

# Vancouver Lake Lowlands Groundwater Model

Development  
Calibration  
Verification

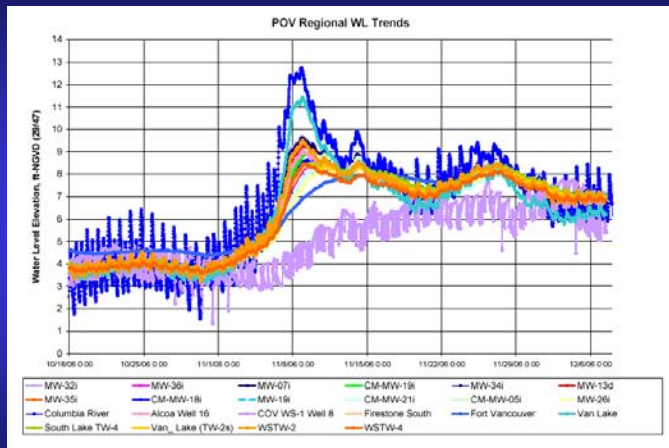
## Study Team

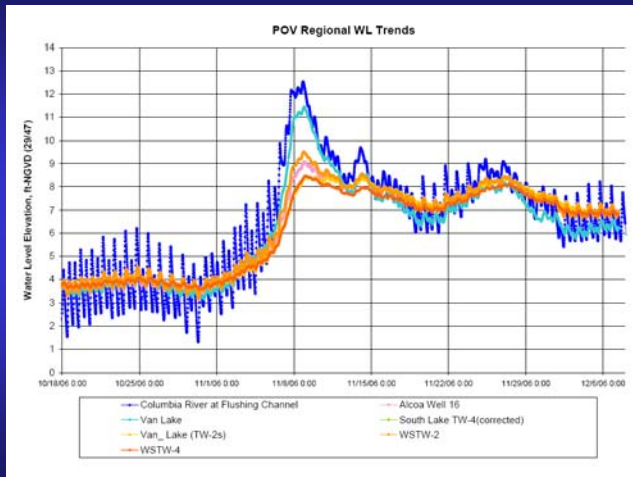
- Dan Matlock, Peter Schwartzman (Pacific Groundwater Group)
- Joel Massman (Keta Water, Inc.)
- Rick Malin (Parametrix, Inc.)
- Mike Riley (S.S. Papadopoulos & Associates)



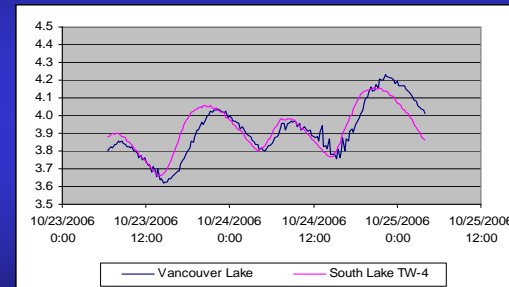
# Transducer Study

- 20 wells, water levels collected every 15 minutes
- Stage measurement in Vancouver Lake
- Gage data from Columbia River gage
- Re-surveyed all measuring point elevations



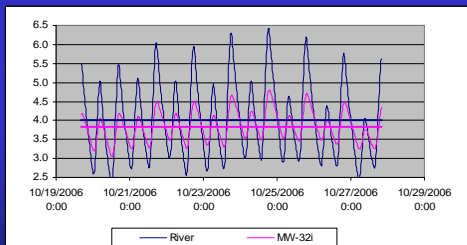


## Time Lag



## Steady-State Period

- Average Water Level
- Tidal Efficiency



## Modeling Software

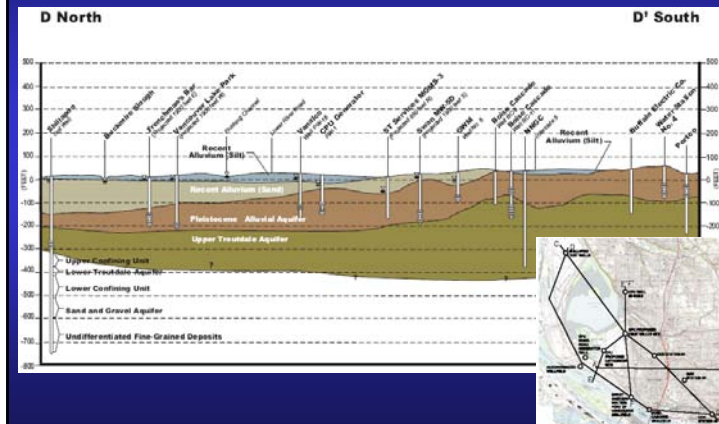
- MODFLOW: Groundwater flow model
- Path3D: Particle tracking model
- PEST: Parameter optimization program

## Modeling Approach

- Determine extent, thickness and depth of aquifers
- Apply boundary conditions at model boundaries
- Initial estimate of model parameters
- Sensitivity analysis of model parameters
- Optimization of model parameters

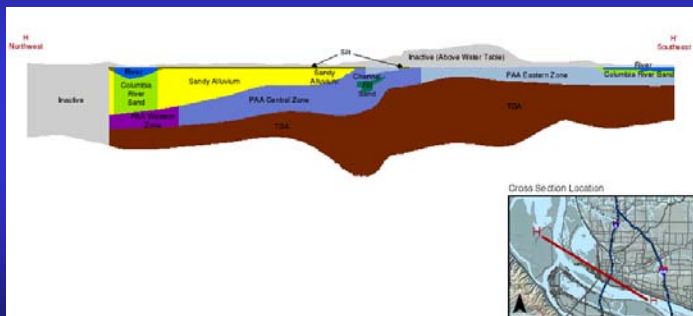
## Model Setup

Determine extent, thickness and depth of aquifers



## Model Setup

Model extent, thickness and depth of aquifers

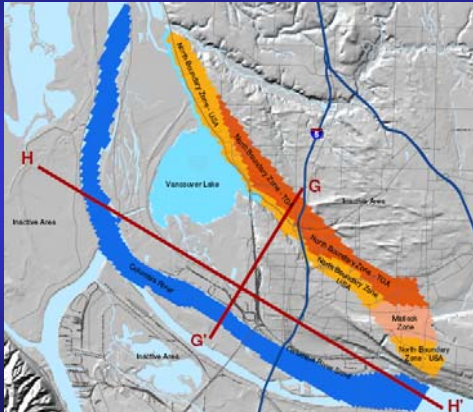


## Model Setup

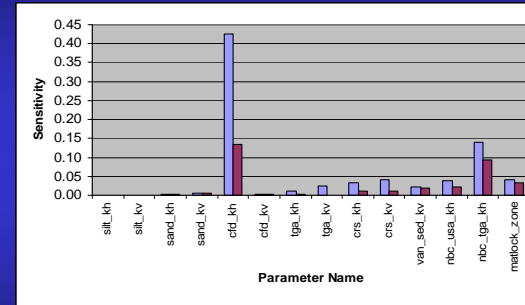
Model grid



## Boundary Conditions



## Initial Parameter Estimation

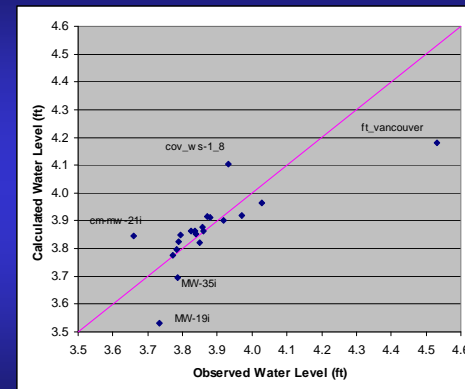


## Model Calibration

Adjusting model parameters to achieve agreement between model results and data

- Quantitative parameters
  - Water level measurement
- Qualitative parameters
  - Transmissivity from pump tests
  - Shape of plumes
  - Capture zone

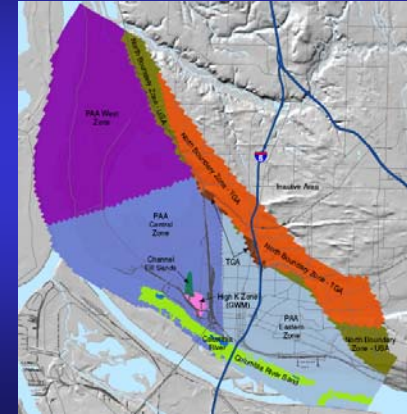
## Model Calibration – Water Levels



## Model Calibration – Zonation Layer 1



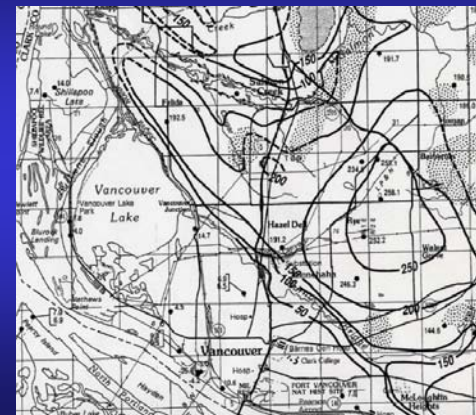
## Model Calibration – Zonation Layer 5



## Model Calibration - Zonation

- Matlock Zone and PAA East: COV\_WS-1\_8 and Ft. Vancouver
- GWM Zone: MW-19i and MW-35i
- PAA Central: All wells
- PAA West: WSTW-2 and WSTW-4

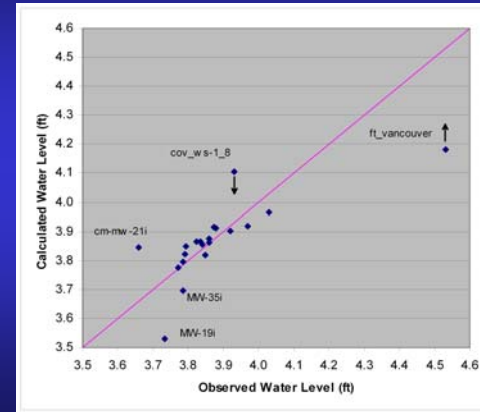
## Model Calibration – Matlock Zone



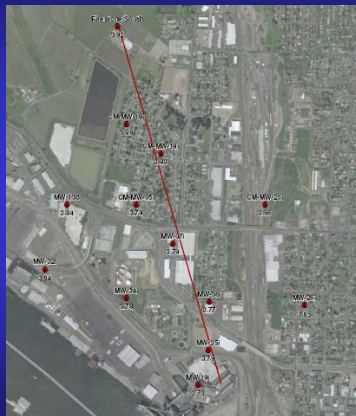
## Model Calibration – Matlock Zone



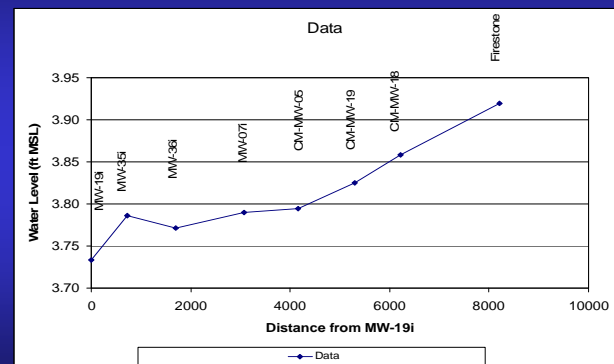
## Model Calibration – Matlock Zone



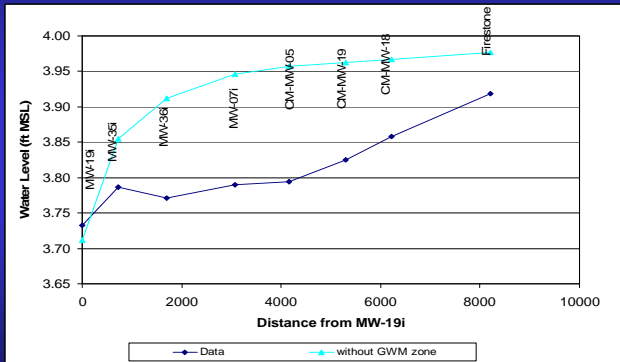
## Model Calibration – GWM Zone



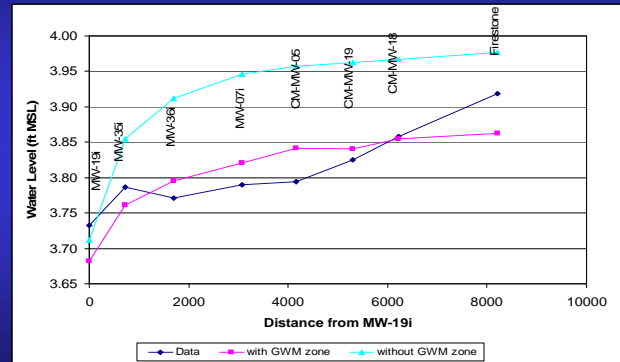
## Model Calibration – GWM Zone



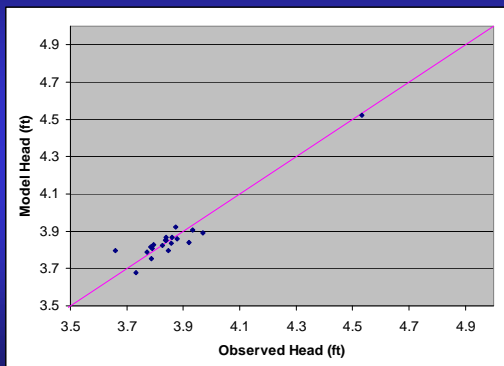
## Model Calibration – GWM Zone



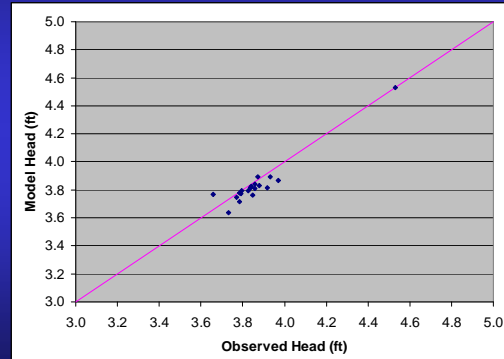
## Model Calibration – GWM Zone



## Model Calibration



## Model Calibration Alternate Parameter Set

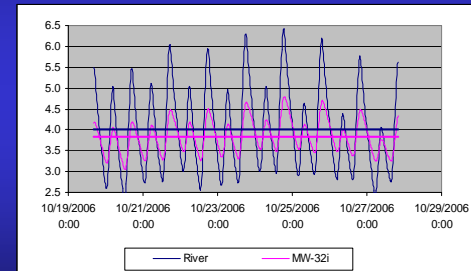




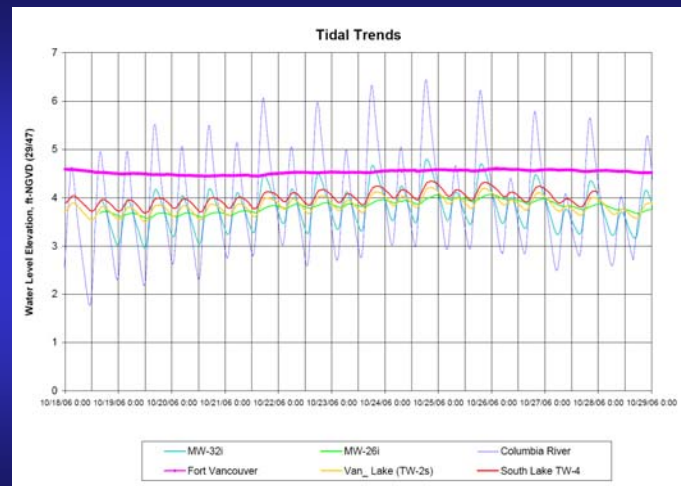
## Model Calibration Statistics

Summary Statistics	Base Case	Alternate Case
Root Mean Square Error (ft)	0.05	0.06
Regression Coefficient (r <sup>2</sup> ): unconstrained intercept	0.92	0.92
Regression Coefficient (r <sup>2</sup> ): intercept = 0.0	1.00	1.00
Residual Mean (ft)	0.00	0.03
Residual Standard Deviation (ft)	0.05	0.05
Absolute Mean of Residuals (ft)	0.04	0.04
Minimum Residual (ft)	-0.14	-0.11
Maximum Residual (ft)	0.08	0.11
Range in Target Values (ft)	0.87	0.87

## Verification Transient Condition



## Tidal Trends



## Verification Tidal Efficiency

Well	Data	Base Case	Alternate Case
MW-26i	12%	12%	10%
MW-32i	40%	47%	33%
Fort Vancouver	5%	2%	2%
South Lake TW-4	14%	9%	9%
Van_Lake (TW-2s)	15%	24%	18%

## Path Forward

- Continued application of models in POV interim action planning
- Application of models in POV FS
- Application of model in CPU wellfield development
- Update models based on new pump test and water level data as systems come on line
- Coordination of data and model changes between POV and CPU