Jacobs Challenging today. Reinventing tomorrow.

Digital Approaches to Improving Collection System Asset Management in an Ever-Evolving World

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Digital OneWater Director, Jacobs

Agenda

1. Collection System Asset Management – Current Approaches
2. Why use Digital OneWater approach?
3. Condition Assessment with Digital Tools
4. Asset Management
5. Smart Sensors for Insights into Operations of Collection System

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Collection System Asset Management – Current Approaches

- Gravity sewers are inspected via many methods
  - Smoke testing
  - Acoustic testing
  - CCTV inspection
- Data from gravity sewer inspections are coded either by contractor or in-house crew
- Results of the coding are sometimes entered into CMMS, but what do you do with these results?

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Sewer Buried Infrastructure Inspection & Maintenance - Overview

US Sewer O&M market: $50B/year
Pipe/infrastructure inspection : ~$4B/year
CCTV Footage Collection: $3.7B/year
» **Footage Review and Defect Coding: $300M/year**

Most cities aim to inspect 10% of system per year

Every year, additional 1M+ miles of CCTV inspection footage is collected

Municipalities typically use in-house (crews and trucks) resources or contract work out to private companies, or have a blend of both

Many Issues for Utilities –

1) Massive CCTV backlogs
2) Low visibility into aging collection systems
3) Shortage of skilled resources
4) Limited capacity to allocate for time-intensive, slow and tedious tasks,
5) Labor is costly
6) Manual coding of defects is also highly error-prone, subjective and inconsistent

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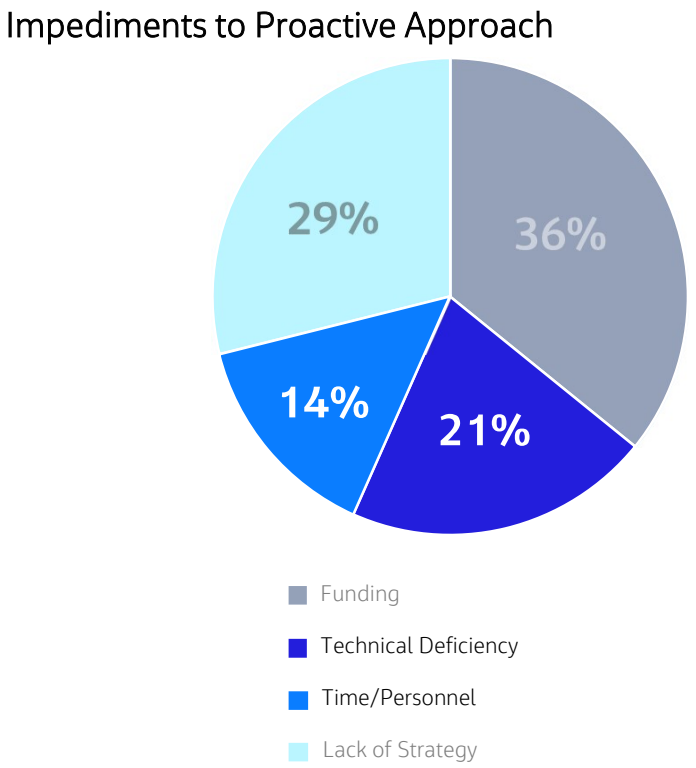
The Status Quo for Sewer CCTV Condition Assessment Cannot Keep Up



- Most cities conduct regular sewer CCTV inspections but still find:
  - Personnel don't have time available to focus on defect coding
  - Methods for defect coding are technically deficient
- In the life span of 1,000LF worth of sewer video: 2-6 hours (30-40% of the total acquisition time) is spent doing defect coding

…Leads to Digital Solutions & Digital OneWater

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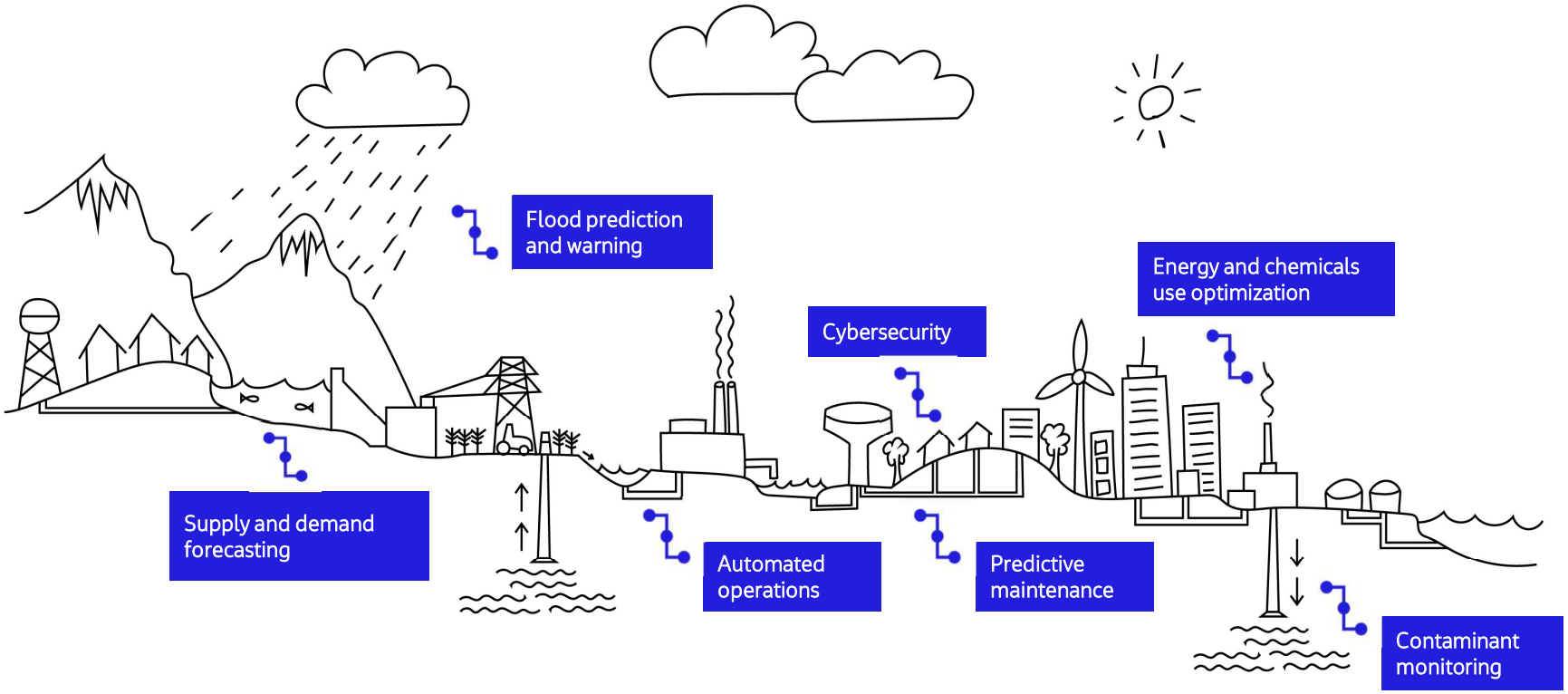
What is Digital OneWater?

» Tools that transform big data into actionable information

» Creates an integrated ecosystem of data-enabled solutions



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How Can Digital OneWater Assist Today's Utilities?

Digital OneWater

More Stringent Regulations

Aging Infrastructure

Staffing Pressures

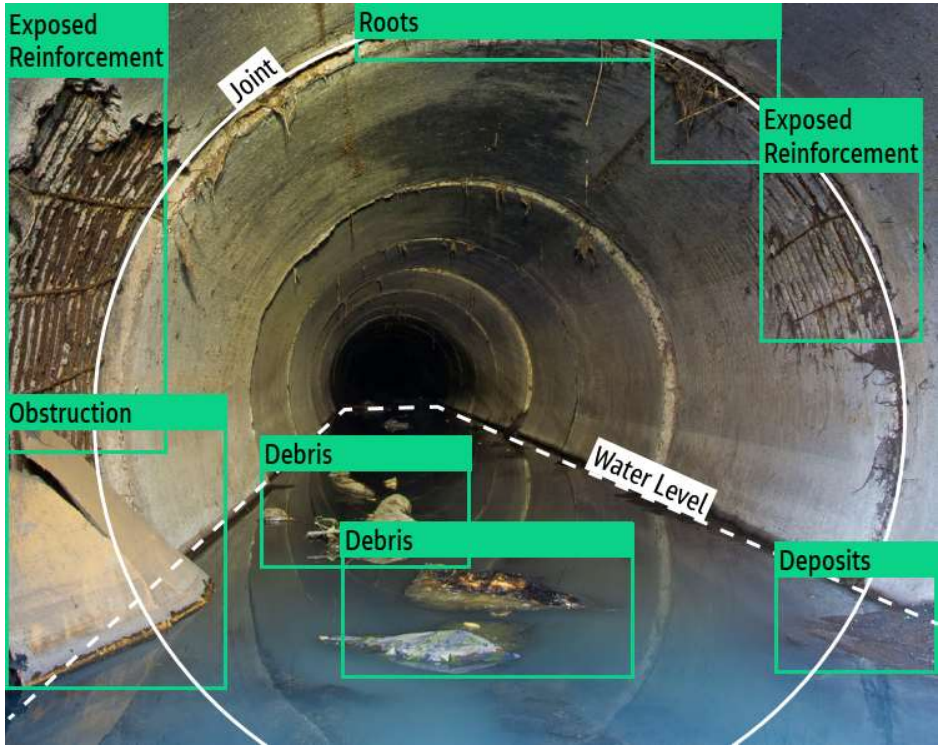
Shrinking Budgets

Dragonfly
by Jacobs

Argon
by Jacobs

What is Dragonfly?

Dragonfly, is an Informed-AI and Machine learning solution, efficiently and accurately detects/codes defects to increase visibility into buried sewer infrastructures, and generates AI-driven recommendations (powered by Argon Insights) to optimize decision making and refine system management and intervention strategies



Automated Sewer CCTV Defect Coding

Dragonfly applies artificial intelligence to automatically detect defects in raw CCTV inspection videos

Industry Standard Output

Dragonfly rapidly produces consistent, accurate PACP output, usable in any pre-existing workflow and CMMS/CCTV software

Reliable Business Intelligence

Dragonfly integrates with Jacobs' Argon tool and supports asset management

Optimizes reinspection and maintenance schedules

Prioritizes asset rehabilitation lists

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How can Utilities utilize Dragonfly?

Dragonfly℠ by Jacobs

Use Dragonfly to -

- To Process historic data – code your old videos to track assets over time
- To Correct quality issues – if you don't trust the coding, have your videos re-coded
- To Include in your in-house process – have your crews focus on running the camera, not coding
- To Add to your contractor SOP – Have your contractors work directly with Dragonfly for additional QC and video quality review

And how can Utilities get more out of their sewer management investments?

Developed by Industry Experts

Combines Jacobs' domain expertise with Hitachi's global Social Innovation and deep computer vision, artificial intelligence, and machine learning expertise

Includes multiple computer models of increasing maturity and sophistication

Rigorous Quality Assurance

AI/ML system trained on over 10 million feet of sewer video footage

Validated by NASSCO PACP certified technicians

Includes on-demand technical support and guidance

Integrates with Existing Asset Management Tools & Programs

Data is easily imported into existing GIS, CMMS, or CCTV data tools and workflows

Informs maintenance and rehabilitation plans, schedules, and costs

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What is Argon?

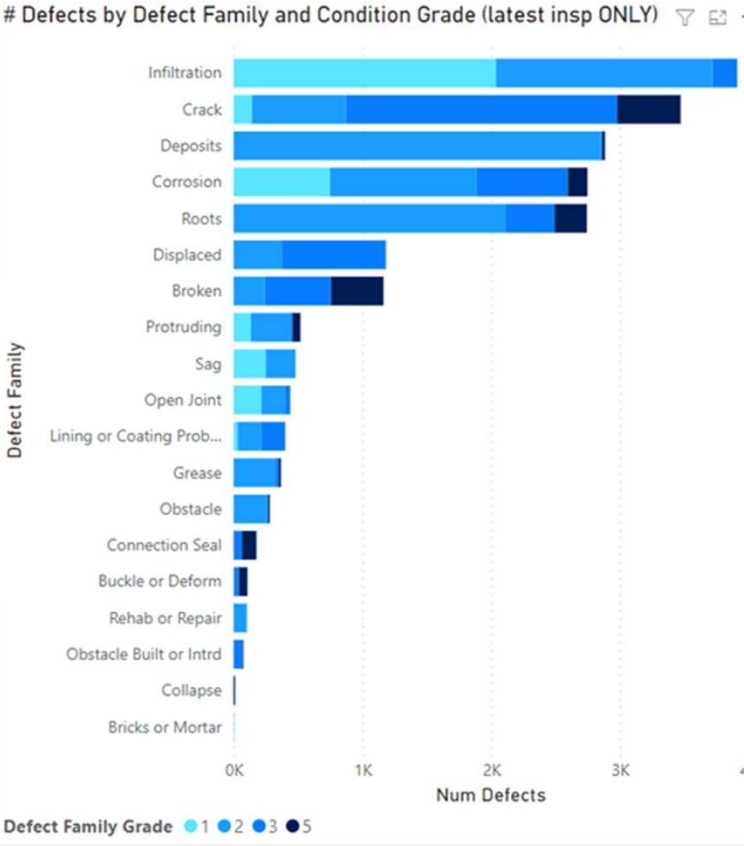
Argon by Jacobs

Argon (formerly known as SCREAM) is a Jacobs' built AI-solution that provides prescriptive asset management for Sewer Utilities Asset Managers.

Argon analyzes pipe inspection defect data to produce:

- Advanced condition scores
- Reinspection and maintenance schedules
- Prioritized lists of pipes needing rehab
- Repair/replacement cost estimates

Featured in EPA Technology Review:
Innovative Internal Camera Inspection and Data Management for Effective Condition Assessment of Collection Systems, 2010



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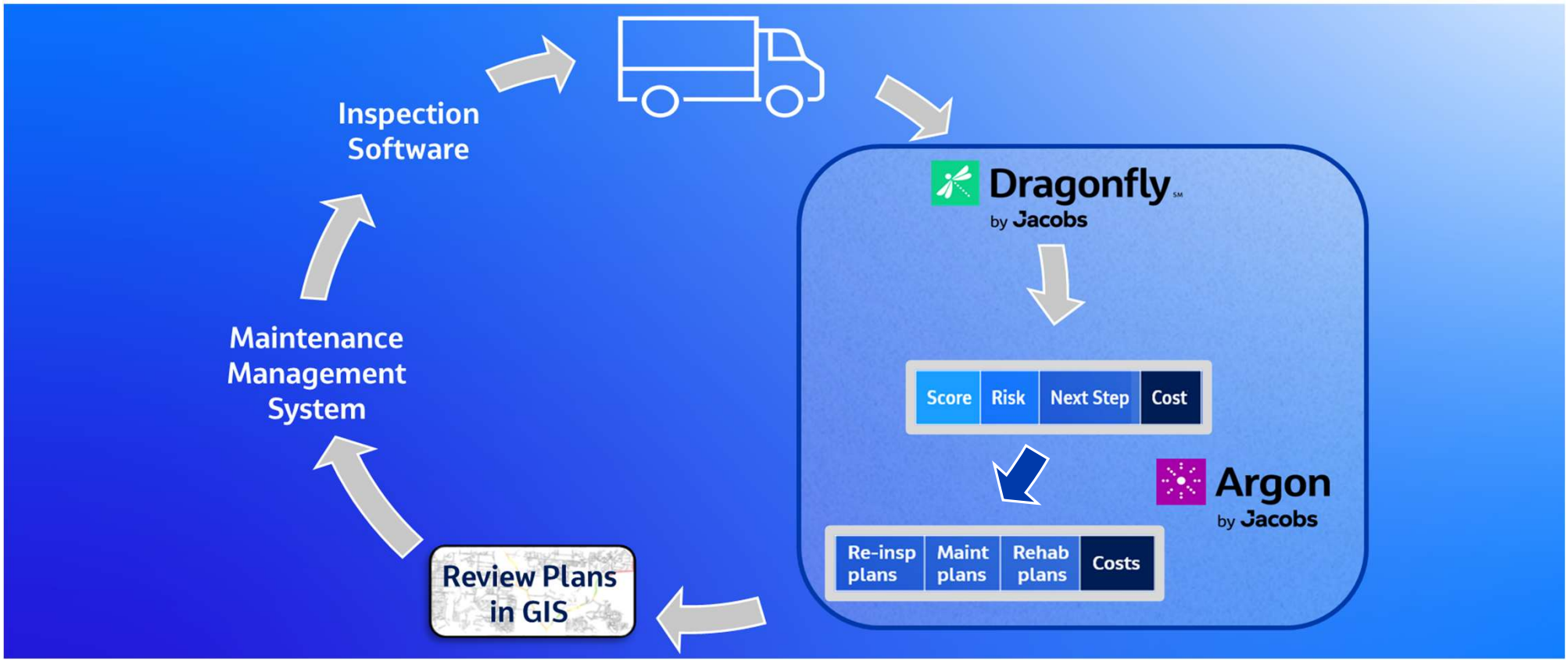
Dragonfly and Argon in the Inspection to Work order cycle.



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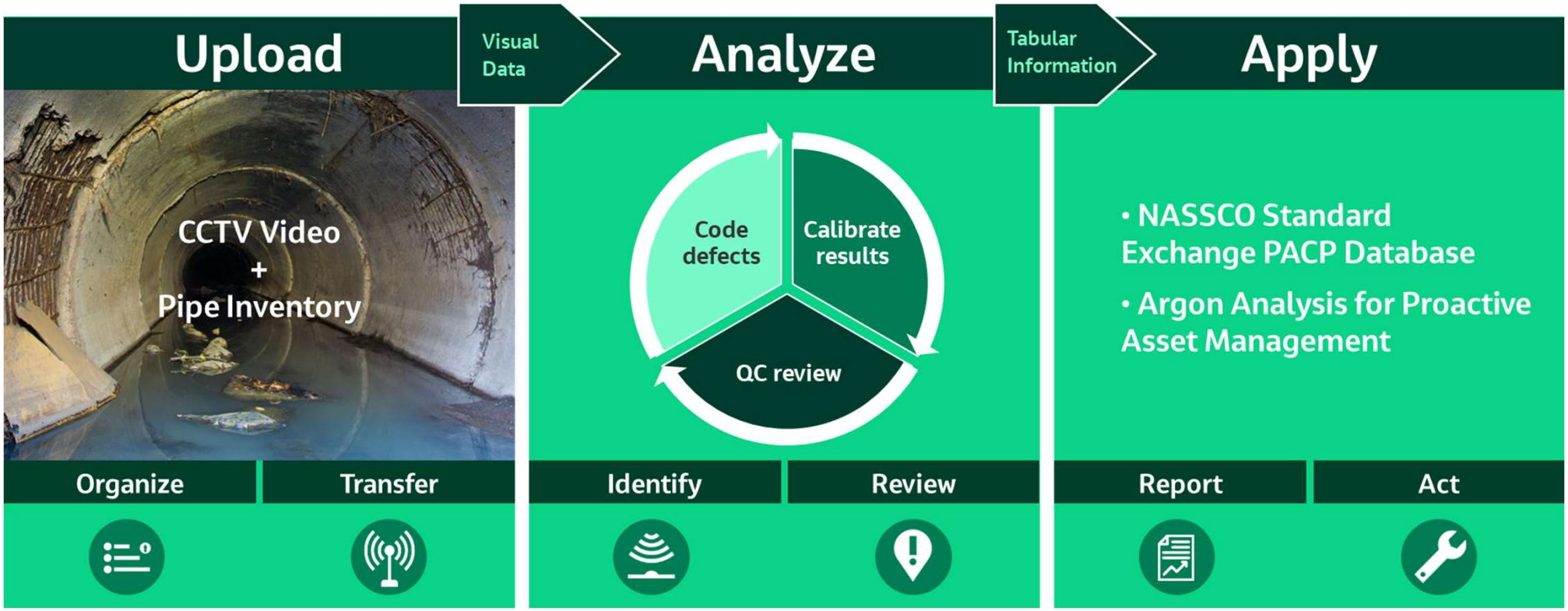
Dragonfly works in 3 easy steps to transform raw data (CCTV inspection video) into the information engineers can use



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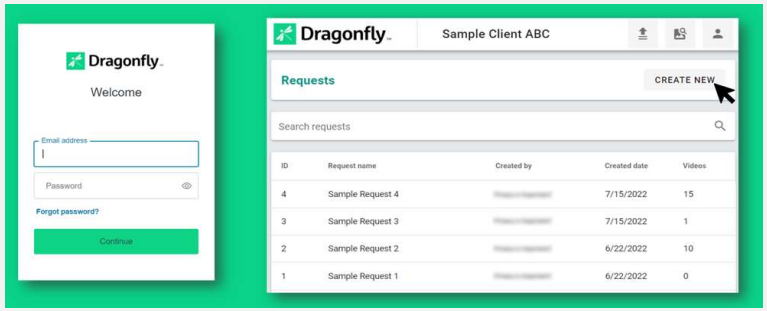
The Dragonfly steps

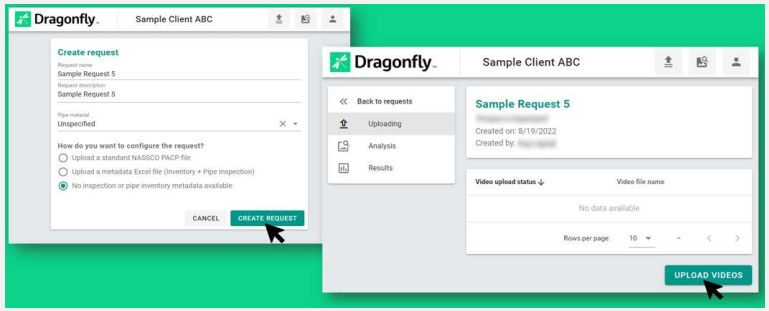
Data Prep

Prepare your videos and corresponding metadata.

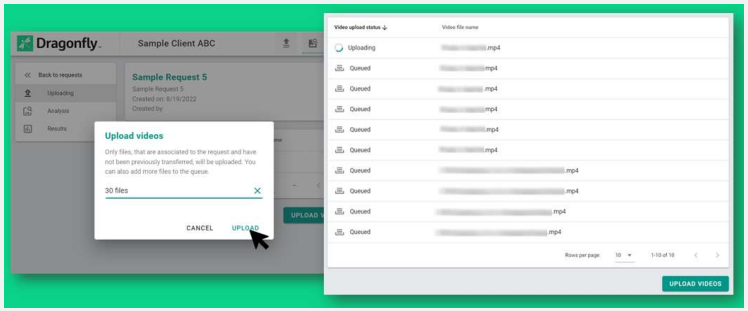
Create Request



Dragonfly login credentials will be issued.



Create a request and upload videos.



Once uploaded, analysis will begin!

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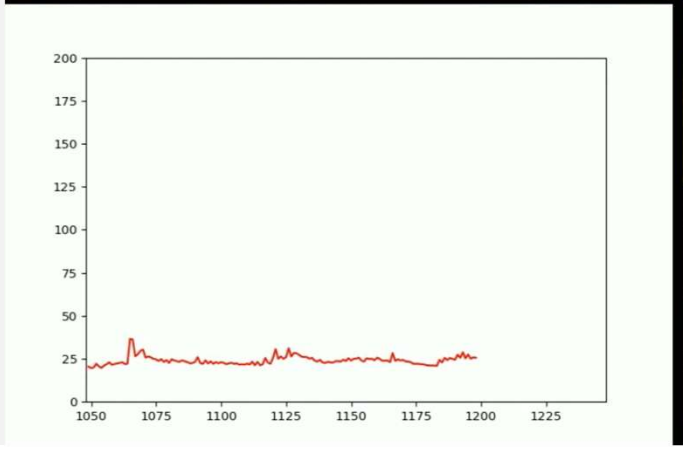
The Dragonfly steps

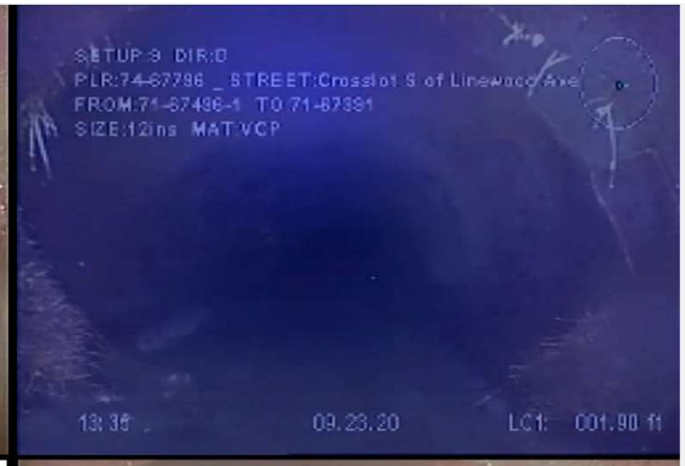
Machine Analysis

1. Original Inspection Video

2. Anomaly Threshold Algorithm



3. Defect Heatmap Algorithm



4. Defect Labeling

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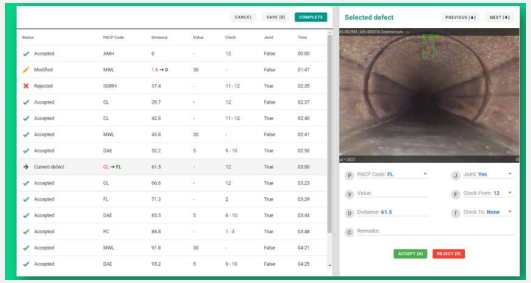
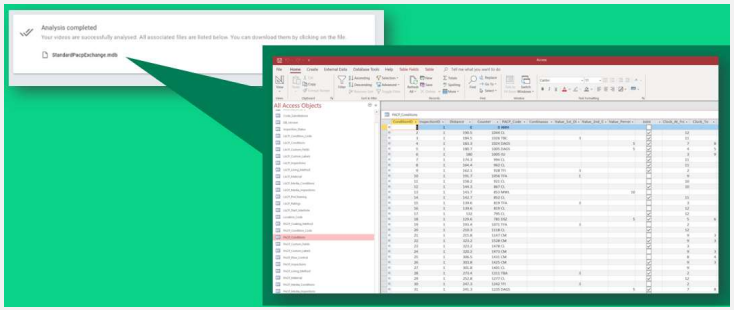
The Dragonfly steps

QA/QC



PACP certified (Jacobs GID India) technicians review and verify machine output.

Dragonfly Complete



Dragonfly produces a NASSCO Standard Exchange PACP database.

Dragonfly to Argon

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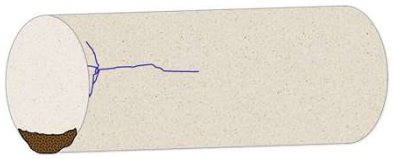
Glimpse into some of Argon's Logic …

Scoring by Material

Example: hairline longitudinal crack



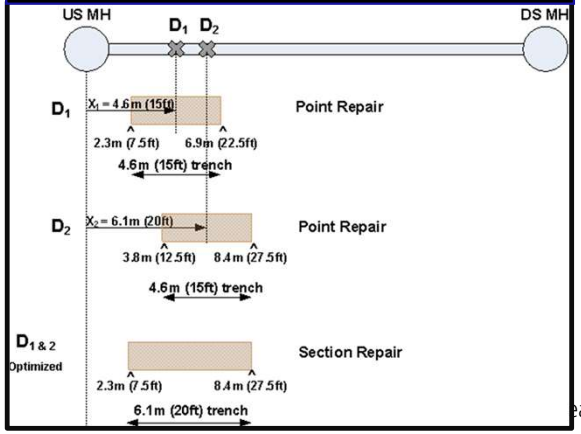
Material	Base Score	Max Score
Brick	5	25
CI	10	30
Clay	20	30
Concrete	5	25
DI	5	20
HDPE	10	30
PVC	10	30
SegBlock	10	30
Steel	5	20

Determine Next Steps / **Structural Grade**

SewerType	Diam	LatestInspType	HighAccel	COFGrade	0	1	2	3	4	5
Sewer	Small	CCTV	No	1	CCTV 30 Years	CCTV 20 Years	CCTV 10 years	CCTV 7 ears	CCTV 3 years	Priority 3
				2	CCTV 30 Years	CCTV 20 Years	CCTV 10 years	CCTV 7 ears	CCTV 3 years	Priority 3
				3	CCTV 20 Years	CCTV 15 Years	CCTV 10 years	CCTV 7 ears	CCTV 3 years	Priority 3
				4	CCTV 20 Years	CCTV 15 Years	CCTV 7 years	CCTV 3 ears	CCTV 18 months	Priority 1
				5	CCTV 15 Years	CCTV 10 years	CCTV 7 years	CCTV 3 ears	CCTV 18 months	Priority 1
				Unknown	CCTV 15 Years	CCTV 10 years	CCTV 10 years	CCTV 7 ears	CCTV 3 years	Priority 3
			Yes	1	CCTV 30 Years	CCTV 20 Years	CCTV 10 years	CCTV 4 ears	CCTV 12 months	Priority 3
				2	CCTV 20 Years	CCTV 15 Years	CCTV 10 years	CCTV 4 ears	CCTV 12 months	Priority 3
				3	CCTV 20 Years	CCTV 15 Years	CCTV 7 years	CCTV 4 ears	CCTV 12 months	Priority 2
				4				CCTV 3 years	CCTV 12 months	Priority 1
				5	CCTV 15 Years	CCTV 7 years	CCTV 4 years	CCTV 18 months	Priority 2	Priority 1
				Unknown	CCTV 15 Years	CCTV 10 years	CCTV 7 years	CCTV 4 years	CCTV 18 months	Priority 2

Only valid inspections are included

Calculating Trenches



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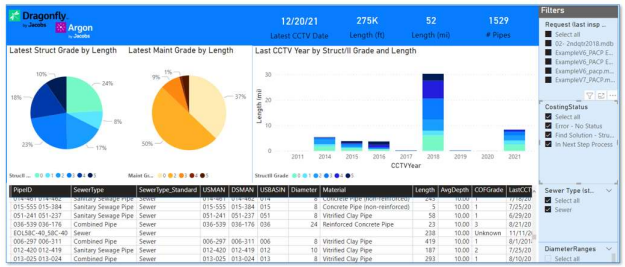
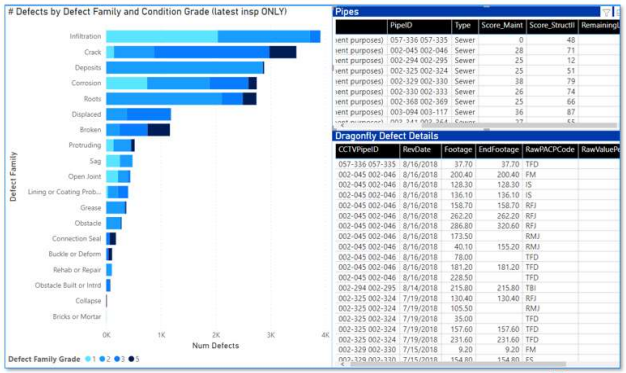
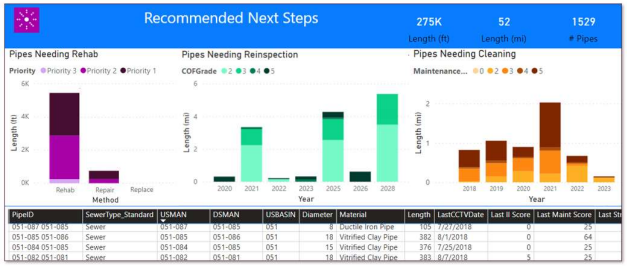
Argon insights viewable/customizable by Client via Dragonfly system

Score

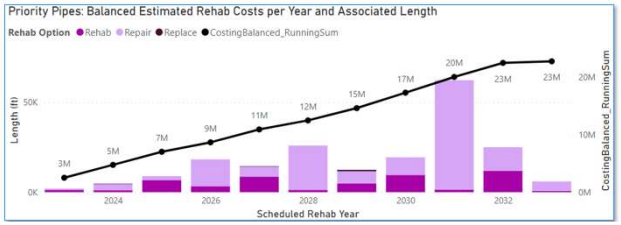




Next Step



Cost



Integrate Argon results with GIS

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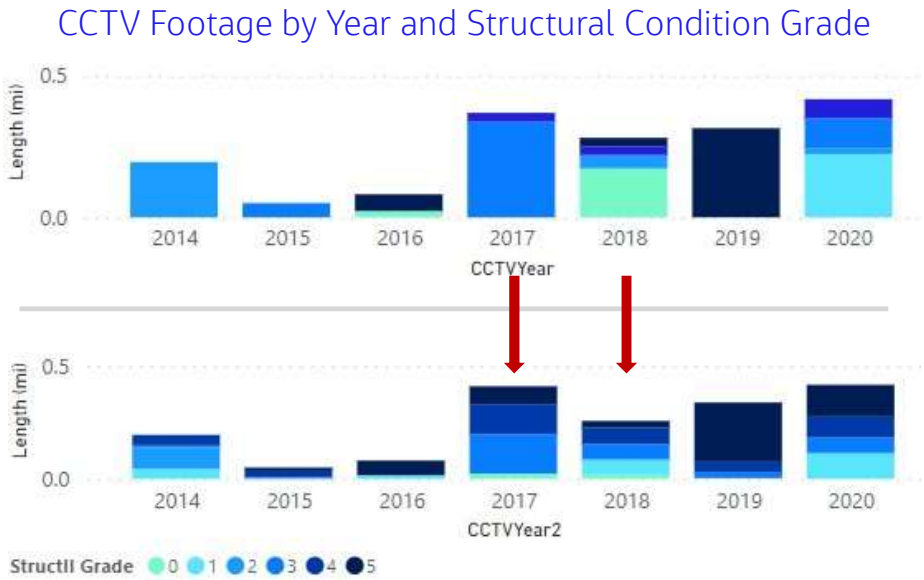
Dragonfly Case Study: City in Northeast US

Case Study: Side-by-Side Comparison

- Large USA municipal utility piloted Dragonfly and compared against 17,000LF of trusted, manually coded, legacy data
- Dragonfly identified important nuanced defects and overall pipe severity levels that were overlooked
- Client enabled to better optimize preventive maintenance and repair plans



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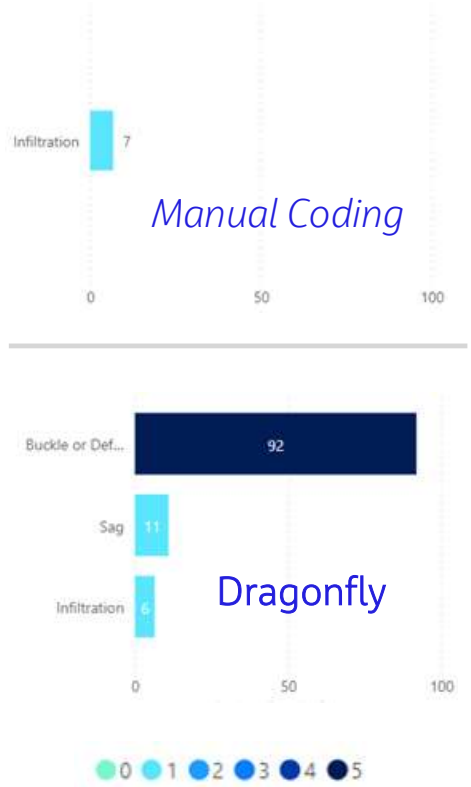
Case Study Findings

Case Study: 12-inch VCP

Case Study: 10-inch CIPP Liner



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Dragonfly with Argon

The Differentiated Value

Accurate and Consistent

- Built by Jacobs engineers and Hitachi computer scientists
- Consistent and objective deliverables
- QA/QC by trained, certified personnel

Actionable Insights & Intelligence

- Create rehabilitation/maintenance plans and schedules
- Support proactive intervention
- Cost estimates for high level budgeting

Efficient

- Handle your backlog with a streamlined one-stop solution
- No software install, no license fee, no proprietary output formats
- Pay-as-you-go, priced per linear foot

Trusted Support EO0

- Backed by Jacobs' commitment to clients, and global water and digital expertise
- Driven by Hitachi's industry-leading advances in data science

Additional Differentiators

- **No-risk service:** No software install, no license fee, no proprietary output formats – only pay for what you want, and its QC-backed by Jacobs.
- **Added value:** Argon insights are more than trend analysis. They provide reliable and optimized pre-engineering recommendations, schedules, and costs.
- **Fastest cloud speed:** Dragonfly lives in the cloud and will always have access to the fastest, most powerful computing clusters. You get your data faster.

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Slide 21

EO0 Keep or kill?

Eskander, Olivia, 2024-03-05T18:02:52.183

Aqua DNA

by Jacobs

What about insights into operations?

- Condition assessment & CIP are half the battle
- Most utilities are operating aging systems with high consequence of failure
- Many digital sensors/data capture tools have come into play in the last 10 years
- However, utilities only use about 10% of the data that they capture

How do you gain insights when you are inundated with data???

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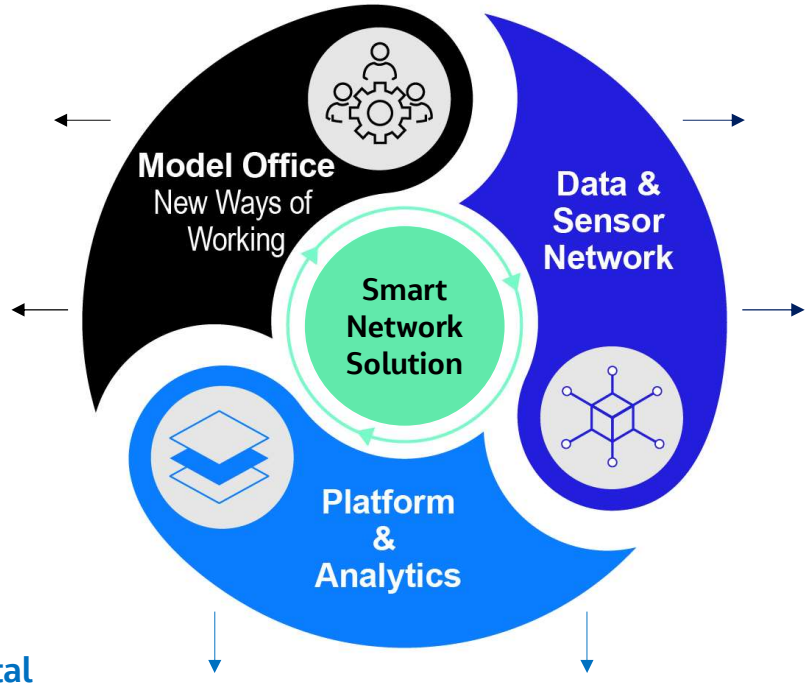
New Ways of Working– Combining Digital with Domain

High Value Advisory Domain

- Moving from Reactive to Proactive working practices
- Transformation from chasing problems to getting ahead of problems before they manifest
- Improving control and allocation of field resources



Engineering Domain

- Harvest existing data – SCADA, telemetry and monitoring
- Monitor points of greatest risk or concern

Digital

- Add value to monitoring data through applied analytics
- Learn behaviour of normal, safe operation
- Identify Emerging Issues, allowing a Response Window for correction

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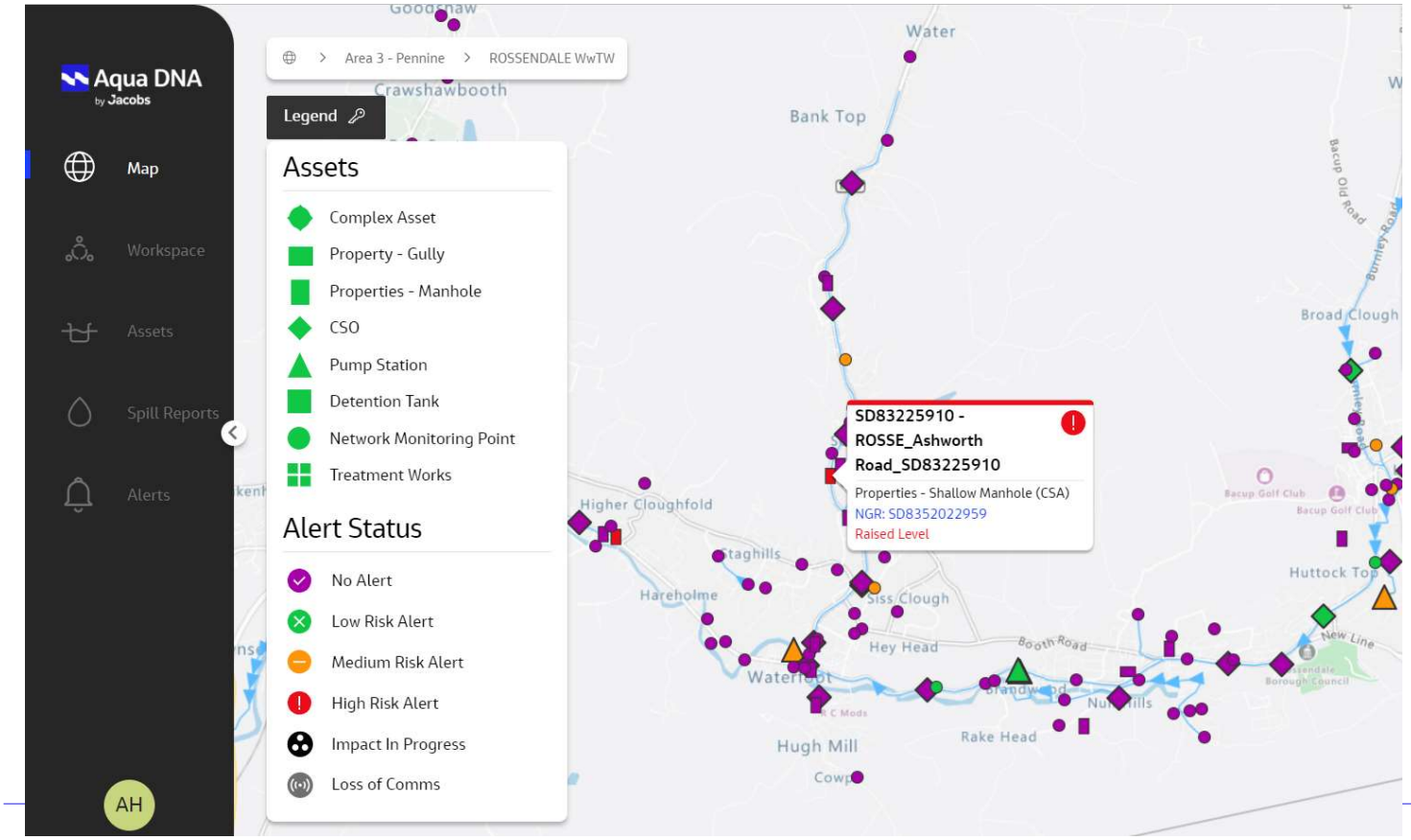
Getting Ahead of the Problem: United Utilities in the UK



- Emerging Issues are risk ranked and priority action assigned to field teams
- Teams get ahead of the issue and prevent sewer problems impacting the customers or the environment

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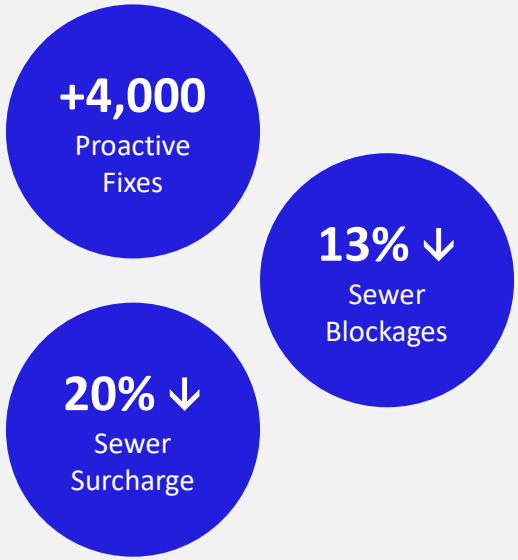
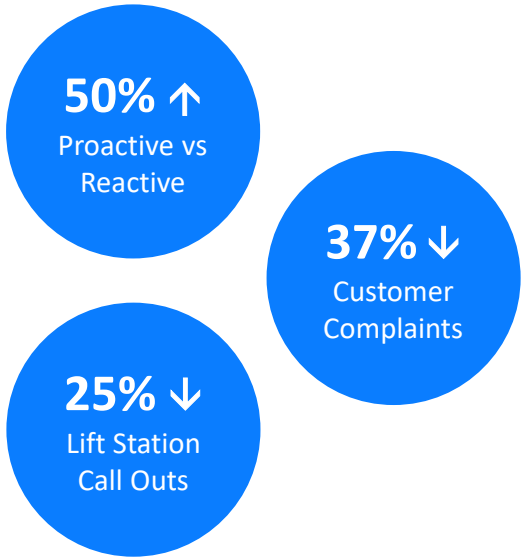
United Utilities Outcomes



Operational Benefit



Business Benefits

- Reduced Operational Costs
- Reduced/Avoided Capital Investment
- Improved Environmental Performance
- Customer Bill Impact Reduced

Asset Management Benefits

City of Wilmington System Overview

Jacobs provide O&M services for wastewater treatment plant, combined sewer overflow facilities and Renewable Energy Biosolids Facility (REBF).

Collection system and WWTP details:

- 168 mgd maximum treatment design flow
- 340 mgd maximum in wet weather
- 41 CSOs
- 4 pump stations
- 3 Real time control (RTC) facilities with storage
- Approx. 375 miles of gravity sewer

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City of Wilmington – CSO Management

Existing Approach

- Field Crew visit all CSO sites 3-5 days a week, mainly to clear blockages;
- Dry-weather overflows can occur if blockage isn't cleared quickly enough;
- Client requesting a modernized approach to system maintenance that reduces risk

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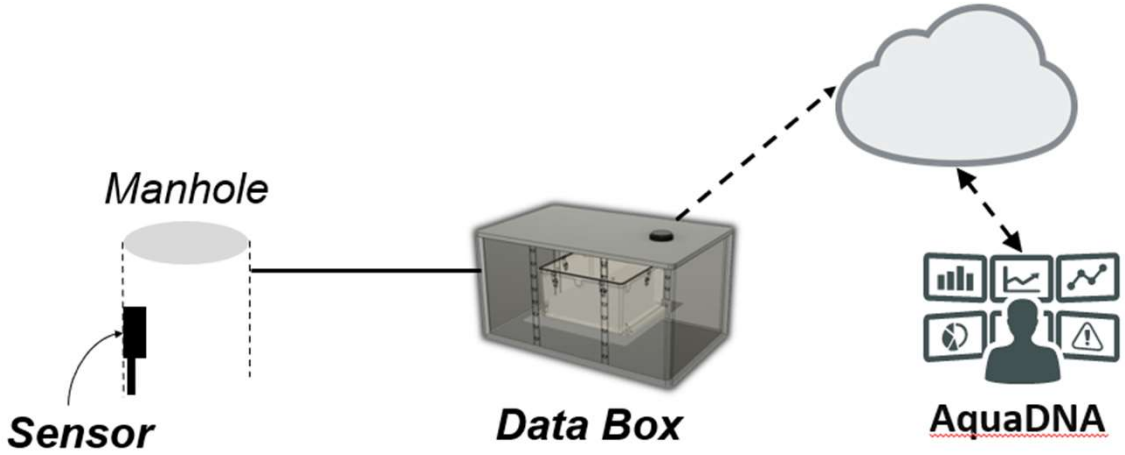
Technology Solution to Modernize CSO Management

New ways of working

- Cybersecurity is “baked in” with remote communications
- Level sensors installed at each CSO
- Crew gets text/email alerts if level is off-trend or sensor stops transmitting data
- Proactive maintenance
- Goal is zero dry-weather overflows in 2024



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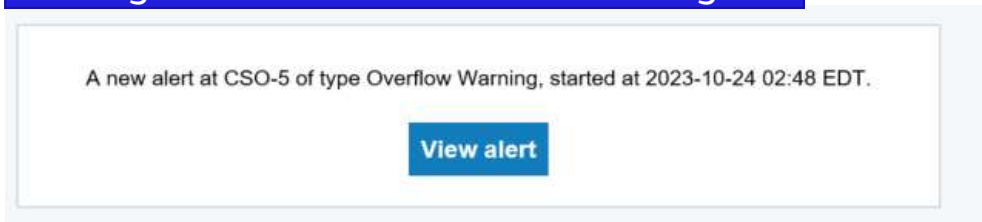
Phase 1 – Alerts & Visualization

Alerts are configured for the following:

- Above baseline
- Dry-weather approaching overflow
- Dry-weather overflow warning
- Tidal correlation
- Sensor not responding

Wet weather alerts show on dashboard but are not sent via email/text (operator does not want 41 alerts during a rain event)

High level alert – overflow occurring



Medium level alert – approaching overflow

Low level alert – above baseline

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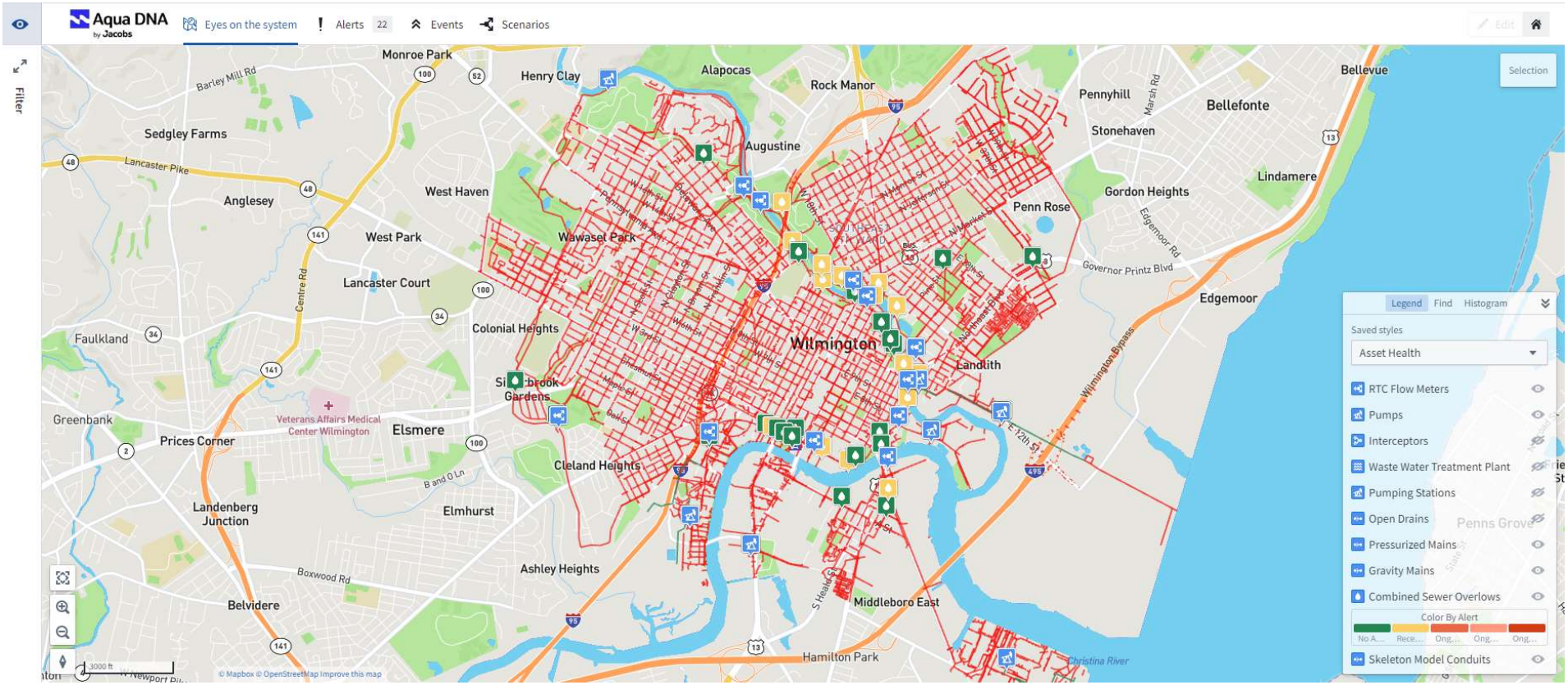
System Wide Real Time Monitoring



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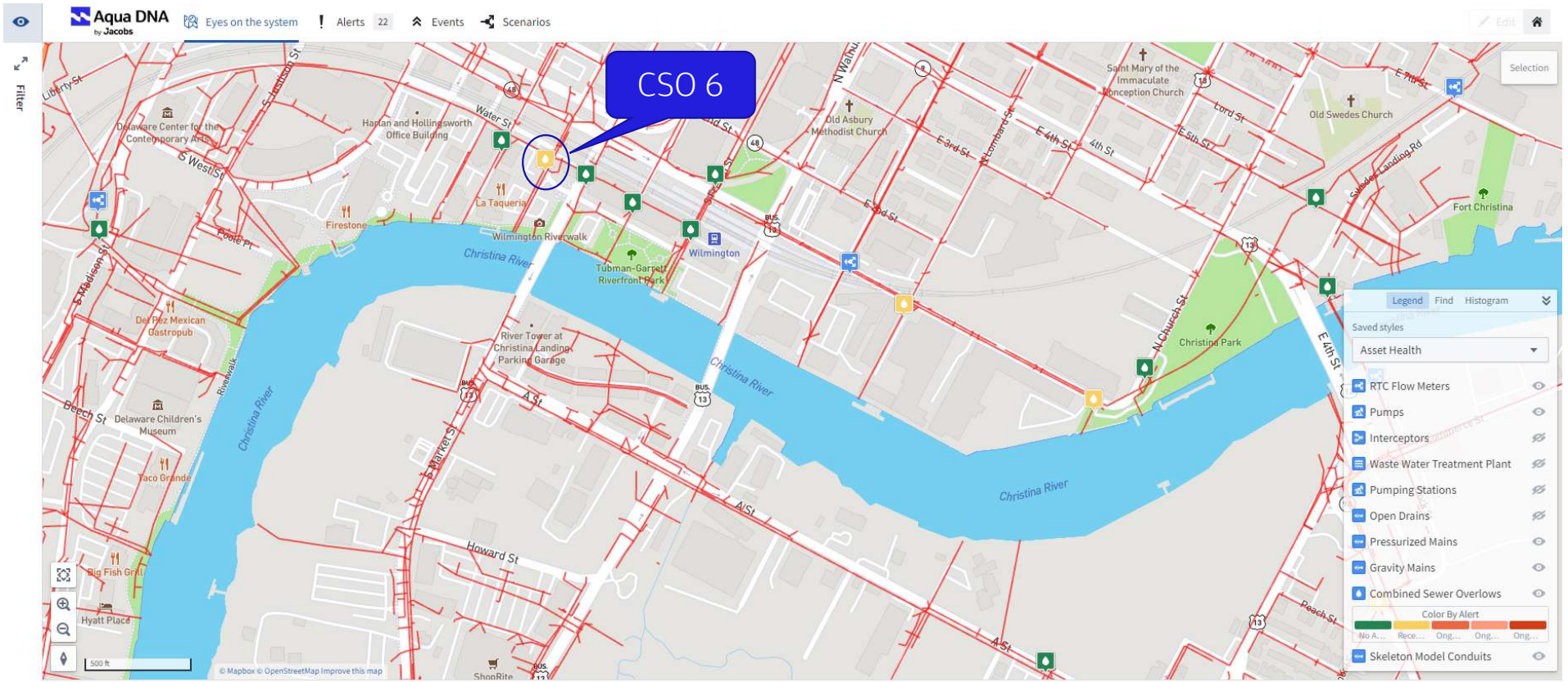
Alert Prioritization



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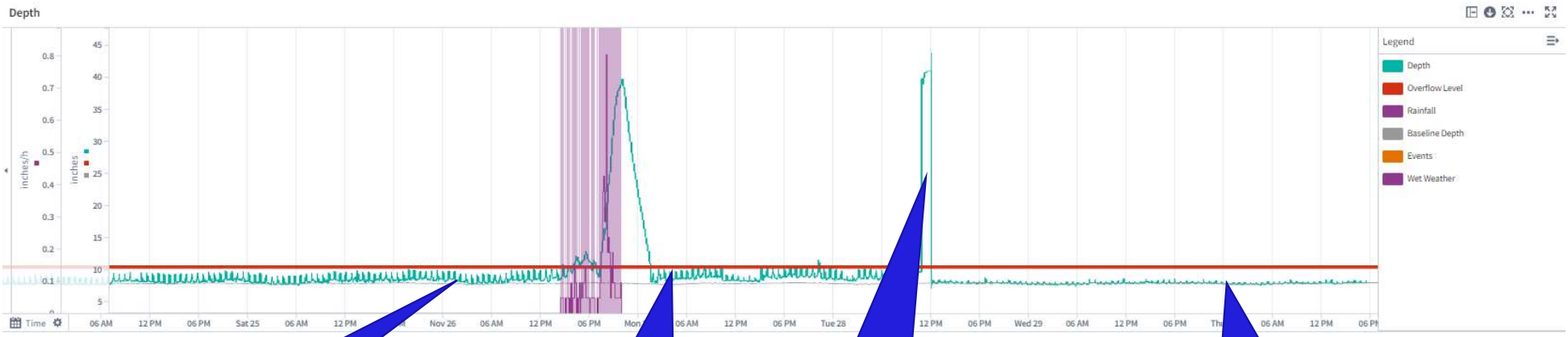
Real Time CSO Performance & Risk Analysis

CSO 6: One Week of Data



Level is slightly above baseline prior to rain event

Level continued to increase following rain event

Jetting underway

Back at baseline

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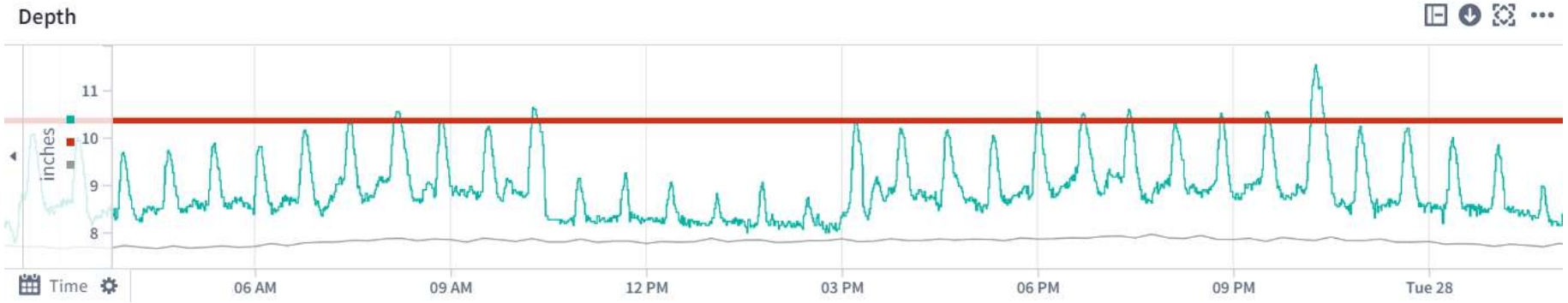
Real Time CSO Performance & Risk Analysis

CSO 6: prior to jetting



CSO 6: after jetting

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Summary and Conclusions

- Utilities are experiencing greater challenges that lead to using digital tools
- Condition assessment, asset management, and risk assessment in your collection system can be performed more efficiently with digital solutions
- Most utilities have more data than a human can ingest/visualize

AI/ML tools can assist with visualizing data and providing insights into the condition and behavior of your collection system

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Thank you!
Questions?

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Jennifer.Baldwin@jacobs.com

Jacobs Challenging today. Reinventing tomorrow.

Value Impact Potential of Dragonfly on 1,000LF of Sewer Video

Task	Task Duration	Cumulative Total Time
FIELD CREWS		
Mob/Recon/Setup	1-2 hr	1-2 hr
Cleaning	3 hr	4-5 hr
Drive the Robot	0.5 hr	4.5-5.5 hr
Data Coding	1.5-3.5 hr	6-8 hr
Extract/Demob	1 hr	7-9 hr
Robot Repairs	0.5-1 hr	7.5-10 hr
Data/Transfer	1 hr	8.5-11 hr
OFFICE ENGINEERS		
Import	0.5-1 hr	9-12 hr
QC Review Coding	2-3 hr	11-15 hr
Report	1 hr	12-16 hr

Dragonfly could reduce 30-40% of the total time spent by humans doing sewer defect coding

Data from Jacobs's sewer inspection services teams

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