Combining NHDPlus HR and Lidar for Improved Streambed Elevations in Agricultural, Suburban, and Urban Areas

The Montana Bureau of Mines and Geology,

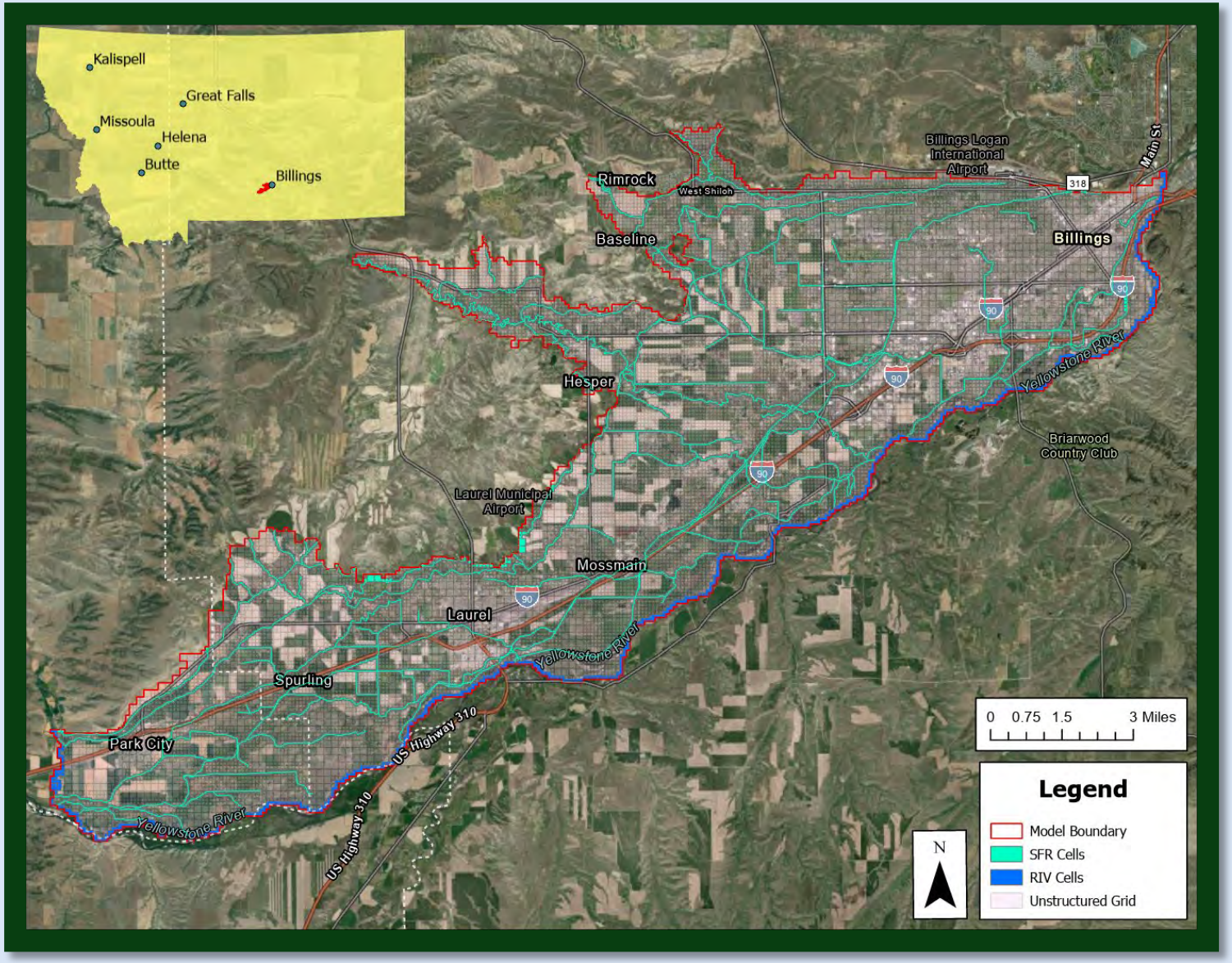
Ground Water Investigation Program

Photo: BBWA
Don Sasse

Brett Oliver,
Kurt Zeiler
October 09, 2025

Outline

- Project Overview
  - Motivation to study the Billings aquifer
  - Physical character of the aquifer
  - Billings Transient Groundwater Model
- Corrections to streambed elevation data for Stream Flow Routing (SFR) package
  - Problems with existing elevation products
  - Solution and Implications



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Motivation

WSJ NEWS EXCLUSIVE

Montana Boomtown Jumps to No. 1 on WSJ/Realtor.com Housing Market Index

Rankings show how the housing boom has ignited homebuying in smaller to midsize cities around the U.S.

By Nicole Friedman Follow | *Photographs by Louise Johns for The Wall Street Journal*

July 20, 2021 5:30 am ET

Billings, Mont., is the new No. 1 on The Wall Street Journal/Realtor.com Emerging Housing Markets Index, boosted by its affordability and appeal to remote workers.

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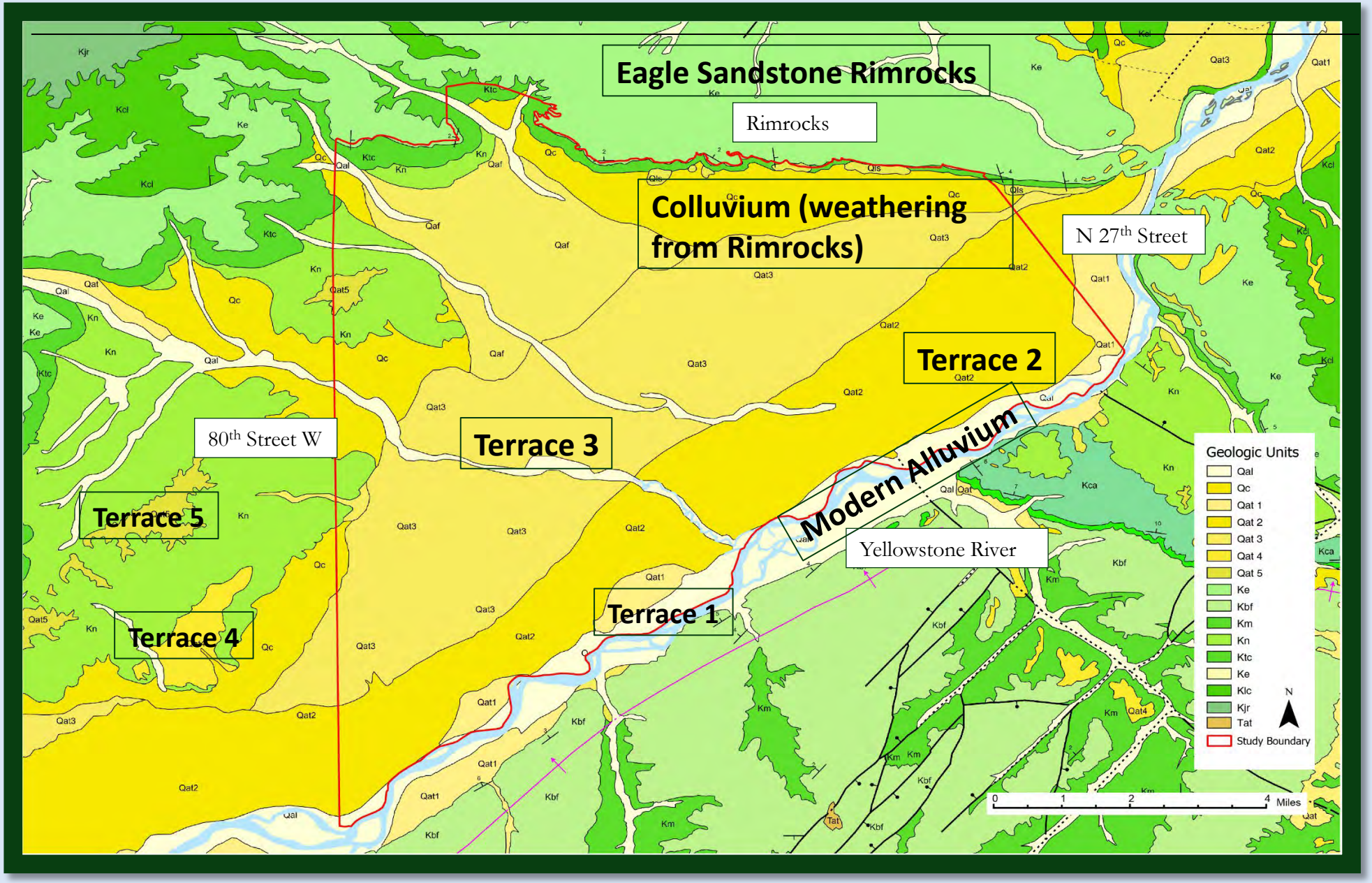
Billings Geology



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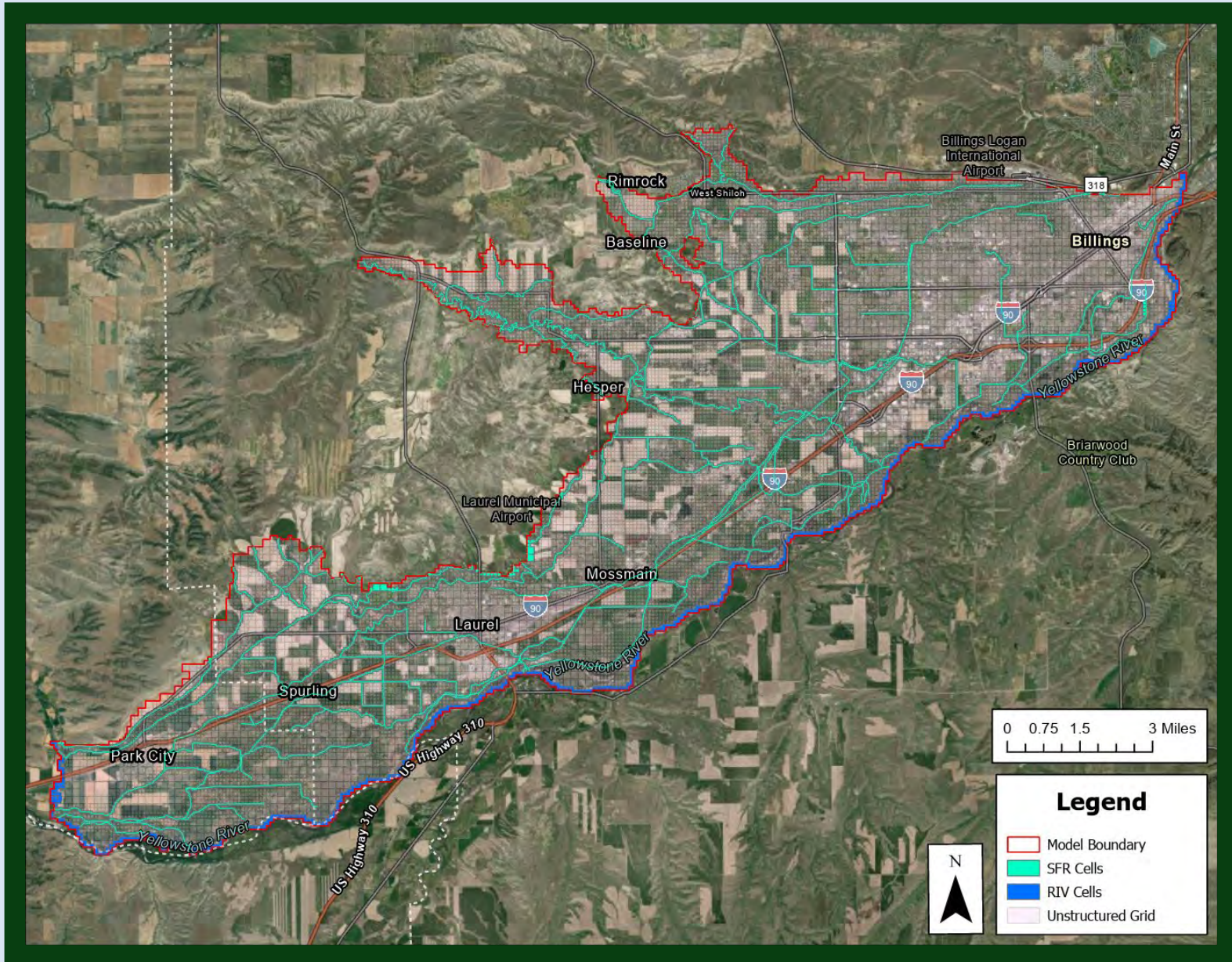
Transient Groundwater Model

- Solver: MODFLOW 6
- Unstructured Grid, representing 2-layers
  - Layer 1: 2-10’ thick fine gained sediment cap
  - Layer 2: ~15’ thick coarse grained sand and gravel overlying low permeability Colorado group shale
- Boundary Conditions
  - Evapotranspiration, consumptive well use, soil water balance, rivers, stream flow routing



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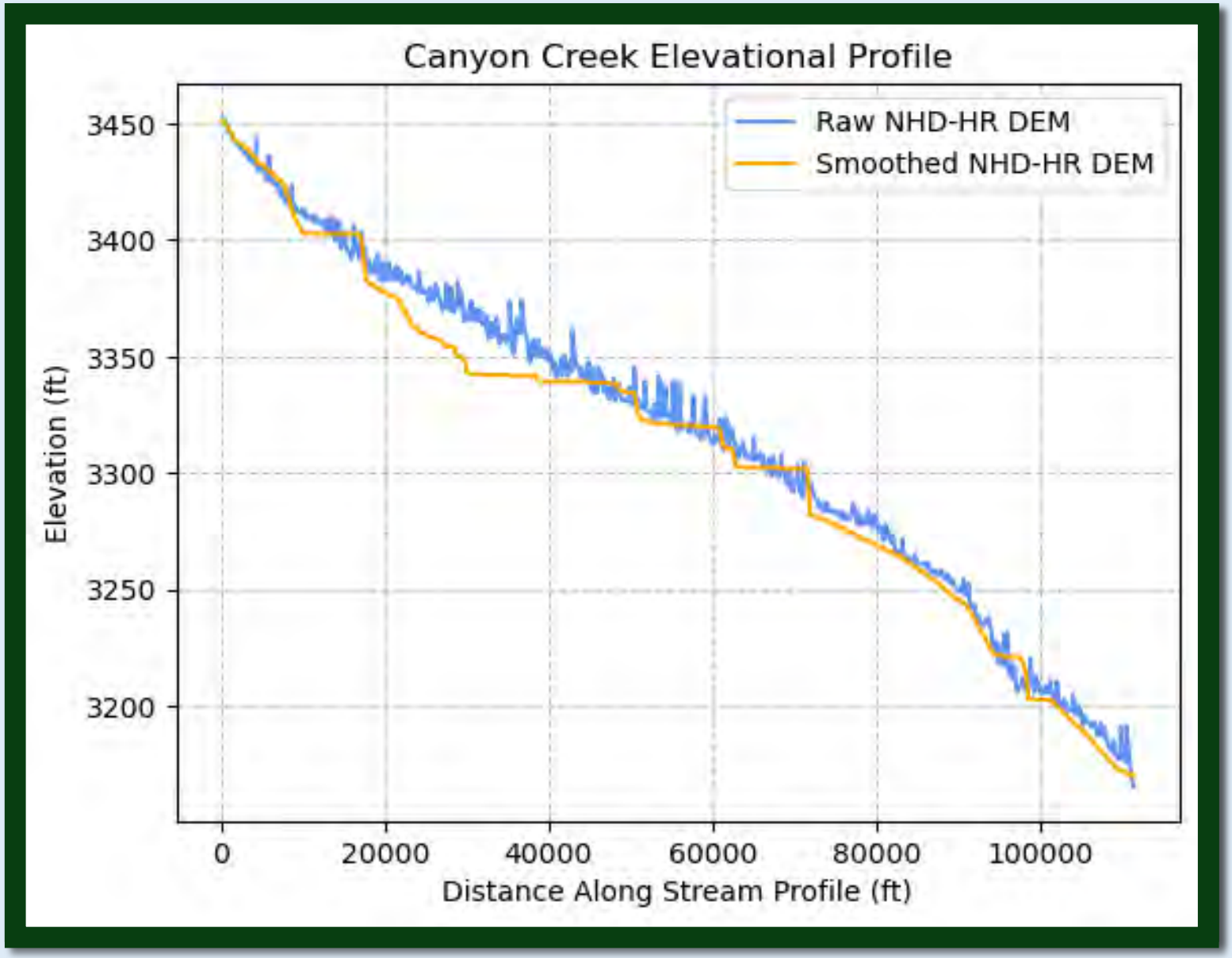
Streambed Elevation Errors

- Original NHD HD DEM doesn't accurately reflect streambed elevations
- Smoothing algorithm developed by the USGS for the SFRmaker Python library applies flat areas and drop offs to stream profiles



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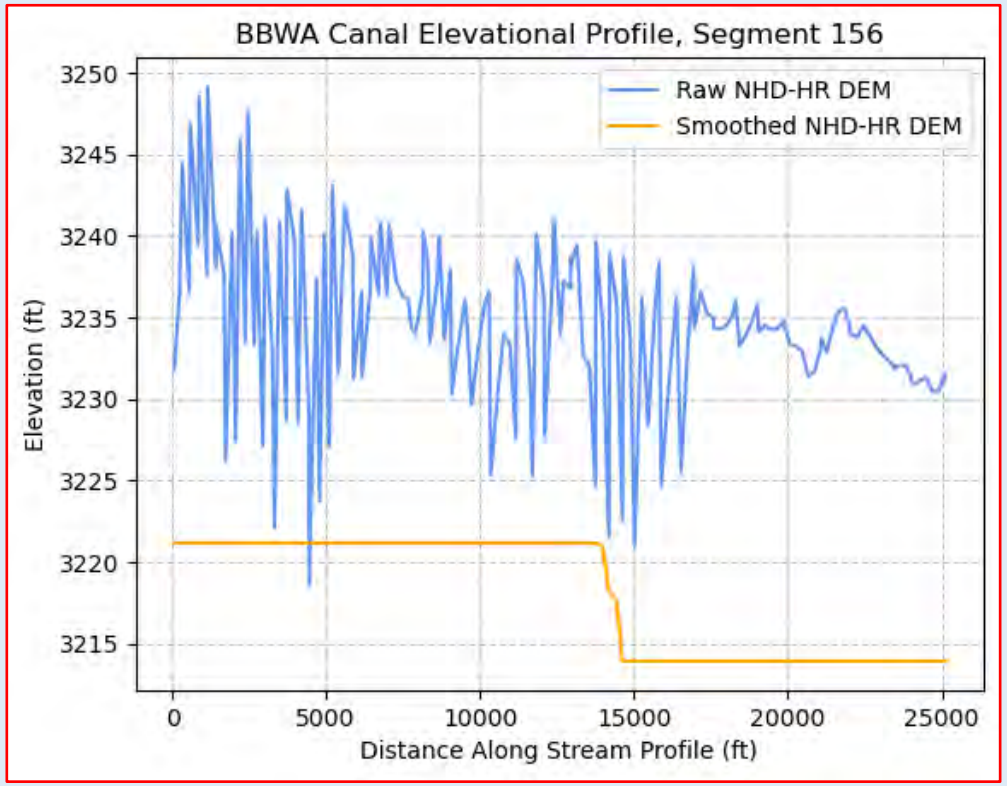
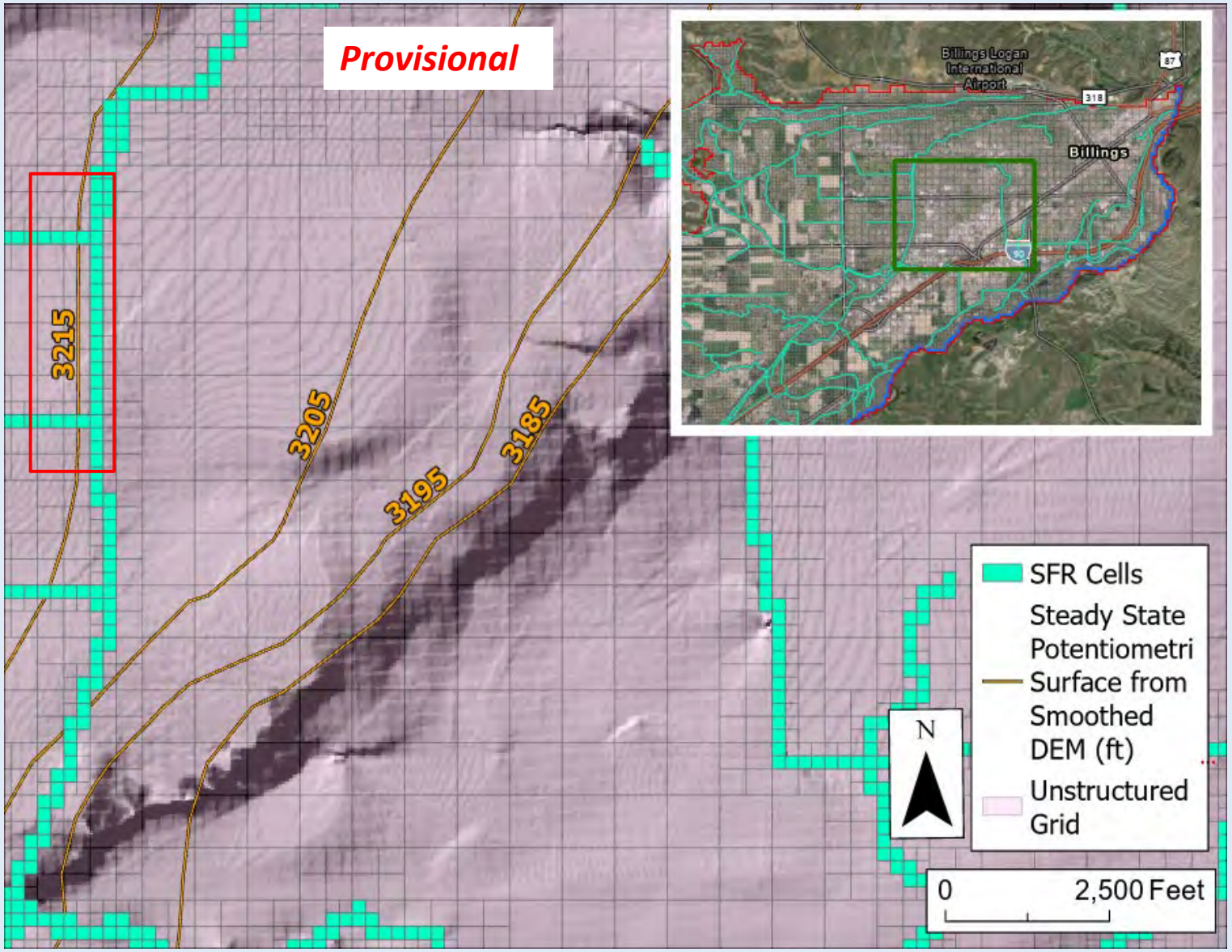
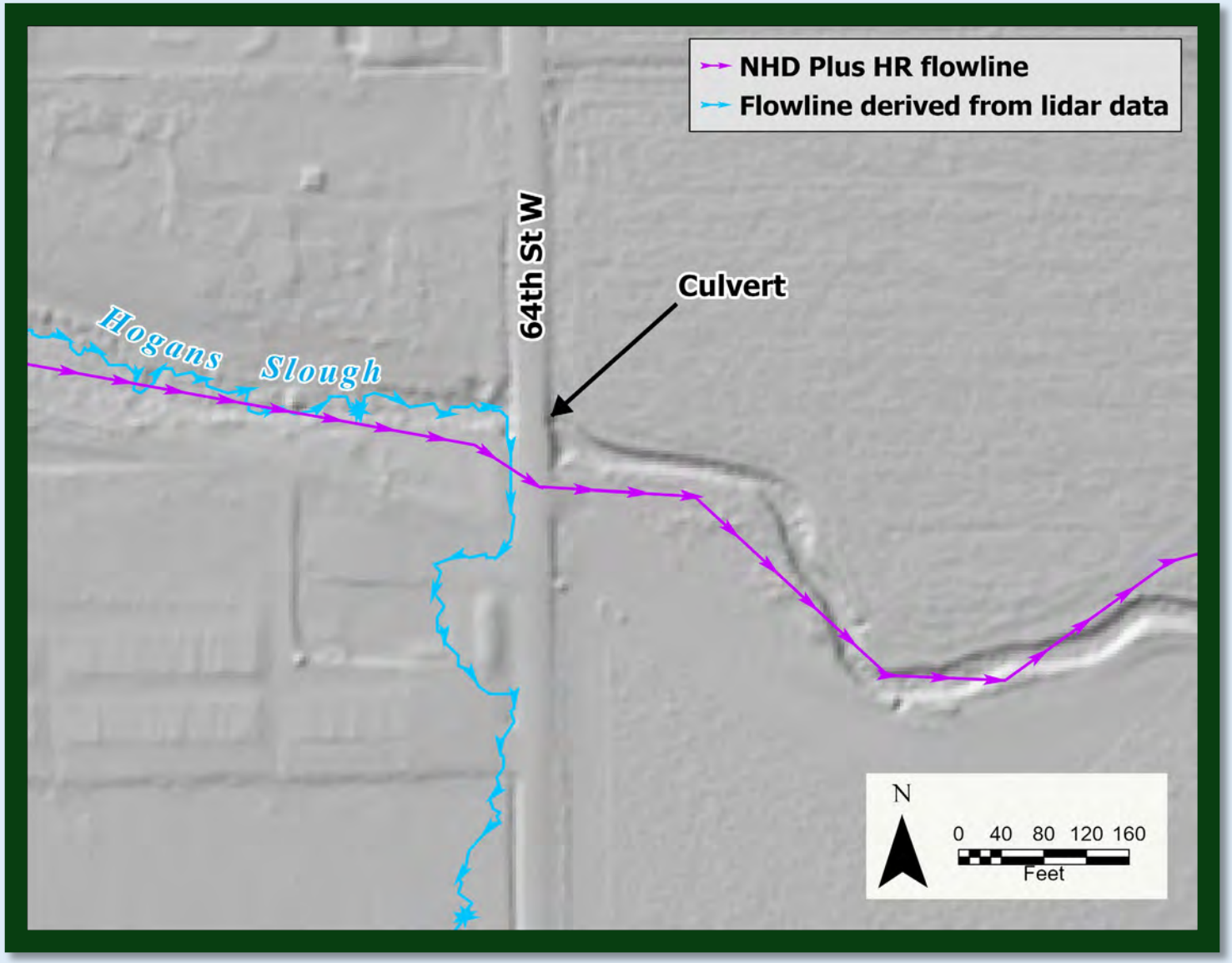
Flat Streambeds as Drains

- Groundwater contours parallel SFR features where flat streambed elevations are applied
- These areas act as drains, and allow too much infiltration





Lidar Misidentifies Routes



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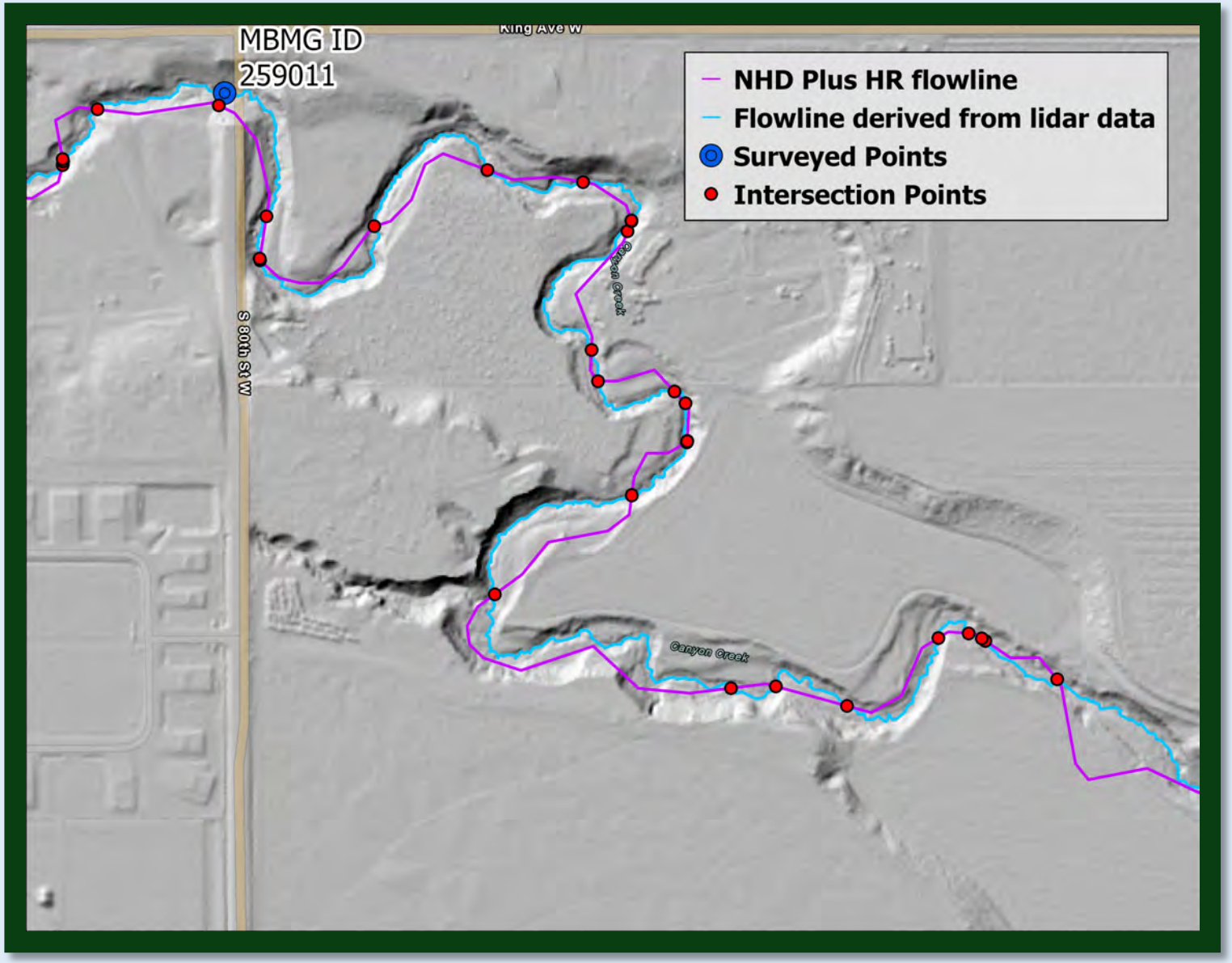
Solution

- Intersect NHD Plus HR Flowlines with Lidar derived flow lines and surveyed points
- Extract the Lidar and surveyed elevations at these points
- Linearly interpolate elevations between points
- Resample elevations to grid with weighted averages



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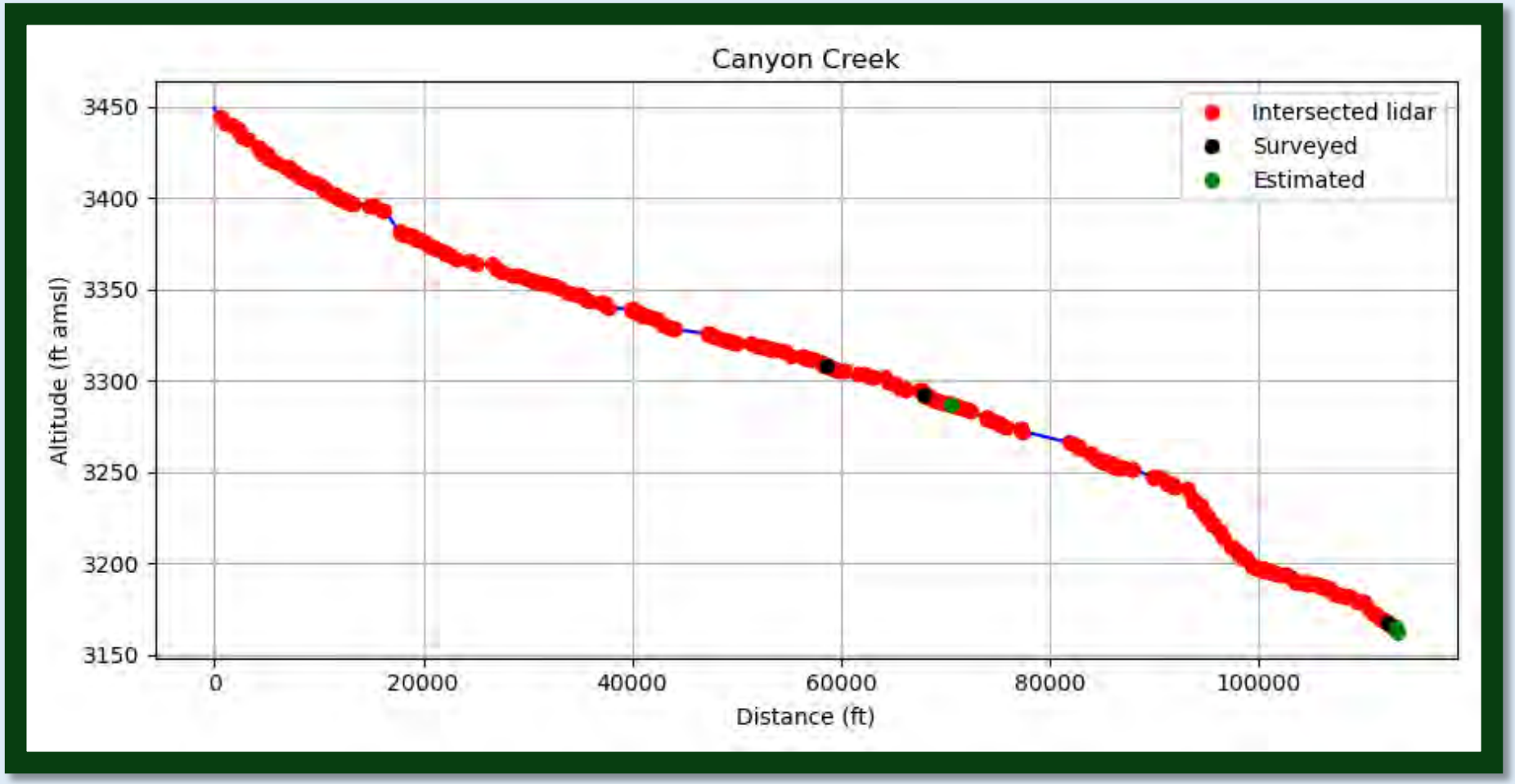
Solution



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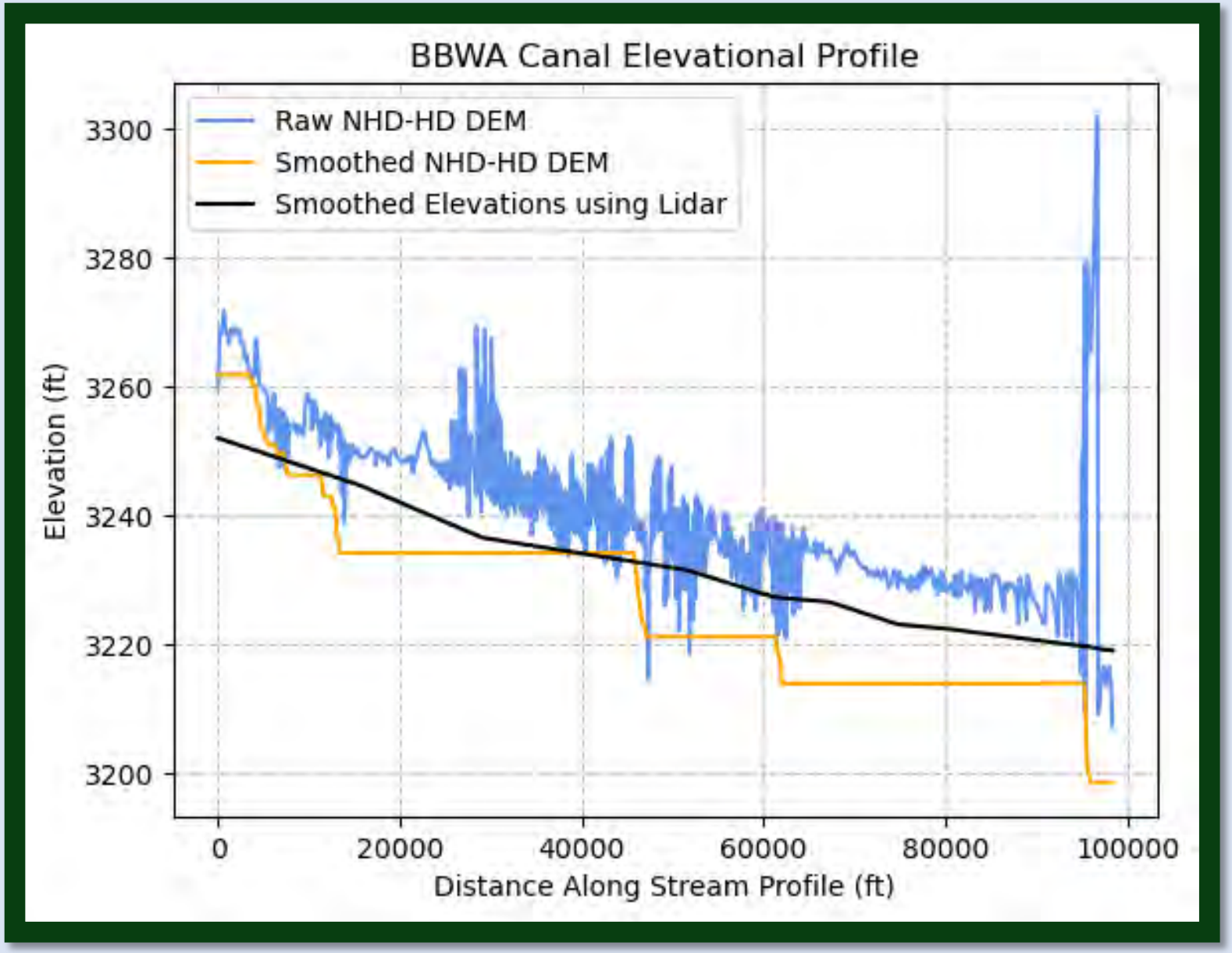
Linear Interpolation with Lidar



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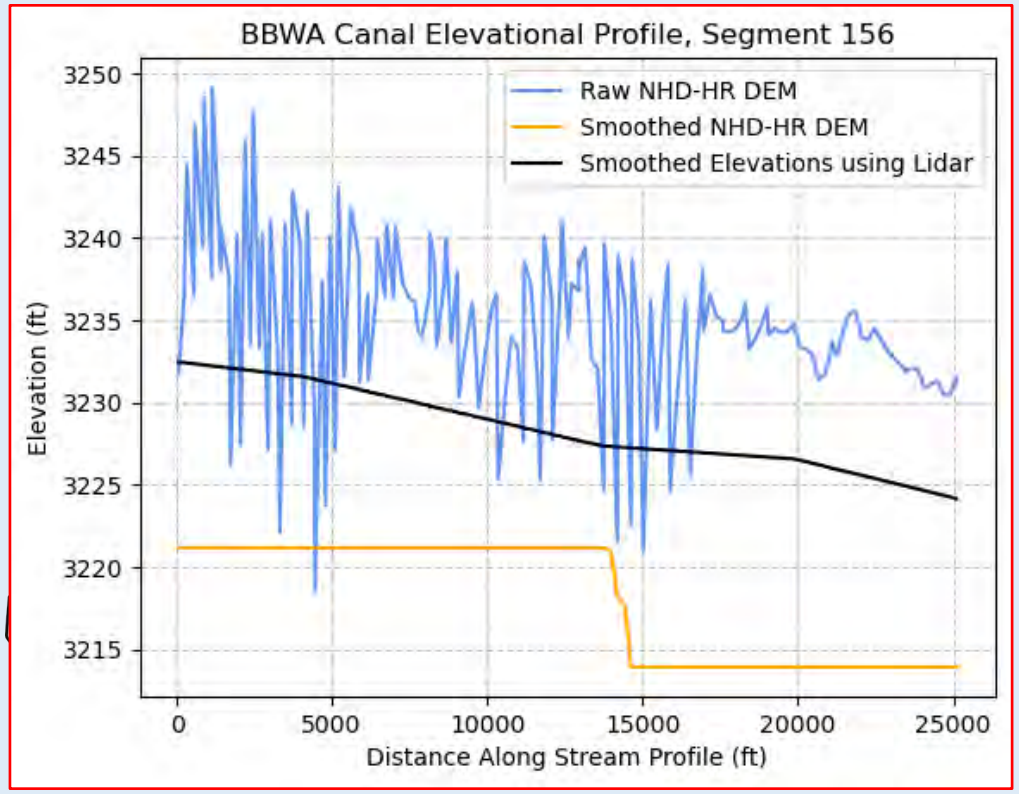
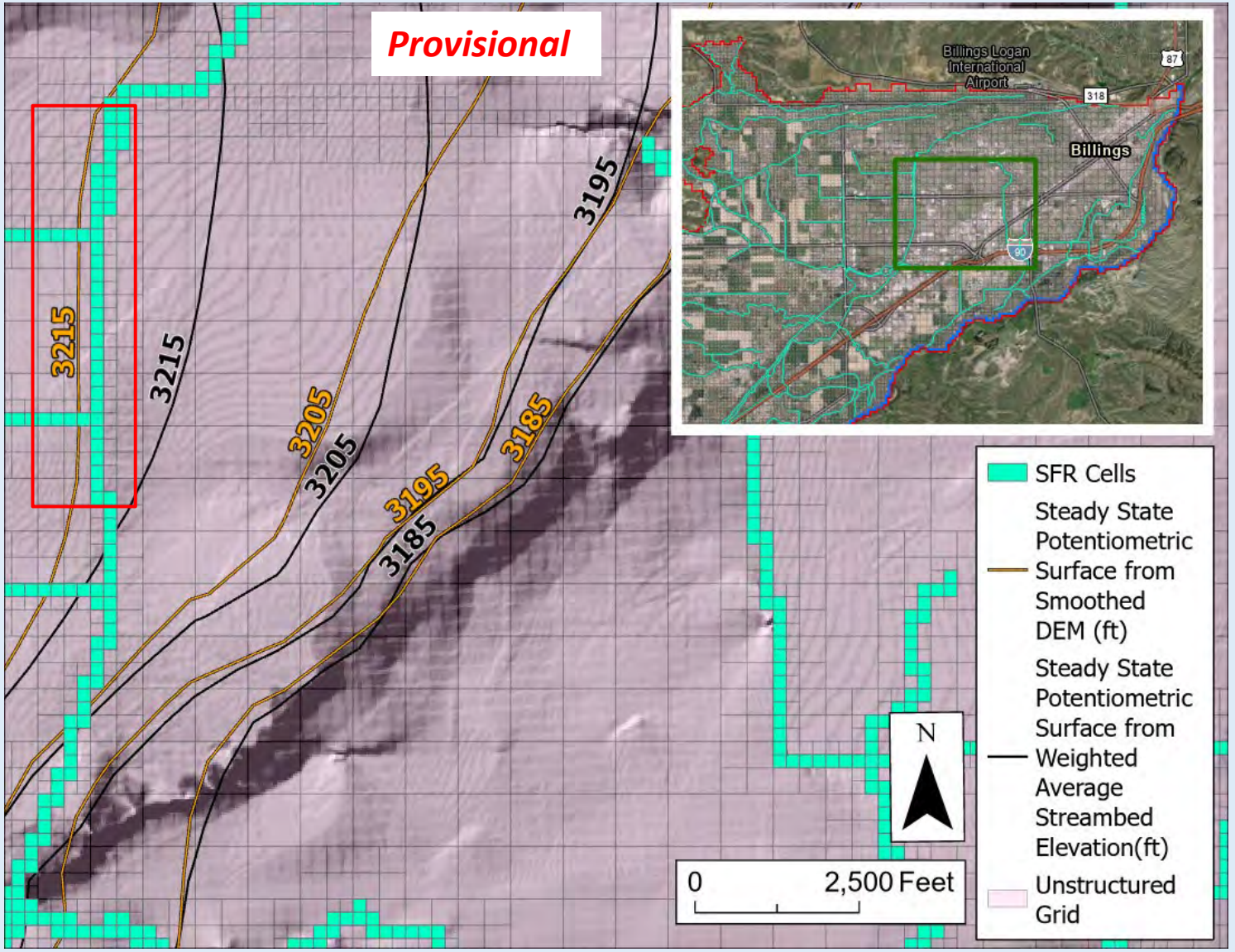
Linear Interpolation with Lidar

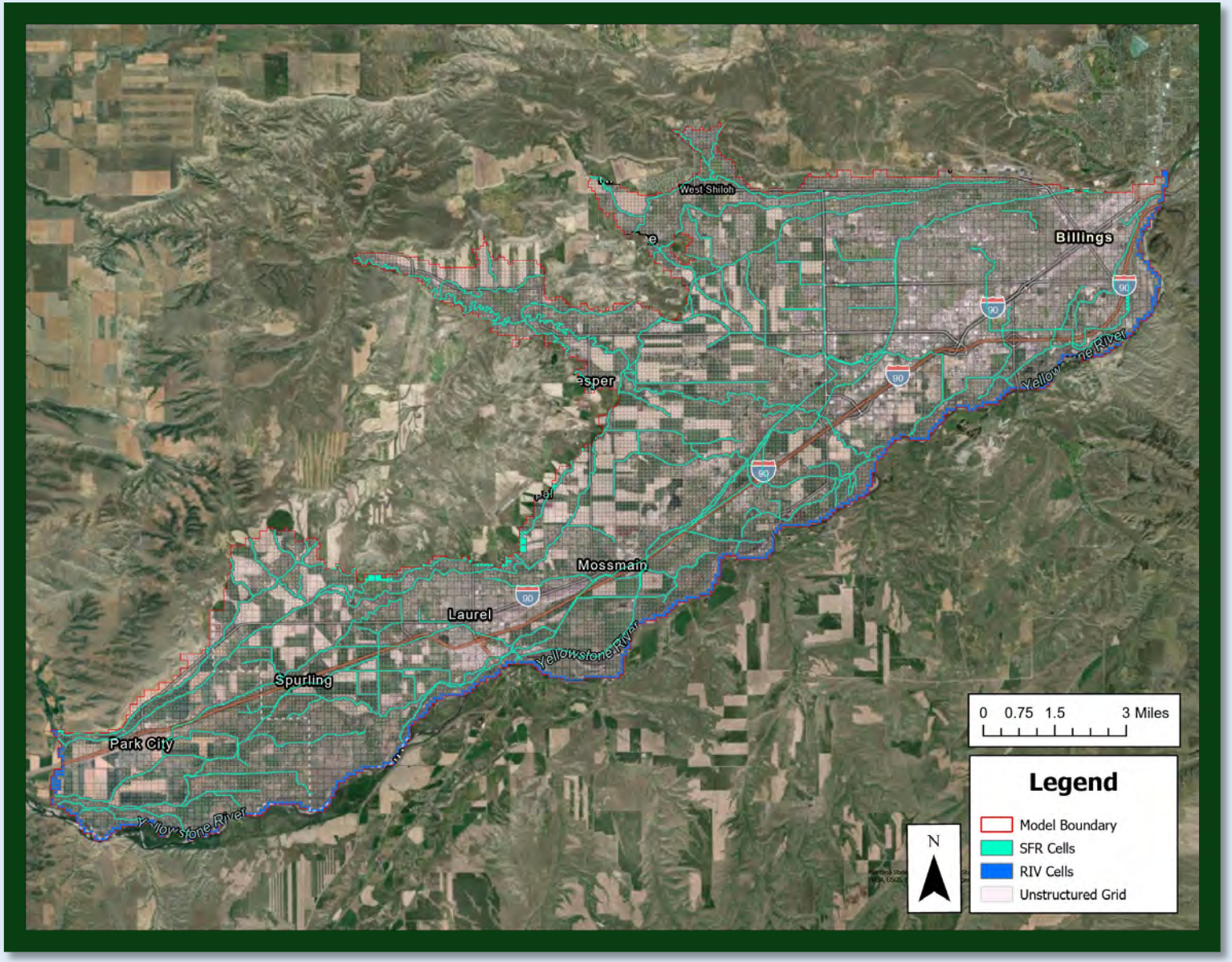
- Removed flat areas (sinks), resampled to unstructured grid using weighted averages
- Potentiometric contours are hydrologically reasonable
- Convergence for transient simulation





Conclusion

- Stream bed elevation smoothing is easily deployable in areas with Lidar, surveyed elevations, and NHD plus HR data
- Helped transient groundwater models with SFR boundary conditions converge
- Stop gap measure until the NHD 3D data set is released for a given area



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Billings Team

Skye Keeshin

Shawn Kuzara

Liddi Meredith

Todd Myse

Matt Smith

Catch Kurt Zeiler's talk at 4:35 in this session

Kurt Zeiler

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