Mapping Wetland Probabilities For Tribal Communities: Tools, Models, and Applications

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National Association of Wetland Managers
EPA CWA Training Meeting
March 2024

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Who Are We?

Three Affiliated Tribes:

- Mandan, Hidatsa and Arikara

- Independent with distinct histories unified by life along the Missouri River
- A farming tradition along the Missouri floodplains and hunters accessing the bison herds of the plains
- Also a significant trading center with goods from as far as South America

Tribal Wetland Stewardship

"A culture that is intertwined with its natural surroundings"

"Our lives are aligned with the changing seasons"

"Dating back to the tribe's earliest years, environmental stewardship included wide-ranging efforts to protect, preserve, and conserve groundwater and surface water resources."

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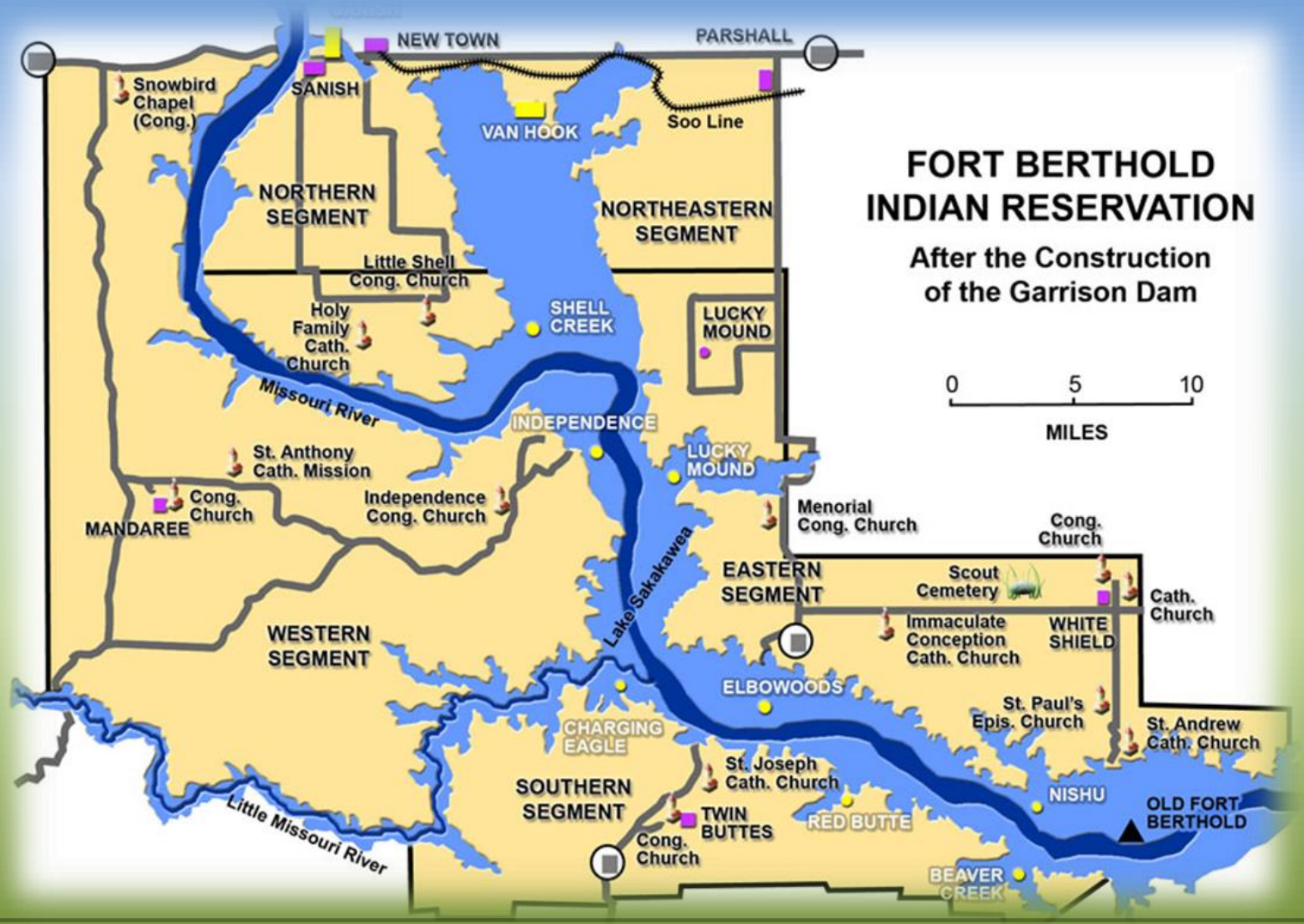
Historical & Cultural Context



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Historical & Cultural Context

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Bakken Oil Boom

- Oil boom began in late 2000's with advent of hydraulic fracturing and horizontal drilling
- Large influx of people, resources & money to Reservation
  - Improved/expanded infrastructure
  - Improved tribal government & public facilities, schools
- At peak of boom (2012), approx. 400 wells within Reservation boundaries
  - Millions of barrels/month
  - Unprecedented construction activities
  - Increased traffic → more accidents
  - Pipelines → leaks
- Spills/leaks of produced water, oil
  - Thousands – millions of barrels of produced water, oil released to environment in some incidents

Bakken Oil Boom

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Tribal Wetland Importance

A long history of wetland/water interactions:

- Tribal origin stories center on wetland plants and animals
- Fresh water supply for various activities
- Numerous tribal medicinal plants and building materials are hydrophytic
- Floodplains of rivers, streams and lake margins are often traditional agricultural areas
- Fishing from rivers, lakes and streams is a primary subsistence activity

Basic Wetland Management Questions:

- Where are the current wetlands
- Where were wetlands historically
- How are they connected to surface hydrography
- How are the functioning ecologically
- How might they be impacted
- Where should management effort and funds be focused

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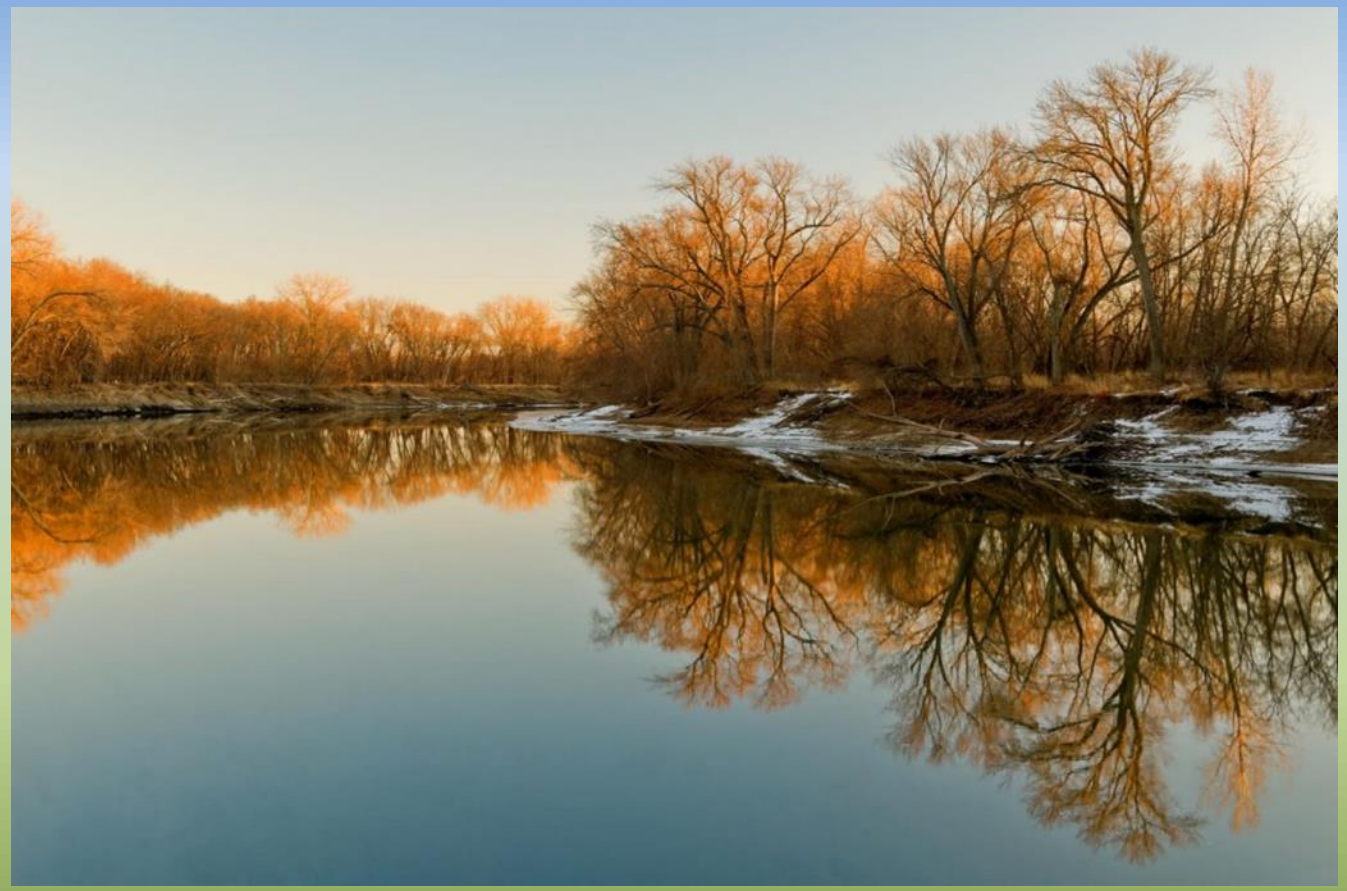
EPA Core Elements Framework



"The Foundation of Wetland Management and Protection"

1. Regulatory
2. Monitoring and Assessment
3. Water Quality Standards for Wetlands
4. Voluntary Restoration and Protection
5. *Tribal Ecological Knowledge*

Wetland Management Issues

Preservation:

- Focused on traditional uses:
  - Hunting and gathering
  - Medicinal plants
  - Cultural traditions

Restoration:

- Loss of historic floodplain
- Degradation through current activities
- Competing land use (e.g. agriculture, oil and gas)

Enhancement:

- Water quality, vegetation, groundwater recharge

Wetland Program Plan

- Funding: Wetland Program Development Grants, BIA grants, Tribal community funds

- Focus of specific Core Elements e.g. Monitoring and Assessment or Voluntary Restoration and Protection etc.

- Primary objective: assess, monitor, control, and protect the health, of tribal land wetlands and adjacent waters

Tasks:

1. Wetland inventory (NWI)
2. Hydrogeomorphic Classes
3. Wetland Functional Assessment
4. Potentially Restorable Wetlands
5. Identify Candidate Sites
6. Site Monitoring and Assessment
7. Improve Tribal Awareness
8. Engage Local Stakeholders

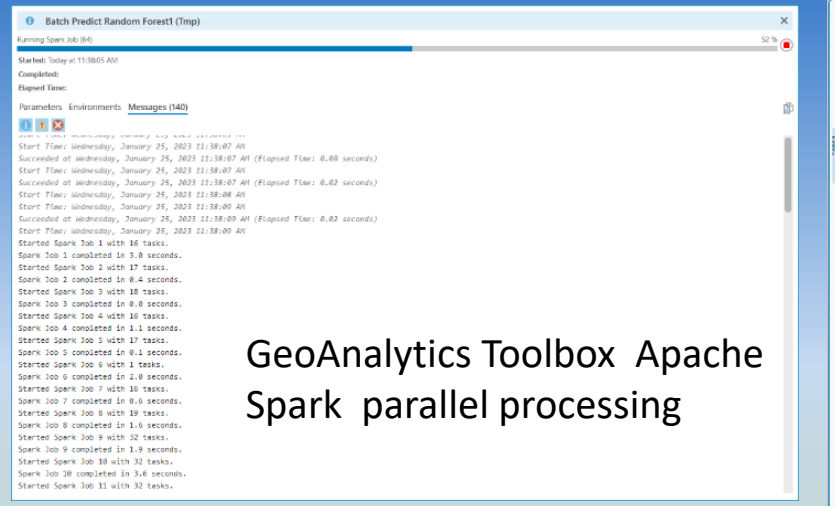
Wetland Program Plan

Key Goals and Objectives:

- Complete a baseline wetland and surface waters inventory
- Develop IBI based assessment of species guild and vegetation data
- Document reference sites or desired future conditions
- Identify/protect unique and high-quality wetlands
- Identify/protect culturally significant or important wetlands and waters
- Identify degraded or imperiled wetlands
- Return as much vegetation as possible to native species
- Protect specific species with cultural significance and RTE status:
  Field mint, Sweetgrass, Native turtles, Whooping crane
- Understand land-use and land-cover change impacts on wetland loss

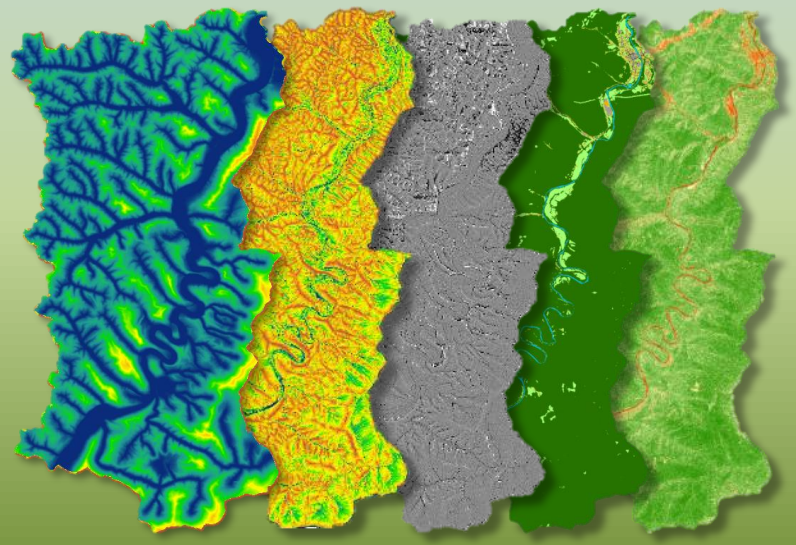
Potential Wetland Landscape Modeling

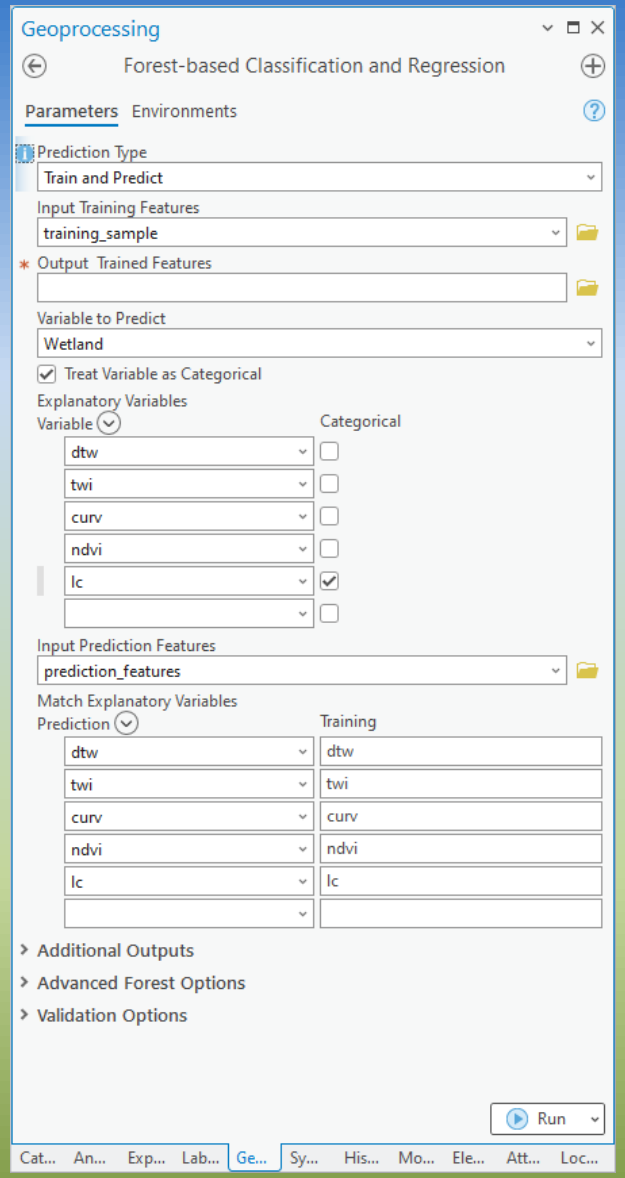
- Machine learning Random Forest algorithm using lidar derived predictor variables, NDVI and high resolution landcover.
- Based on Wetland Identification Model (WIM) processing methods in Arc Hydro – Gina O'Neil
- Modified WIM process to iteratively process multiple HUC12s for larger geographic areas and to overcome processing limitations.
- Processed large areas of VT (120 huc12s) and WV (360 huc 12s).
- Experimented with other predictor variables such as SSURGO, local land cover etc.
- Less accurate in agricultural and developed areas where hydrography has been modified.



GeoAnalytics Toolbox Apache Spark parallel processing

DTW TWI CURV LC NDVI





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Potentially Restorable Wetlands

- Narrowed the wetland data layer to identify areas of focus for restoration
- Based on landscape level indicators derived from
  - DEM
  - SSURGO (hydric, spring ponding, summer flooding, depth to water, etc.)
- Excluding existing NWI polygons

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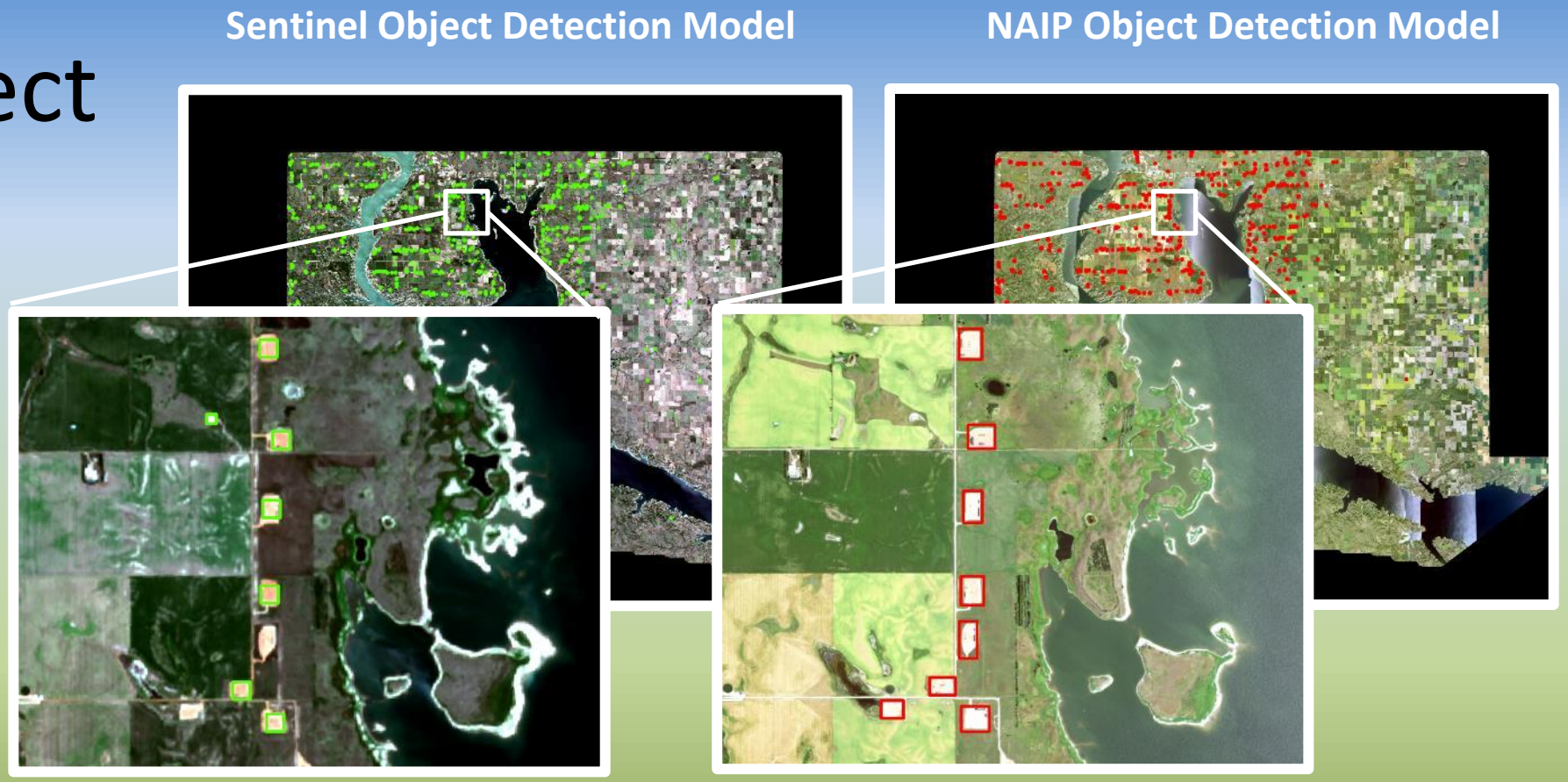
Deep Learning, Oil Well Pad Object Detection

- Utilized pretrained oil well pad detection model for Sentinel data.
- Also created deep learning object detection model for NAIP imagery.
- Both models had issues with false positives and negatives but overall produce good results
- Combined model results for analysis



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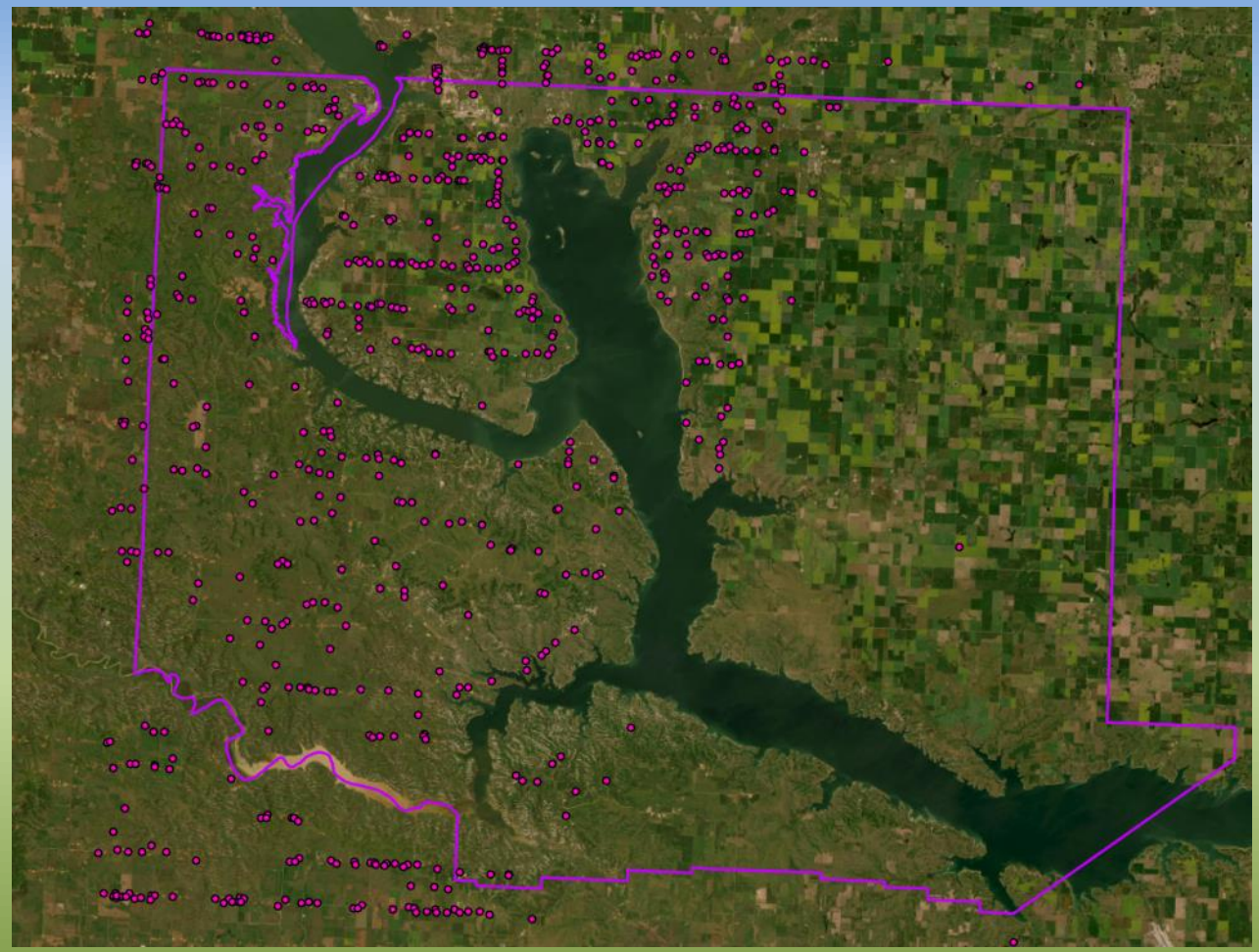
Oil/Gas Well Pad Identification

- 725 well pads were identified
- Concentrated on the west side

How do we analyze these well pads for their proximity to wetlands?



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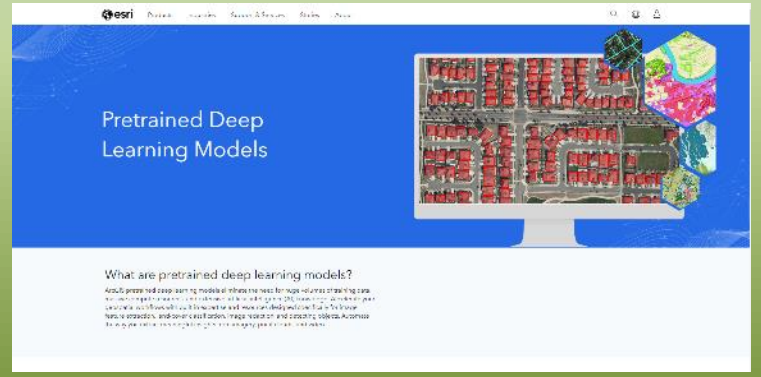
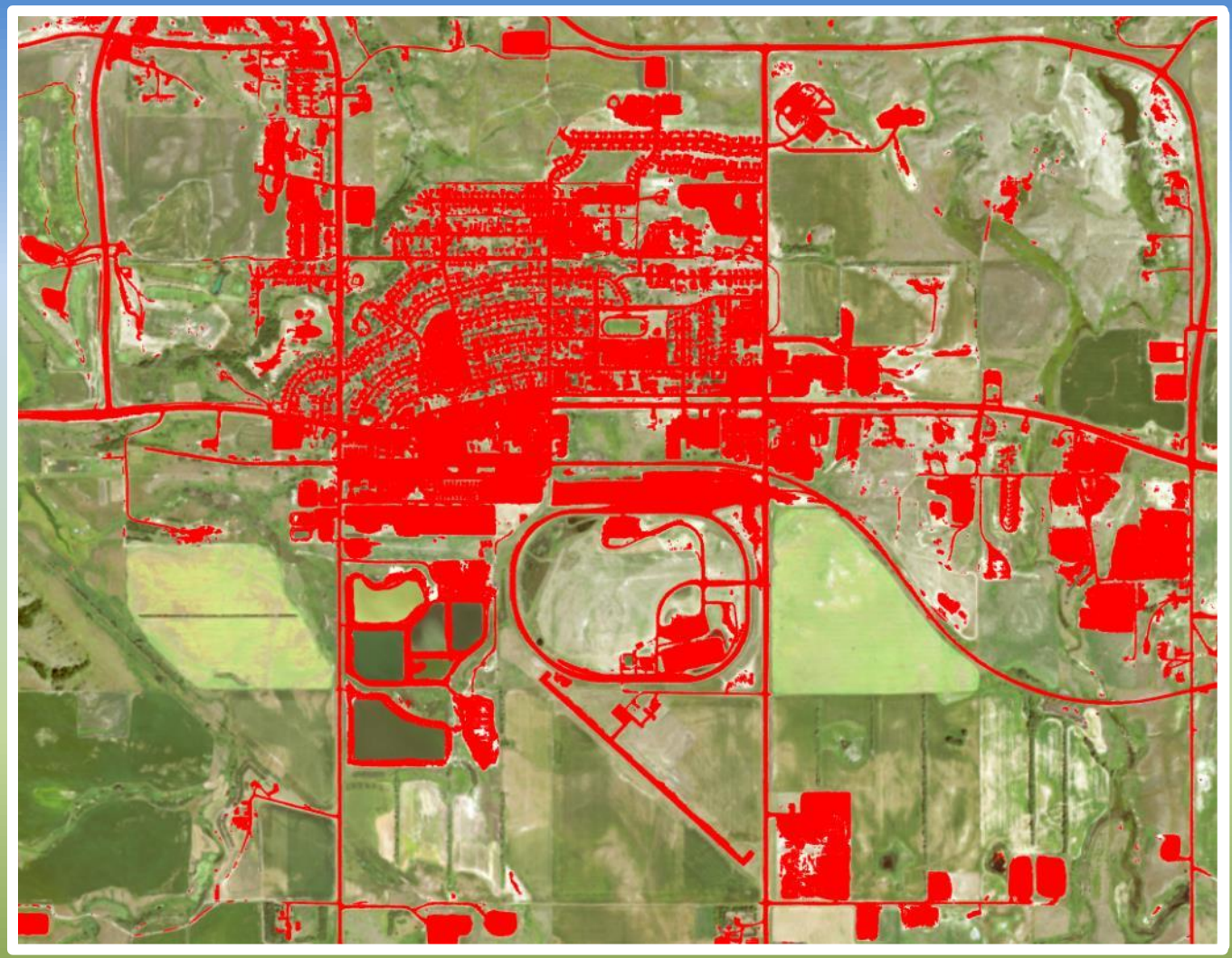
Deep Learning, Impervious Surface Extraction

- Pretrained ESRI deep learning model for pixel classification of high resolution imagery.
- Source imagery NAIP resampled to 1m
- Found that this model performs best in Eastern Temperate Forest biome but less accurate as you move into Great Plains biome





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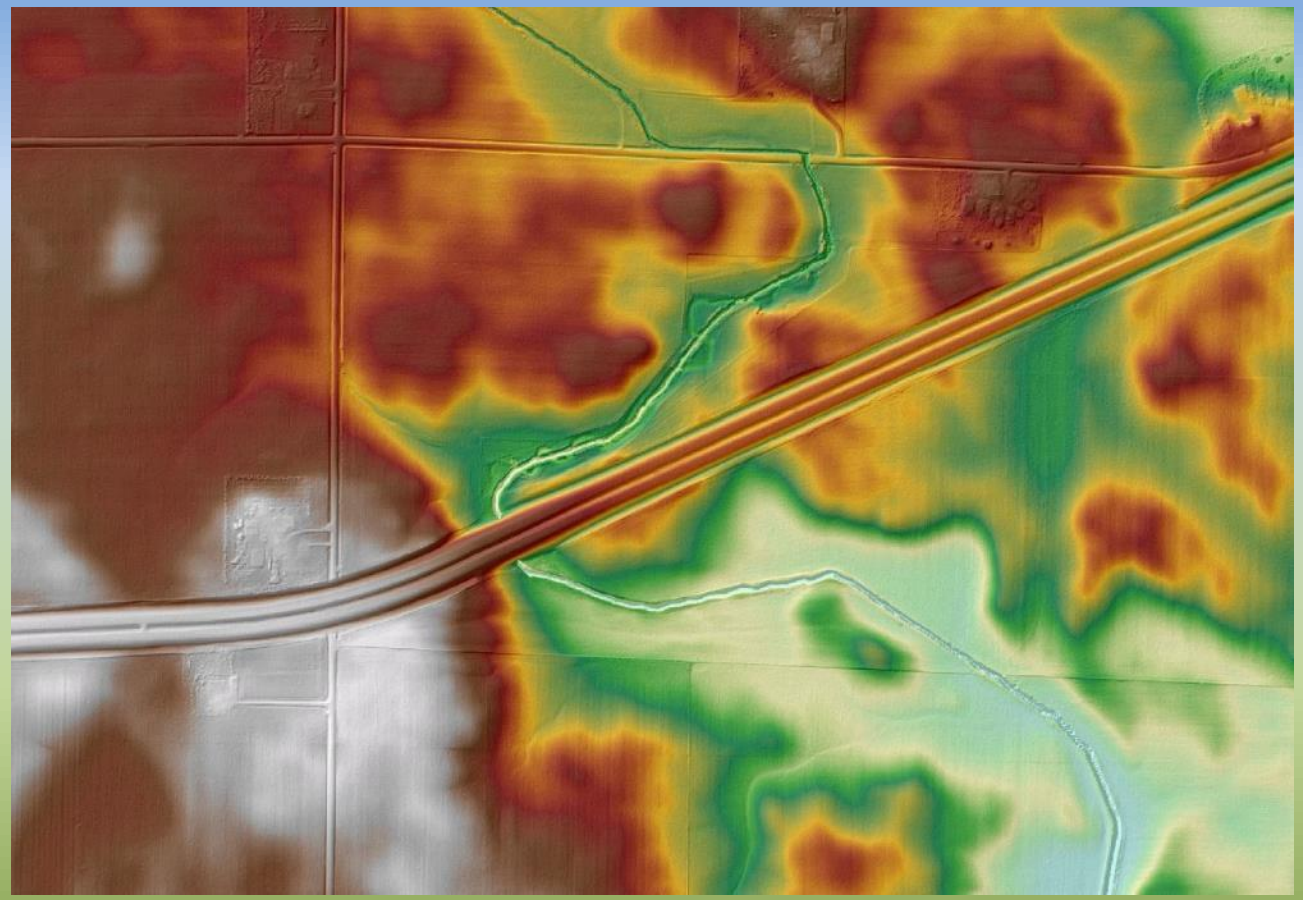
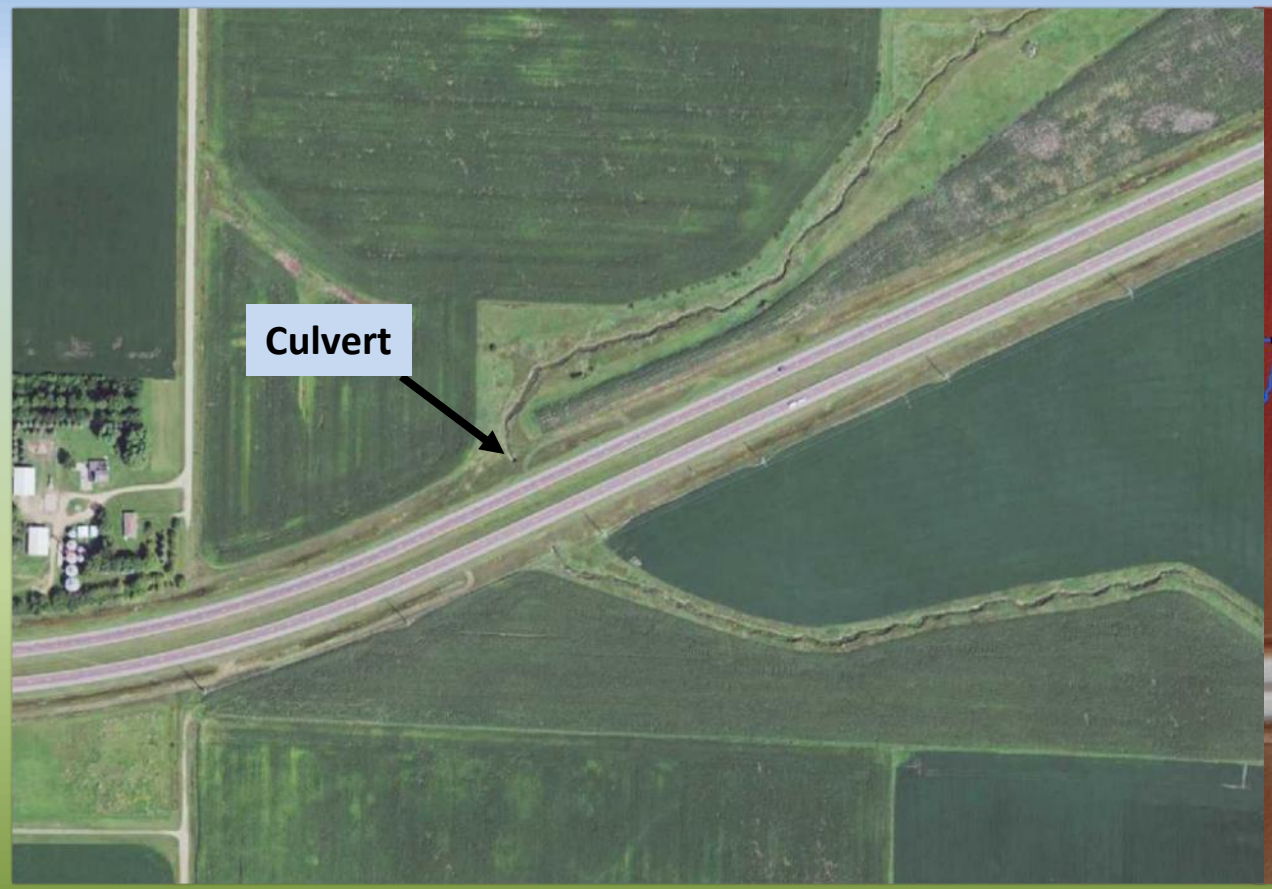
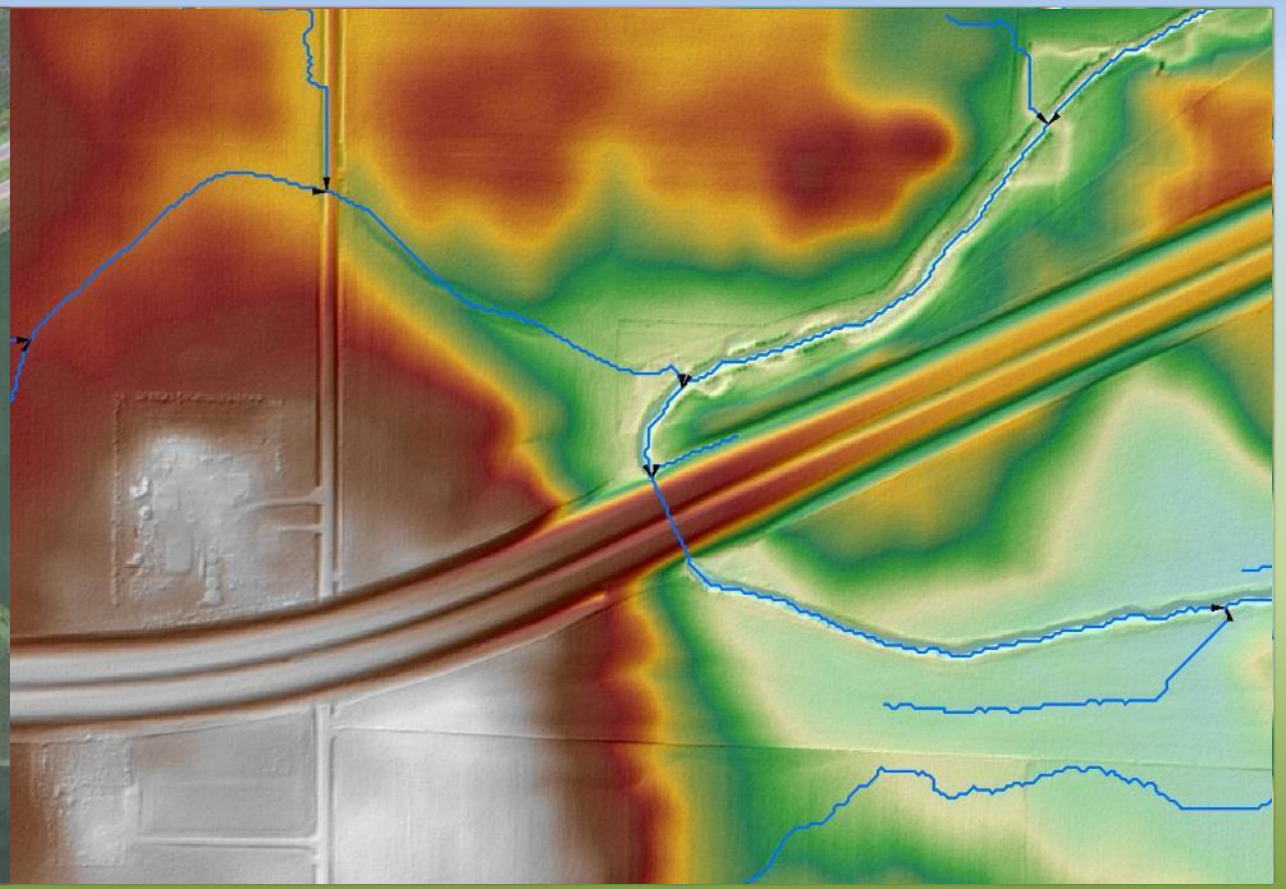
Hydro-Modification of DEM

- Goal is to create a contiguous surface that accurately models flow across the landscape.
  - Breach Digital Dams
  - Define accurate flow direction
  - Precision of flow lines



Digital Dams – Accurate Flow Direction





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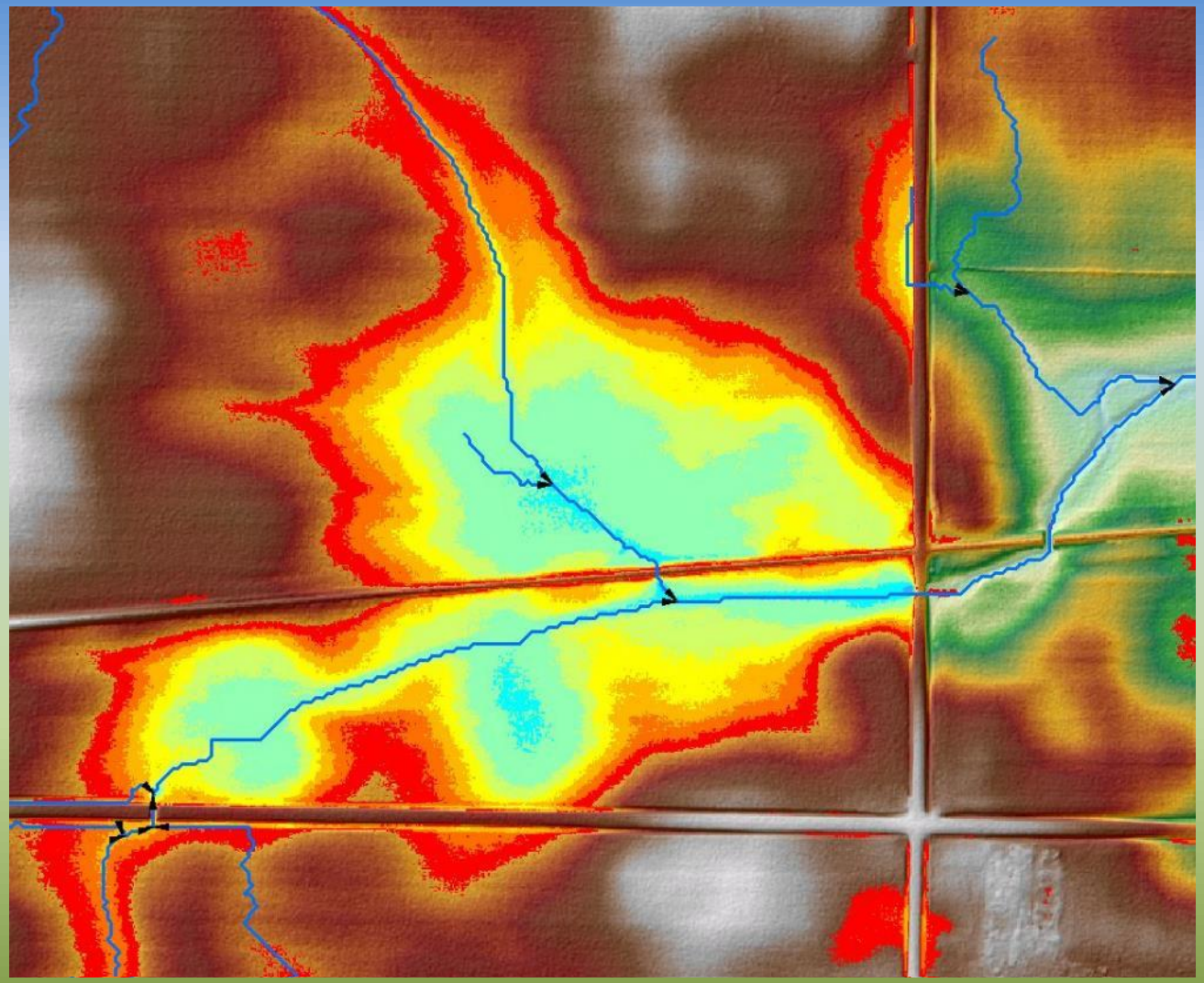
Accurate Flow Representation

- Enhance the precision of flow lines
- Accurate representation of surface flow
- Integrate with other spatially accurate data products

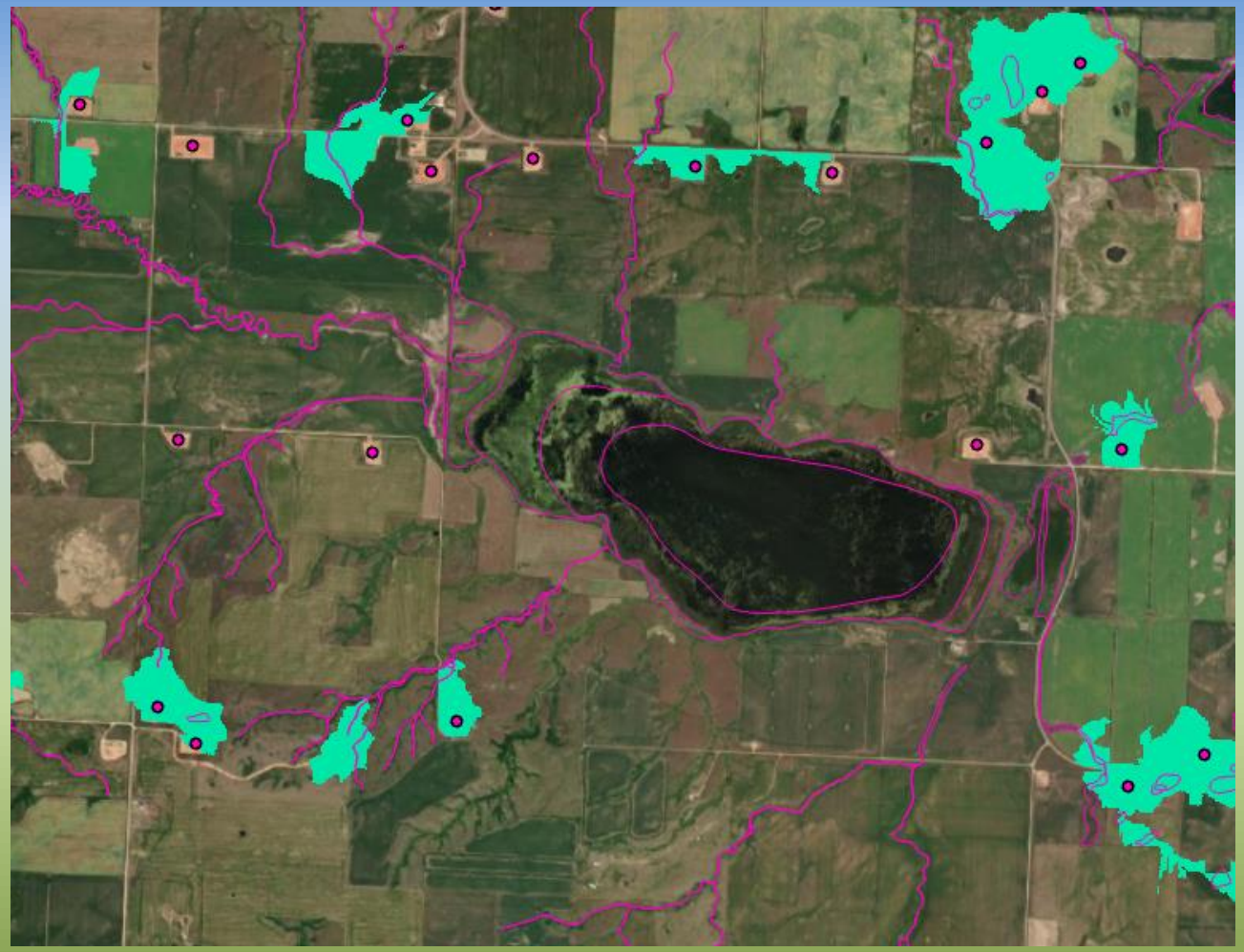


Why is this important for our assessments?

Oil/Gas Proximity Analysis

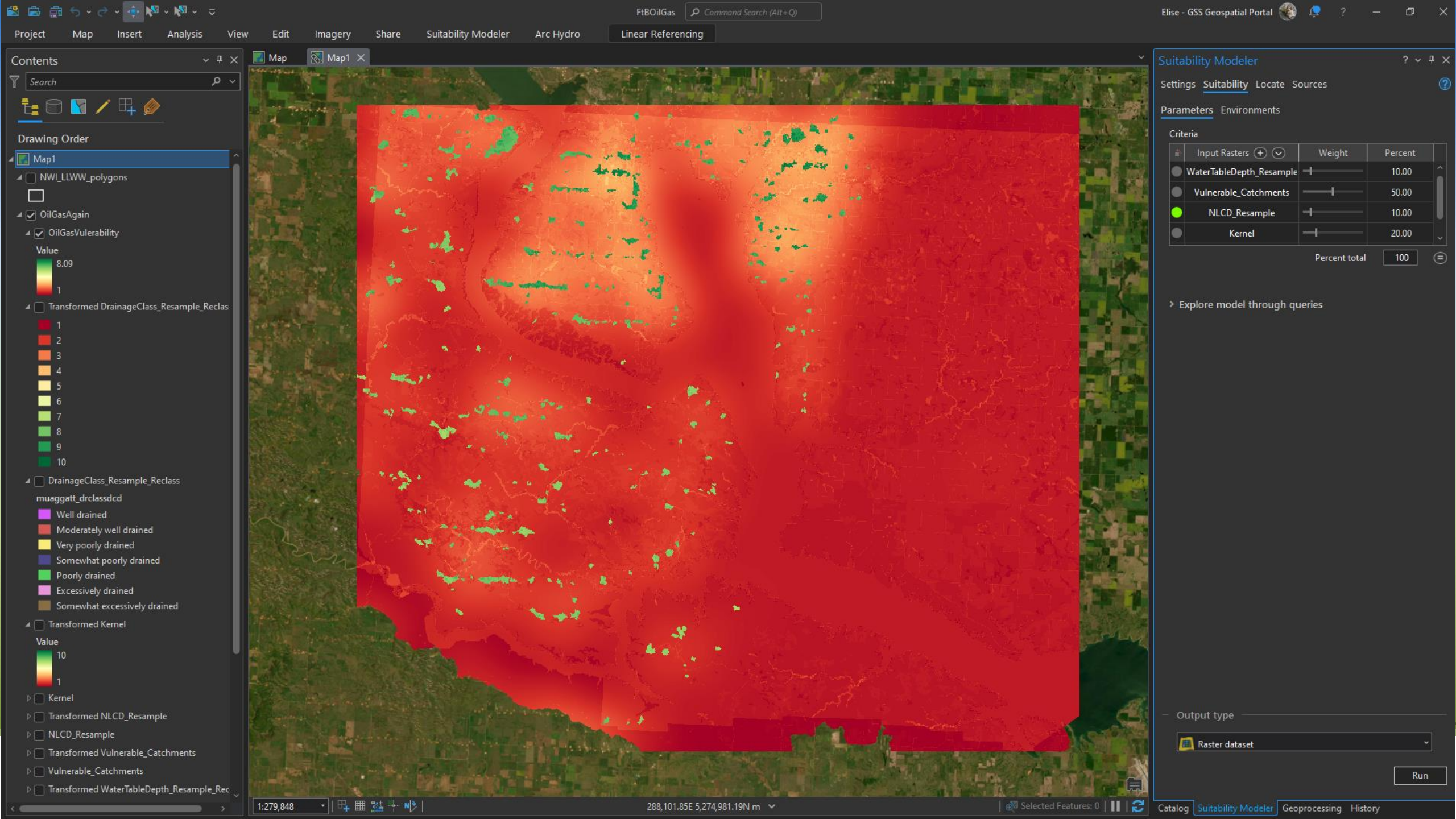
- 1- meter DEM, hydrologically modified
- Synthetic surface flow network
- Represents flow path and direction
- Pour points placed ~ 250 meters downstream and directly upstream of individual or groupings of well pads to identify potentially vulnerable catchments

What other landscape criteria are important to consider?



Wetlands Potentially Vulnerable to Oil/Gas

- Incorporated additional criteria variables in the vulnerability of wetlands to oil/gas
    - Proximity analysis – catchments
    - Proximity/Density analysis – kernel density
    - SSURGO – water table depth
    - SSURGO – drainage class
    - NLCD
- Used ESRI's Suitability Modeler within ArcGIS Pro to weigh criteria variables


FtBOilGas
Command Search (Alt+Q)
Elise - GSS Geospatial Portal
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Arc Hydro
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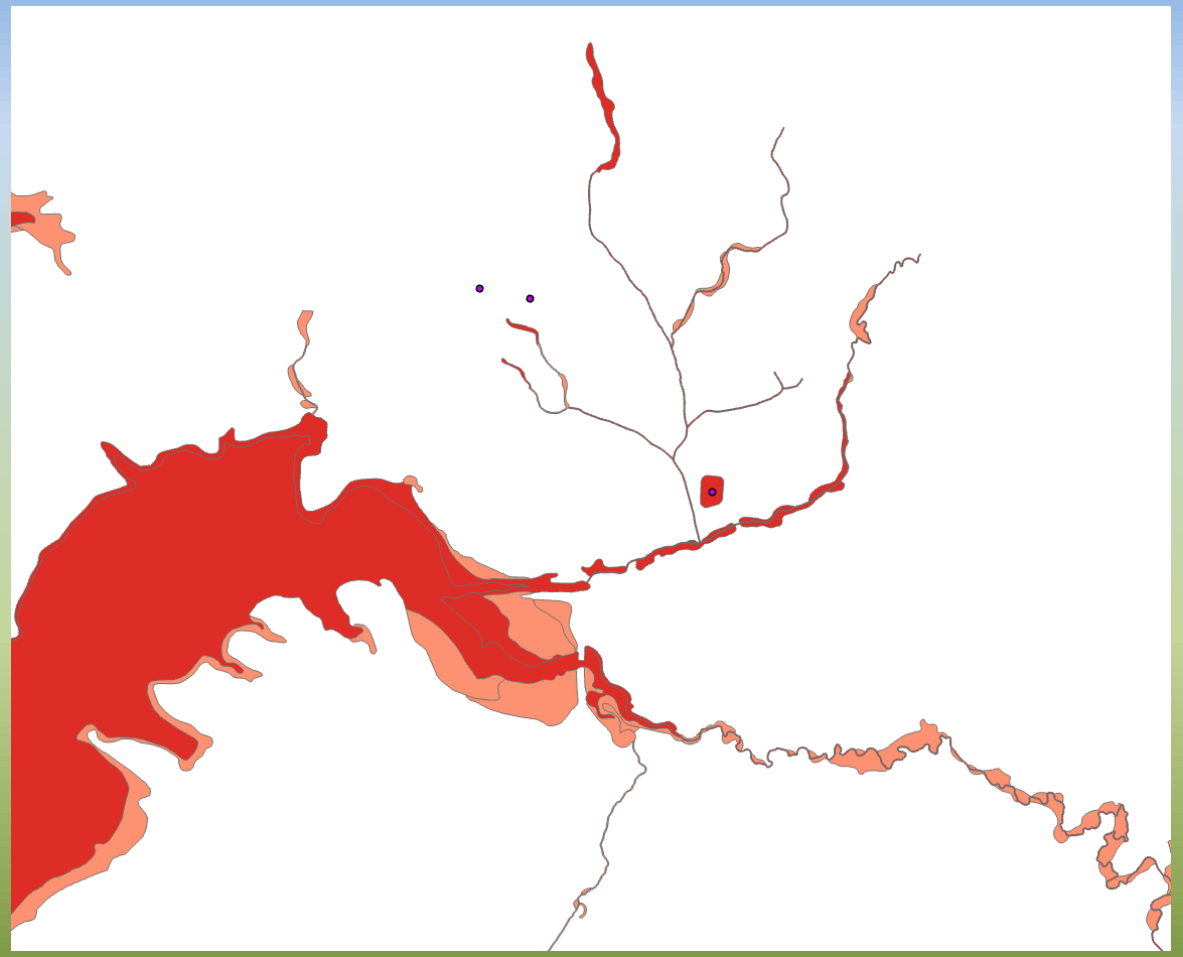
Selected Features: 0
Catalog
Suitability Modeler
Geoprocessing
History

Wetlands Potentially Vulnerable to Oil/Gas

- Created output showing wetlands of low, medium and high vulnerability to oil/gas impacts
- Three Affiliated Tribes may use this data to help prioritize protection/restoration efforts



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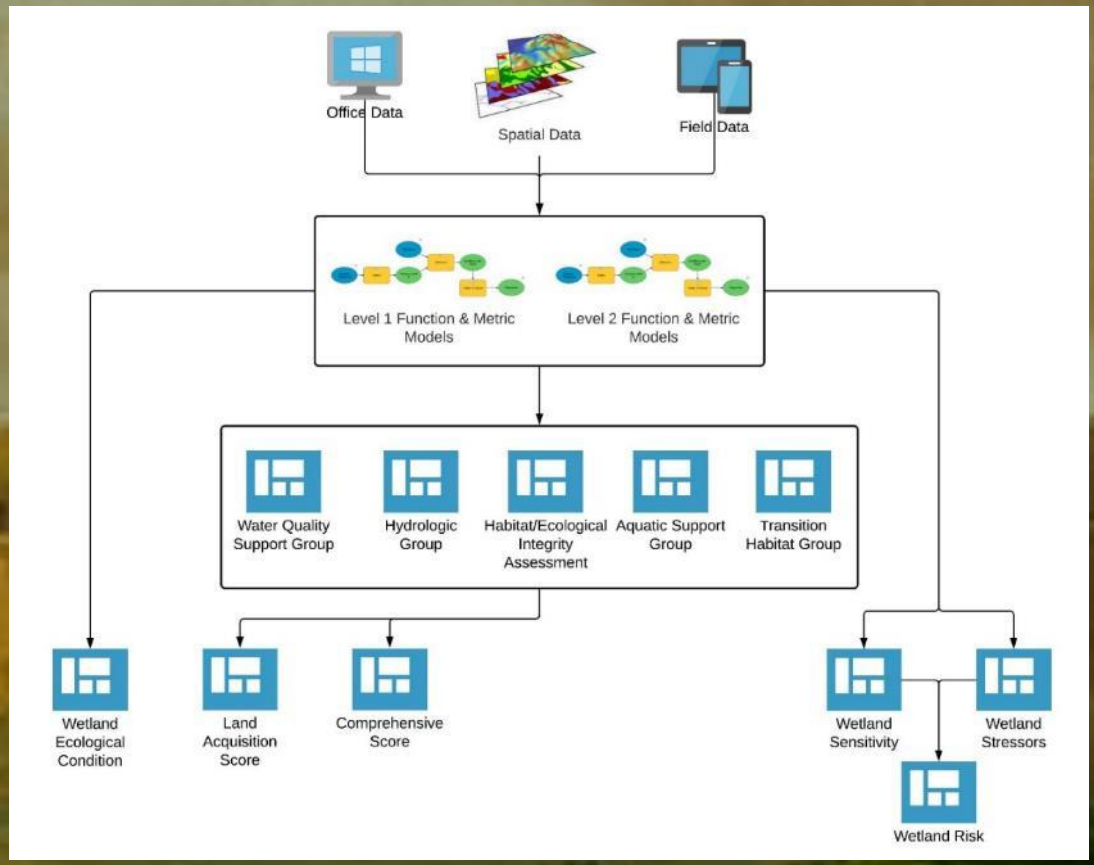
Wetland Rapid Assessment Method

- Quantitative Scoring of Wetland Resources
- Field and Office Based Metrics Assessed
- Survey 1-2-3 Field Application integrated with ArcPro
- 14 Different Wetland Functions Assessed
- Incorporates Cultural Significance and History
- Includes Curriculum for Engaging Tribal College and Youth



NUETA HIDATSA SAHNISH COLLEGE
Tribally educated; globally prepared.

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Questions?

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Wetland Program Development

"Meeting States and Tribes where they are"

- EPA - financial support and guidance for developing tribal wetland programs
- Published a common set of guidelines and program objectives
- Core Elements of State and Tribal Wetland Programs (2009) or the Core Elements Framework (CEF)
- Guidelines plus specific tribal goals and objectives = Tribal Wetland Program Plan