Climate Change Impacts On Water Availability

Preliminary Results and Findings

WSP Stakeholder Meeting January 25, 2023

What We'll Cover Today…

- Water Supply Plan Climate Change Approach
- NJ Climate Change Science Refresher
- Climate Change-Water Supply Analyses and Findings
  - Reservoirs
  - Saltwater intrusion into aquifers and estuaries
  - Groundwater recharge
- Water Supply Plan Response

Note: These results are still being refined and may change based upon input from other Department programs or stakeholders

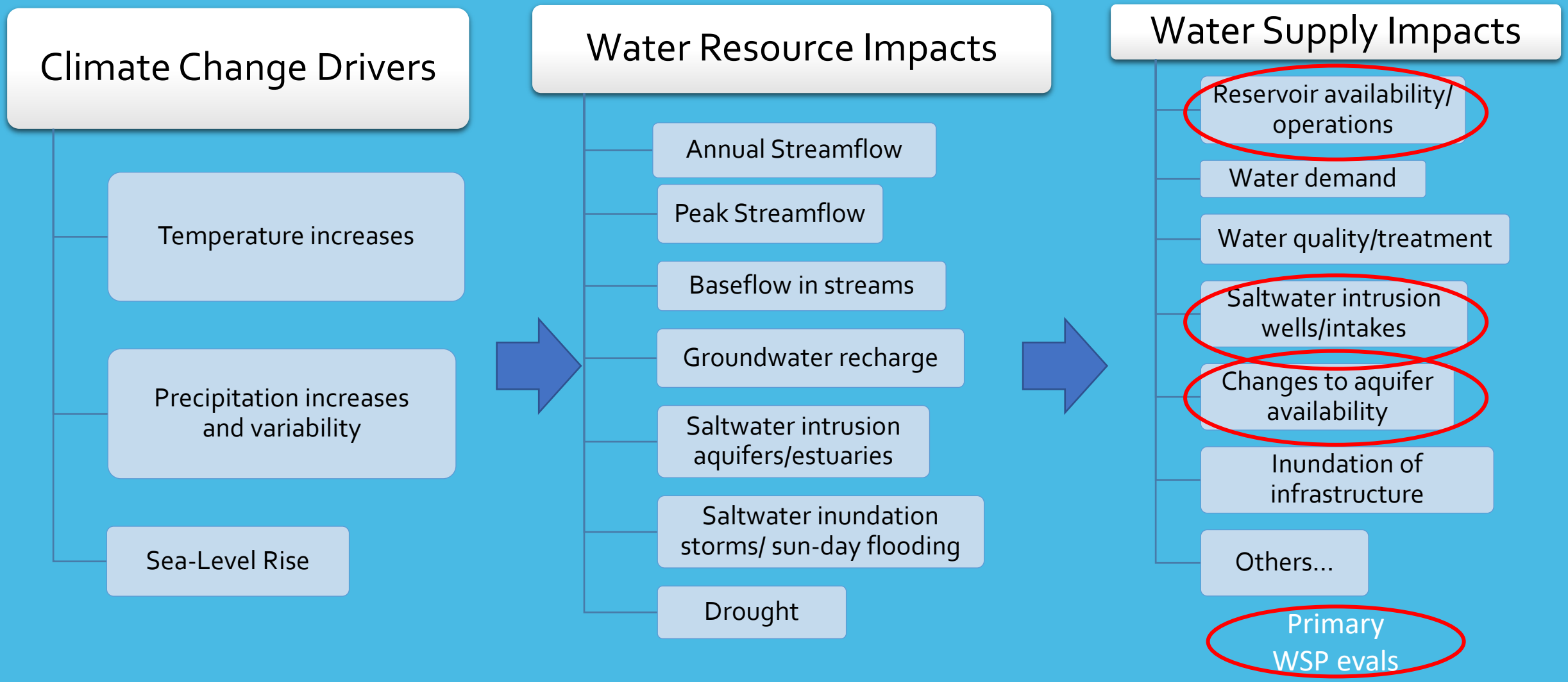
NJ Water Supply Plan and Climate Change

- 2017 WSP provided limited consideration…
- 2023 WSP initial assessments:
  - Limited in scope to DWSG conducted research
  - 2050 focus to synch with WSP demand forecasts
  - General direction and magnitude type-of findings
  - Identify limitations, data gaps, next steps and recommendations (where warranted)
  - Develop climate change water supply action plan for implementation during 2023-2028

2023 WSP Climate Change Approach

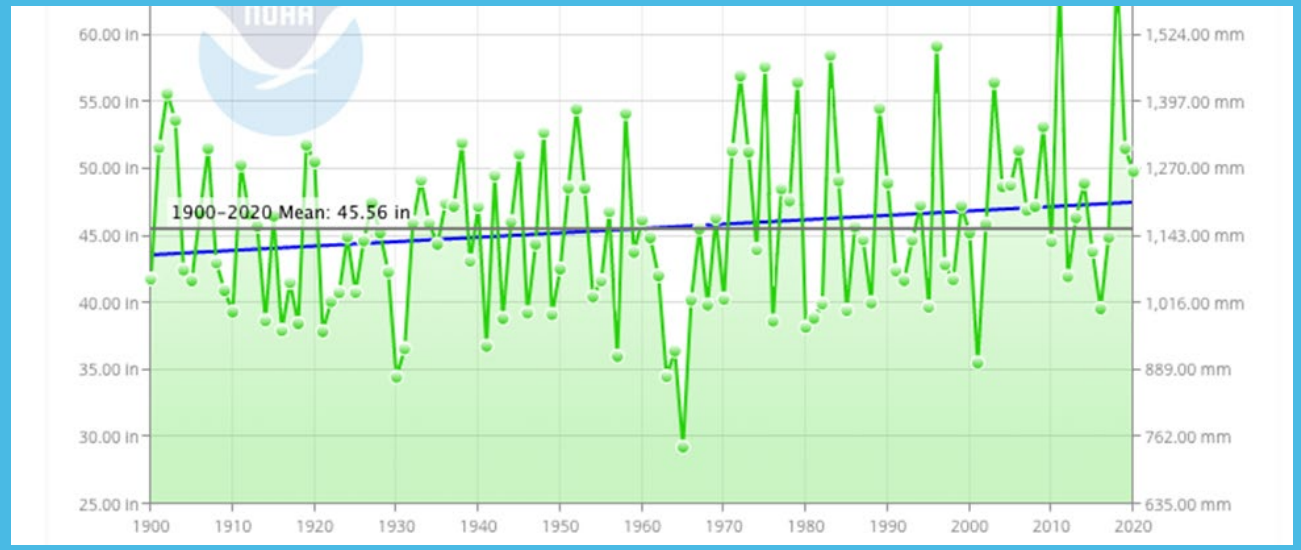
- 2017 WSP had limited consideration…
- Utilize Department's climate change science to evaluate impacts to the state's water supply sources:
  - Precip, temp and SLR primary climate drivers
  - Evaluate impacts to surface water supply reservoir systems, unconfined and confined groundwater
- DWSG conducted resource assessments:
  - Demand and streamflow effects on surface water supply reservoir systems
  - Precip and temp effects on groundwater recharge
  - Sea-level rise induced saltwater intrusion into potable aquifers and estuaries

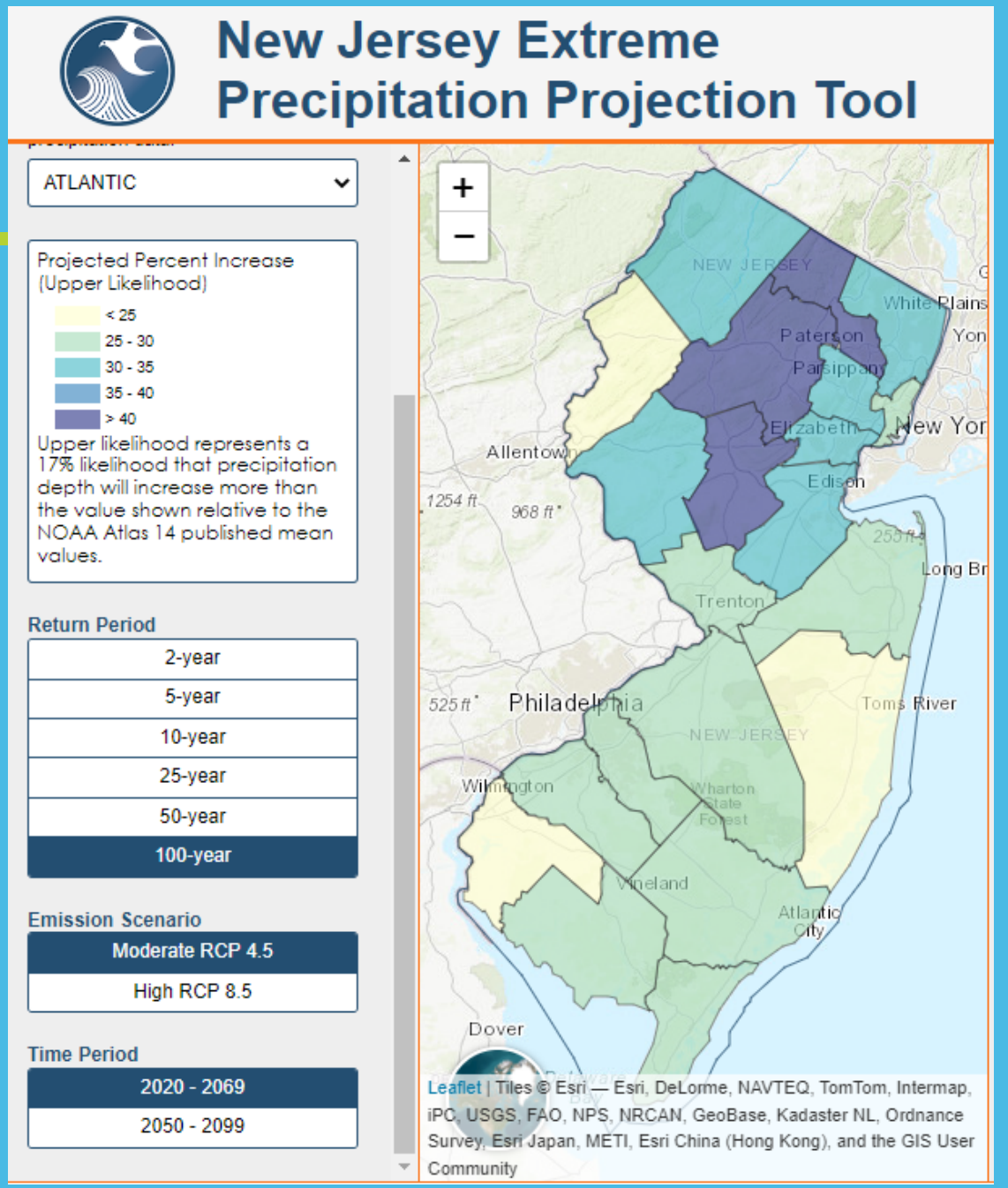
Climate Change-Water Supply Nexus



NJ Climate Science: Precip

- Already receiving more annual precipitation
  - Receiving 3+ inches more than last century
  - 4% to 11% more by 2050
- South and coast and fall and spring wetter
- Larger events more frequent
- Subregions show more variability +-

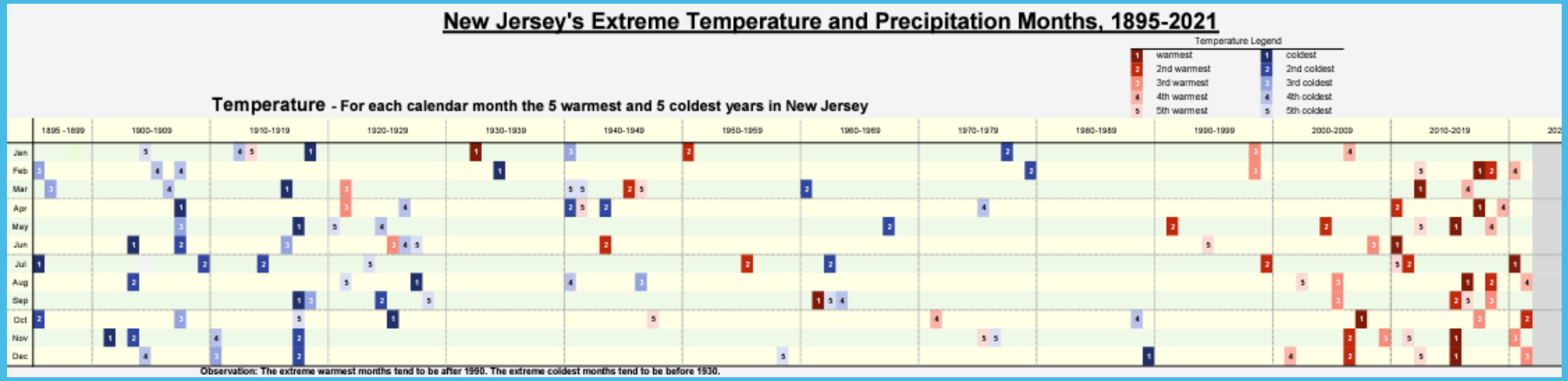




https://njprojectedprecipitationchanges.com/

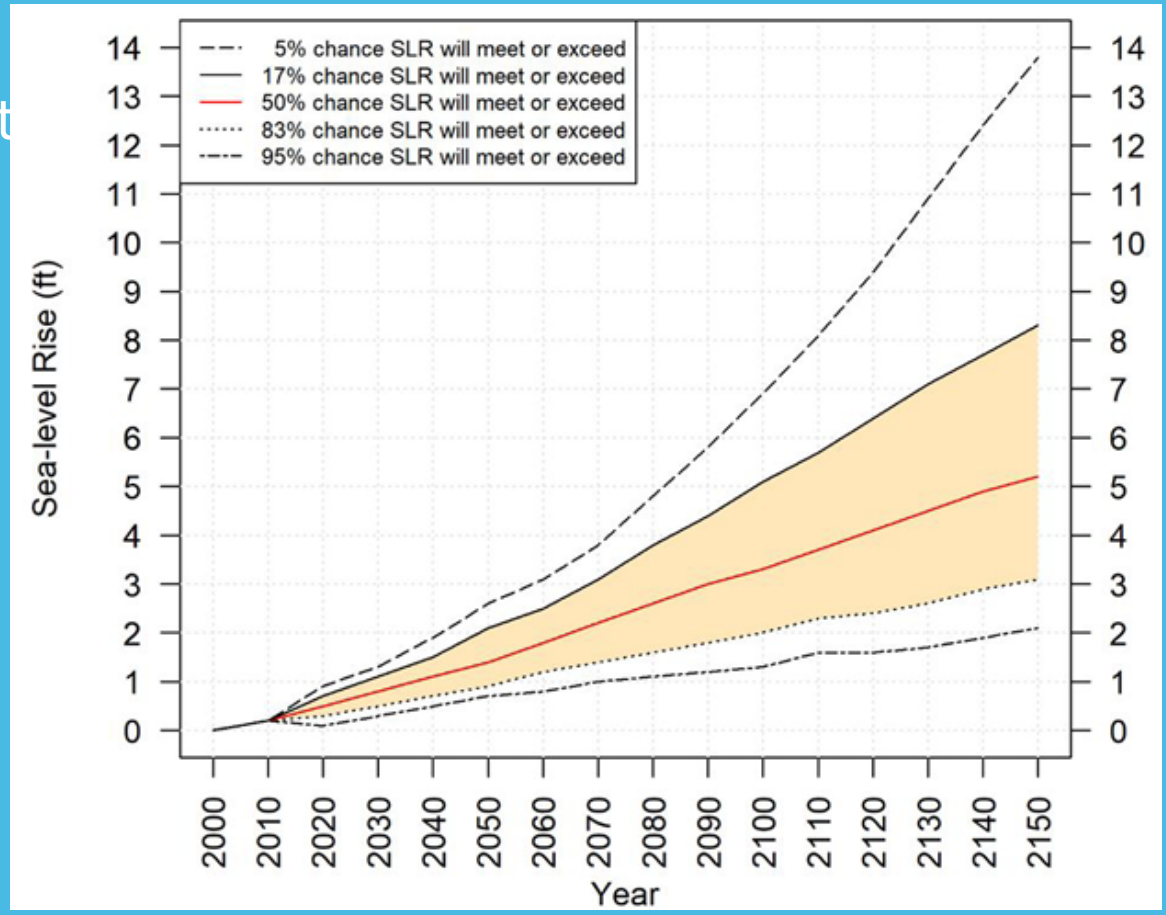
NJ Climate Science: Temperature

- New Jersey is warming faster than the rest of the Northeast region and the world
- Since 1895, New Jersey's annual temperature has increased by 3.5°F
- Annual temperatures increasing by 4.1°F to 5.7°F by 2050
- Winters warming faster coupled with hotter summers



NJ Climate Science: Sea-Level Rise

- Sea-levels are increasing at a greater rate in New Jersey than other parts of the world, in part due to:
  - Ice melt, thermal expansion, isostatic rebound, aquifer compaction, circulation, et
- By 2050, sea-level rise will likely rise between 1.4 and 2.1 feet.
  - Those levels increase to between 3.3 and 5.1 feet by the end of the century
  - "Sunny day flooding" will occur more often
- Hurricanes, Nor'easters, etc. likely to increase in frequency and severity



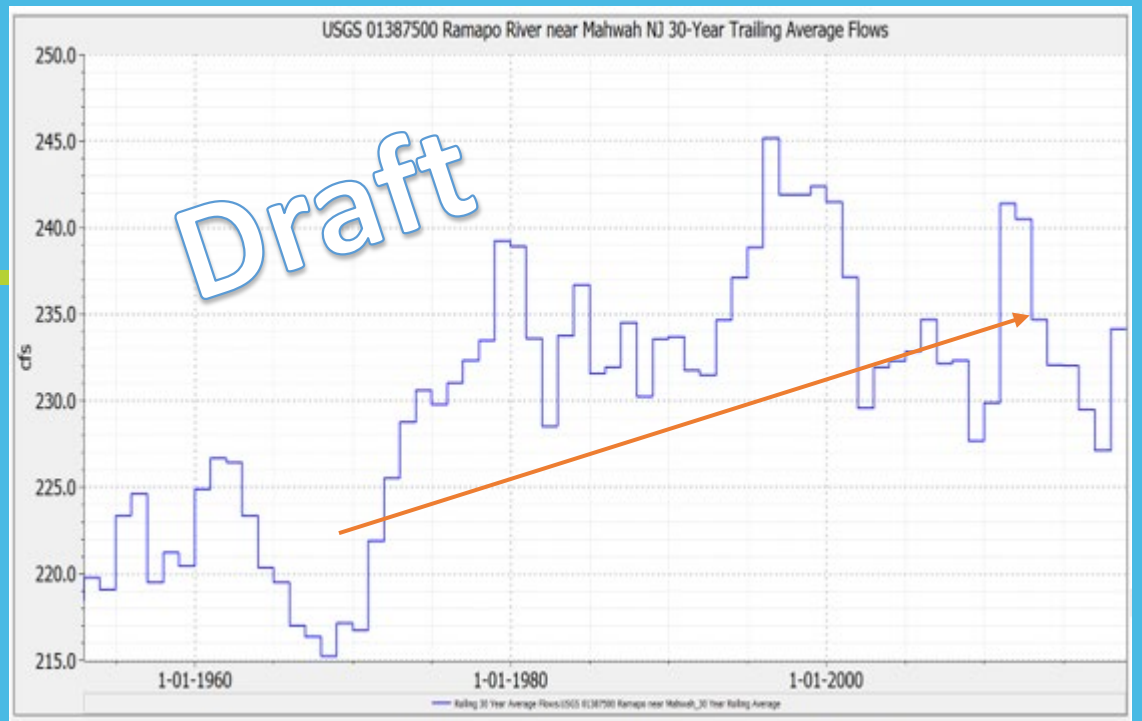
2020 NJ Scientific Report on Climate Change

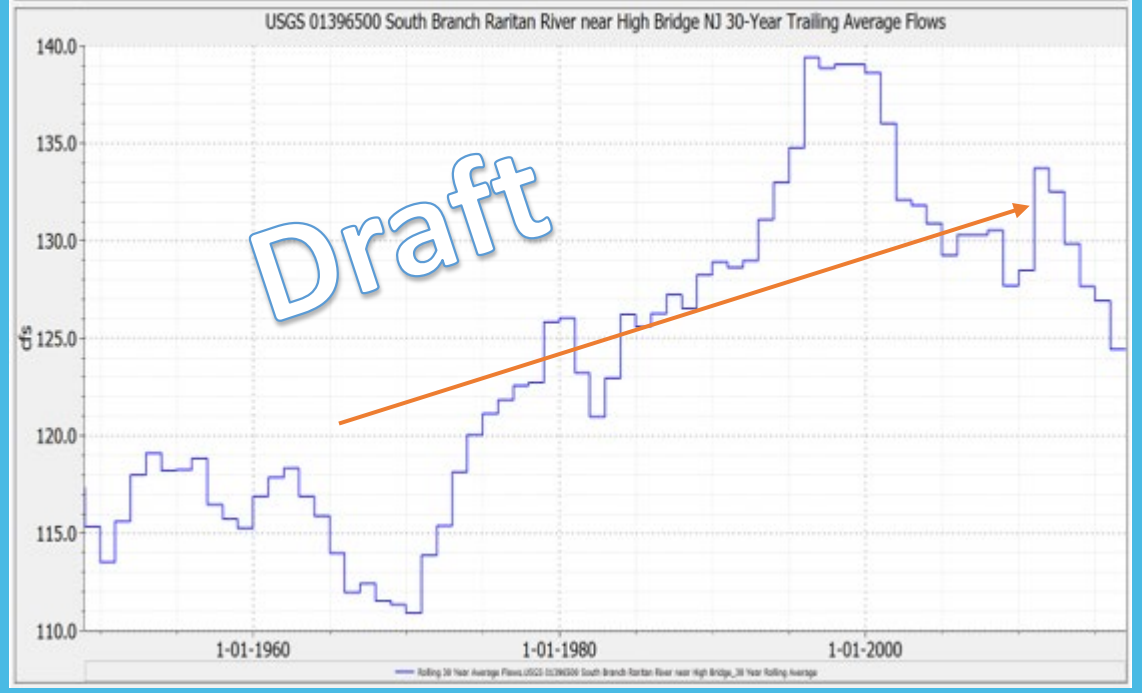
https://www.nj.gov/dep/climatechange/data.html

Water Supply Plan Climate Change Water Availability Analyses and Findings…

Surface Water Supply Reservoir Systems

- Assessed annual and monthly streamflow for 30-year running averages for 10 key USGS stream gages for data through 2019
  - In general, there is more annual flow
    - Two gages in south Jersey show small downward trends
  - Some, while higher overall, show recent, short-term decreasing trends
  - Monthly flow trends more variable, but in general, more flow in fall and early winter
  - Need to continue to monitor and analyze observed data

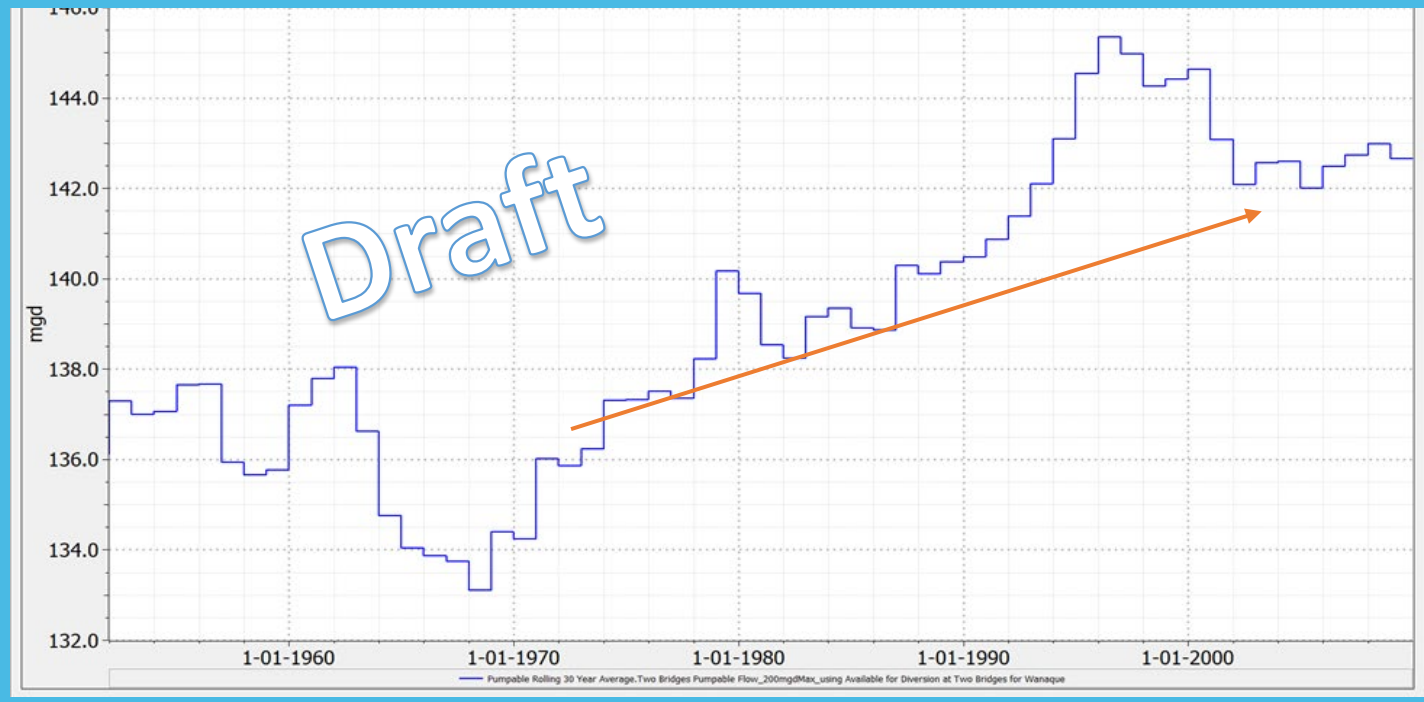




Surface Water Supply Reservoir Systems

- Used the NJ RiverWare model to assess impacts
- More streamflow is generally beneficial to run-of-river reservoirs (from a quantity perspective)
- Pump-storage systems important to NJ:
  - Pumpable flows are generally increasing over time, but more so in fall/early winter and less so in late winter/early spring
  - Systems respond differently
    - Earlier pumping important factor
    - Pumping costs vary
    - Net effects of pumpable flows vs annual flows slightly positive
- Water quality changes key, but not simulated

Pumpable Water – 30-year Running Averages



Surface Water Supply Reservoir Systems

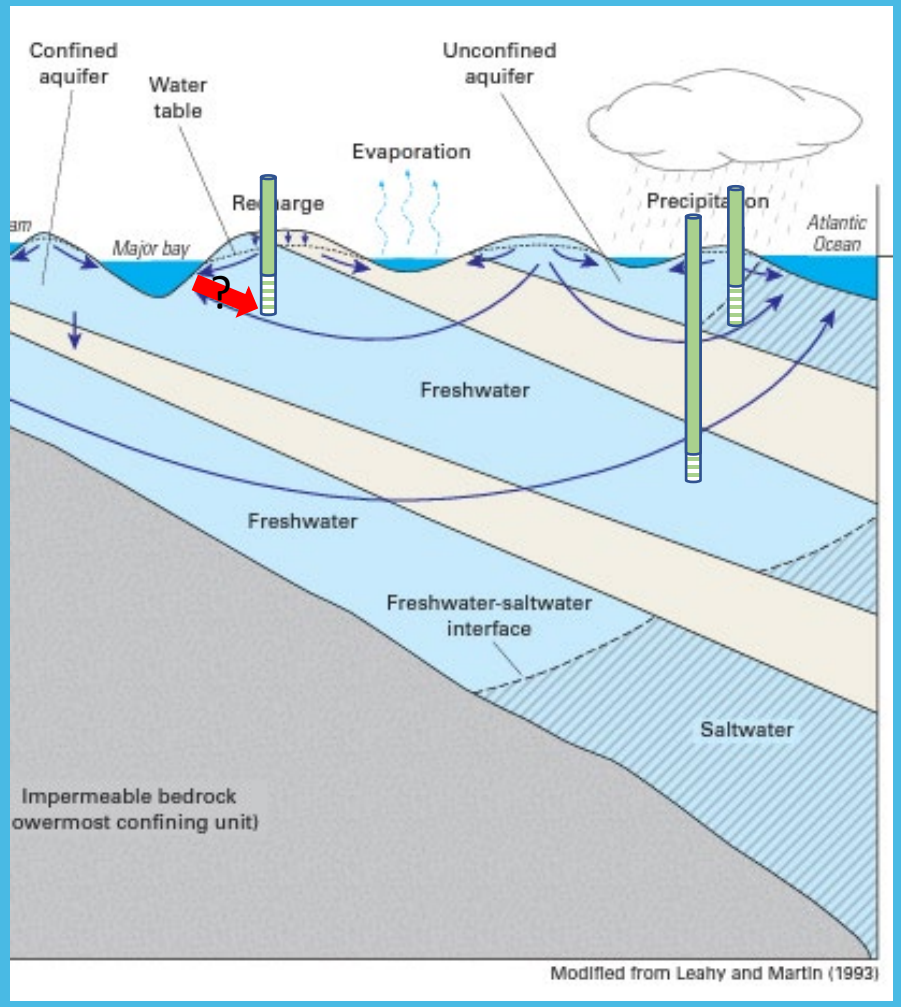
- 'What if' climate change scenarios:
  - Increased demand (5-10%) and reduced streamflow (5-10%) during spring, summer and fall simulated in NJ RiverWare model
  - Results:
    - Increased water-supply drought frequency and duration
    - More water needs to be pumped, especially without draft reductions
    - Combined northeast storage adequate, but variations between systems
    - Draft reductions important
    - Raw and finished water interconnections important
- Surface Water System Findings:
  - Limited potential for adverse water supply impacts to systems
  - Better data needed for future streamflow and drought severity and duration
  - Water quality impacts need to be assessed
  - Climate change effects on demands need to be quantified and evaluated
  - Need adaptability to respond to extreme events- flooding, water main breaks, etc

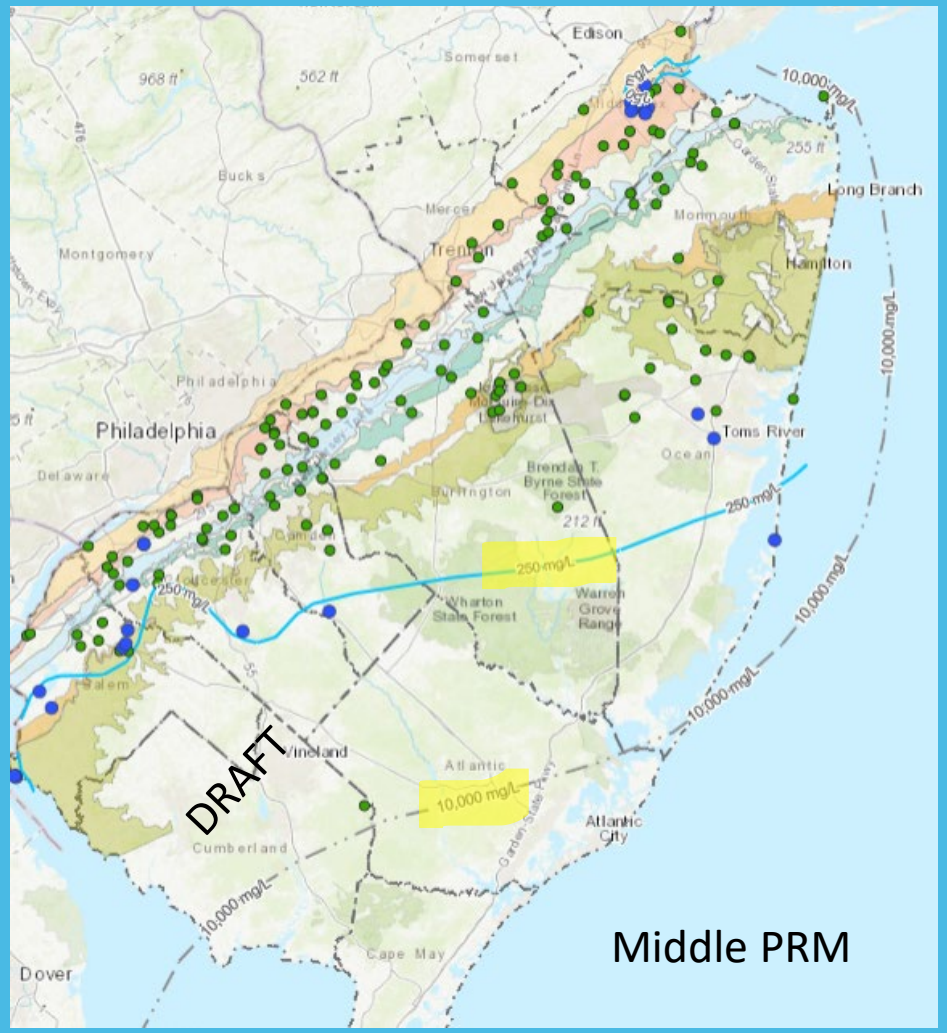
Questions or Comments?

Sea-level Rise and Saltwater Intrusion: Coastal Plain Aquifers

- Approach:
  - Review existing research and groundwater models specific to NJ
  - Synthesize findings
  - Identify aquifers, areas, and potable wells potentially impacted
- Good News:
  - Saltwater moves offshore faster than onshore due to GW recharge areas/rates
  - Saltwater still equilibrating to SLR from 71K years ago- over 100ft lower
  - Saltwater moves slowly @ 0.2 miles per 10K years
  - Recent/projected sea level rises relatively insignificant and not expected to change current onshore migration rates
  - Saltwater movement not sensitive to groundwater diversions
  - Atlantic Ocean/LBI region potable aquifers not likely to be impacted by SLR driven SWI (with caveats)

Sea-level Rise and Saltwater Intrusion: Coastal Plain Schematics and Data



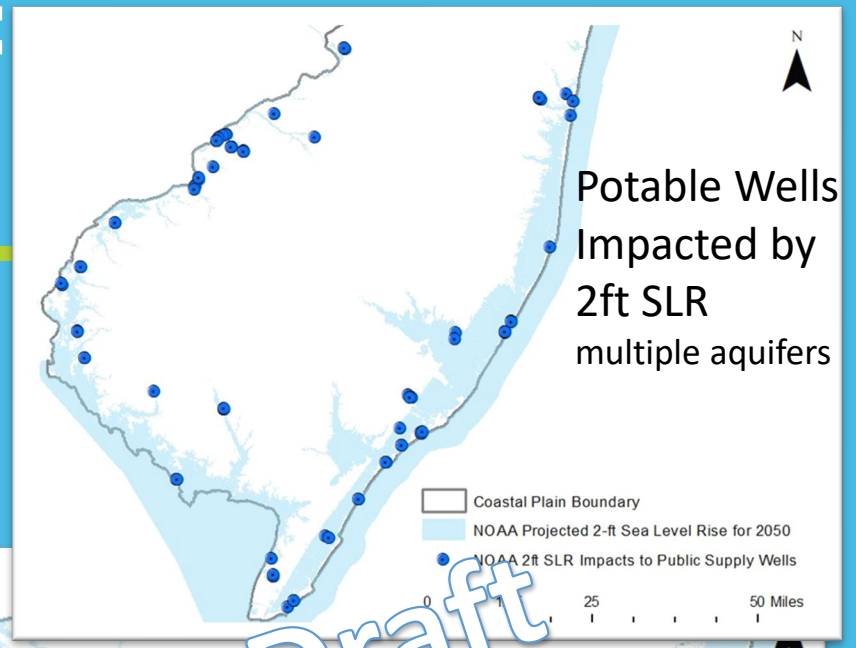


Sources:
Left- USGS Circular 1262
Right- 2018 USGS Synoptic (draft)

Sea-level Rise and Saltwater Intrusion: Coastal Plain Aquifers

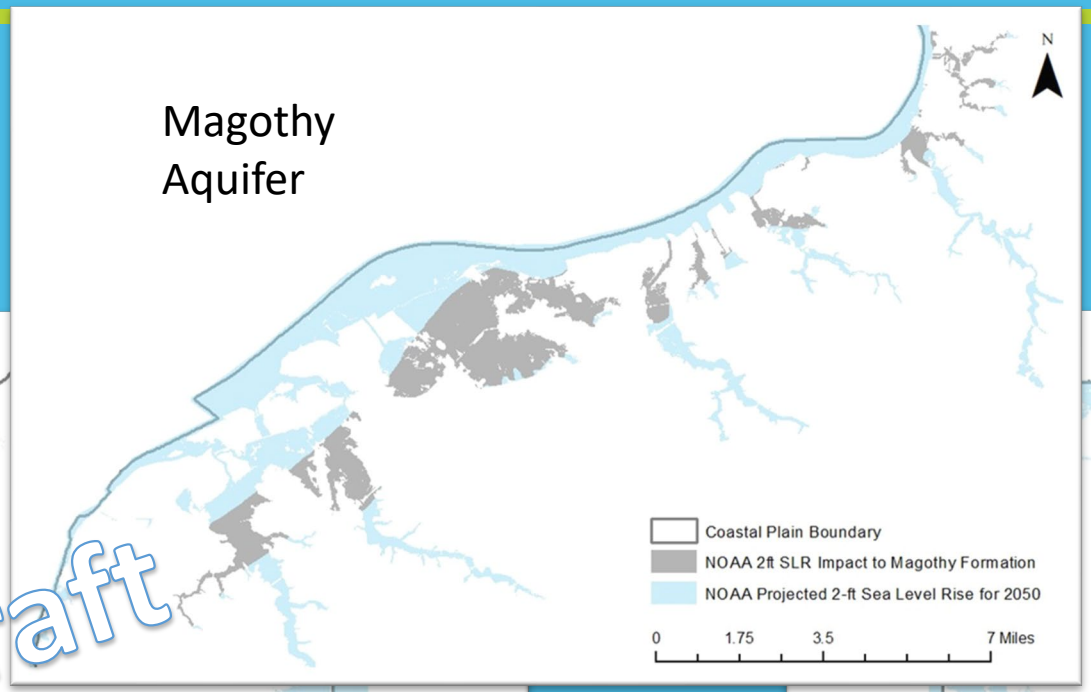
- Bad News:
  - Existing areas with saltwater issues require active management
    - Cape May, Raritan Bay, and Salem/Gloucester regions (multiple aquifers)
    - Blending, MAR, demand management, diversion limits/CAs, well relocation, etc. still needed
  - Unconfined aquifer systems most at risk to SLR induced SWI
    - SLR allows infiltration of seawater into freshwater sources
    - 31,500 acres of Kirkwood-Cohansey aquifer inundated at 2 ft SLR
    - 8,100 acres of Potomac and Magothy aquifer outcrop areas inundated at 2 ft SLR
  - Near-ocean/estuary wells
    - Improperly sealed/constructed wells can allow saltwater at the surface to vertically migrate to confined aquifers
    - 91 public community supply wells under water with 2 ft of sea-level rise
    - Multiple non-public community supply wells at risk as well

Sea-level Rise and Saltwater Intrusion: 2050 2 ft of sea-level rise



Potable Wells Impacted by 2ft SLR
multiple aquifers

Draft



Magothy Aquifer

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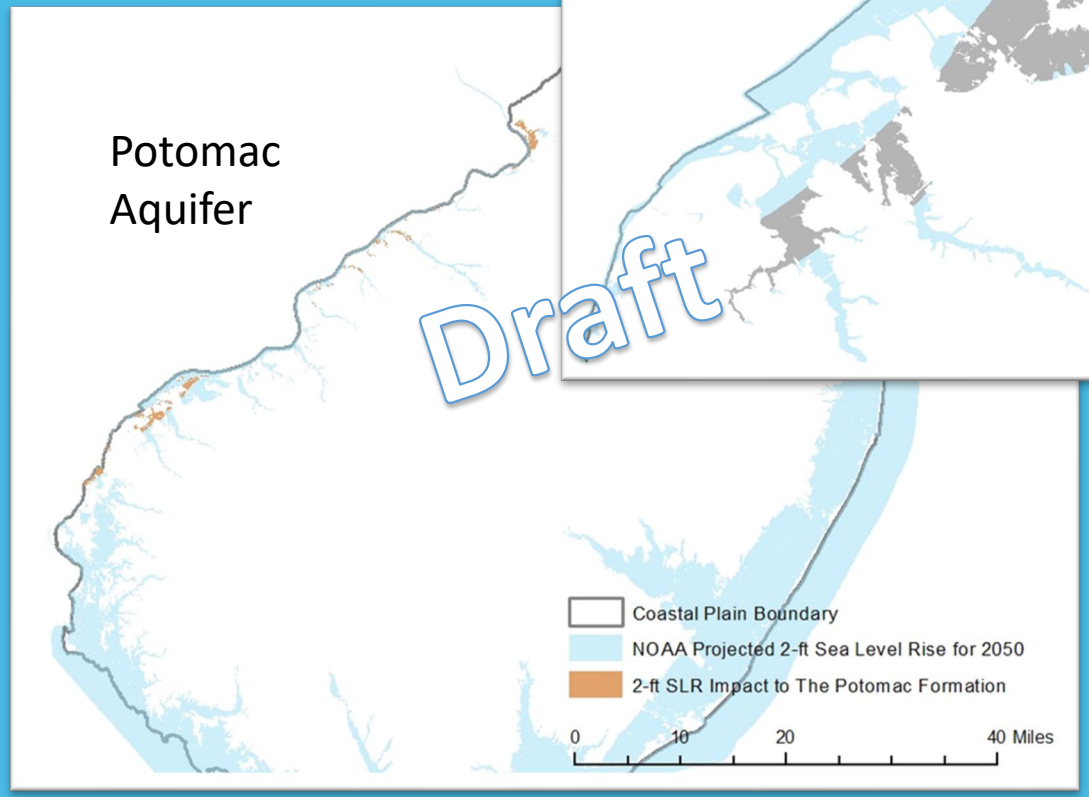
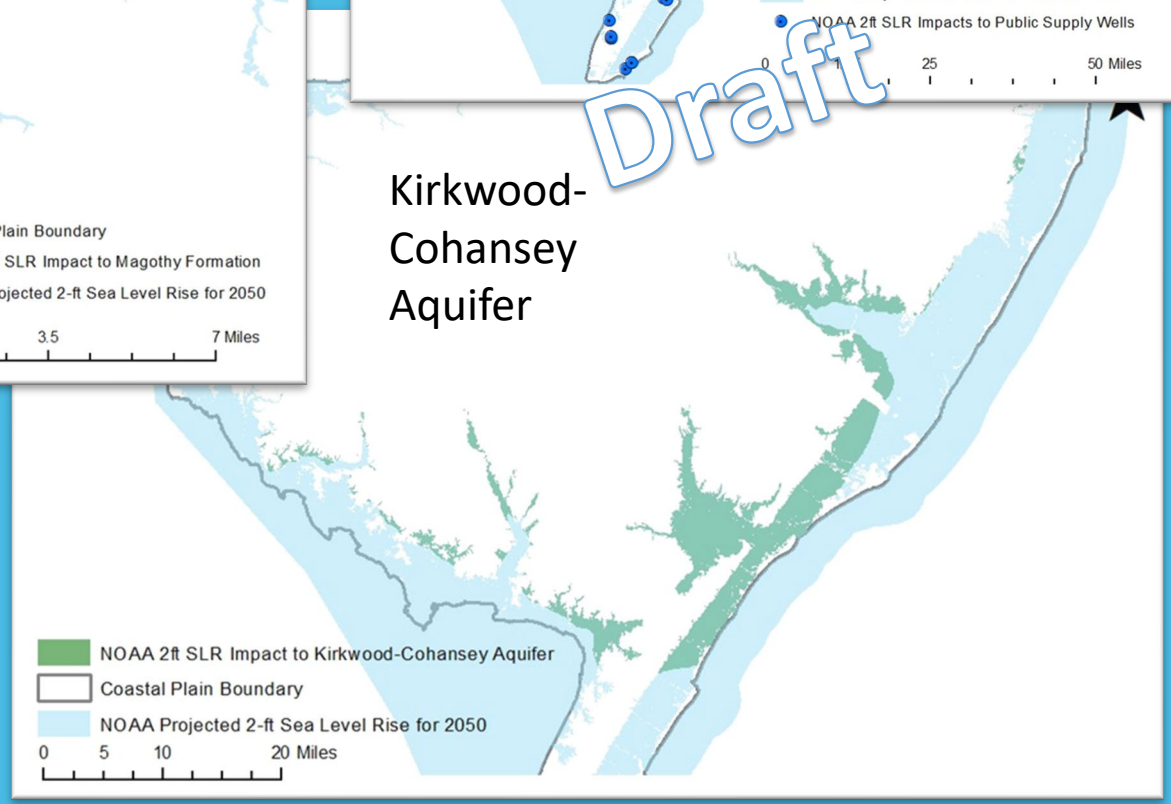


Potomac Aquifer

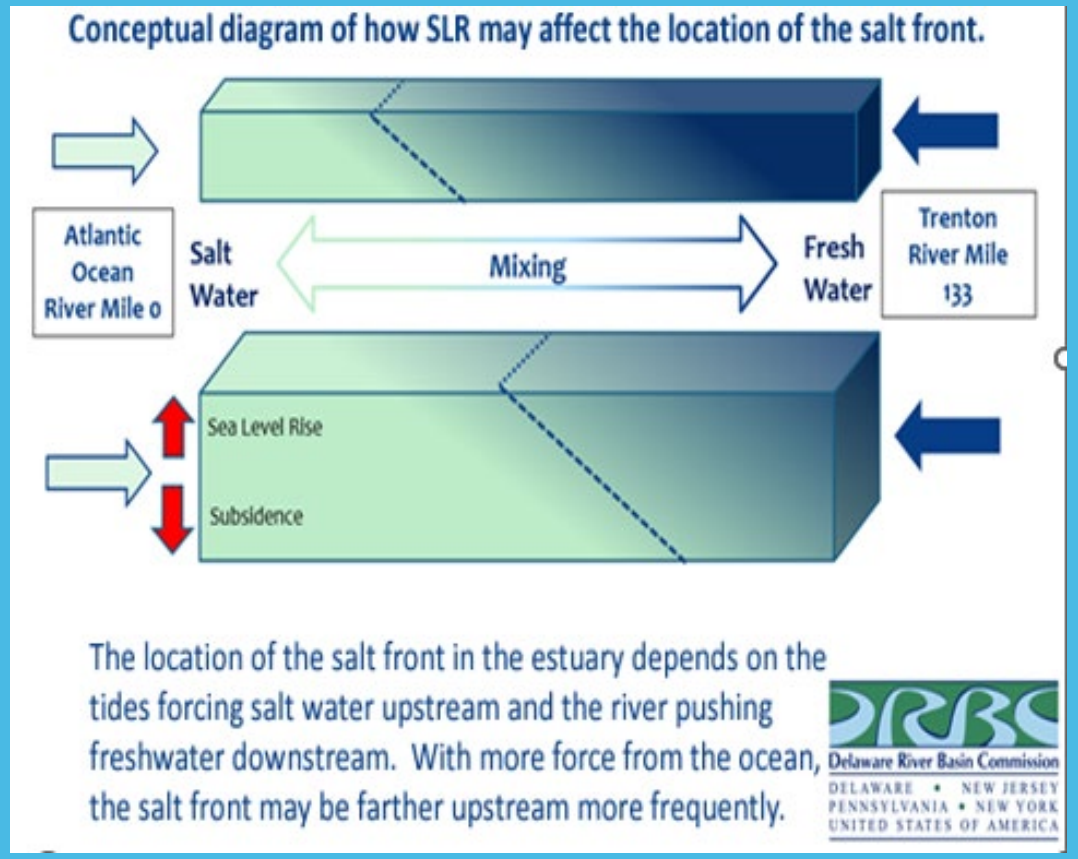


Kirkwood-Cohansey Aquifer

Sea-level Rise and Saltwater Intrusion: Estuaries and Other Sources

- Non-coastal plain aquifers, e.g. Newark basin aquifers
  - Very few wells near ocean/estuary in these aquifers
- Delaware Estuary
  - DRBC currently assessing degree of saltwater movement upriver under a variety of SLR and freshwater inflow scenarios
  - Initial assessment suggests some increased risk of 250 mg/L impact potable intake with 1 meter of SLR and drought of record flow conditions
  - Increased frequency of salty water near the PRM aquifer recharge area
- Reservoirs
  - Multiple water supply reservoirs near ocean/bay and/or at low elevations

Sea-level Rise and Estuaries

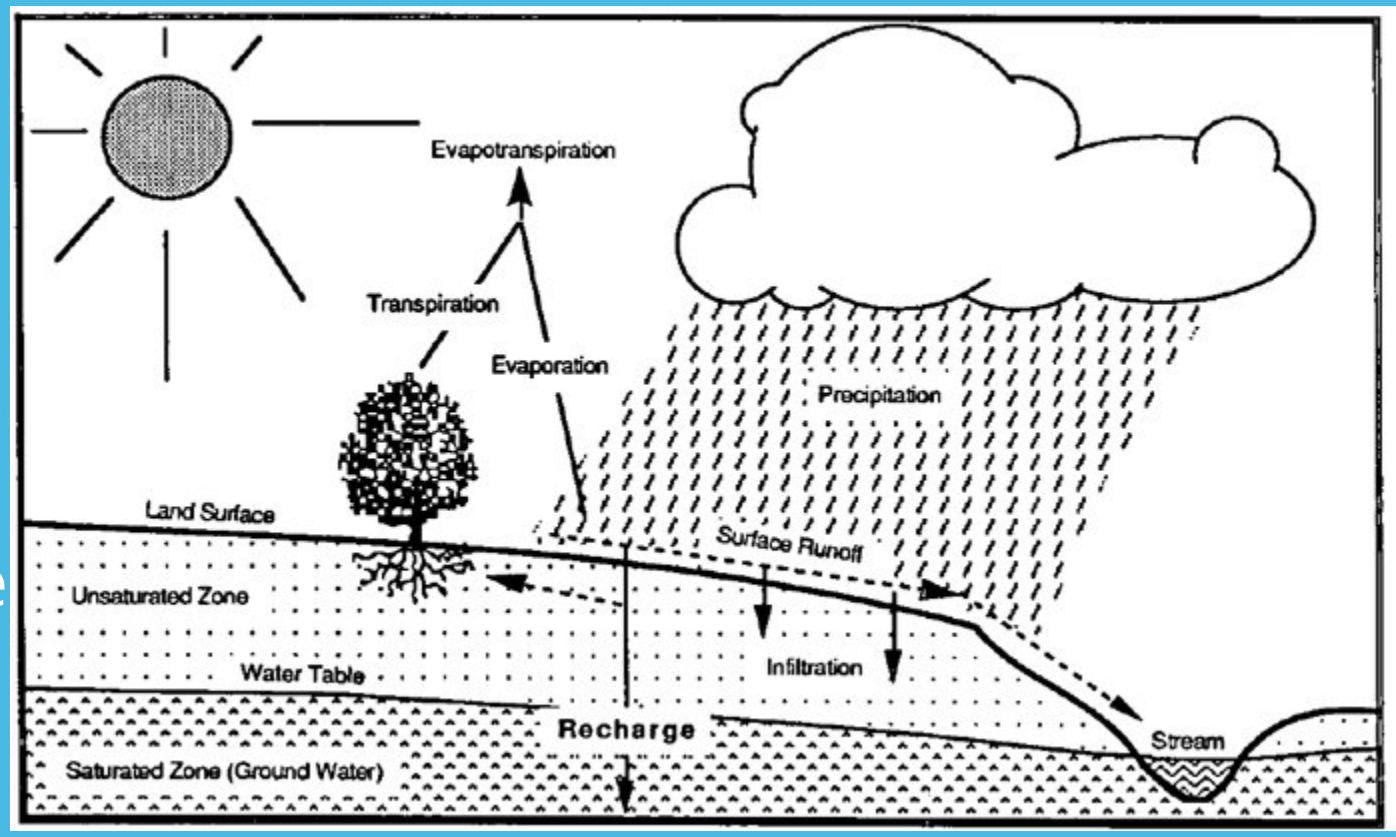


https://www.state.nj.us/drbc/library/documents/ACCC/101222/shallcross-chen_salinity-modeling.pdf

Questions or Comments?

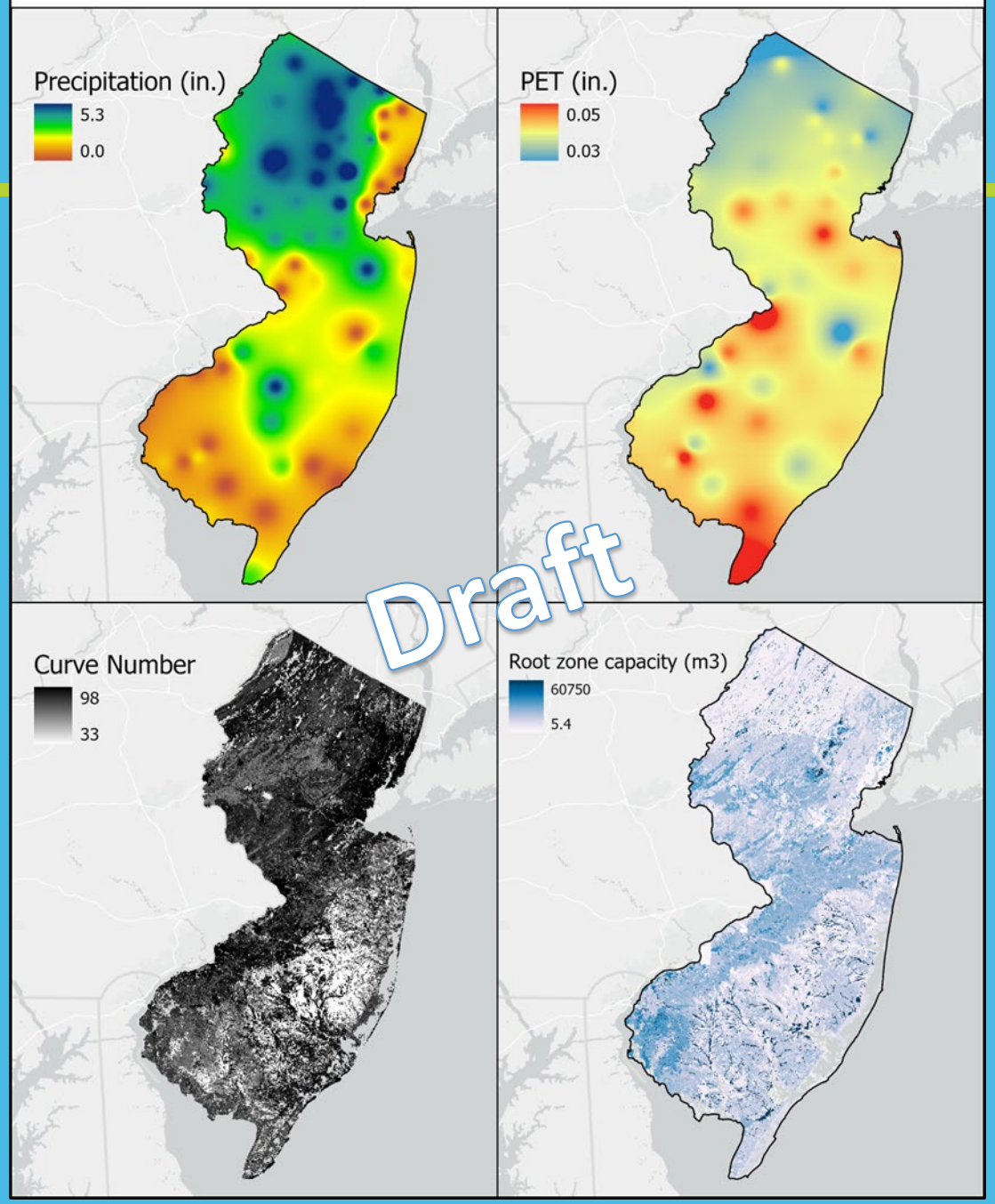
Groundwater Recharge

- Updated NJGWS's groundwater recharge methodology (GSR32)
  - Land Phase Model or LPM
- Daily timestep soil-water budget methodology at 300-meter grid for the 1921 to 2020 time period
- Produces daily gridded values for groundwater recharge, runoff, ET, soil water deficit, and others
- Once calibrated, used to estimate range of climate change effects on groundwater recharge

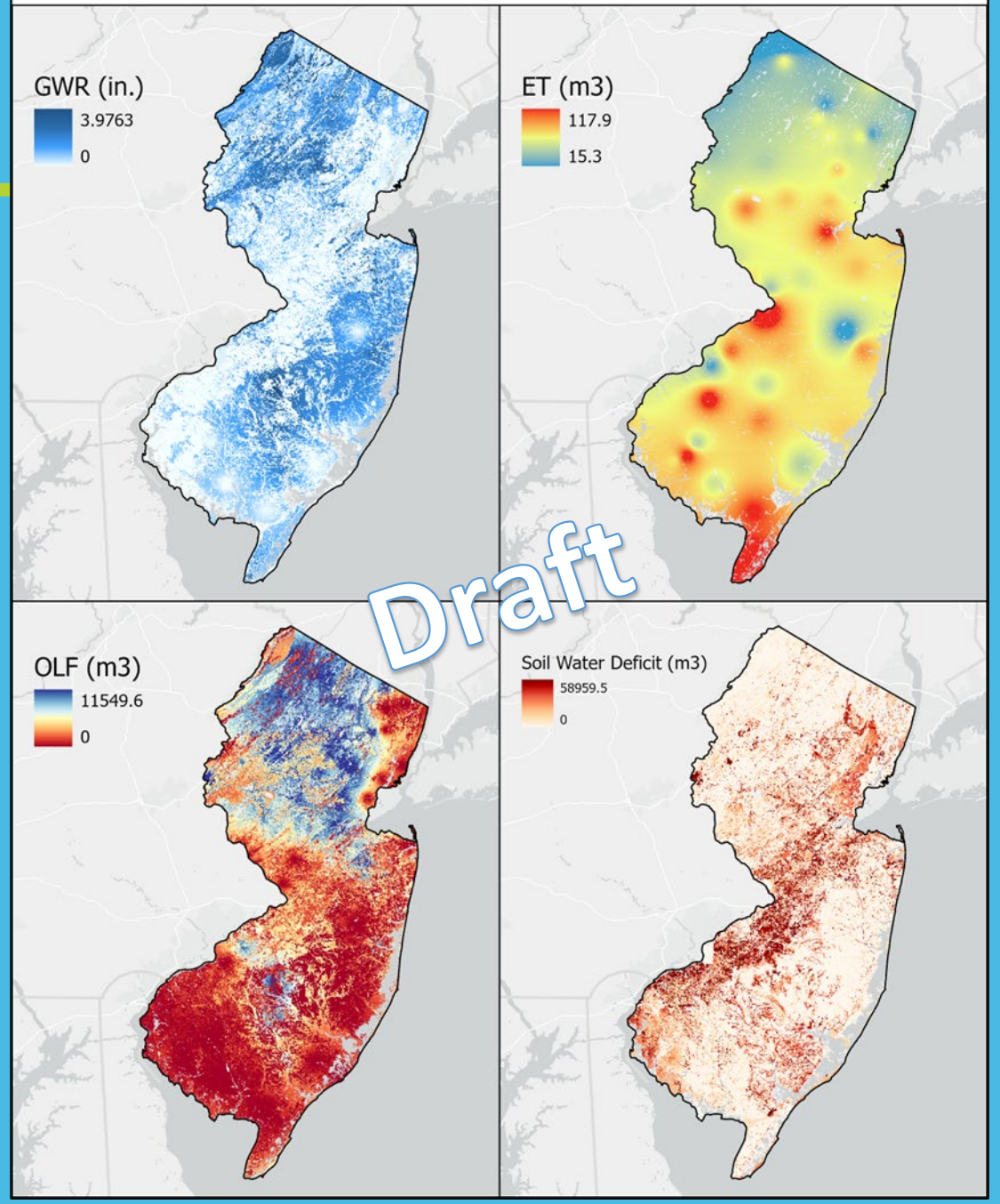


LPM: Input and Output Data

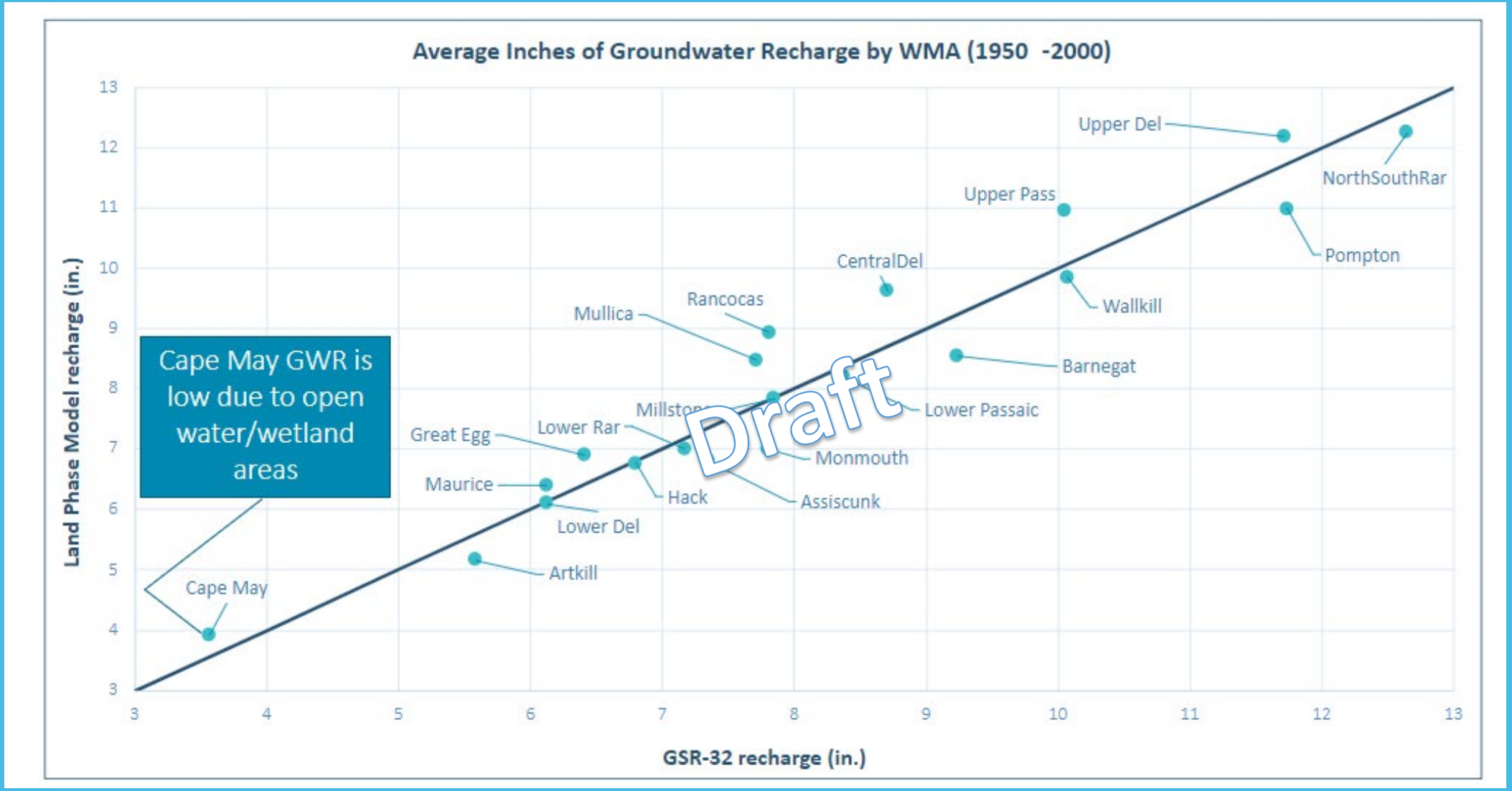
Land Phase Model Inputs: Nov 09, 1972



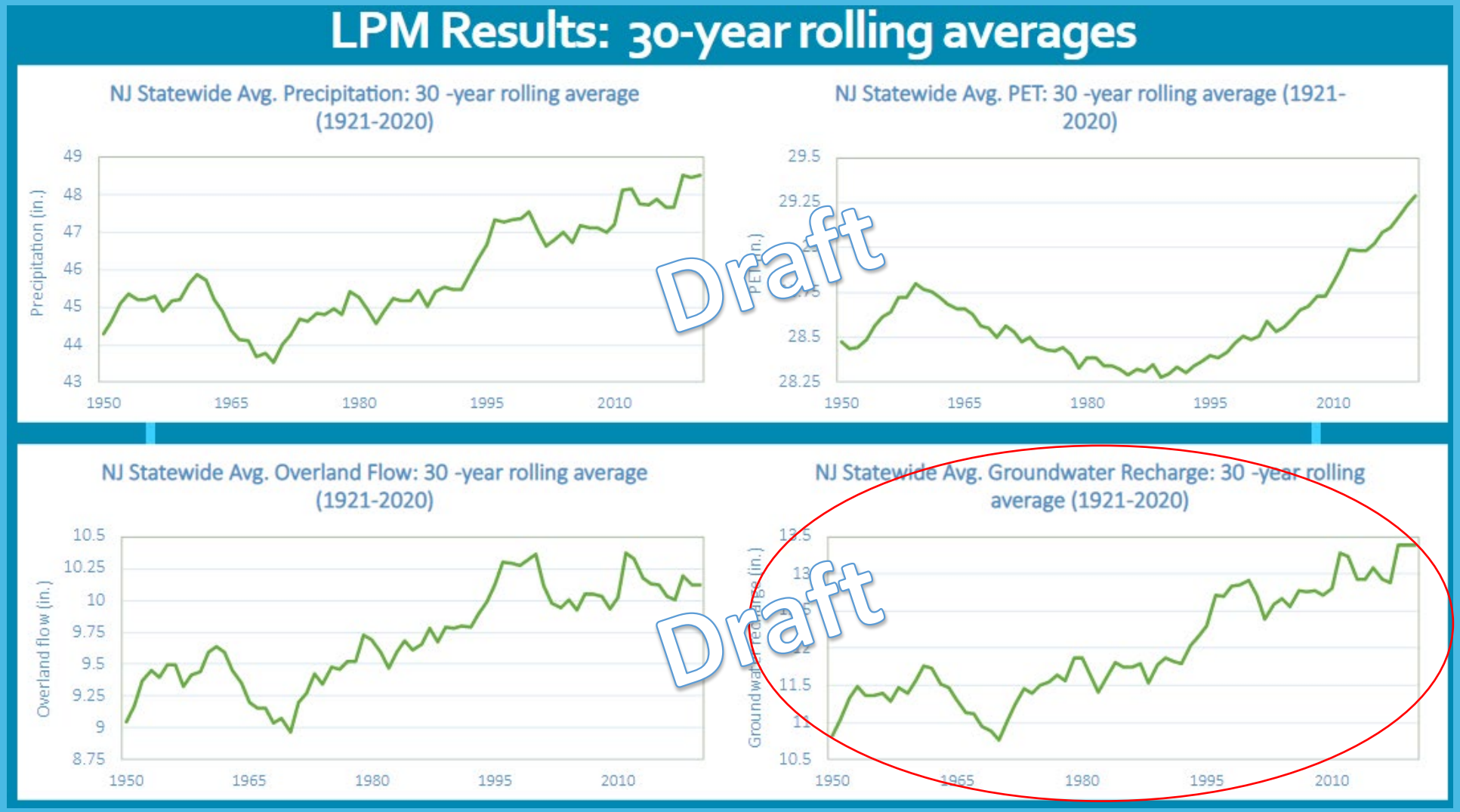
Land Phase Model Outputs: Nov 09, 1972



LPM: Groundwater Recharge Calibration



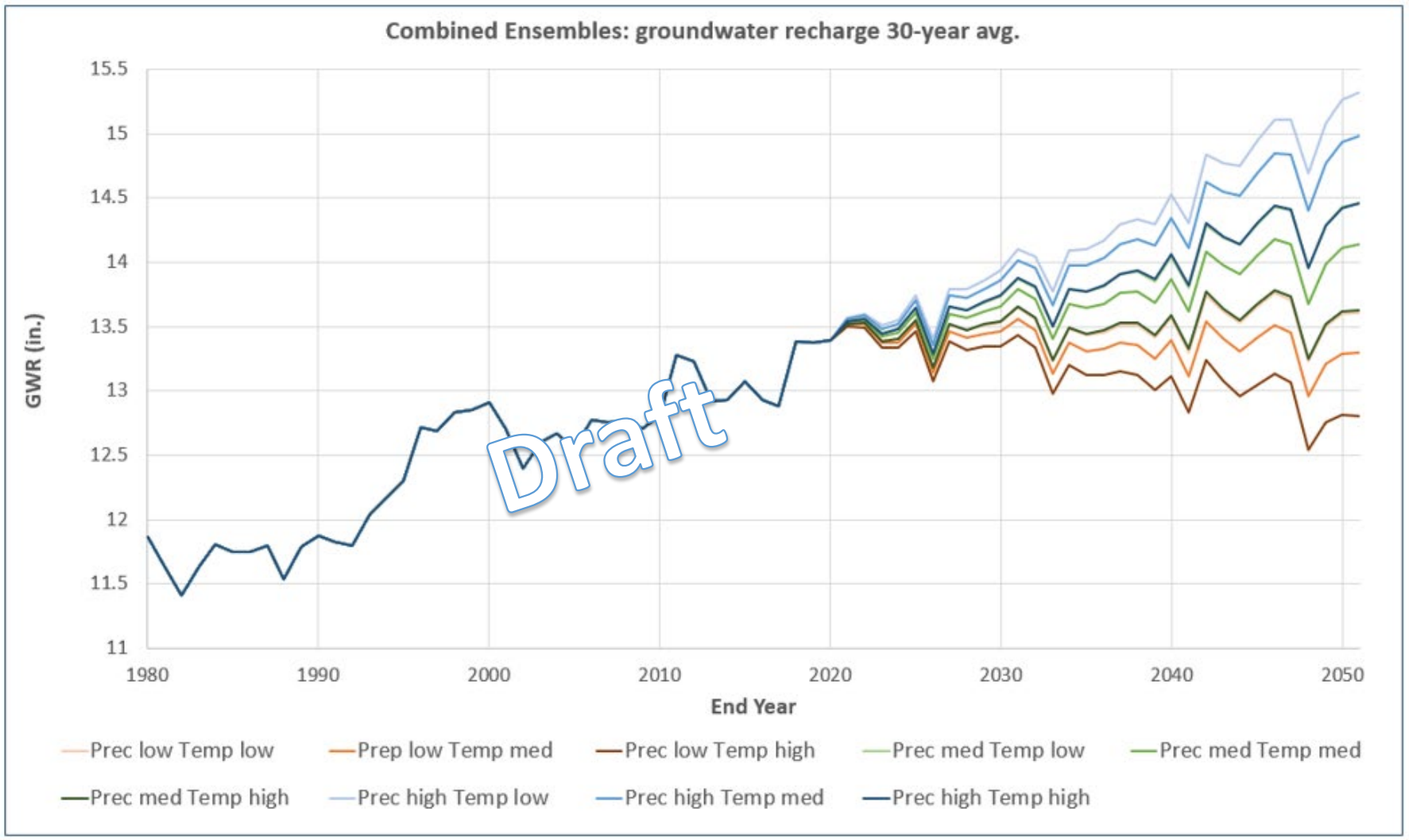
LPM: Observed Trends



LPM: Groundwater Recharge Projections

Variables:
Precipitation:
High-med-low
Temperature:
High-med-low

-9 alternatives



LPM: Groundwater Recharge Findings

- Overall, more water is likely to be available to recharge groundwater
- Out of the nine climate ensembles…
  - 5 forecast an increase in GWR from 2020 to 2050
  - 2 forecast a decrease in GWR from 2020 to 2050
  - 2 forecast stable GWR from 2020 to 2050
  - All forecast more GWR in 2050 than in 1980
  - None of the ensembles suggest that future groundwater resources are an immediate cause for concern from a water quantity perspective
- Caveats:
  - Recharge forecasts do not match trends observable in data from shallow groundwater monitoring wells, observed data much more variable…
  - More model development is needed to determine how much water is actually recharging aquifers ⟹ Developing LPM 2.0

Questions or Comments?

Overall WSP CC Findings…

- In general, ***and with caveats***, the results of these initial evaluations suggest that NJ has and will continue to have more available water as a result of climate change through 2050:
  - Assuming:
    - Climate forecasts and water resource models are reasonably accurate
    - Demands remain stable ± and water quality impacts are manageable
    - Existing infrastructure and sources are maintained
- Specifically:
  - Reservoirs have adequate supply, even with decreased flow and increased demand
    - Variability exists between systems and pumped storage systems most sensitive to change
  - Groundwater recharge currently increasing and likely to stay the same or increase
  - Sea level rise will not cause significant new saltwater intrusion impacts to potable aquifers, but existing areas still need to be actively managed and low-lying infrastructure may need to be hardened

Note that regional/local water supply problems exist and new ones may emerge, and periodic stresses will continue to occur

However…

- Uncertainties exist in forecasted climate conditions, especially beyond 2050, and current forecasts will change as the science evolves and information specific to NJ is improved
- WSP water availability impacts evaluations were limited and need to be continued and enhanced to confirm findings
- Normal and severe dry and wet events will still occur, floods likely to be worse, and infrastructure needs to maintained and/or hardened to withstand these events
  - Raw and finished water transfers will be needed
  - More research is needed to characterize future drought frequency, duration, and severity, with increased occurrence of *flash drought-like* events (already happening?)

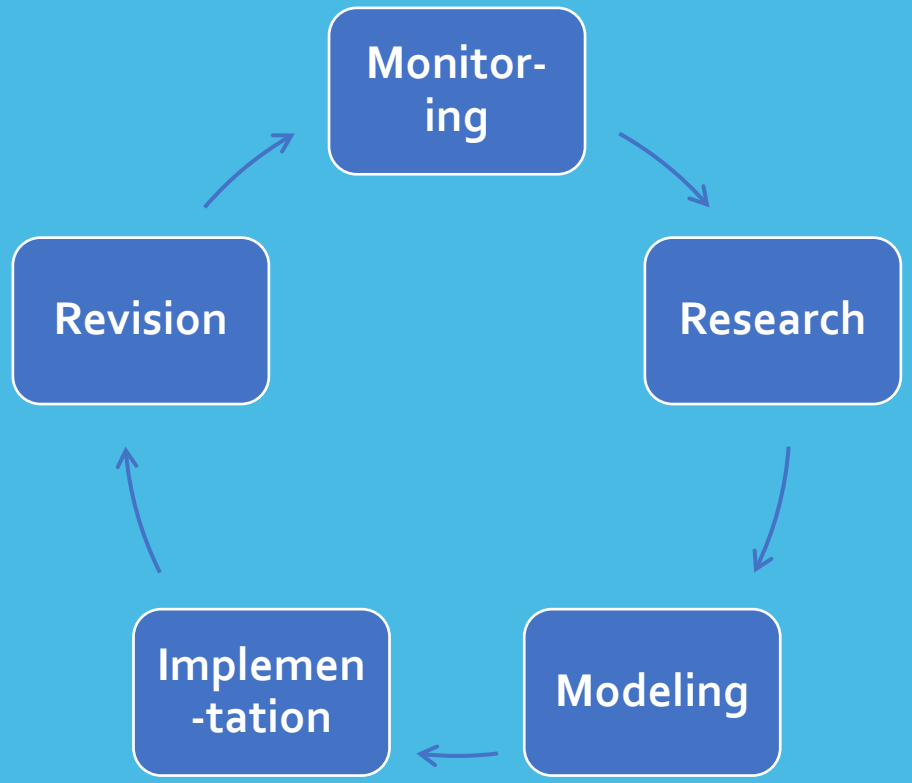
However…

- Existing saltwater problem areas still need to be assessed and actively managed
- Water quality impacts (e.g. HABs) were not quantified but are anticipated and need to be evaluated, results could be significant
- Sea-level rise will impact unconfined potable aquifers and outcrop areas, and will inundate wells and related infrastructure
- Saltwater will move further upriver and more often potentially impacting lower elevation dams, intakes and reservoirs
- Future demands are likely to change in response to climates changes; e.g. longer growing seasons or hotter summers

What's Next….

WSP CC Action Plan… with details to come

- Monitoring
  - e.g., real-time, climate, hydrologic…
- Research
  - e.g., global and downscaled climate forecasts, water quality, demands…
- Modeling
  - e.g., improved/confirmed CC impacts on water availability…
- Implementation
  - e.g., policies, mid-WSP updates, water allocation permitting…
- Revision
  - e.g., WSP revisions…



Questions or Comments?

Thank You

Water Supply Plan Team

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  - NJGWS Water Supply Modeling and Planning
  - DWSG Director's Office
  - AC WRM's Office
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