Modeling the Impact of Aquifer Recharge, Instream Water Savings, and Canal Lining on Water Resources in the Walla Walla Basin

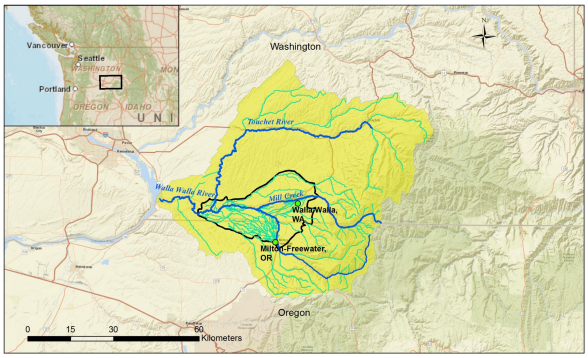
Jacob Scherberg, Jason Keller, and Michael Milczarek
GeoSystems Analysis, Inc.

Steven Patten and Troy Baker
Walla Walla Basin Watershed Council



June 2016

Model Location



Water Resource Issues in the Walla Walla Basin

- Over allocation
  - Historic dewatering of river during summer, until 2000
  - Agreement to maintain minimum flows in Walla Walla River for fish habitat
- Endangered Fisheries
  - ESA listed Steelhead and Bull Trout
  - Reintroduced Chinook Salmon
- Declining Aquifer
  - Documented water table decline of 4.8 cm (1.9 “) per year since 1950
- Channel Seepage
  - Estimated 20% loss of stream flow (source of aquifer recharge)


Project Goals

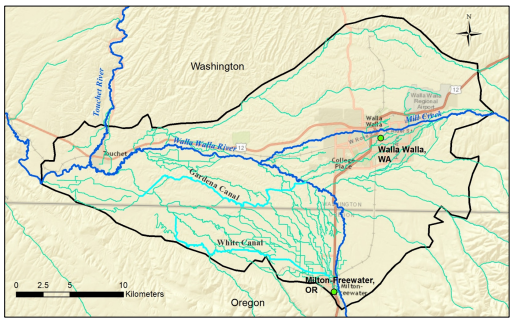
- Develop calibrated groundwater-surface water model for alluvial aquifer portion of the Walla Walla Basin
- Quantify current demands and distribution of water resources
- Evaluate hypothetical surface water and groundwater management scenarios:
  - Baseline (current MAR levels)
  - Canal lining (pipeline) and:
    - -No MAR
    - -Current MAR levels
    - -Increase MAR levels
    - -Maximum MAR levels

Managed Aquifer Recharge (MAR)

- Water diverted from Walla Walla River for MAR (November to May)
- Water percolates into aquifer through permeable basins or infiltration galleries (perforated underground pipeline)
- Uses existing irrigation network
- Used as seasonal storage to:
  - supplement irrigation
  - build groundwater levels
  - Increase base flows

Model Development and Calibration

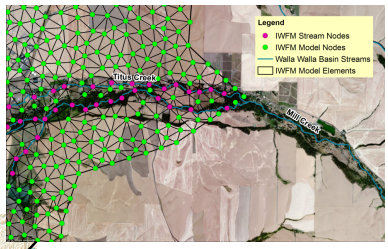
Model Domain

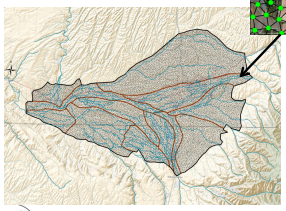


- Uses Integrated Water Flow Model (IWFM) developed by the California Department of Water Resources

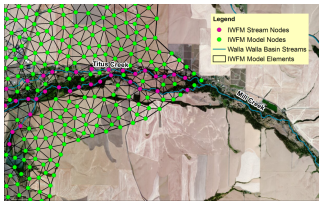
Model Grid

- 16215 Model elements (average ~10 acres)
- 8294 Nodes (average spacing 1004 feet)
- 1506 Stream nodes
- 91 Stream segments



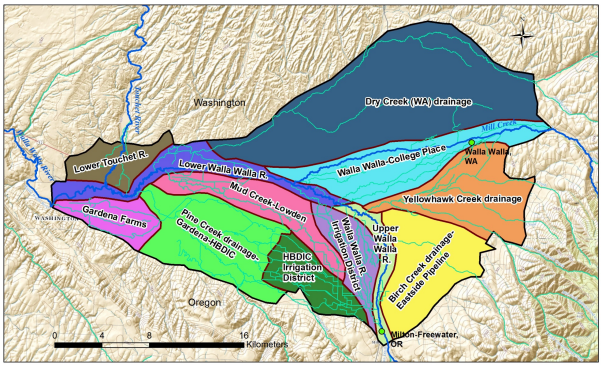


Model Layers



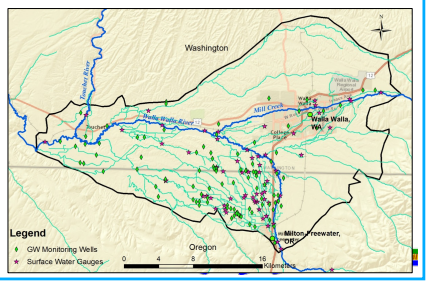
Representative finite element

Model Sub-regions



Calibration Methods

- Performed sensitivity analysis – (aquifer conductivity and stream bed conductivity were most sensitive)
- Systematically adjust sensitive parameters to improve fit of simulation results to measured data
- Calibration data 2007-2009, 2011, 2013
- Validation Data 2010 & 2012



Model Scenarios

Model Inputs – All Scenarios

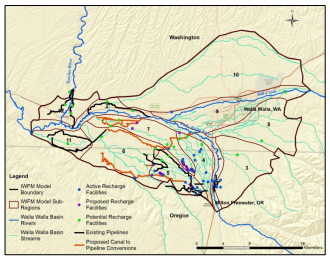
- Forward model projecting 10 years from end of model development period to attain steady-state conditions.
- Applies calibrated model parameters.
- Average daily data from model development period for:
  - climate
  - GW boundary conditions
  - stream inflows
  - agricultural water use
- MAR inputs from WWBWC based on active recharge facilities

Scenario Summary

1. Baseline Forward Model
   - MAR applied at 7 currently active sites at rate of 1.11 x 10^7 m^3/yr (current average)
   - No additional pipelines

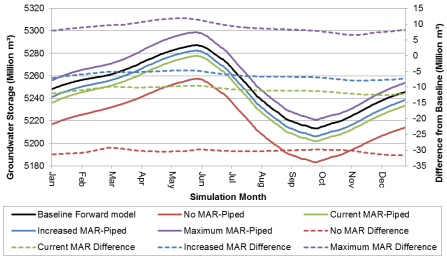
Pipe Installation (primary irrigation canals converted into pipelines) with:

2. No MAR
   - No MAR is applied
3. Current MAR
   - MAR same as Baseline Forward Model
4. Increased MAR
   - MAR applied at 22 locations at the proposed rate of 1.80 x 10^7 m^3/yr
5. Maximum MAR
   - MAR applied at 60 locations at the proposed rate of 2.99 x 10^7 m^3/yr



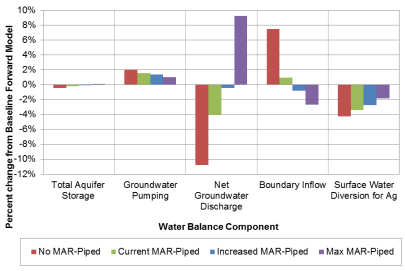
Model Results

Scenario Impact - Groundwater Storage



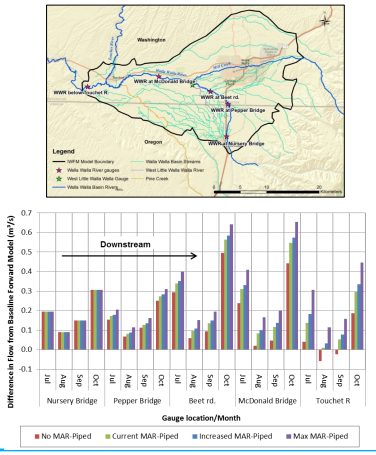
- Changes relative to Baseline Forward Model greatest in late spring
- Pipe installation predicted to decrease aquifer storage if MAR is not increased from current levels
- Maximum MAR scenario increases aquifer storage despite deceased seepage following pipe installation.

Scenario Impacts - Water Budget

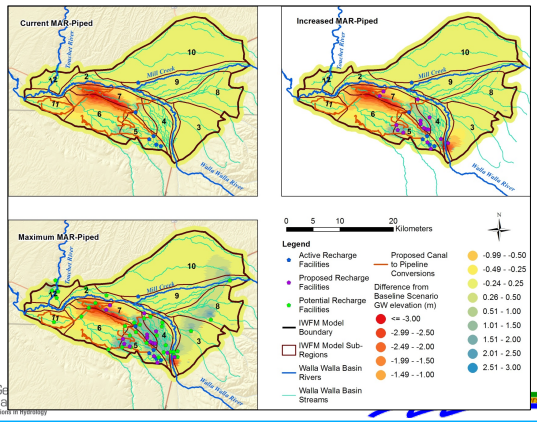


- Management scenarios have greatest impact on net groundwater discharge
- Loss in net groundwater discharge to streams predicted for the pipe installation scenarios with No MAR, Current MAR, and Increased MAR
- Increase in net groundwater discharge to streams predicted for pipe installation with Maximum MAR scenario

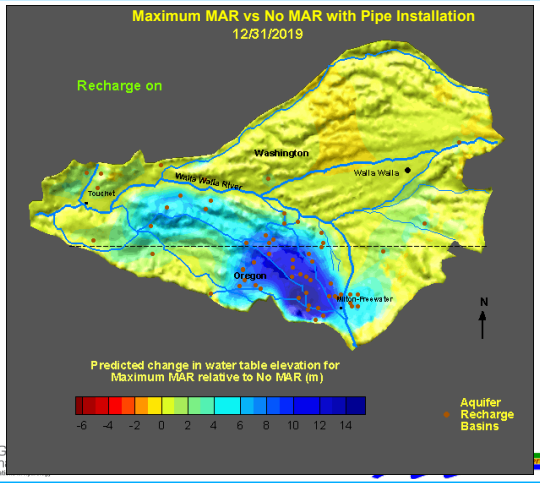
Walla Walla River – Predicted Flow



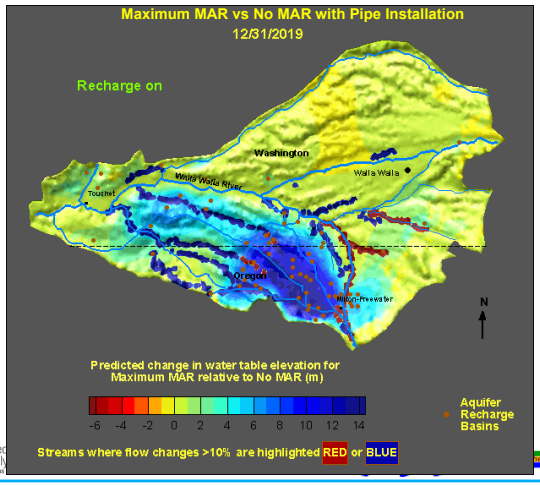
Predicted change in groundwater elevation under scenario conditions relative to Baseline Forward Model



Maximum MAR vs No MAR with Pipe Installation 12/31/2019



Maximum MAR vs No MAR with Pipe Installation 12/31/2019



Conclusions

- Canal lining allowed for decreased diversions from the Walla Walla River
- MAR increased groundwater storage in vicinity of recharge sites increasing available water for irrigators
- Canal lining is likely to decrease aquifer storage and potentially limit benefits of instream water savings
- MAR can mitigate aquifer storage losses resulting from conversion of canals to pipelines if increased to the level of "Increased MAR" scenario
- Maximum MAR scenario provides the potential to increase aquifer storage and meet irrigation demand with currently available water supplies
- Conjunctive management of groundwater and surface water can potentially provide water for irrigators while allowing for increased summer flows and improved habitat in the Walla Walla River

Acknowledgements

Washington Department of Ecology

Office of Columbia River

Walla Walla Watershed Management Partnership

Hudson Bay District Improvement Company

Walla Walla River Irrigation District

Gardena Farms Irrigation District

Other contributors (John Selker, Frank Nicholson, Willy Breshears, Bob Bower, Jeremy Nguyen, Eric Hartwig, Paul Hartwig…)

Jacob Scherberg; GeoSystems Analysis, Inc.
jacob@gsanalysis.com; 503-757-9537