Intake Dam ADH Hydraulic Modeling Fish Passage Ramp

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US Army Corps of Engineers

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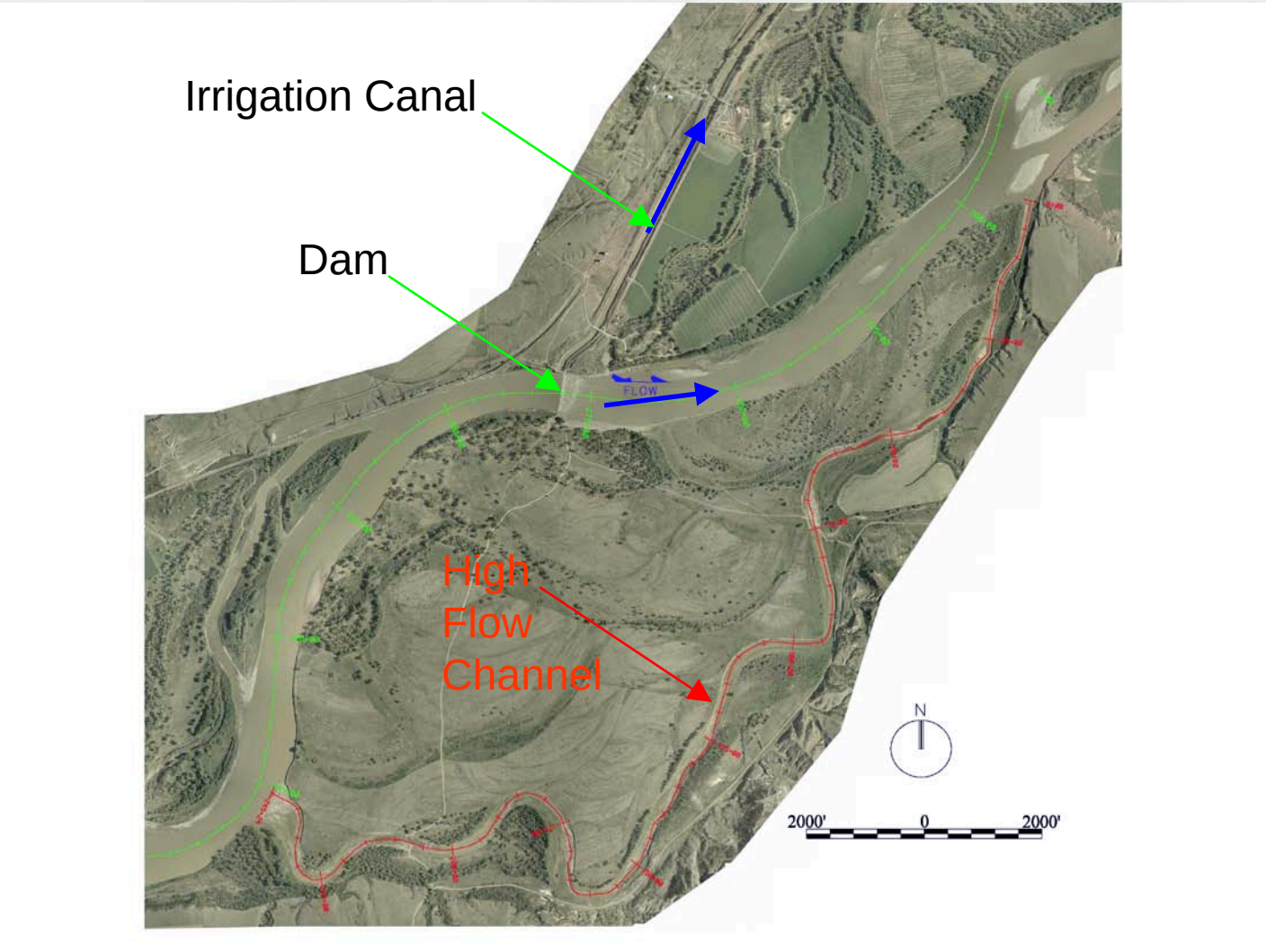
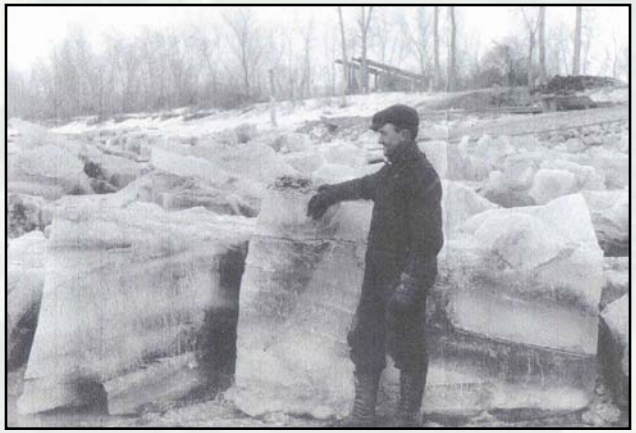
Lower Yellowstone Irrigation Project (Intake Dam)



Intake Dam-Overview



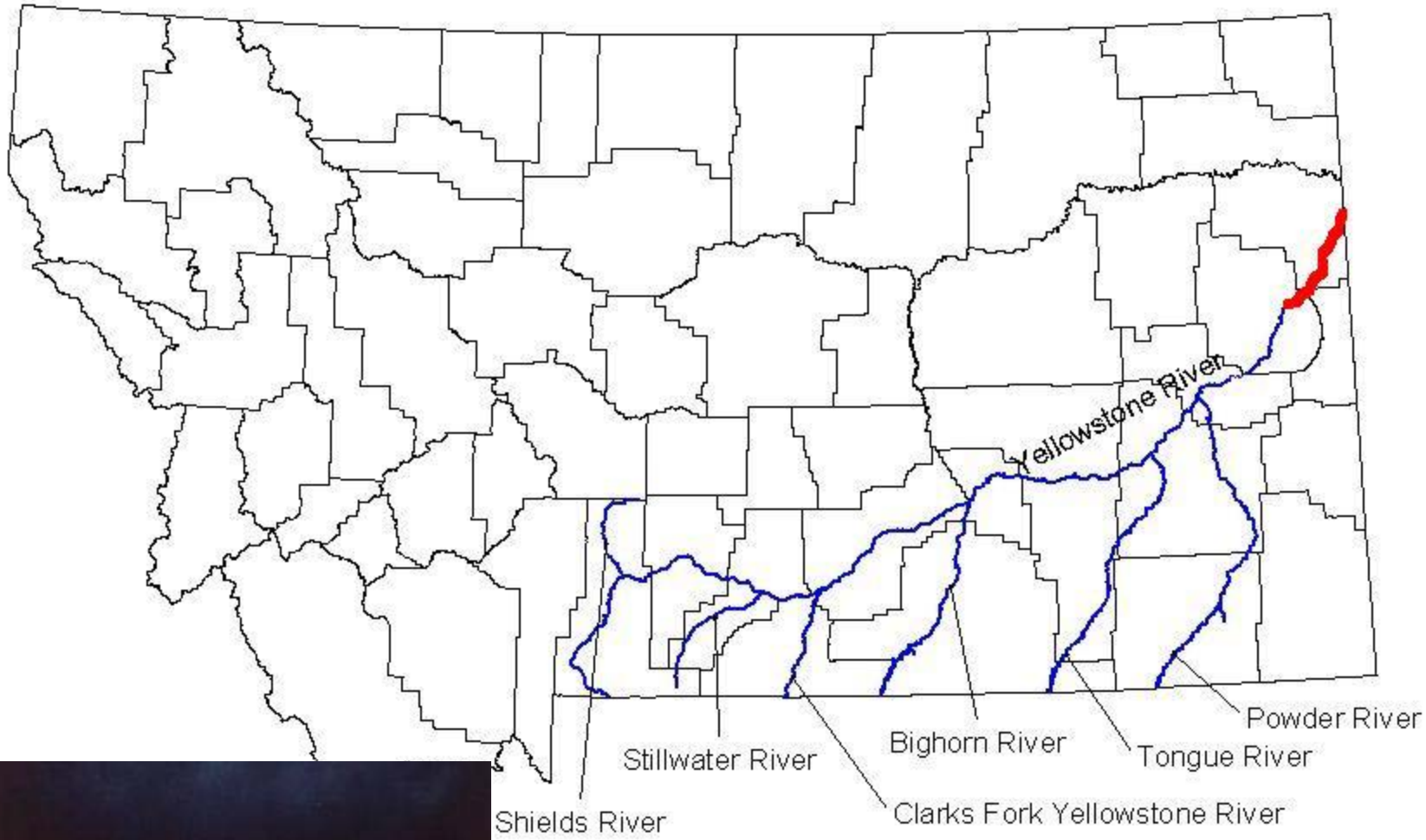
Authorization:
- Reclamation Act of 1902

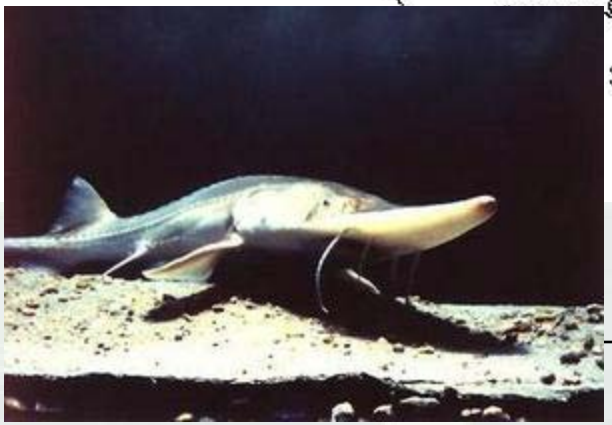
Construction:
- 1905-08 by Reclamation

Operation:
- Diverts ~1,400cfs into Main Canal for delivery to ~52,000 acres

Maintenance:
- Placement of rock on the crest of dam to maintain head and replace rock washed downstream by high flow and ice

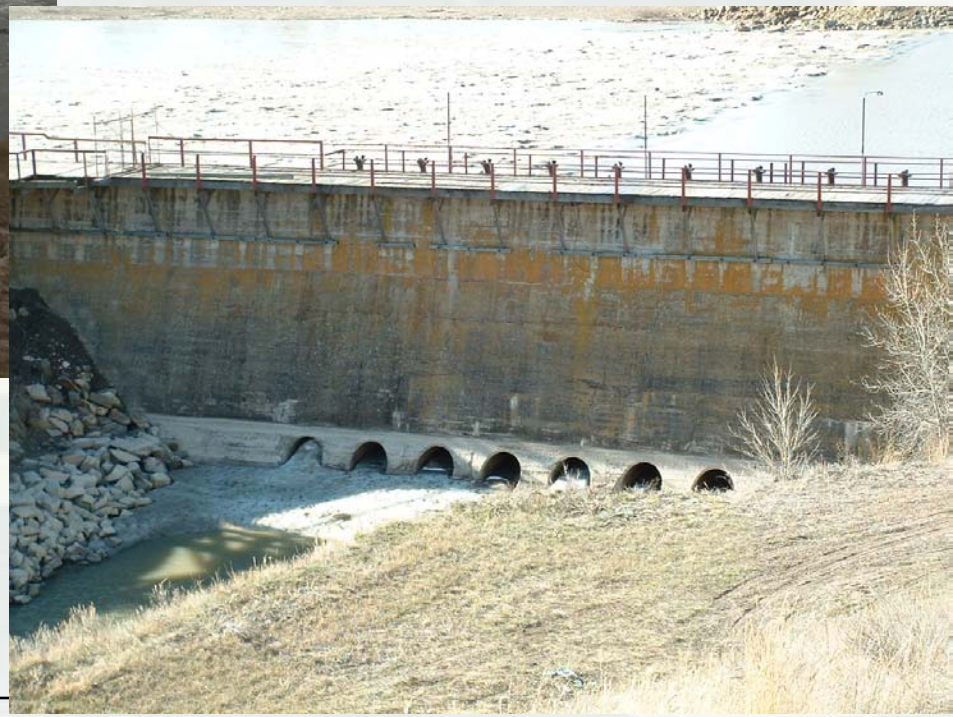
Current range of Pallid sturgeon in the Yellowstone basin.





Issues: Fish Passage and Entrainment

Fish Passage Issue



Entrainment Issue

Study History

-Initial efforts started by Reclamation response to FWS endangered species (Pallid Sturgeon)

-Corps interest due to Missouri River Recovery Biological Opinion, not an RPA but have reached agreement with FWS for milestone relief

-EA nearly complete, considered numerous alternatives

-Selected ramp to provide full river width passage (other options not acceptable)

-Headworks construction award FY10

-Ramp likely two phases, construction award FY11 and FY12

-Biologic Review Team (BRT) multi agency group to provide biological feedback regarding likely fish passage success

Design Goals

-Allow passage under flow conditions to be experienced during spring and summer (BRT criteria)

-Reduce velocities experienced across crest and throughout ramp

-Maintain depths necessary for passage throughout the ramp

-Provide head for diversion at 3000 cfs (August 95% confidence flow rate)

Depth Ranges (ft)	Velocity Ranges (fps)
0 to 1.64	0 to 2
1.64 to 3.28	2 to 4
3.28 to 30	4 to 6
	6 to 8
	8 to 12

50% Exceedance by Month
April-8,470
May-14,800
June-30,700
July-17,100
August-7,080
September-6,660 cfs

Design Tools

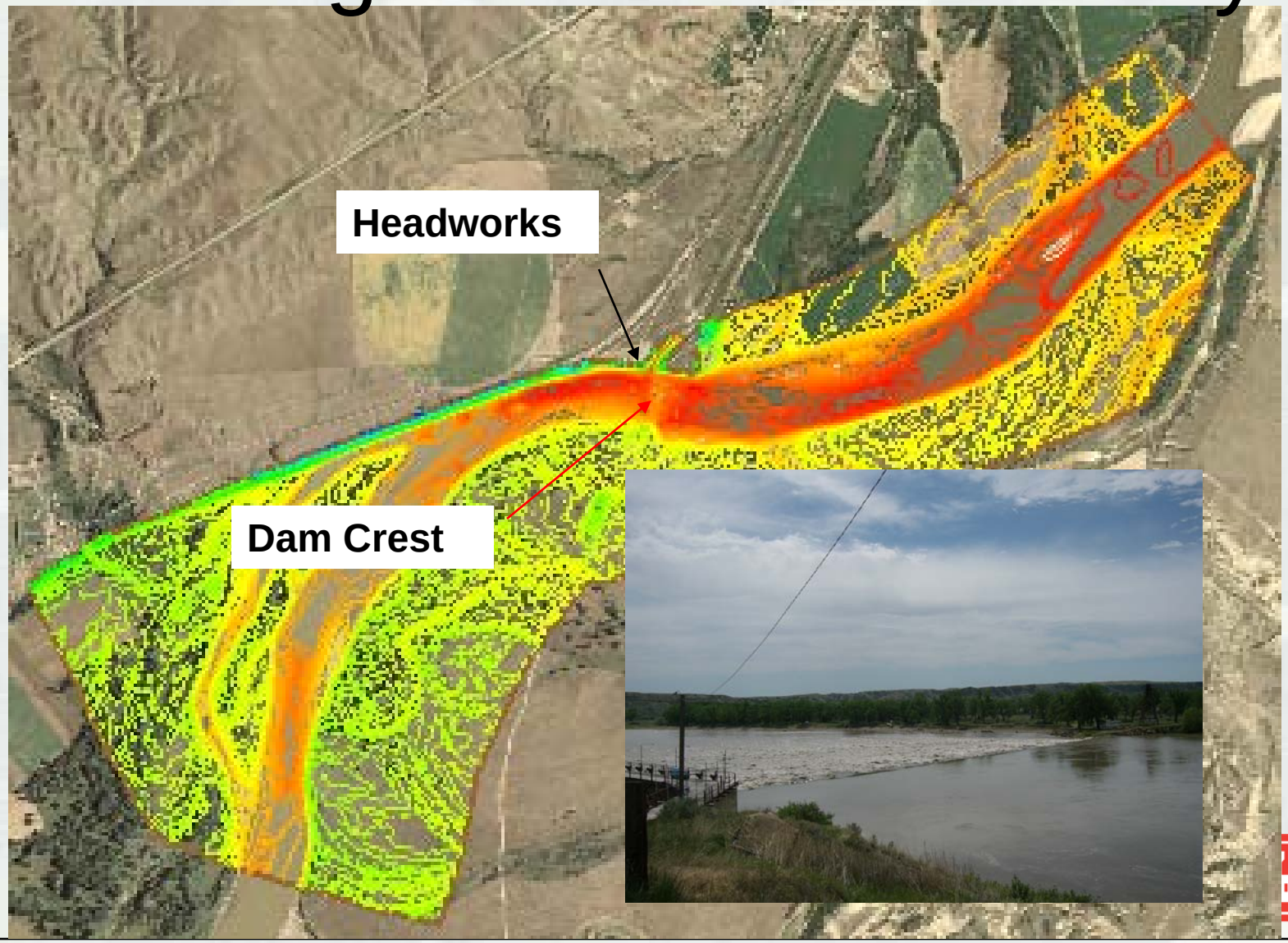
-Site data collection (surveys, wsel from several flows, sediment data)

-RAS 1D model for initial ramp configuration

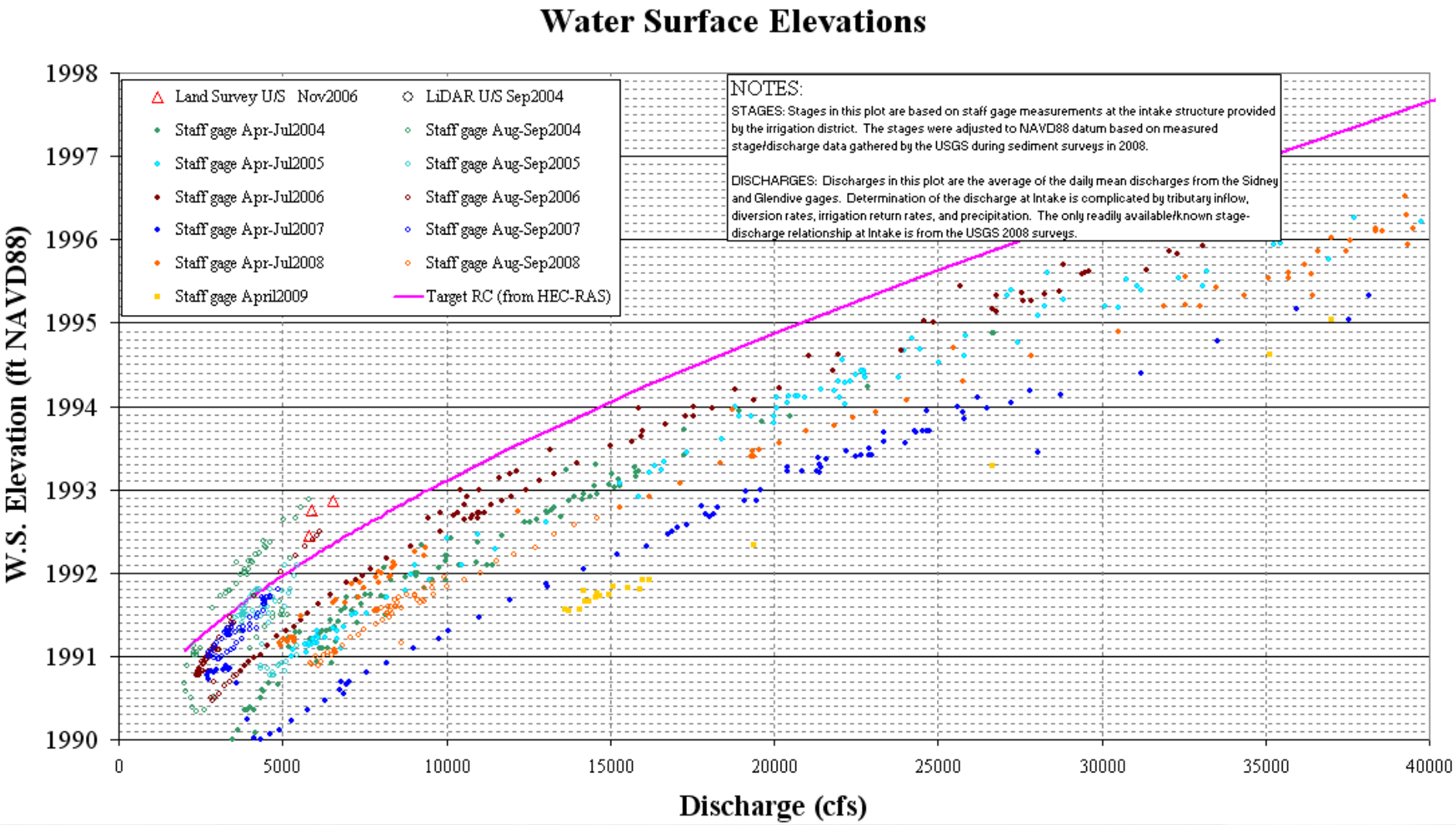
-ADH 2D modeling

-Physical model at Reclamation lab at Denver TSC (2 phases for headworks and ramp, include sediment)

Existing Condition Geometry



Existing Condition

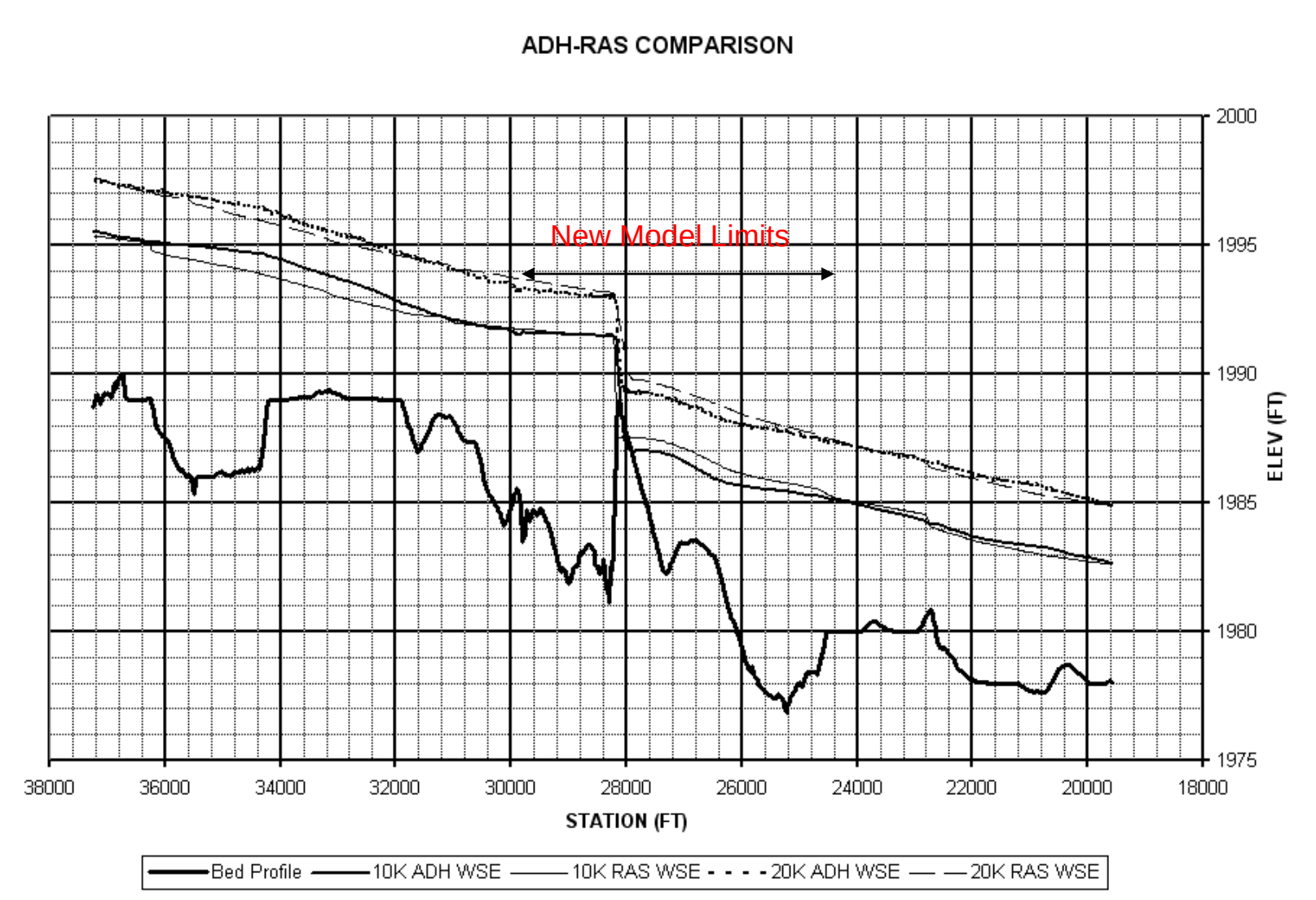


Mesh

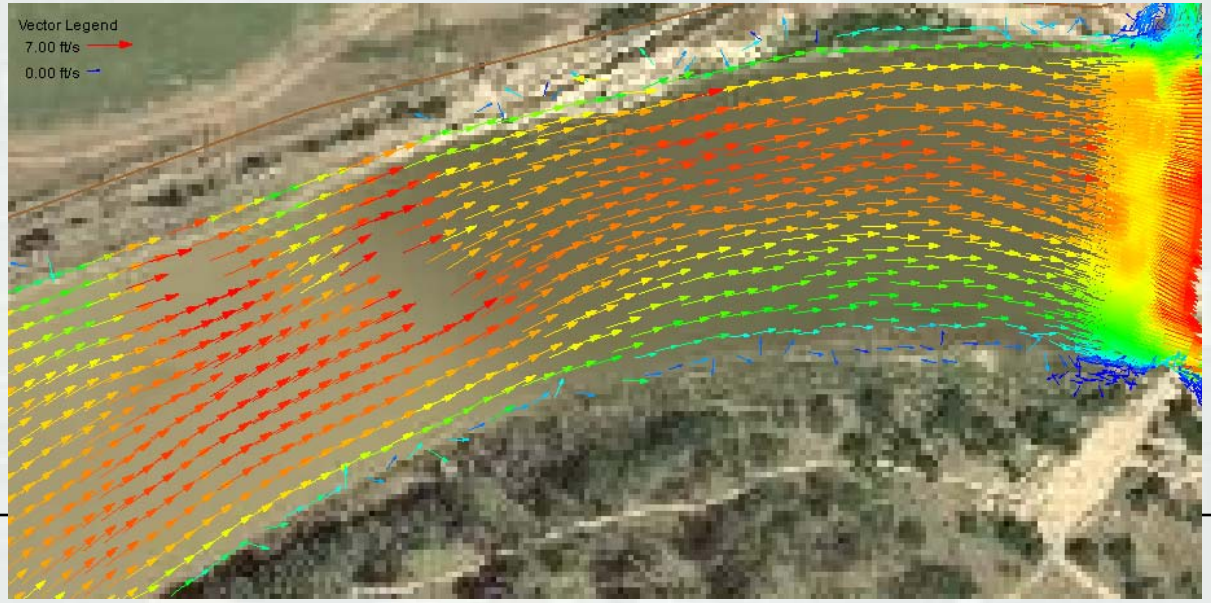
- Yellowstone RM 70.8 – RM 74.1
- 70,000 Elements; 35,000 Nodes
- Boundary Condition Derived from HEC-RAS
- …LONG run times

material	n
Banks	0.05
Diversion Channel	0.038
High Flow	0.031
Downstream	0.03
Ramp	0.043
Upstream	0.0285

Calibration



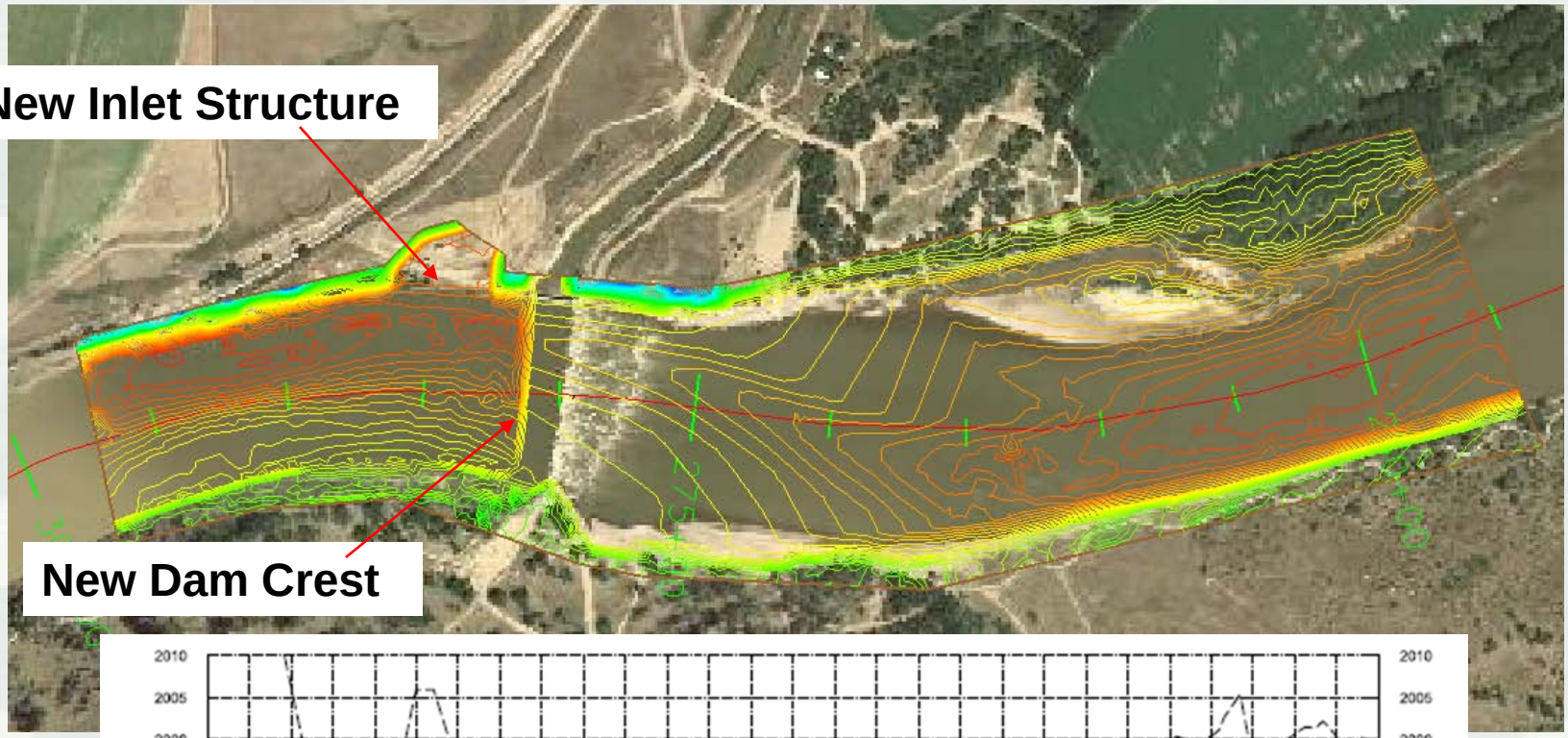
ADCP Comparison

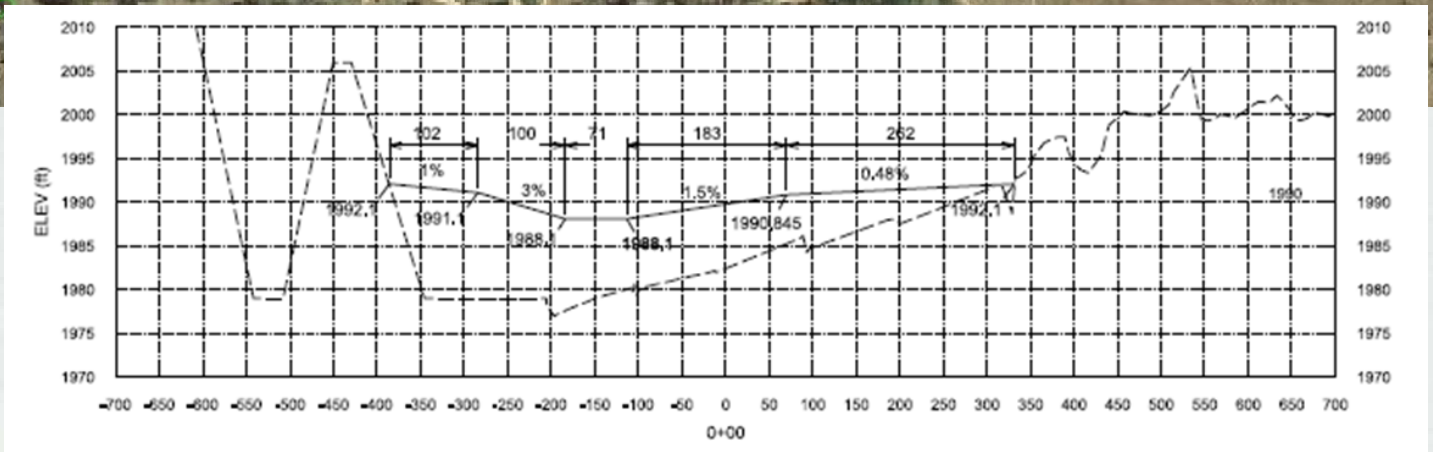


Selection of Design Geometry

- Multiple Iterations, 10+
- Variable Slope Ramp
  - Extends over 1500’, overall slope just over .004 ft/ft
  - Varying Crest from 1988.1 to 1992.1

Design Geometry

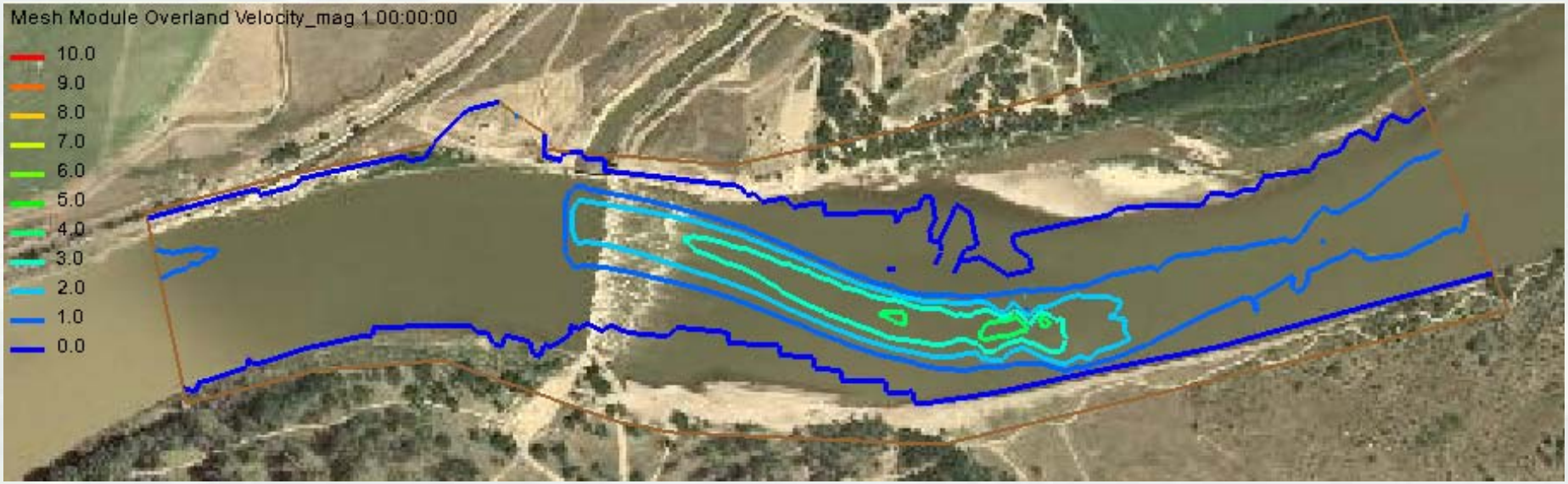


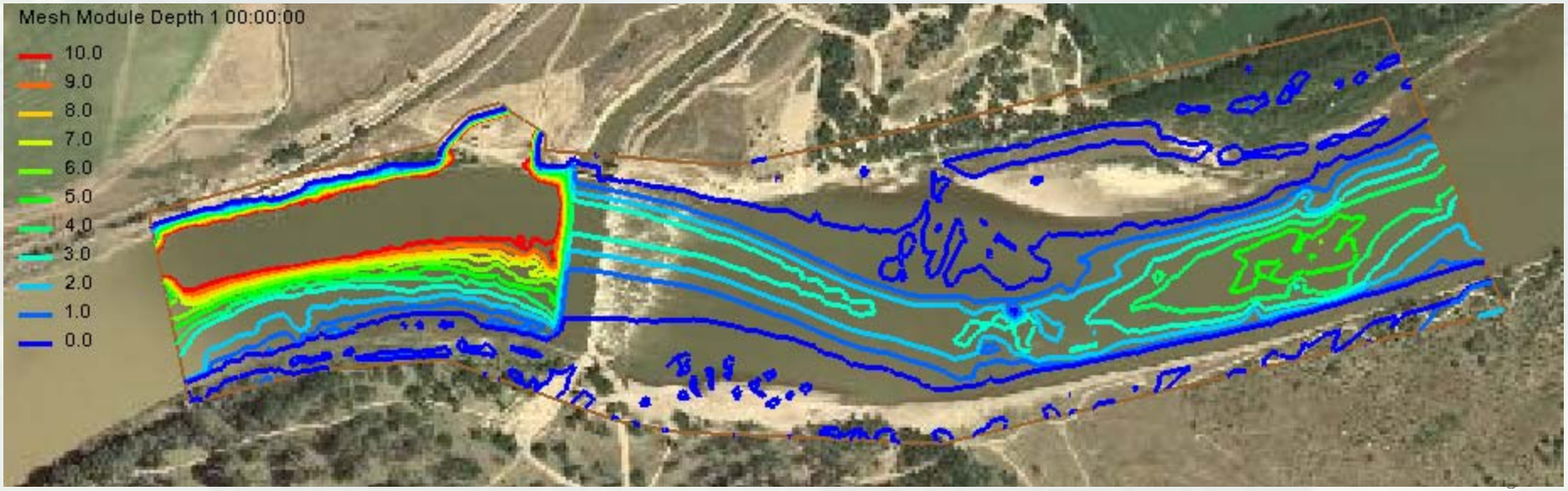


Model Parameters

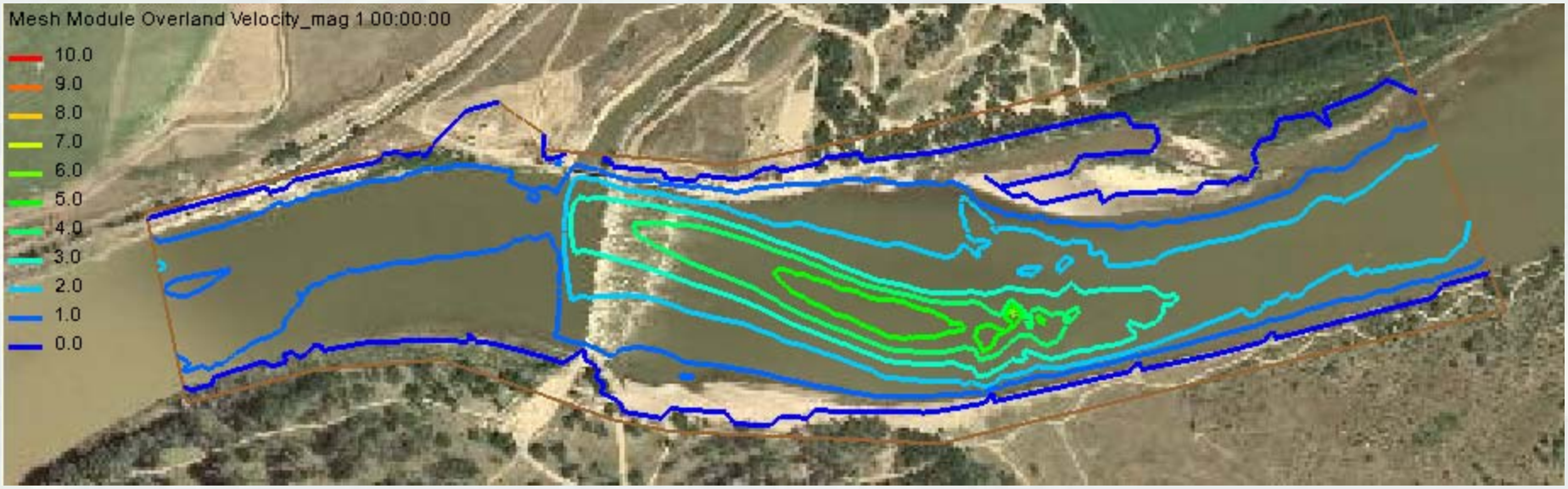
- 7700 Elements; 4000 nodes
- Downstream boundary set based on ADH model of existing conditions.
- Canal outflow set to 1360 cfs, gates not modeled
- IP NTL and ITL set to 0.1
- No refinement
- Wetting and drying, from 0.4/0.4 to 0.3/0.5
- FR MNG for roughness
  - .0285 - .031 for upstream/downstream channel
  - .043 for ramp, .032 for sensitivity analysis

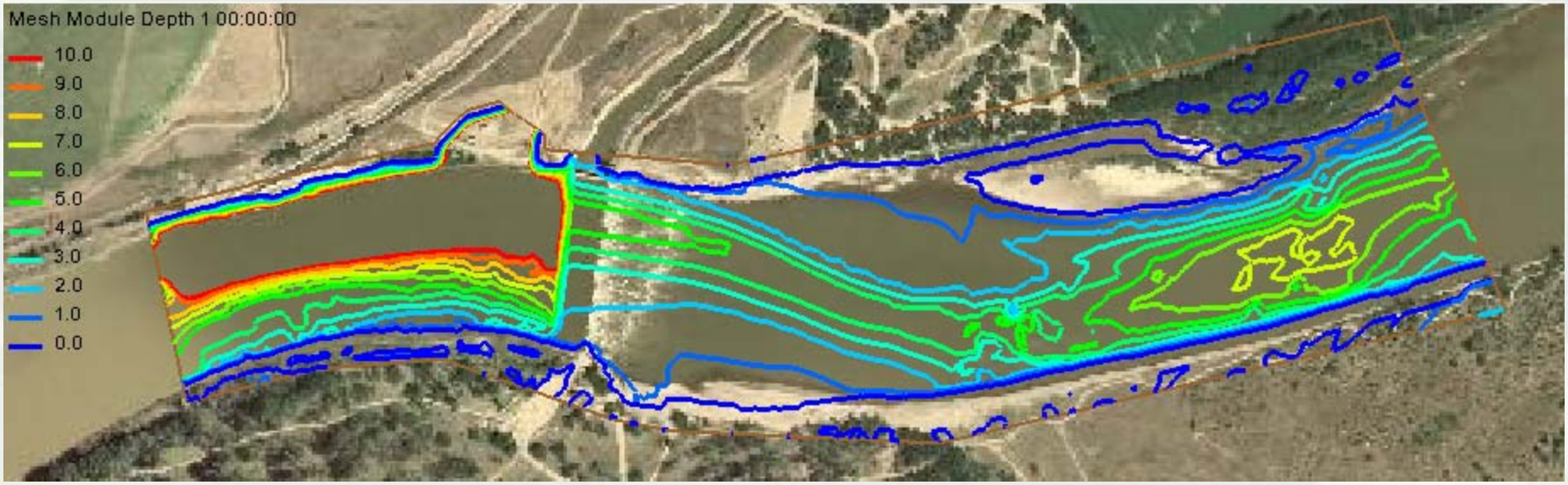
Results – 3000 cfs



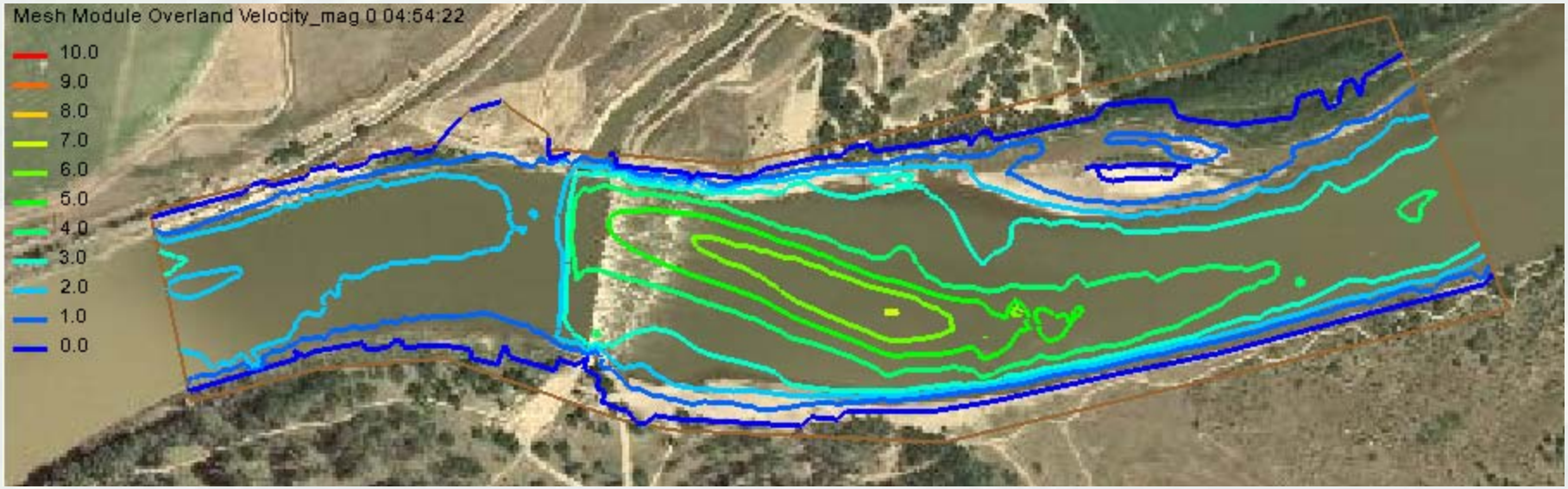


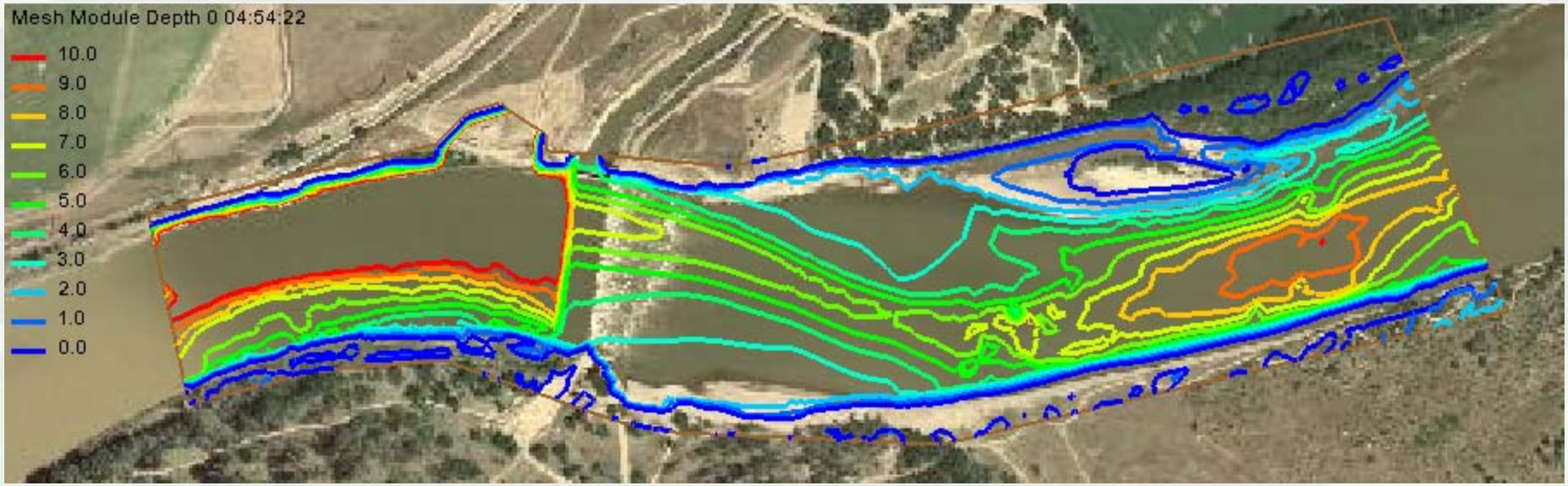
Results – 7000 cfs



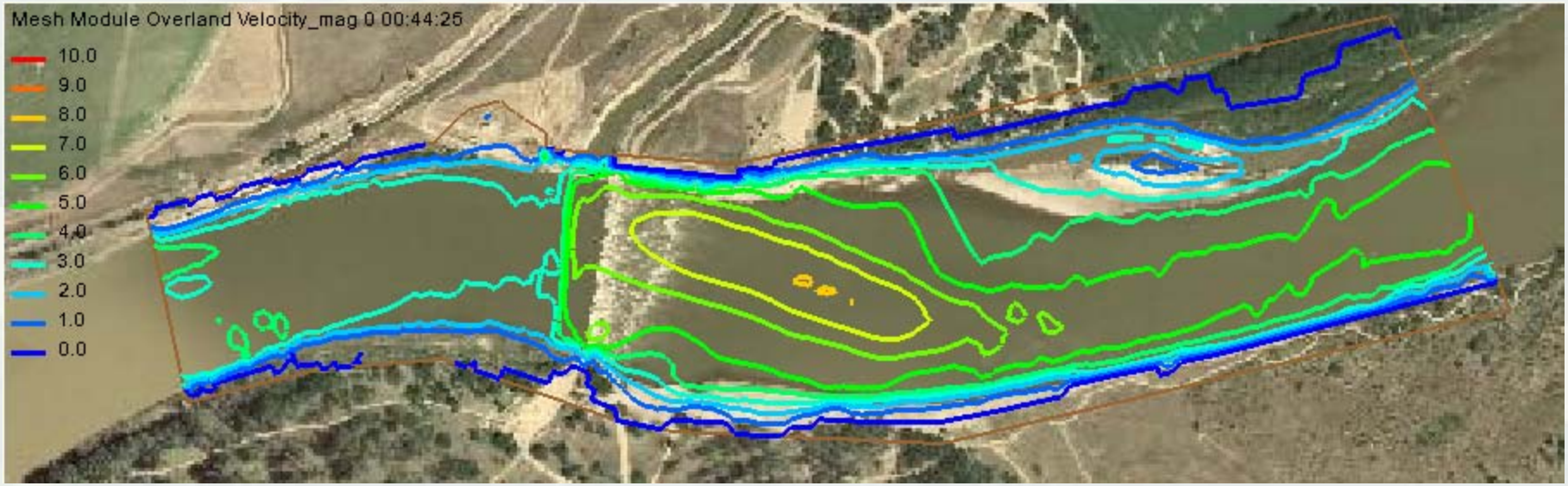


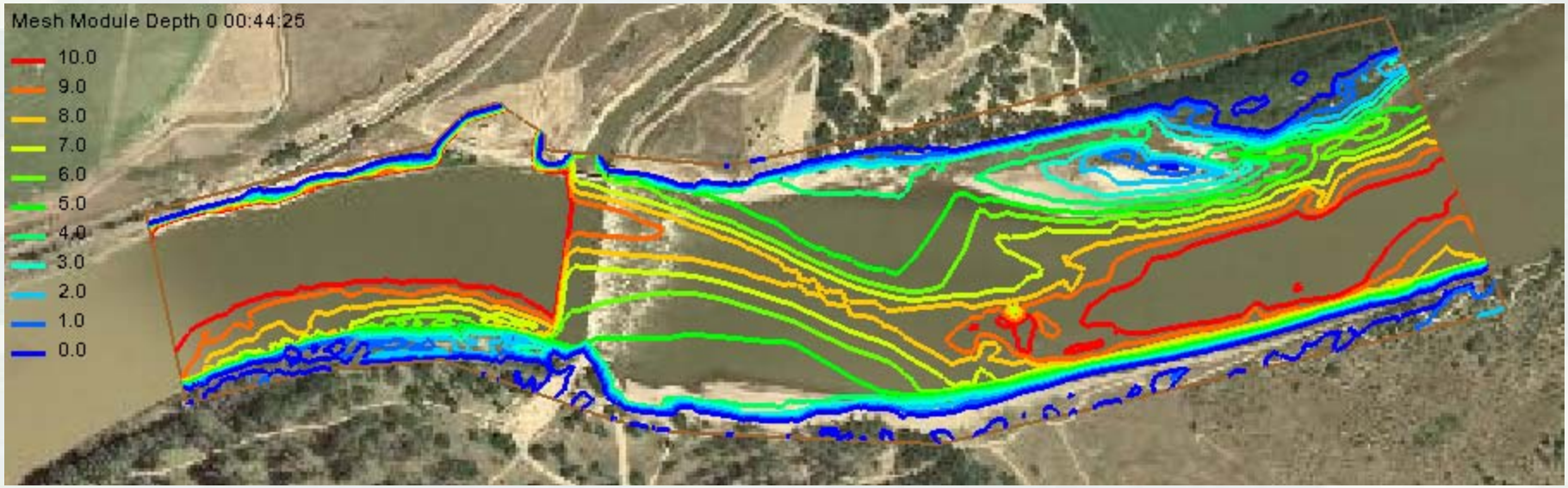
Results – 15000 cfs



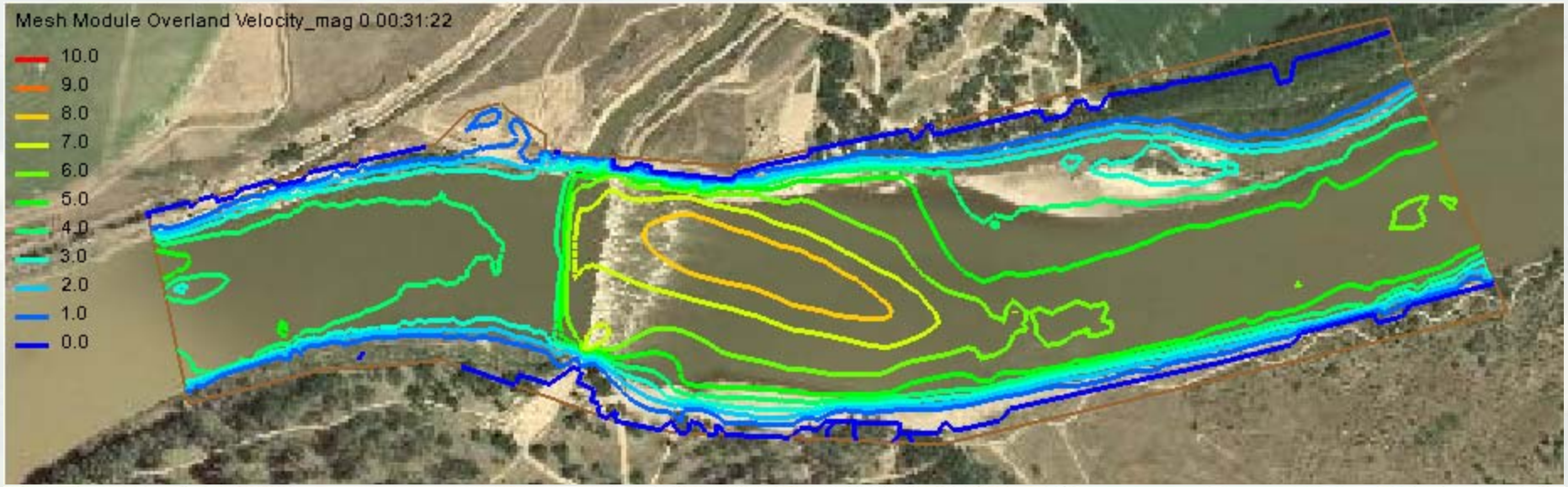


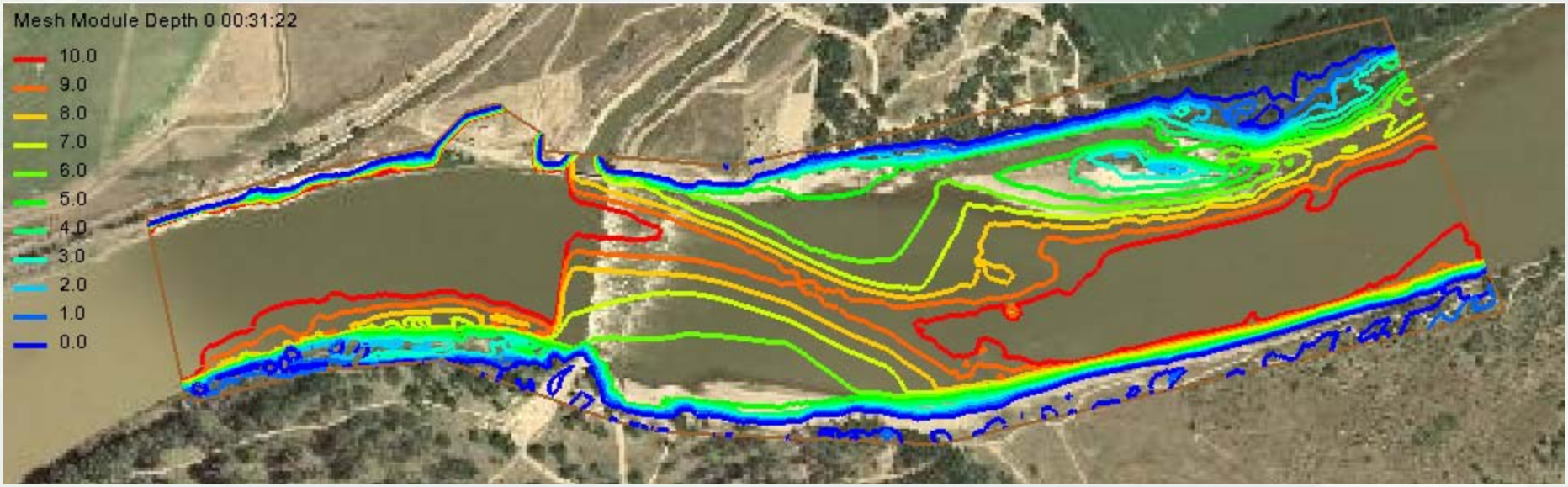
Results – 30000 cfs





Results – 40000 cfs

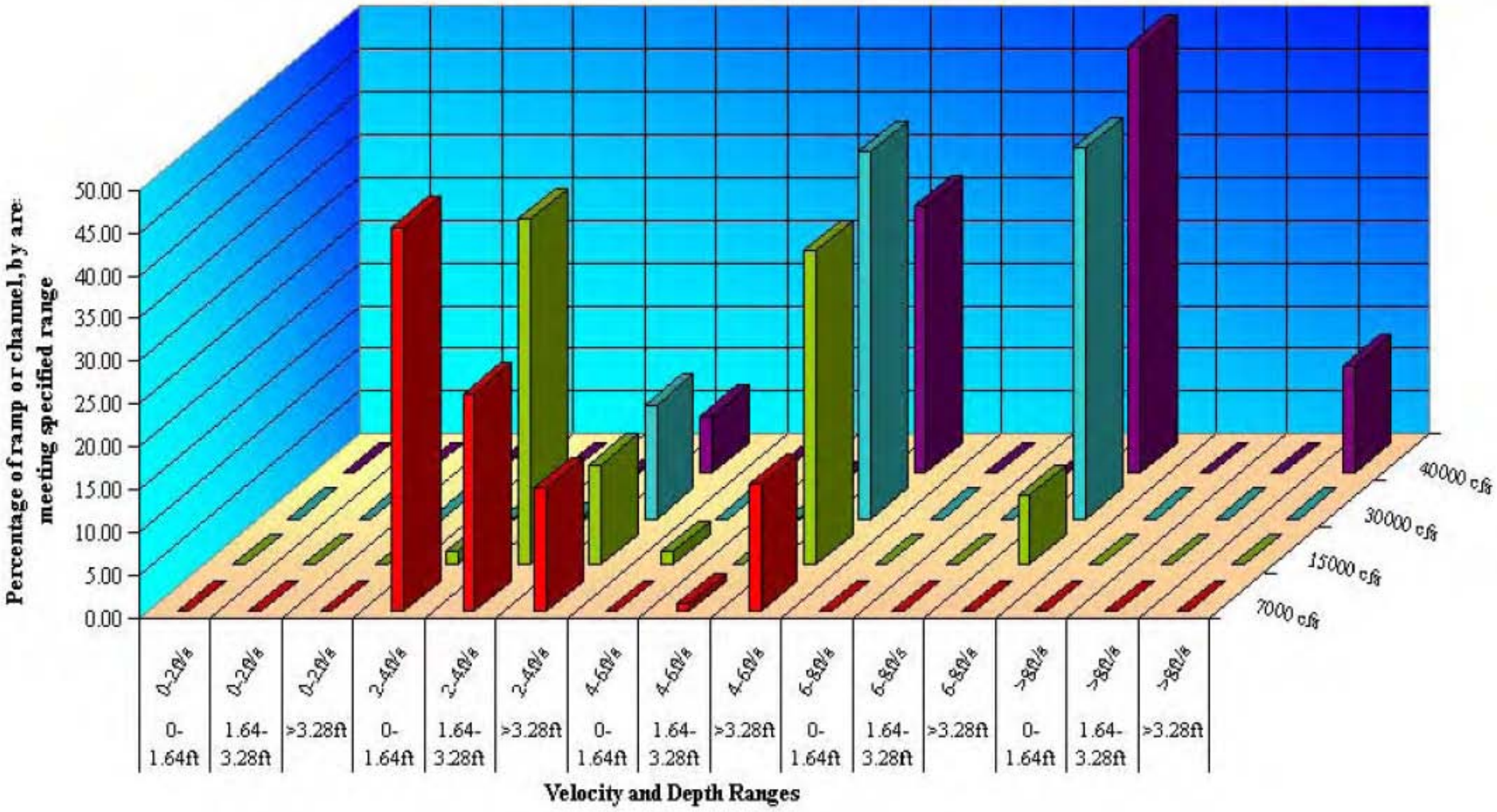




Model Evaluation Tool

- Tool developed by Ronnie Heath, ERDC
- Allows evaluation of depth and velocity area on the ramp, use to compare performance
- GIS based with x, y, parameter for input

Results Summary



Issues

- Moving target for calibration
- Best way to handle roughness?
  - ADH is showing values considerably greater than HEC-RAS and Physical Models of the same geometry
  - Estimating roughness height for ramp (D100 about 24 inches, backfilled with choke stone native river gravels)
- Demonstrating ramp fish passage and meeting design criteria (depth/velocity), most interested in the shallow flow, low velocity areas, concerns with both ADH and physical model values in shallow depths with high roughness

Discussion?