

TRANSFORMING STORMWATER MANAGEMENT WITH AGENTIC AI AND DIGITAL TWINS

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HydroTrek
Global Quality Corp.

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Virtual



Global Quality Corp.

Palo Alto, CA and Covington, KY



3D Digital Twin- Duck Typing Principle

Supports multiple Levels of Detail (LoD)

- 2D Maps (Several Types)
- 3D Maps (Several Types)
- Google Photorealistic Tiles
- Google StreetView

Matches the existing physical system behavior through models (Physics-based or AI)

- Hydraulics and Hydrology
- Pollutant Transport

Provides access the system measurements at the appropriate locations

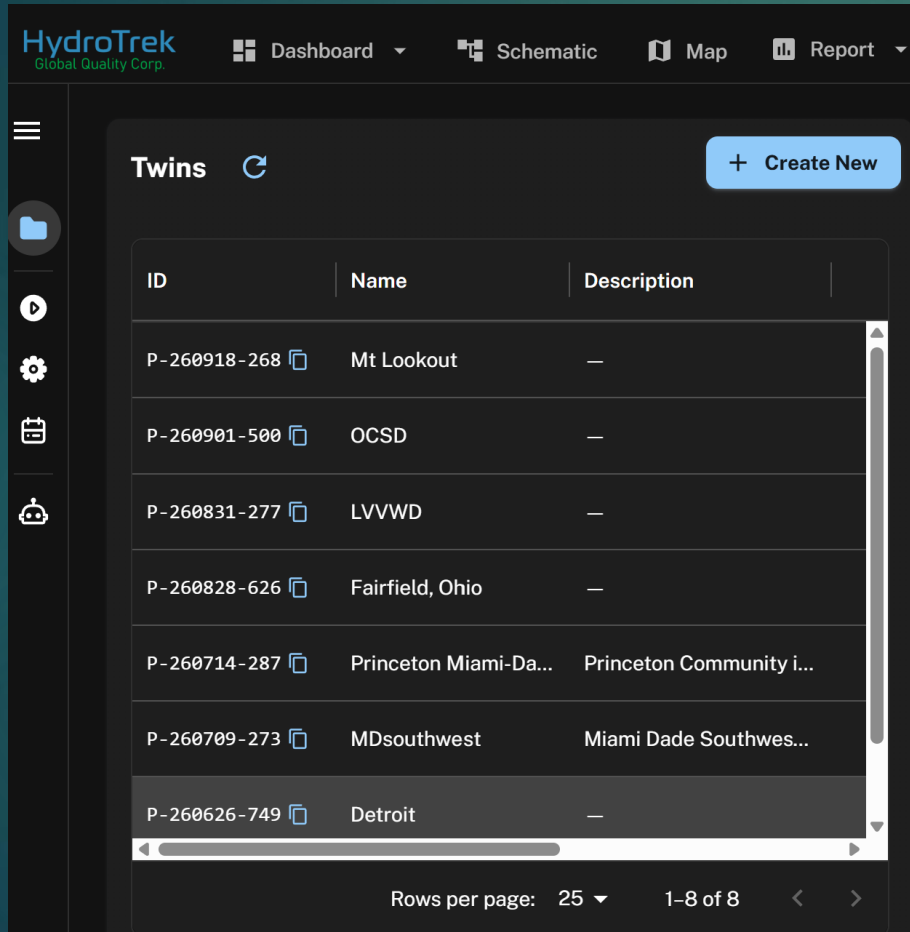
- SCADA
- Field Monitoring Data
- Rainfall
- Sewer Defects

Predicts the future behavior but MAY or MAY NOT MODIFY THE PHYSICAL SYSTEM

- Response to a predicted storm
- AI assistant supported by a complete Agentic Framework

Stormwater Collection System (CCS)

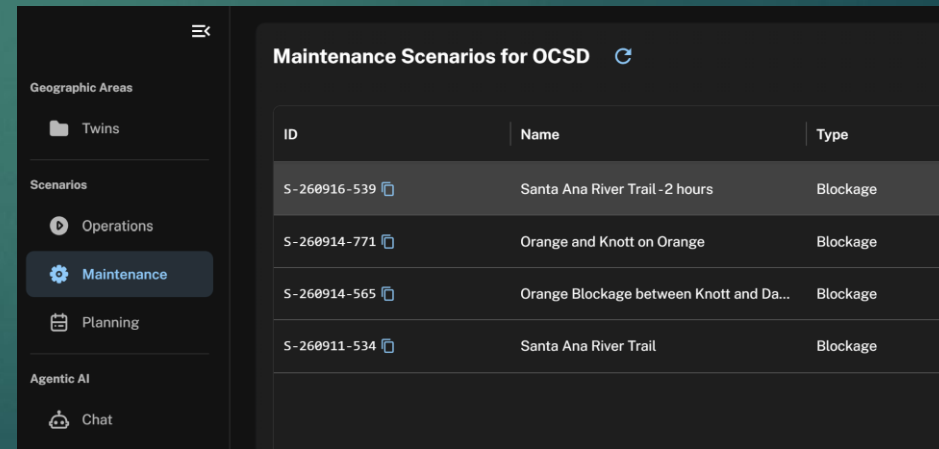
3D Digital Twin (DT) : Examples



The screenshot shows the HydroTrek software interface. At the top, there's a navigation bar with 'HydroTrek Global Quality Corp.' logo and tabs for 'Dashboard', 'Schematic', 'Map', and 'Report'. A sidebar on the left contains icons for home, folder, play, settings, calendar, and a chatbot. The main content area is titled 'Twins' with a '+ Create New' button. It displays a table of digital twins with columns for ID, Name, and Description. The table lists several entries, including 'Mt Lookout', 'OCSD', 'LVVWD', 'Fairfield, Ohio', 'Princeton Miami-Da...', 'MDsouthwest', and 'Detroit'. At the bottom, there's a pagination control showing 'Rows per page: 25' and '1-8 of 8'.

ID	Name	Description
P-260918-268	Mt Lookout	—
P-260901-500	OCSD	—
P-260831-277	LVVWD	—
P-260828-626	Fairfield, Ohio	—
P-260714-287	Princeton Miami-Da...	Princeton Community i...
P-260709-273	MDsouthwest	Miami Dade Southwes...
P-260626-749	Detroit	—

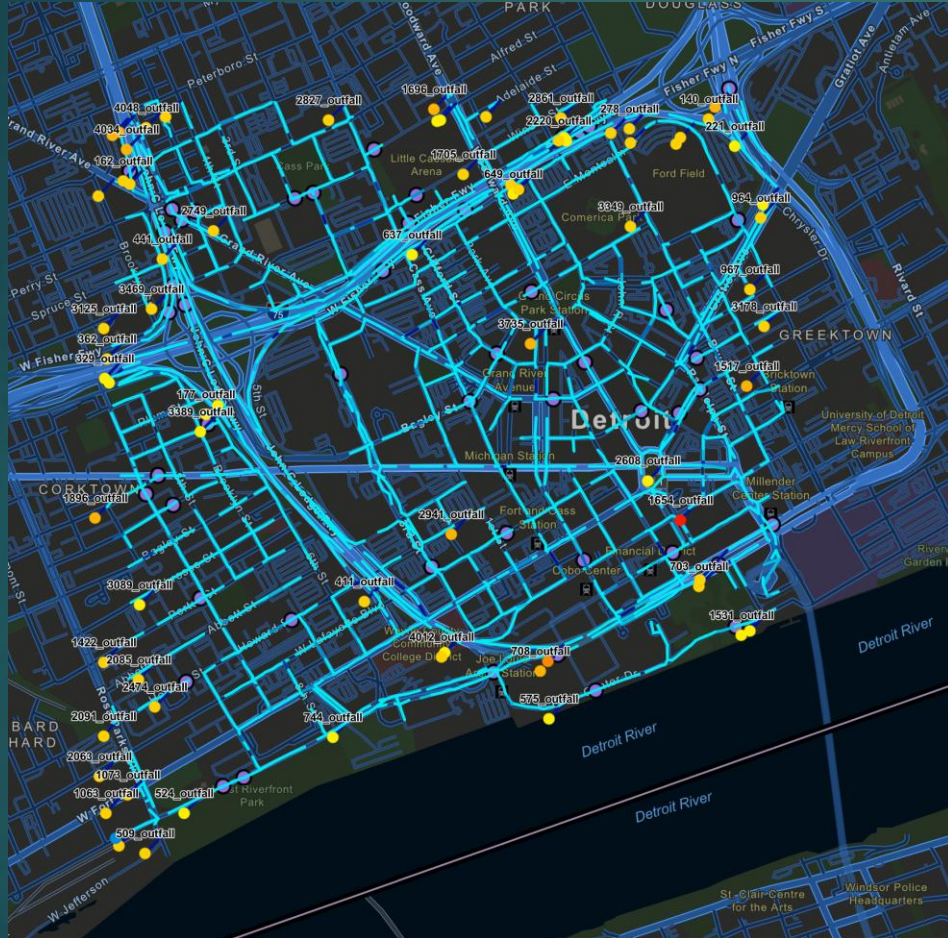
- ▶ Multiple Realistic Examples
- ▶ Created from publicly available GIS data and reports
- ▶ Leveraged GQC's domain knowledge and ChatGPT
- ▶ Took just a few of hours



The screenshot shows a detailed view of 'Maintenance Scenarios for OCSD' in the HydroTrek software. The left sidebar has a menu with 'Geographic Areas' (Twins), 'Scenarios' (Operations, Maintenance, Planning), and 'Agentic AI' (Chat). The 'Maintenance' option is selected. The main content area shows a table of maintenance scenarios with columns for ID, Name, and Type. The table lists five scenarios, all of which are 'Blockage' types.

ID	Name	Type
S-260916-539	Santa Ana River Trail -2 hours	Blockage
S-260914-771	Orange and Knott on Orange	Blockage
S-260914-565	Orange Blockage between Knott and Da...	Blockage
S-260911-534	Santa Ana River Trail	Blockage

Detroit: Model vs DT



Chat ✕

> ● lifecycle_open_model Done

> ● lifecycle_list_sessions Done

> ● lifecycle_close_model Done

> ● lifecycle_open_model Done

The current scenario, named "Base Scenario", is part of the "Detroit" project. Here are the key details:

Simulation Period: April 2, 2026, 00:00 to April 4, 2026, 00:00

Total Nodes: 2,279

Total Links: 2,206

Total Subcatchments: 1,763

Total Rain Gauges: 1

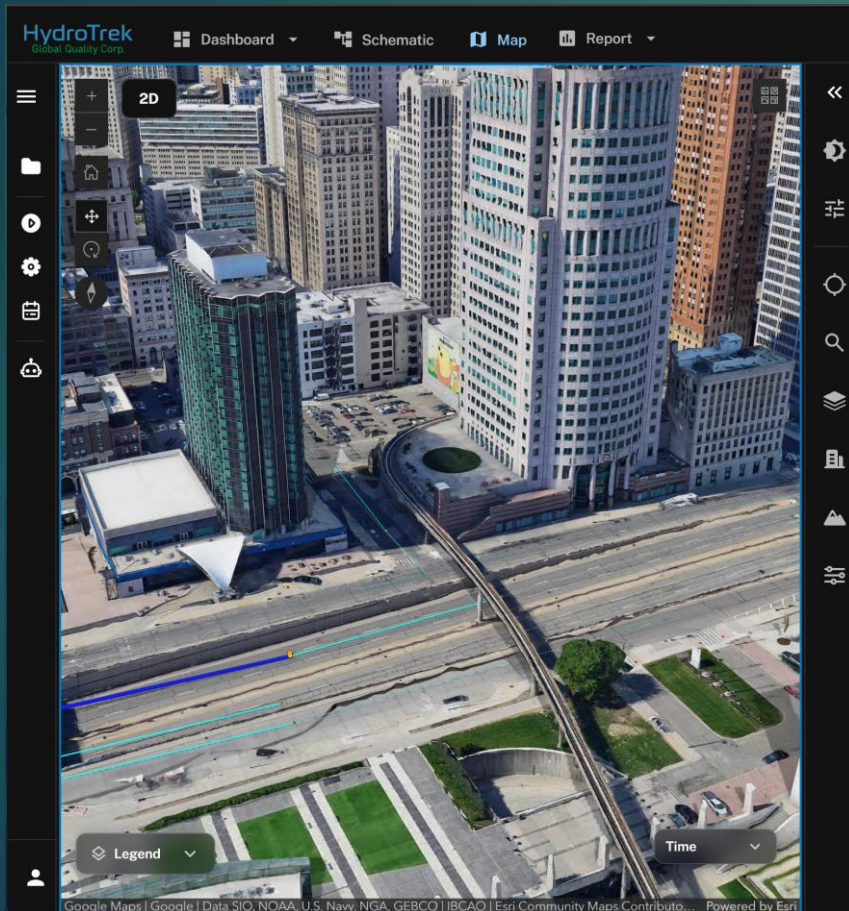
Total Pollutants: 0 (No pollutants are currently specified)

Units

+ ↑

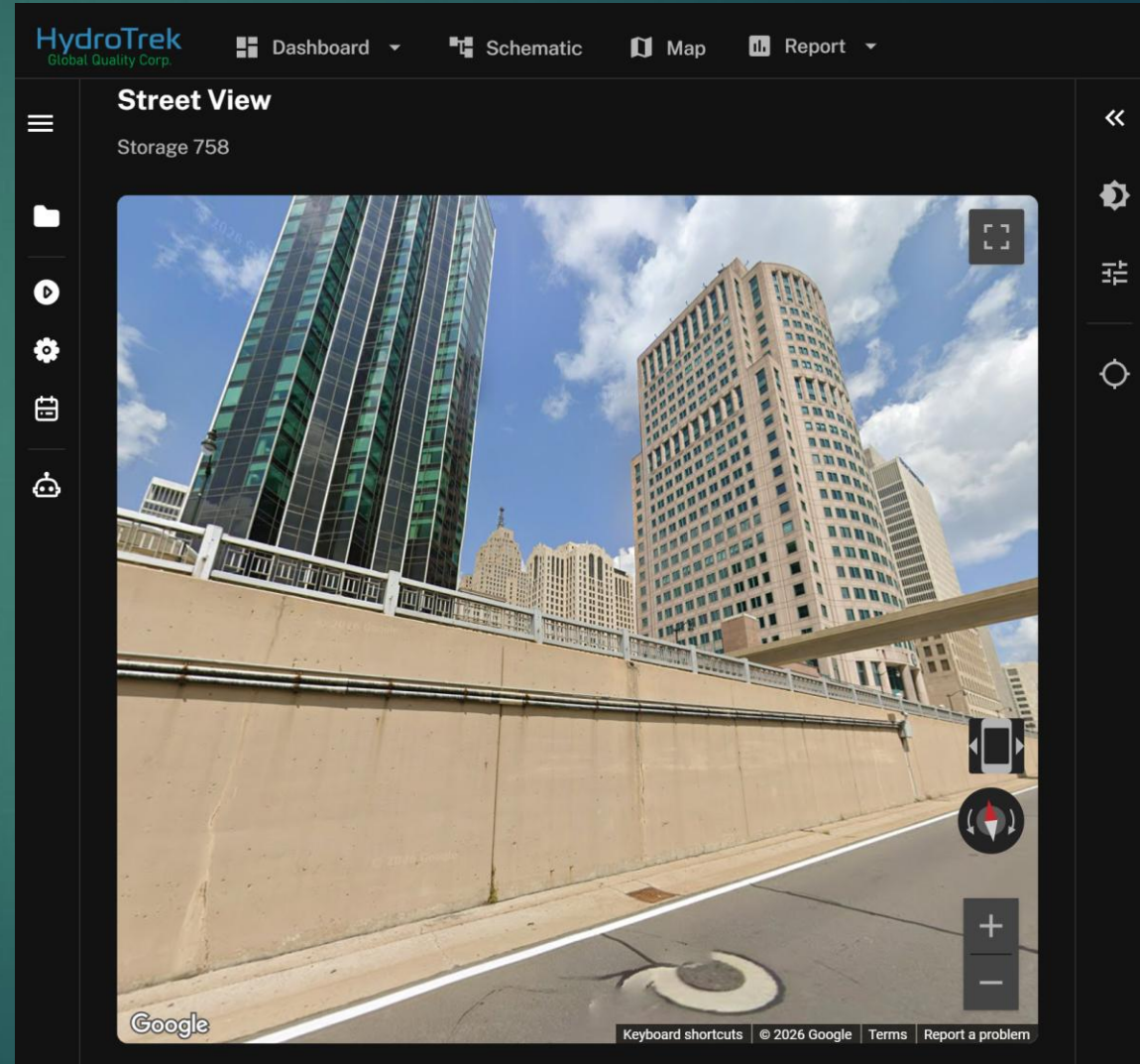
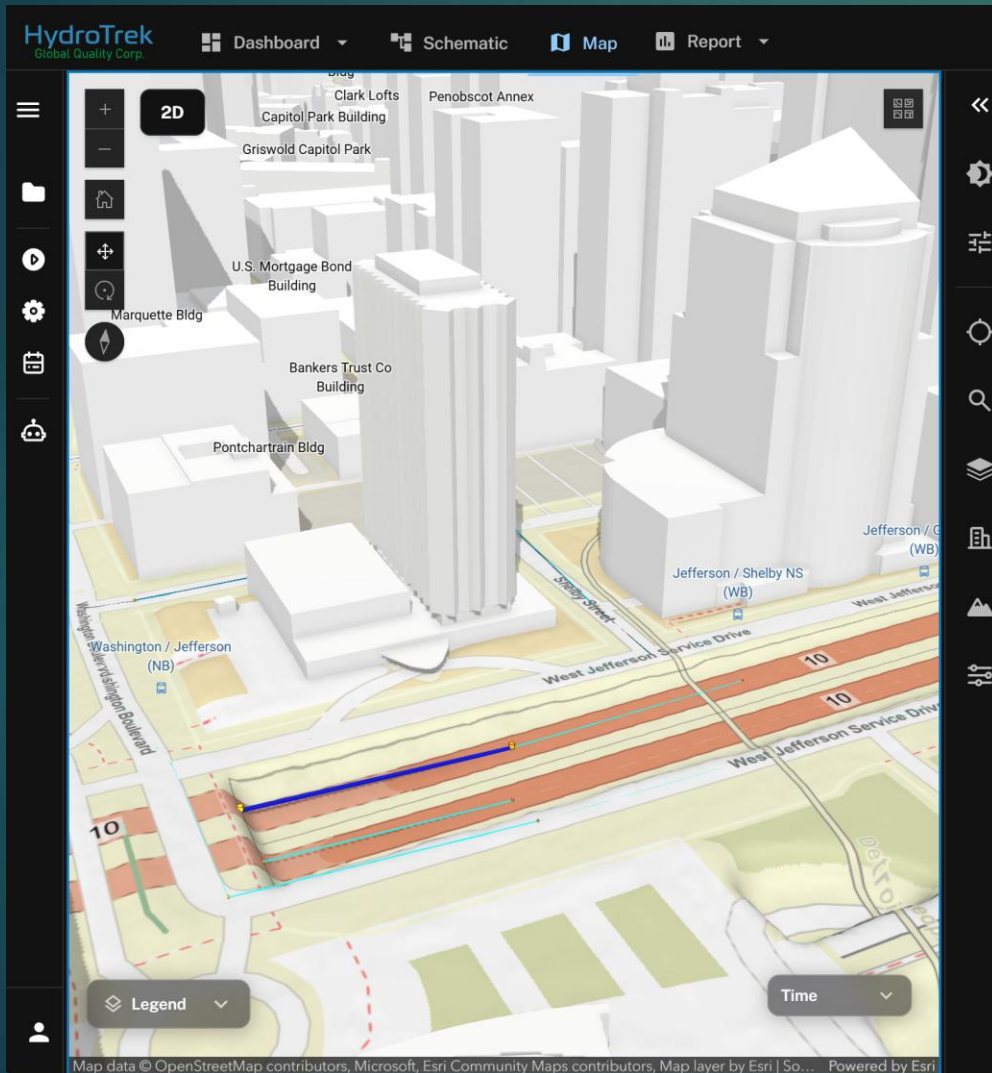
AI can make mistakes. Please verify important information.

3D DT: Overview

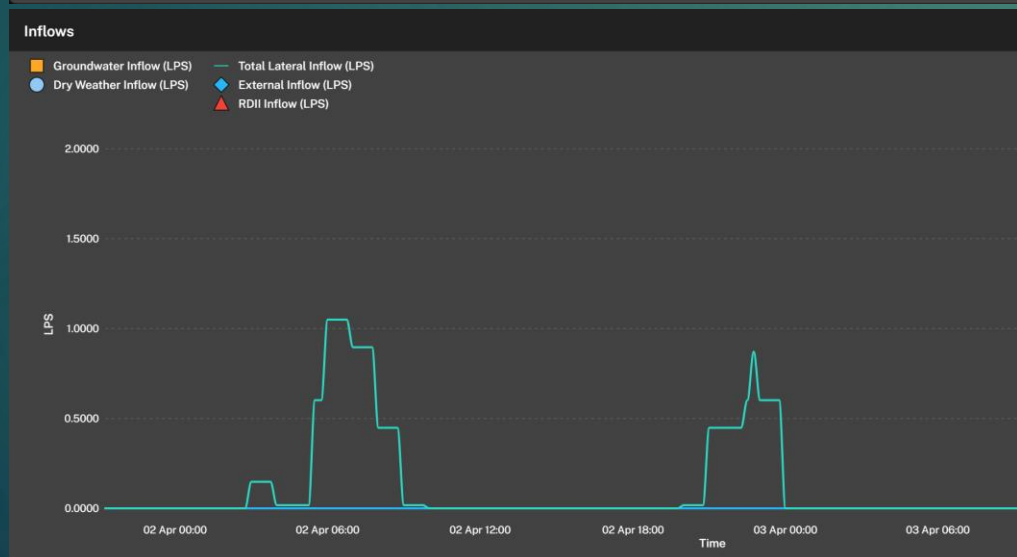
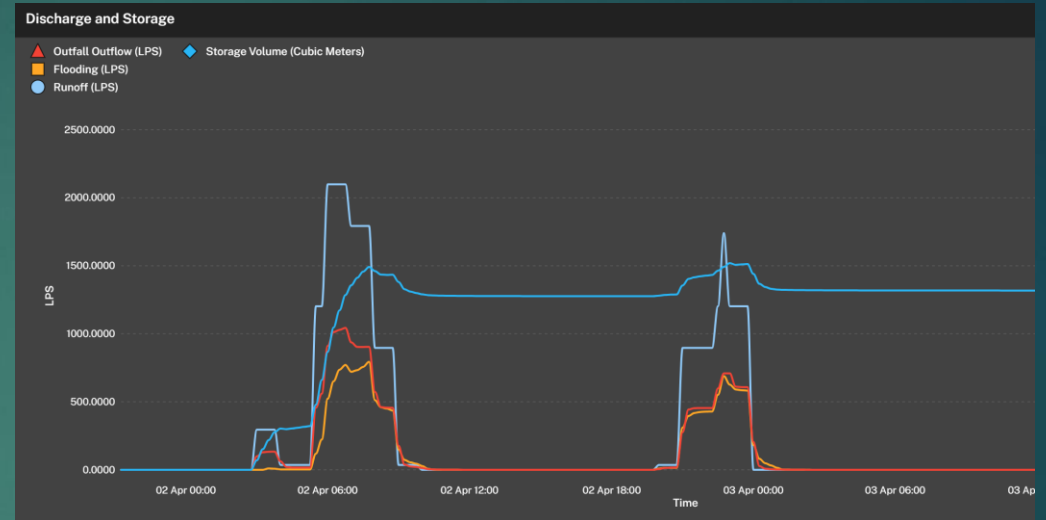
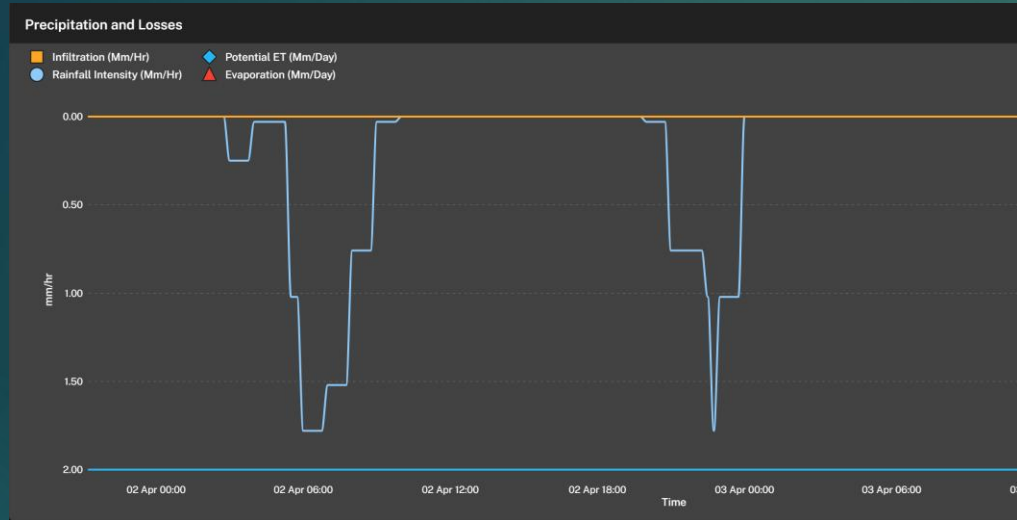


- ▶ No modeling experience should be needed
- ▶ Core implementation in a few hours
- ▶ Evaluate strategies for reducing flooding and CSOs
- ▶ Explore the impact of blockages
- ▶ Examine multiple operating strategies
- ▶ Visualize pipe defects in 2D and 3D
- ▶ Predict pipe defect locations to prioritize inspections
- ▶ A single pane of glass (SPoG)

3D DT: LoD



3D DT: Model Outputs



Blockage

Blockages

Add Blocked Conduit

Conduit

Capacity Factor

0.5

Add Blockage

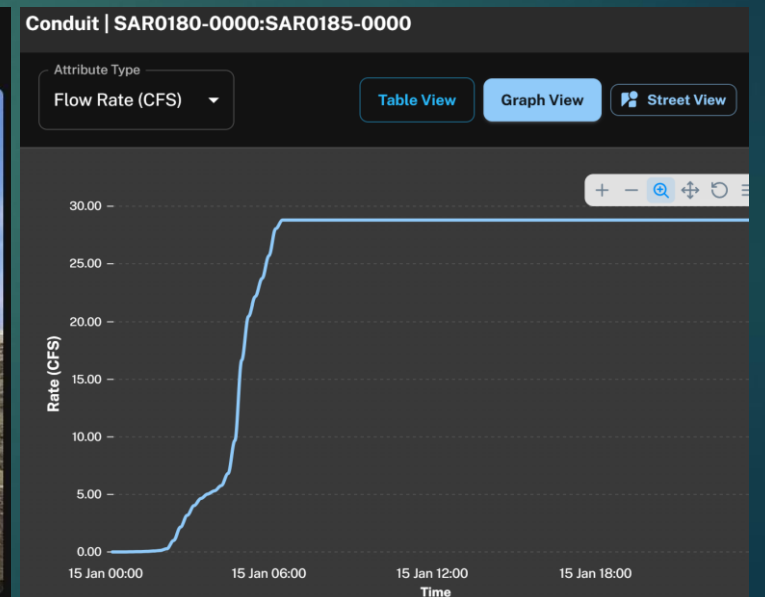
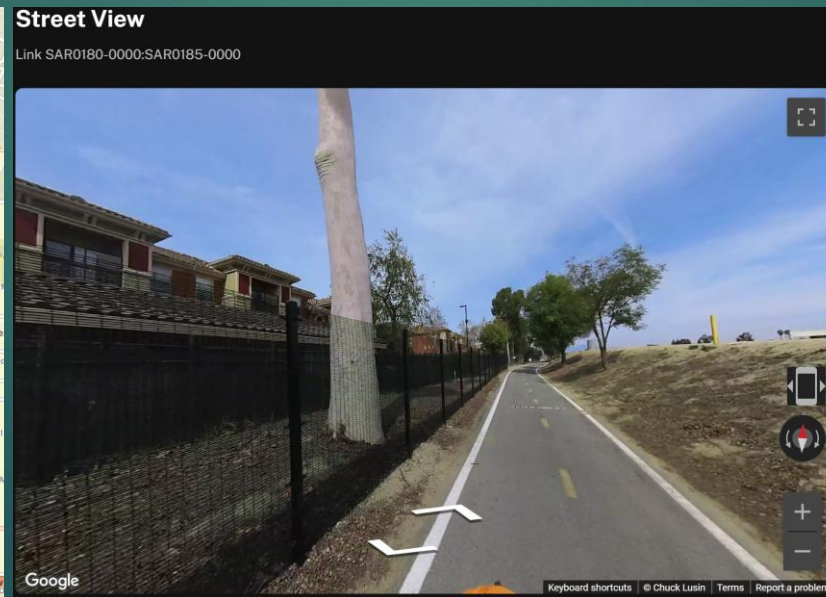
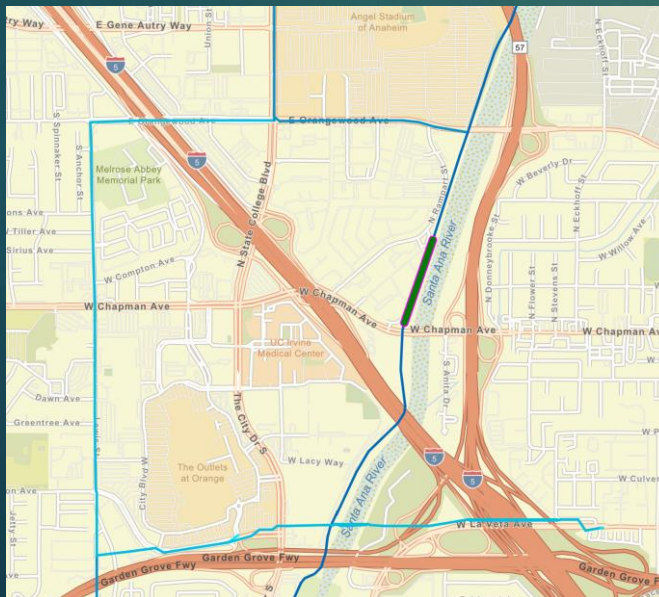
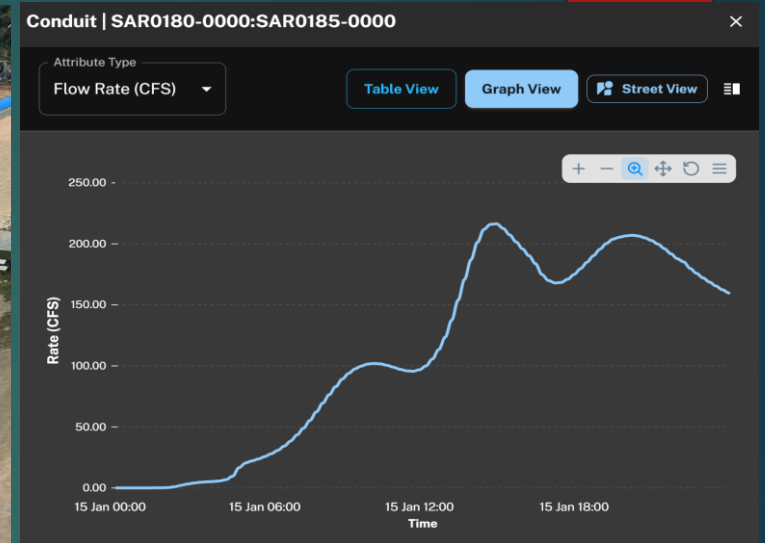
Clear All

Configured Blockages

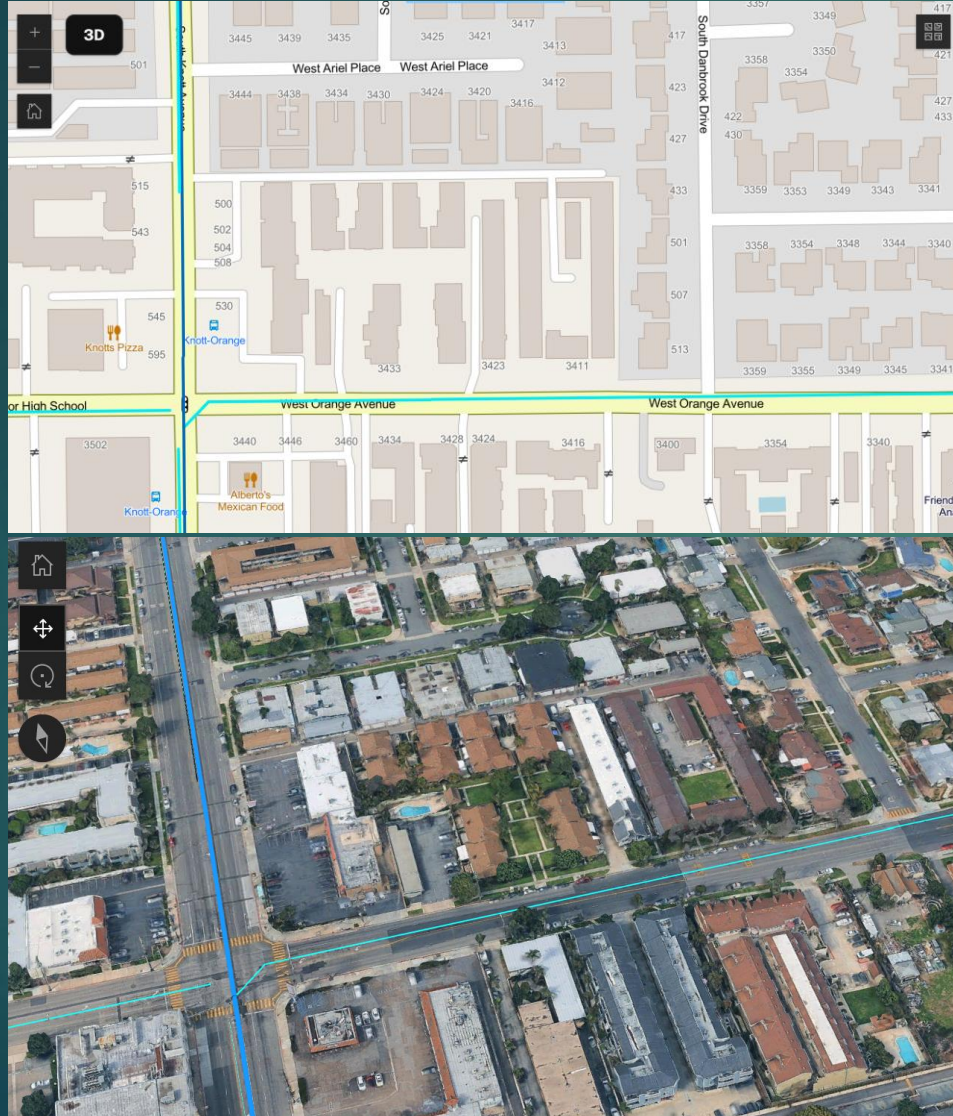
Conduit SAR0180-0000:SAR0185-0000: factor=0.1

Cancel

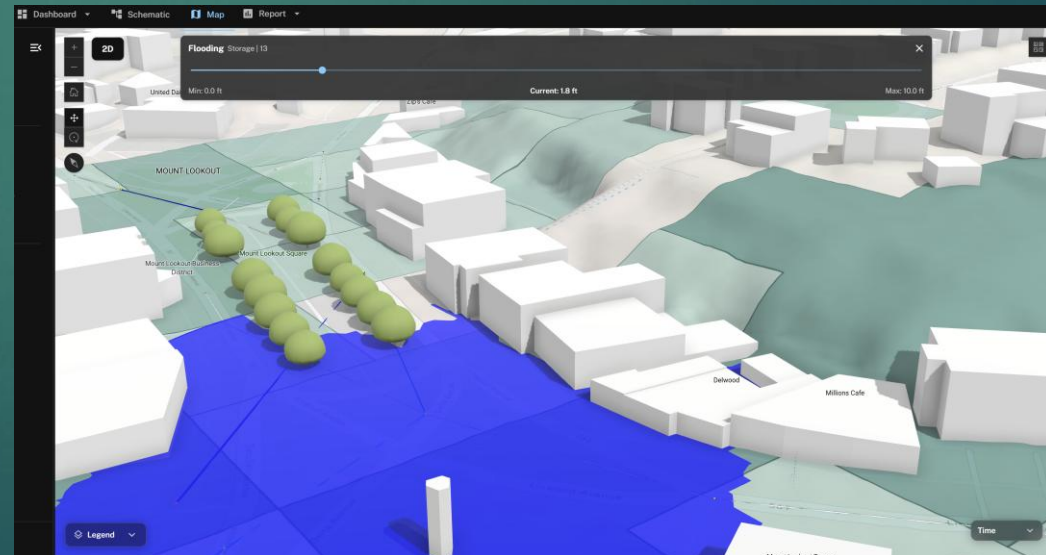
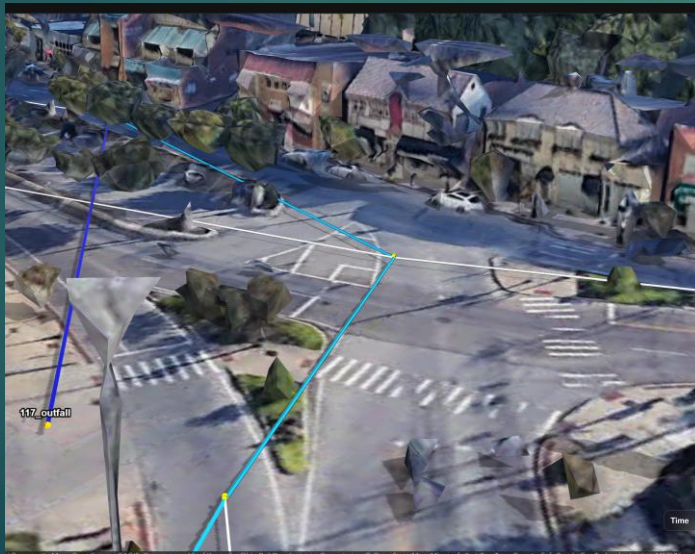
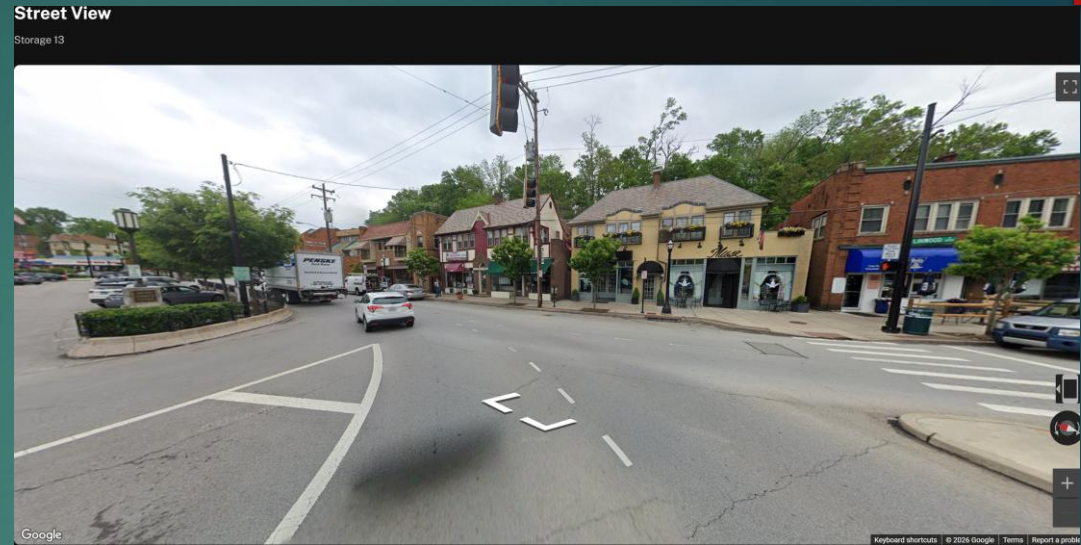
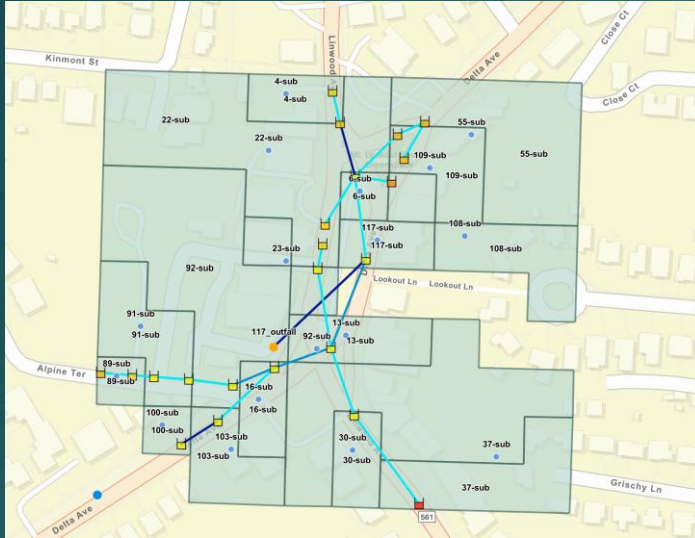
Update



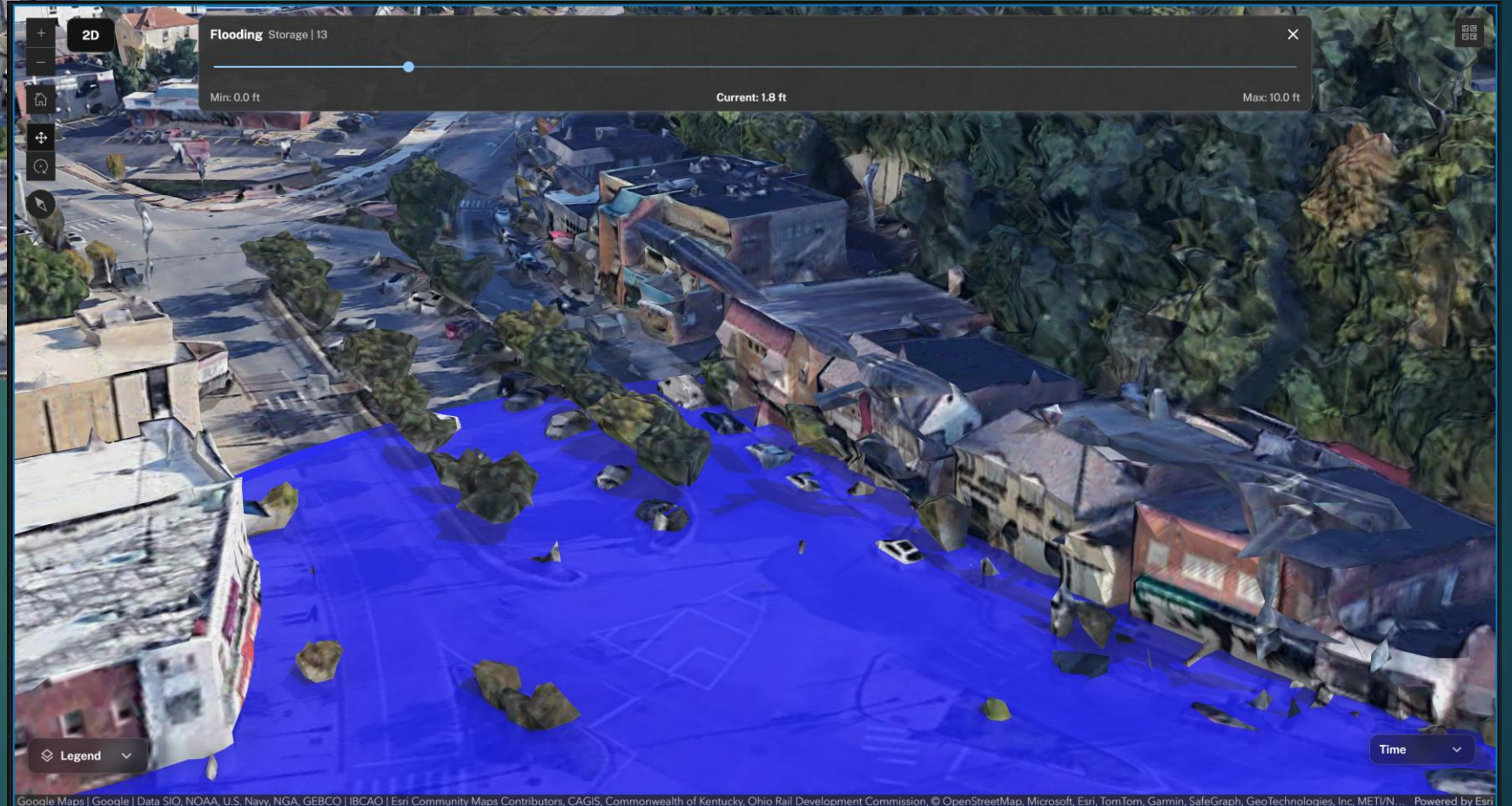
Ponding



Severe Flooding: Mt Lookout, July 17



Severe Flooding: Mt Lookout, July 17

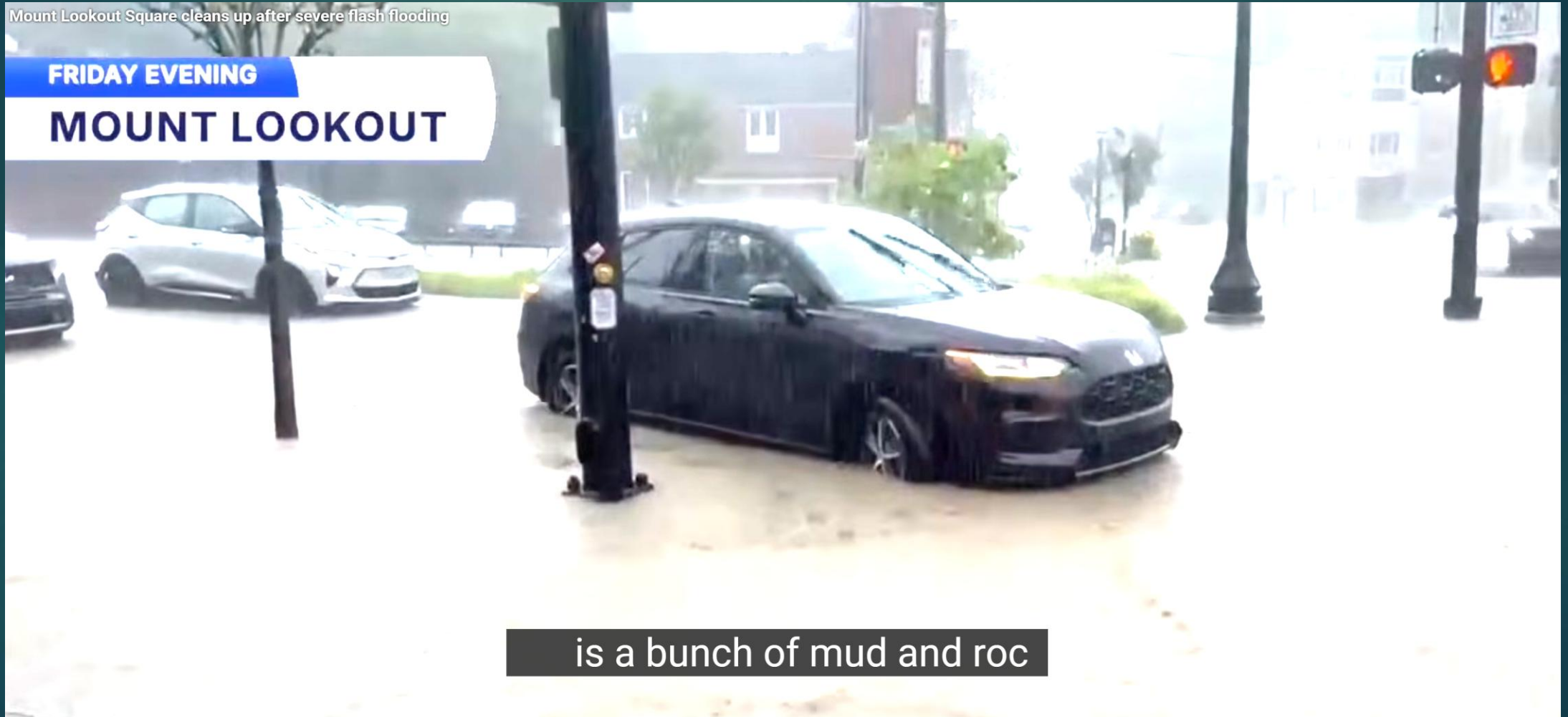


Severe Flooding: Mt Lookout, July 17

Mount Lookout Square cleans up after severe flash flooding

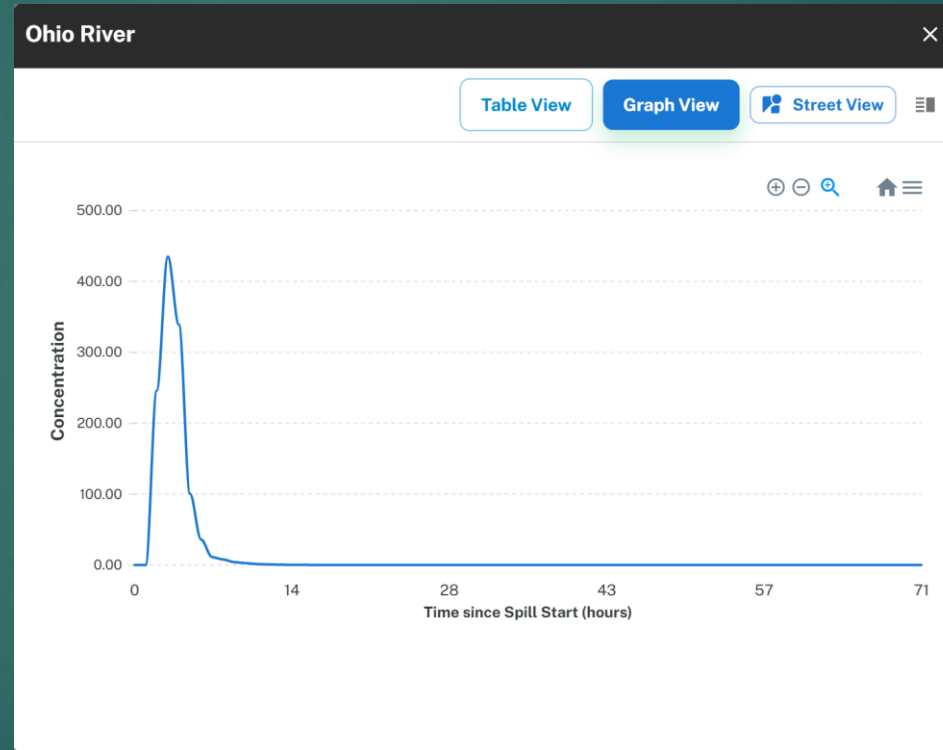
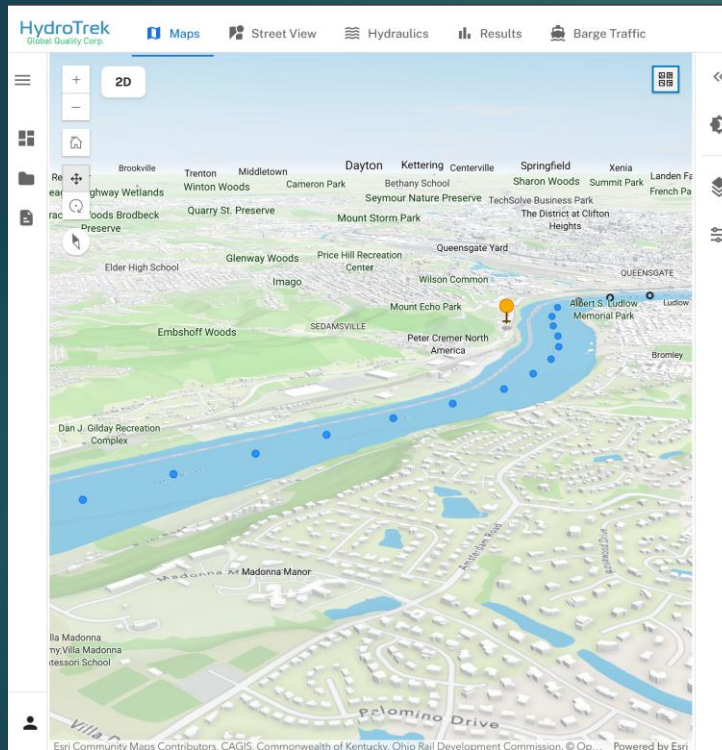
FRIDAY EVENING

MOUNT LOOKOUT



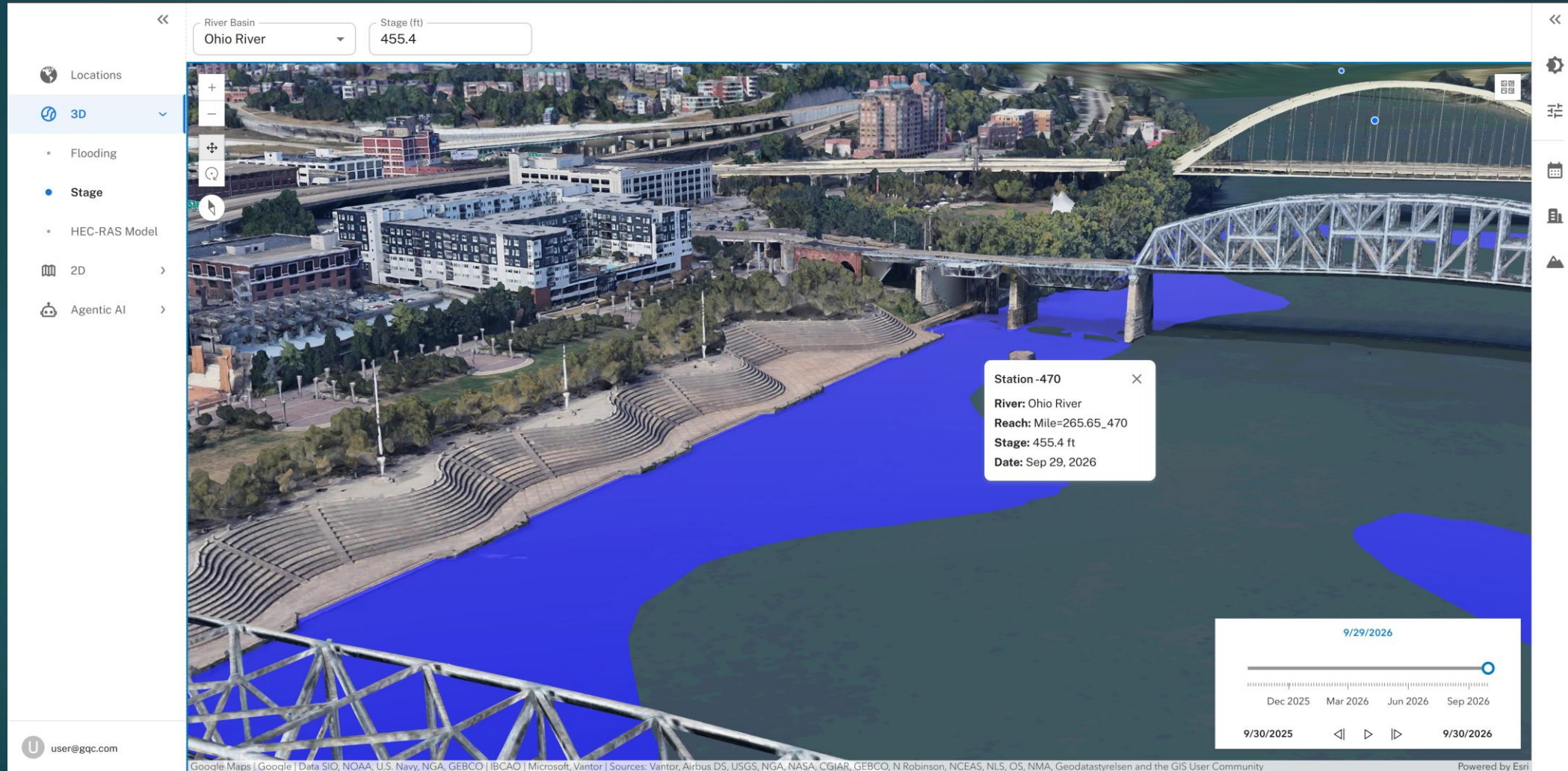
is a bunch of mud and roc

CSO Spill: Mill Creek



- ▶ Accurate Branched-Lagrangian Pollutant Transport Model
- ▶ Predicted Flows and Velocities from HEC-RAS
- ▶ Used for multiple types of pollutants
- ▶ ORSANCO has used it for every spill including the East Palestine Spill

Fluvial Flooding



Fluvial Flooding



Agentic AI Framework

<https://agenticai-learning.org/f25>

- LLM Agents Overview
- Evolution of System Designs from an AI Engineer Perspective
- Post-Training Verifiable Agents
- Agent Evaluation & Project Overview
- Some Challenges and Lessons from Training Agentic Models
- Multi-Agent AI
- Predictable Noise in LLM
- AI Agents to Automate Scientific Discoveries
- Practical Lessons from Deploying Real-World AI Agents
- Multi-Agent Systems in the Era of LLMs
- Autonomous Agents: Embodiment, Interaction, and Learning
- Agentic AI Safety & Security



LLM Agents Overview

General LLM training pipeline

Only for reasoning models

Pretraining

Predict next word on internet

Data: > 10T tokens
Time: months
Compute cost: > \$10M
Bottleneck: data & comp.

Eg LLaMA 3

Reasoning RL

Think on questions with objective answers

Data: ~1M problems
Time: weeks
Compute cost: > \$1M
Bottleneck: RL env & hacks

Eg DeepSeek R1

Classic post-training / RLHF

Max user utility & prefs

Data: ~100k problems
Time: days
Compute cost: > \$100K
Bottleneck: data & evals

Eg LLaMA-instruct

Still called post-training

All numbers are approximate from different open-source projects, especially LLaMA and DeepSeek.

Definitions

- What is AI
 - ML/DL
 - CV
 - GenAI/LLM
 - Tool
- What is an Agent
 - Chat Agent
 - Other Agents
- What is an Agentic Framework
 - Harness
 - Orchestration
 - MCP

Agent = Model + Instructions + Tools + Context+ Skills

Model

LLM / Chat Client

Instructions

Role

Goals

Behavior

Tools

Functions

APIs

MCP Tools

Context Providers

Conversation History

Memory

RAG / Retrieved Knowledge

Dynamic Context

Skills Provider

Skills

Specialized Instructions

Reference Resources

Scripts

```
agent = Agent(  
    client=OpenAIChatClient(model="gpt-5"),  
  
    instructions="You are a hydraulic modeling expert.",  
  
    tools=[  
        run_epanet,      # Local Python function  
        get_network_data, # Local Python function  
  
        MCPStreamableHTTPTool(  
            name="WaterModeling",  
            url="https://water-modeling/mcp"  
        )                # Remote MCP server  
    ],  
  
    context_providers=[  
        HistoryProvider(),  
        MemoryProvider(),  
        RAGProvider(),  
        SkillsProvider("./skills")  
    ]  
)
```

The model reasons;
context informs it; skills
tell it how to perform
tasks; tools let it take
actions.

Model Context Protocol (MCP) Server

Tools = Actions

run_epanet, get_results

Resources = Information

models, documentation

Prompts = Instructions

pressure diagnosis,
pump analysis

```
from fastmcp import FastMCP
mcp = FastMCP("Water Modeling")
# TOOLS — perform actions
@mcp.tool
def run_epanet(model: str):
    return epanet.run(model)
@mcp.tool
def get_results(model: str):
    return epanet.results(model)
# RESOURCES — provide information
@mcp.resource("model://{project}")
def get_model(project: str):
    return load_model(project)
@mcp.resource("docs://epanet")
def get_epanet_docs():
    return load_epanet_docs()
# PROMPTS — provide instructions
@mcp.prompt
def diagnose_pressure(node: str):
    return f"Diagnose low pressure at {node}."
@mcp.prompt
def analyze_pump(pump: str):
    return f"Analyze the performance of {pump}."
mcp.run()
```

A Sample Chat

HydroTrek
Global Quality Corp.

Dashboard Schematic Map Report

Geographic Areas

- Twins

Scenarios

- Operations
- Maintenance
- Planning

Agentic AI

- Chat

user@gqc.com

Twins

ID	Name
P-260918-268	Mt Lookout
P-260901-500	OCSD
P-260831-277	LVVWD
P-260828-626	Fairfield, Ohio
P-260714-287	Princeton Miami-Dade
P-260709-273	MDsouthwest
P-260626-749	Detroit
P-260521-499	Rivershore

Chat

Hi, summarize the scenario, please

lifecycle_open_model

Done

model_get_unit_system

Done

lifecycle_list_sessions

Done

lifecycle_close_model

Done

lifecycle_open_model

Done

lifecycle_resolve_scenario_path

Done

lifecycle_open_model

Done

AI can make mistakes. Please verify important information.

Scenarios

Created

1	09/18/2026 01:17 PM	
8	09/01/2026 01:28 PM	
1	08/31/2026 01:15 PM	
1	08/28/2026 07:41 AM	
5	07/14/2026 09:11 AM	
1	07/09/2026 10:12 AM	
1	06/26/2026 11:57 AM	
7	05/21/2026 10:16 AM	

Rows per page: 25 1-8 of 8

Chat

Chat

×

> ● lifecycle_run_simulation

Done

> ● analysis_get_simulation_summary

Done

Scenario Summary: Base Scenario - 3 hours (Mt Lookout)

Simulation Overview:

Session ID: default

Units: US Customary (CFS)

Start Time: July 17, 2026, 16:00

End Time: July 17, 2026, 19:00

Elapsed Simulation Time: 3 hours (0.125 days)

Steps Completed: 2162

Routing Model: DYNWAVE

Network Attributes:

Nodes: 23

Links: 22

Subcatchments: 17

Gages: 1

+

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AI can make mistakes. Please verify important information.

Chat

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have specific questions or need further analysis regarding this node or others, feel free to ask!



what tools do you have?

In HydroTrek, I can use a variety of tools to assist with modeling, analysis, and simulation concerning both wastewater collection systems and stormwater systems. Here are some of the key tools and functions available:

Project and Scenario Management

List Projects: Retrieve a list of available projects.

List Scenarios: Get a list of scenarios for a specific project.

Open Model: Open a specific model based on its input file.

Run Simulation: Execute the simulation for the active model.

Model Analysis

Mass Balance: Analyze the mass balance of the simulation results, including runoff and routing totals.

Flooding Summary: Summarize the flooding results across the network.

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AI can make mistakes. Please verify important information.

Chat

Chat ✕

Node, Link, and Subcatchment Analysis
Get Node Info: Retrieve detailed information about a specific node, including hydraulic parameters.
Get Link Info: Get details for links in the system, such as flow rates and capacities.
Get Subcatchment Info: Access information regarding subcatchments, including area, slope, and imperviousness.

Forcing and Control
Set Forcing: Apply external influences on nodes, links, or subcatchments.
Control Settings: Adjust the operational settings for pumps and other control devices.

Hydrology and Hydraulics
Query Hydrology Parameters: Analyze parameters and settings affecting runoff and response.
Evaluate Water Quality: Examine the available water quality metrics in the system.

Detailed Reports and Diagnostics
Generate Reports: Produce detailed reports of the simulation, including various metrics and information.
Node and Link Statistics: Access detailed statistics for specific nodes and links

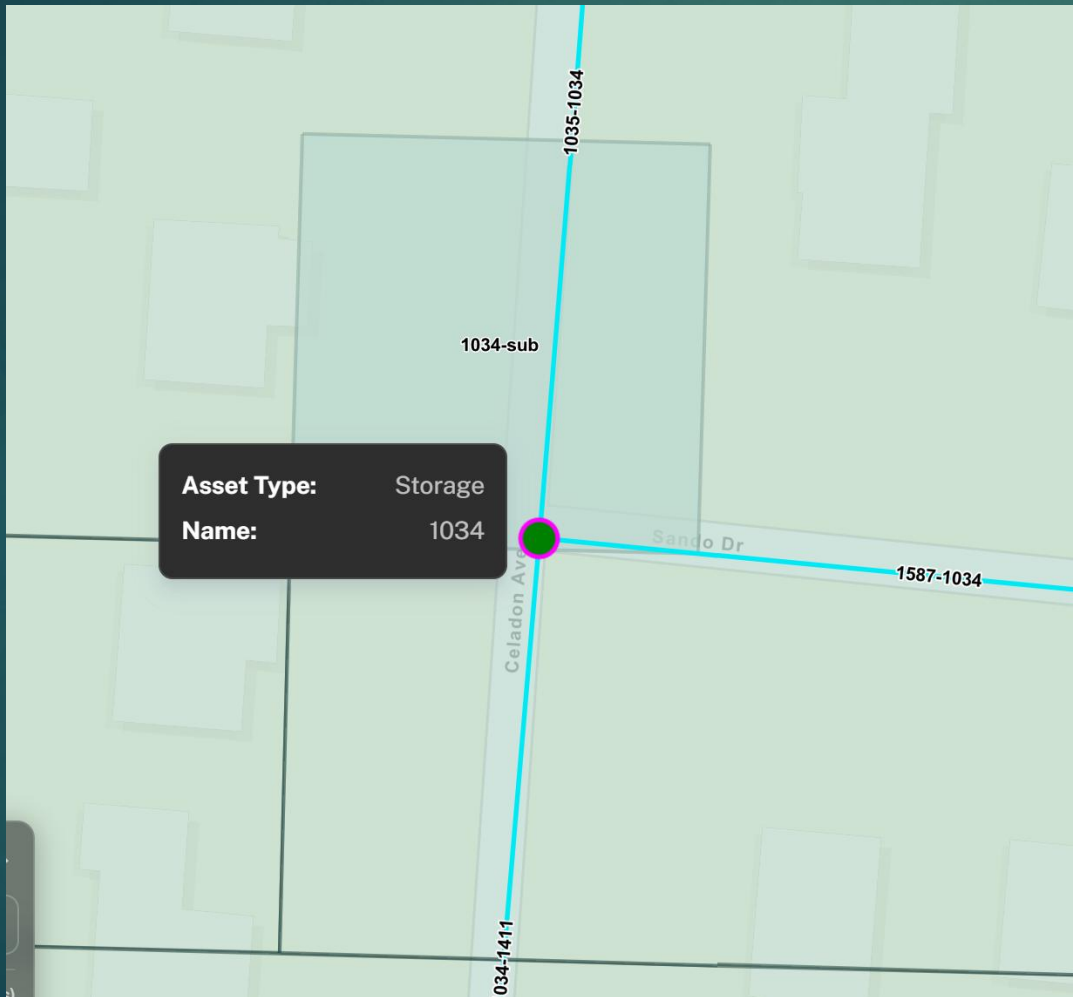
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AI can make mistakes. Please verify important information.

- Domain knowledge is essential in defining the tools
- Define the problems that you want to solve and how one or more models and tools can address that
- Analyze your SCADA data
- Analyze your monitoring data
- Predict hydraulics and water quality
- Get weather predictions
- ... Limited by your imagination...
- Long running jobs can be handled but be patient

Upload an image and ask



Chat ✕

Supporting decision-making for infrastructure improvements.

In summary, stormwater modeling is a critical tool in urban planning and environmental management, helping to create systems that effectively handle runoff while minimizing flooding and pollution. If you have more specific questions or need further information, feel free to ask!



Tell me about the highlighted node

> ● query_get_node_info

Done

Here are the details for the highlighted storage node 1034:

Node Information

Asset Type: Storage

Node ID: 1034

Node Index: 812

Invert Elevation: 179.80 ft

Crown Elevation: 180.33 ft

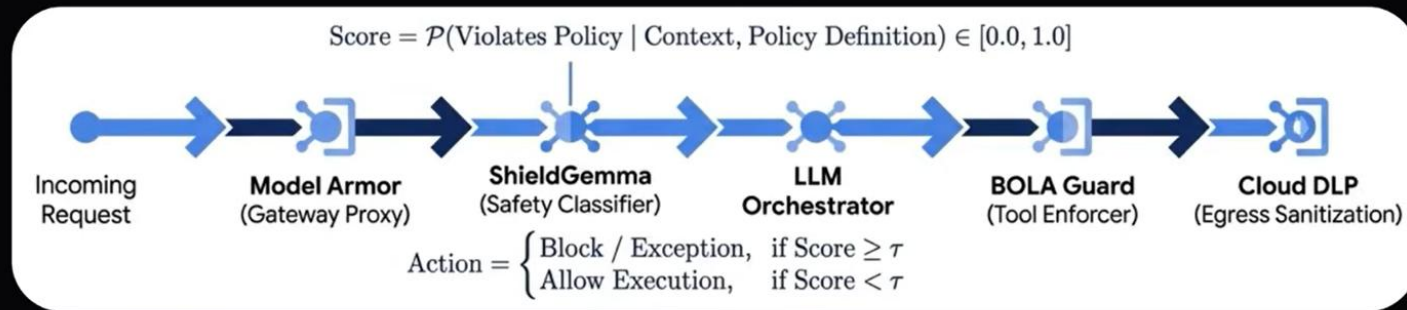
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AI can make mistakes. Please verify important information.

Framework Security

Tier 1 | Semantic Ingress Guardrails and Contextual Authorization



Model Armor (Inspect & Block): Acts as an inline proxy, identifying jailbreaks, prompt injection patterns, and malicious URIs before tokens enter the orchestrator context window.

ShieldGemma (2B/9B): An open-weights text-to-text safety classifier evaluating prompt-response pairs against formal harm taxonomies.

BOLA Guard: A deterministic tool-layer check. Verifies the authenticated caller principal possesses legitimate authorization for the specific object ID.

BOLA Guard: Cloud DLP: Egress boundary sanitization, automatically applying cryptographic token masking to any PII that attempts to leave the system.

Google for Startups

example is Gemini 3.5 3.5 and
then after that's being passed

Q&A and Contact Info

- ▶ Appreciate your time today, Thanks
 - ▶ Sudhir Kshirsagar, sudhir@gqc.com, HydroTrek.com