PUMA Workshop
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Water Utility Modeling at Seattle Public Utilities

Paul Fleming
Manager, Climate and Sustainability Group
Joan Kersnar
Manager, Drinking Water Planning
Seattle Public Utilities

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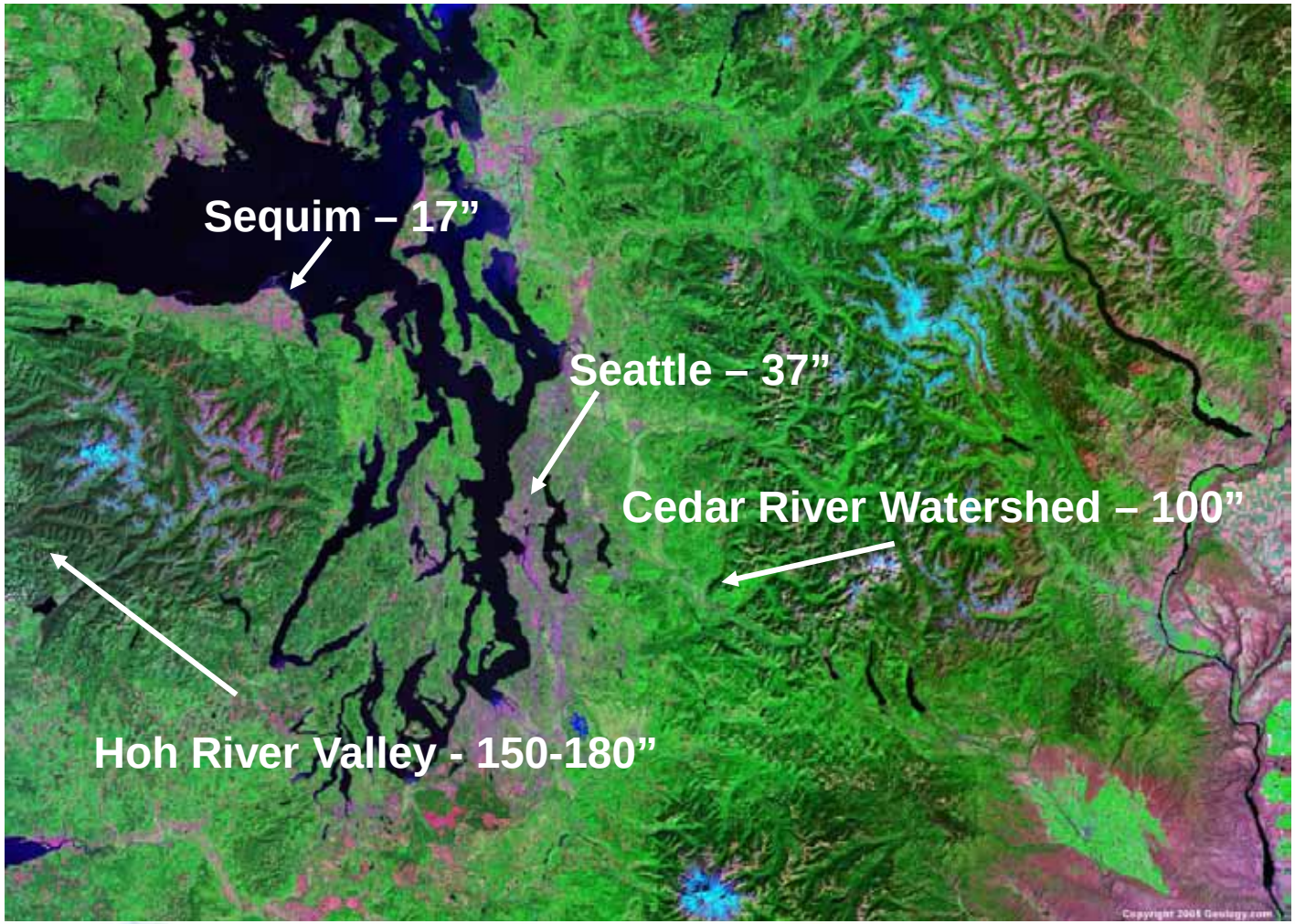
Outline

- Seattle context
- SPU's Climate Program
- Chain of Models
- Water Supply Modeling
- Hydrologic Modeling
- Conclusion

Hydrologic and Physical Context



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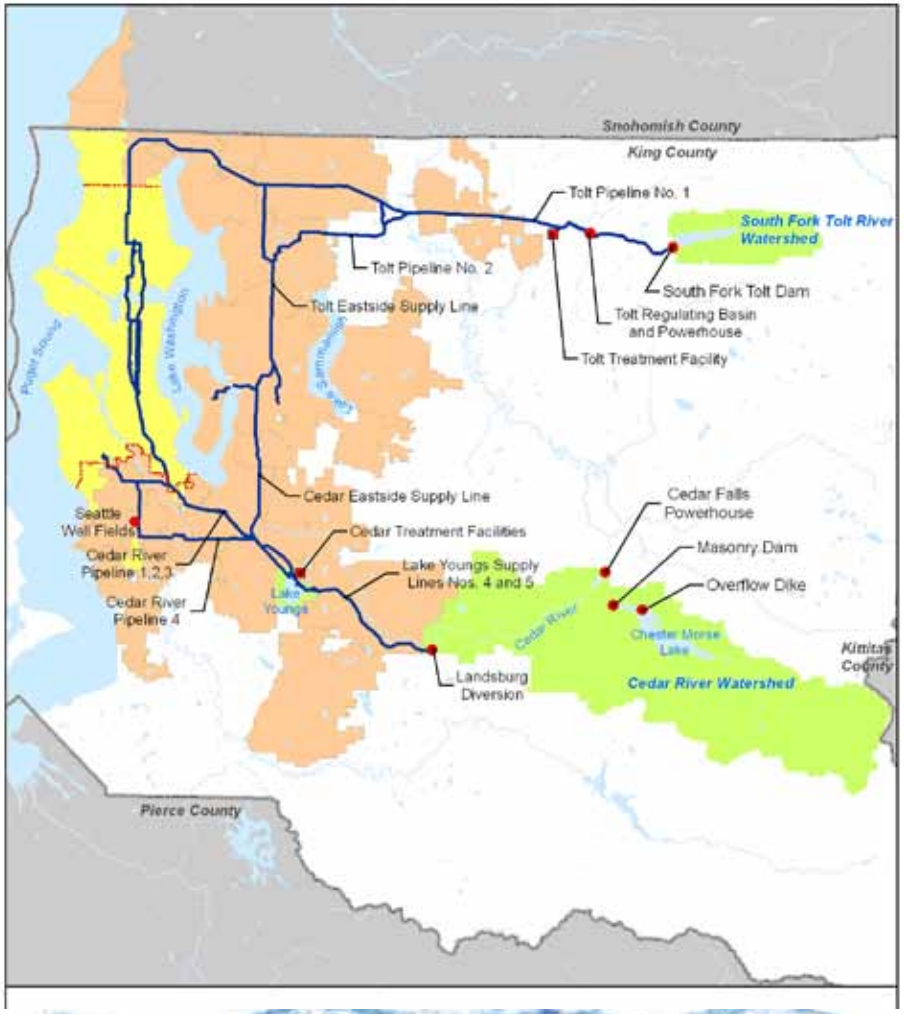
Operating Context

- Seattle Public Utilities
  - Department of City of Seattle
  - Part of Executive Branch
  - Budget/rates approved by City Council
  - Federal statutory requirements
- 1.4 million retail and wholesale customers
- ~ 1400 employees
  - *Water Management* responsible for modeling, system operations
  - *Long Term Planning* responsible for planning
  - *Climate and Sustainability* responsible for climate issue

Seattle's Water Supply System



- Responsibilities:
  - Water supply for people
  - Instream flows for salmon habitat in perpetuity
  - Flood management
  - Hyrdopower generation
  - Land management
- Mountain-based surface water supplies, nominal groundwater
- Cedar storage – 19% of annual flow; Tolt 49%
- Largest supply is unfiltered
- Rely on snowpack and rain, may be more dependent on rain than snow

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Seattle's Water Supply Outlook

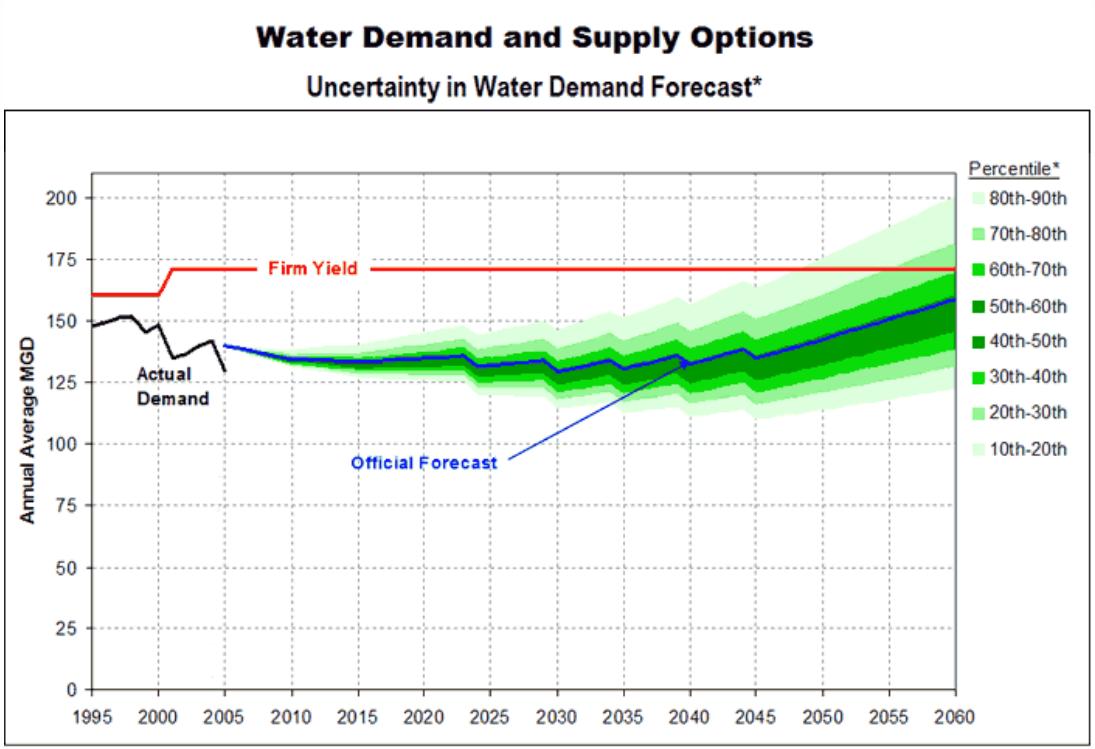
Average Daily Demand:

2009: 130 mgd

2060: 159 mgd

Available Supply:

171 mgd can be diverted after meeting instream flows



Note: Percentiles represent the probability that actual demand will be less than the value shown. Ranges reflect uncertainty in projected household, employment, price and income growth, price elasticity, income elasticity, and conservation. Note that the Official Forecast is at about the 57th percentile.

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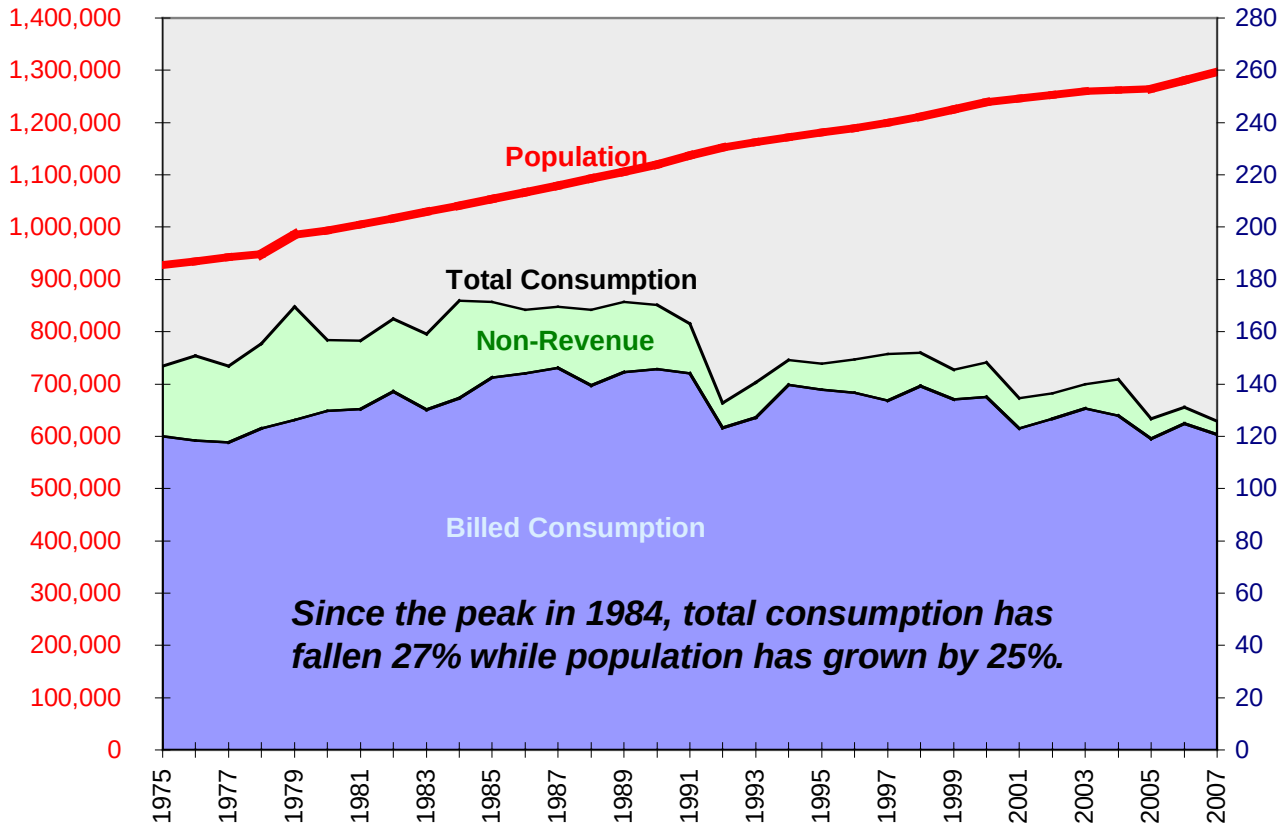
Growth in Population and Water Consumption

Seattle Regional Water System: 1975-2007



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Adaptation and Mitigation

- Adaptation
  - Identifying impacts
  - Pursuing “no regrets” options
  - Enhancing our knowledge
  - Building internal capacity
  - Collaborating
- Mitigation
  - Finalizing GHG inventory
  - Assessing potential for climate neutrality

Engagement and Collaboration

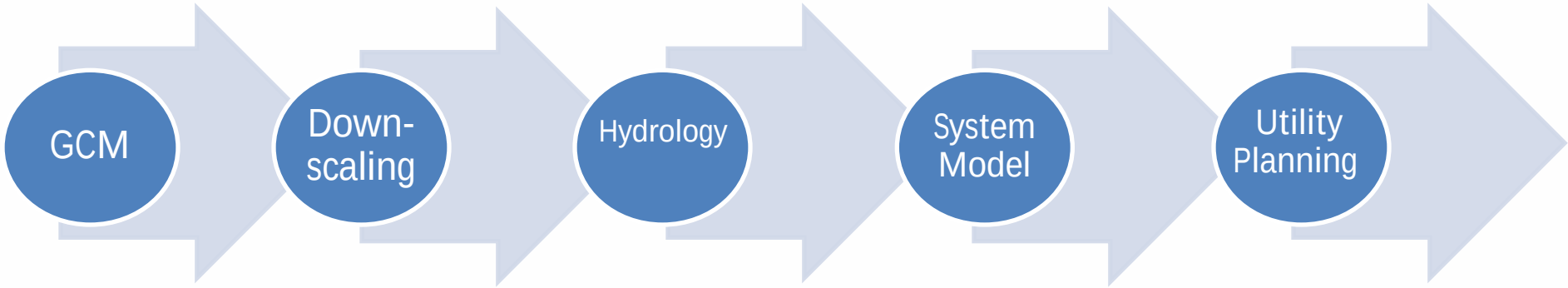
Challenges and Issues

- Projecting climate impacts on supply
  - Effects on snowpack – timing and quantity
  - Changes in precipitation
  - Return of fall rains
- Projecting climate impacts on quality
  - Extreme events
  - Frequency and extent of forest fires
- ENSO/PDO
- Co-production of knowledge
- Incorporating climate signal into decision-making

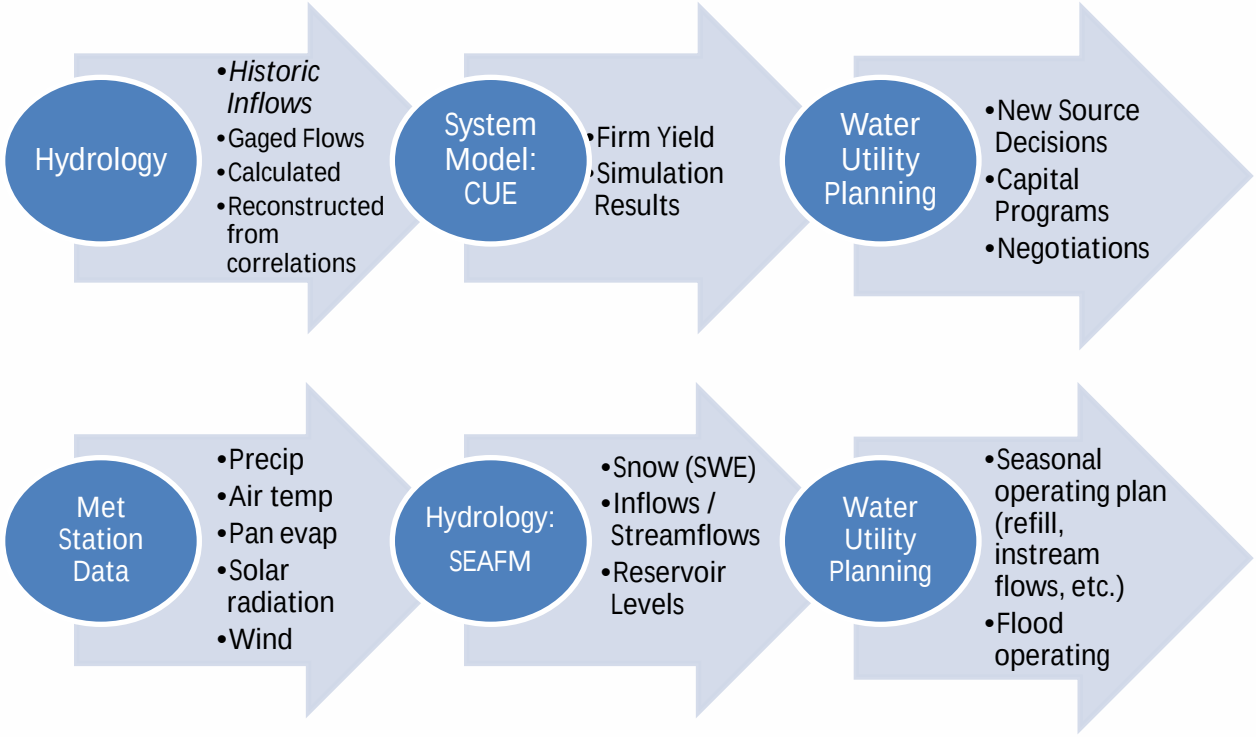
Data, Monitoring and Forecasts

- Real time forecasting and monitoring info is essential
- Utilize several federal agency sources
  - USGS stream gages
  - USDA/NRCS SnoTel sites
  - NOAA/NWS daily and mid range weather forecasts
  - NOAA's Climate Prediction Center 30-90 day outlooks
  - NOAA/NASA remote sensing of snowpack
- Applications
  - Inform short term operational needs and longer term planning horizons
  - Compliance with instream flows
  - Inform reservoir management and releases
  - Project water supply availability

Chain of Models

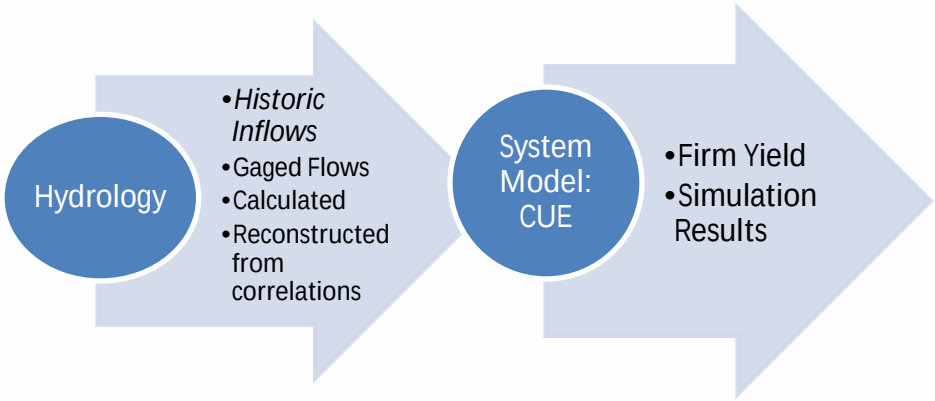


Utility Modeling



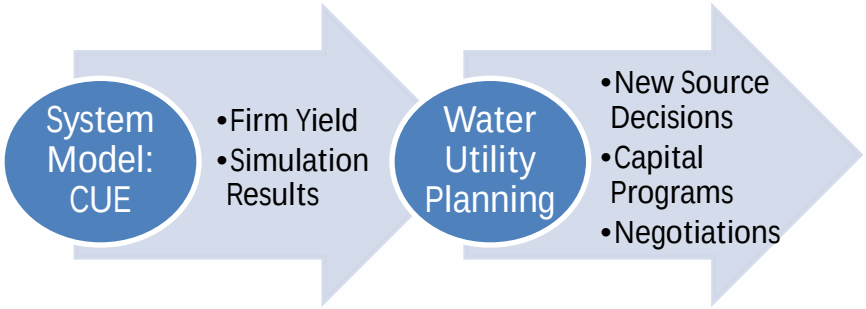
Conjunctive Use Evaluation (CUE) Model

- Simulates reservoir and river operations at *weekly* timestep
- Models entire system - Cedar, SF Tolt, Lake Youngs (optional)
  - Programmed in Stella to enable users to set operating rules
- Uses historic inflow data
  - Reconstructed 81 years, starting in 1929
  - Can also use other inputs
- Provides SPU with insights about system performance and vulnerabilities



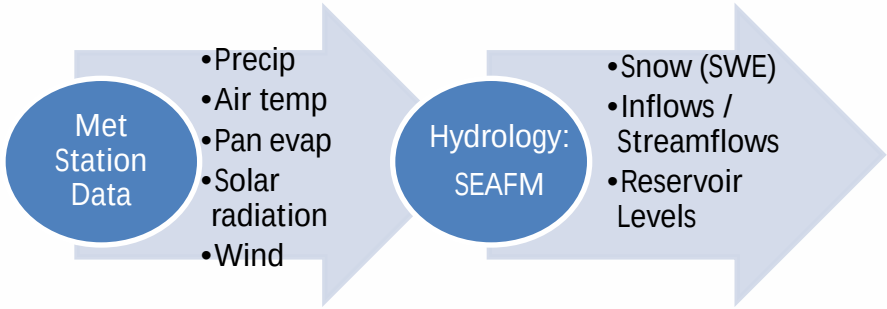
Water System Model Uses

- Estimating firm yield
- Optimizing use of multiple sources, maximizing of existing
- Determining yield from new supply alternatives, impacts on reservoir levels and streamflows
- Impacts of long term flood management operations
- Evaluating instream flow regime proposals
- Establishing management triggers
- Determining frequency of critical operations
- Assessing climate impacts to all of the above



Seattle's Hydrology Model - SEAFM

- Continuous watershed simulation model with *hourly* timestep
  - Based on HSPF
  - Also using HFAM
- Driven by met data from nearby weather stations
- Produces information on snowpack, streamflows and reservoir level, among other items
- Cedar and Tolt watersheds calibrated and modeled separately
  - Characterized by land segments



Hydrologic Segments – Cedar River

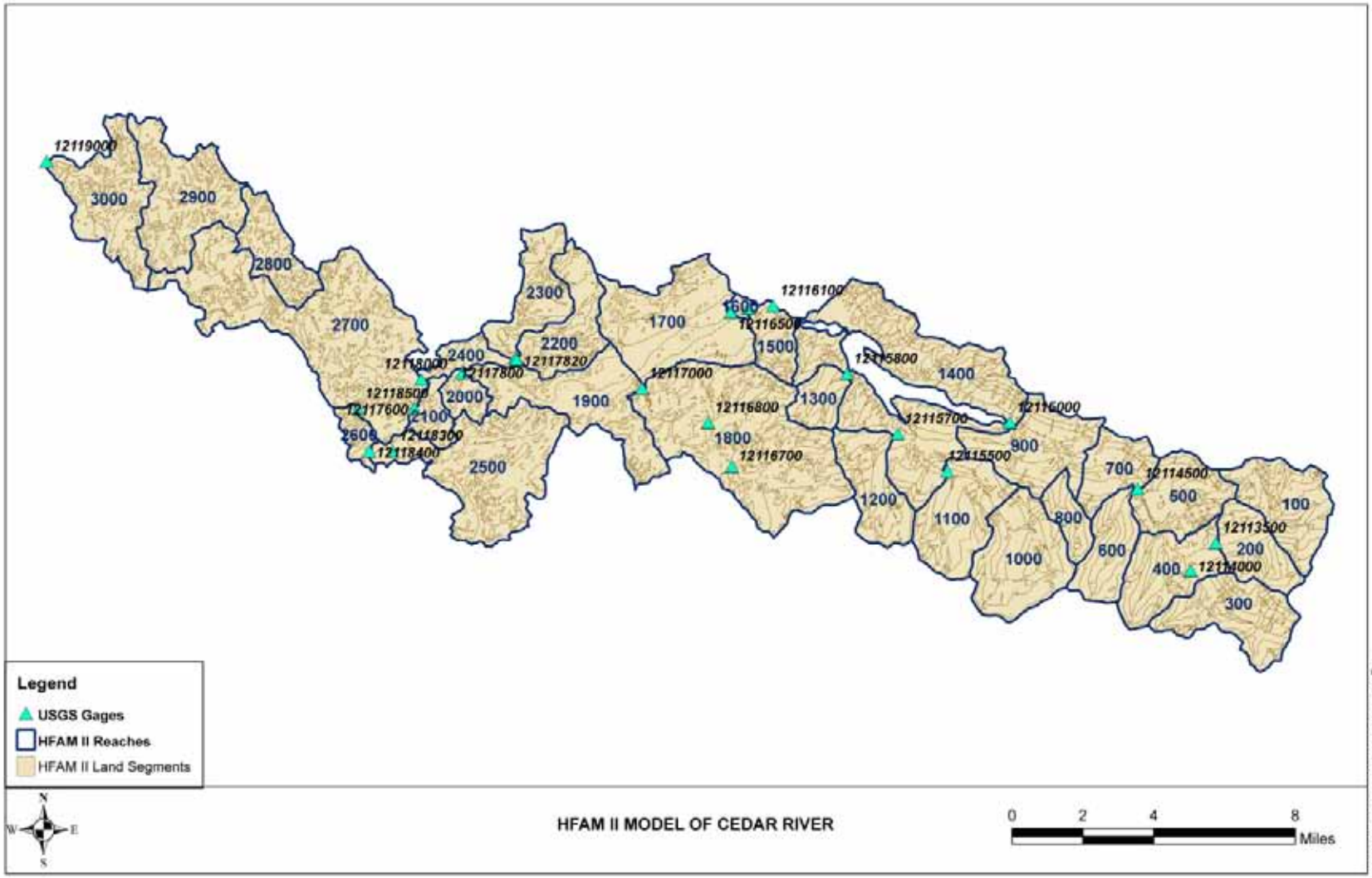


Figure 1. HFAM II Model of Cedar River

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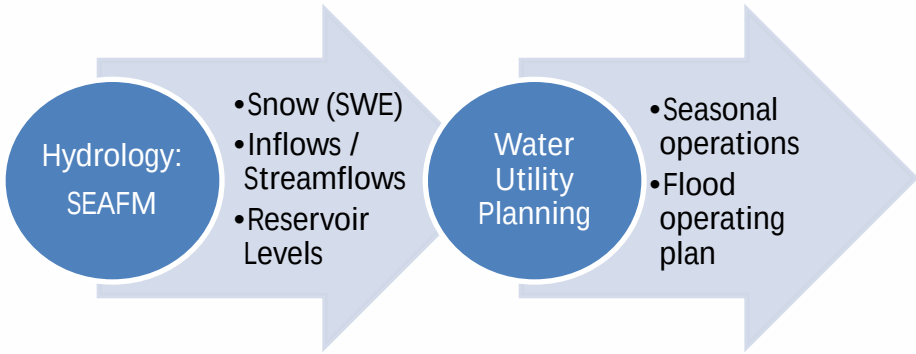
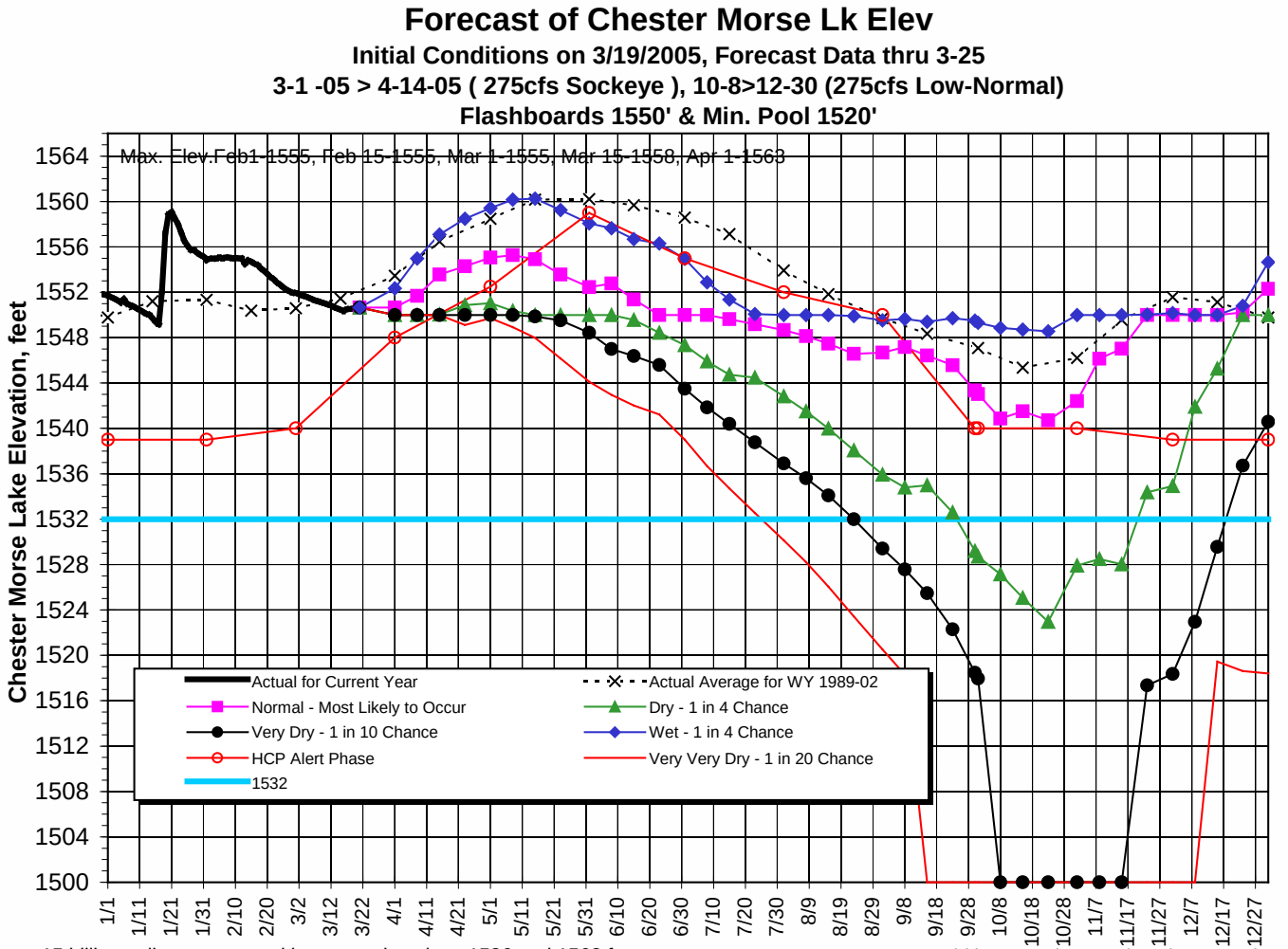
Hydrologic Model Uses

- Used in day-to-day operational decisions
  - Dynamic rule curve
  - Predicting runoff
  - Mid-range probability forecasts
- Run Modes:
  - Probabilistic forecast – able to consider El Nino
  - Forecast – short term flood management
  - Calibration – using data from 1929
- Can produce inflow weekly inflow datasets to feed into CUE
- SPU gains insights about watershed sensitivity to various weather conditions



System Modeling – Probabilistic Seasonal Forecasts



Almost 15 billion gallons are stored between elevations 1536 and 1562 feet and more than 1.5 billion gallons between elevations 1532 and 1536 feet.

Pumps would be turned on at elevation 1536 feet

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Wrap Up and Conclusions

- Built up capacity over past four years
- Answer questions, understand impacts, inform adaptation
- Collaborate
- Understand strengths and limitations of climate assessment tools
- Deploy utilities modeling expertise, tacit knowledge
- Opportunities for co-production


Thank You