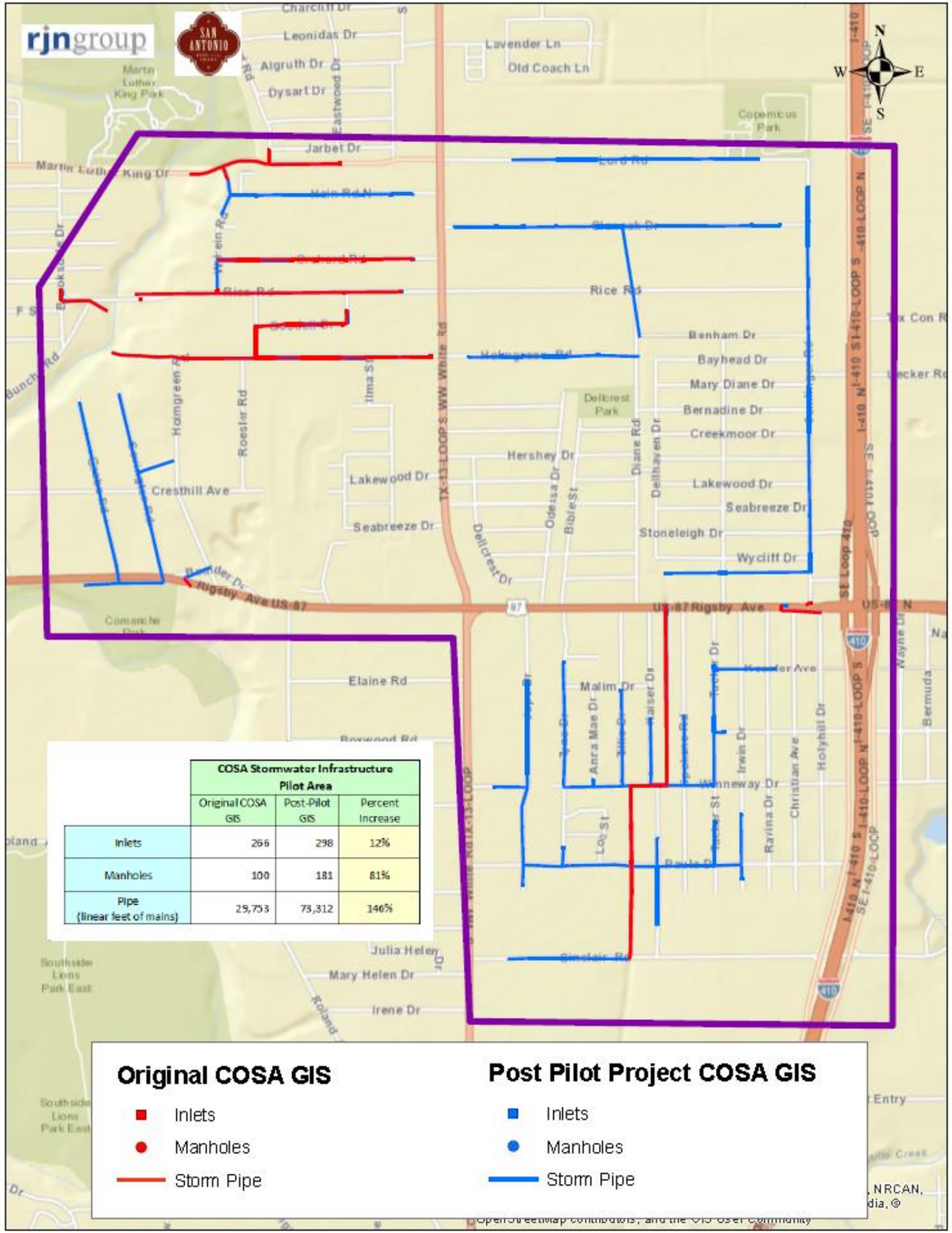
Project Results



COSA Stormwater Infrastructure Pilot Area	Original COSA GIS	Post-Pilot GIS	Percent Increase
Inlets	266	298	12%
Manholes	100	181	81%
Pipe (linear feet of mains)	29,753	73,312	146%

COSA Stormwater Infrastructure Pilot Area	Original COSA GIS	Post-Pilot GIS	Percent Increase
Inlets	264	298	13%
Manholes	104	170	63%
Pipe (linear feet of mains)	29,753	72,802	145%

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COSA Stormwater

Conclusions: By utilizing multiple advanced technologies and software programs throughout the Pilot Project, our team was able to efficiently map and analyze the stormwater system within the outlined schedule and budget.

We recently finished Year 2 of this project and have starting Year 3.

	CCTV (lf)	PACP Coding (lf)
Pilot	72,000	
Year 2	76,000	180,000
Year 3	130,000	50,000
TOTAL	278,000	230,000

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COSA Stormwater CCTV Master Plan

- During Year 3 the City has decided to develop a long-term plan for conducting CCTV and condition assessment for all the storm pipe in the City
  - Integrate LOF and COF into the risk assessment to identify the high risk assets for priority CCTV
    - Corrugated Metal Pipe
    - Soil Type
      - Highly acidic soils
      - Soils with high plasticity

- Currently developing the CCTV Master Plan criteria
  - Roadway Type
  - Critical Facilities
  - Low Water Crossings

COF Score	LOF Score 1	LOF Score 2	LOF Score 3	LOF Score 4	LOF Score 5
5	0 Pipes 0.0 Miles	0 Pipes 0.0 Miles	0 Pipes 0.0 Miles	0 Pipes 0.0 Miles	0 Pipes 0.0 Miles
4	1 Pipe 0.0 Miles	0 Pipes 0.0 Miles	0 Pipes 0.0 Miles	0 Pipes 0.0 Miles	1 Pipe 0.1 Miles
3	17 Pipes 0.6 Miles	3 Pipes 0.1 Miles	8 Pipes 0.9 Miles	7 Pipes 0.4 Miles	7 Pipes 0.6 Miles
2	266 Pipes 11.9 Miles	97 Pipes 6.7 Miles	71 Pipes 5.1 Miles	106 Pipes 7.2 Miles	113 Pipes 9.1 Miles
1	23 Pipes 0.6 Miles	4 Pipes 0.2 Miles	3 Pipes 0.1 Miles	3 Pipes 0.1 Miles	1 Pipe 0.1 Miles

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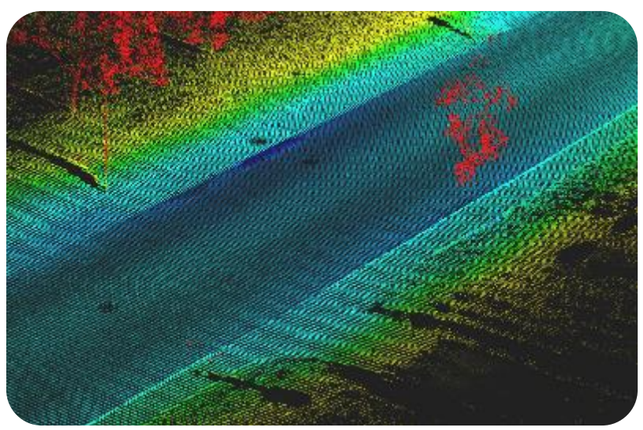
Utilizing Advanced Technologies for Stormwater System Mapping and Condition Assessments

QUESTIONS?



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