PWD Water Supply Planning:
PWD Salinity Model Phase I Simulation Results

Regulated Flow Advisory Committee January 24, 2023

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PWD Salinity Model Phase I Simulation Results

1. Introduction
2. Modeling Objective
3. Results Discussion

PWD RFAC Presentations to Date

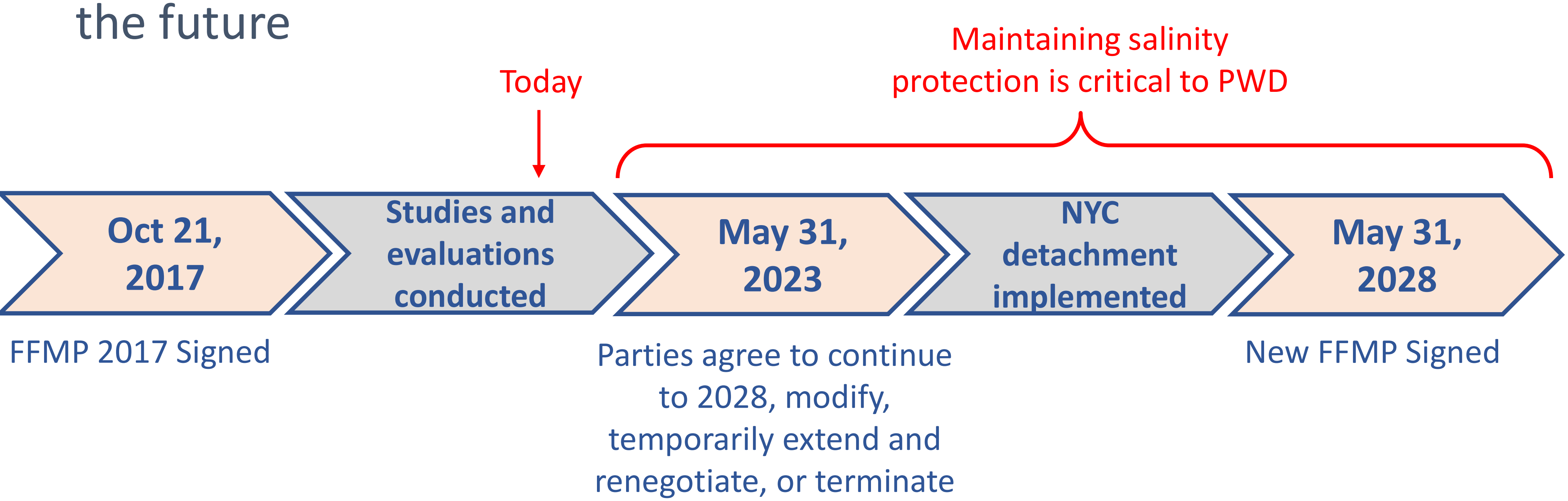
https://water.phila.gov/sustainability/watershed-protection/

1. **May 24, 2018**
   - Water Supply Planning Introduction
2. **April 9, 2019**
   - Salinity Intrusion in the Delaware Estuary
3. **May 14, 2020**
   - PWD Salinity Model and Validation
4. **December 15, 2021**
   - PWD Salinity Model Production Run Setup
5. **January 2023**
   - PWD Salinity Model Phase I Simulation Results

More to Come!

FFMP Timeline

- Reservoir operations are currently designed to manage the location of the 7-day average 250 mg/L chloride isochlor (not prevent intrusion, not dilute upstream pollution)
- Changes to NYC drought emergency flow targets are under consideration by the FFMP (detachment)
- One FFMP clause is critical to Philadelphia regarding possible salinity protection changes in 2023 that would last through 2028 and likely the future



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PWD Needs to Know How Salinity is Responsive to Flow

Modeling needs to inform:

1. 2028 conditions
   - Capture the influence of policies decided in 2023 that will dictate drought management until 2028
   - Includes 2028 sea level rise
2. Intrusion upstream of Chester
   - FFMP flow objectives manage intrusion once it moves upstream of Chester
3. Sustained intrusion
   - Altered flow targets or reservoir operations could lead to longer intrusion events
4. Influence of Schuylkill and Trenton flows on salinity
   - Streamflow combinations including both locations

What the PWD Salinity Model is Simulating

Critical Period Setup – September to December

- Discharges and intakes set to November 2014 values
- Water temperature time series for critical period
- Tributary salinity set to 2028 projected salinity
- Tributary streamflow set to 7Q10
- Water level times series from 2016

Sea Level Rise

- 2028 projected from observed data trend

Event Simulated

- Sustained 12 PSU at Reedy Island, brings salt to Chester
- Intrusion is sustained to observe flow target performance

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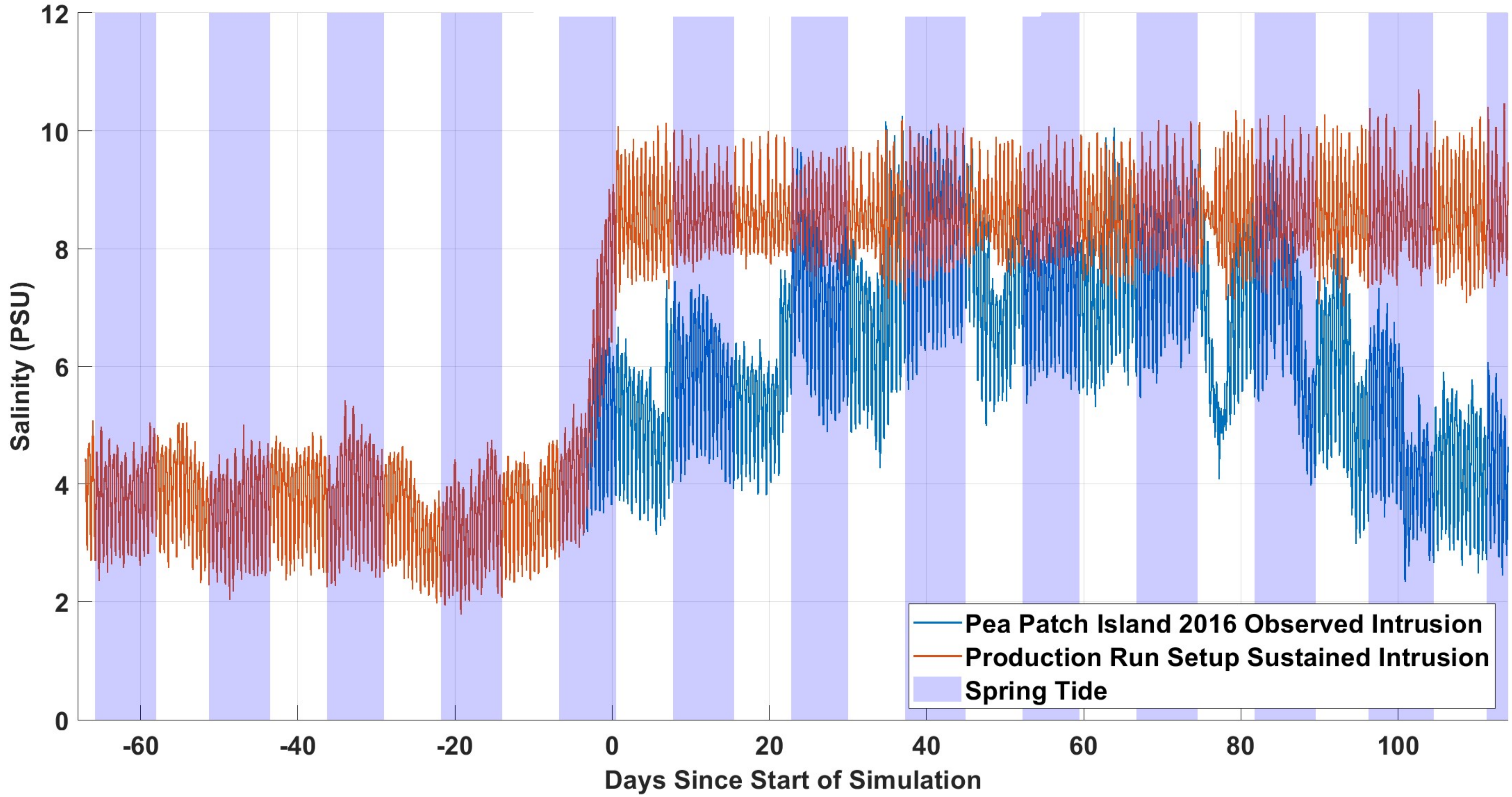
Open Boundary Salinity Input – Sustained Intrusion



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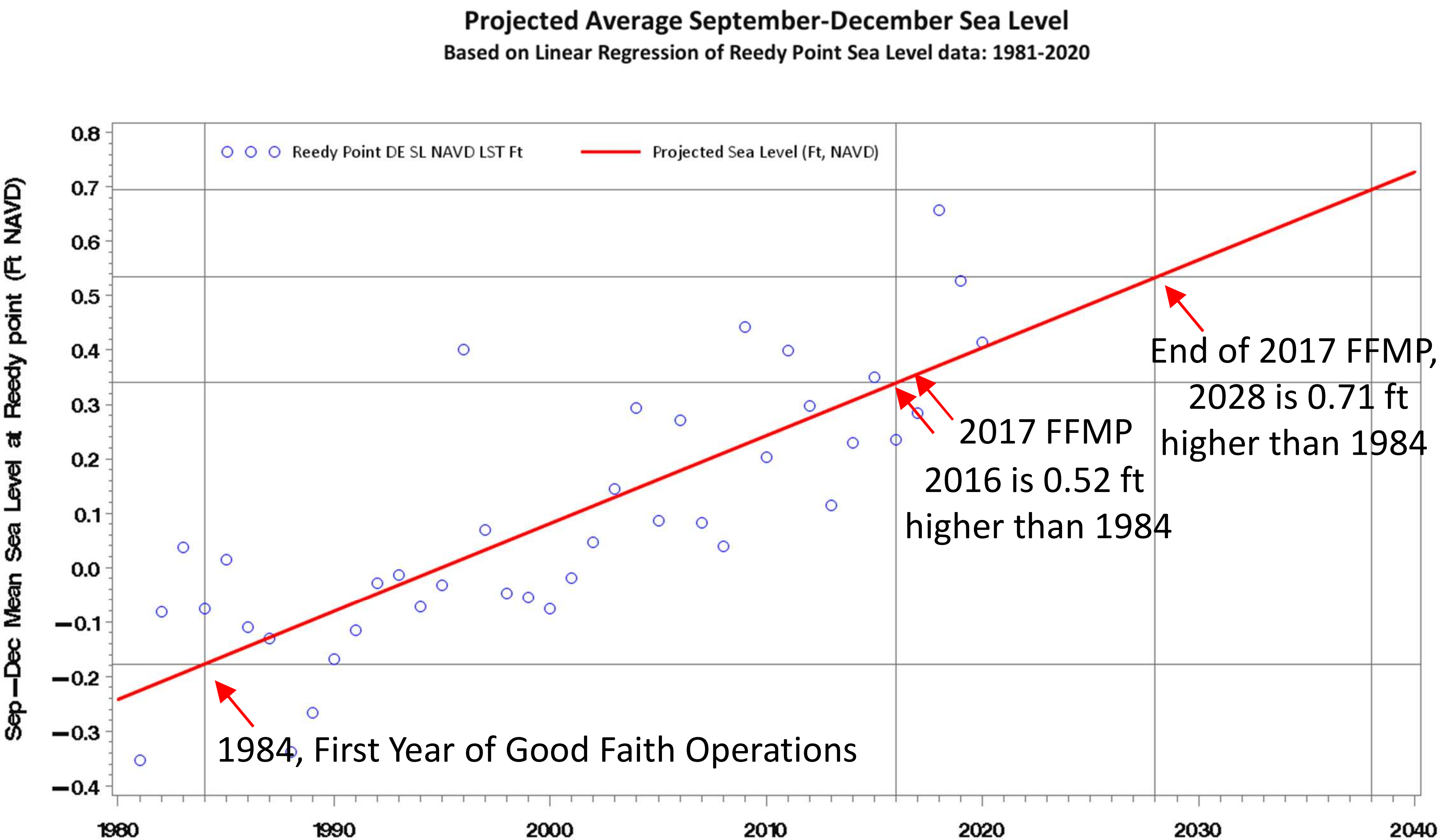
Sea Level Rise through Salinity Regulation History



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Phase I Production Runs – 34 Runs

- Analyze tributary chloride inputs projected to 2028
  - Presented at last RFAC, increasing tributary chloride from 2016 to 2028 created an increase of approximately 5 mg/L at Ben Franklin Bridge
- Analyze sea level rise
  - Presented at last RFAC, increasing sea level from 2016-2028 created an increase of approximate 10 mg/L at Ben Franklin Bridge
- Compare flow combinations
  - Understand salinity sensitivity to incremental changes in flow
  - Matching a range of flows at Trenton (3,000 CFS – 1,500 CFS) to a range of flows at Schuylkill (700 – 100 CFS)

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  - Match a range of flows at Trenton (1,500 CFS – 3,000 CFS) to a range of flows at Schuylkill (100 – 700 CFS)

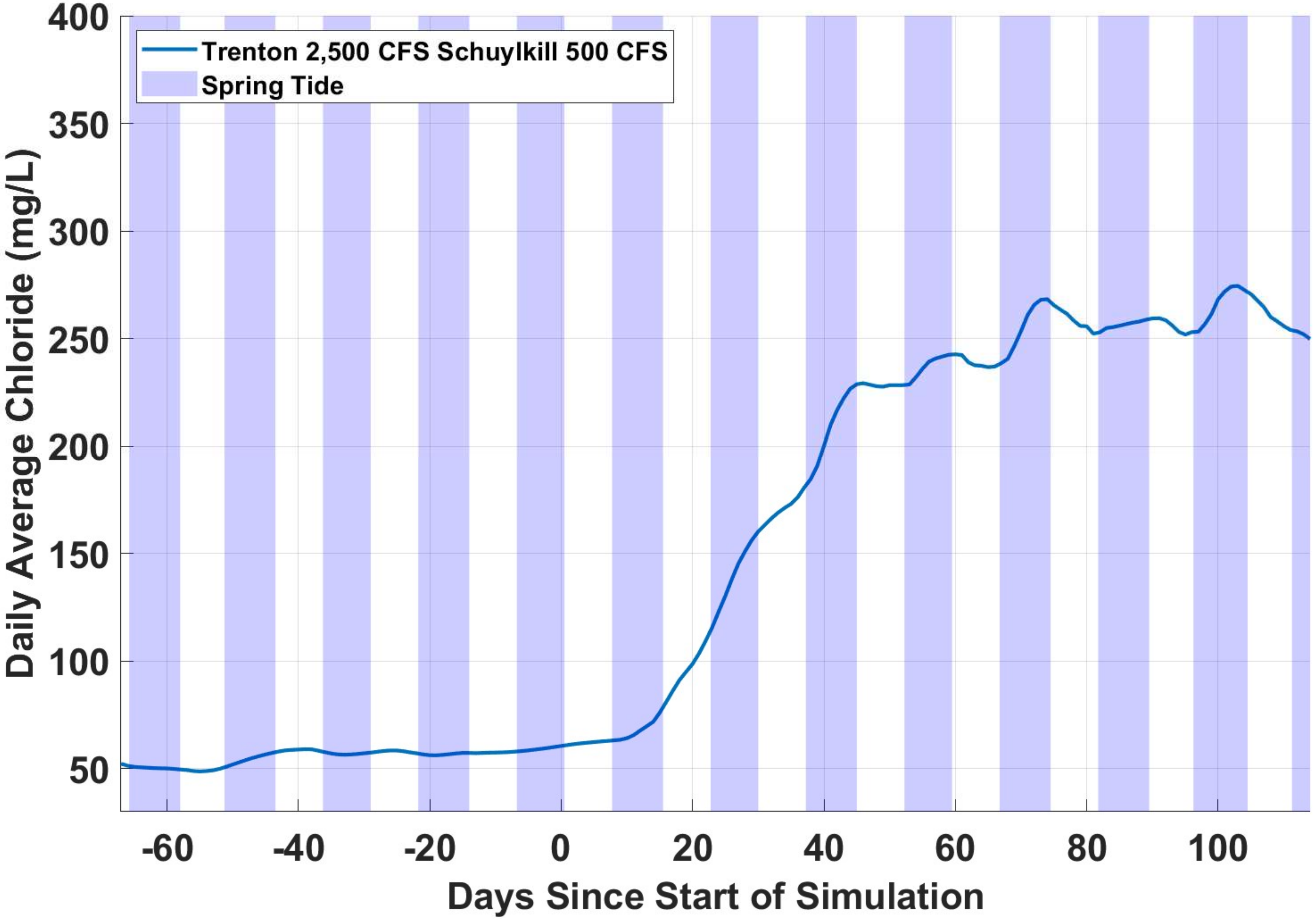
Salinity Metrics to Support Policy and Regulatory Contexts

1. FFMP definition of salt line is 7-day average of 250 mg/L chloride
   - Maximum salt line intrusion river mile (RM)
   - Maximum 30-day average salt line intrusion RM
2. DRBC Zone 3 maximum 30-day average of 180 mg/L at RM98
   - # of days 30-day average at RM 98 is ≥180 mg/L chloride
3. DRBC Zone 2 maximum 15-day average of 50mg/L chloride above RM 108.4
   - Ambient conditions exceed criteria during critical period

Location: River Mile 100, Ben Franklin Bridge

Trenton Streamflow: 2,500 CFS

Schuylkill Streamflow: 500 CFS



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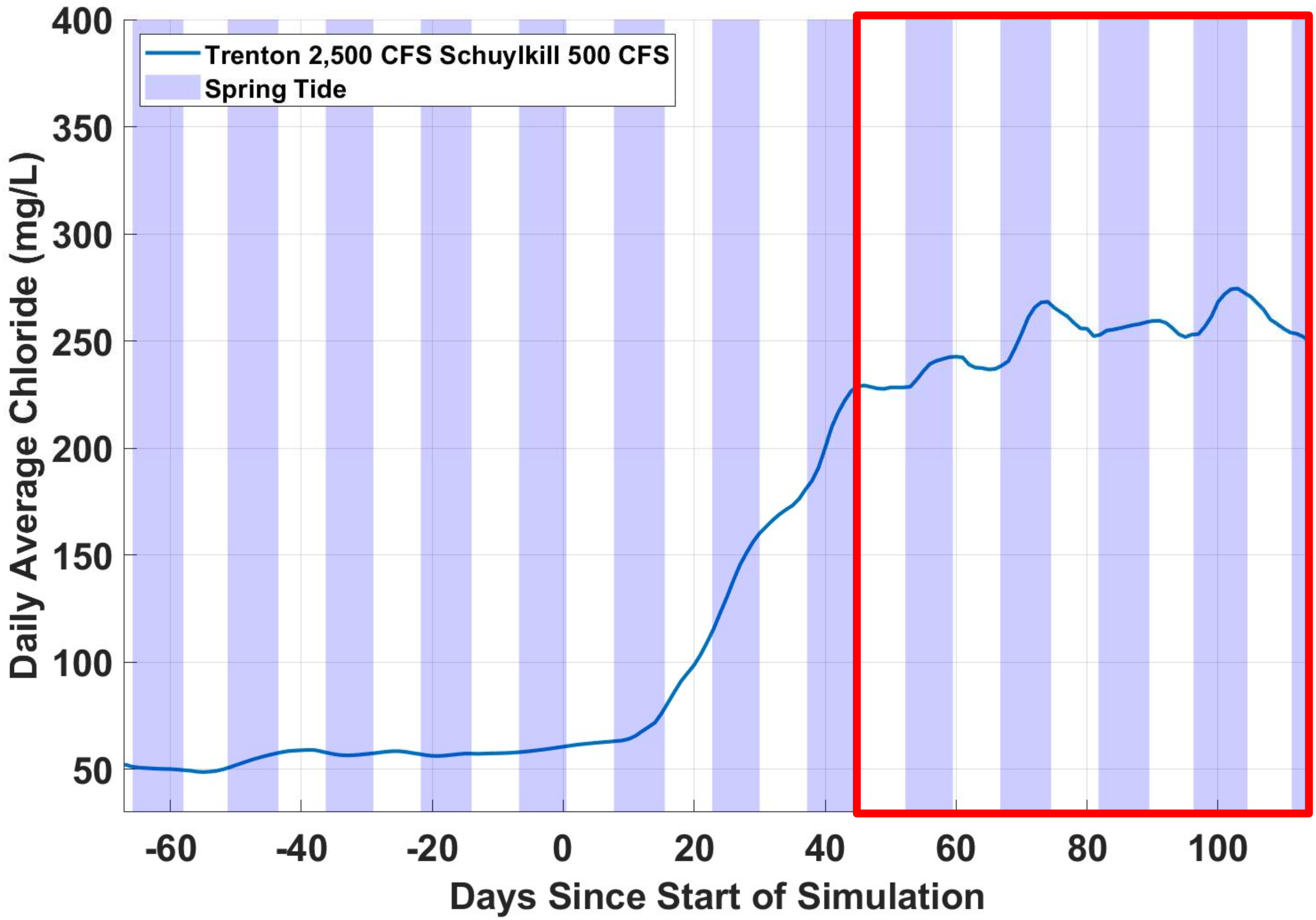
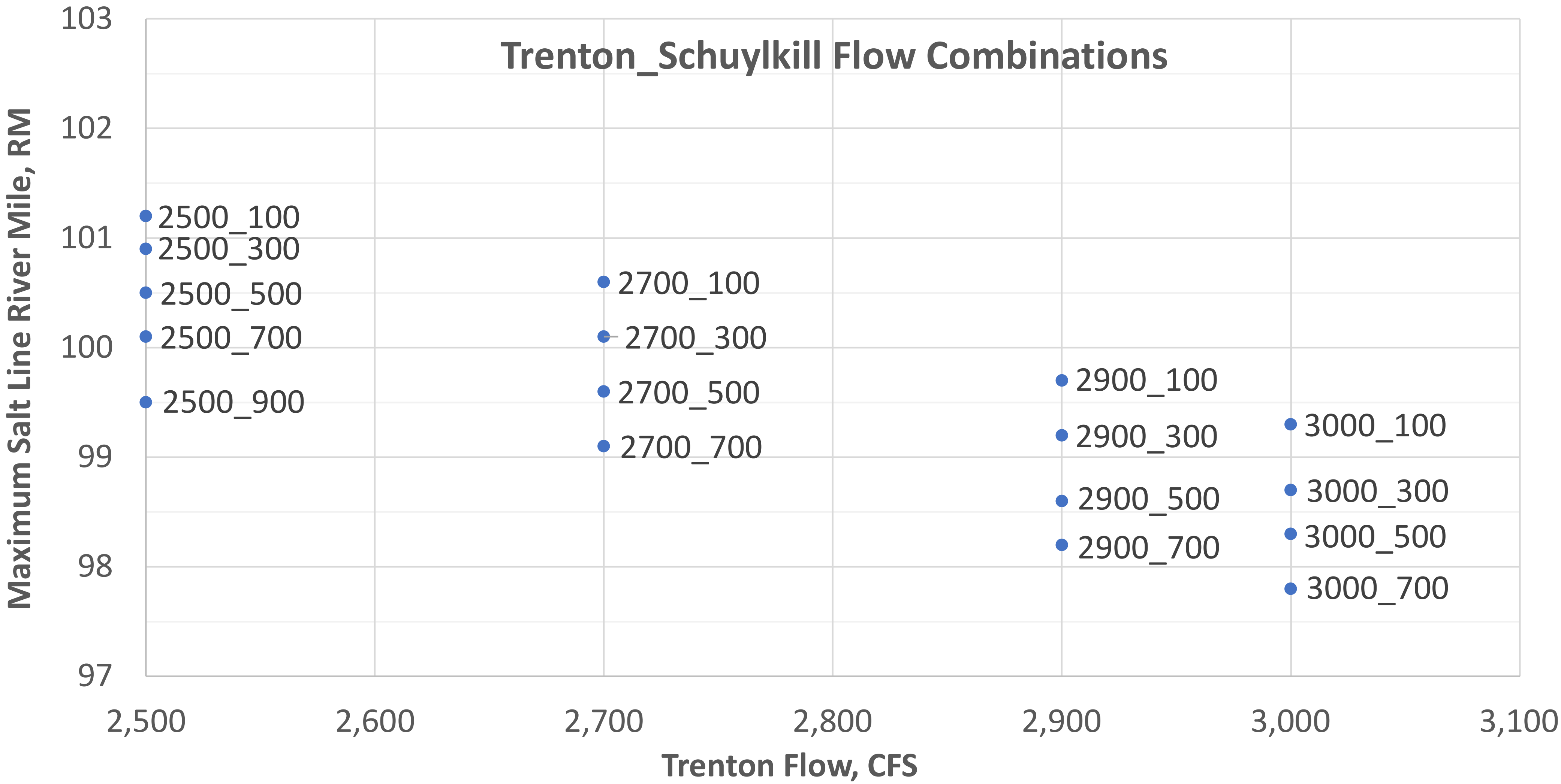


PWD Salinity Model 2028 Results, Max. Intrusion

Question: Is the salt line sensitive to incremental increases in flow at Trenton?

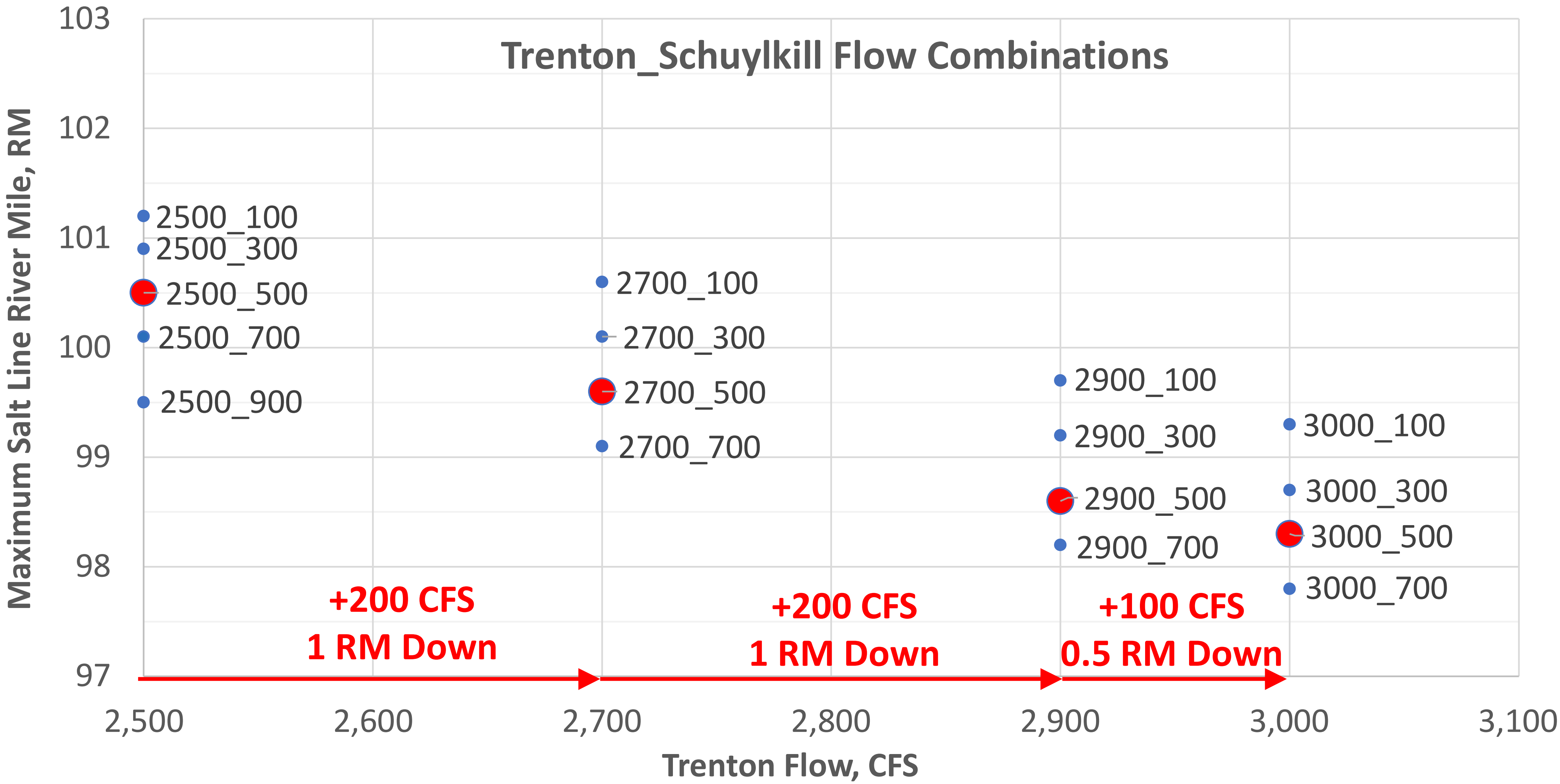
Compare salt line location adding 200 CFS to Trenton



PWD Salinity Model 2028 Results, Max. Intrusion

Question: Is the salt line sensitive to incremental increases in flow at Trenton?

Compare salt line location while adding small increments to Trenton



 The salt line is sensitive to small incremental flow changes at Trenton

What are the salinity model results telling us?

1. **The salt line is sensitive to incremental flow increases at Trenton**
   - Increasing Trenton by 200 CFS repelled the salt line 1 mile downstream
   - Big response for a small amount of flow

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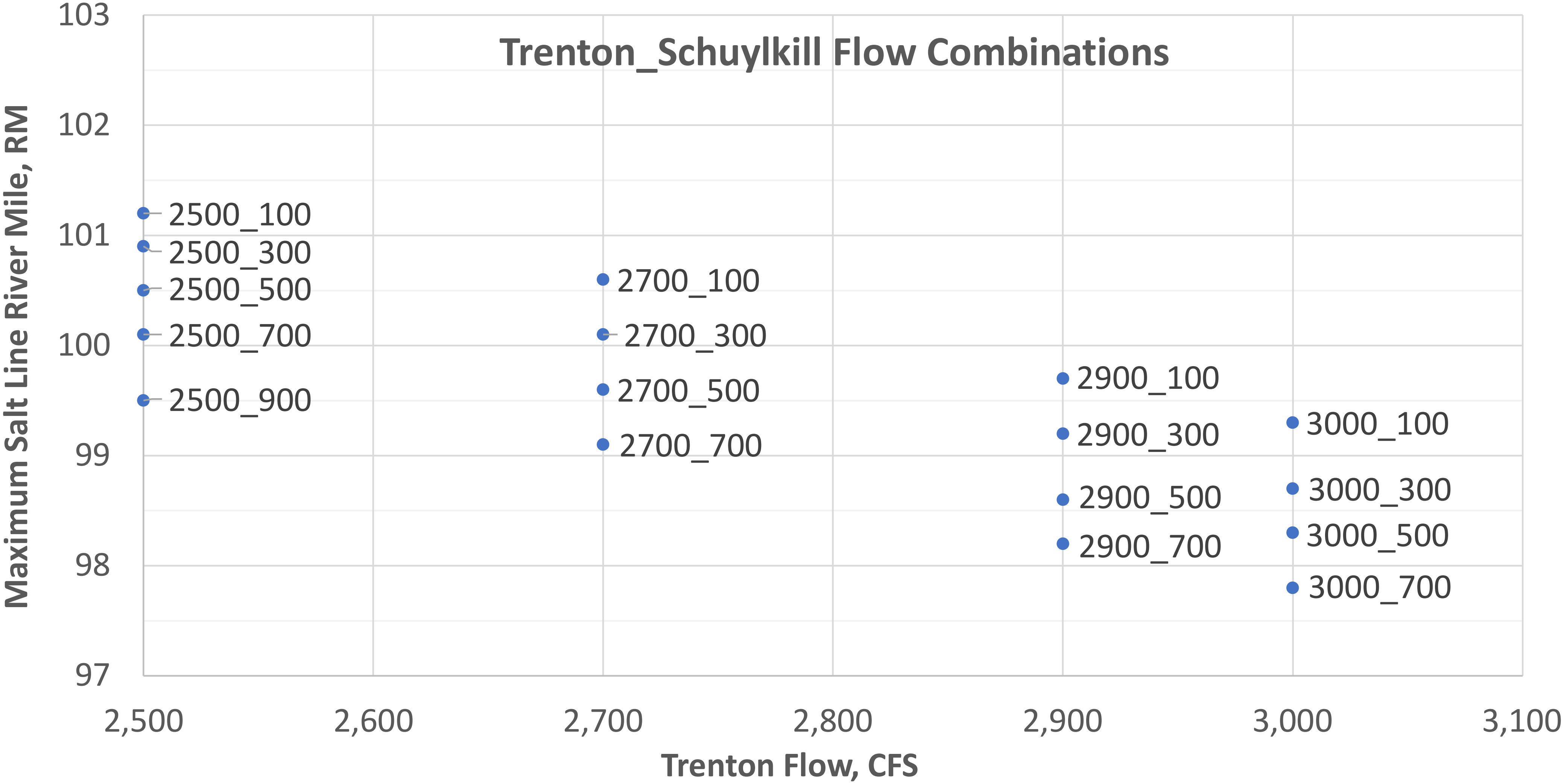
PWD Salinity Model 2028 Results, Max. Intrusion

Question: Are releases added to the Schuylkill equivalent to releases added to Trenton?

Compare salt line location adding 400 CFS to Trenton vs. adding 400 CFS to the Schuylkill



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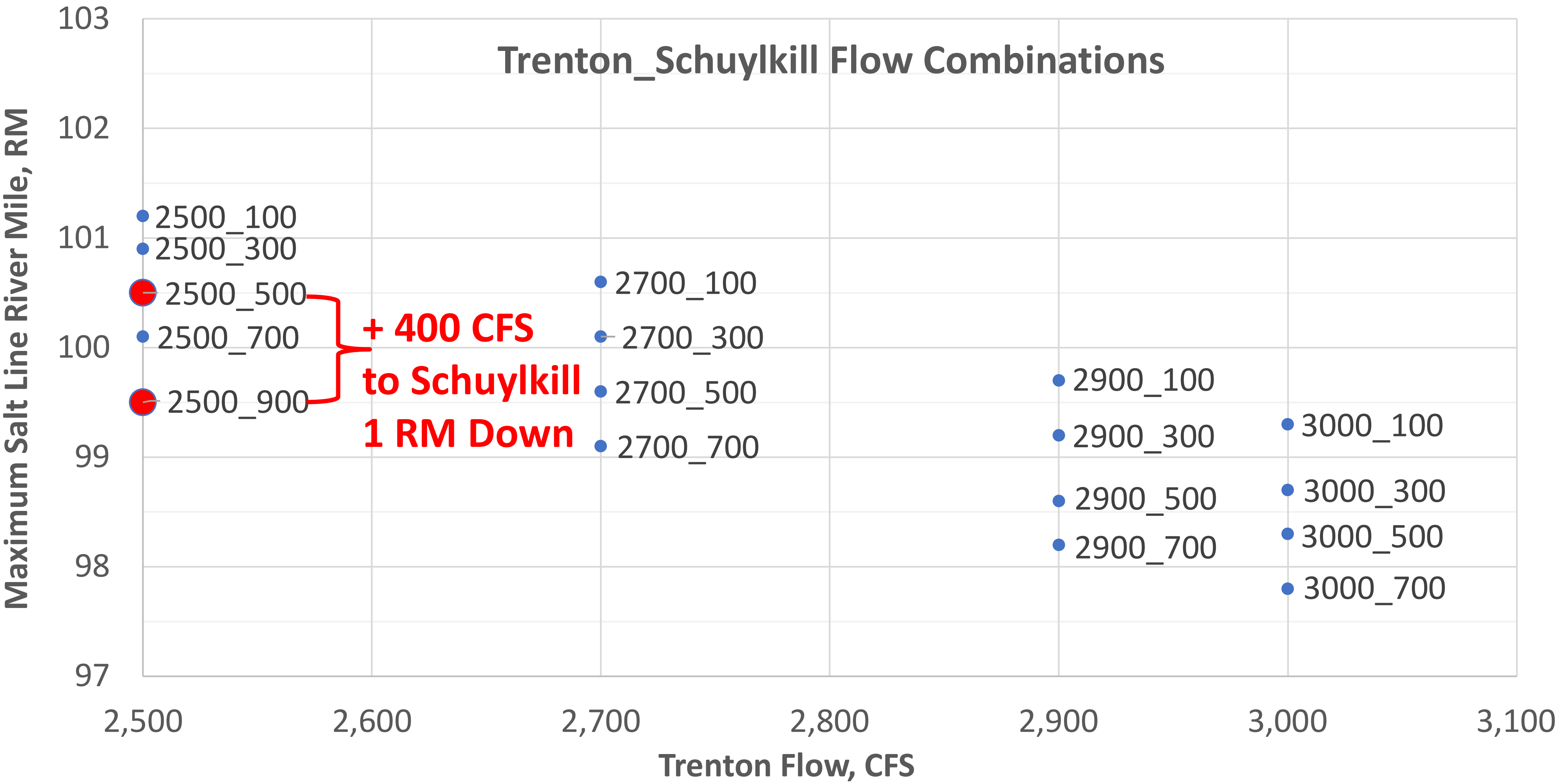

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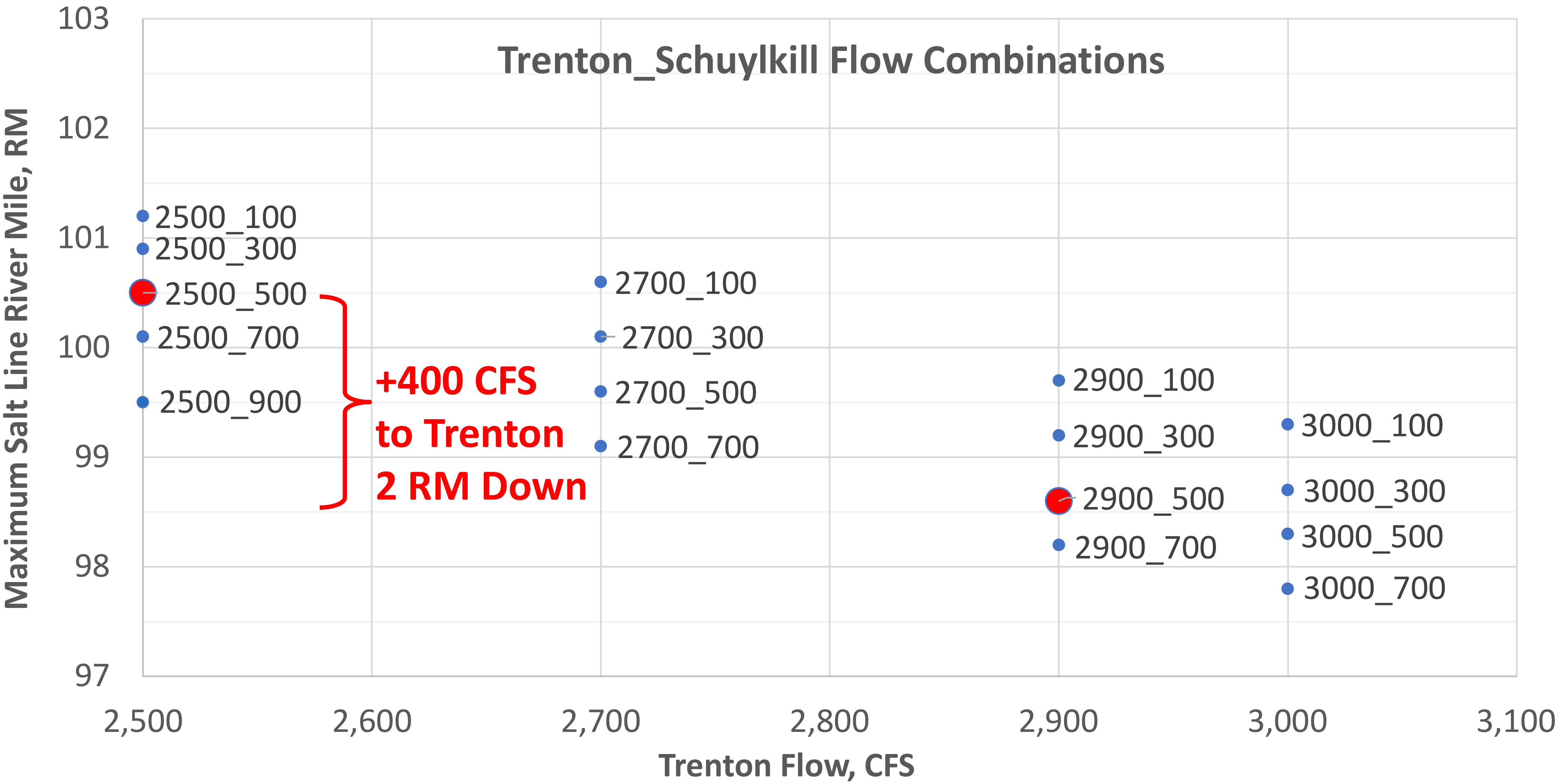

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What are the salinity model results telling us?

1. **The salt line is sensitive to incremental flow increases at Trenton**
   - Increasing Trenton by 200 CFS repelled the salt line 1 mile downstream
   - Big response for a small amount of flow
2. **Water added to the Schuylkill to repel the salt line is half as effective as water added to Trenton to repel the salt line**
   - Increasing Trenton by 400 CFS repelled the salt line 1 mile further downstream compared to increasing the Schuylkill by 400 CFS
3. **All flow combinations simulated led to an exceedence of the DRBC Zone 3 chloride criteria (30-day average chloride >180 mg/L at RM 98)**

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What are the salinity model results telling us?

4. **Flow targets manage salinity intrusion in the upper estuary within a narrow location range depending upon the flow**
   - Under sustained intrusion conditions, there are small differences between the maximum salt line intrusion location and the 30-day average salt line location
   - From all model runs, the range of differences calculated between the maximum salt line location and maximum 30-day average salt line location is 0.1-0.5 miles
5. **PWD metrics indicate that ocean salt may reach the drinking water intakes at RM 110 when the salt line reaches and exceeds RM 100.5**
6. **Through 2028, the FFMP flow targets simulated are capable of maintaining the salt line between RM 97.8-101.2**
   - This range is higher than RM 100.5

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Modeling Results in the 2017 FFMP Context

1. **An additional 200-400 CFS at Trenton matters**
   - Additional flows of this size push the salt line down 1-2 miles, a distance that could mean the presence or absence of ocean salt in drinking water supplies
   - The 2007 FFMP reduced Montague flow targets that granted NYC detachment included a decrease from the current Montague flow targets of 150-500 CFS depending upon the month.
2. **Any reduction in upstream reservoir releases to support Montague must be offset with new sources to not reduce flow at Trenton**
   - Decreasing Montague, while releasing from existing reservoir resources to make up the difference at Trenton, depletes Lower Basin storage therefore decreasing flow reliability to Trenton and Basin drought resiliency

Modeling Results in 2017 FFMP Context

3. **Modeling demonstrates that the concept of *Trenton Equivalent Flow* is flawed**
   - Releases added to the Schuylkill are half as effective at salt line repulsion as releases added to Trenton, they are not equivalent
4. **The flow targets allow ocean salinity to reach locations in the upper estuary, they do not maintain the salt line at the RM indicated in the drought emergency flow target table**

Next Steps

1. **Phase II salinity model runs**
   - Compounded Risks – 2028 severe intrusion with:
     - Simulated meteorologically-induced (i.e., offshore shelf wind-induced) water level setup based on historical observations
   - Understanding the timing of salinity response to flow change
     - Input time series that change flow targets
2. **Understand the co-occurrence of specific Schuylkill and Trenton flow combinations**
   - Utilize PWD refined version of PST
   - Work to improve model ability to more accurately hit the Trenton flow target

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THANK YOU!

www.phila.gov/water/sustainability

Inquiries may be directed to:

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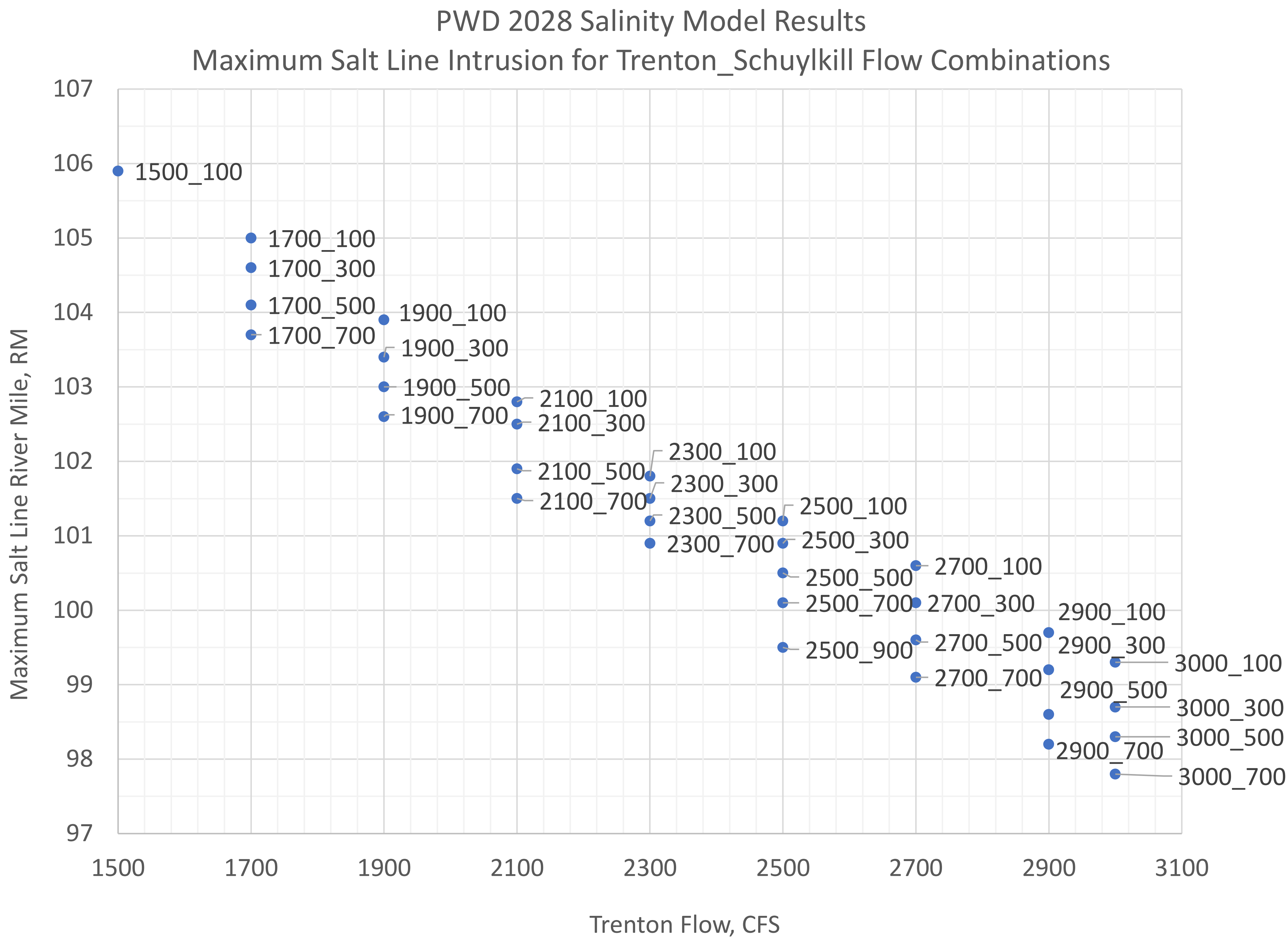

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