RECLAMATION

Managing Water in the West

Hood River Basin Study

Groundwater Modeling

19NOV2013

U.S. Department of the Interior

Bureau of Reclamation

Previously…

- Presented Steady-State model development, results, and calibration
- Proposed an approach and received feedback towards scenario modeling
- Met with USGS and County for modeling and scenario refinement

Today

- Transient model development, results, and calibration
- Modeling scenario definitions and results

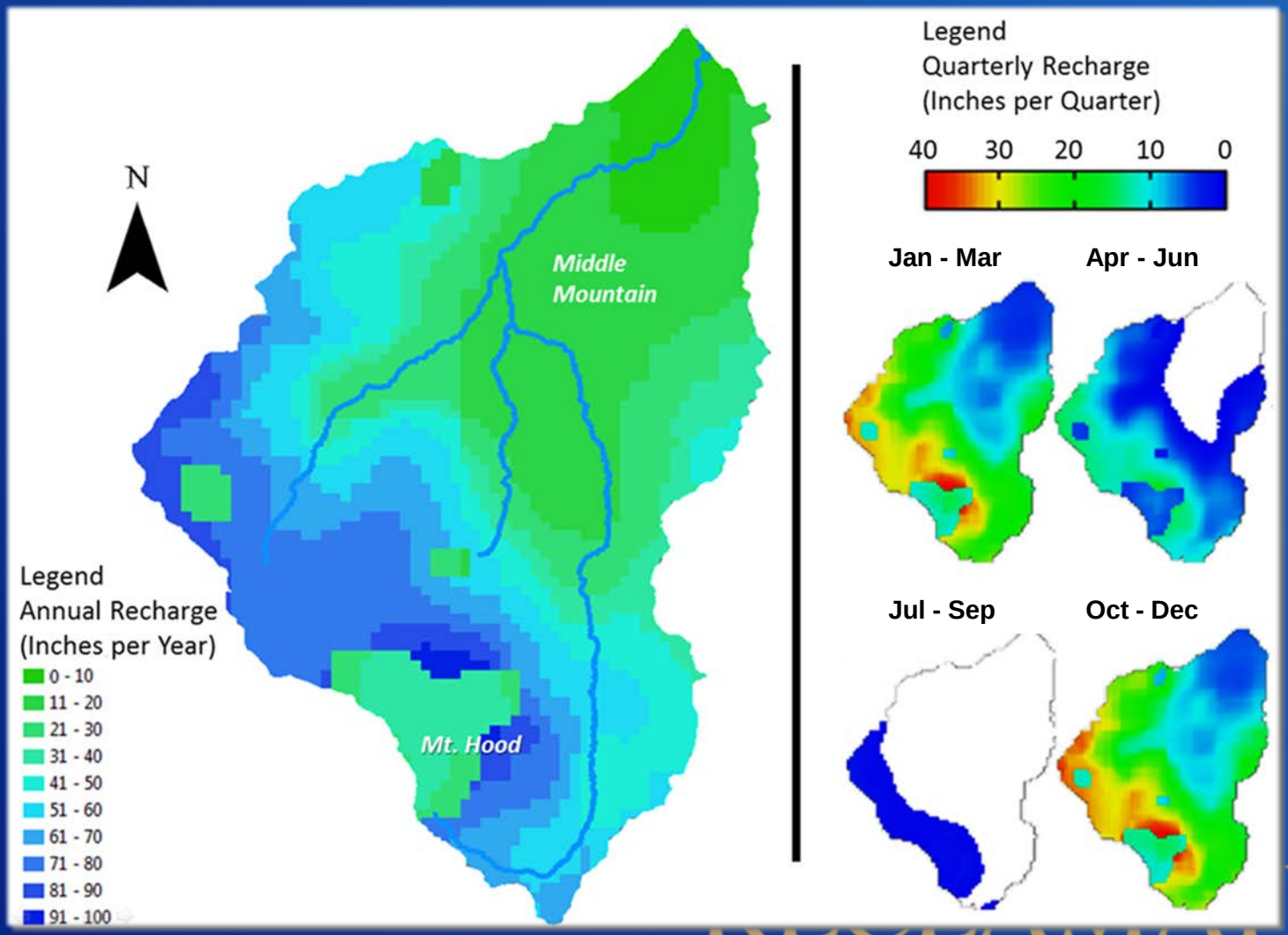
Transient Model Development

- All model inputs and parameters are adapted from the Steady State model
  - Pumping, recharge, conductivities, etc.
- Quarterly model time-steps (Jan – Mar, Apr – Jun, etc.)

Transient Aquifer Recharge

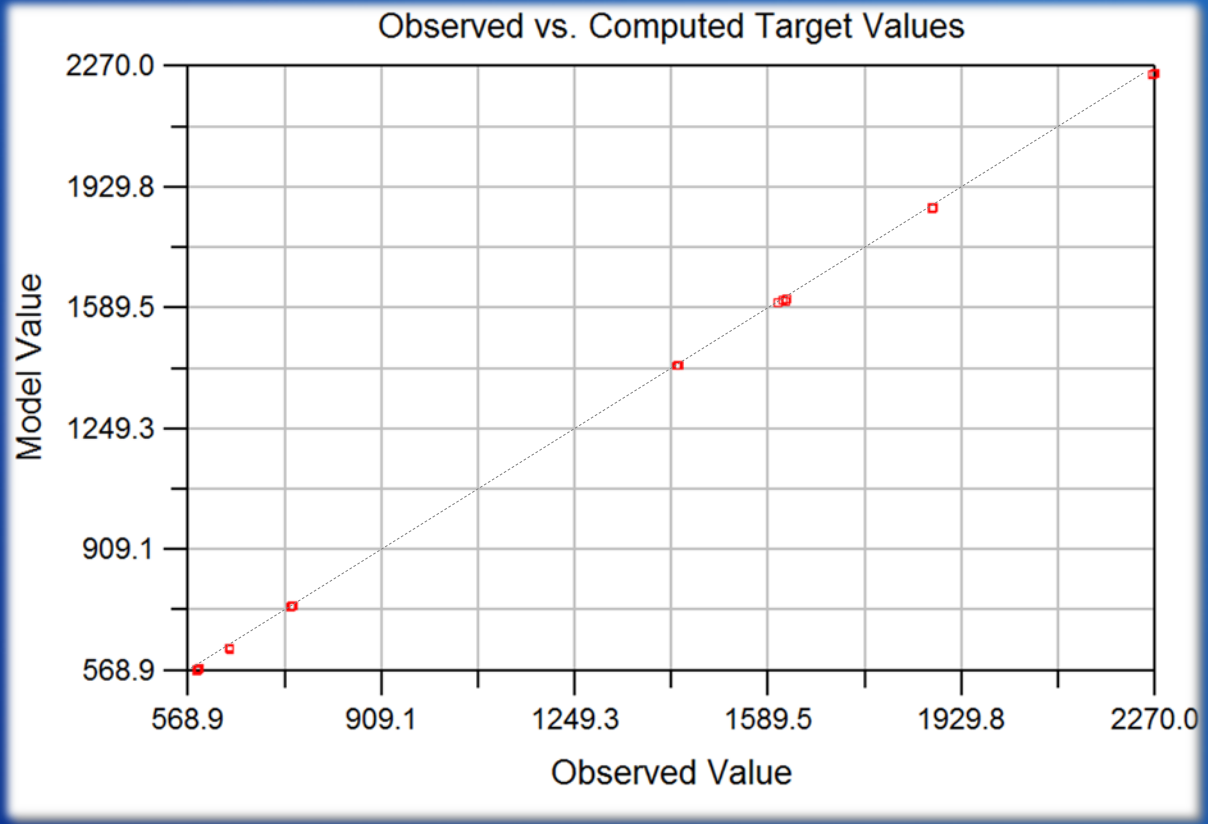
Steady State

Transient



Model Calibration: Transient

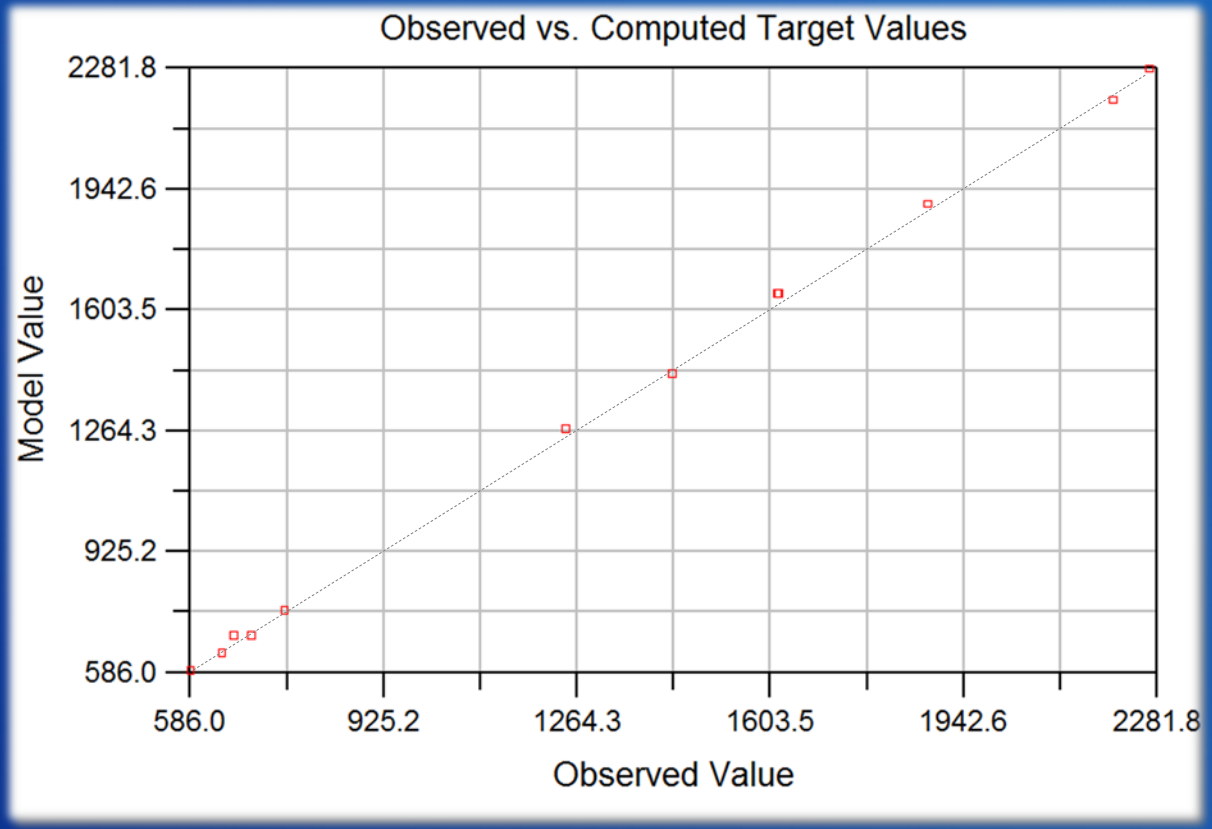
Residual Mean	= 8.46
Residual Standard Dev.	= 6.42
Absolute Residual Mean	= 8.51
Residual Sum of Squares	=1.58e+004
RMS Error	=10.62
Minimum Residual	= -0.83
Maximum Residual	= 21.14
Range of Observations	= 1686.00
Scaled Res. Std. Dev.	= 0.004
Scaled Abs. Mean	= 0.005
Scaled RMS	= 0.006
Number of Observations	= 140



RECLAMATION

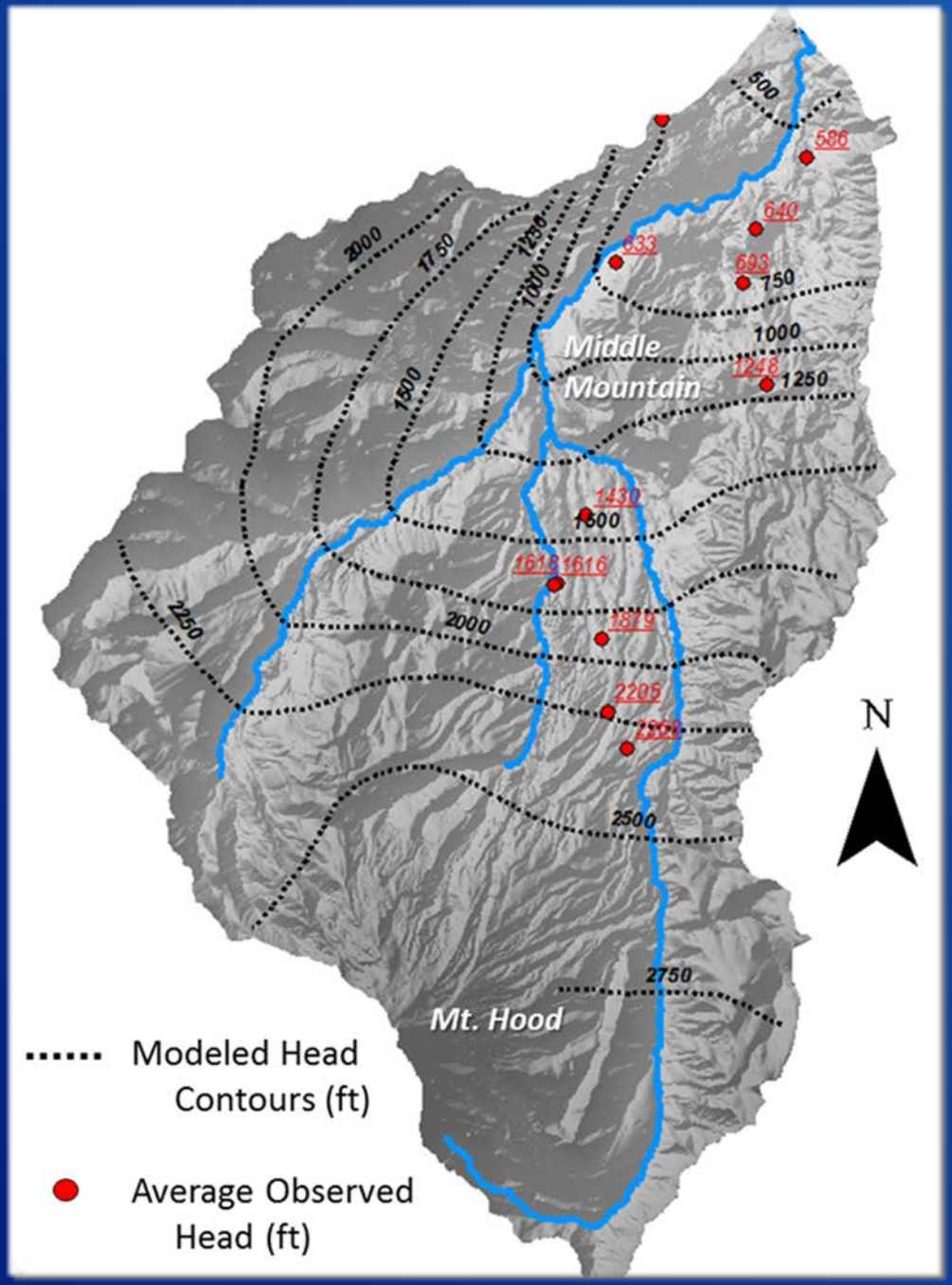
Model Calibration: Steady State

Residual Mean	= -12.60
Residual Standard Dev.	= 14.56
Absolute Residual Mean	= 15.58
Residual Sum of Squares	=4.45e+003
RMS Error	=19.25
Minimum Residual	= -33.34
Maximum Residual	= 10.41
Range of Observations	= 1682.00
Scaled Res. Std. Dev.	= 0.009
Scaled Abs. Mean	= 0.009
Scaled RMS	= 0.011
Number of Observations	= 12



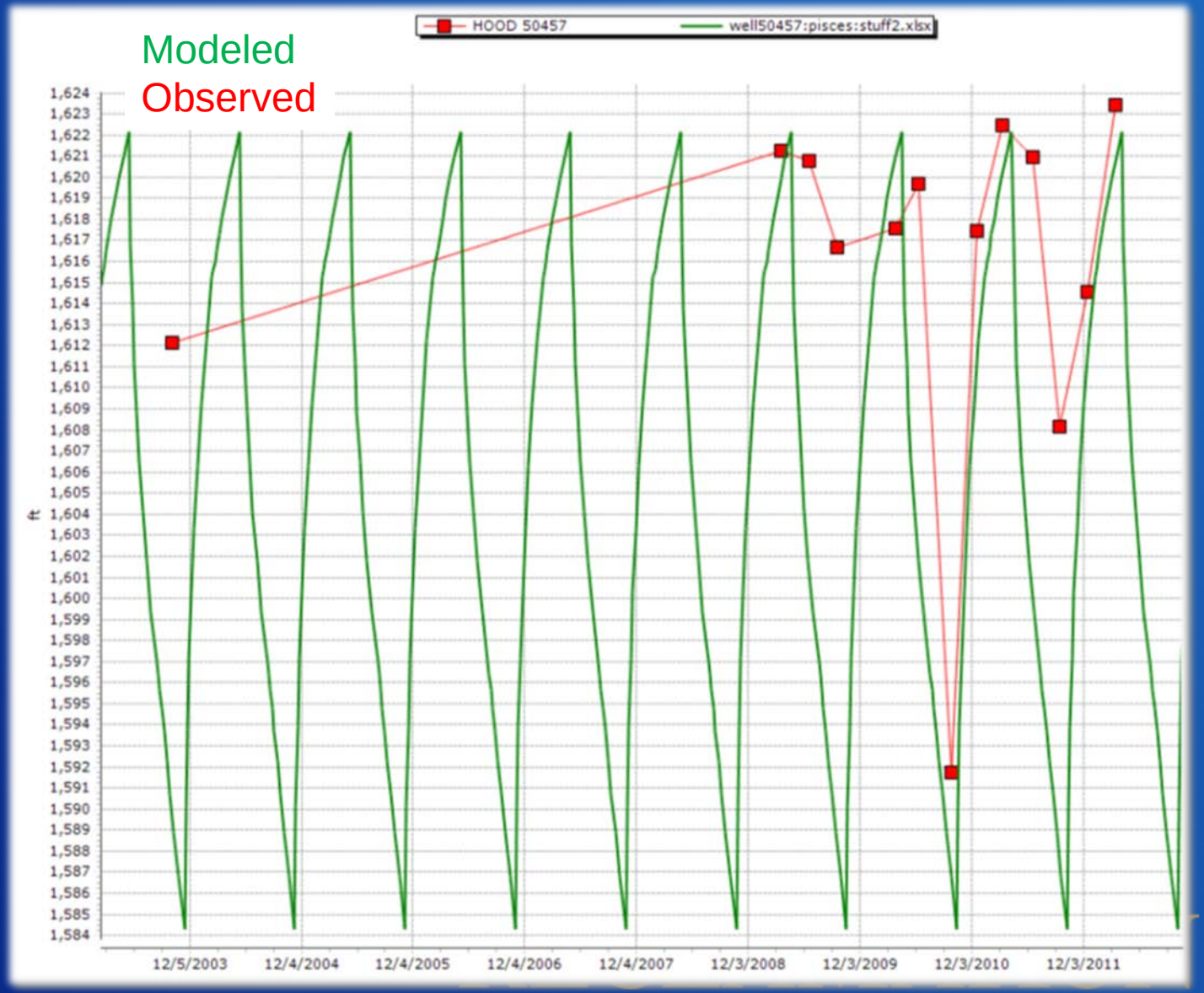
RECLAMATION

Head Comparison: Steady State

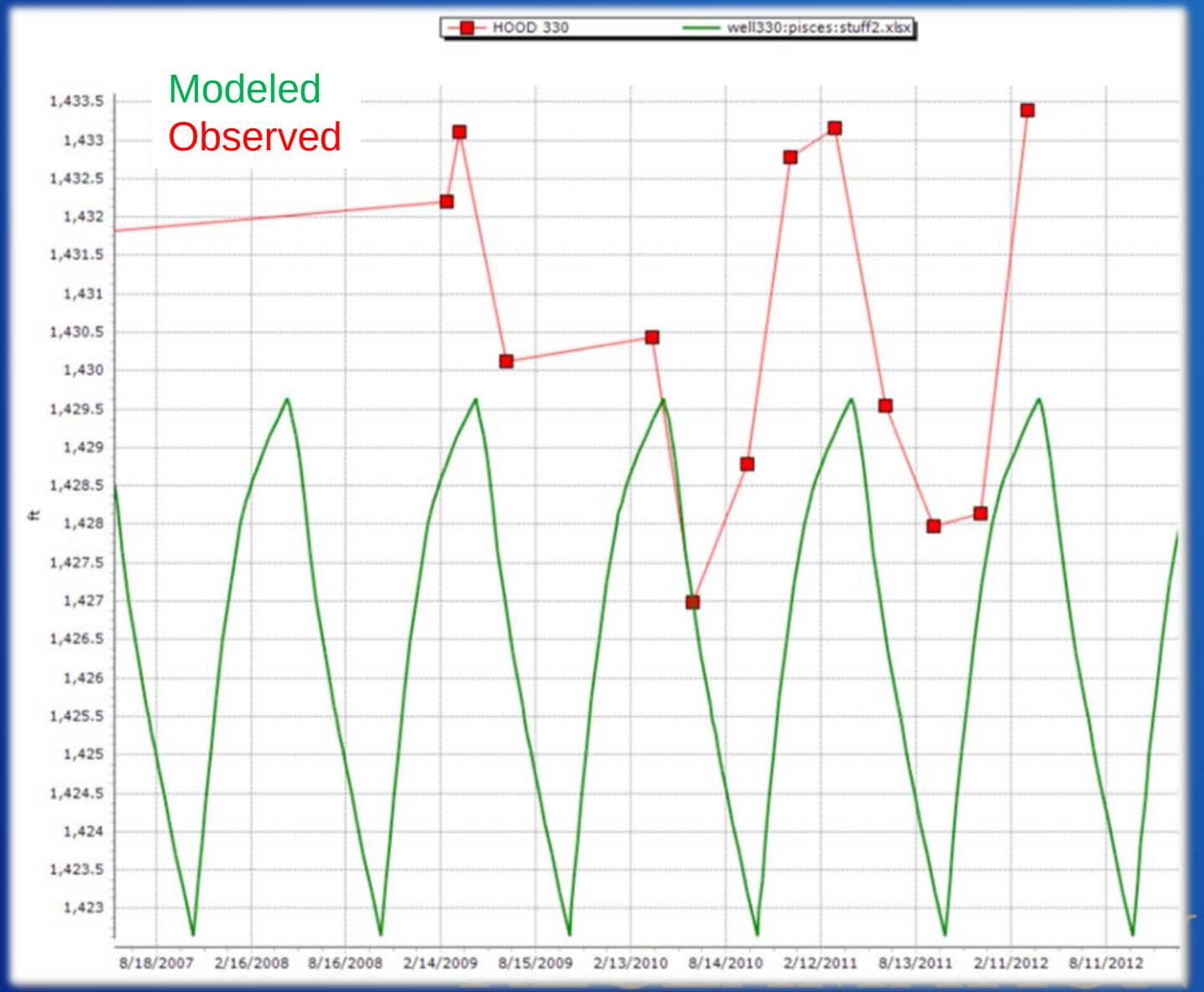


RECLAMATION

Head Comparison: Transient



Head Comparison: Transient



Modeling Scenarios

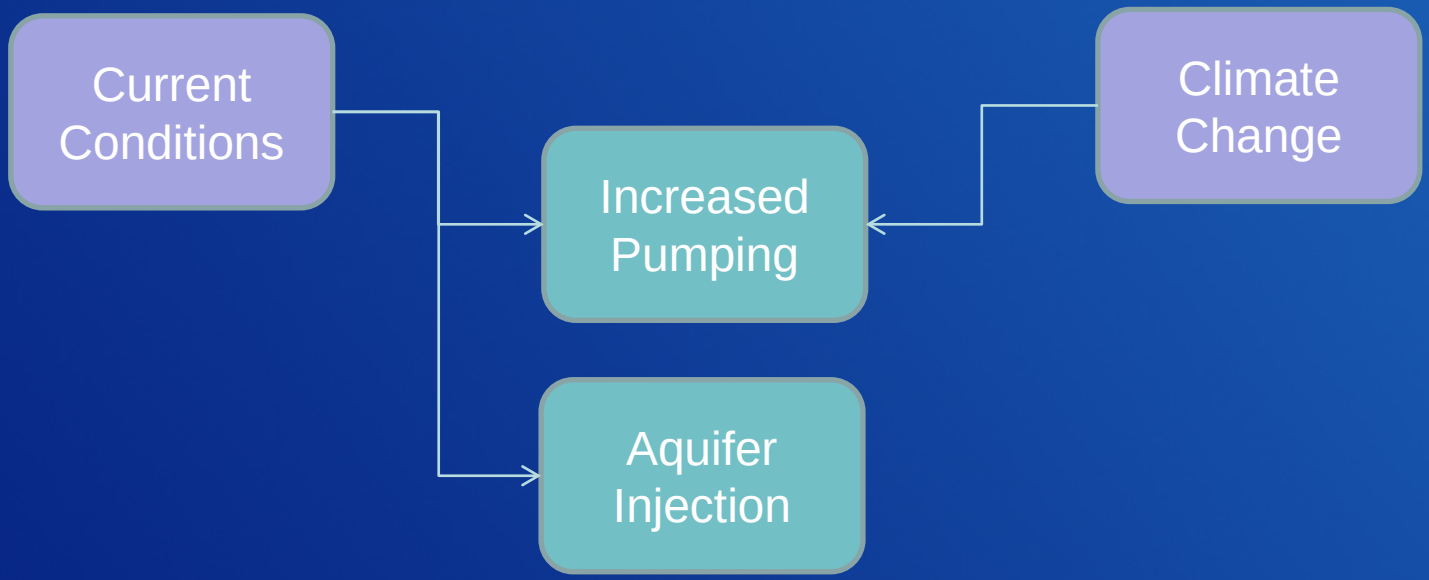
RECLAMATION

Scenario Goals

- Scenarios were formulated to answer the following questions:
  1. How will hydrologic changes due to climate change impact groundwater conditions?
  2. How will new development impact groundwater conditions in the basin including discharge to streams?
  3. Is managed recharge a viable option for improving stream flow?
  4. Can the basin aquifer be used for aquifer storage and recovery?

Model Scenarios

- Two underlying conditions each with two different scenarios
  - Conditions:
    - Current conditions
    - Climate change conditions
  - Scenarios:
    - Increased pumping
    - Aquifer injection



Current Conditions

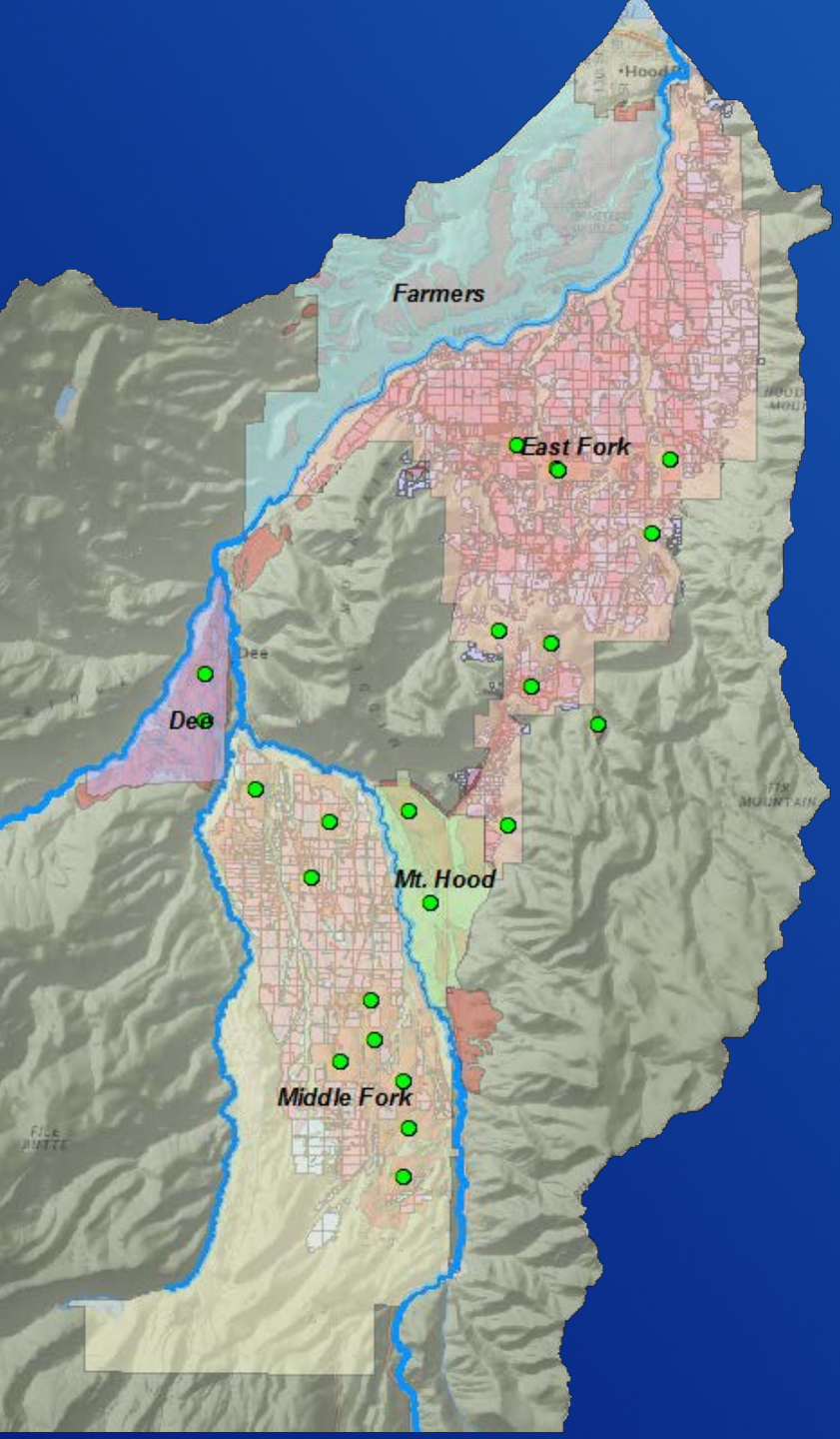
Scenario: Increased Pumping

- Maintain DMCI use
  - ~ 1% Domestic & Municipal, ~29% Commercial & Industrial, 70% Irrigation
- Increase irrigation use based on available irrigable acreage

ACREAGE IN HOOD RIVER COUNTY IRRIGATION DISTRICTS

District	Irrigable (acres)	Irrigated (acres)	Available (acres)	Qreqd (af/acre)	Wells Now	Needed Wells
DID	1297	951	346	2	0	2
EFID	10400	8525	1875	2	8	10
FID	7033	7033	0	2	6	
MFID	8000	6373	1627	2	2	9
MHID	1331	1090	241	2	0	2
SUM	28061	23972	4089			acres per well
Source: Hood River Soil & Water Conservation District, 1978.						200

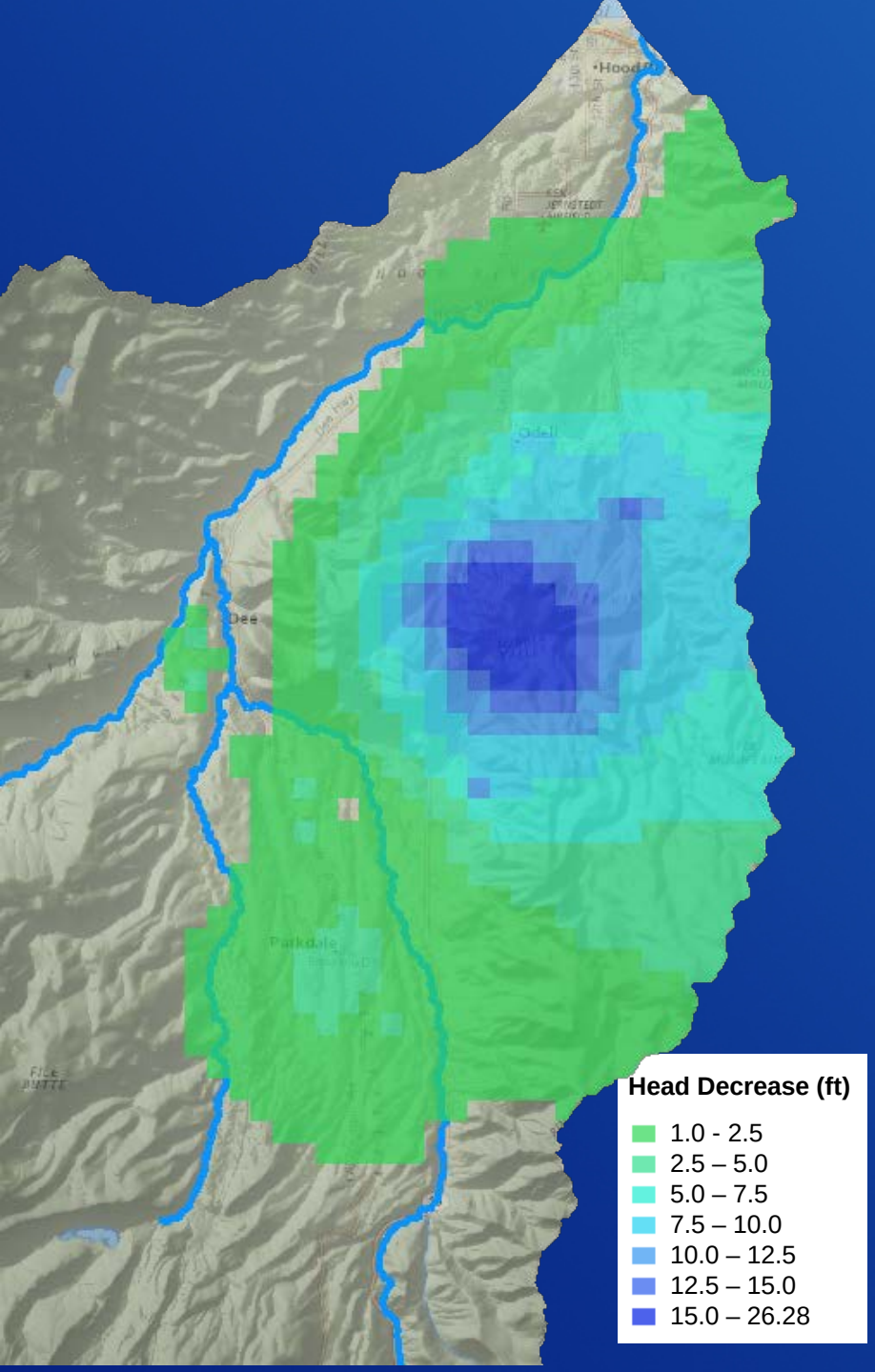
Source: http://www.co.hood-river.or.us/vertical/Sites/%7B4BB5BFDA-3709-449E-9B16-B62A0A0DD6E4%7D/uploads/%7B1A759675-F44C-4224-A1E2-311BC2003587%7D.PDF



Scenario: Increased Pumping

- Pumps added to irrigate prime farmlands within ID boundaries that are currently not irrigated

RECLAMATION



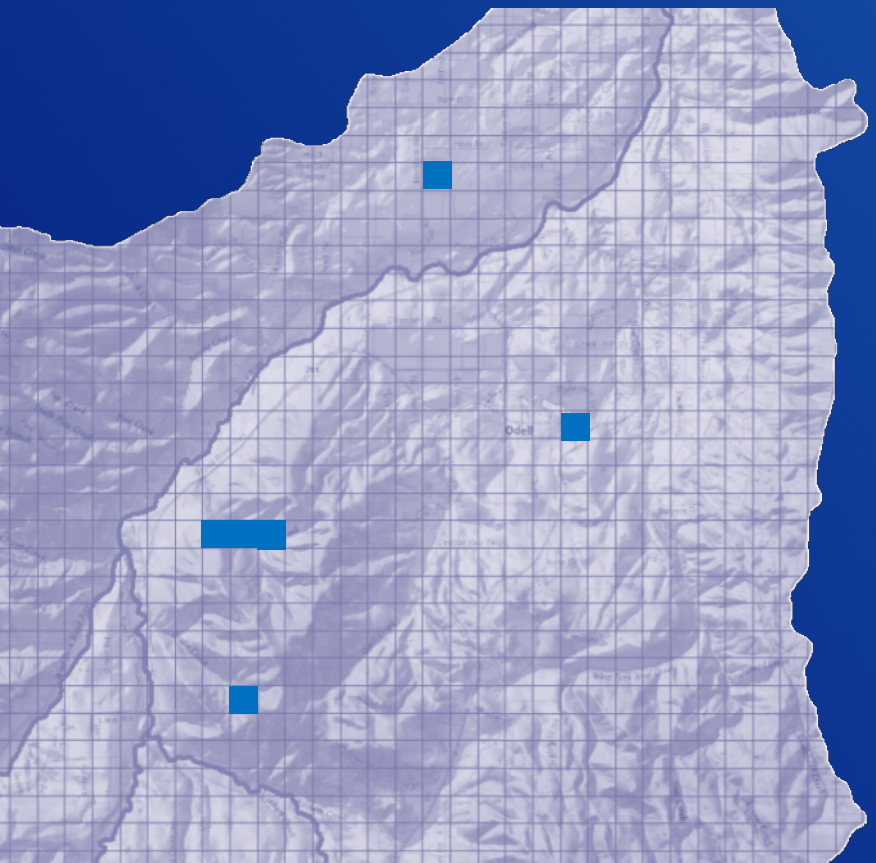
Scenario: Increased Pumping

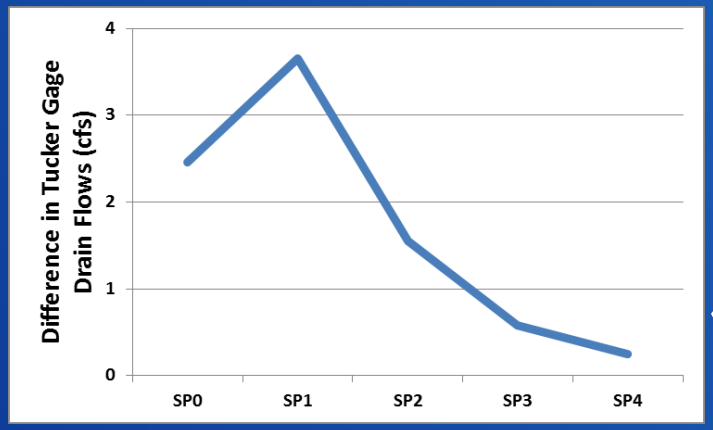
- Greatest head difference between Baseline and the scenario shown here
  - End of summer Year 5 for the given well configuration

RECLAMATION

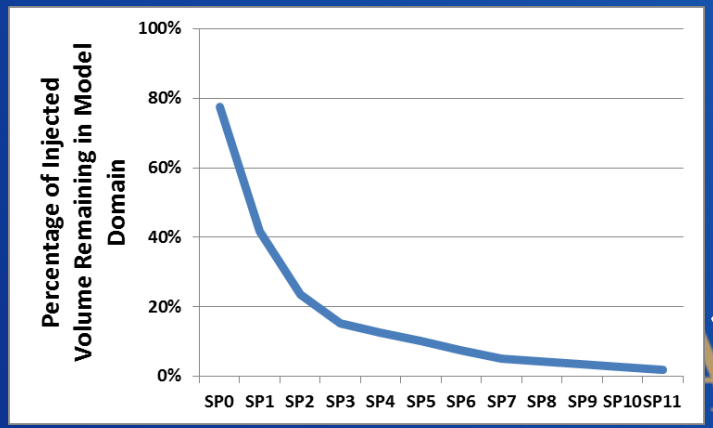
Scenario: Aquifer Injection

- Injection wells were iteratively added to each model cell and response for the entire model domain was evaluated and compared to the Baseline.





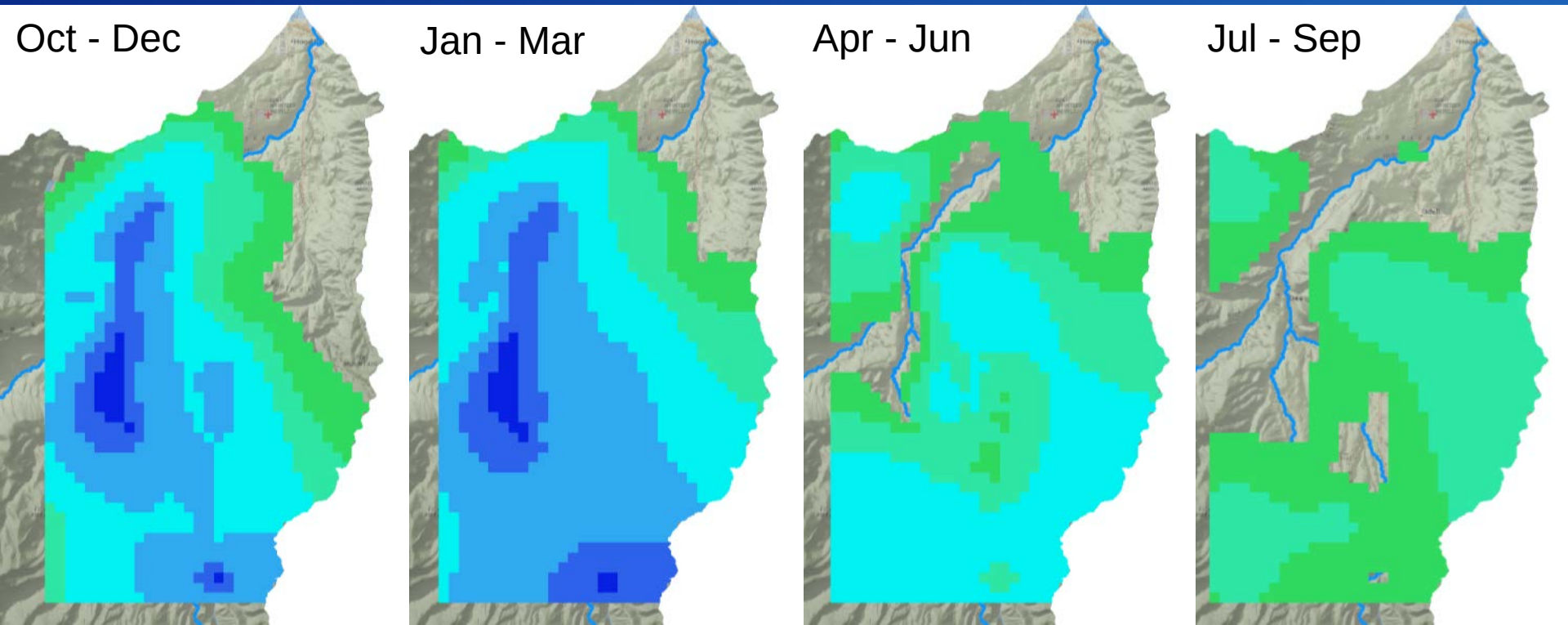
ASR for Streamflow Augmentation



ASR for Irrigation Withdrawal

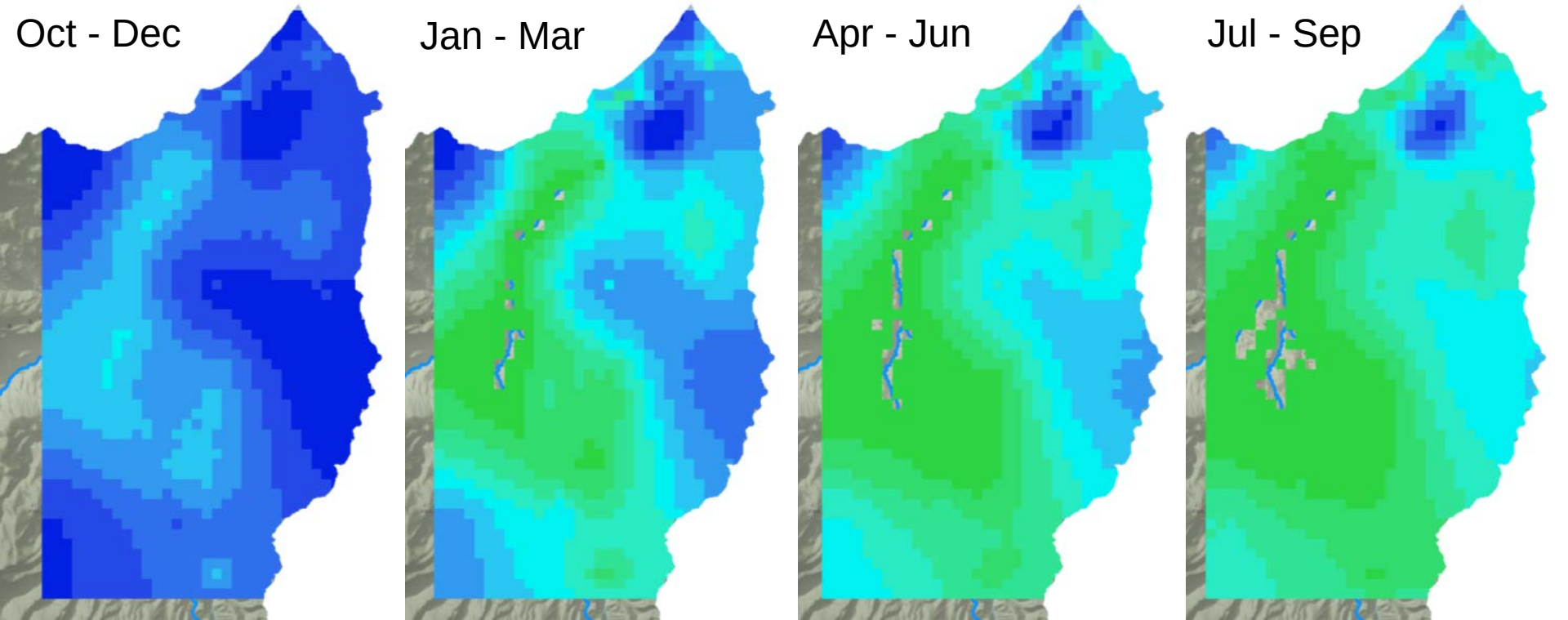
Scenario: Injection for Streamflow Augmentation

- Model response pertaining to the difference in stream gains for the Hood River at Tucker Bridge is mapped



Scenario: Injection for Irrigation Withdrawal

- Model response pertaining to the volume of injected water that is retained within the model domain is mapped



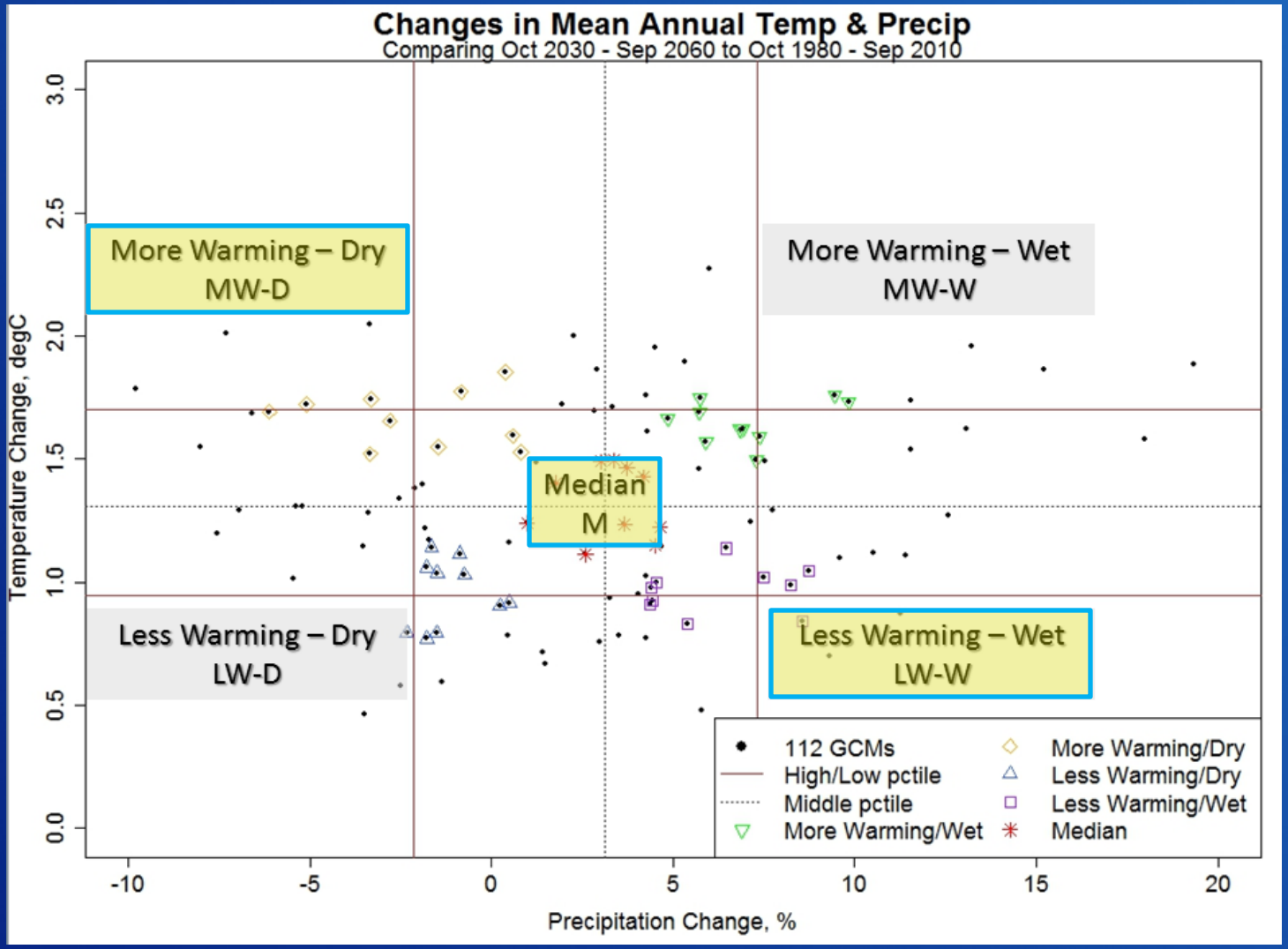
Climate Change Conditions

RECLAMATION

Climate Change Conditions

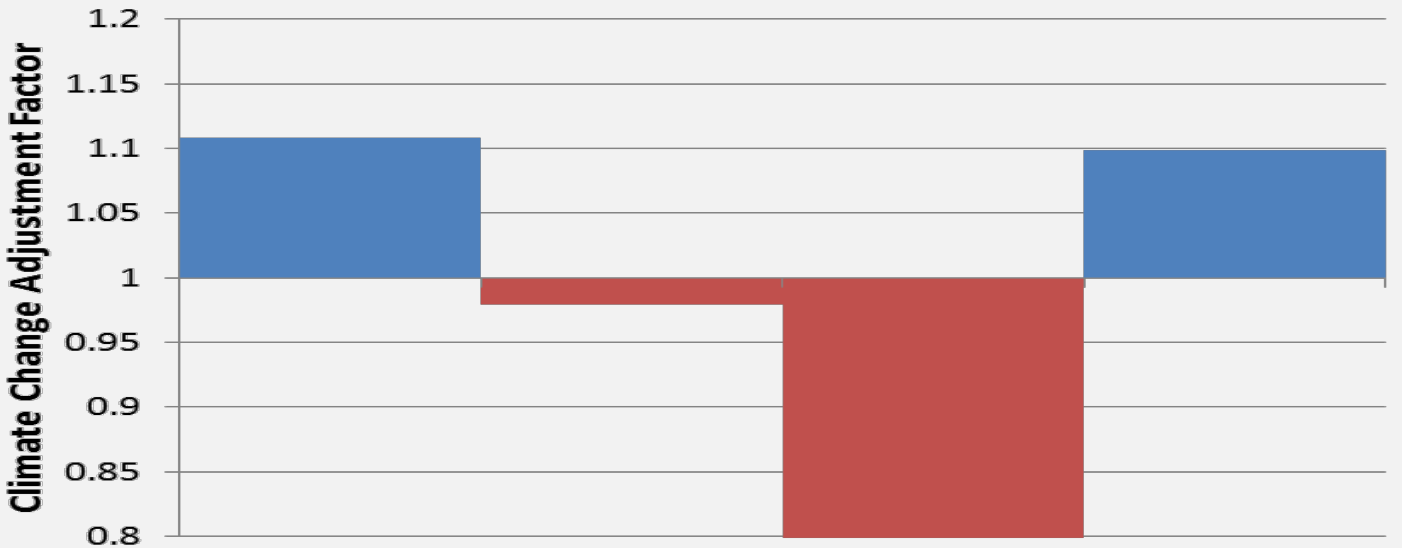
- Simulation of climate change conditions mimic procedures and strategies used in other Reclamation studies.
  - Projection Selection & Characterization
    - *3 Climate signals with 10 Projections each using the 20th, 50th, and 80th percentiles.*
  - Temporal Extent Selection
    - *Period Change: 1980 – 2010 vs. 2030 – 2060*
  - Projection Processing Methodology
    - *Hybrid Delta Ensemble*
  - Dataset Selection
    - *CMIP3*

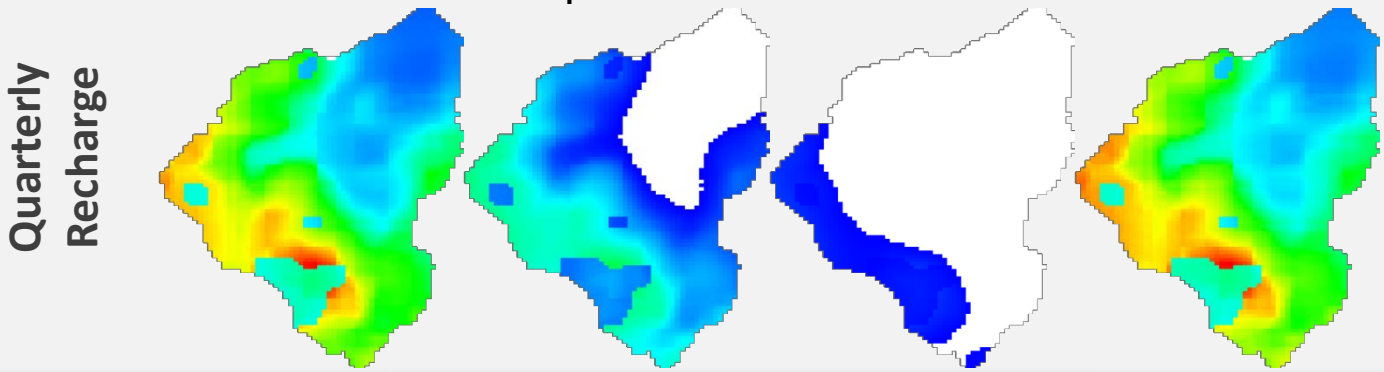
Climate Change Conditions



RECLAMATION

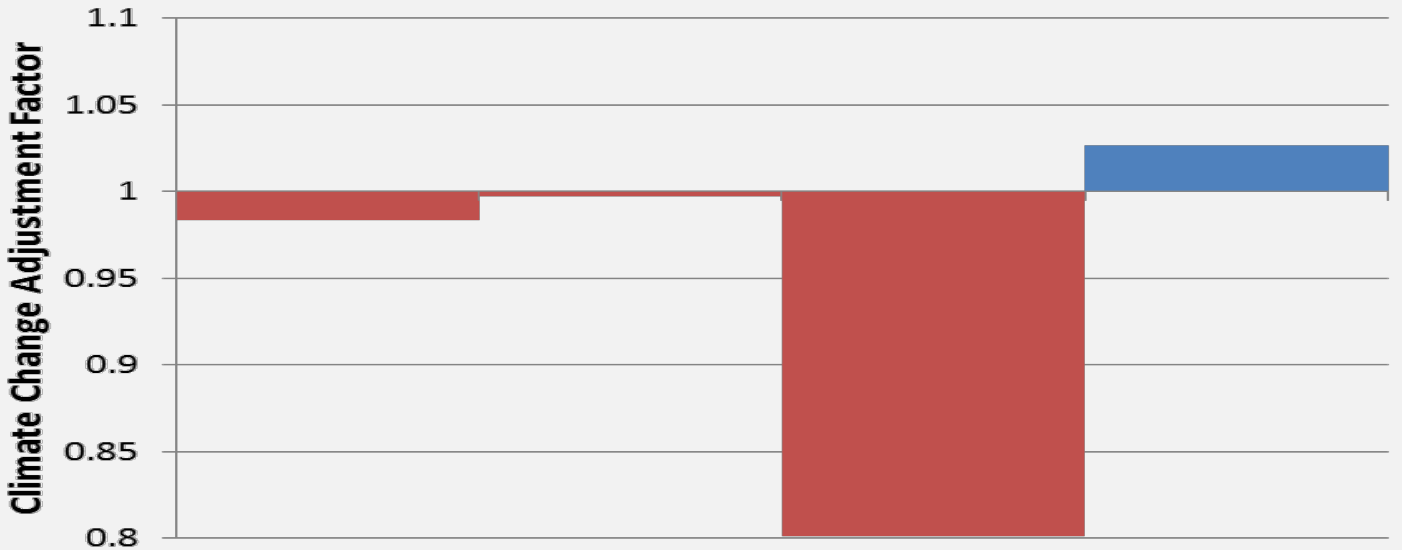
Modeled Recharge: Wet Conditions





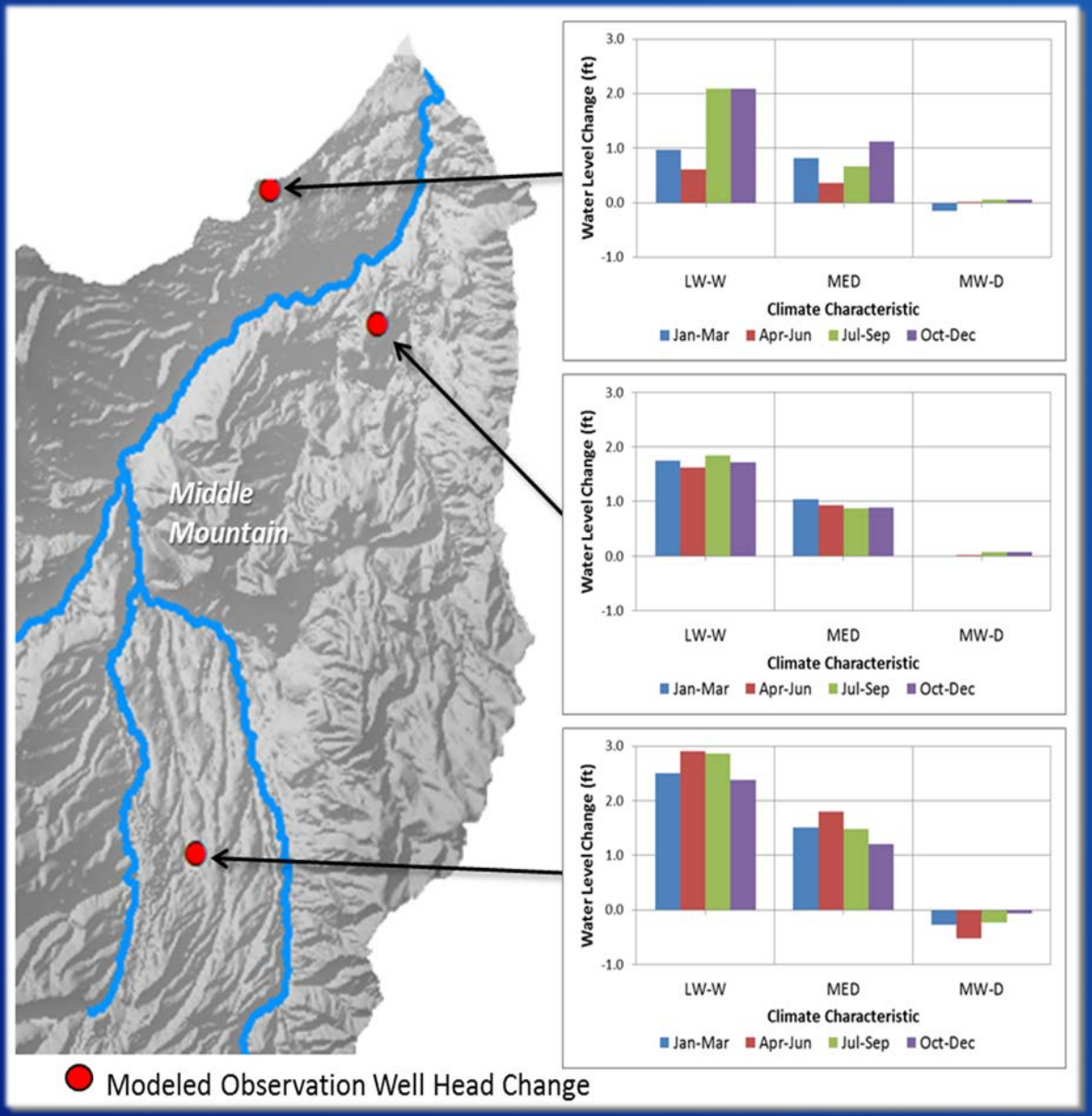
RECLAMATION

Modeled Recharge: Dry Conditions



RECLAMATION

Climate Change Head Change

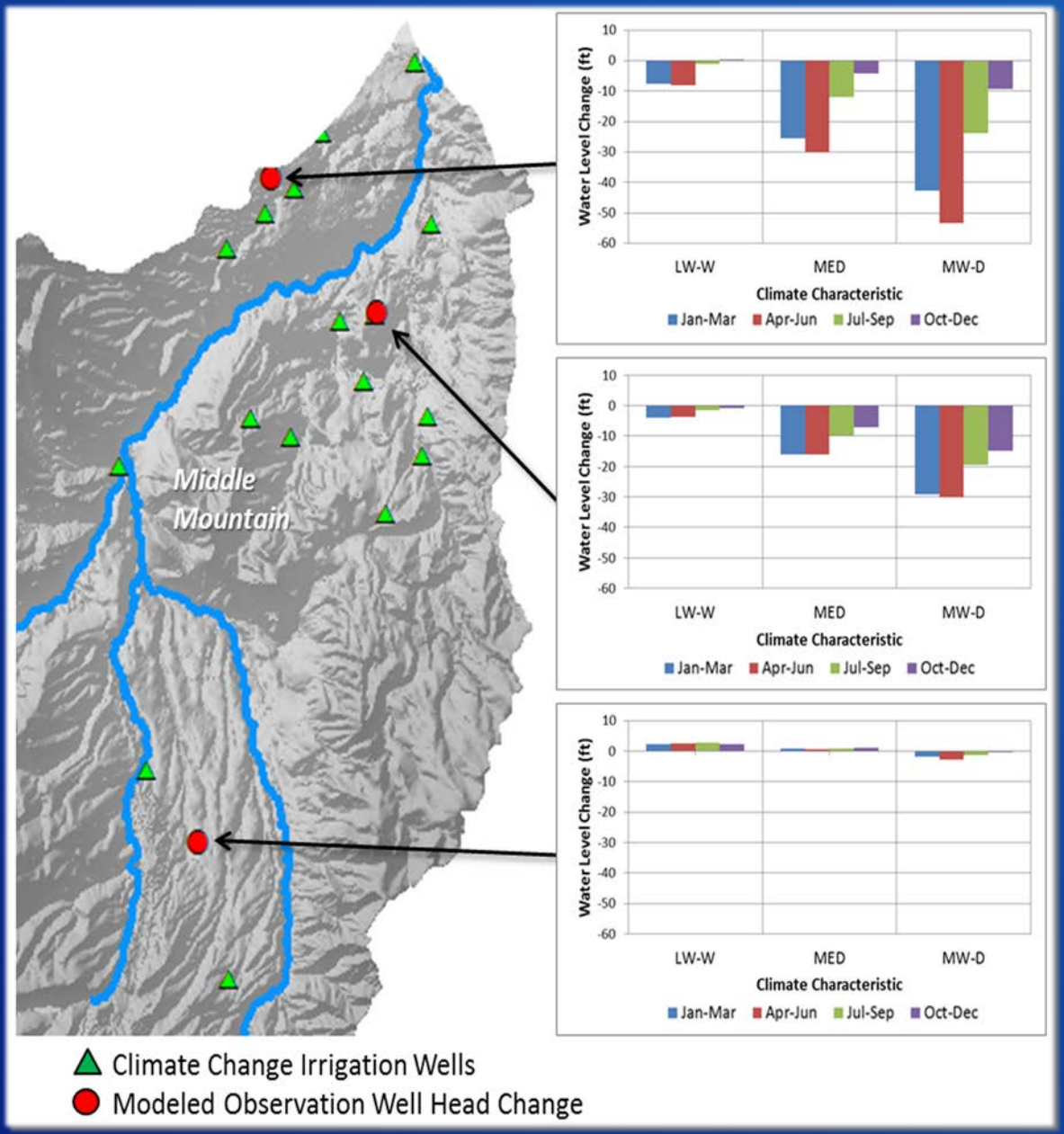


MW-D: More Warming – Dry
MED: Median
LW-W: Less Warming – Wet

RECLAMATION

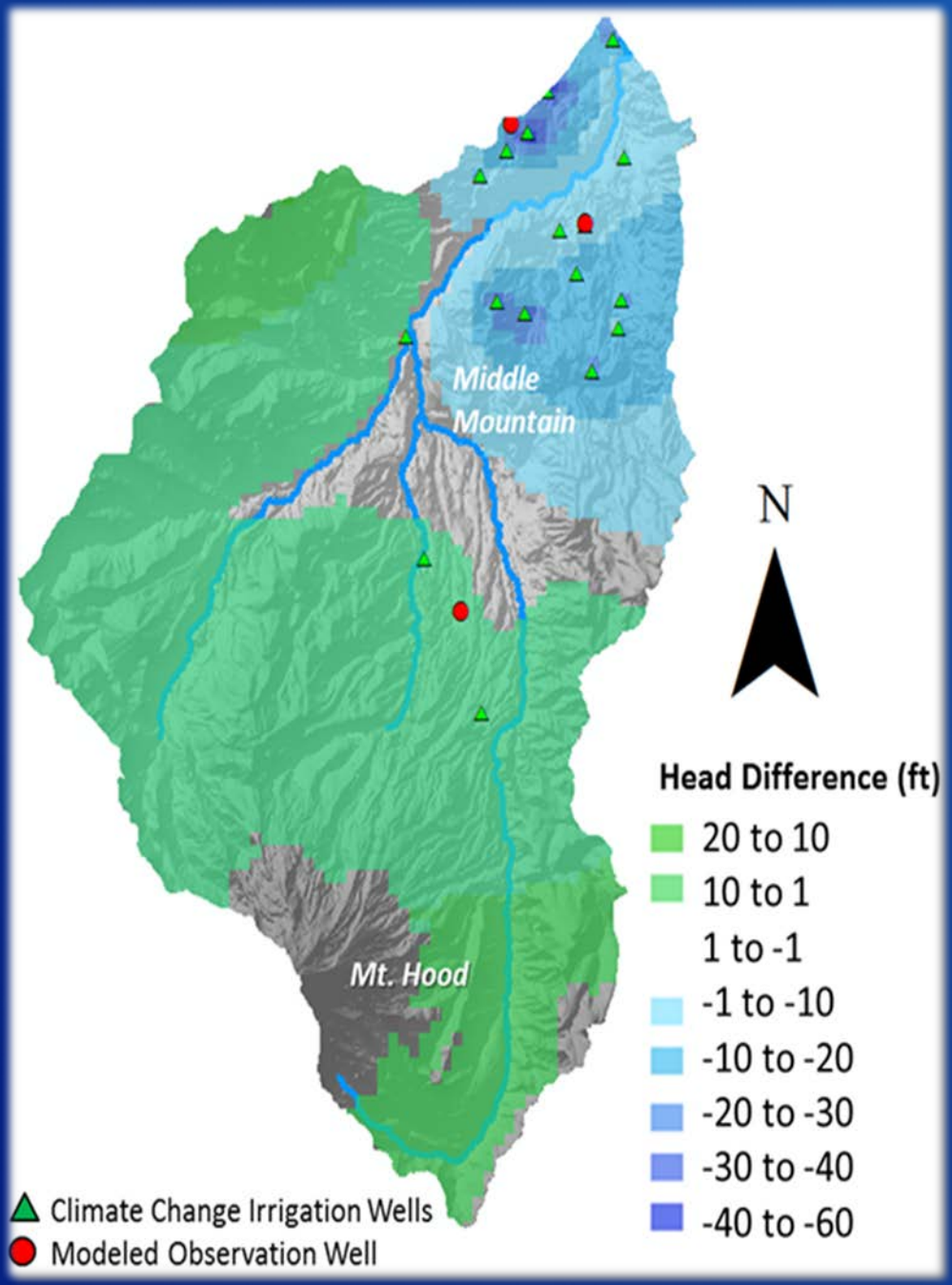
Climate Change Head Change: Increased Pumping

- Additional pumping demand equivalent to 50% of modeled streamflow decrease due to climate change



MW-D: More Warming – Dry
MED: Median
LW-W: Less Warming – Wet

RECLAMATION



Climate Change Head Change: Increased Pumping

- Median condition, end of summer, year 30 shown here

RECLAMATION

Ongoing Efforts

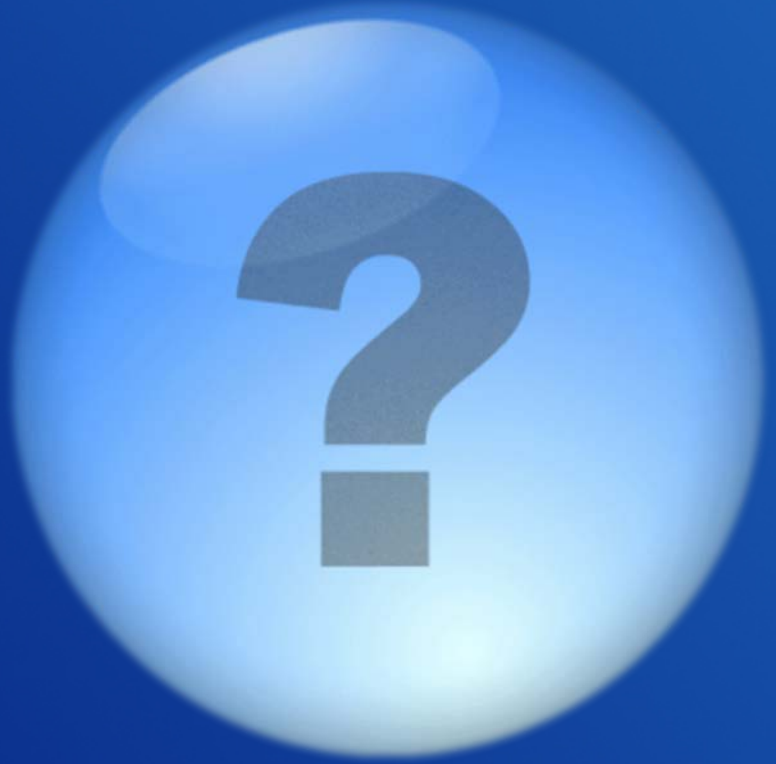
- Documentation
- Packaging

Acknowledgements

- Marshall Gannet, Erick Burns, & Terrence Conlon (USGS)
- Niklas Christensen
- Mattie Bossler

RECLAMATION

Questions



RECLAMATION