BUREAU OF RECLAMATION

**DRAFT**

# Groundwater Modeling Results

## Lower Santa Cruz River Basin Study

**17 December 2020**

**Brandon House | Reclamation TSC**

# Outline

- Scenarios and introduction
- Groundwater model inputs for scenarios
- Results from scenario runs
- Comparison of scenario results

# Supply-Demand Basin Study Scenarios

A. Official Projections: Medium, mixed-density growth and Current climate

B. Slow, compact growth and Best Case climate

C. Rapid, outward growth and Best Case climate

D. Slow, compact growth and Worse Case climate

E. Official Projections and Worse Case climate

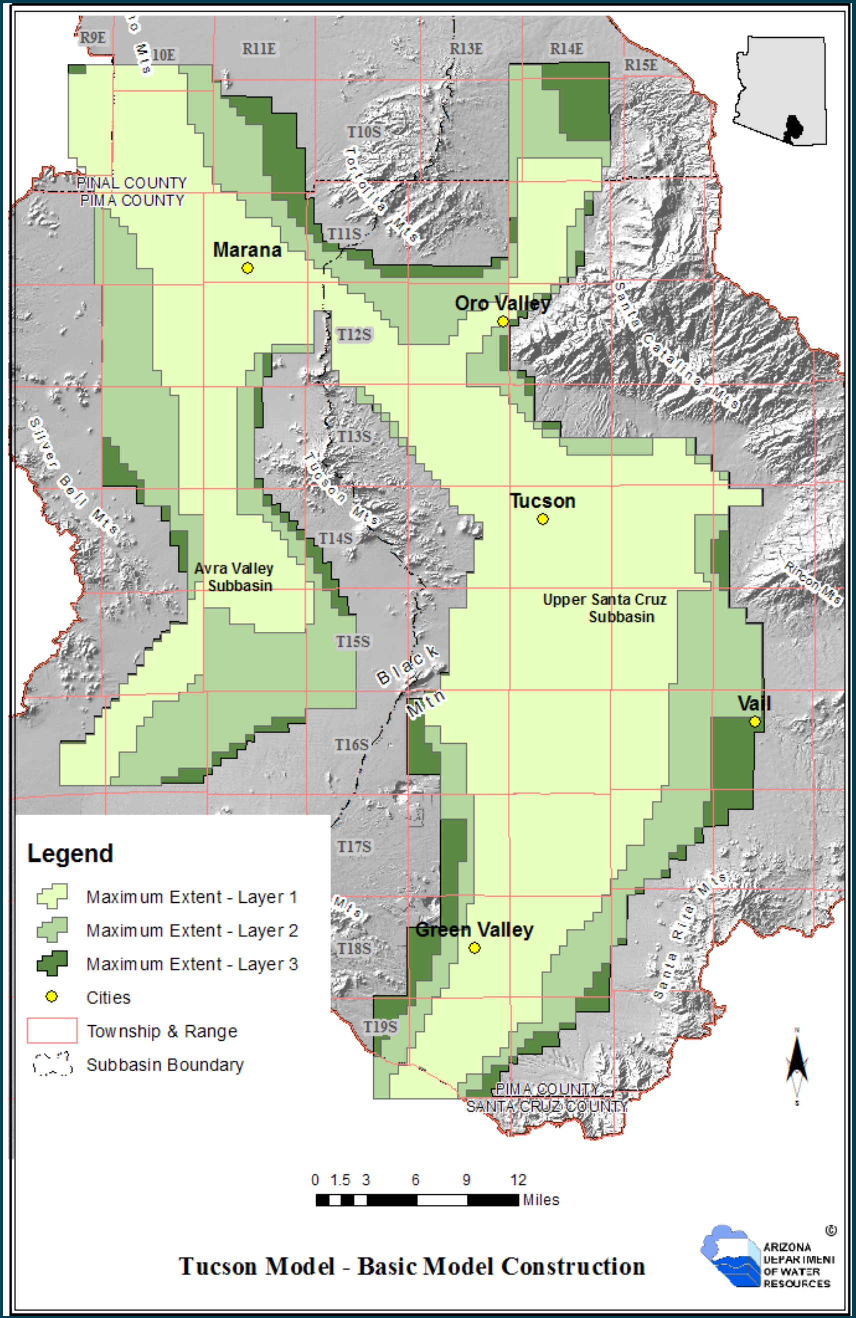
F. Rapid, outward growth and Worse Case climate

| Climate | | Demand Growth | | |
|---|---|---|---|---|
| | | Slow, Compact | Medium, Official | Rapid, Outward |
| Climate | Worse Case | D | E | F |
| Climate | Best Case | B | | C |
| Climate | Current Climate | | A | |

*Higher Risk*

# TAMA Groundwater Model

- Developed by ADWR (2013) using MODFLOW
- Solved annually 1940-2010
- Three Layers
  - Based on geology
- Half-mile by half-mile grid cell resolution



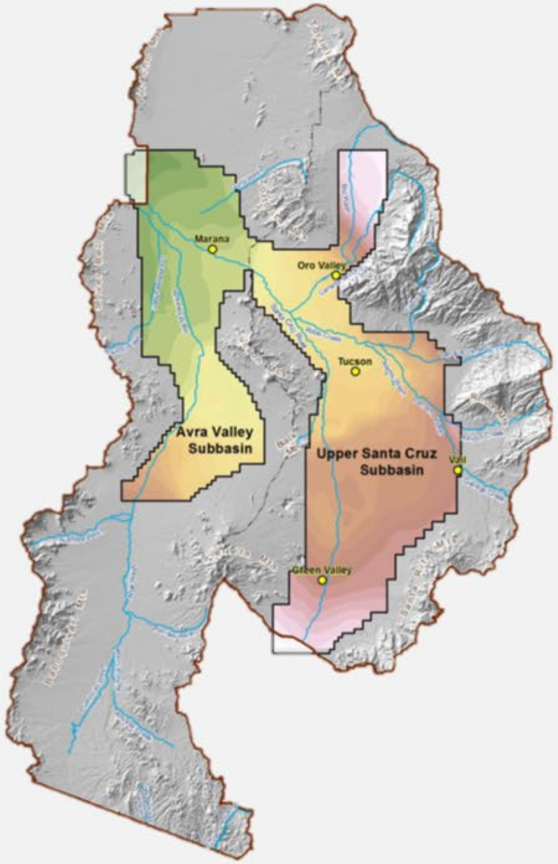

Mason, D., & Hipke, W. (2013). *Regional groundwater flow model of the Tucson Active Management Area, Arizona*. (24), 97.

# Groundwater Model Scenario Development

## Inflows

- Mountain Front Recharge
- Stream Infiltration
- Underflow from other basins
- Artificial Recharge (CAP and effluent)
- Incidental Recharge

## ADWR TAMA Groundwater Model




## Outflow

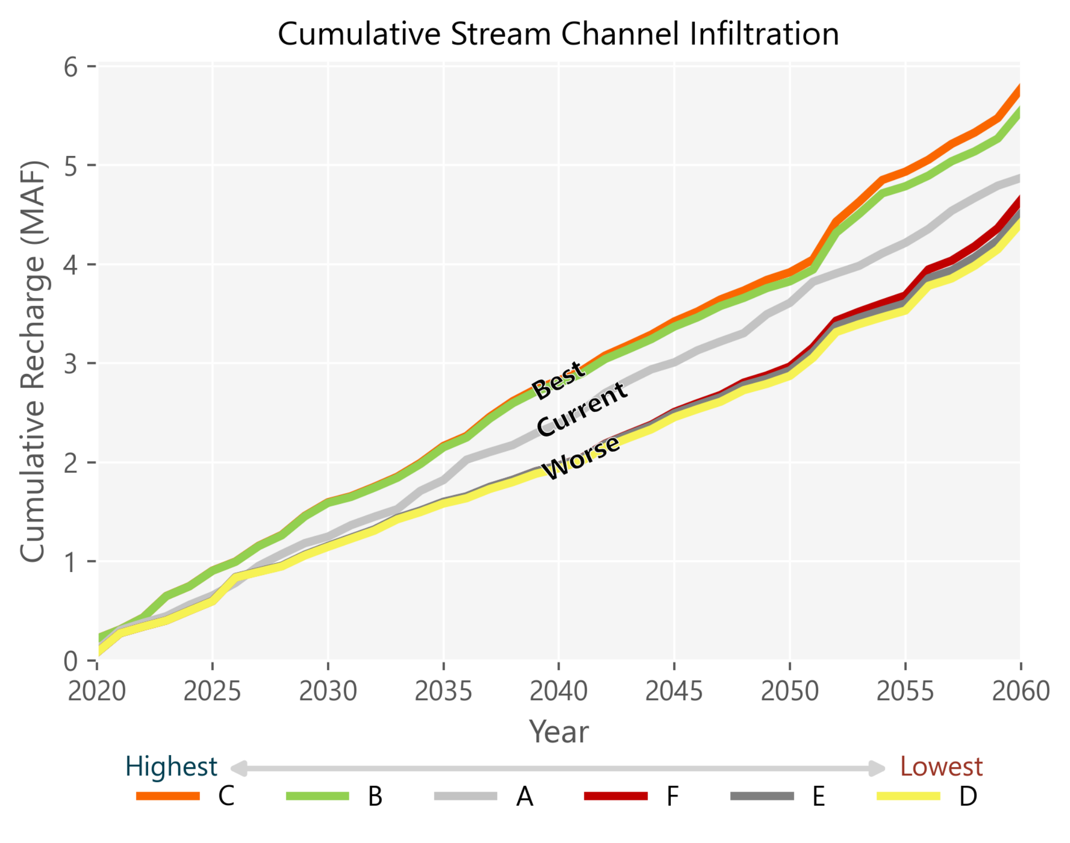
- Pumping (Municipal, Industrial, Agricultural)
- Evapotranspiration by Riparian Areas
- Underflow to other basins

Drivers:

- Primarily Socio-Economic Forces
- Primarily Climate
- Estimated within Model

# Stream Channel Infiltration

- Wastewater discharge projections from CAP
- Streamflow from climate projections and historic simulation

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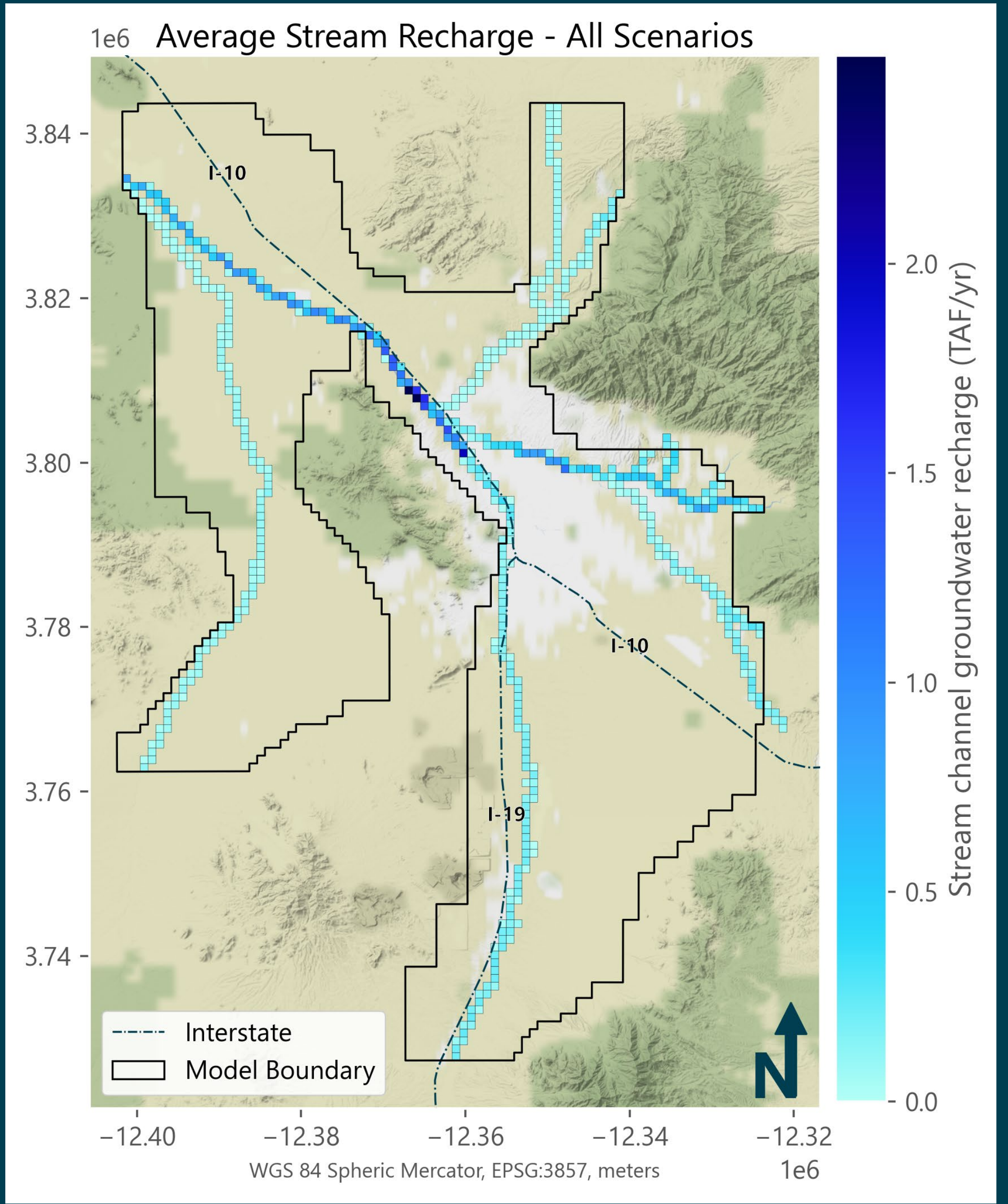
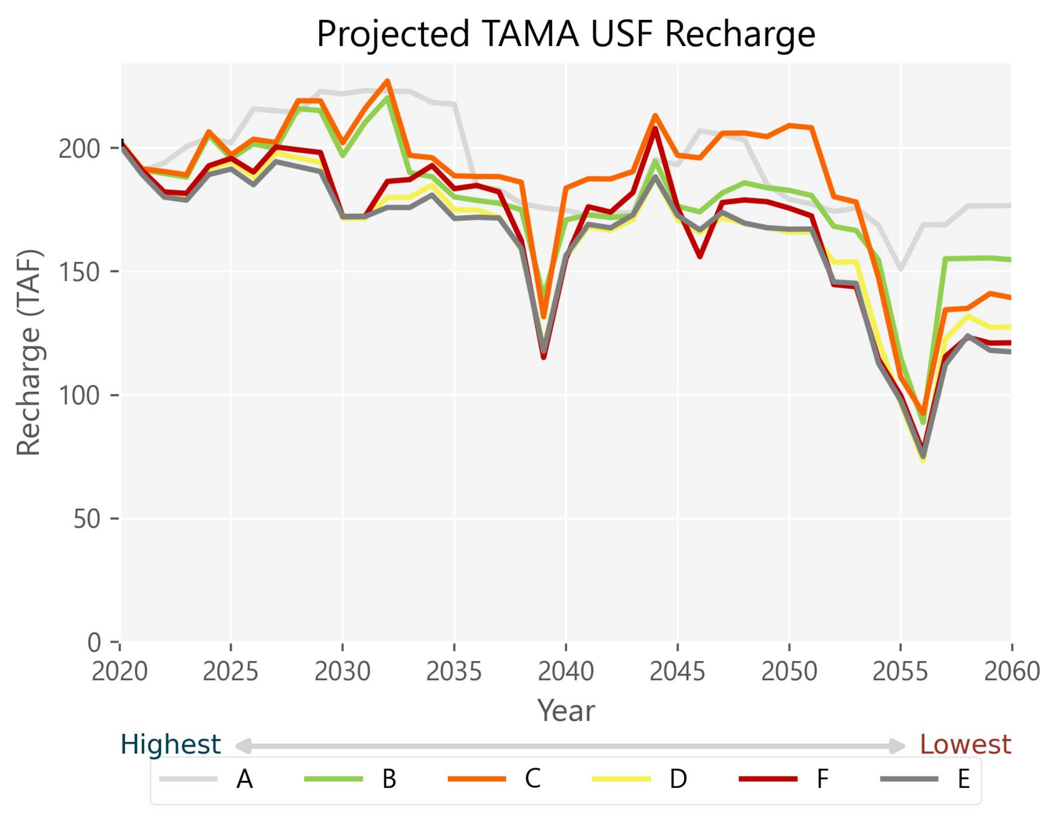


# Underground Storage Facilities (USF) Recharge

- Recharge projections from CAP

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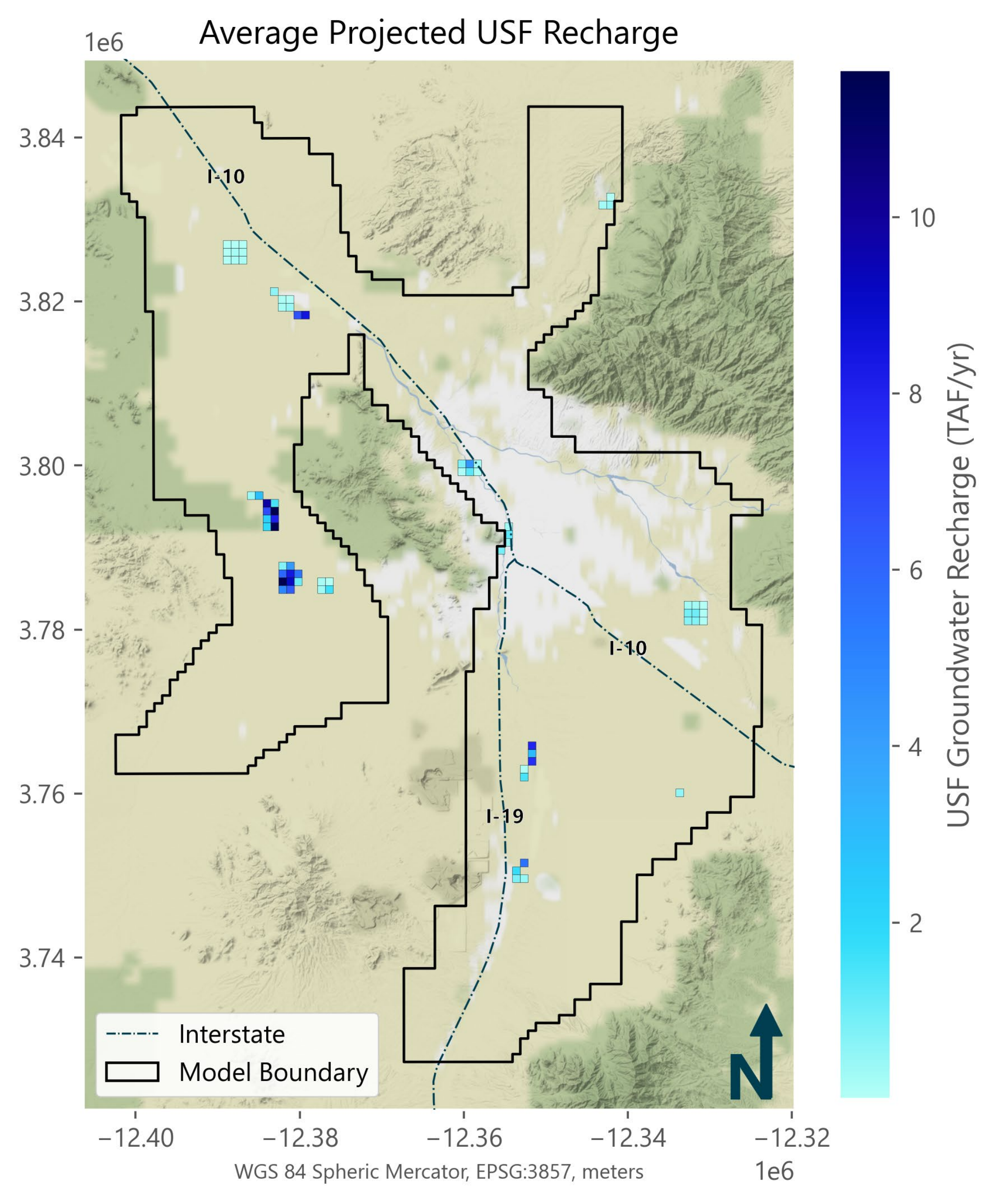
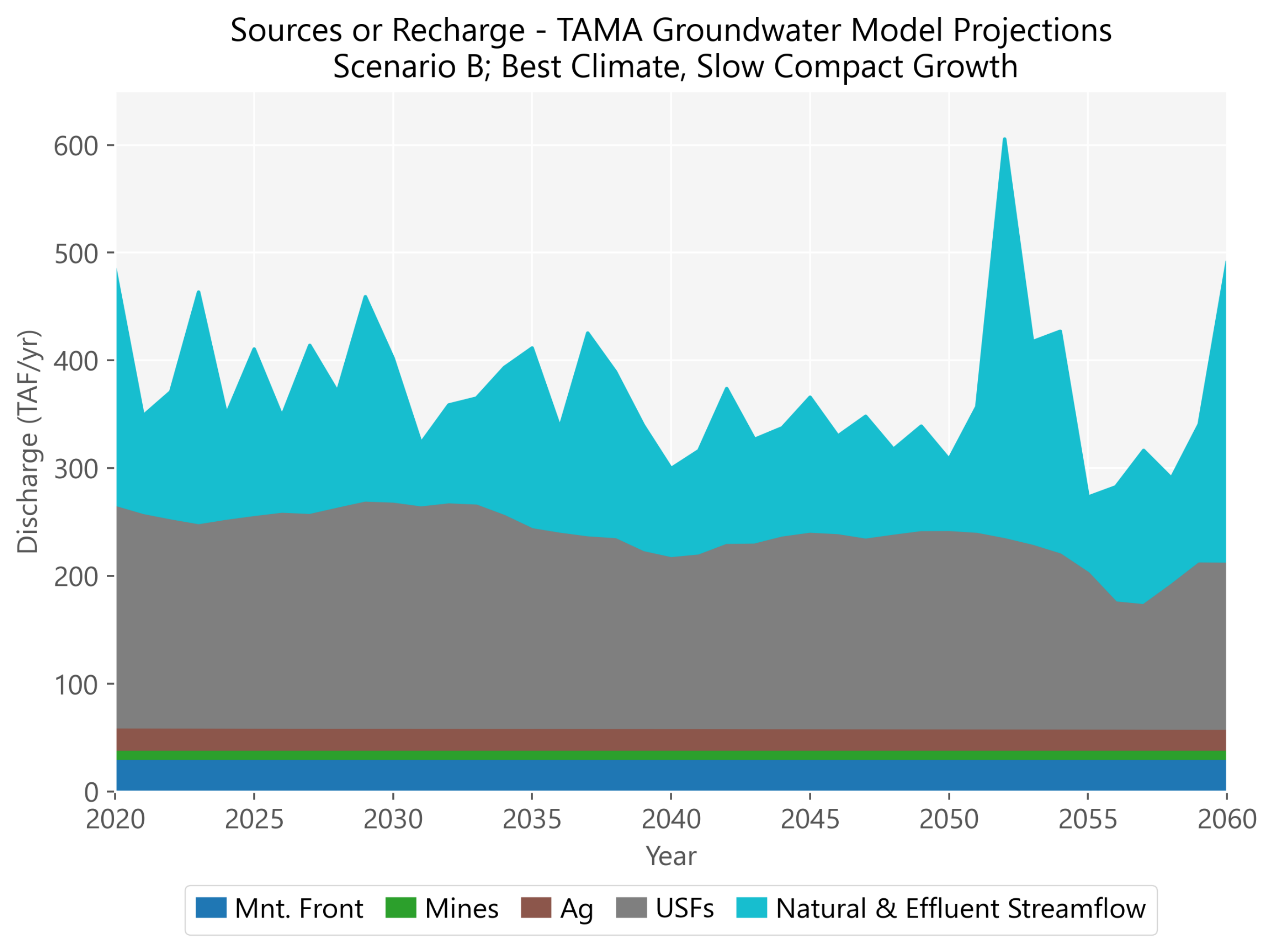


# Major Sources of Recharge

- Constant Rates:
  - Mountain front recharge
  - Mine tailings ponds
- Variable Rates:
  - Ag (Commercial, Tribal, IGFR)
  - USFs (CAP and effluent sources)
  - Natural streamflow based on climate projections and projections of effluent discharge to Santa Cruz River



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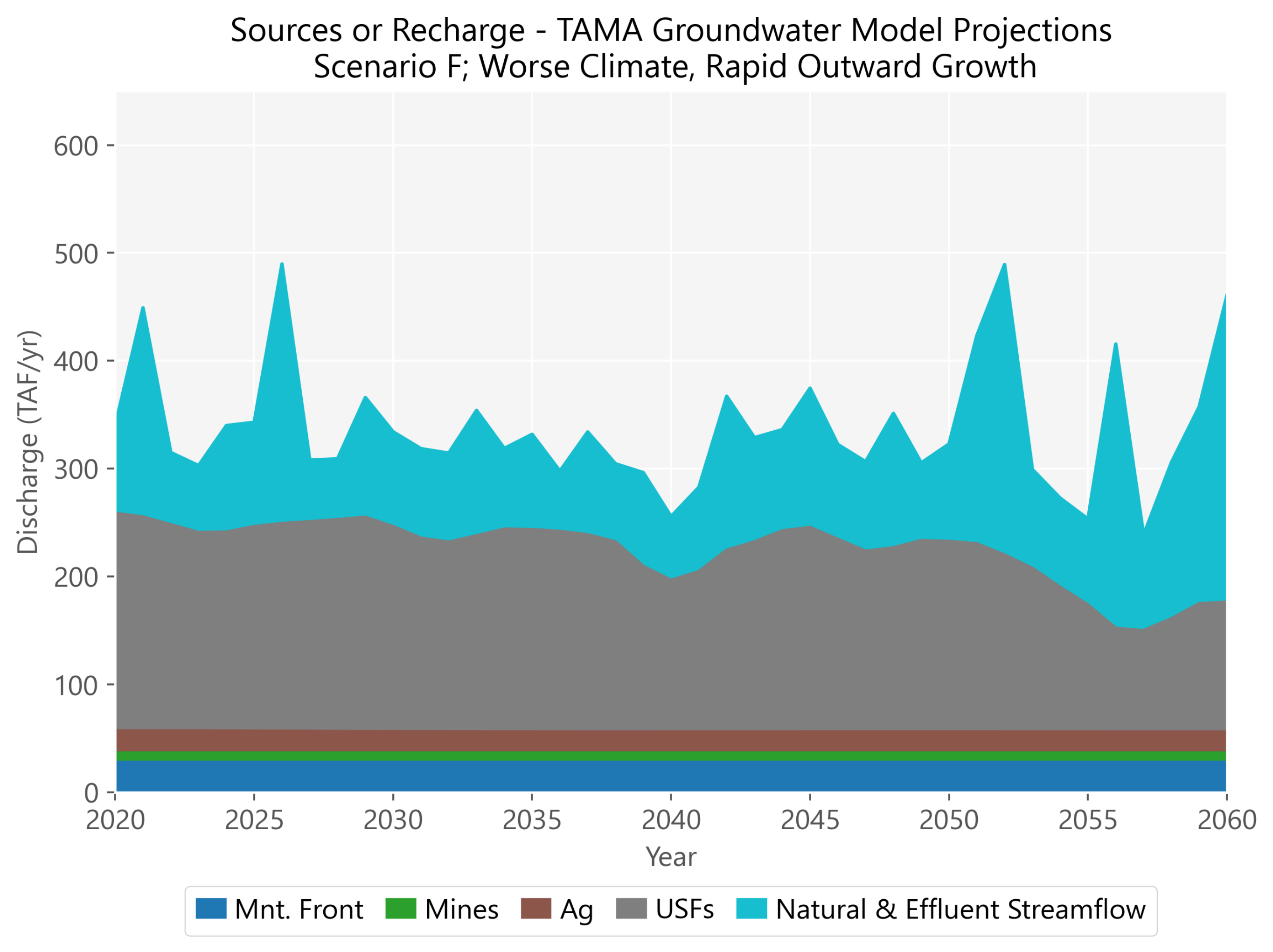
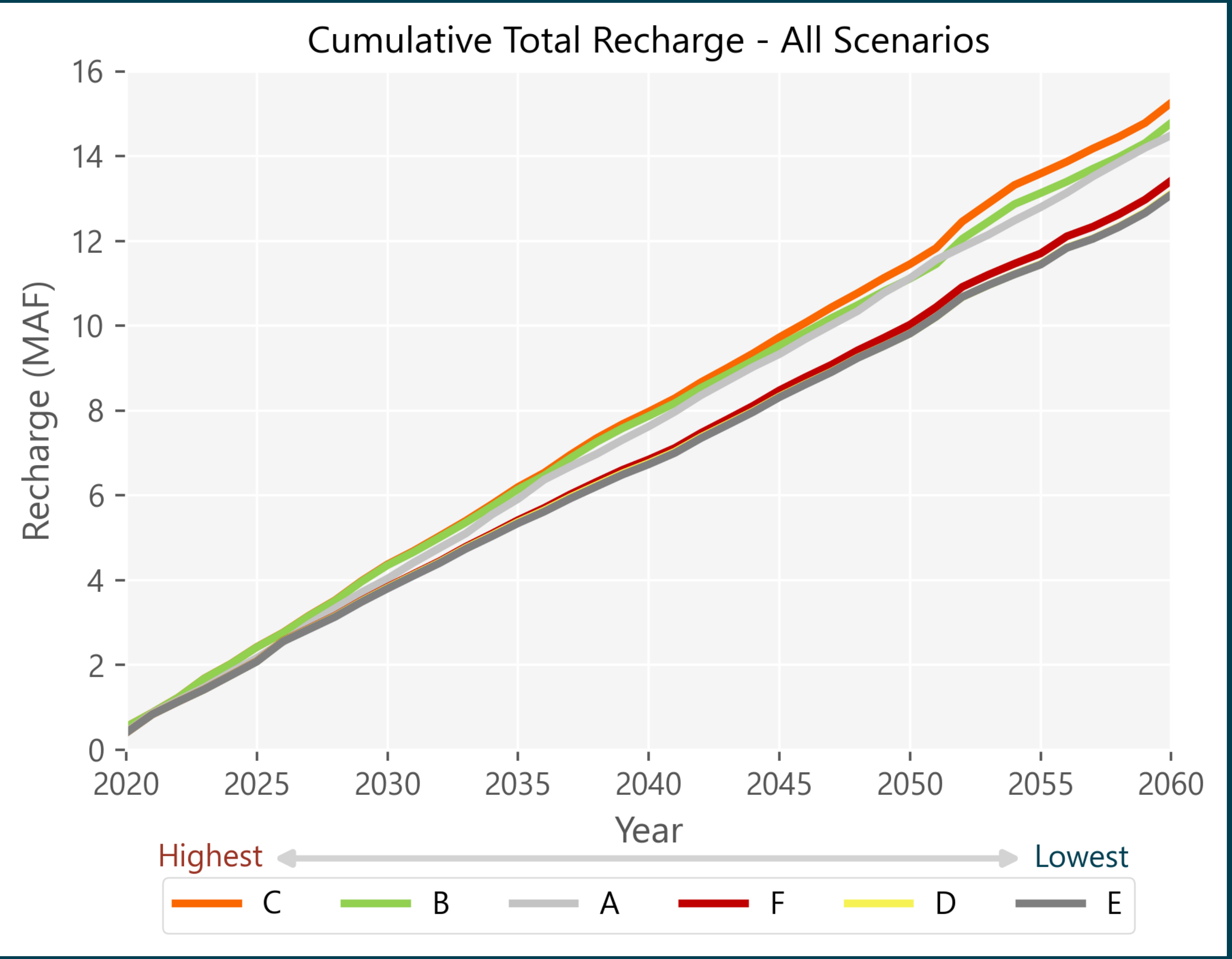


# Groundwater Recharge Projections

- Total recharge from:
  - Streamflow, USFs, WWTP Discharge, Ag, Mountain fronts, and Mine tailings ponds
- Typical Highest Rate (Scenario C): 360 TAF/yr
- Typical Lowest Rate (Scenario E): 305 TAF/yr



# Pumping Projections

- Projections to 2060 (inside TAMA) include:
  - Municipal
  - Agricultural
  - Stored Water Recovery (Nevada, Phoenix)
  - Mining (Scns. C & F)
- Constant Pumping
  - 5-yr historic average (industrial, turf, some municipal, and ag outside TAMA)

| Climate | Demand Growth: Slow, Compact | Demand Growth: Medium, Official | Demand Growth: Rapid, Outward |
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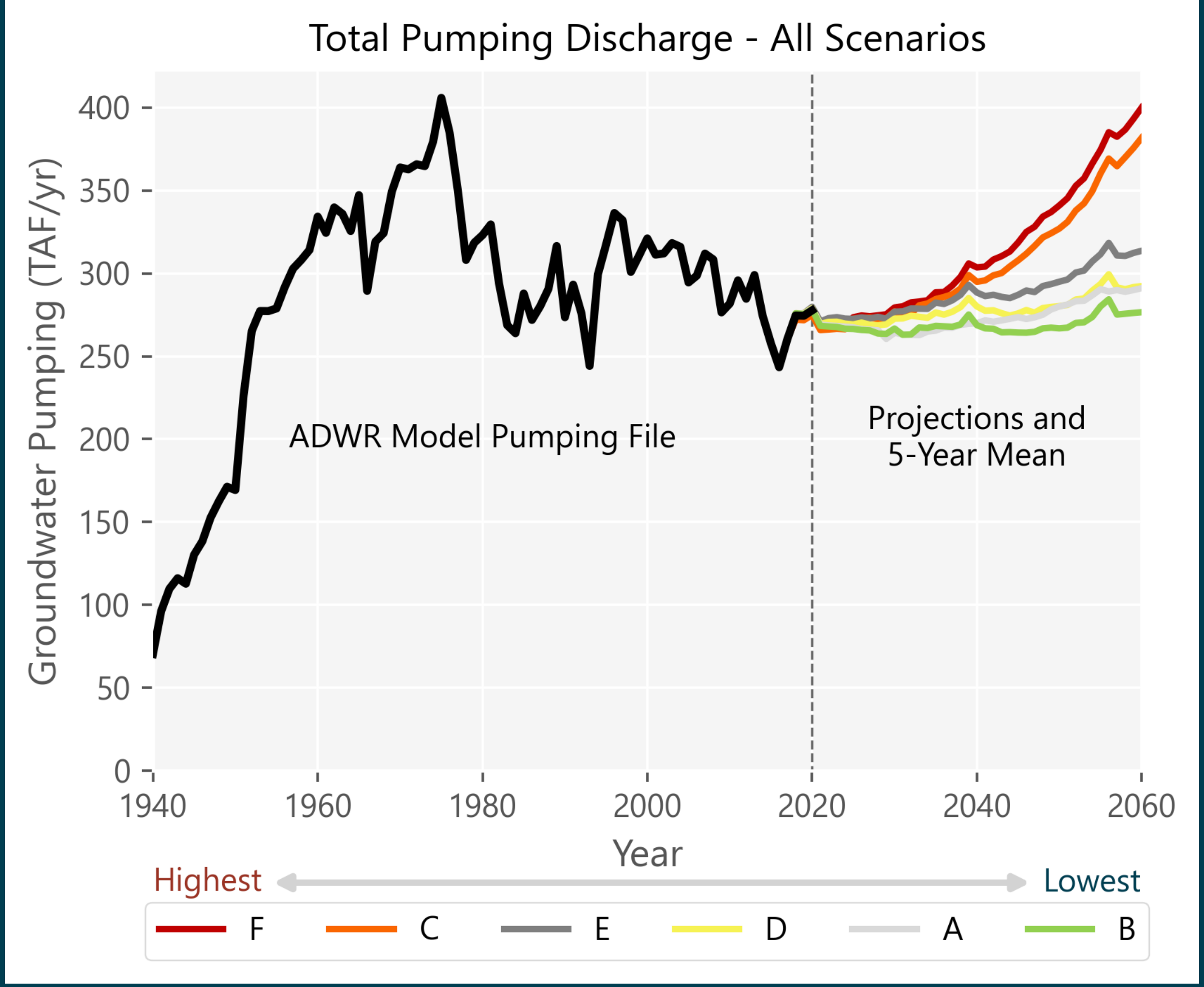
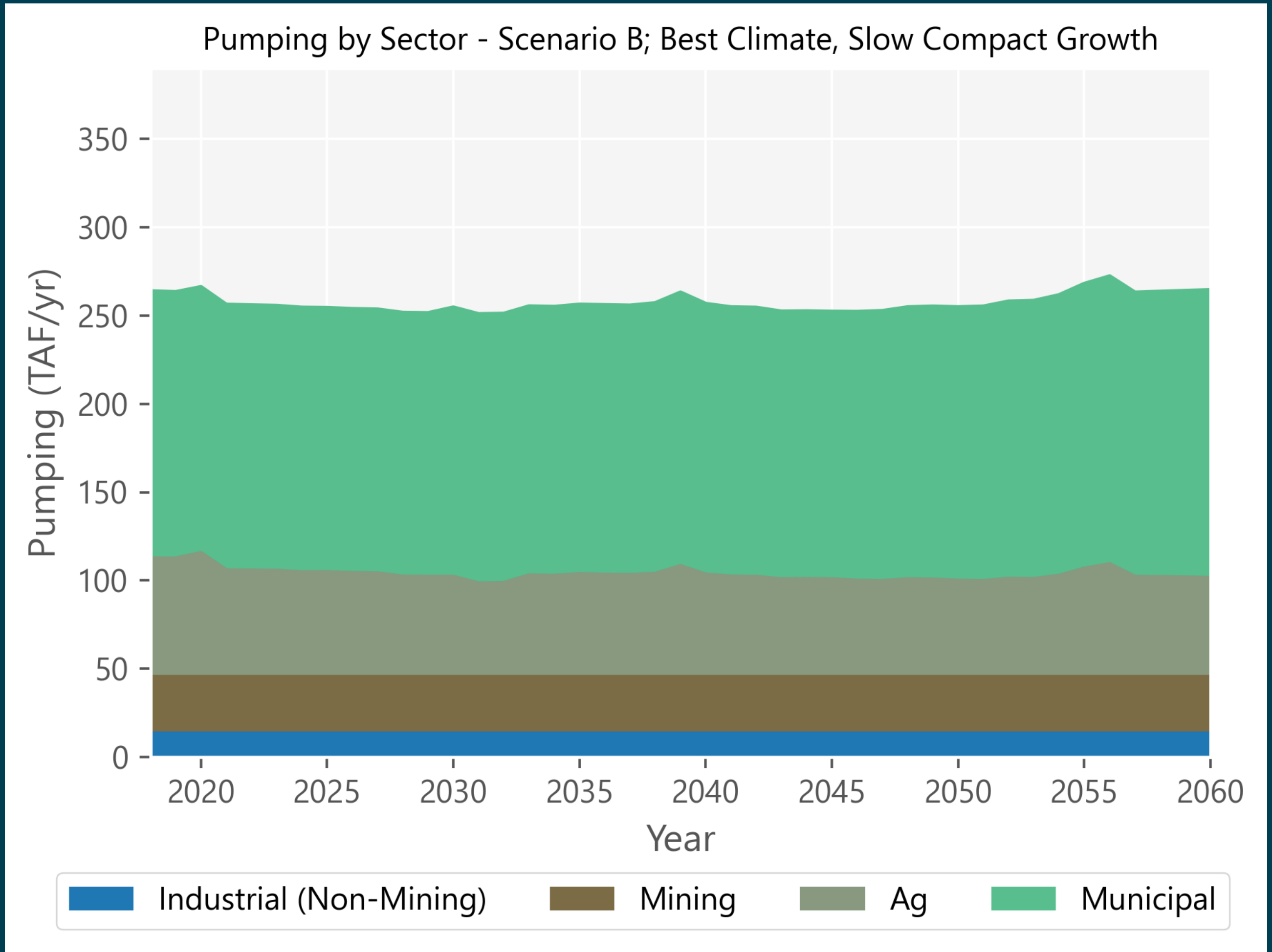


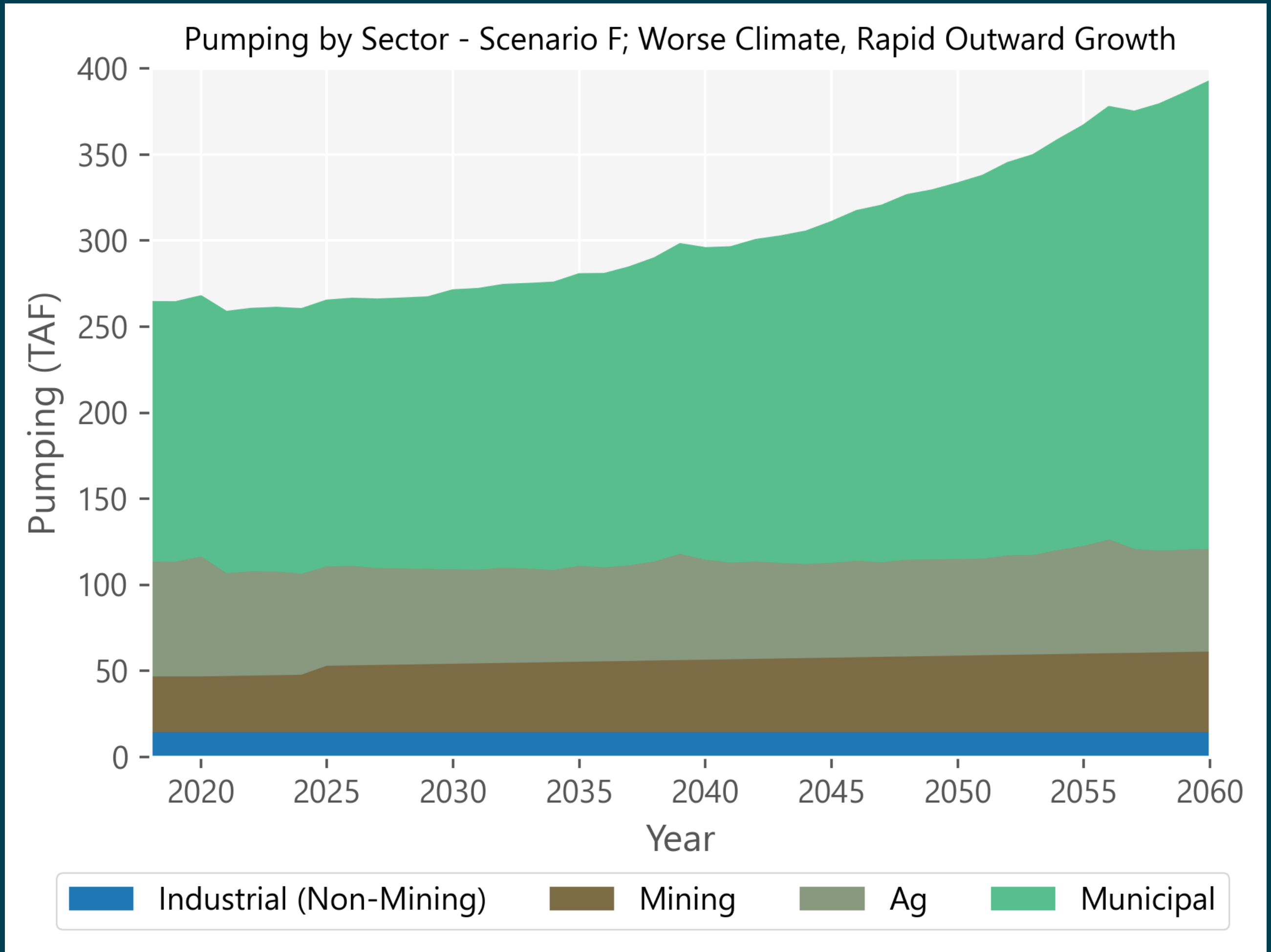
# Pumping Projections by Sector, Scenario B

- Municipal
  - Municipal water providers
  - Exempt wells
  - Stored water recovery
- Agricultural
  - Irrigation districts
  - Tribes
  - Individual rights
- Mining
  - Constant
- Industrial
  - General industrial, turf facilities



# Groundwater Pumping Projections

- Municipal (largest sector)
  - All water districts
  - Domestic
  - Stored water recovery
- Agricultural
  - Commercial, Tribal, IGFR
- Mining
  - 30% increase by 2060
  - Rosemont mine supply
- Industrial
  - General industrial, turf facilities



# Groundwater Model Projection Results

# Replenished Groundwater Storage by 2060

| Climate | Demand Growth: Slow, Compact | Medium, Official | Rapid, Outward |
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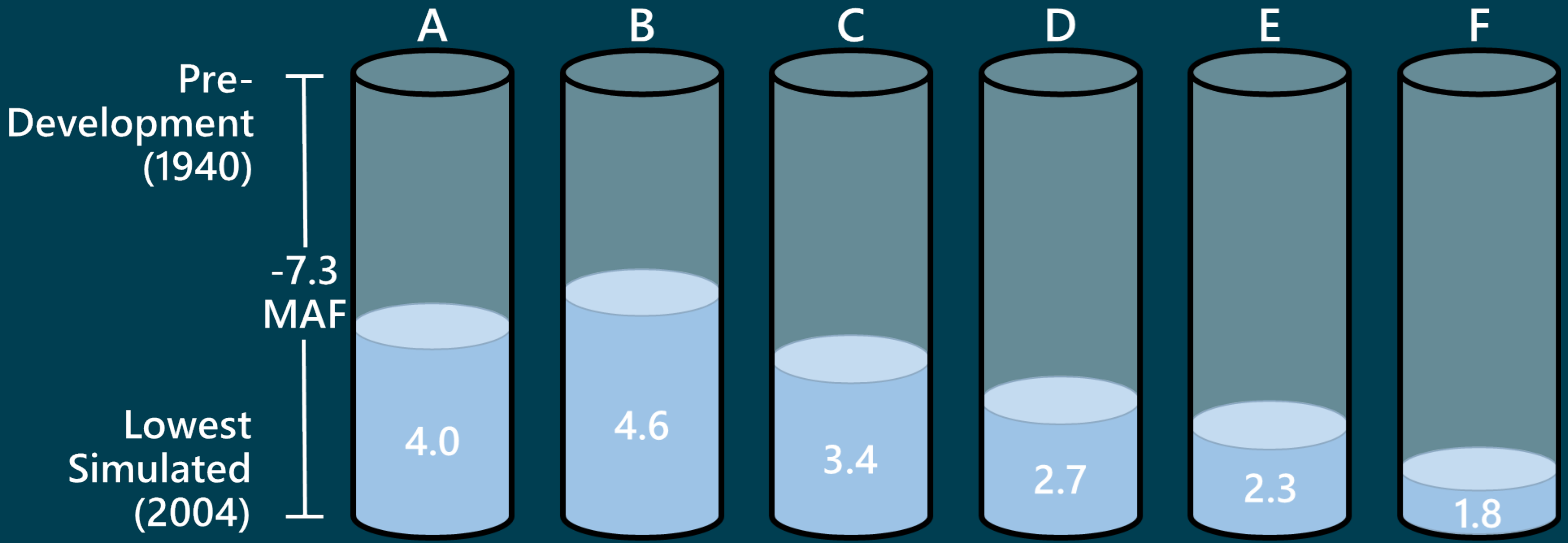

# Change in Groundwater Storage
# 1940 to 2060

| | | Demand Growth | | |
|---|---|---|---|---|
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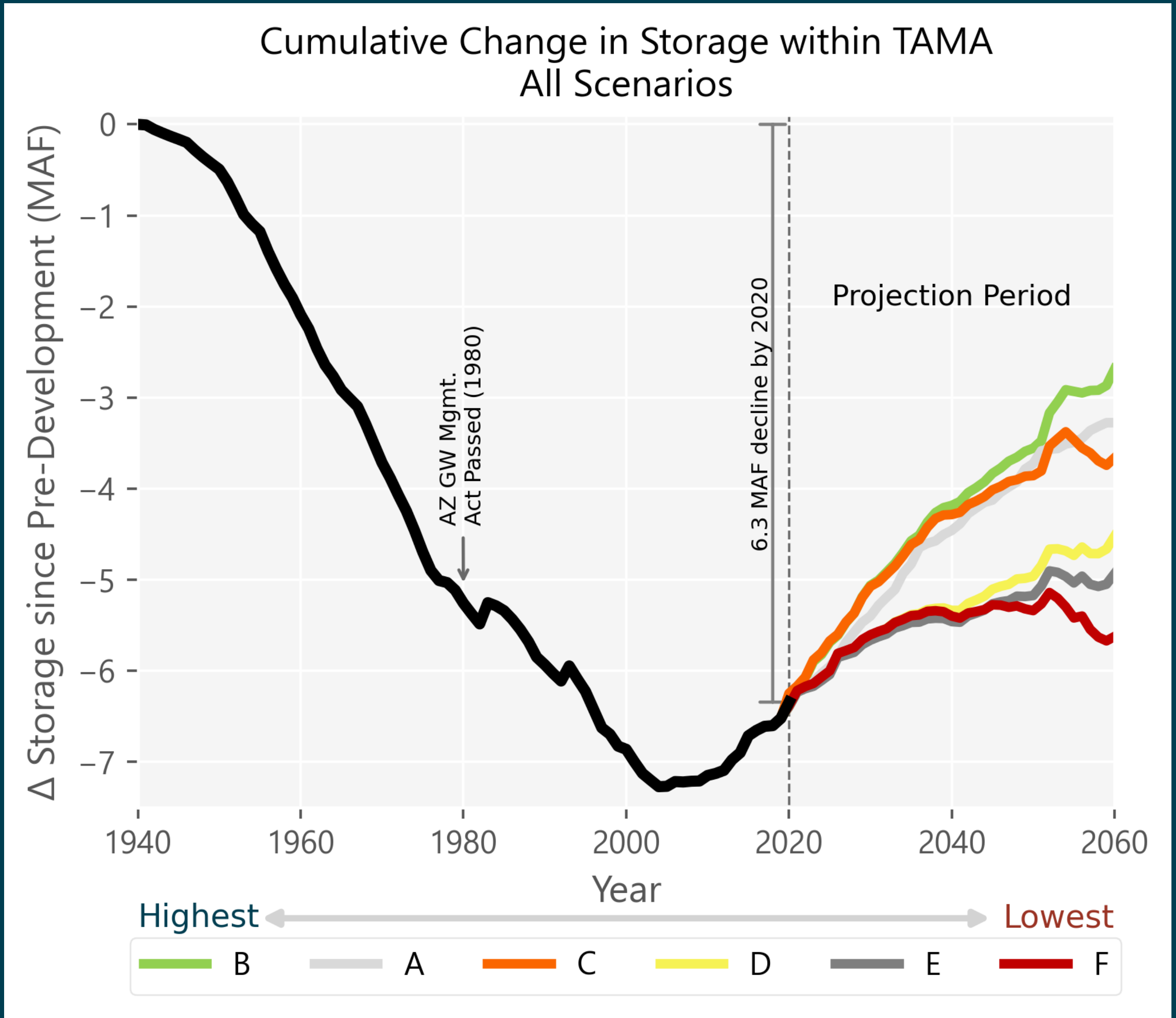

# Change in Groundwater Elevation 2020 to 2060

| | | Demand Growth | | |
|---|---|---|---|---|
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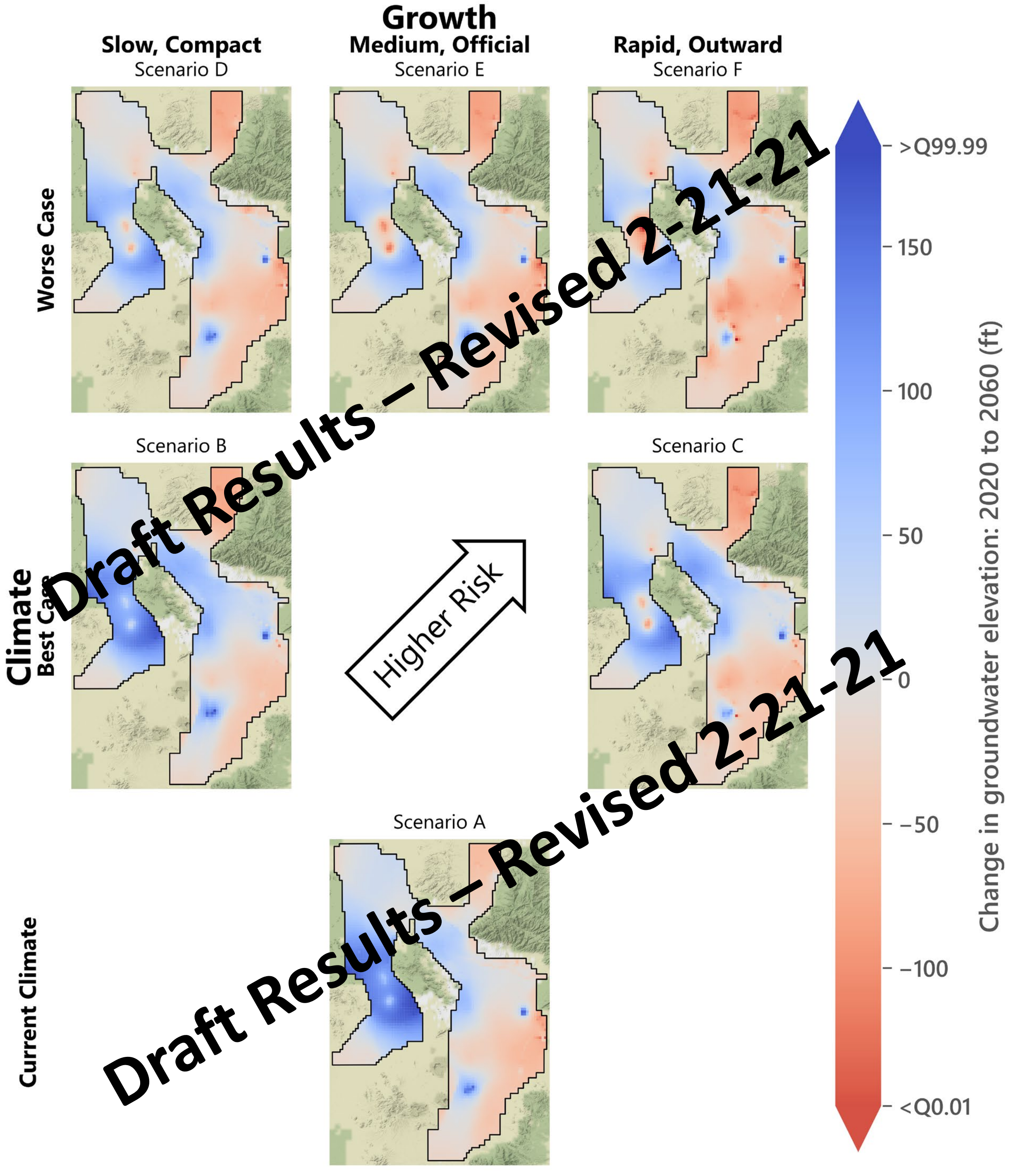

# Supply-Demand Scenarios: Impact of Climate and Growth

A. Official Projections: Medium, mixed-density growth and Current climate

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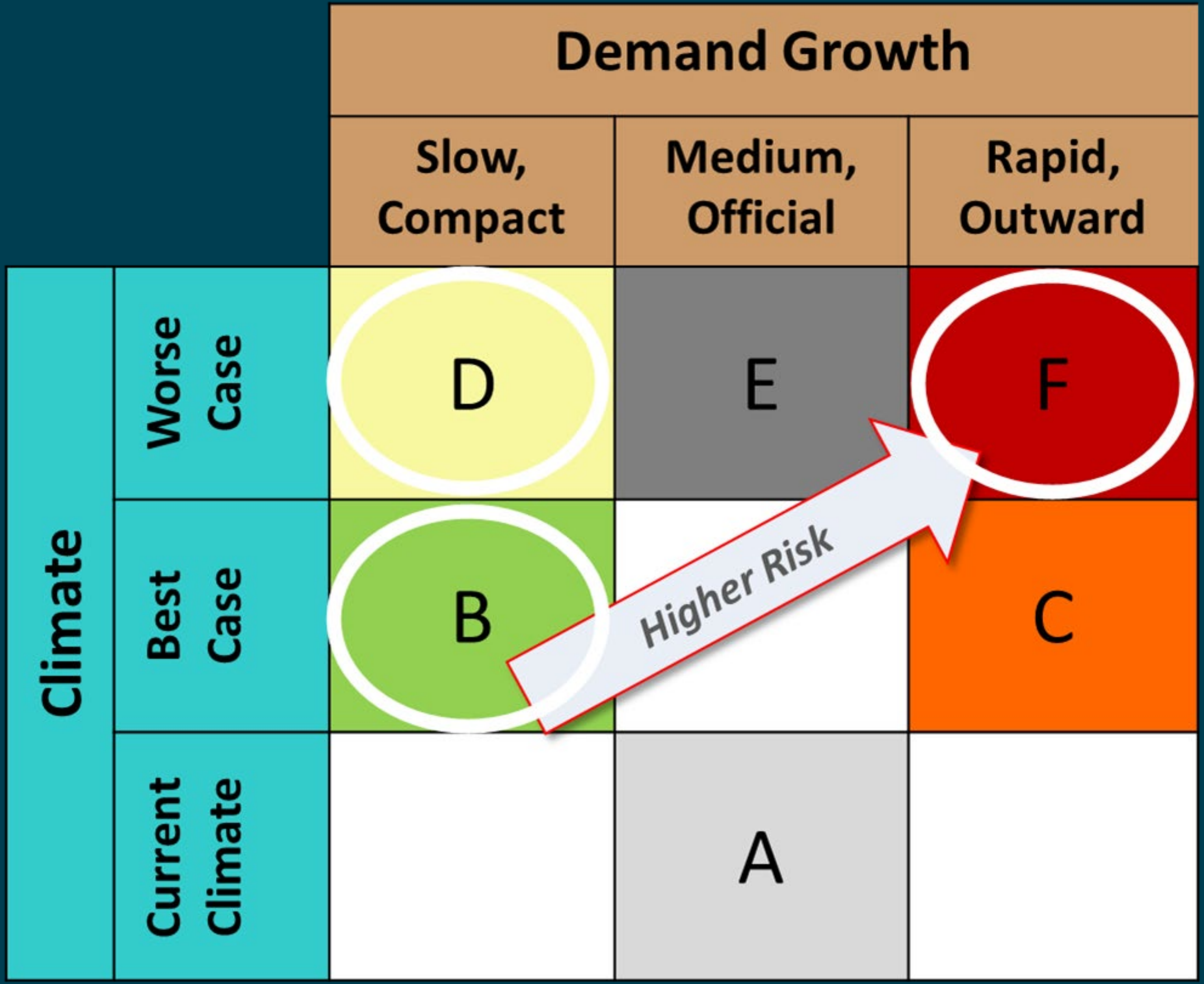
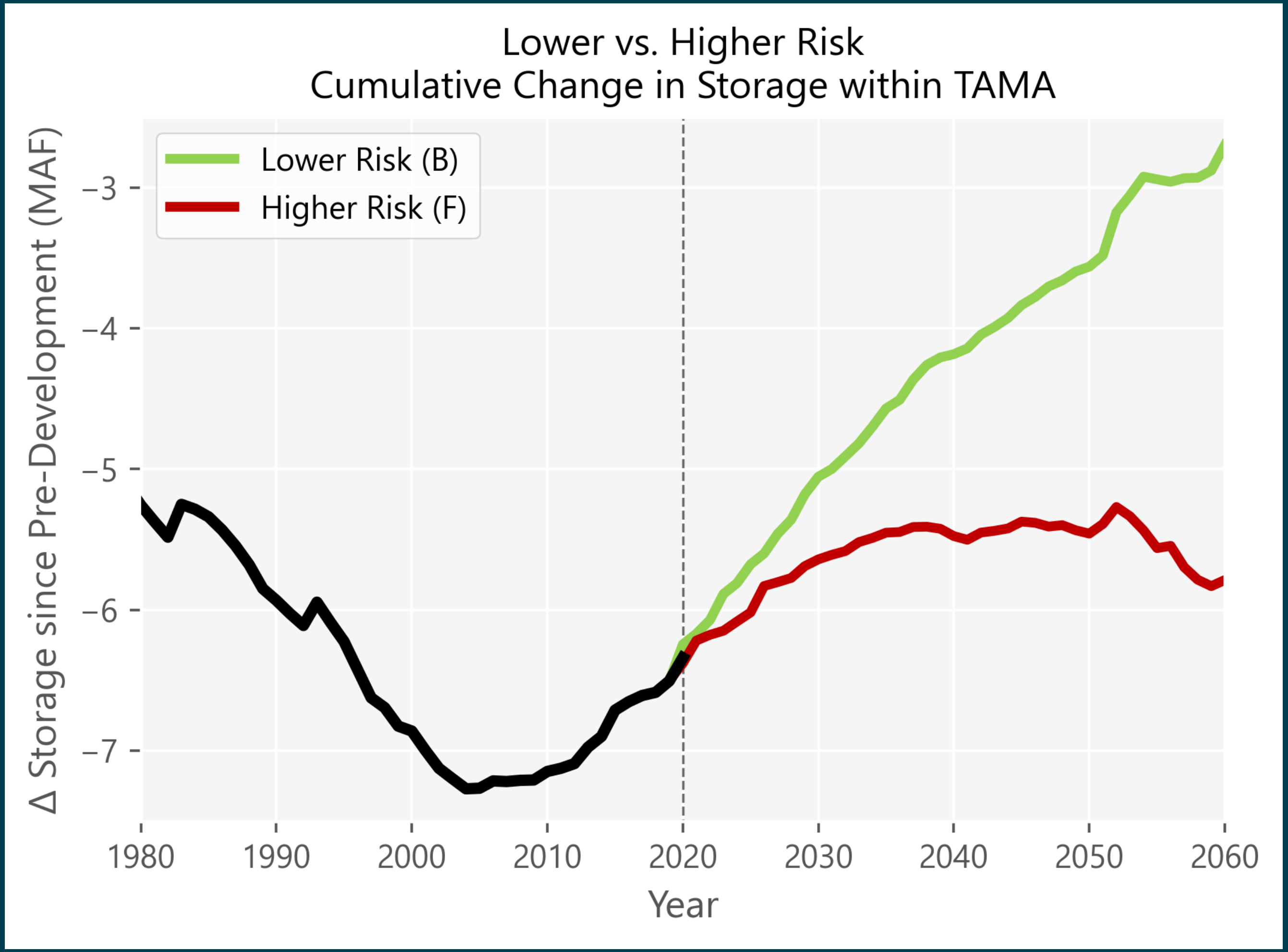
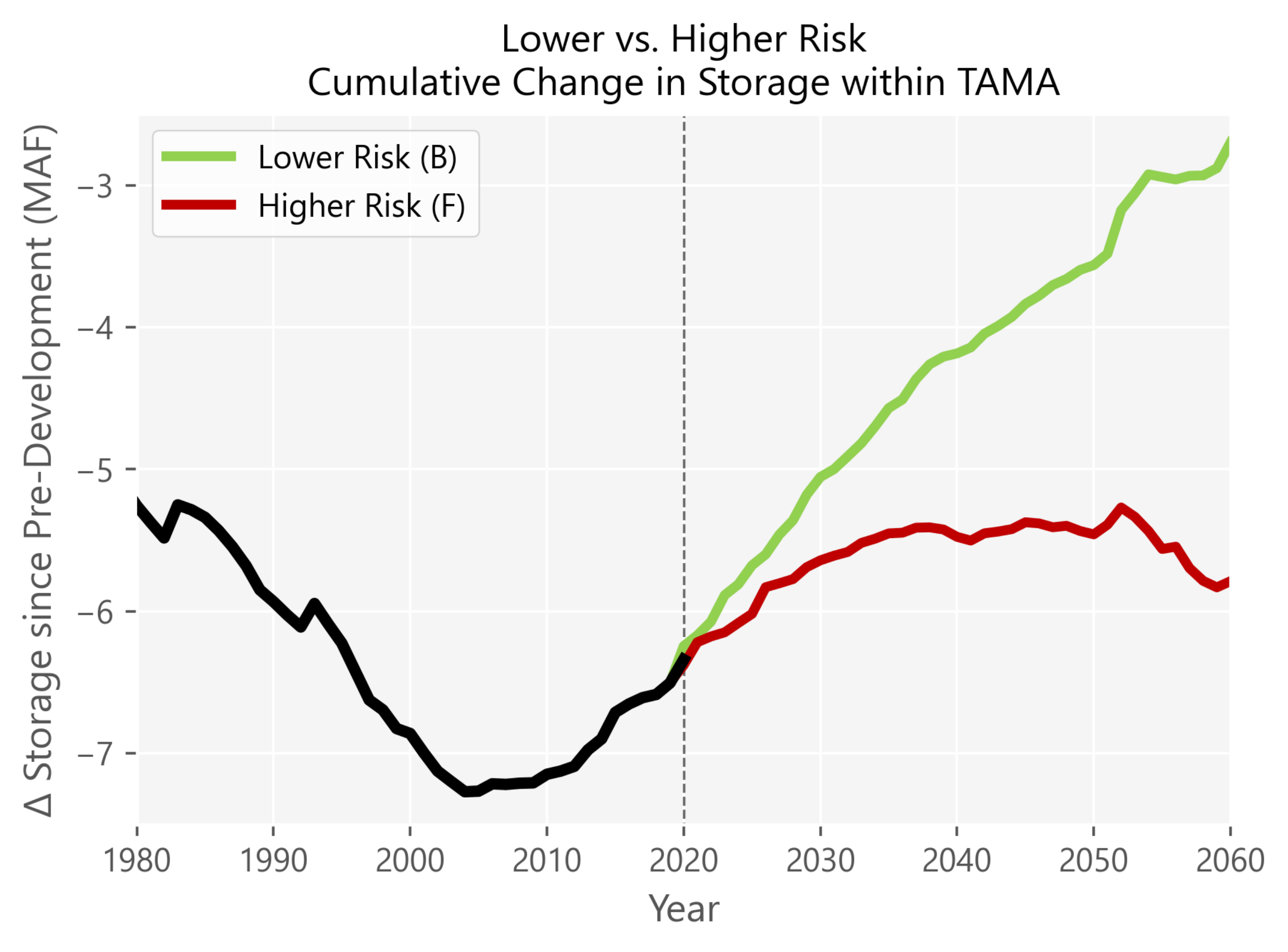


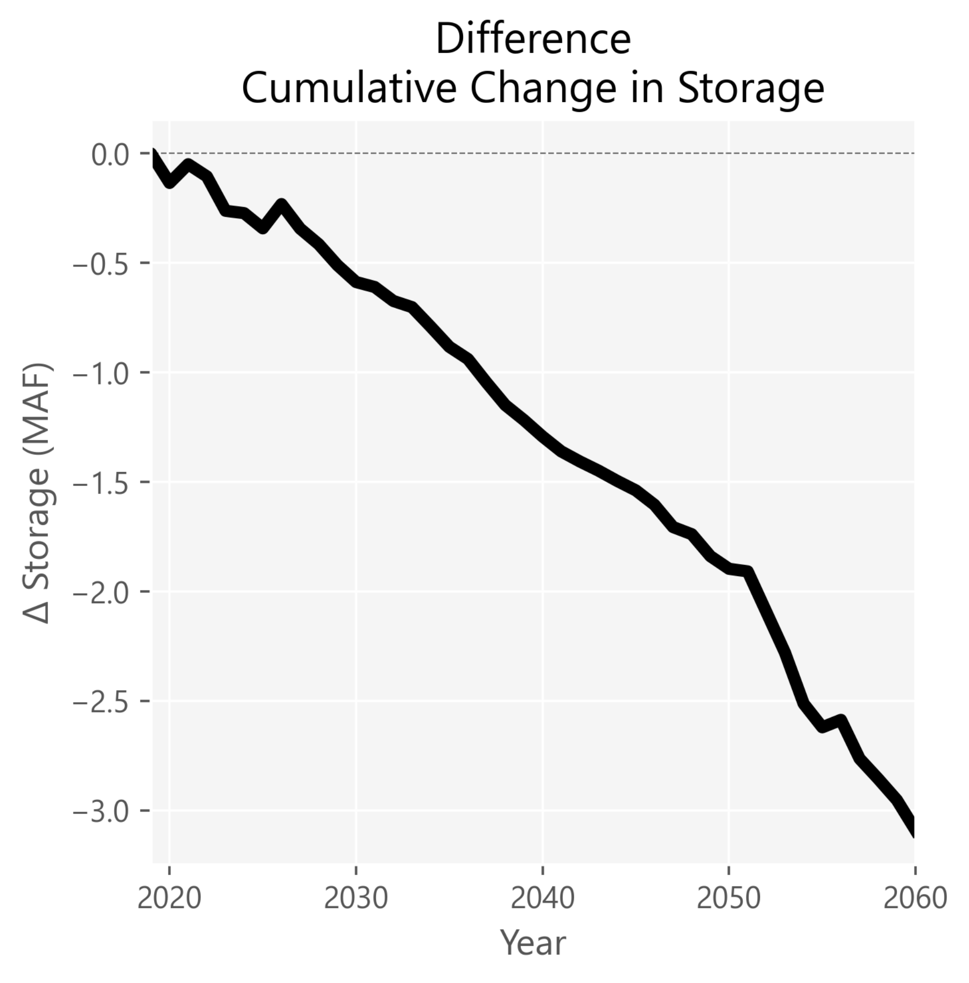
# Risk Comparison
# Change in Groundwater Storage

- Change in groundwater storage within TAMA boundary since pre-development (1940)
- Decrease until early-2000s



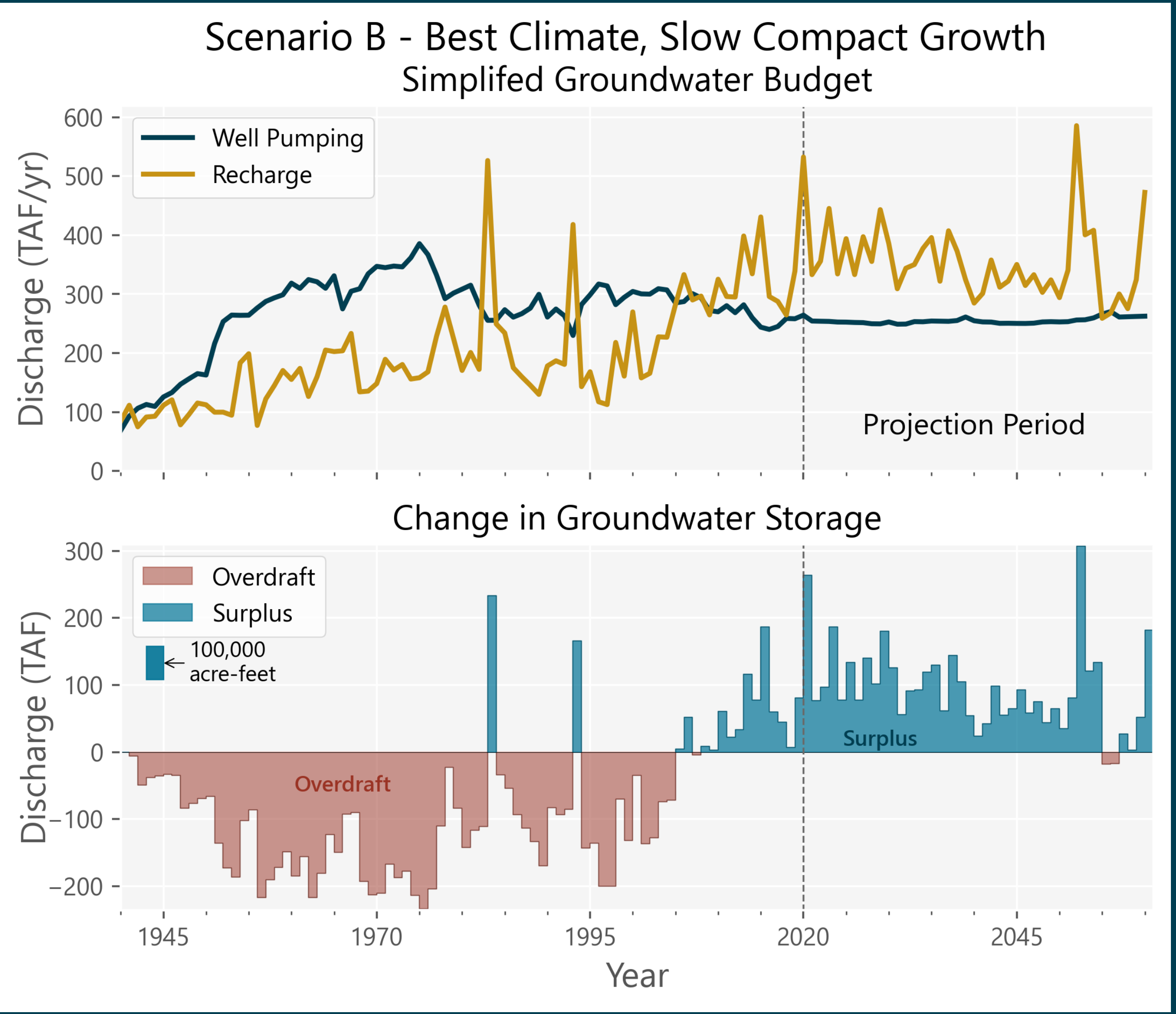
# Risk Comparison
# Change in Groundwater Storage continued



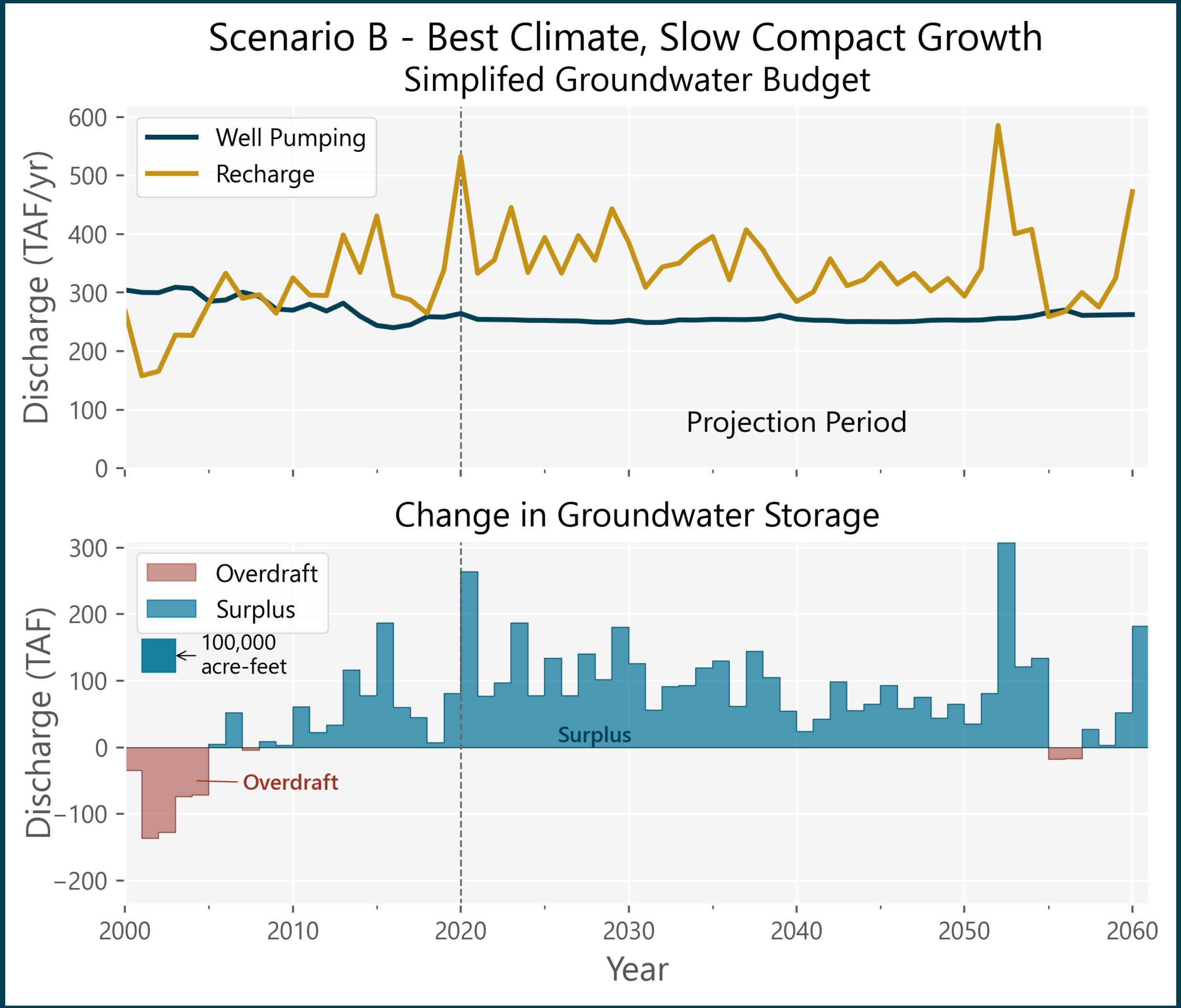



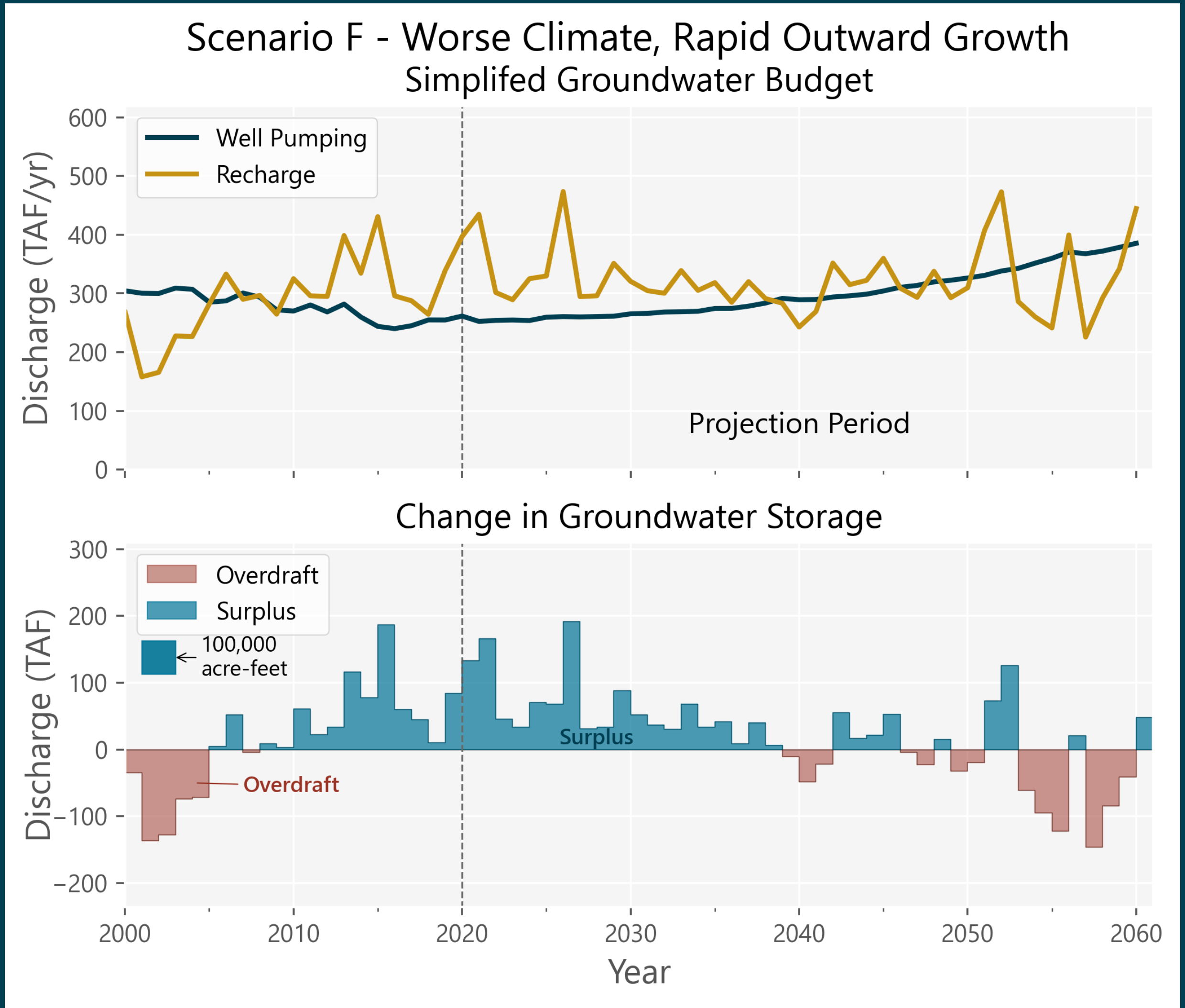
# Risk Comparison
# TAMA Water Balance

- Minor impacts/discharges excluded from plot
- Outflows <u>remove</u> groundwater
- Inflows <u>add</u> groundwater
- Outflows < Inflows = +ΔStorage = Surplus (Good)
- Outflows > Inflows = -ΔStorage = Overdraft (Bad)



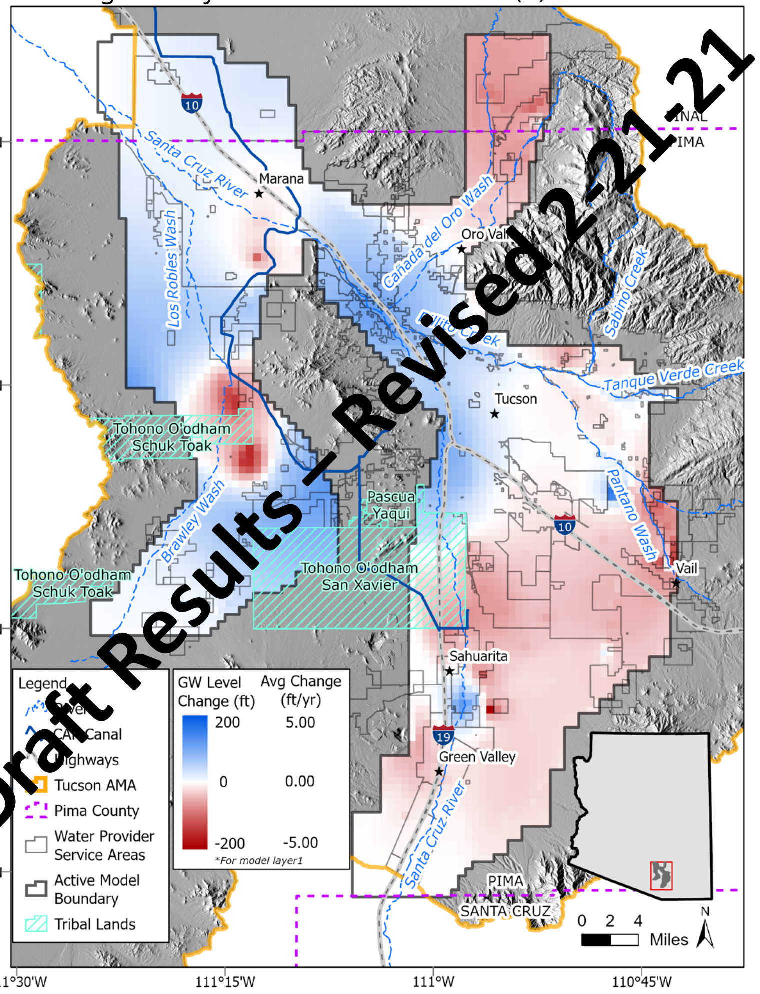
# Risk Comparison - TAMA Water Balance



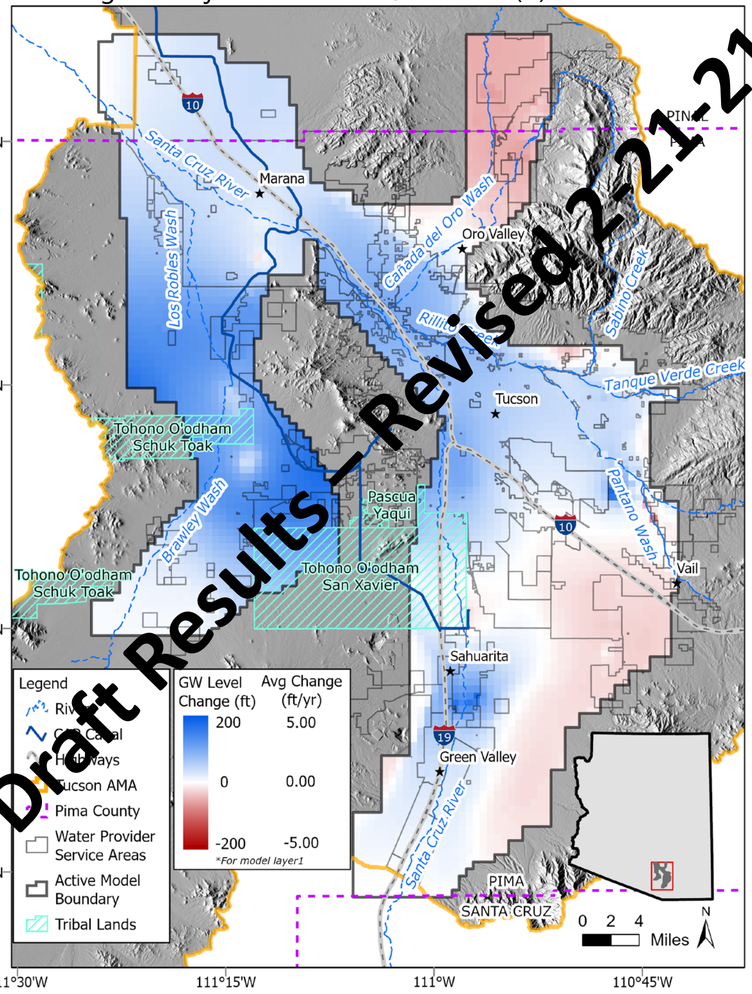



# Risk Comparison - Change in Head

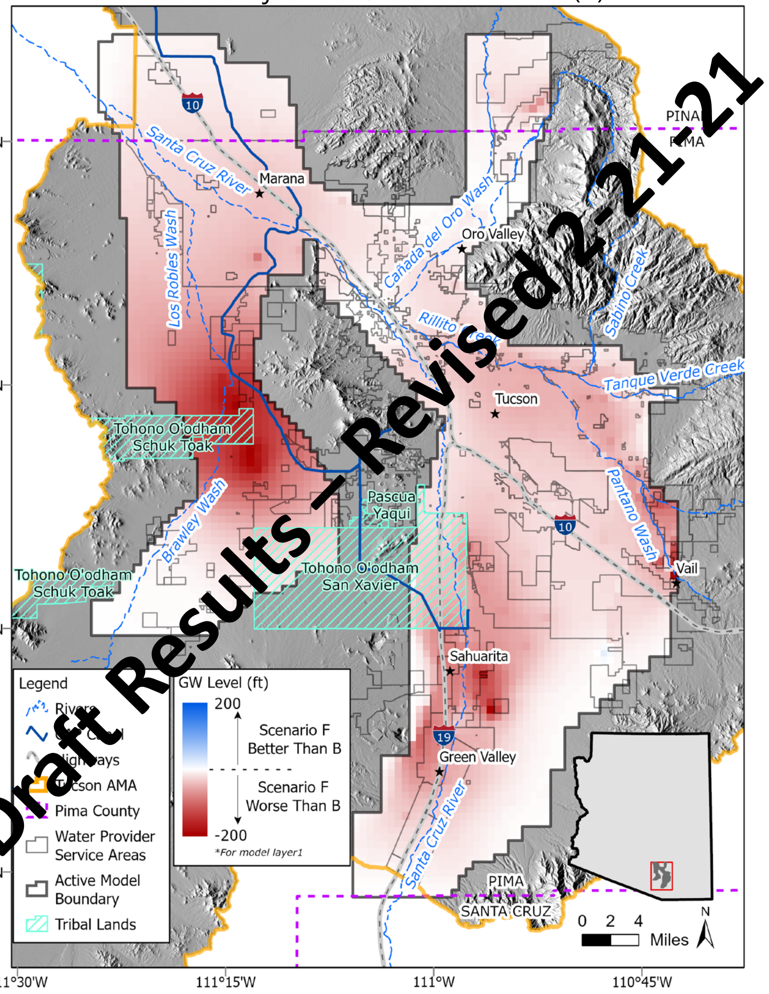
**Scenario F**
Change in Projected Groundwater Level (ft): 2020 - 2060



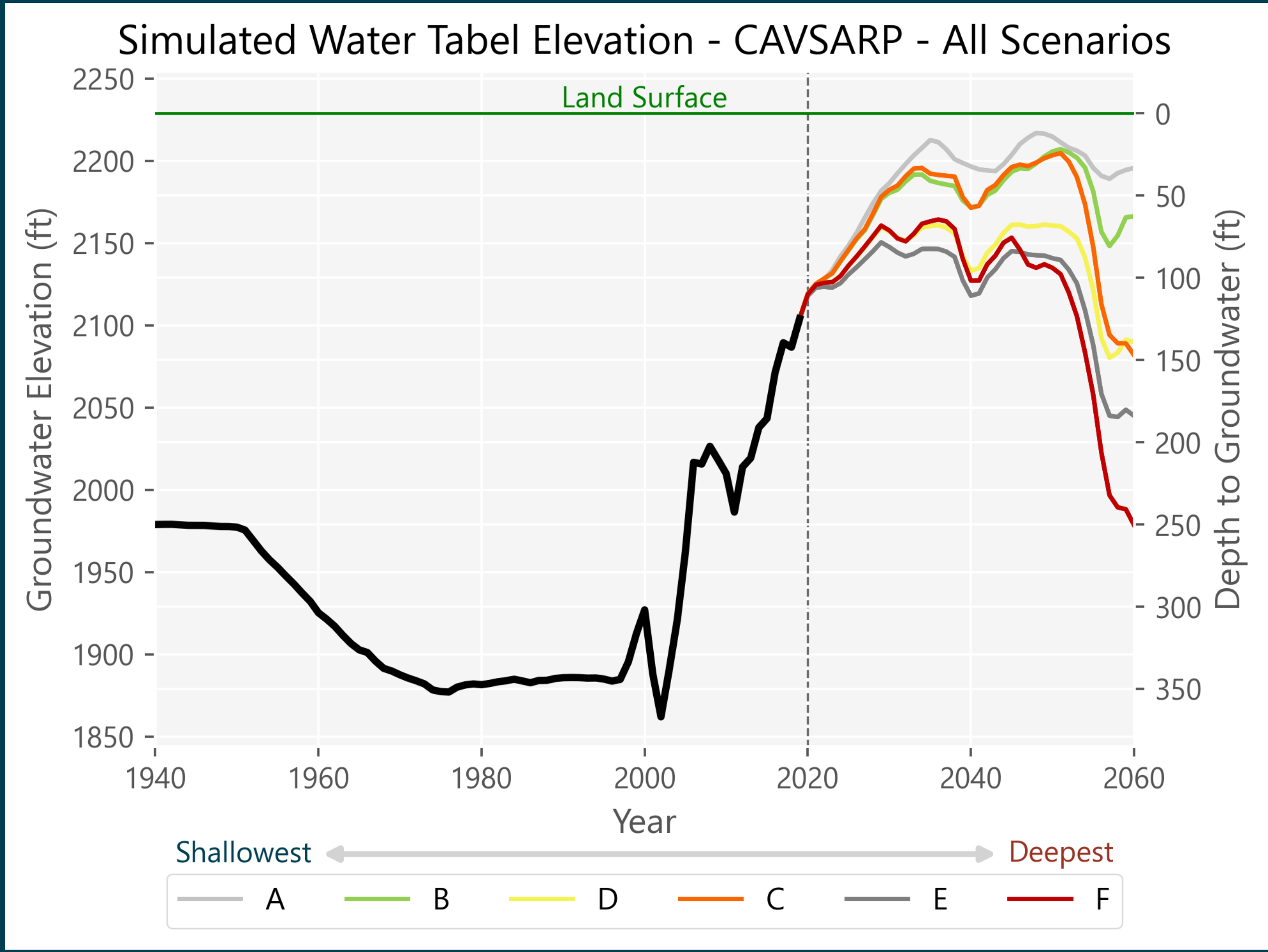

**Scenario B**
Change in Projected Groundwater Level (ft): 2020 - 2060

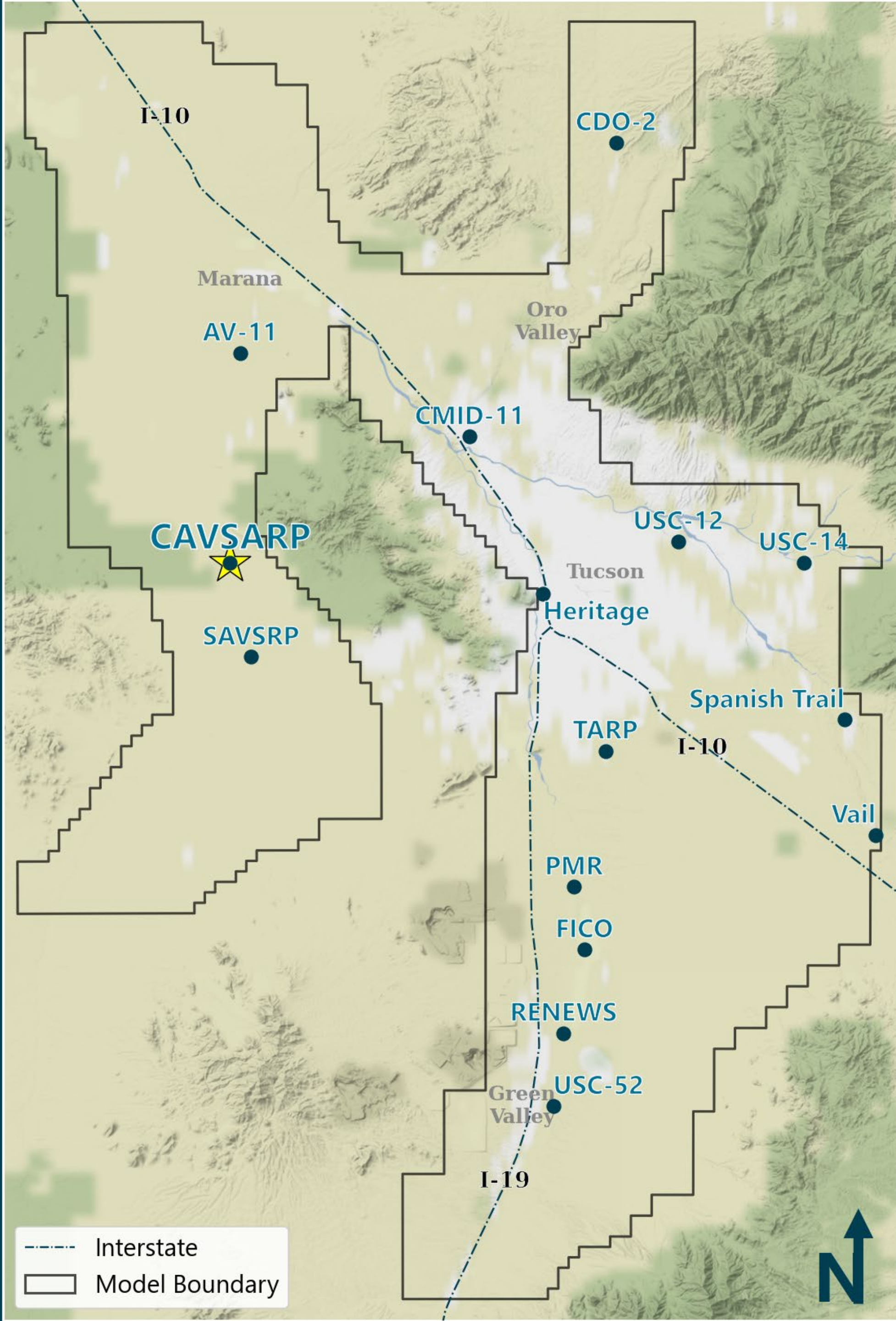



**Scenario F vs B**
Difference in Projected Groundwater Level (ft): 2060

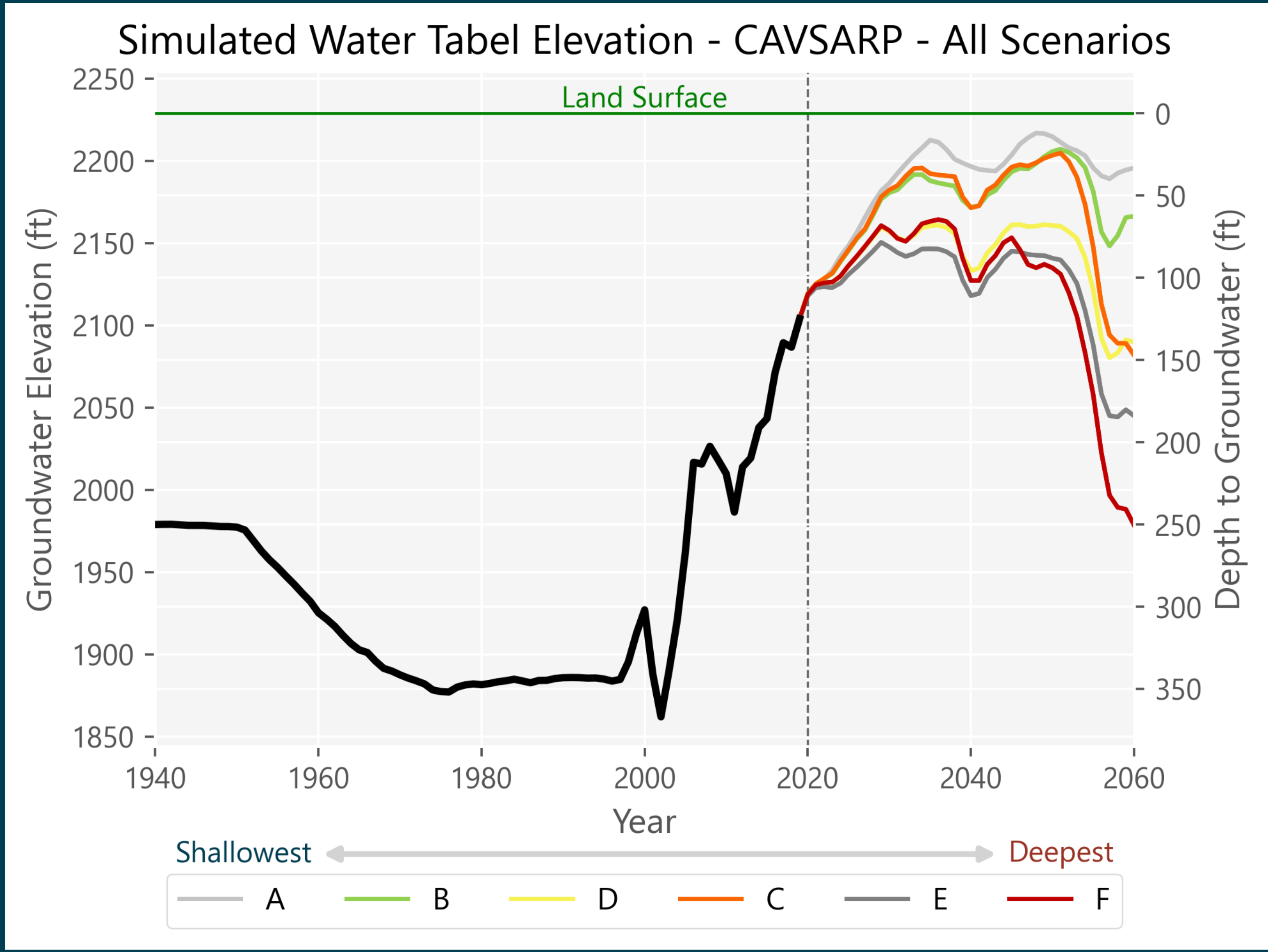


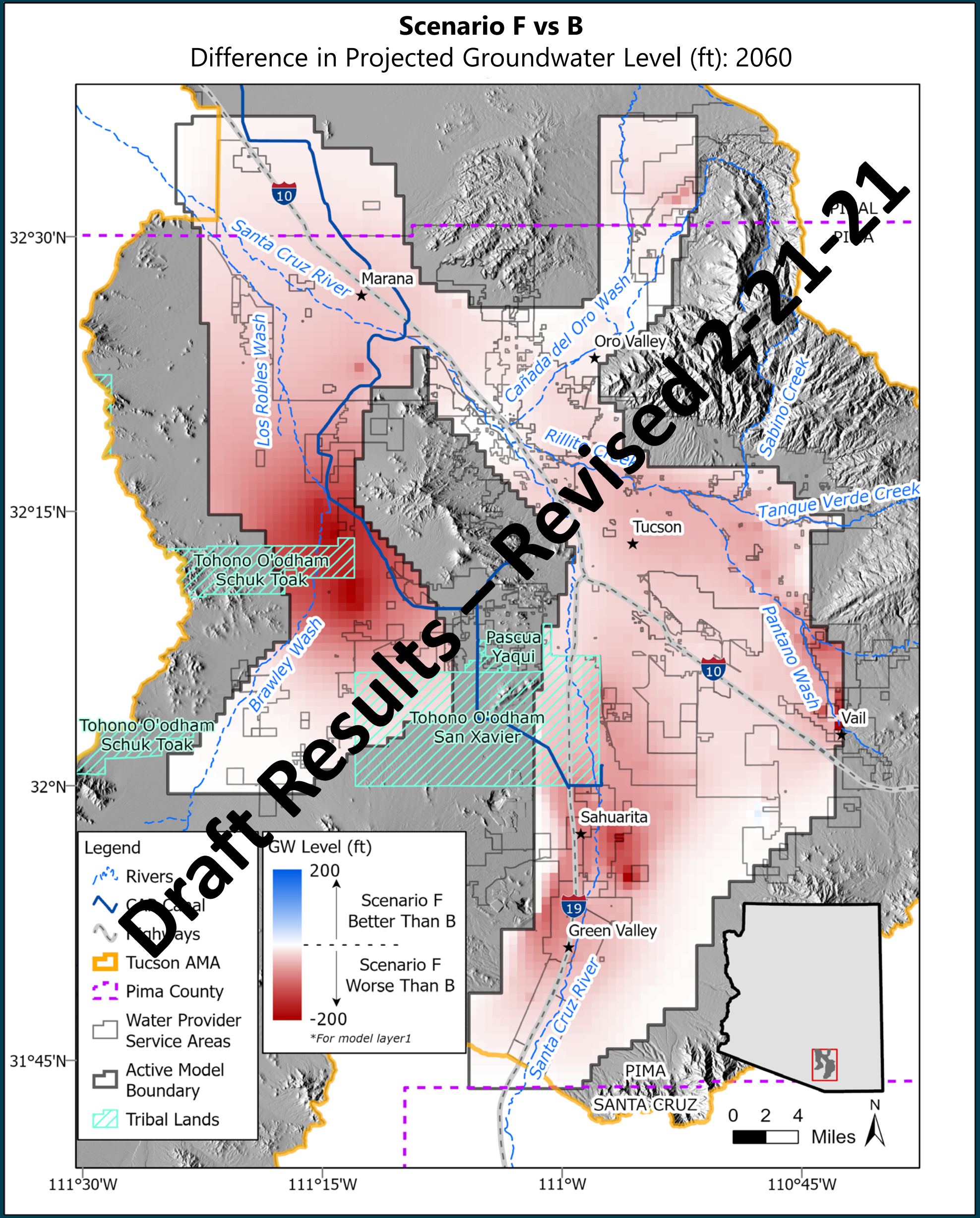
# Hydrograph CAVSARP



# Hydrograph
# CAVSARP with Model Results



# Supply-Demand Basin Study Scenarios, D vs. F

A. Official Projections: Medium, mixed-density growth and Current climate
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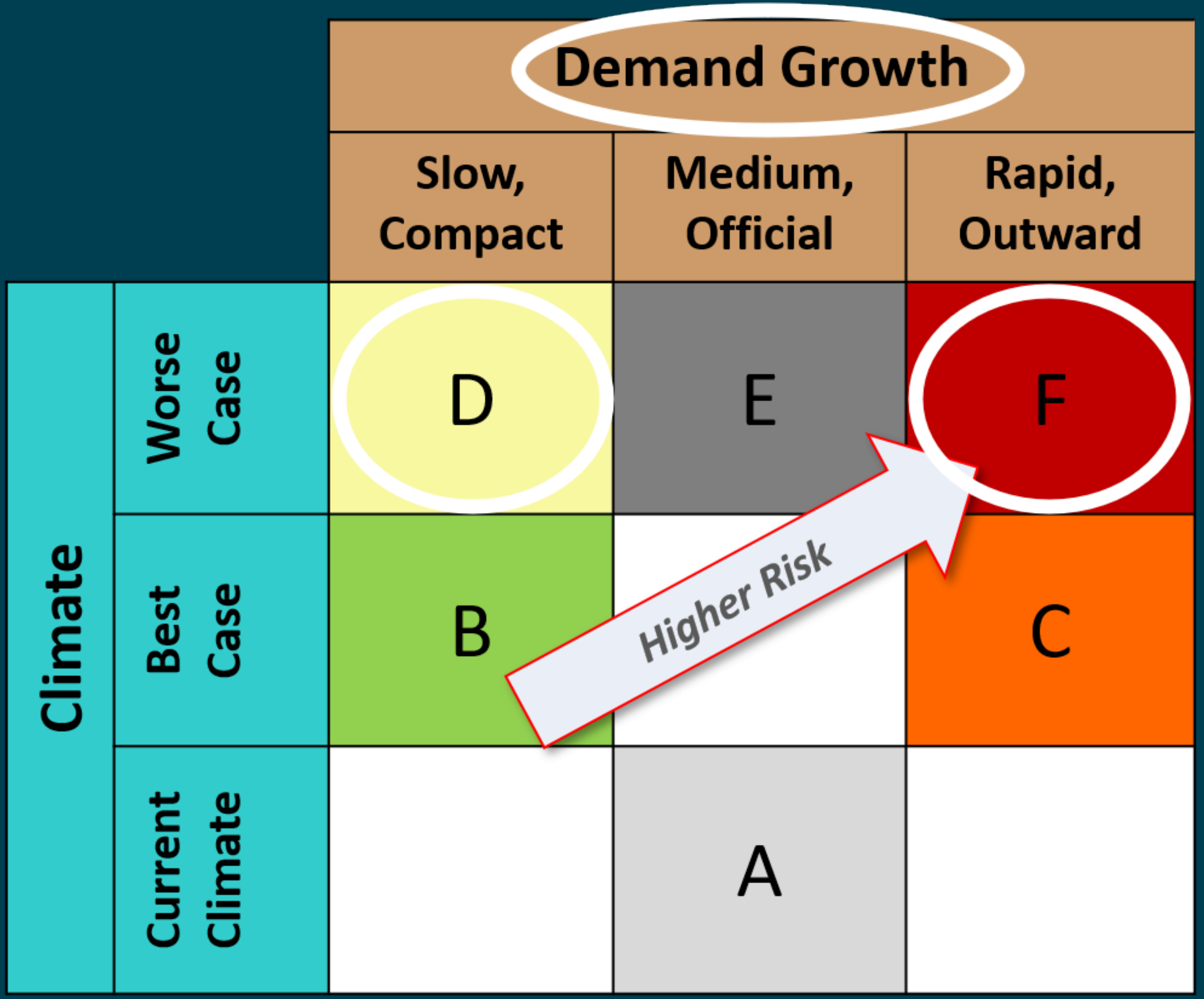
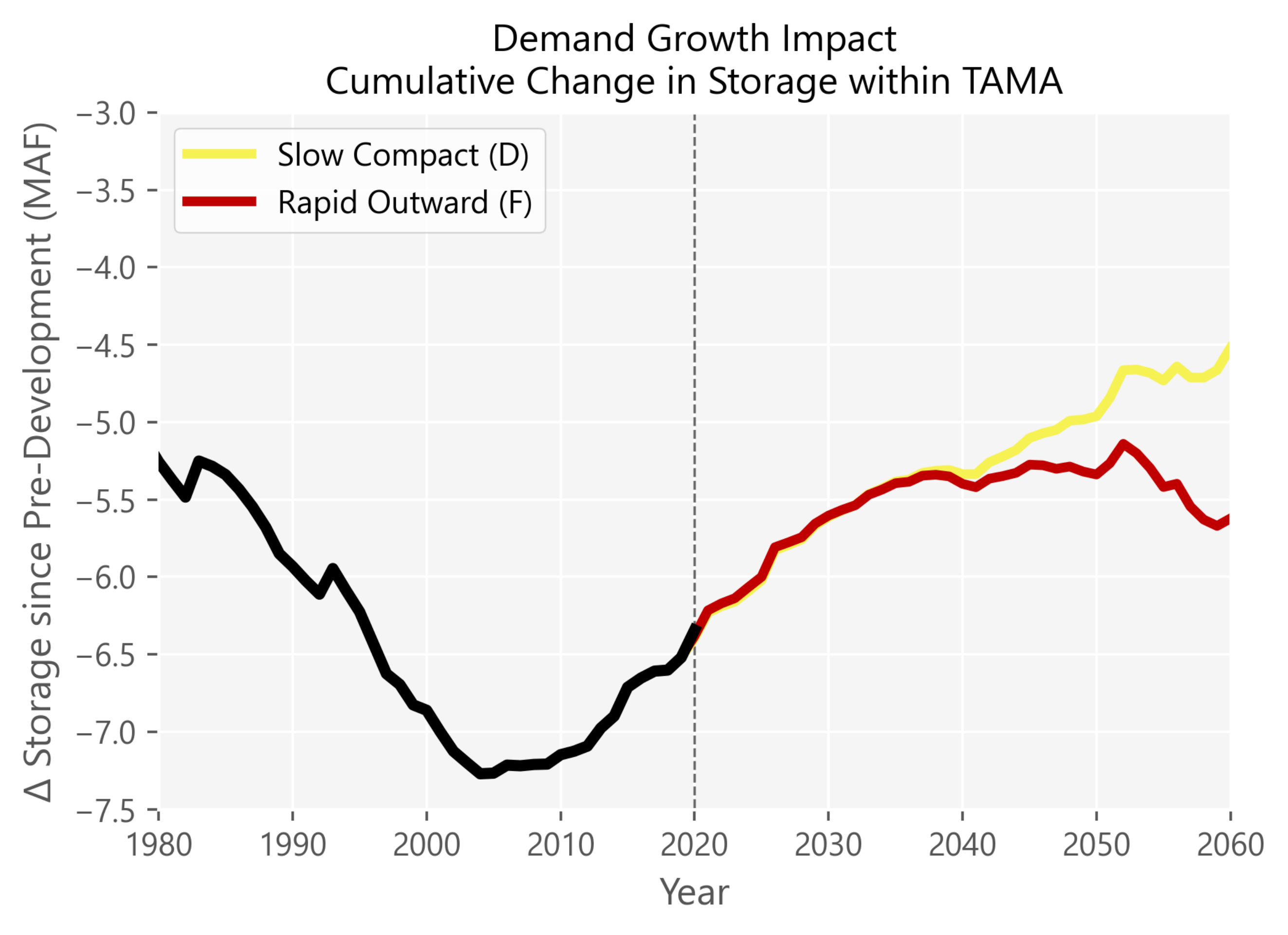
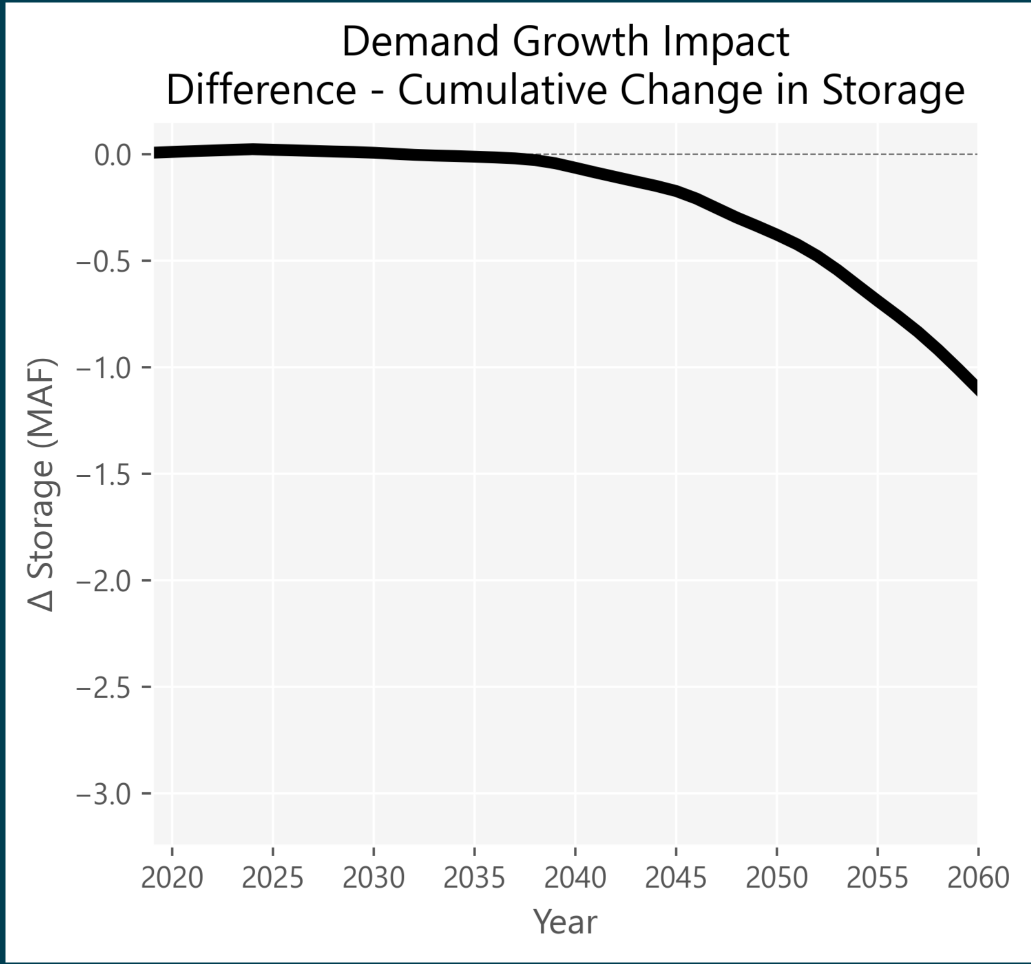
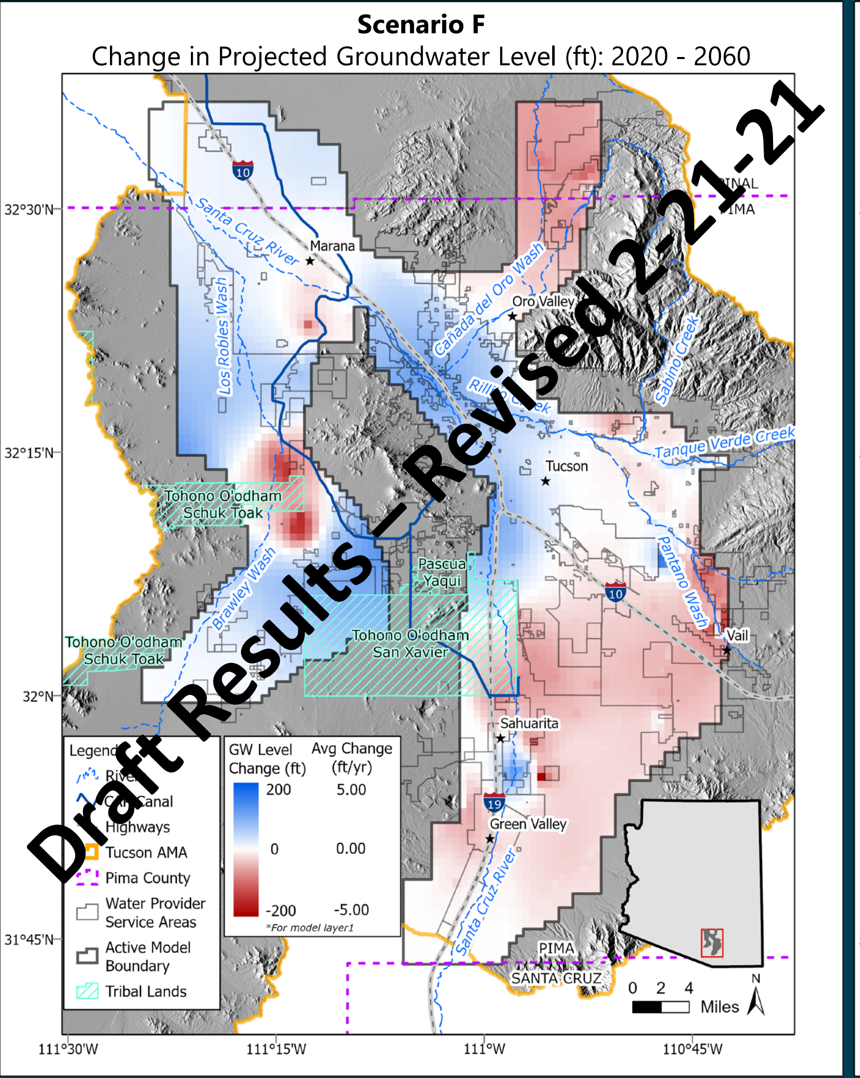


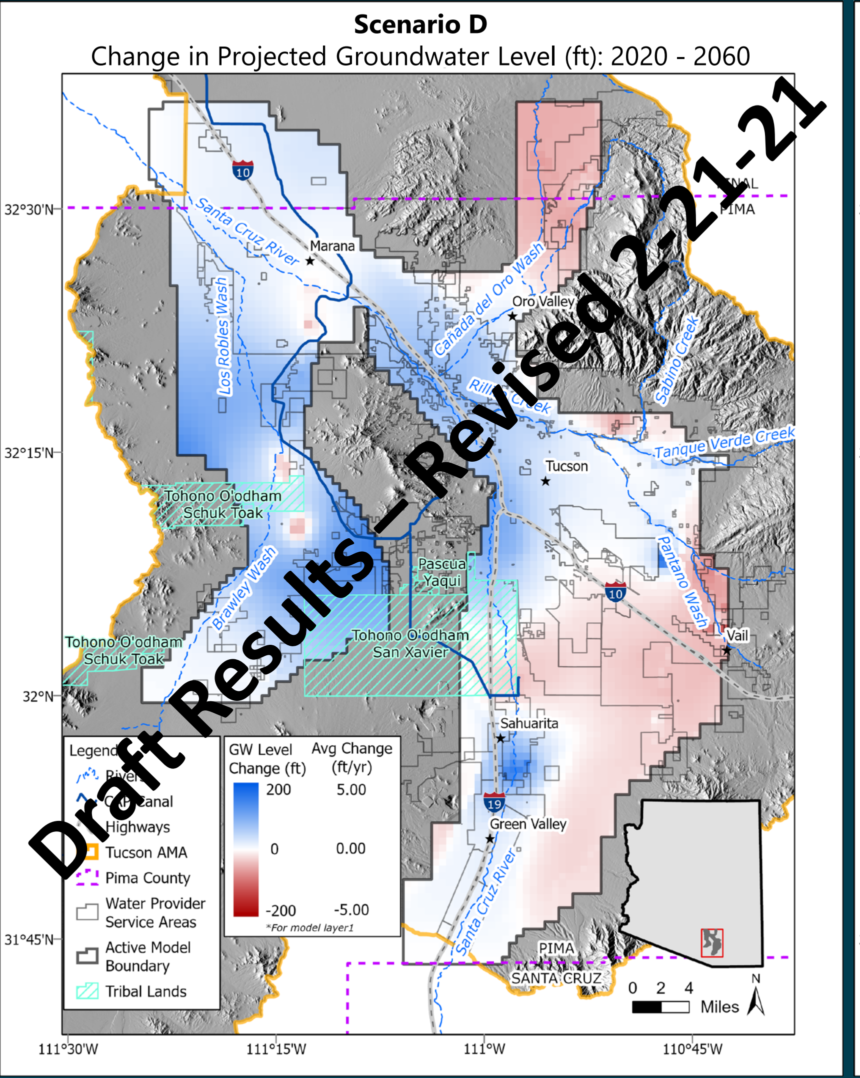
# Demand Growth Impact
# Change in Groundwater Storage

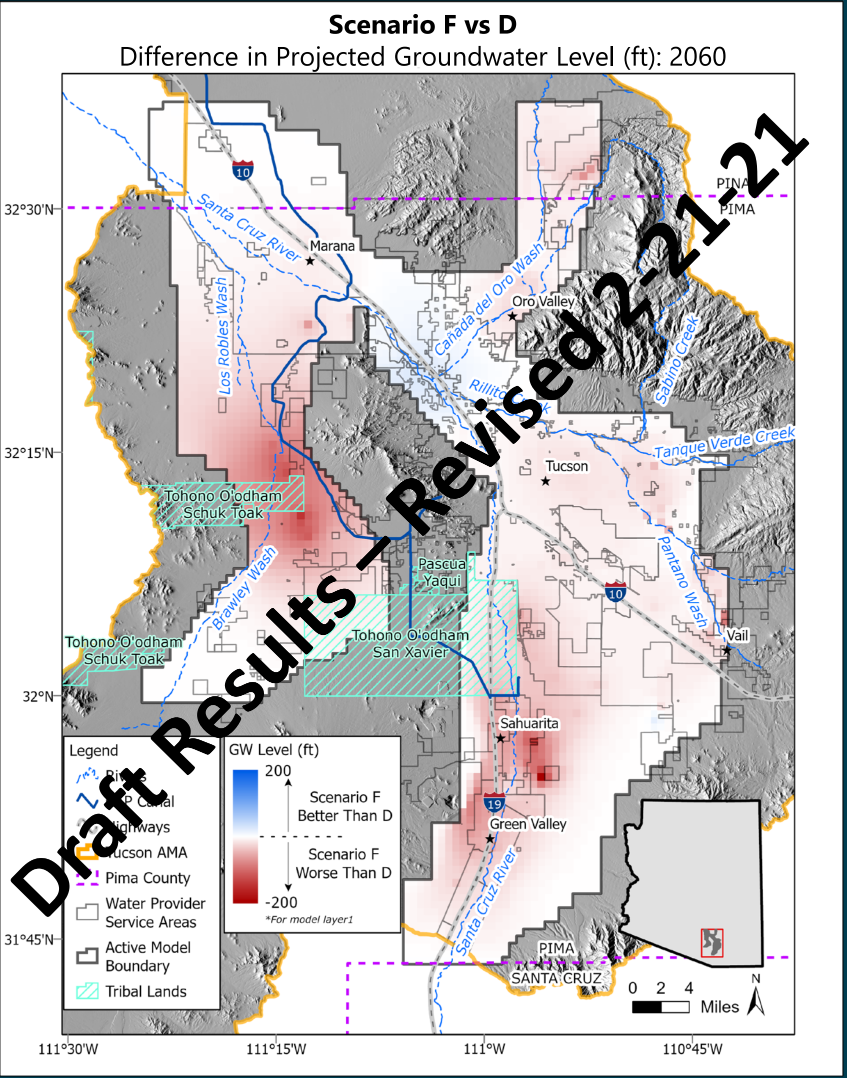


# Demand Growth Impact - Change in Head



# Supply-Demand Scenarios – Impact of Climate

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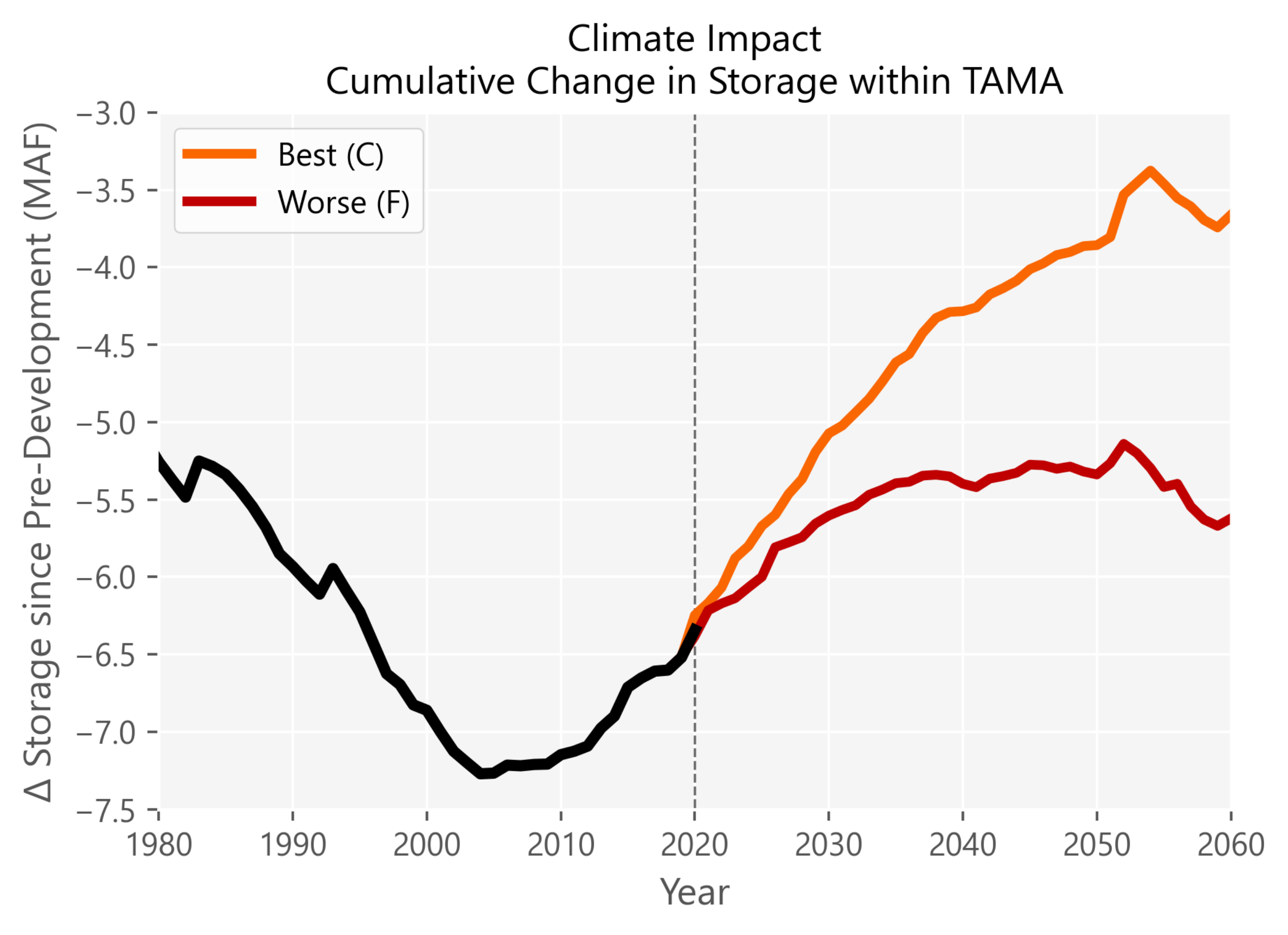
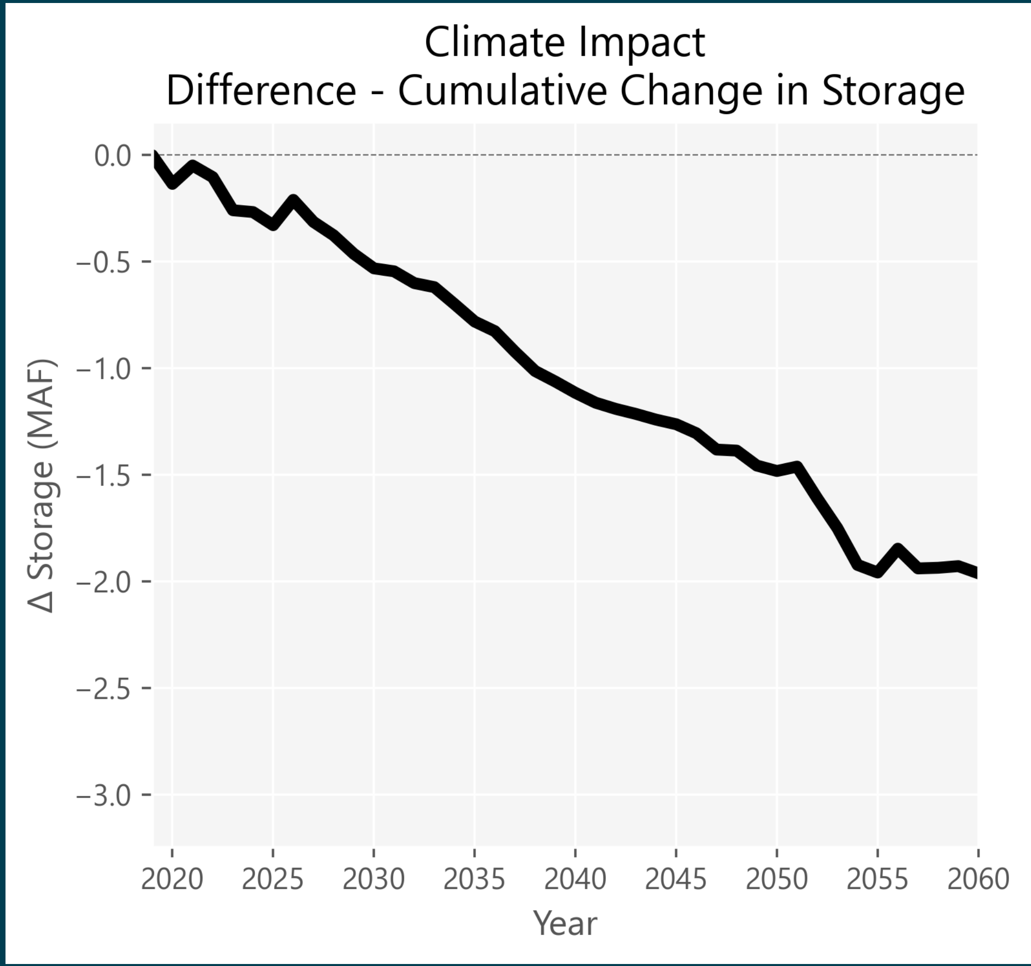
Higher Risk

# Climate Impact
# Change in Groundwater Storage

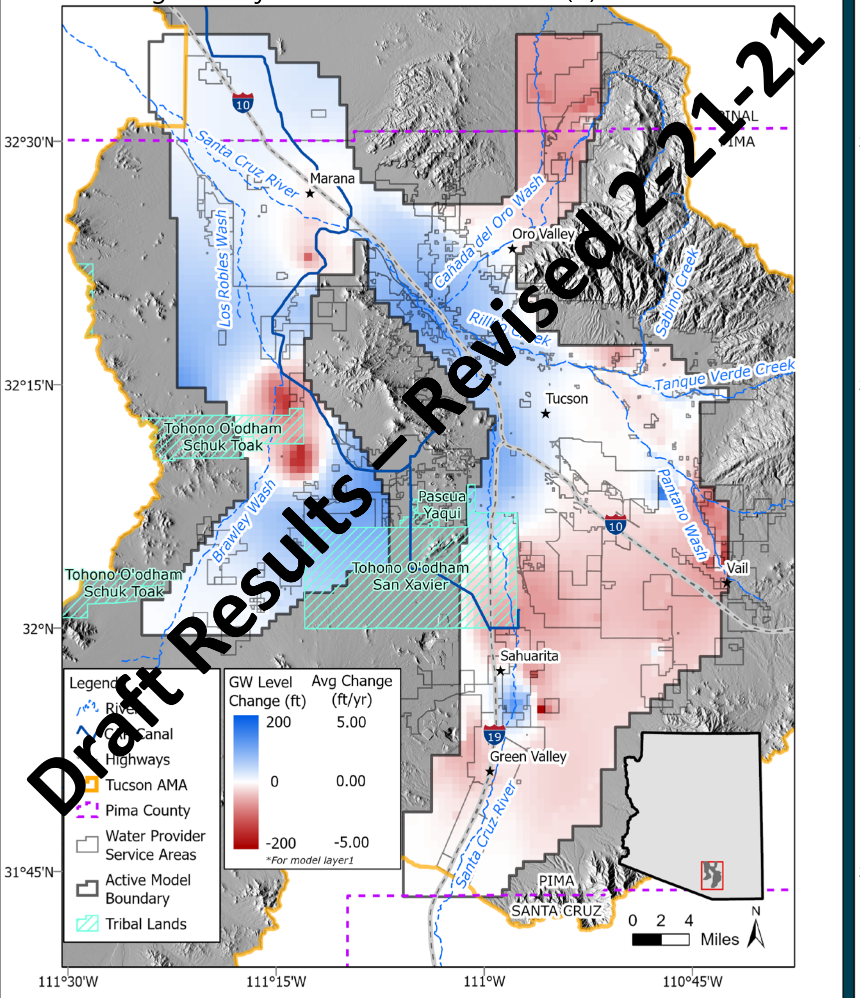


# Climate Impact - Change in Head

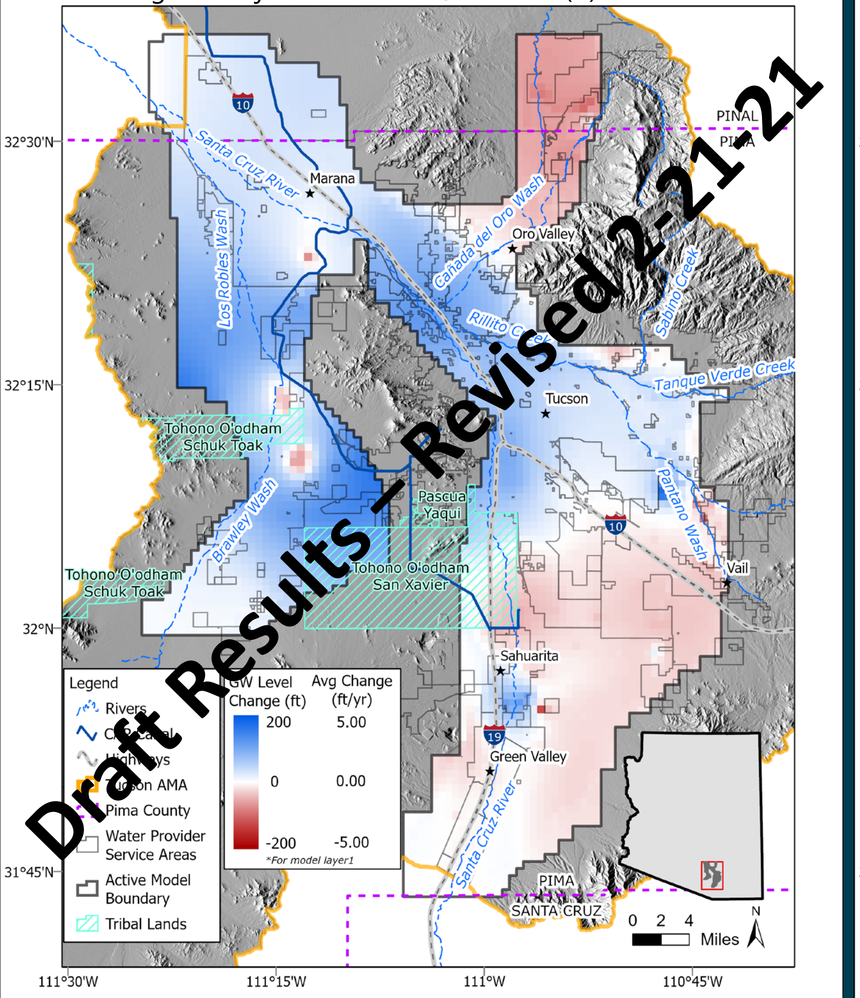
**Scenario F**

Change in Projected Groundwater Level (ft): 2020 - 2060



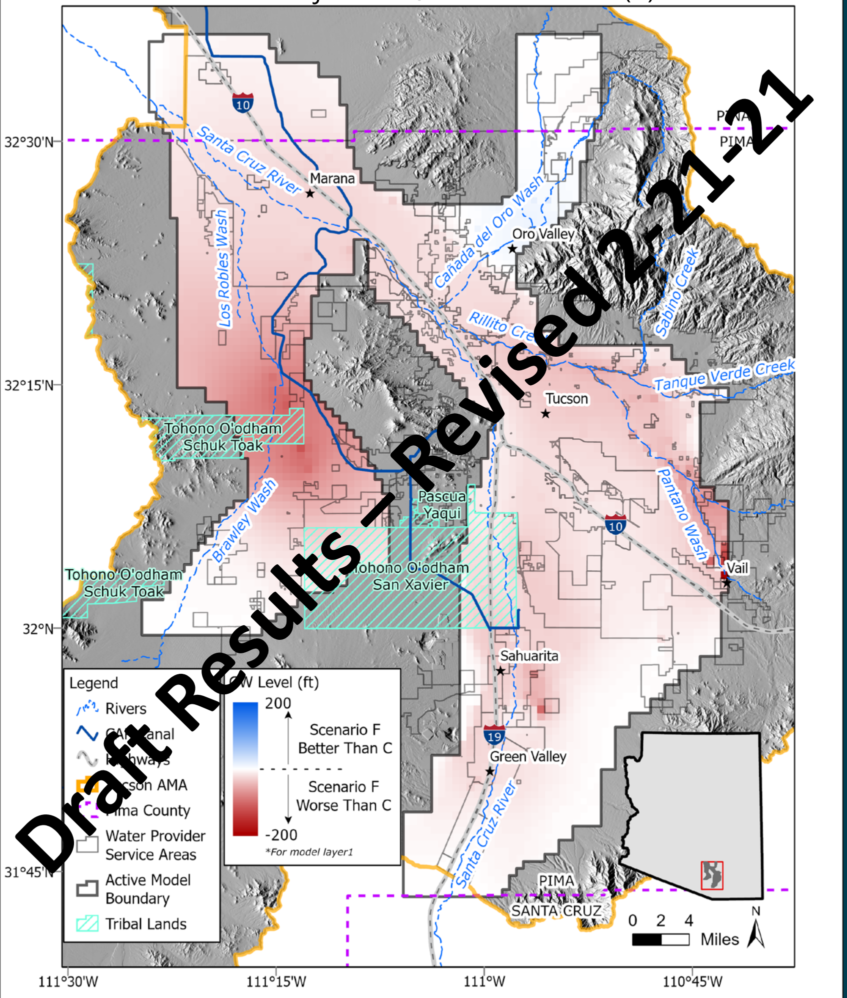

**Scenario C**

Change in Projected Groundwater Level (ft): 2020 - 2060




**Scenario F vs C**

Difference in Projected Groundwater Level (ft): 2060



# Supply-Demand Basin Study Scenarios
# B vs. D vs. F

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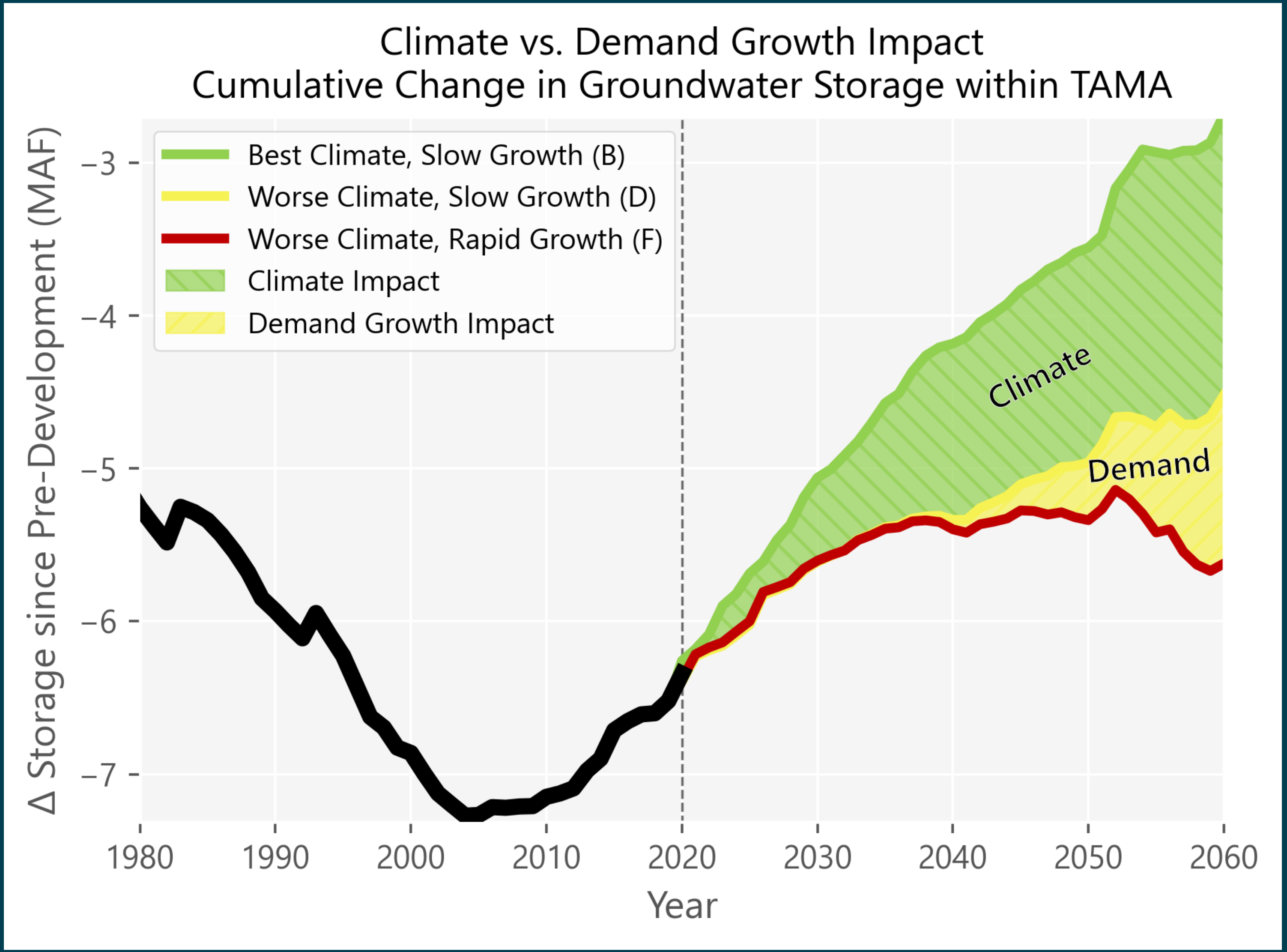
|---|---|---|---|---|
| | | **Slow, Compact** | **Medium, Official** | **Rapid, Outward** |
| **Climate** | **Worse Case** | D | E | F |
| | **Best Case** | B | | C |
| | **Current Climate** | | A | |

*Higher Risk*

# Climate vs. Demand

- Cross-scenario comparison suggests impact of climate (green) has greater influence on groundwater supply future than demand growth (yellow)



# Key Takeaways

- Impacts of demand growth are largely driven by local decisions
- Impacts of climate are largely driven by global decisions
- Climate has greater impact than demand growth
- Areas of adaptation (see maps)

# Next Steps…

- Identify risks
- Develop/Refine adaptation strategies