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*Managing Water in the West*

# The Technical Service Center's Involvement in the Yakima Basin to Improve Fish Habitat and Study Geomorphology

U.S. Department of the Interior
Bureau of Reclamation

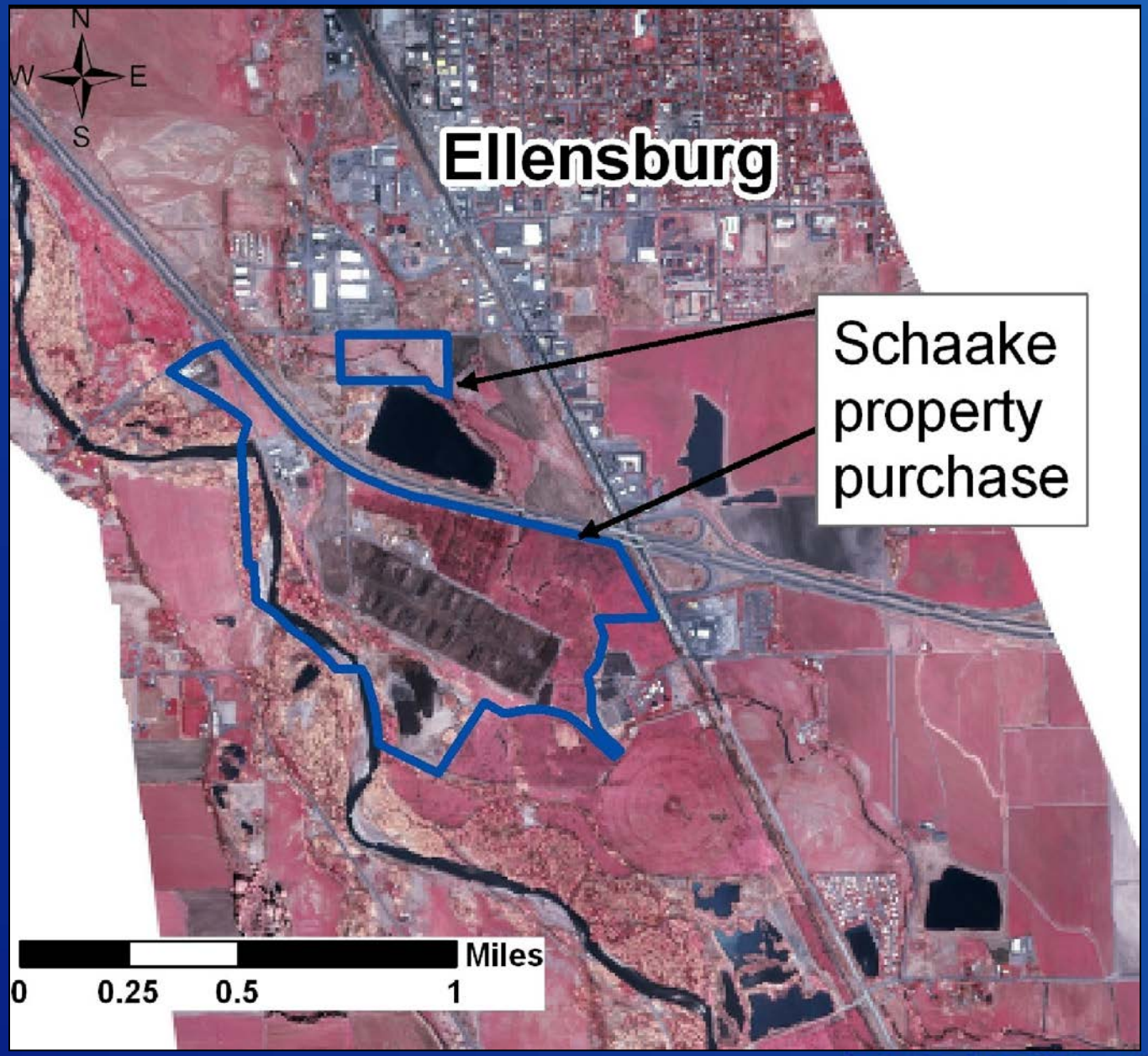
# Outline

- Kittitas Reach study for YRBWEP (Schaake Project)
- Water storage study for habitat inventory and geomorphology
- Advancements in bathymetric surveys
- Future studies related to gravel pits
- Sediment modeling with SIAM
- Conclusions

# Schaake Project

- Purpose – to improve habitat conditions and address potential flooding issues
  - Two reports to YRBWEP
  - Interim report detailing a geomorphic study
    - Included a historic and geomorphic study of previous channel forms and locations using 1912 survey and 1966 aerial photography
    - Determined the level of channel incision and anticipated frequency of floodplain inundation using a 1-D hydraulic model and 27 years of gage data
  - Final report detailing proposed levee setback and pilot channel locations
    - Three levee scenarios modeled in two dimensions to evaluate flooding
    - Smaller scale 2-D model to study interaction between pilot channels and main channel

# Schaake Project




Project Location

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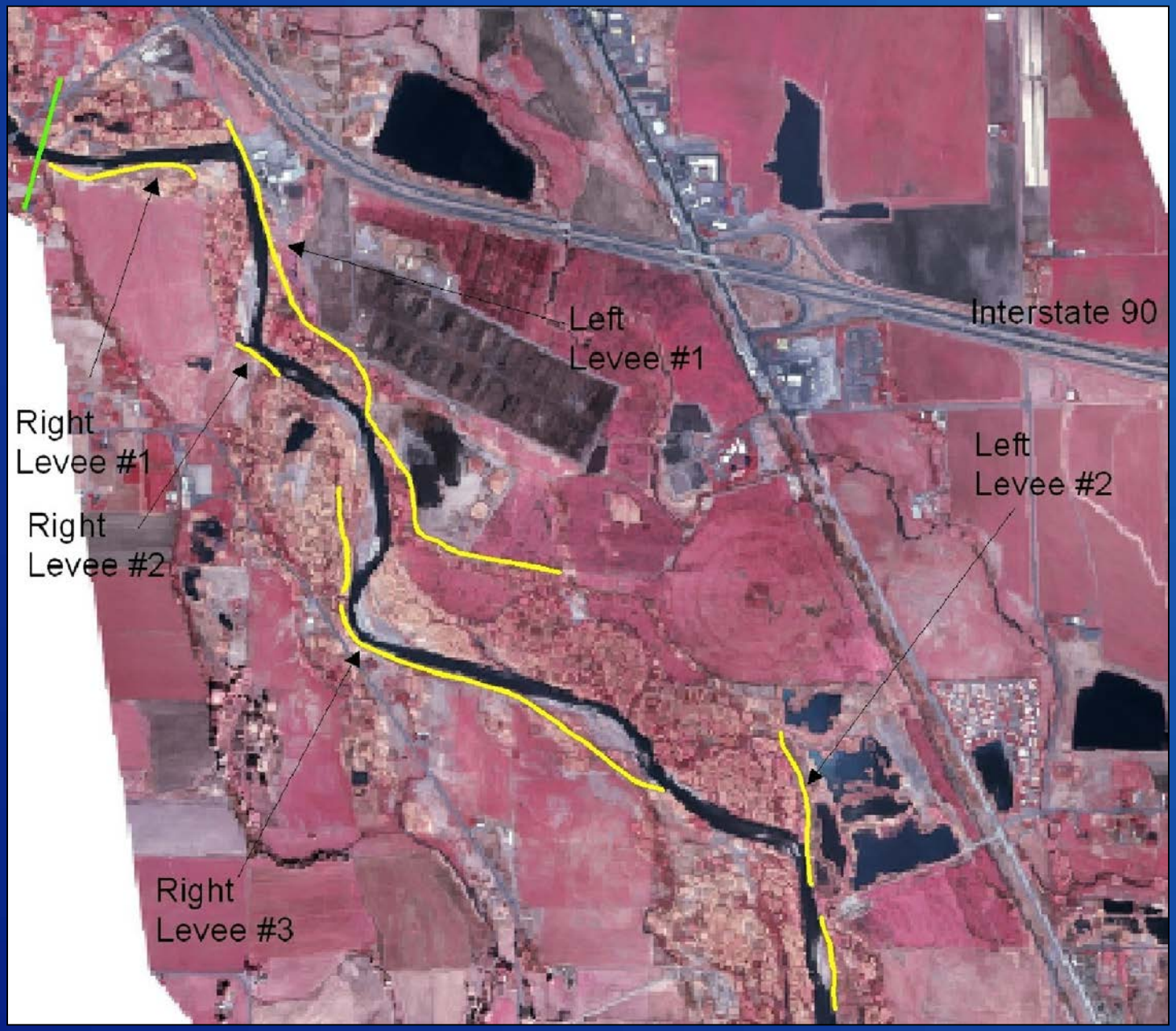
# Schaake Project




Existing conditions

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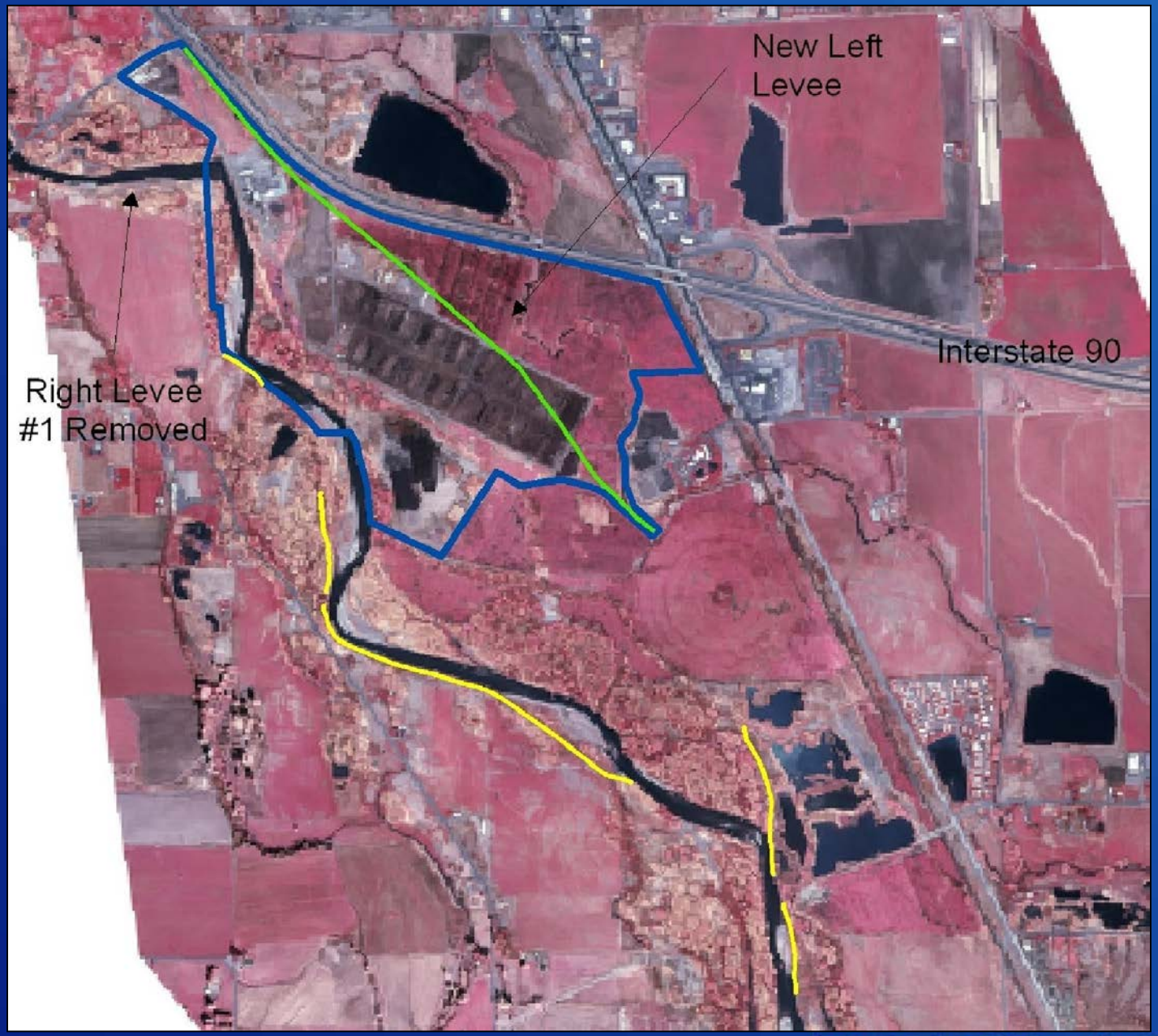


# Schaake Project

Proposed levee reconfiguration – Mod 1

Proposed levee in green

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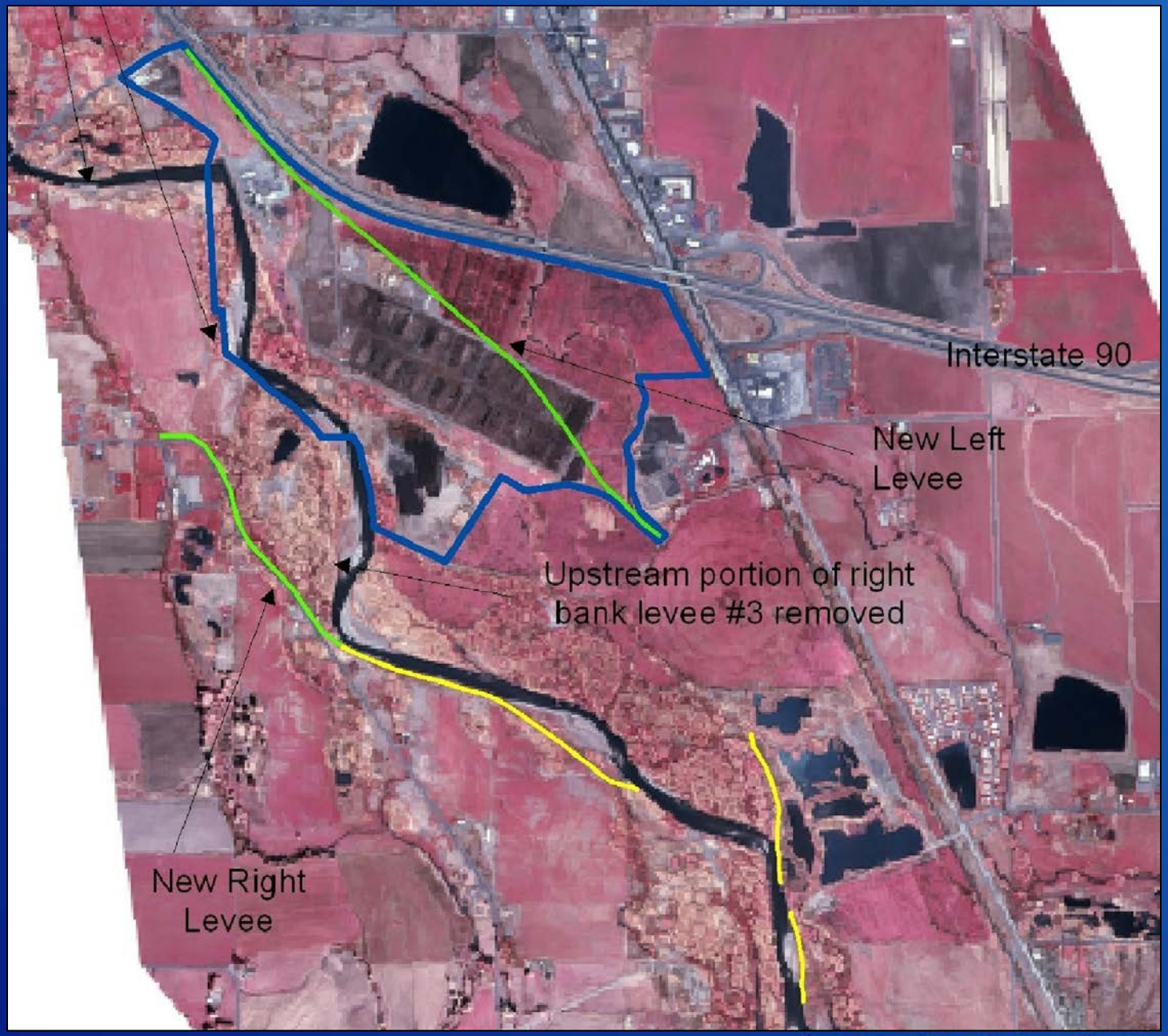


# Schaake Project

Proposed levee reconfiguration – Mod 2

Proposed levees in green

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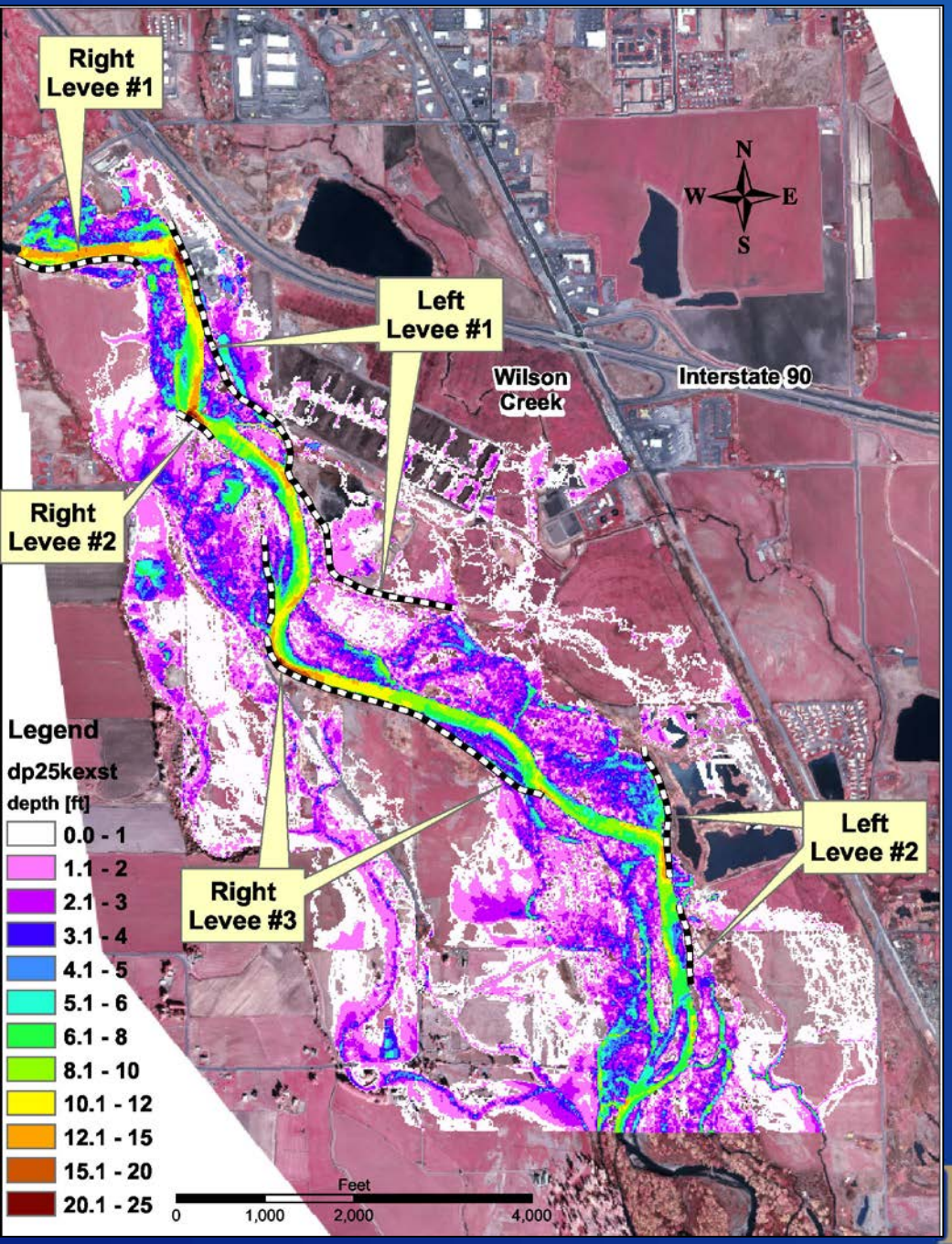


# Schaake Project

2-D model results of 25,000 $ft^3/s$ for existing conditions

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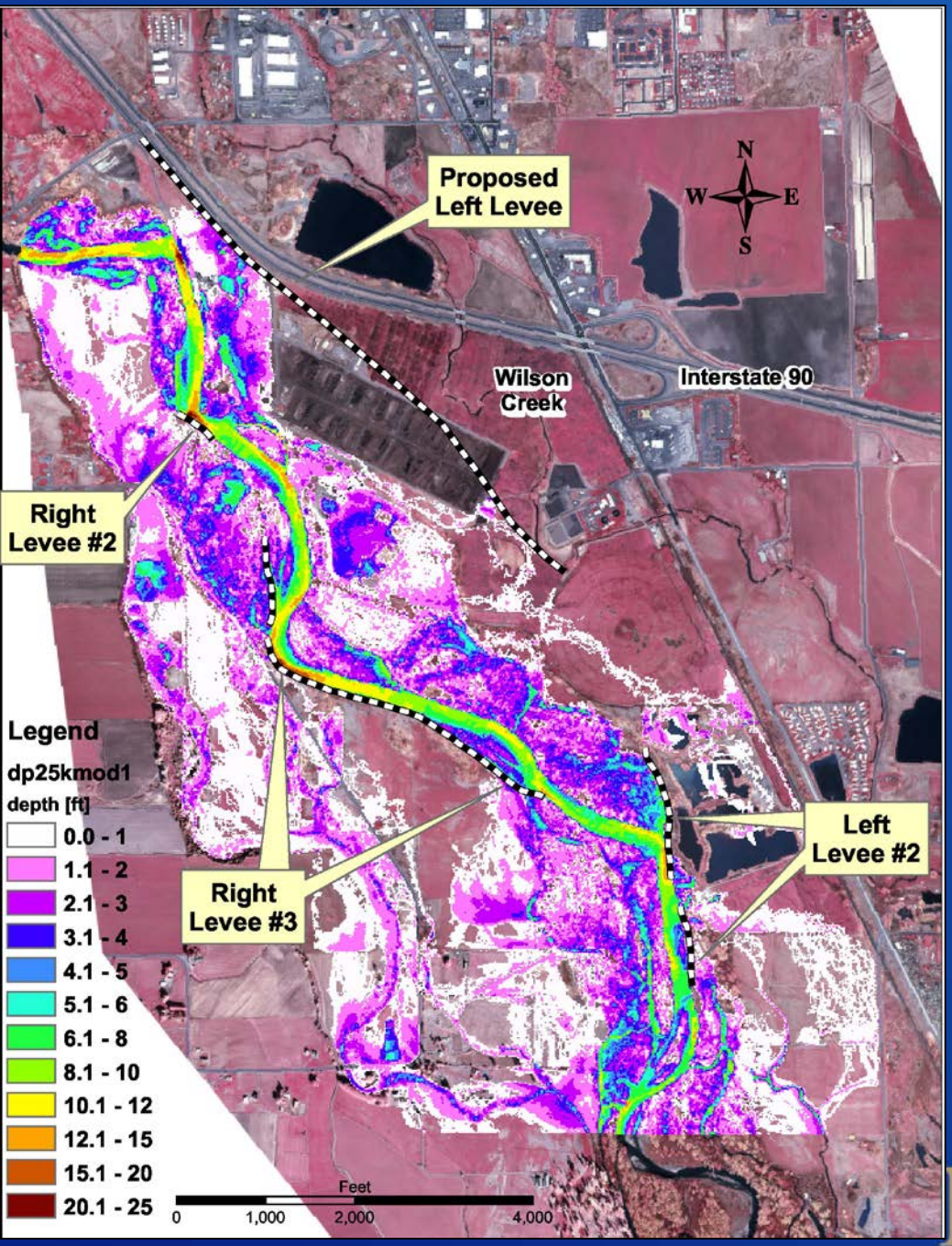
# Schaake Project




2-D model results of 25,000 $ft^3/s$ for Mod 1

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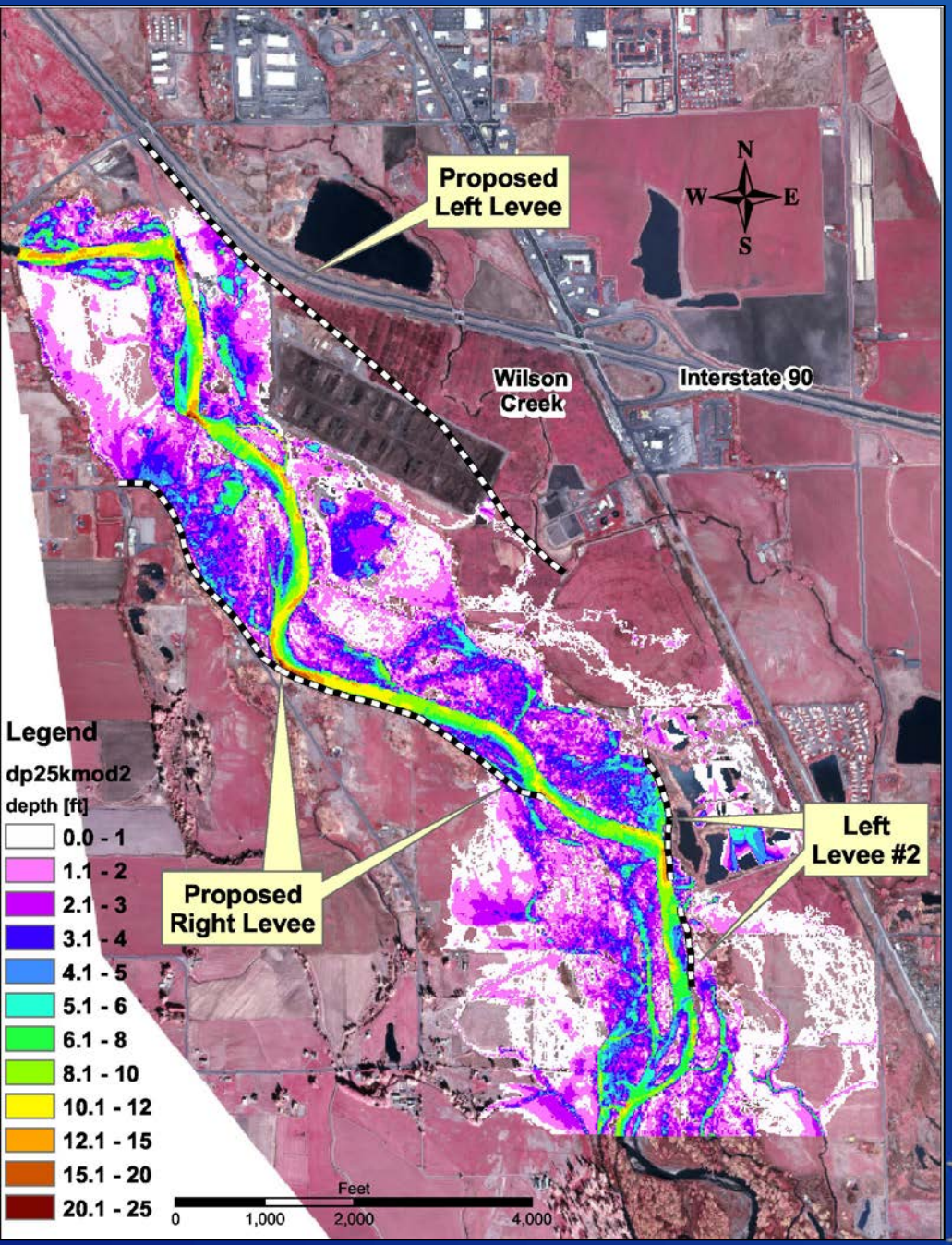
# Schaake Project




2-D model results of 25,000 $ft^3/s$ for Mod 2

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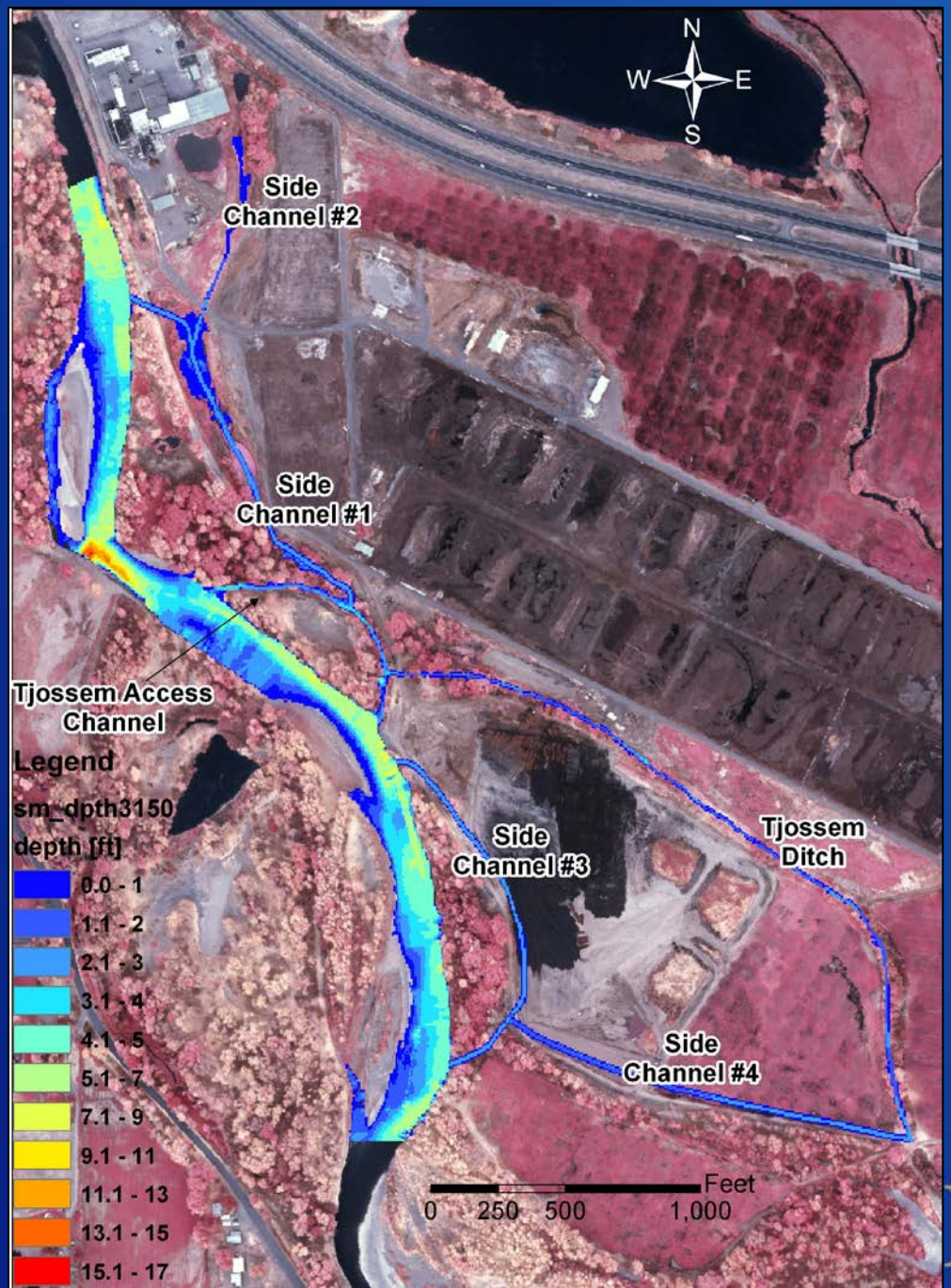


# Schaake Project

- 2-D model results of 3,150 $ft^3/s$ to evaluate side channel flows

- Side channel interaction designed for flows greater than 1000 $ft^3/s$

- This reach of the river would be expected to aggrade and bed material size to decrease to pre-levee conditions and

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# Water Supply Project

- Need to provide input for Ecosystems Diagnostic and Treatment (EDT)
- Hydraulic Modeling (1-D and 2-D)
  - 1-D hydraulic model (Upper Columbia Area Office) for coarse evaluation of hydraulic conditions (wetted width, cross section velocities, etc.)
  - 2-D hydraulic model determines habitat quantity and quality on a finer scale for a few selected reaches (4 – 12 miles)
- Determine sediment transport conditions using SIAM
  - Provide input to EDT
  - Gain an understanding of potential channel change following increased flow

# 2-D Hydraulic Modeling

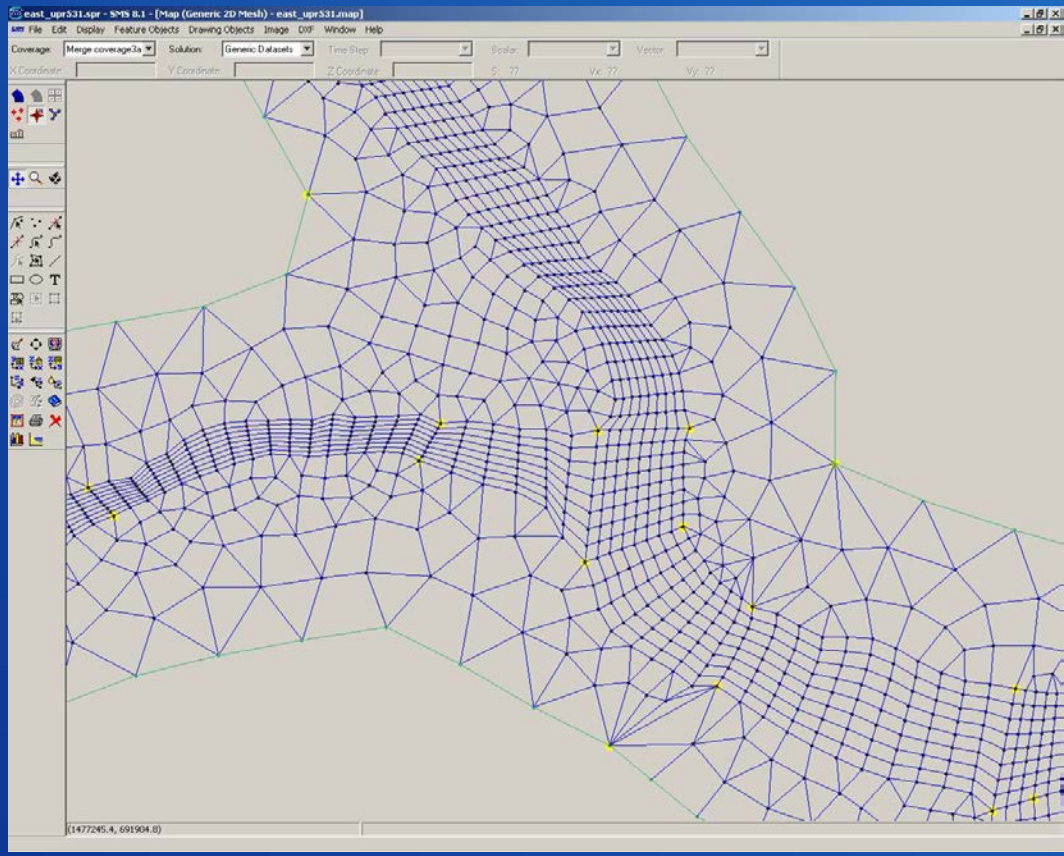
- Model used is GSTAR-W (Generalized Sediment Transport for Alluvial Rivers and Watersheds), a comprehensive watershed model incorporating overland flow, channel flow and sediment transport (being developed in-house)
  - OVERLAND FLOW
    - Rainfall runoff, interception, evaporation and transpiration, infiltration, and saturated zone/channel interaction
  - CHANNEL FLOW - 1-D and 2-D solutions
    - 2-D solutions offer dynamic or diffusive wave, implicit or explicit solutions
  - SEDIMENT TRANSPORT
    - Overland and channel transport and deposition
    - Can assess TMDLs

# 2-D Model

- The current application uses the channel network portion of GSTAR-W
  - Finite element, diffusive wave, implicit solution for depth averaged velocity and water depth
- Deliverable products
  - Depth and velocity at various steady state flows
    - Shape files compatible with Arc GIS

# 2-D Hydraulic Model

- Mesh generation
  - Combined structured/unstructured curvilinear mesh
    - Structured portion represents the main channel
    - Unstructured portion represents the overbank areas
  - The combination of a structured and unstructured mesh optimizes model development, computation time, and representation of channel form and hydraulics

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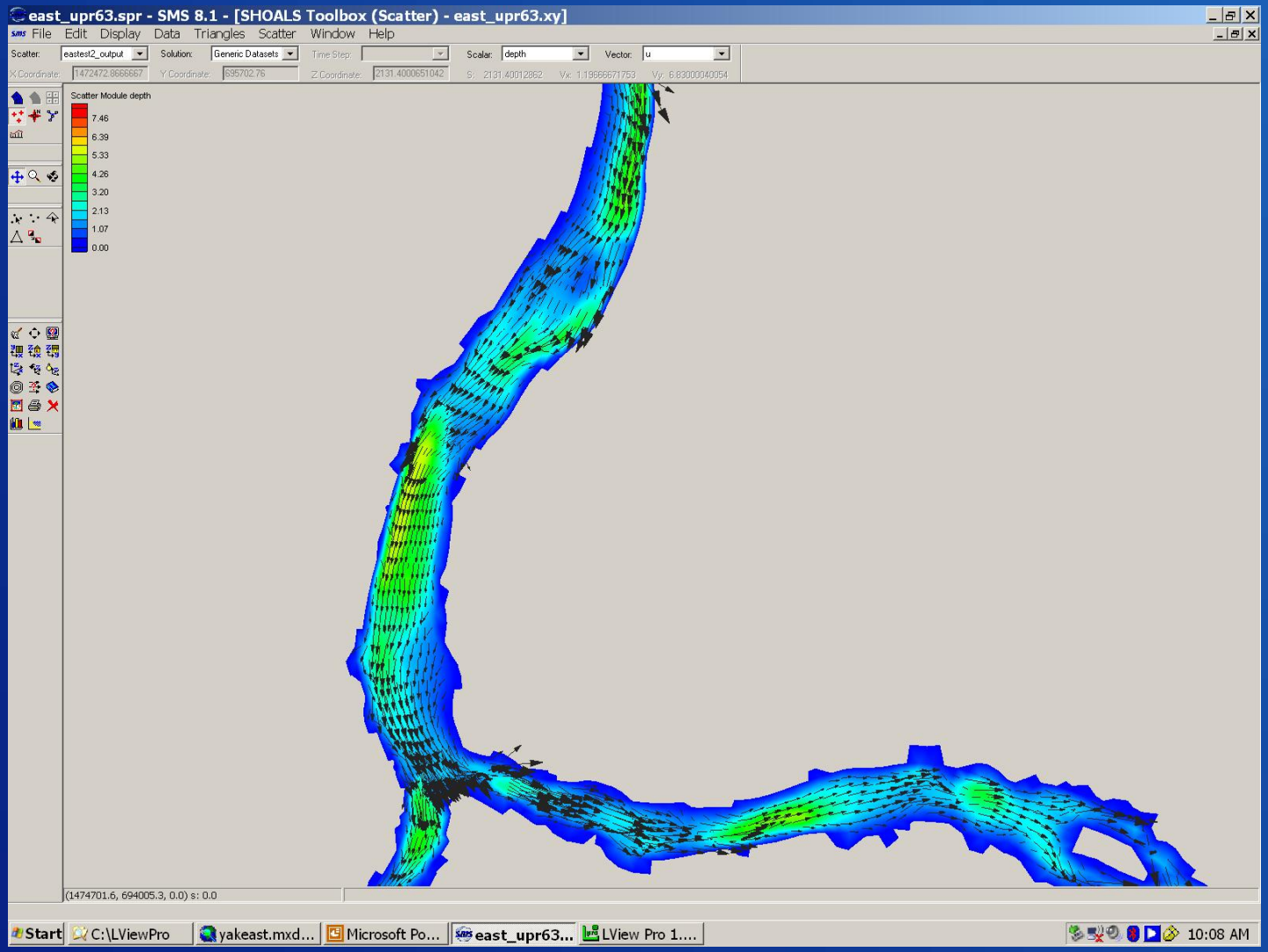
# Preliminary Results, 2-D Model




Velocity and depth displayed in SMS

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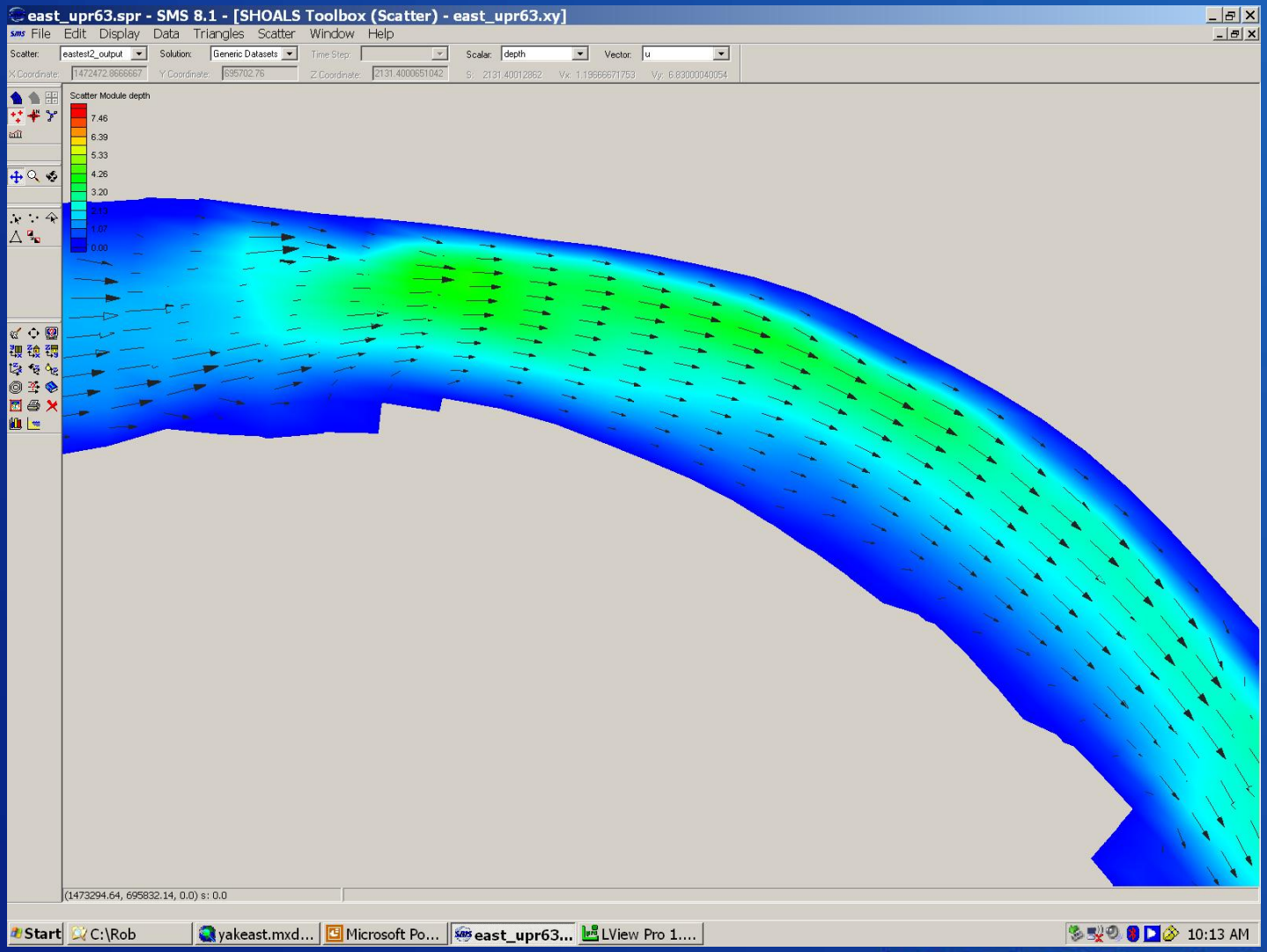


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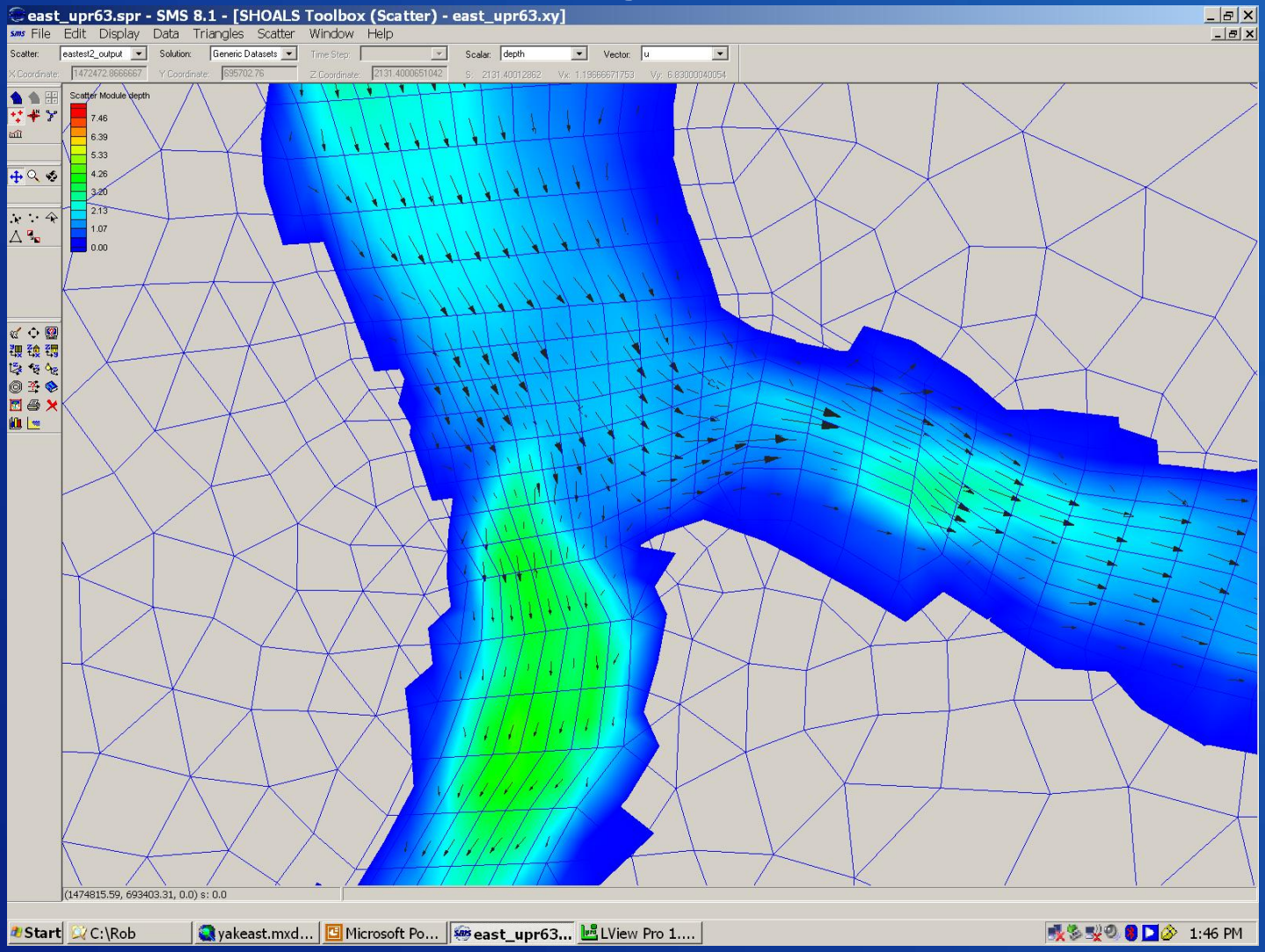


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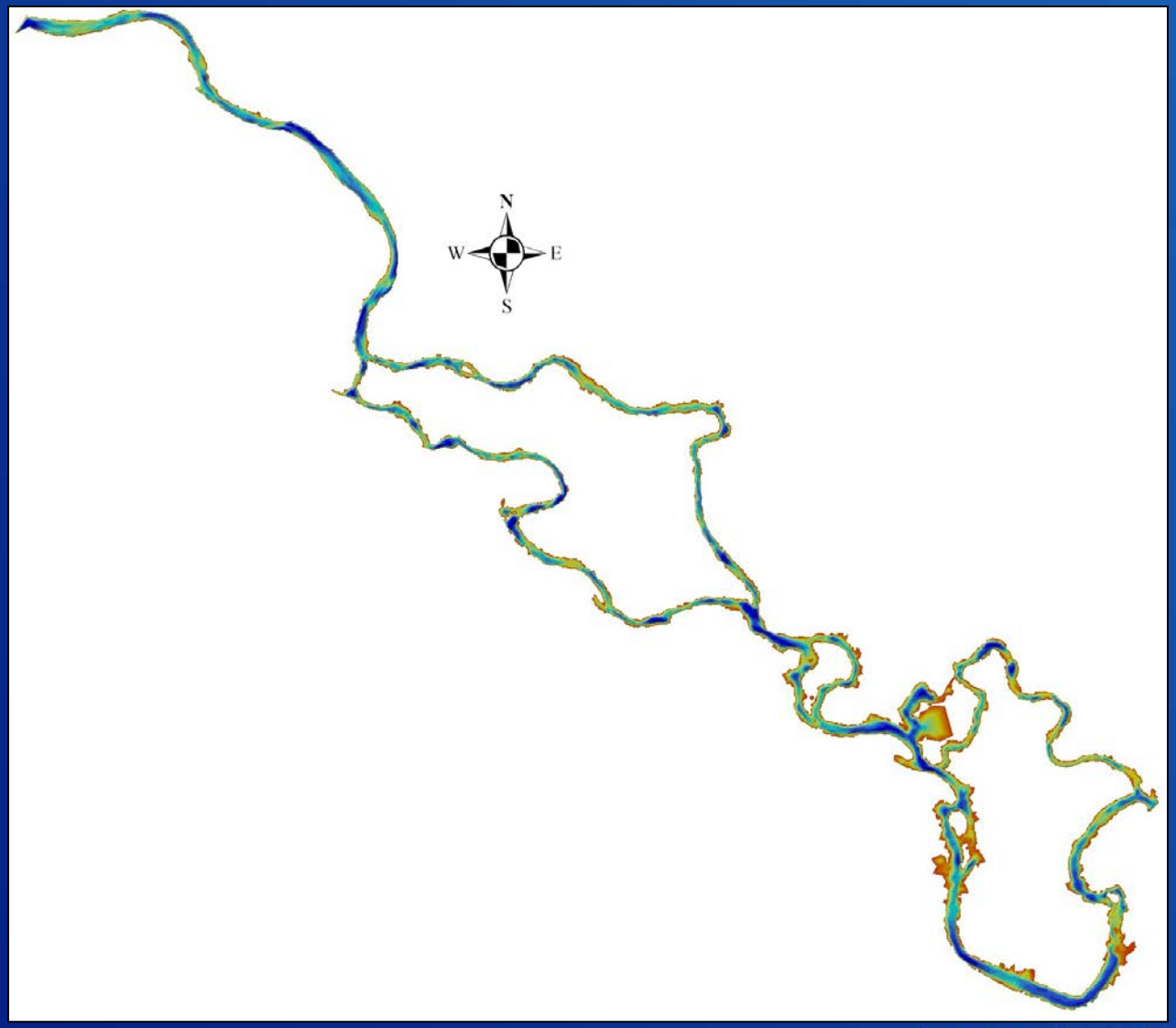


Flow depth for entire model thus far displayed in Arc GIS

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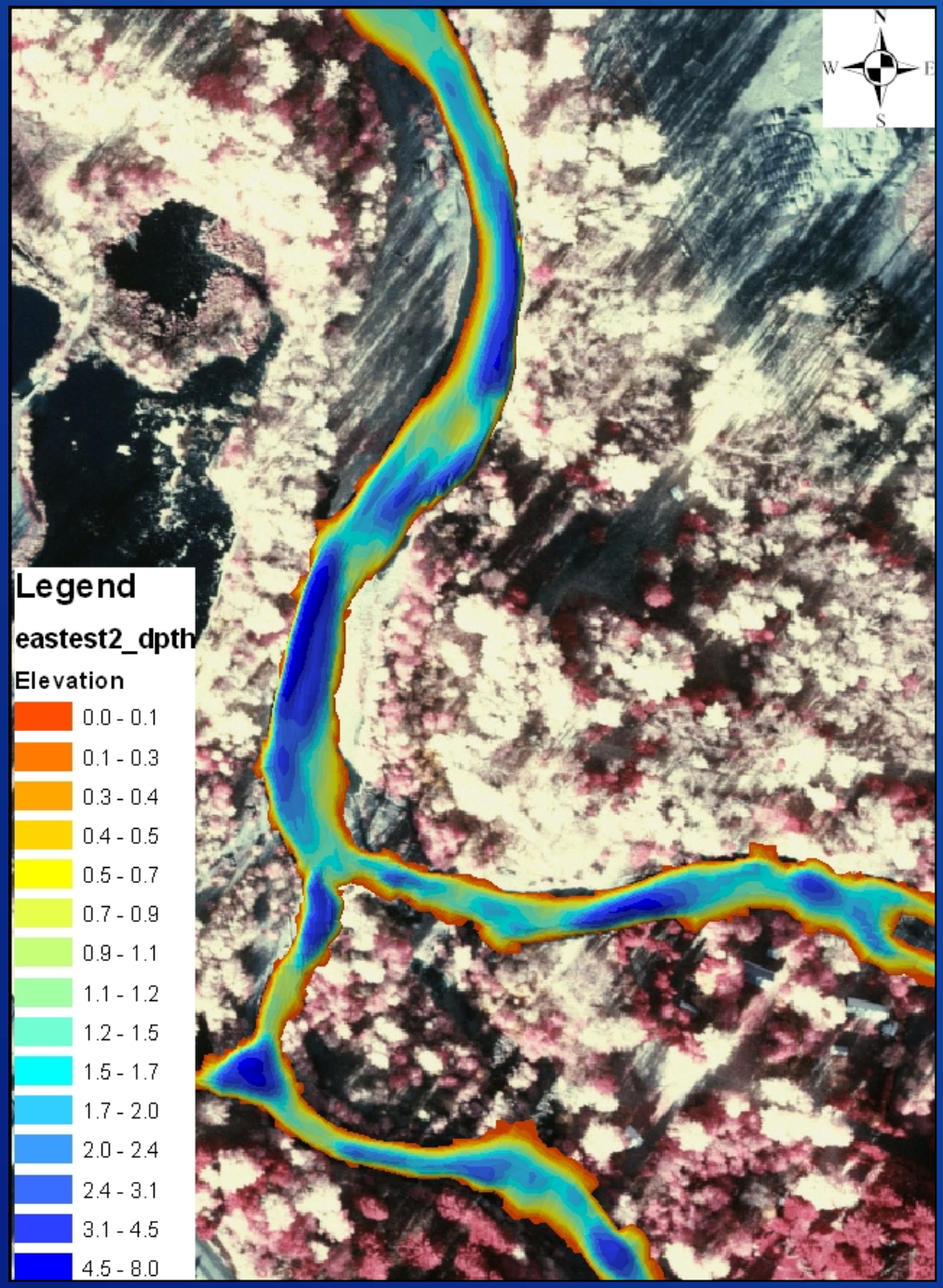


# Preliminary Results, 2-D Model

Zoomed in flow depth over CIR photo in Arc GIS

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# Bathymetric LiDAR

- SHOALS-1000T bathymeter manufactured by Optech
- Previous to flights on the Yakima River in Sept. 2004, this survey method was limited to coastal applications
- Kittitas and Easton reaches were flown in Sept. 2004
- Five other reaches of the Yakima and Naches rivers flown in Apr/May 2005
- Requires mostly clear water for successful data collection

# Bathymetric LiDAR

SHOALS-1000T system installed in a King Air 90




Photos courtesy of Woolpert, Inc.

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# Bathymetric LiDAR

SHOALS system looking aft


Photos courtesy of Woolpert, Inc.

# Bathymetric LiDAR

SHOALS system looking forward


Photos courtesy of Woolpert, Inc.

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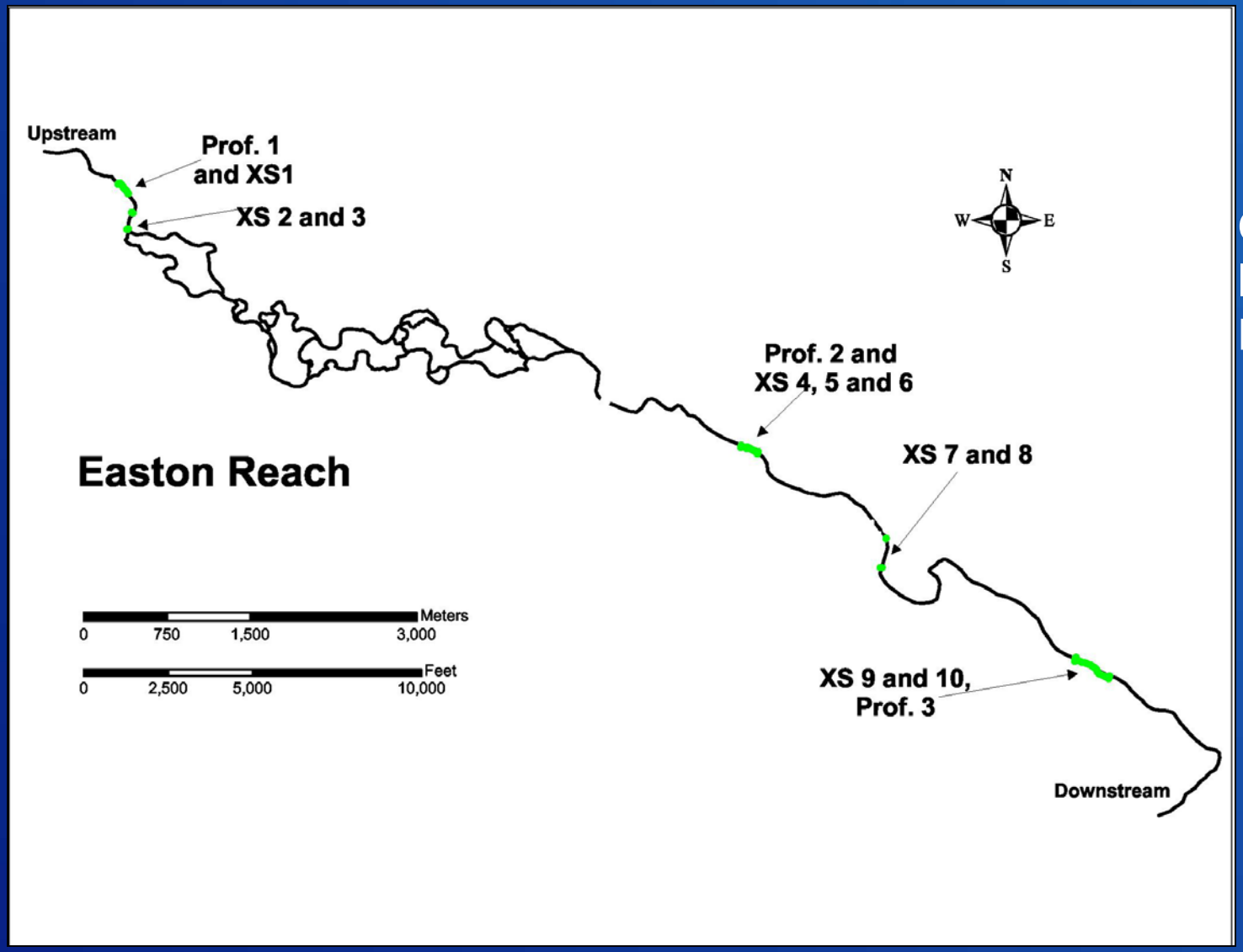
# Bathymetric LiDAR

- Advantages of aerial method
  - Boating/rafting safety not an issue
  - No access issues
  - Much faster data collection (~ 13 river miles/day)
  - No post processing by Reclamation
  - Little or no ground support required by Reclamation
  - Data delivered within 60 days
  - Much denser coverage (2x2 m spot spacing)
  - Data can be collected in side channels not accessible by boat or raft




Ground Truthing locations in the Easton reach

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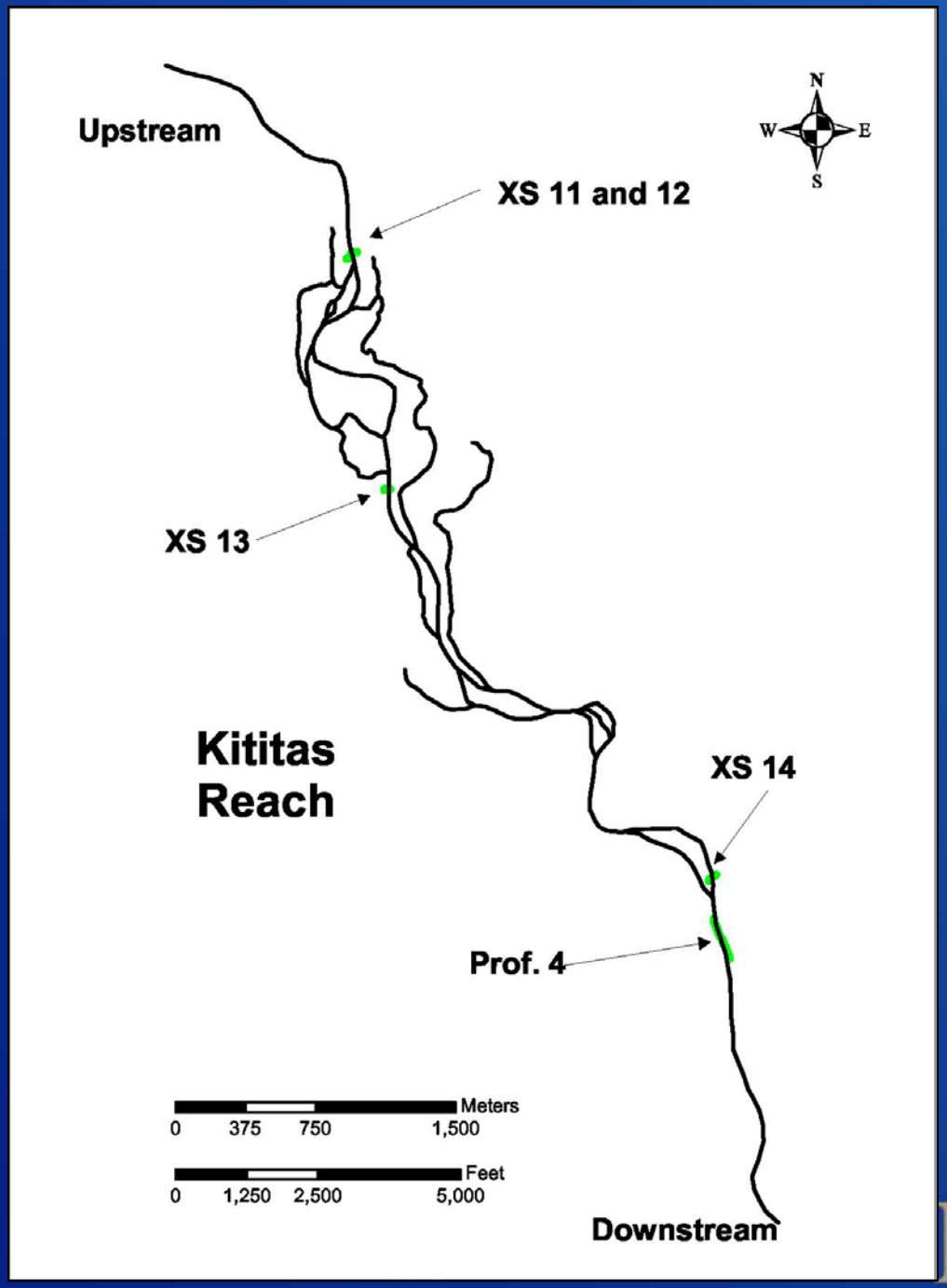


Ground truthing locations in the Kittitas reach

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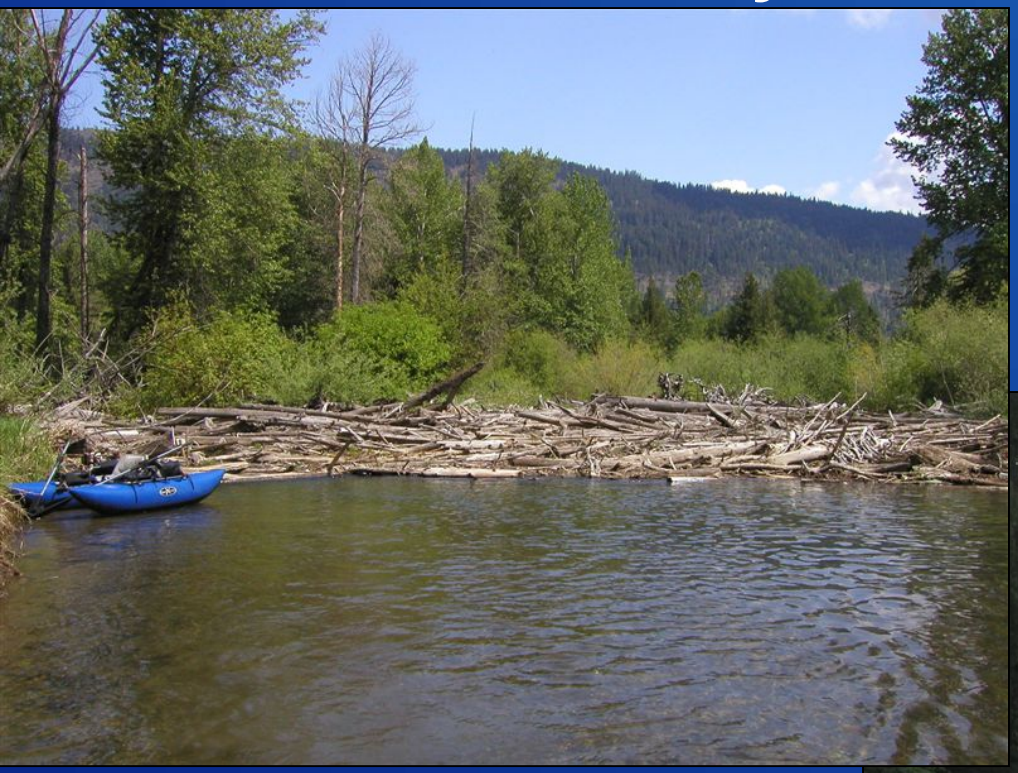
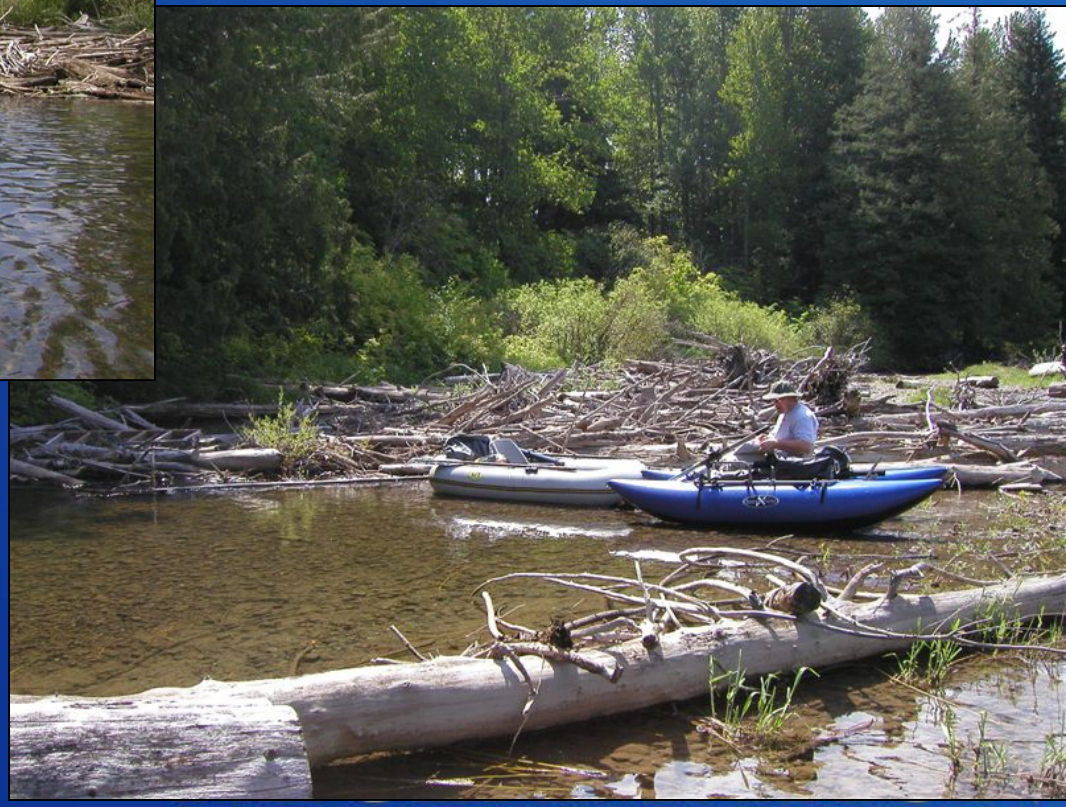
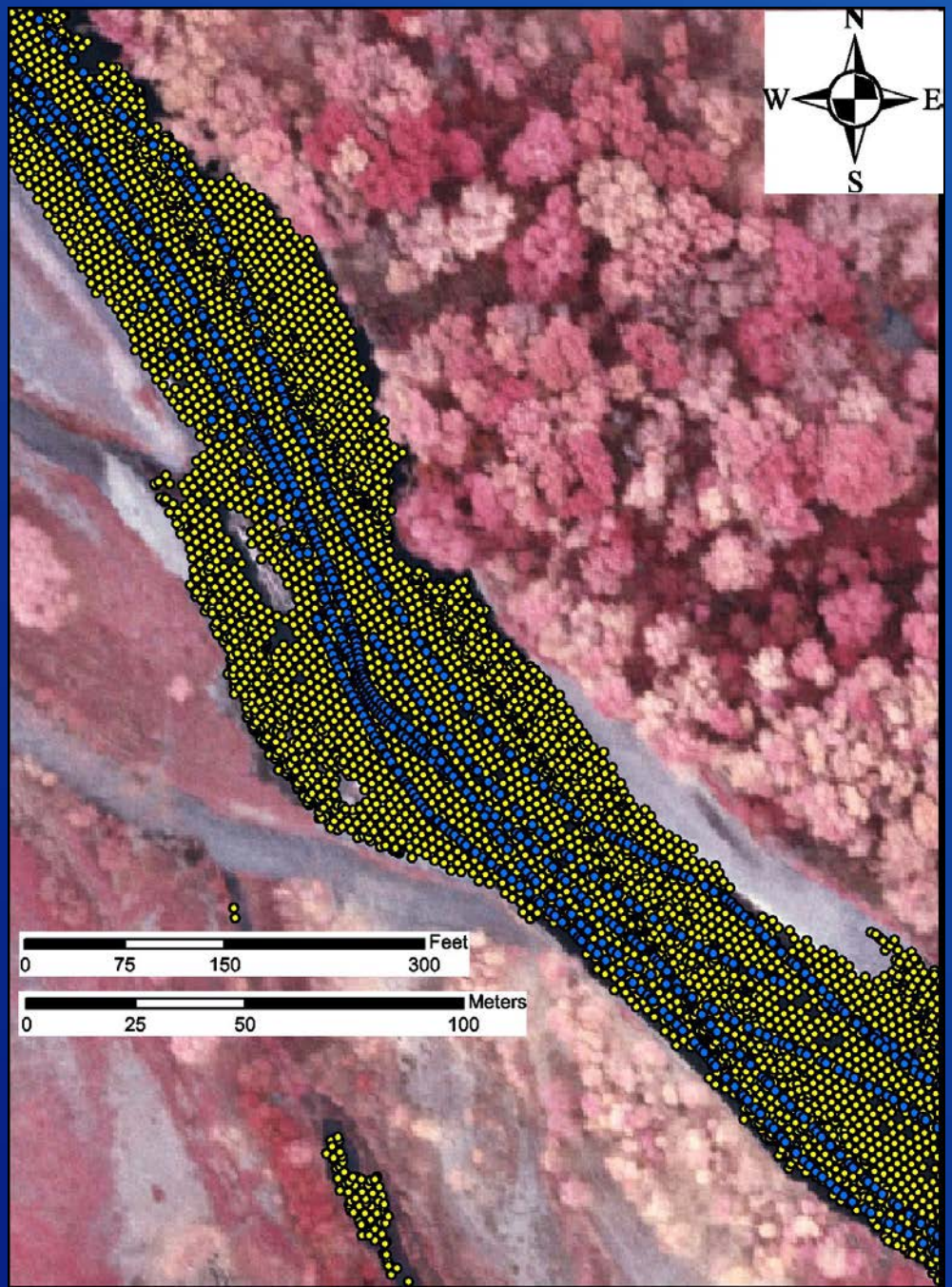
# Bathymetric LiDAR



Channel-wide log jams in the Easton reach



Photos courtesy of Rocky Lancaster




# Bathymetric LiDAR

- Comparison coverage – LiDAR to raft survey
  - Yellow = LiDAR survey
  - Blue = raft survey

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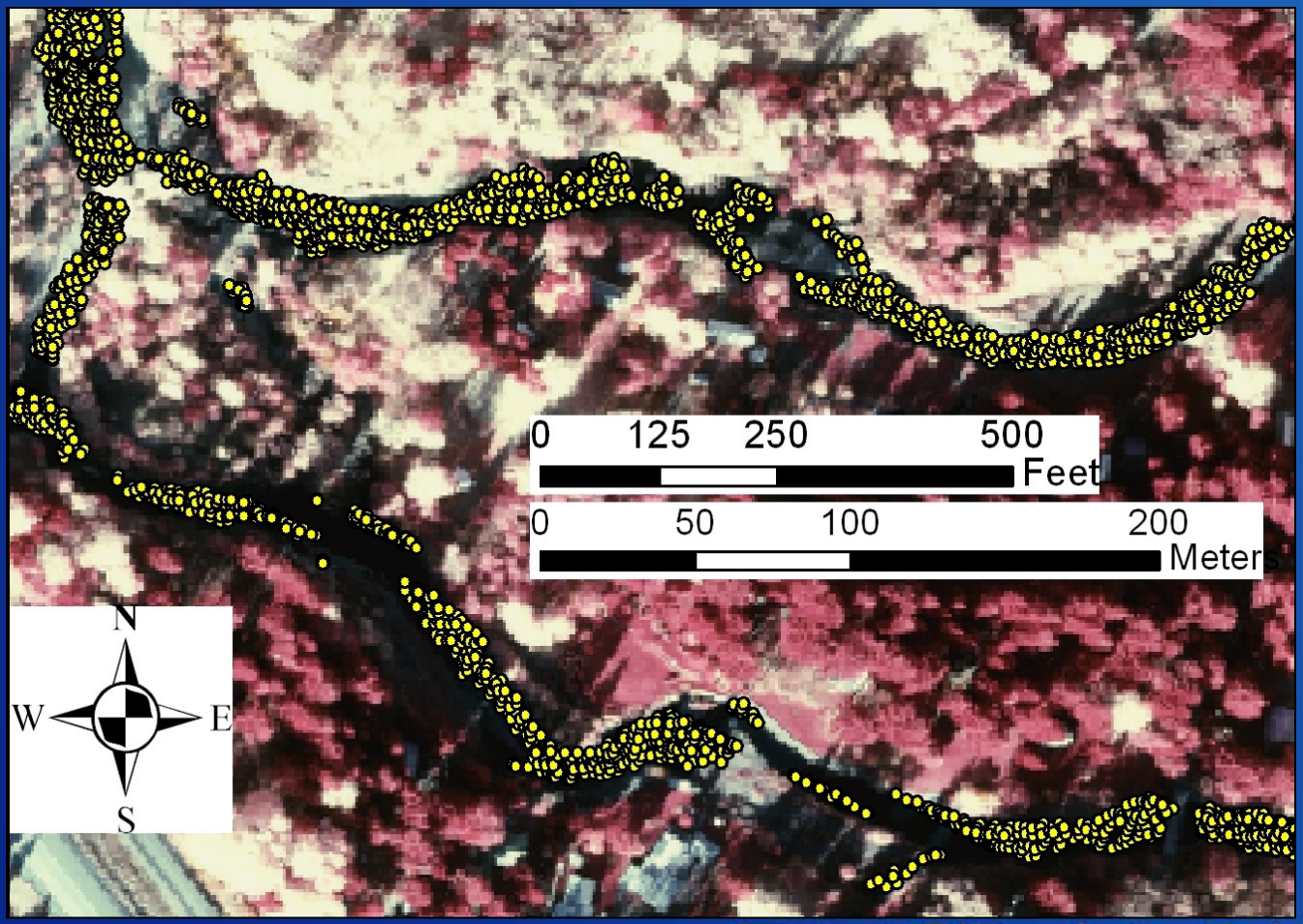
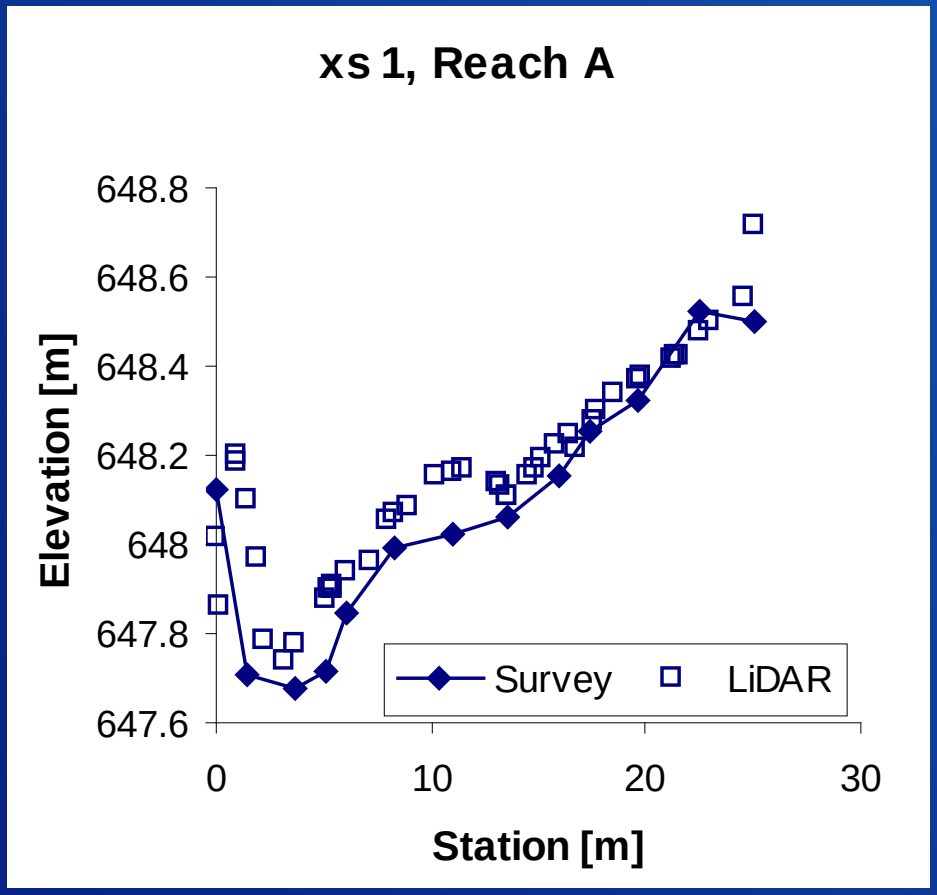
# Bathymetric LiDAR

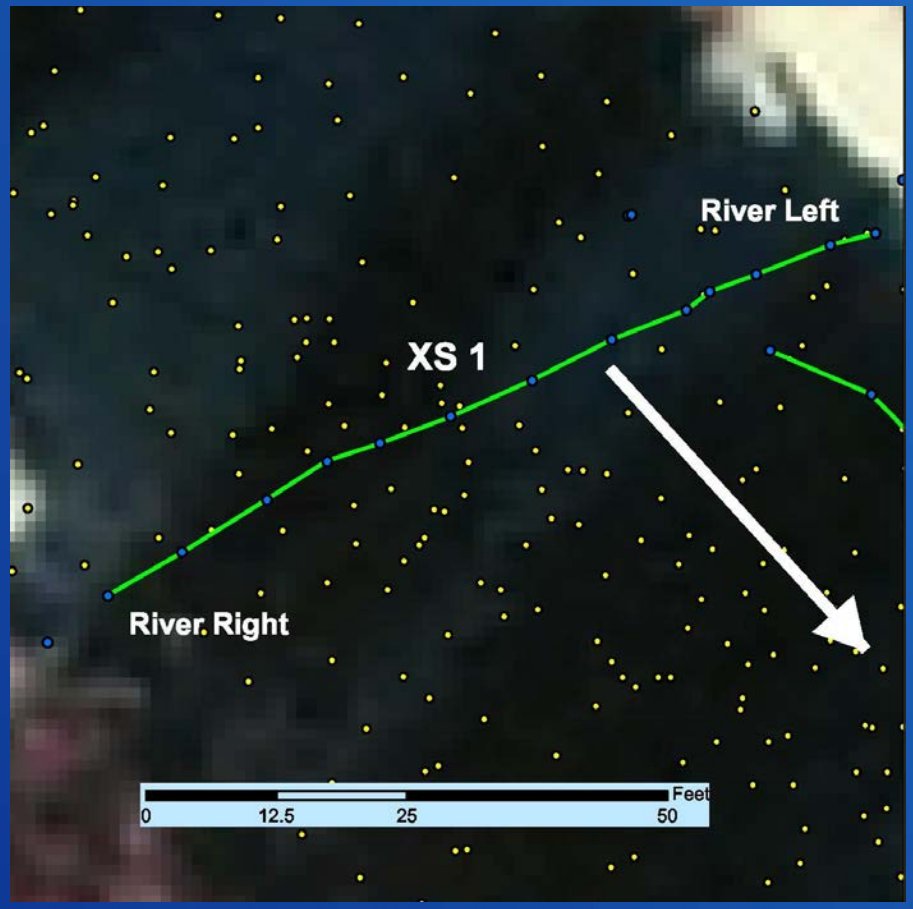
- Example of areas with spotty coverage



# Bathymetric LiDAR

Cross sectional data comparison with ground truth data

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# Bathymetric LiDAR

- Statistical comparison with ground truth data for accuracy and precision

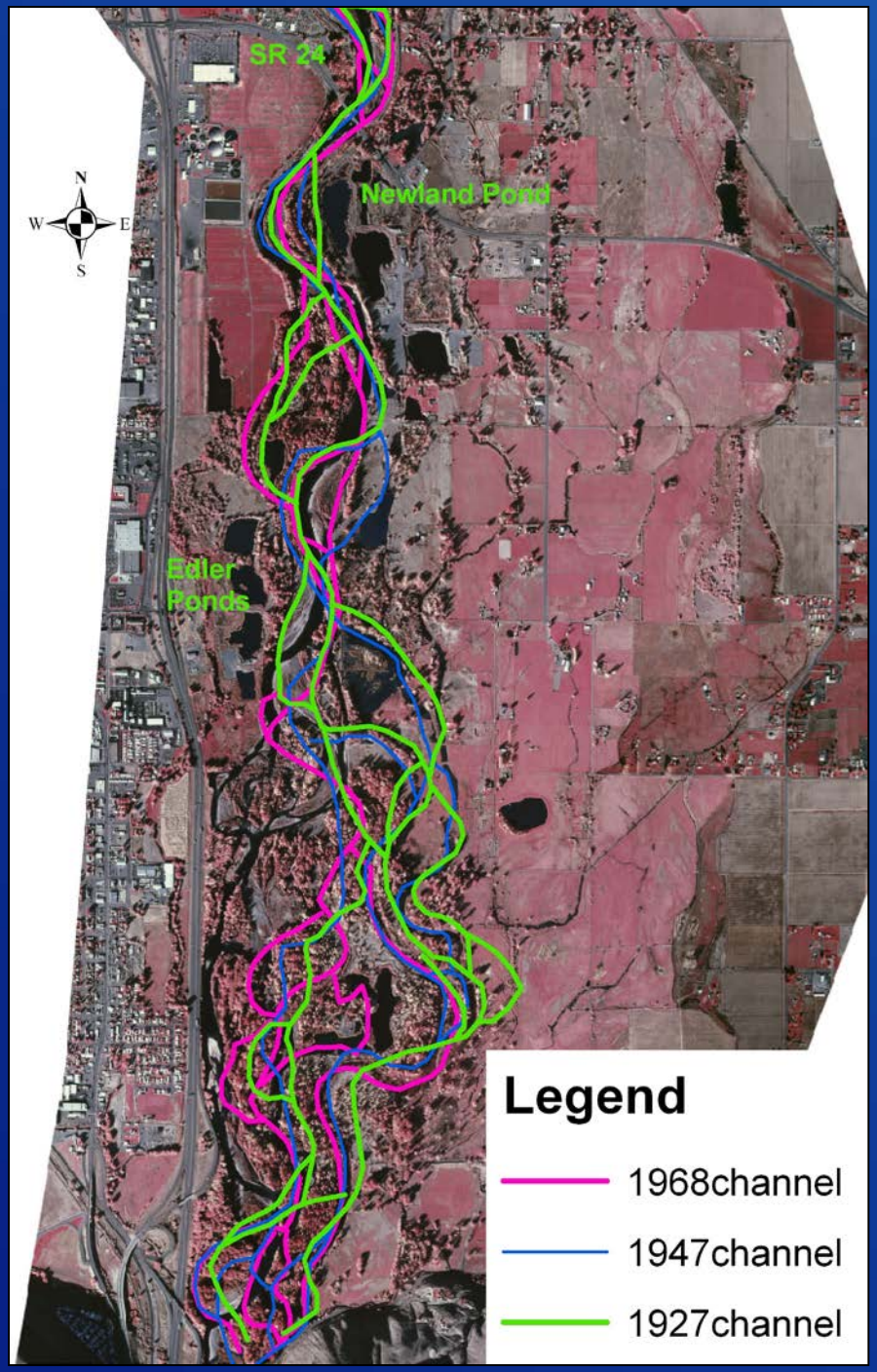
| | Easton Reach | | | Kittitas Reach | | |
|---|---|---|---|---|---|---|
| | <0.9 m | < 0.6 m | < 0.3 m | <0.9 m | < 0.6 m | < 0.3 m |
| mean | 0.13 | 0.13 | 0.11 | 0.21 | 0.19 | 0.11 |
| median | 0.13 | 0.15 | 0.16 | 0.26 | 0.28 | 0.19 |
| **1 std. dev.** | **0.22** | **0.24** | **0.18** | **0.39** | **0.39** | **0.35** |
| sample size | 141 | 70 | 23 | 91 | 46 | 11 |

# Gravel Pits

- Dave Norman et al. (WaDNR) have documented the hazards of pit capture of floodplain mines by the Yakima and other rivers
  - Washington Geology, September, 1998
- Also documented are the potential benefits of incorporating these pits into the normal flow of the river
- Floodplain Mining Impact Study recommends a study for reclaiming floodplain mines
- Several floodplain pits have already avulsed, including:
  - Gladmar, I-90, Selah, Parker and others

# Gravel Pits

- Discussions are on-going with Yakima County to begin a multi-agency effort to study the feasibility of connecting the floodplain mines to the main flow of the river
  - Levee set-back
  - Partial fill of pits with old levee material
  - Force partial river flow into and out of gravel pit(s)
  - Partial sediment load in river to fill remaining volume over time
  - This effort will create a multi-channel system
    - In some reaches of the Yakima River, this is a natural configuration




# Gravel Pits

- Gap to gap reach d/s of SR 24 bridge

- Much of the riparian property in this reach of the river is in public ownership

  -WA state, Reclamation, Yakima Greenway, WDFW?

- Yakama Nation also owns riparian property

-Remaining property is under private or corporate ownership

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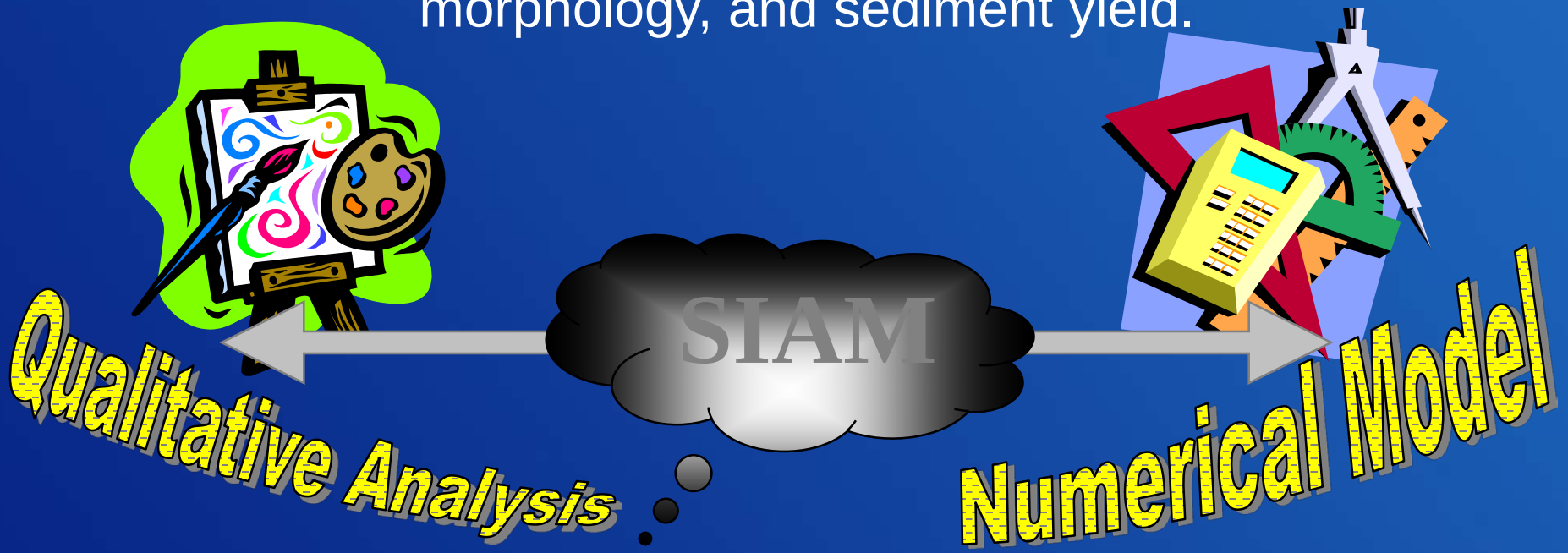
# Gravel Pits

- Meeting in July is tentatively planned
  - Meet with potential partners
  - Present initial study plan
  - Take input from partner organizations
  - Develop a plan of study, timeline and budget

# Sediment Transport – SIAM Overview

Sediment Impact Analysis Methods, SIAM, evaluates the linkages between sediment features, channel morphology, and sediment yield.




Data Products Include: Channel Stability and Adjustment, Sediment Yield, and Sediment Supply – Impact Linkages

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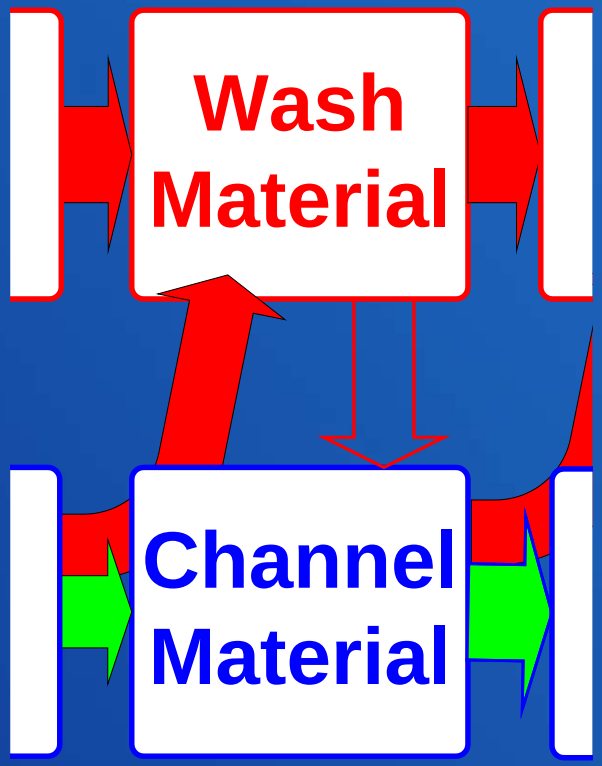
# Key SIAM Concepts

- **Rapid Assessment**: SIAM provides a transparent computation model to take advantage of geomorphic principles for simulating sediment movement and channel interactions.
- **Scalable Inputs**: The model can range from small to very large channel networks at varying levels of detail.
- **Source – Impact Linkages**: SIAM identifies individual constituents contributing to a sediment impact.
- **Synthesis Tool**: SIAM brings together disparate and independent process models to draw conclusions on ultimate impact.
- **Trend Analysis**: SIAM provides the magnitude and direction of change, not ultimate conditions, adjustment time frames, or intermediate states.
- **Regime Input**: SIAM operates on the full range of hydrology, hydraulics, and sediment loadings through flow-duration curves.

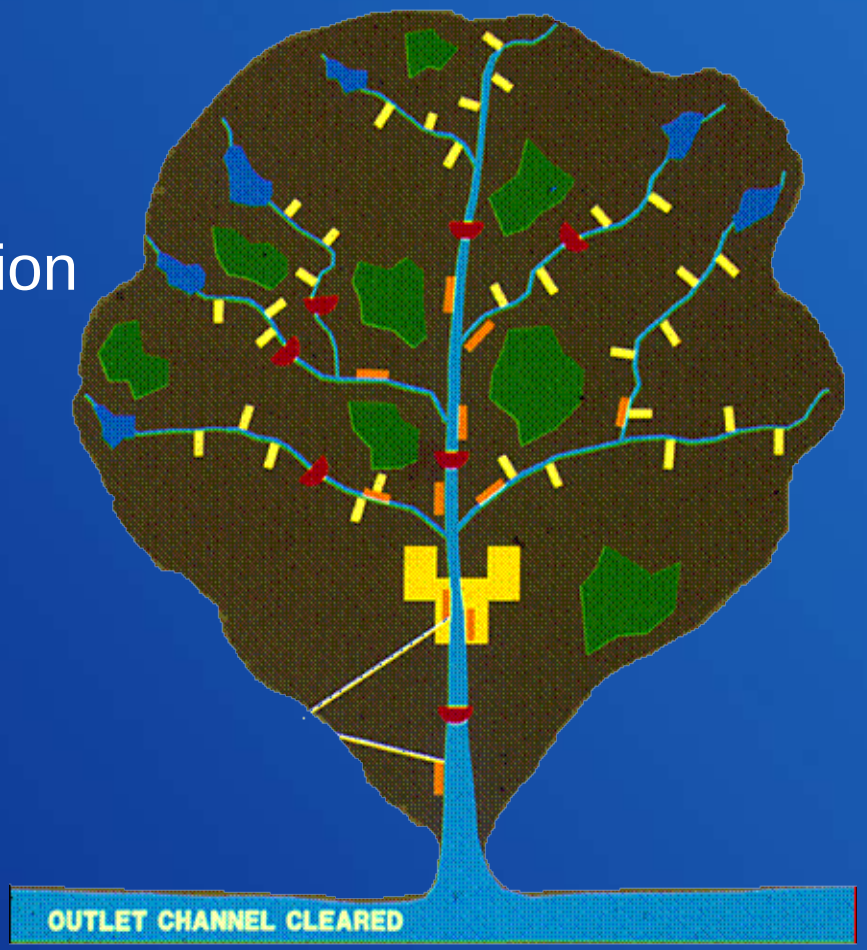
# Basic Conceptual Model

- Model Input
  - Hydrology, Hydraulics, and Sediment Transport
  - Local Sediment Sources
  - Bed Material Composition and Properties
- Bed and Wash Transport Modes
  - Immediate connection and impacts through the wash reservoir
  - Longer term morphology connection through the channel reservoirs
  - Material can transition from one reservoir to another.
- Trend Analysis
  - Predicts magnitude and direction of change
  - Final state or evolution is not represented.



# Example Applications

- Changes in Land Use
  - Urbanization
  - Best Management Practices
- Rehabilitation and Restoration
  - Cumulative Restoration and Stabilization Impacts
  - Sizing and Spacing of Grade Control
- Planning and Management
  - Altered Flow Regimes
  - Identification of Causality
  - Impact mitigation

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# SIAM Application to Yakima Basin

- HEC-RAS Model will provide hydraulics
- Bed material sampling will specify the composition of the channel and sediment transport parameters
- Each hydrologic regime will represent a different SIAM scenario
- Data Products Include
  - Evaluate Channel Stability
  - Determine Source and Sink Reaches
  - Evaluate Fining or Coarsening of the Bed
  - Identify potential areas requiring mitigation
- The SIAM model may identify reaches which could benefit from a more detailed mobile boundary model.

# Conclusions

- The TSC is available to assist Reclamation region and area offices with collaborative efforts with local, state and federal agencies as well as tribes
- Reclamation's TSC is funded through clients willing to hire us