# Hinkson Science Team Meeting Minutes

A meeting of the Hinkson Creek Science Team occurred on May 5, 2026, starting at 3:00 PM via Microsoft Teams call.

## Science Team Members

| Name | Organization | Area of Interest or Role | Present/Absent for Meeting |
|---|---|---|---|
| Dane Boring | U.S. Environmental Protection Agency | Water Chemistry/Water Quality/ CWA Section 303d | Present |
| Paul Blanchard | Retired | Hydrology/ Water Quality | Present |
| Robert Voss | Missouri Department of Natural Resources | Water Chemistry/Water Quality/CWA Section 303d | Absent |
| John Holmes | Allstate Consultants | Civil/Environmental/Water Resources Engineer | Present |
| Robb Jacobson | University of Missouri Columbia, Adjunct Professor | Potamologist | Present |
| Dave Michaelson | Missouri Department of Natural Resources | Aquatic Macroinvertebrate Biologist/ Water Quality | Present |
| Chris Schmitt | Retired/Emeritus U.S. Geological Survey | Aquatic Toxicology | Absent |
| VACANT | VACANT | Modeling/BMP related? | VACANT |
| Alba Argerich | University of Missouri Columbia | Water Quality/Stream Ecology | Present |

**Other People in Attendance:** Michele Woolbright, Lynne Hooper, Nicki Rinehart, Josh Horne, Ted Haeussler, Muhammad Waqar Saleem, Baolin Deng

## Minutes

The minutes for April 2026 were approved.

## Discussion Items

1. Muhammad Waqar Saleem, a doctoral candidate with the University of Missouri, presented his Hinkson Creek Digital Twin Model research findings and provided a tour of his website (https://mofloodwatch.me/).
    a. This is a forecasting model that takes rainfall input in the Hinkson Creek watershed and creates a graph neural network machine learning tool.

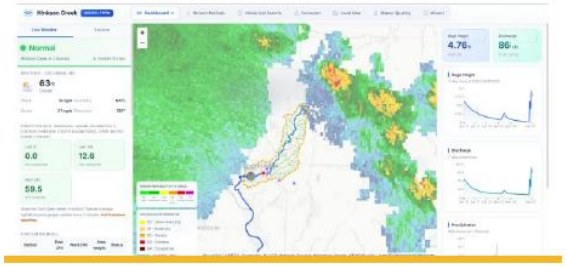
b. Among many other features, this model can show areas likely to be affected by flooding given current flows and predicted rainfall totals.
c. Dr. Argerich's synoptic water quality data, from 2024 to the present, are also available through the model.
d. Future goals for the model are to predict road and bridge effects at 50- and 100-year flow events, continuous live updates, 3-D streets and buildings, and energy and critical infrastructure information.
e. For a more in-depth look at the model's capabilities, users can visit the website using the link above.

2. Open Topics
    a. Jason Hubbart has posted some of his Hinkson Creek data on the University of West Virginia's website at https://researchresearchrepository.wvu.edu/iwss-datasets/1/
    b. Michele Woolbright is updating the Help the Hinkson website and is currently modifying the most recent Science Strategy Document so that it is ADA Title II / 508 compliant prior to posting it to the website.

**Excerpts from the University of Missouri presentation:**

MOFLOODWATCH.ME

# The Website at a Glance



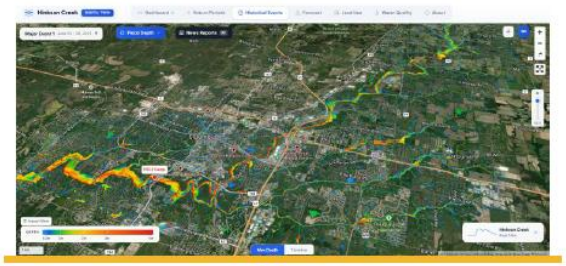
**Dashboard**

Live USGS gauge, weather, alerts



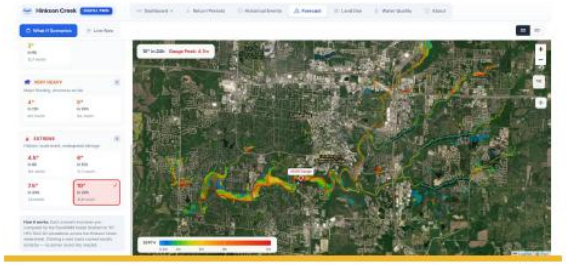
**Return Periods**

5/10/25/50/100-year flood maps



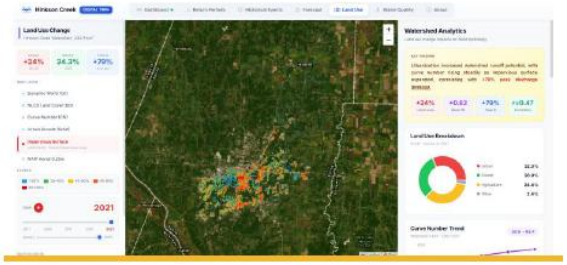
**Historical Events**

10 documented floods · animations



**Forecast**

What-If + Live GNN inference



**Land Use**

NLCD trends · curve-number




**Water Quality**

Water Quality Parameters

METHODS

# How the Forecast Works

**Rainfall input**

5 AgEBB gauges
Thiessen-weighted
basin-average mm/h

**HEC-RAS**

100 documented
storm events
2D unsteady flow

**Graph neural net**

TransformerConv
edge-conditioned
message passing

**Live forecast**

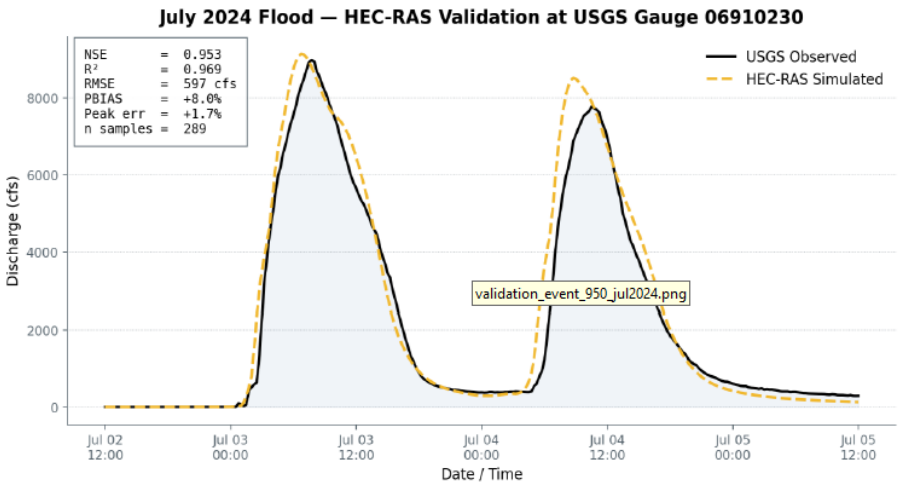
825,781 mesh nodes
4.8 M edges
~16 s per inference

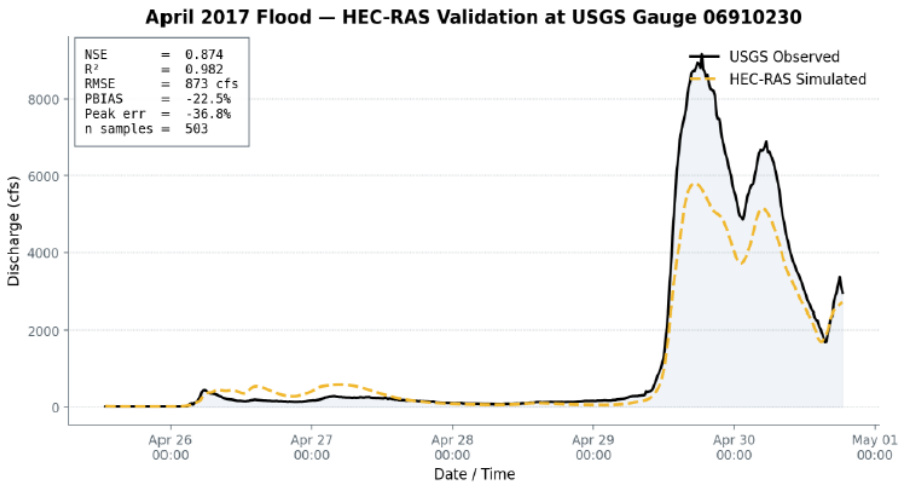
## Why a graph neural network?

- HEC-RAS is the most widely used 2D hydraulic model but takes hours per storm.
- A neural surrogate trained on those HEC-RAS outputs reproduces them in seconds.
- Graph structure mirrors the watershed mesh - every node is a real spatial location.
- Trained on 100 storm events from 2002 to 2024, spanning calm to record floods.

PHYSICS-BASED MODEL PERFORMANCE

# Step 1 - HEC-RAS Validation




### July 2024 - Validation

- NSE = 0.953 (excellent)
- $R^2$ = 0.969

### April 2017 - multi-day storm sequence

- NSE = 0.874 (good)
- $R^2$ = 0.982 (excellent timing match)

*These HEC-RAS outputs become the training data for the neural network surrogate.*

REAL-TIME MODEL TRAINED ON HEC-RAS

# Step 2 - Graph Neural Network Surrogate

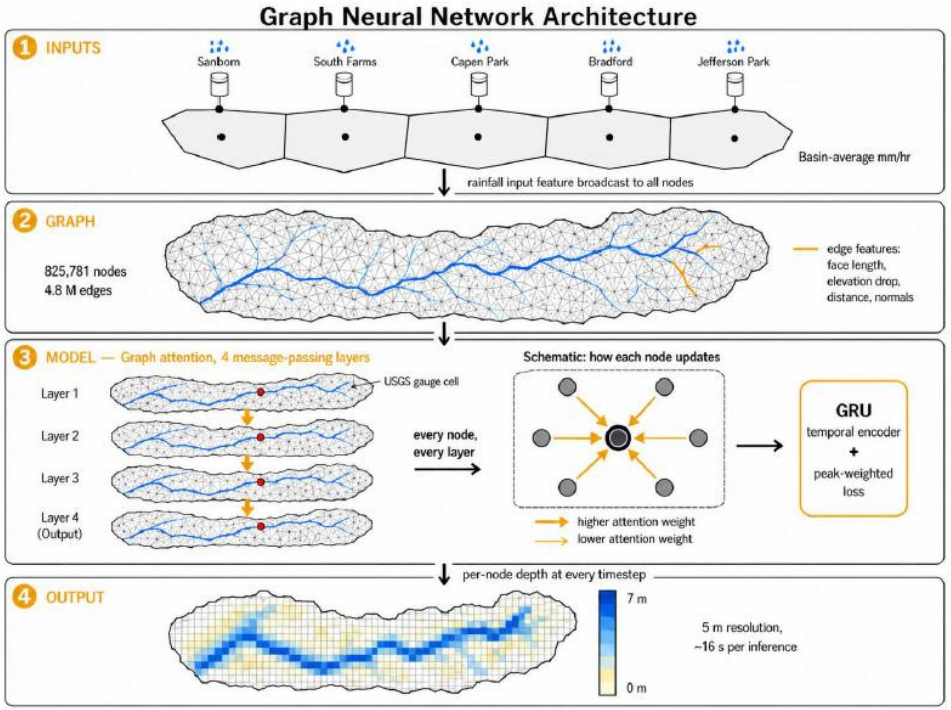
| 0.93 | 0.998 | 0.08 m | ~16 s |
|---|---|---|---|
| **NSE** | **FLOOD F1** | **DEPTH RMSE** | **INFERENCE** |
| Nash–Sutcliffe efficiency on validation | Wet/dry classification at every node | Per-node depth error (≈ 3 in) | Versus hours for HEC-RAS |

## Model architecture and training

- Mesh: 825,781 unstructured nodes, 4.8 M graph edges
- 4-layer TransformerConv with edge-conditioned message passing
- Trained on 100 HEC-RAS-simulated events (2000 – 2025)
- Inputs: rainfall sequence + per-node static features (elevation, slope, land cover)
- Output: per-node flood depth and binary inundation, every 15 minutes

TECHNICAL DETAILS

# Inside the Model




| | |
|---|---|
| **Architecture** | TransformerConv graph attention (4 layers) |
| **Edge features** | face length, elevation drop, distance, normals (5 dims) |
| **Temporal encoder** | GRU + dual peak-weighted loss |
| **Mesh size** | 825,781 nodes / 4.8 M edges |
| **Training data** | 101 HEC-RAS storms (2002 - 2024) |
| **Precision** | FP32 (no mixed precision) |
| **Hardware** | NVIDIA H100 (training) / Cloud Run (inference) |
| **Inference time** | ~ 16 seconds for a 24-hour forecast |

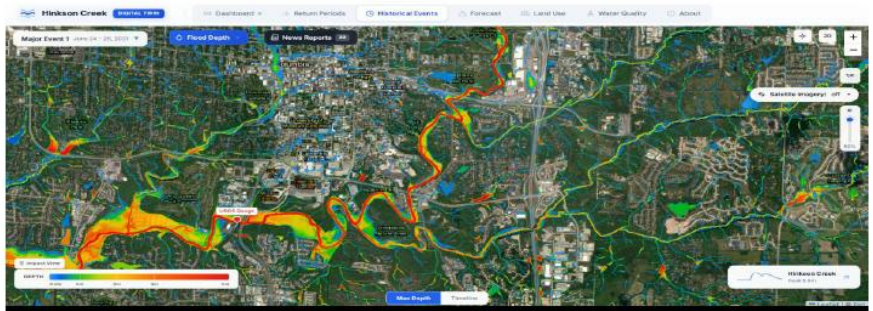
## Why this design works

- Edge features encode local hydraulics (slope, channel width).
- Transformer attention propagates the flood wave faster than plain GCN.
- FP32 trades speed for stability on TransformerConv attention overflow.

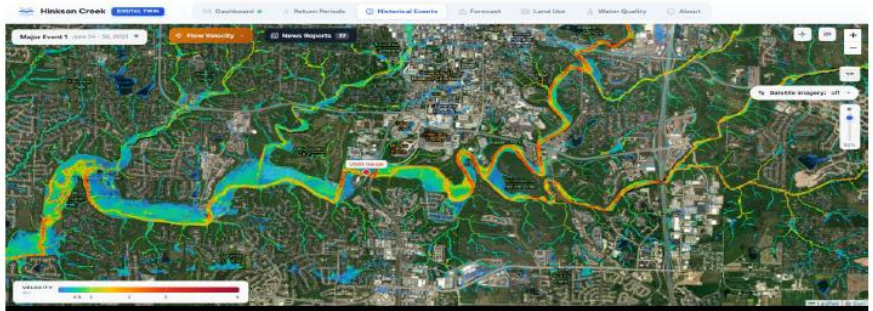
REPLAY ANY OF 12 DOCUMENTED FLOODS

# Historical Events

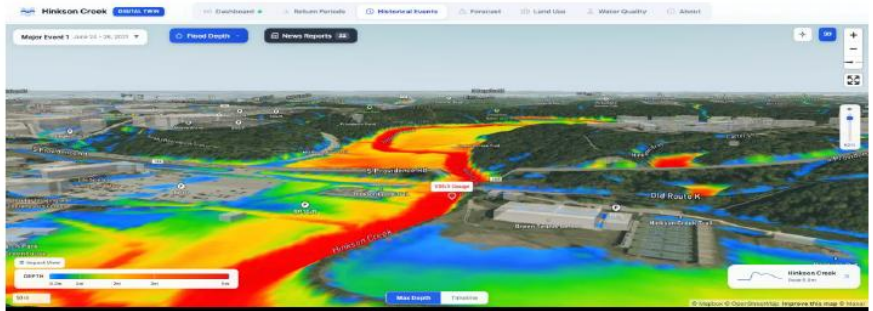
12 events from May 2002 to July 2024 - each with max depth, peak velocity, animation, and USGS hydrograph.



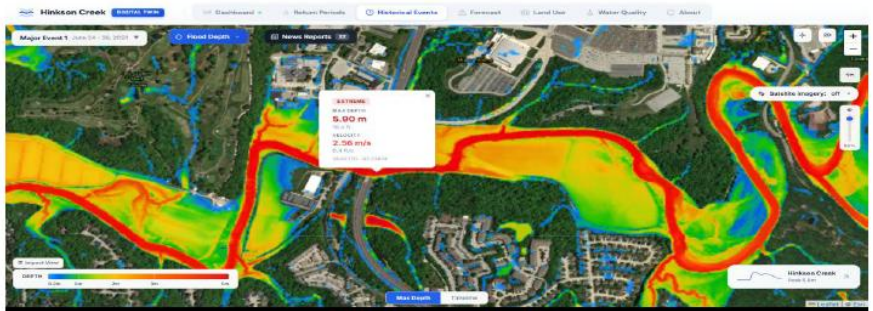
Max depth (2D)



Velocity overlay



3D terrain view



Click-to-query depth

PREDICT FLOOD DEPTHS FROM CURRENT RAINFALL

# Forecast - Live Now

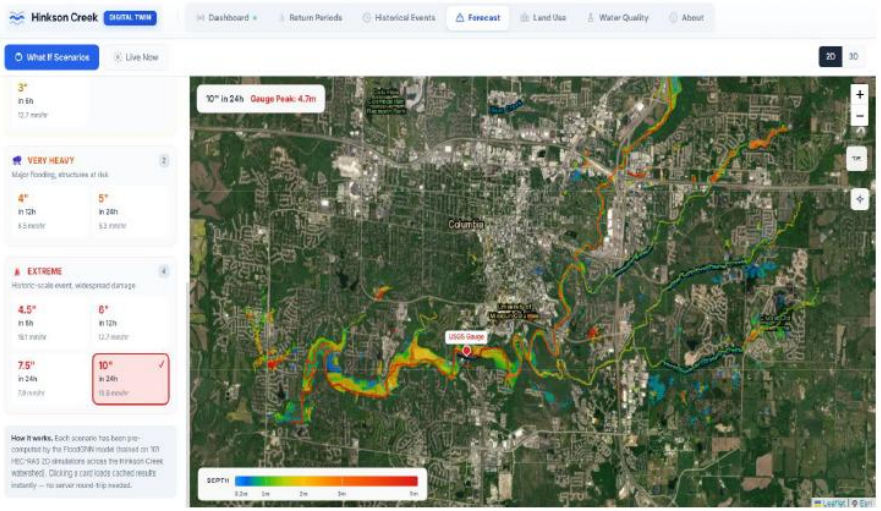
**▶ LIVE DEMO - switch to mofloodwatch.me / Forecast**

## What-If Scenarios

25 pre-computed storms covering 5 rainfall intensities x 5 durations for instant side-by-side comparison.

## Live Now

Current AgEBB rainfall feeds a 12-hour NWS forecast through the GNN and produces a fresh flood-depth map.




**Live forecast on mofloodwatch.me**

WHY THIS MATTERS BEYOND RESEARCH

# Benefit to Columbia and Mid-Missouri

## Residents

- See whether your home or neighborhood is exposed at 5-100-year events
- Free, public, no login - open on any phone or laptop
- Weather, gauge, and forecast all on one page

## Emergency responders

- Live picture of which roads, schools, hospitals are at risk
- Replay past floods for training and after-action review
- Click any location to read predicted depth in seconds

## Planners and utilities

- Quantify flood exposure of city assets - substations, treatment plants
- See land-use change impacts on runoff over the past 20 years
- Open data, open methods - no proprietary software lock-in

## Educators and citizens

- Plain-language flood explainer with historical Hinkson floods
- Visualize the watershed - many residents have never seen it whole
- Resource for K-12, MU classes, public talks

WHERE WE ARE TAKING THE PLATFORM NEXT

# Future Work

**Bridges and roads**

Boone County NBI bridge inventory; predict which roads and bridges are flooded at 50/100-year events for evacuation routing.

**Continuous live updates**

GPU back-end re-runs the model every 5 minutes and refreshes warning overlays automatically.

**Climate-change scenarios**

Return-Periods toggle for SSP2-4.5 and SSP5-8.5 in the 2050s and 2080s using CMIP6 / LOCA2 rainfall scaling.

**3D streets and buildings**

Photorealistic 3D city model with extruded buildings and water surfaces, similar to the Texas A&M FlowsDT platform.

**Energy and critical infrastructure**

Overlay 60+ critical assets (substations, hospitals, data centers, fire stations) for cascading-impact analysis.

WHO WE ARE

# Research Team


## Dr. Binbin Wang

**Principal Investigator**

eFLOW Laboratory · Department of Civil & Environmental Engineering, University of Missouri. Research in computational hydraulics, flood modelling, and machine learning for water resources engineering.

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## Muhammad Waqar Saleem

**PhD Researcher**

eFLOW Laboratory · Department of Civil & Environmental Engineering, University of Missouri. Lead developer of the FloodGNN model and the mofloodwatch.me digital twin platform.



## Support and collaborators

- Supported by the Missouri Water Center target funding
- Computing resources: MU Hellbender HPC
- Field data: USGS, Missouri Mesonet (AgEBB), MU Aquatic Ecology Lab, NEXRAD
- Open-source built: PyTorch, FastAPI, React, Leaflet, Mapbox, HEC-RAS