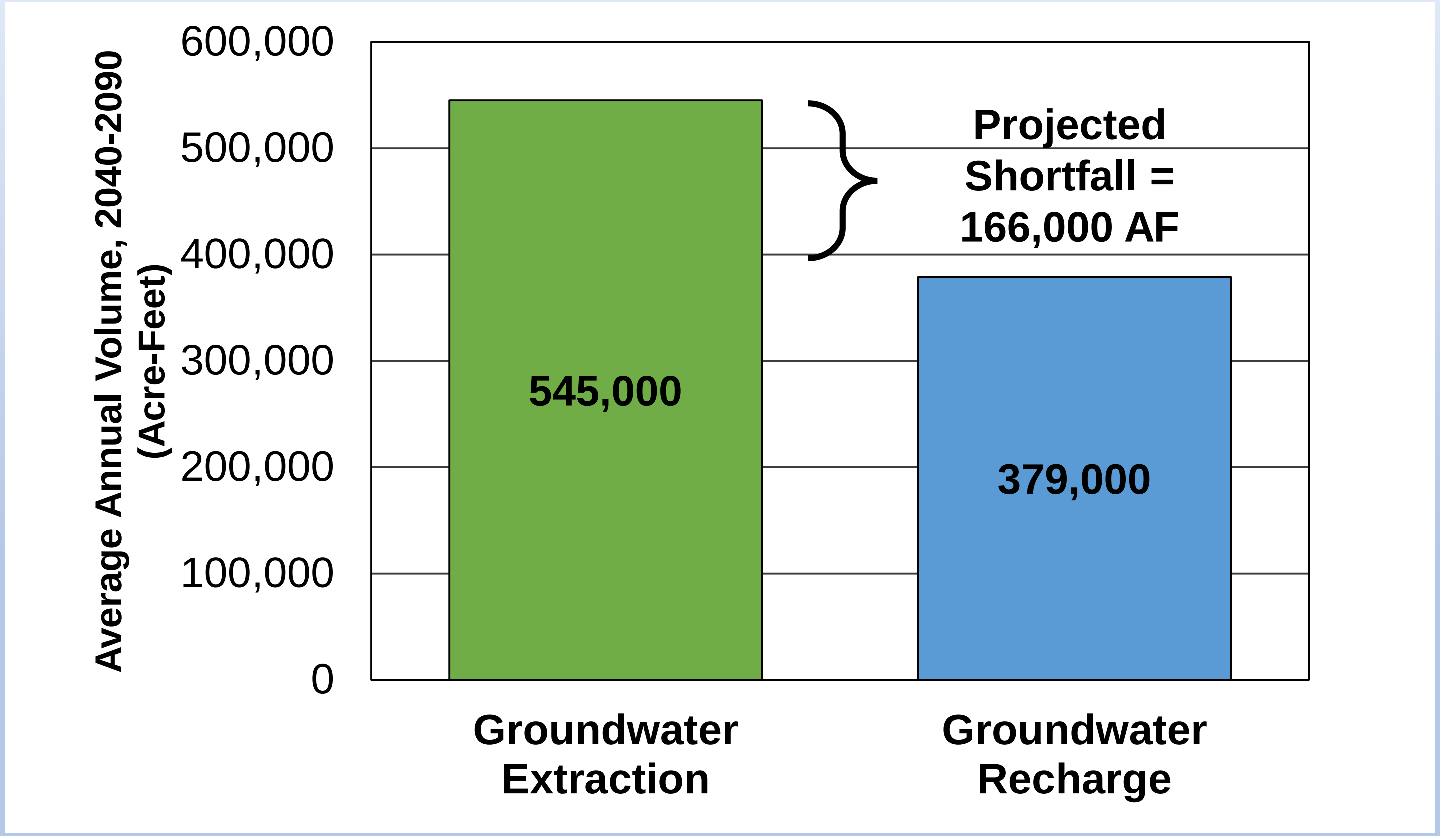
Agenda

1. Introduction
2. GW Model Calibration
3. Projected Future Hydrology
4. Projects
5. GW Model Results
6. Minimum Thresholds and Measurable Objectives

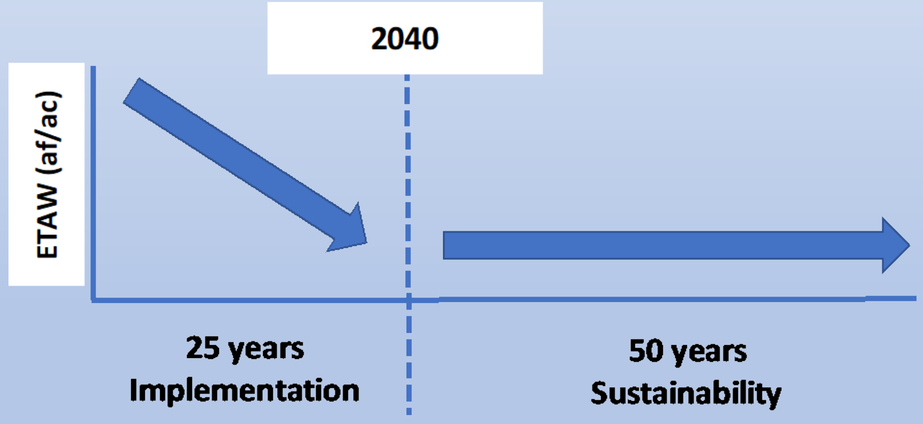
Simplified Groundwater Condition No Action 2040-2090



DRAFT PRELIMINARY ANALYSIS AND RESULTS TO BE REFINED AS GROUNDWATER SUSTAINABILITY PLAN DEVELOPMENT PROCEEDS

Plan for Meeting the Shortfall

- Recharge projects
- Incremental reduction from current consumptive use
- Continued use of stored groundwater (lowering levels) during project implementation period
- Use GW model to estimate future



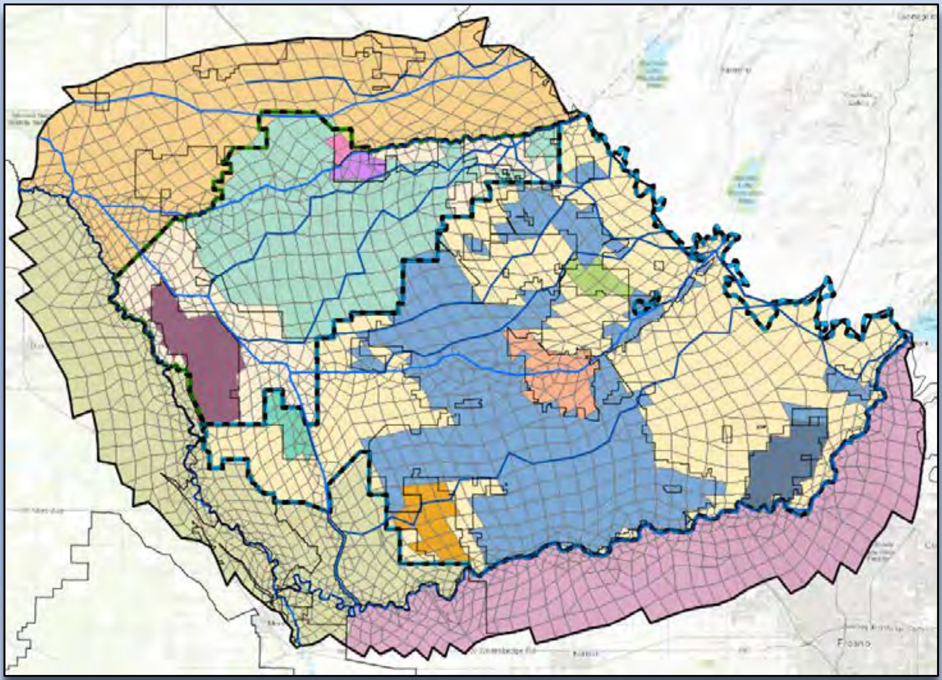
Role of Groundwater Modeling in GSP Development

- Groundwater Models are Tools
- Help Understand Potential Outcomes of Projects with respect to future GW levels
- Can Inform Decisions – Relative Effects; Relies on Specified Input Parameters
- Limitations in Capabilities
  - Representation of complexity/heterogeneity
  - Limited calibration data/conditions/variables
  - Regional vs local – local variability not captured
  - Relative vs absolute – differences btwn scenarios

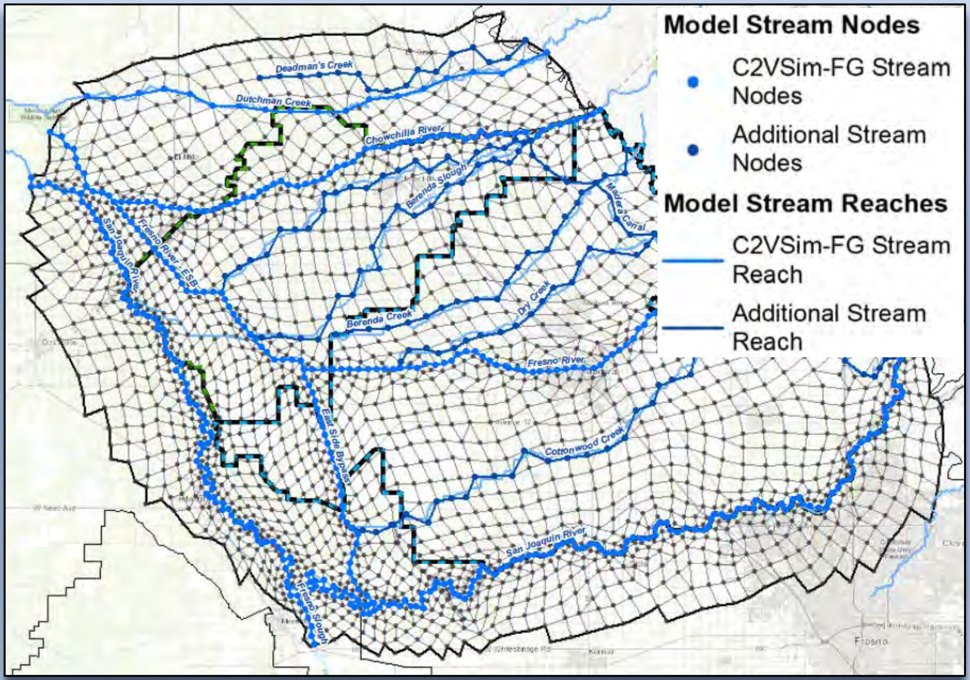
MCSim Model Calibration - Background

- Key refinements to local model information

Water balance subregions (subbasins/GSAs)



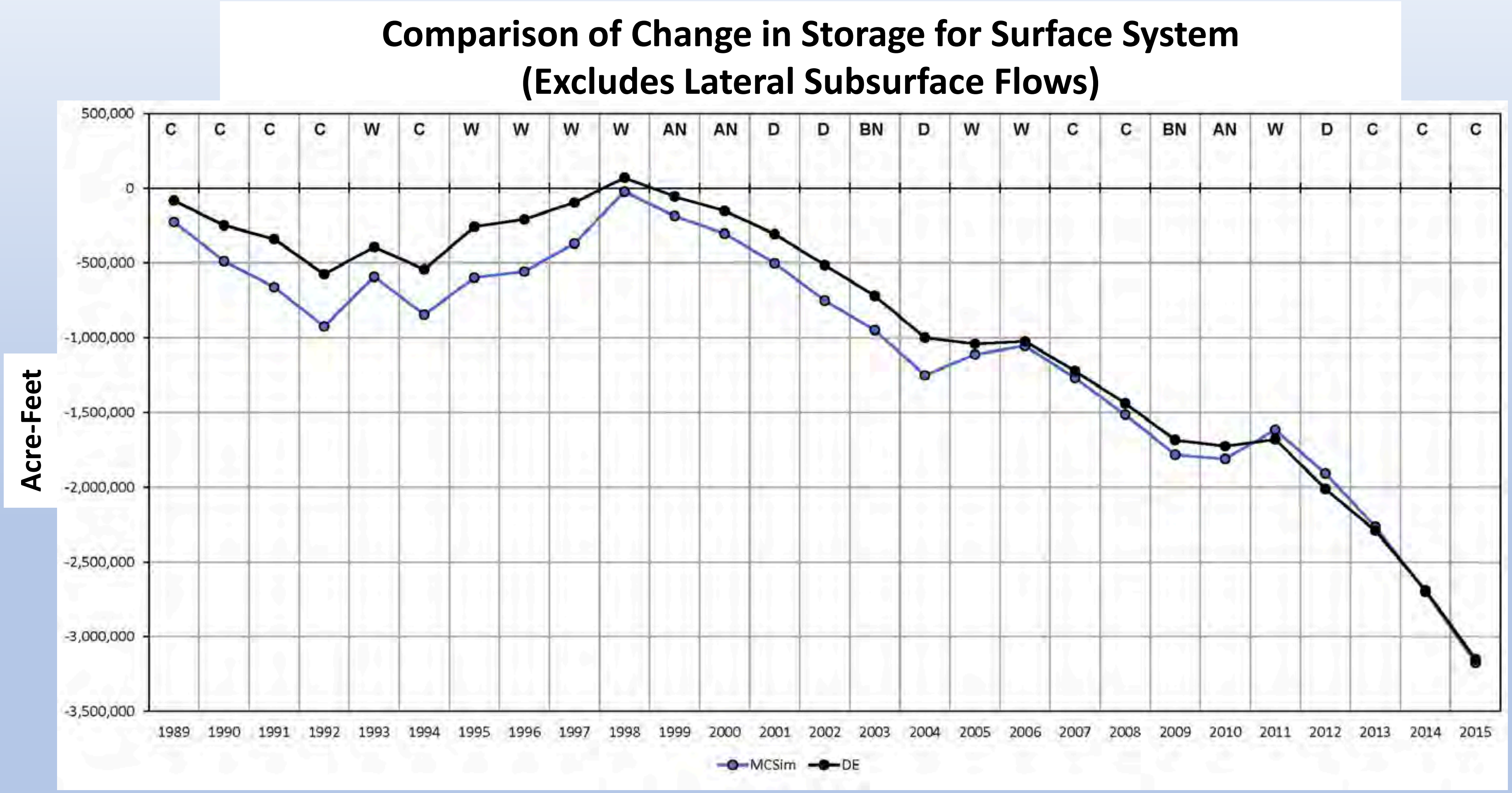
Streams – added Dry Creek, Cottonwood Creek and Berenda Creek; others outside Madera Subbasin



MCSim Model Calibration - Process

- MCSim Refined from C2VSim
- Base Period 1989 to 2015
- Matching Model to:
  - DE Surface System Water Budget
  - Historic Stream Flow
  - Historic Groundwater Level Fluctuations
- Adjustments to Model:
  - Initial and Boundary Heads (Groundwater Levels)
  - Aquifer Parameters
  - Stream Parameters

MCSim Model Calibration – Base Period



Methodology and Assumptions

- Historical (1965-2015) hydrology (precipitation, evapotranspiration, and streamflow)
- Projected water demand
  - Land use
    - use 2017 crop areas
    - projected changes from ag to urban land use (Urban Water Management Plans and census data)
  - Historical climate (evapotranspiration and precipitation)
- Projected surface water supply adjusted for San Joaquin River Restoration
- Model
  - Projects
  - Crop water use reduction

Methodology and Assumptions—Modeling Projects Approach

- Estimate “New” water available for irrigation supply or recharge, must be water that would have:
  - Left the subbasin without the project, or
  - Not entered the subbasin without the project
  - Not been used by another project

Projects

- 17 projects
- Total “new” water (purchased and recharged) 120,000 to 130,000 AF
- Total available water (purchased and recharged) 160,000 to 180,000 AF

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Projects and Actions: City of Madera GSA

- New surface water into GSA
  - Recharge basin added since SGMA
  - Continue to work with MID
- Significant urban demand reduction
  - Due to implementation of water meters, volumetric billing, and conservation rebates
- Agricultural land conversion
  - Conversion of ag to urban and use of surface water vs. ground water for remaining ag

Type	Max Rate and frequency	Estimated Avg. Annual Benefit
(Values in acre-feet)		
Recharge Basin (With MID)	10 - 55 57% of years	20 - 30
Urban Area Conservation	3,350 Annually	3,350
Agricultural Land Conversion	2,000 Annually	2,000

Projects and Actions: Madera County GSA

- New surface water into GSA
  - Recharge during non-irrigation
  - Irrigate with surface water
- New surface supplies need:
  - A secured water source(s):
  - Conveyance agreement(s) (Reclamation/MID)
  - New diversion/deliver infrastructure
  - Funding
- Significant demand reduction
  - Up to ~50% less pumping by 2040

Type	Max Rate and frequency	Estimated Avg. Annual Benefit
(Values in acre-feet)		
Recharge along Bypass	30,000 - 40,000 35% of years	10,000 to 15,000
Recharge in east area	20,000 15%-30% of years	5,000 to 7,000
Irrigate with surface water in east area	3,000 – 10,000 60%-70% of years	3,000 to 5,000
Demand reduction	Steady-annual decrease in consumption to 2040	Increase ~5,000/yr (additive) to ~90,000/yr

Projects and Actions: Madera Irrigation District GSA

- Completed Projects 2015-2019
  - Recharge basin rehabilitation-6 basins
  - Pipeline projects-12,000’
  - On Farm Recharge Program
  - Deannexation of 320 acres to RCWD
  - System automation-54 sites
  - Joint Recharge Basins-City and County
  - New Basin Acquisition-22 acres
- Recharge Basin Acquisition
- Water Supply Development-Partnerships
- On Farm Recharge Program
- New Fee Structures and Incentives

Type		Estimated Avg. Annual Benefit
(Values in acre-feet)		
Completed Projects		~11,500 AF
Recharge Basin Acquisition		5,500 AF
Water Supply Development-Partnerships		2,000 AF
On Farm Recharge		2,000 AF
New Fee Structures and Incentives		5,000 AF

Projects and Actions: Madera Water District

1. Import new surface water
   - Irrigate with surface water
   - Store water for later deliveries
2. Pipeline connection to Madera Lake
3. Construct storage reservoirs
4. Increase Dry Creek deliveries
5. Demand reduction

Type	Max Rate and frequency	Estimated Avg. Annual Benefit
(Values in acre-feet)		
Madera Lake Deliveries	4,500 35% of years	1,820 AF/yr
Dry Creek Deliveries	1,500 35% of years	670 AF/yr
Demand Reduction	Land conversion from AG to storage reservoirs	600 AF/yr

Projects and Actions: Gravelly Ford Water District

1. Independently develop GSP
2. Achieve sustainability by importing new surface water
   - Acquire additional flood water for underground storage
3. Construct storage reservoirs
4. Improve surface water conveyance system for recharge
5. Demand reduction if necessary

Type	Max Rate and frequency	Estimated Avg. Annual Benefit
(Values in acre-feet)		
Additional Flood Water	5,000 15% - 30% of years	1,200-1,800
Demand Reduction	If necessary	

Projects and Actions: New Stone Water District

1. **Independently develop GSP**
2. **Achieve sustainability by importing new surface water**
   - **Maximize Bypass channel water rights (15,700 AF/yr)**
   - **Acquire additional flood water for underground storage**
3. **Construct storage reservoirs**
4. **Improve surface water conveyance system**
5. **Demand reduction if necessary**

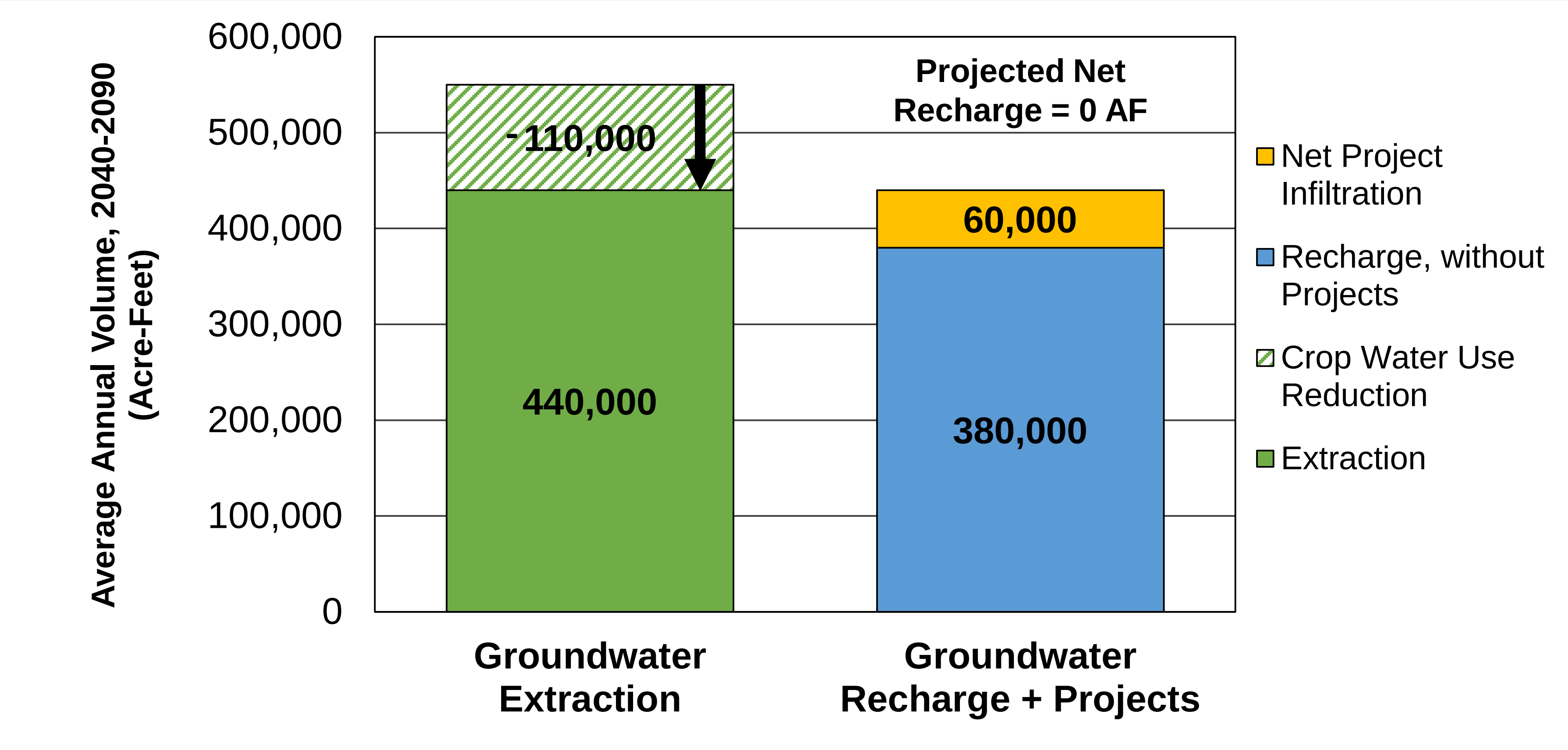
Type	Max Rate and frequency	Estimated Avg. Annual Benefit
(Values in acre-feet)		
Bypass Channel Deliveries	15,700 15%-30% of years	2,400-4,700
Additional Flood Water	5,000 15%-30% of years	750-1,500
Demand Reduction	If necessary	

Projects and Actions: Root Creek WD GSA

- Import surface water into GSA
  - Irrigate with surface water
  - Recharge during non-irrigation
- Surface Supplies:
  - Madera ID – Conveyance and wet year supplies up to 10,000 AF
  - Wonderful – up to 7,000 AF
- Land Use Change
  - Riverstone – 2,000 acres developed to M&I
  - Reduction in agricultural demands

Type	Max Rate and frequency	Estimated Avg. Annual Benefit
(Values in acre-feet)		
In-Lieu Recharge Project	1,000 – 10,000 Every year	3,500
Land use change	1,000 Every year	1,000

Simplified Groundwater Condition With Projects (2040-2090)



Crop Water Use Reduction Program: Madera County GSA 90,000 af. Remaining crop water use reduction due to permanent recharge basins replacing irrigated area.

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Projects Summary

- A combination of projects and demand reduction eliminates the overdraft
- GSA must implement projects between 2020 and 2040 according to the draft schedule
- Actions to reduce crop water use also required
  - Ensure basin is operated within sustainable yield
  - Convince DWR that the basin can be operated within sustainable yield
- Projects and demand reduction may be scaled up or down as needed during implementation period

MCSim Preliminary Model Results - Background

- Initial model results without climate change to allow comparison to historical/current climate
- Subsequent model results with climate change per DWR guidance document (not presented today)
- Projected Future without projects/management actions
- Projected Future with projects/management actions

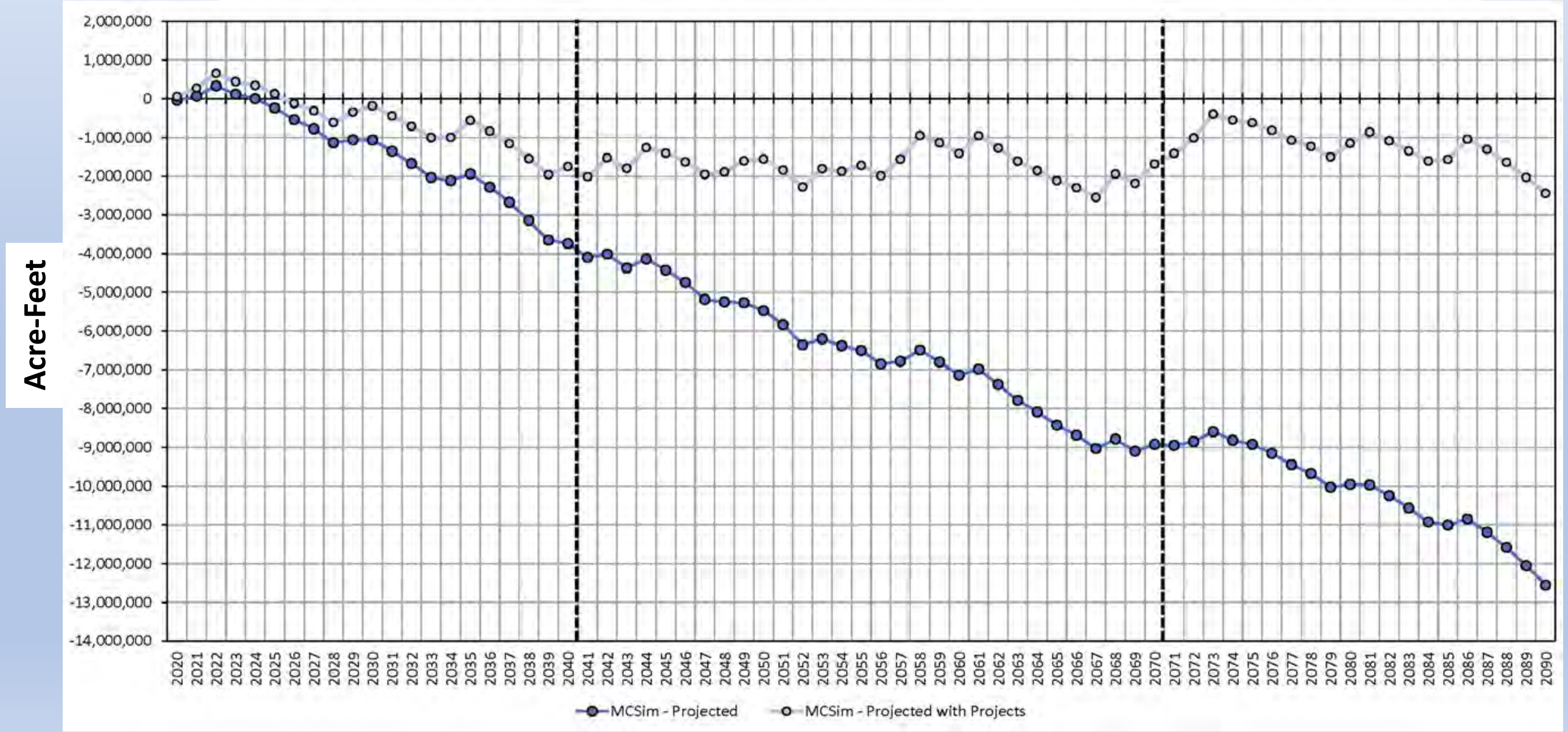
MCSim Preliminary Model Results – With and Without Projects for Entire Subbasin

- Projected Boundary Conditions Assume Adjacent Subbasins Implement Projects for With Project Model Runs
- Average Annual Net Recharge from SWS 2040-2090
  - Without Projects -165,000 AF/year
  - With Projects 0 AF/year
- **Preliminary Results Still Under Review**

MCSim Preliminary Model Results – With and Without Projects for Entire Subbasin

- Projected Boundary Conditions Assuming Adjacent Subbasins Implement Projects

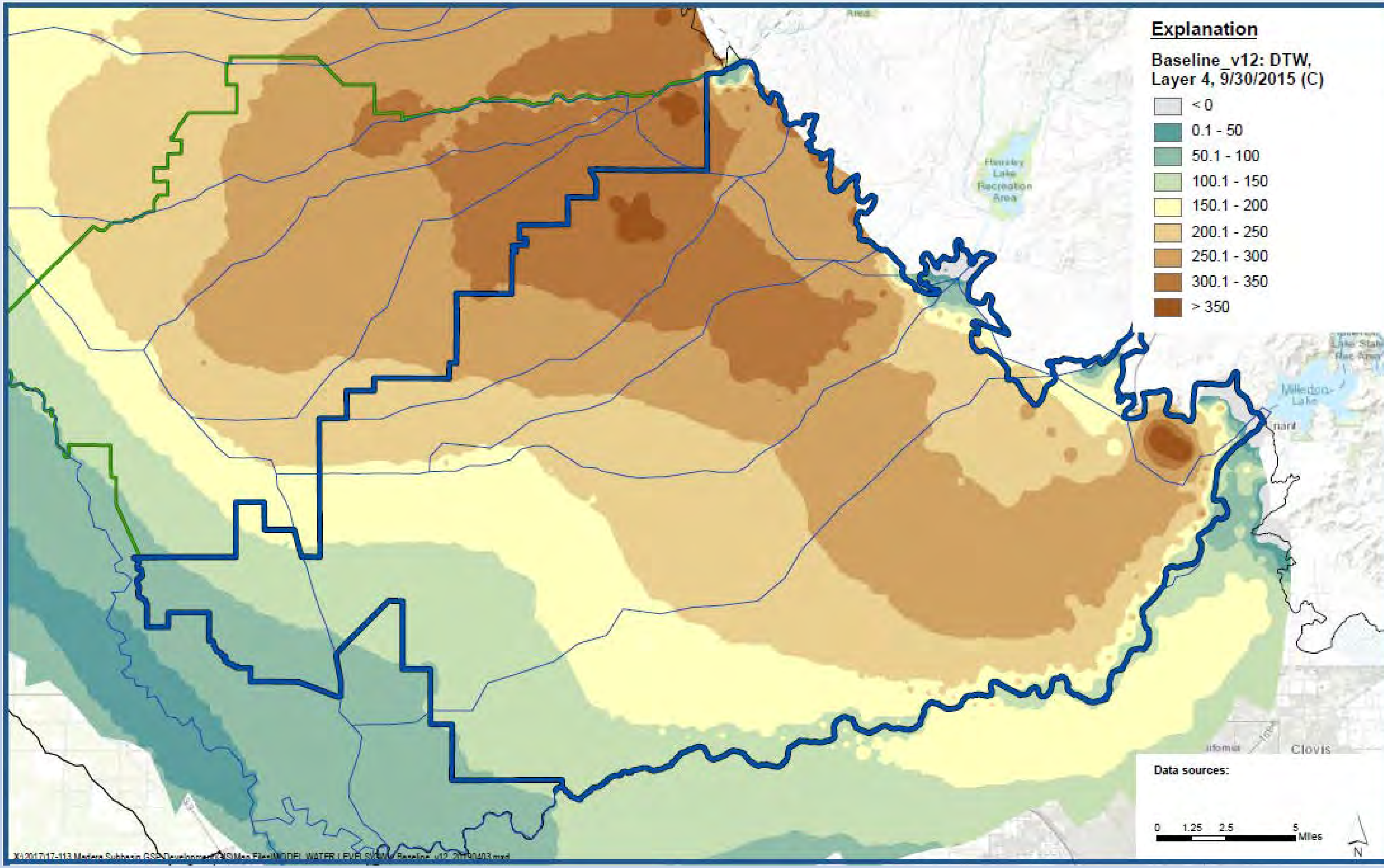
Projected Change in Storage for Surface System
(Excludes Lateral Subsurface Flows)



MCSim Preliminary Model Results – With Projects

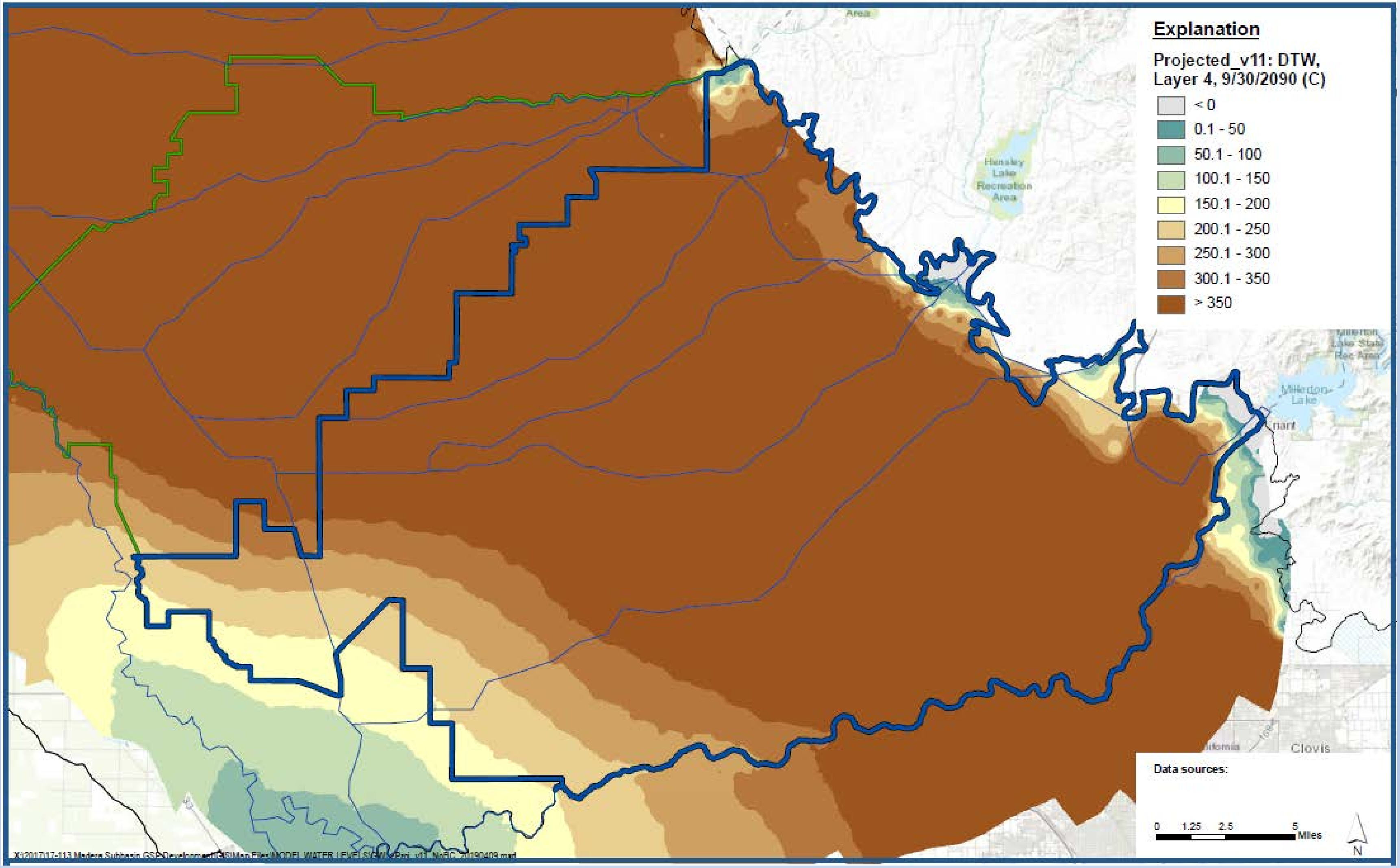
- Selected Depth to Water (DTW) maps
- Following maps show DTW for Model Layer 4 (Below Corcoran Clay)
- Current Year (2015)
- Projected without projects (Critical Dry Years), no future increase in subsurface inflow from boundaries
- Projected with projects (Critical Dry Years), adjacent subbasins implement projects

MCSim Preliminary Model Results – Current Year, Lower Aquifer, (2015)

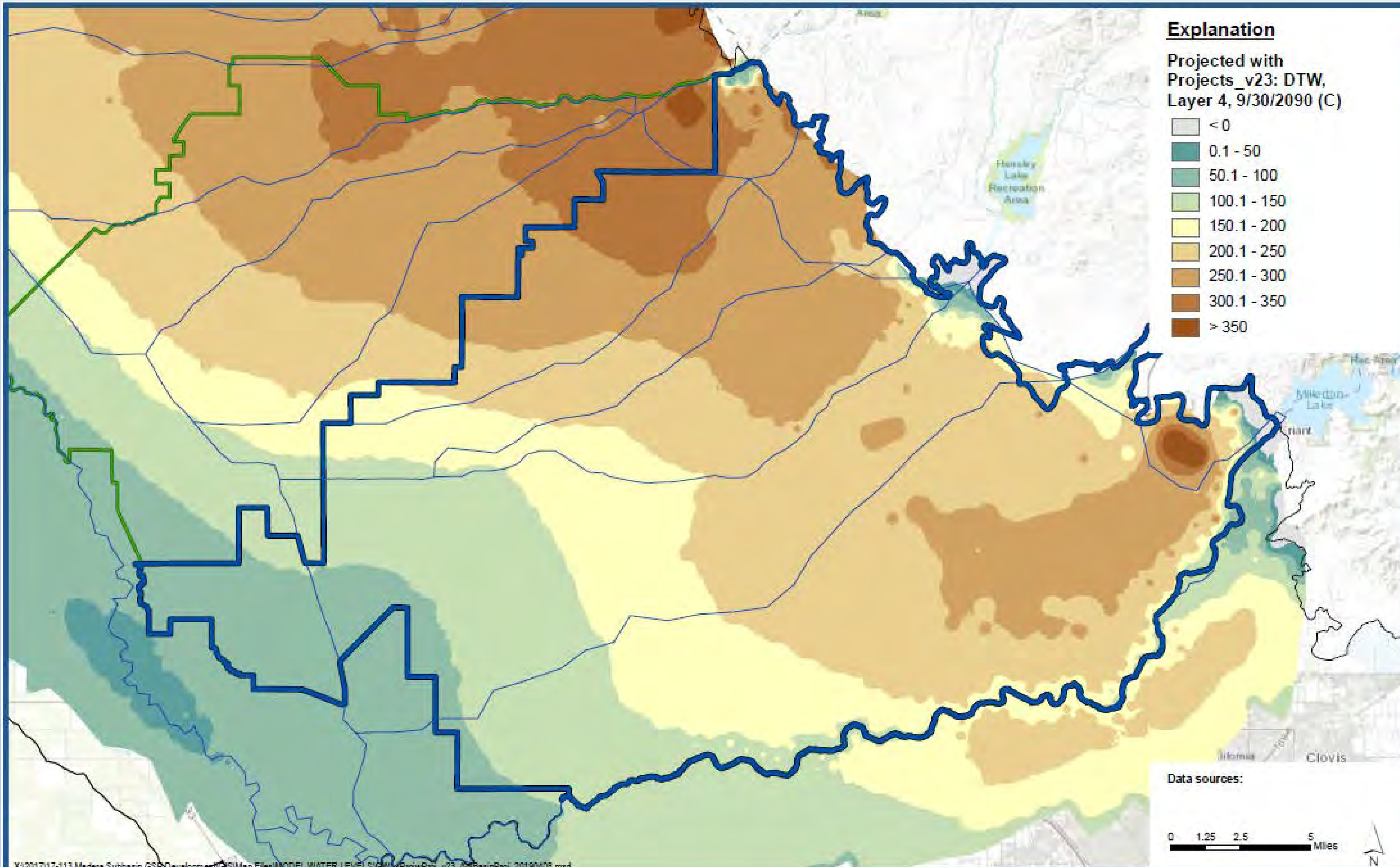


MCSim Preliminary Model Results – Without Projects, Lower Aquifer, Critical Dry Year (2090)

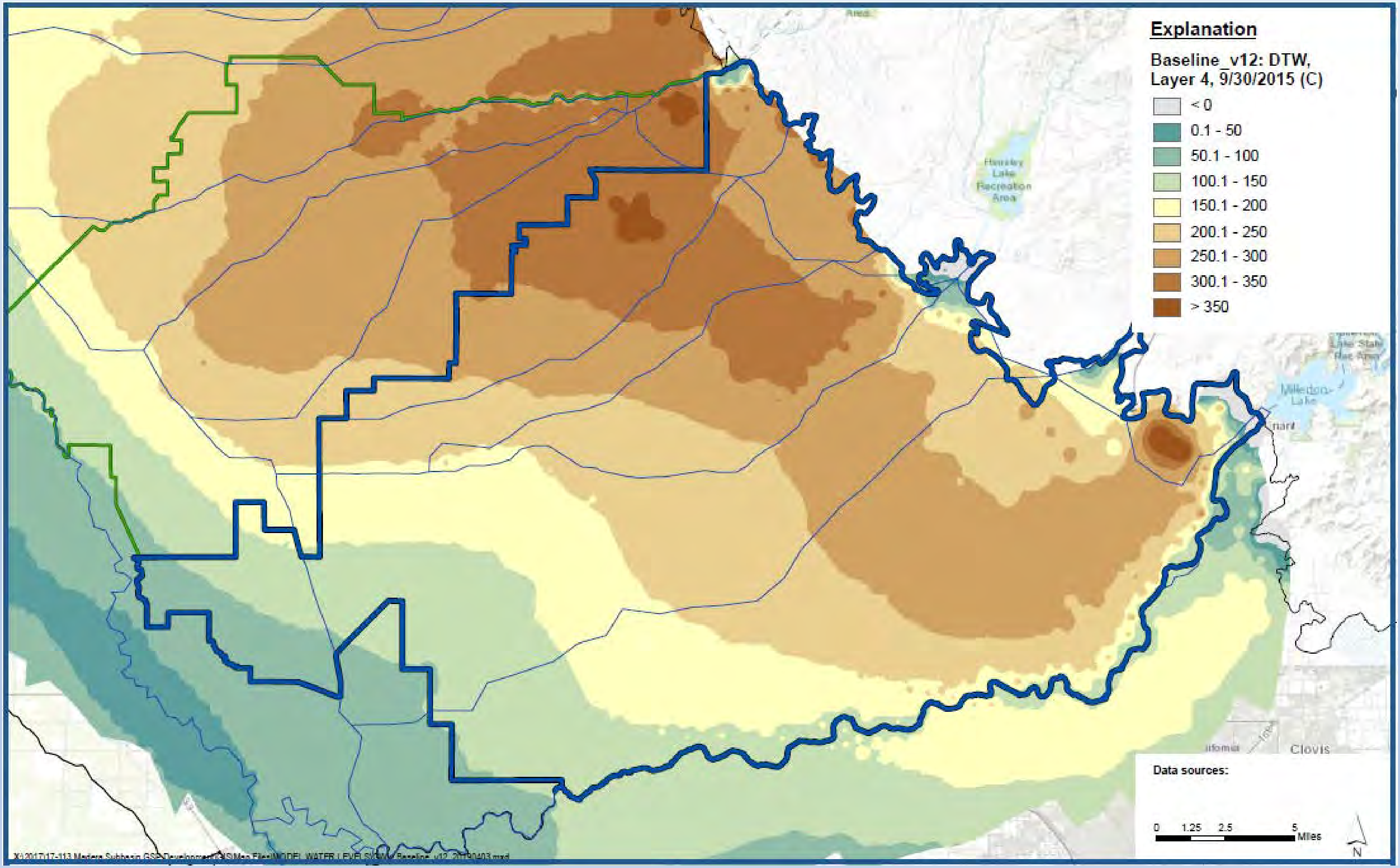
- No increase in subsurface inflow to offset water level declines



MCSim Preliminary Model Results – With Projects, Lower Aquifer, Critical Dry Year (2090)



MCSim Preliminary Model Results – Current Year, Lower Aquifer, (2015)



SGMA Requirements

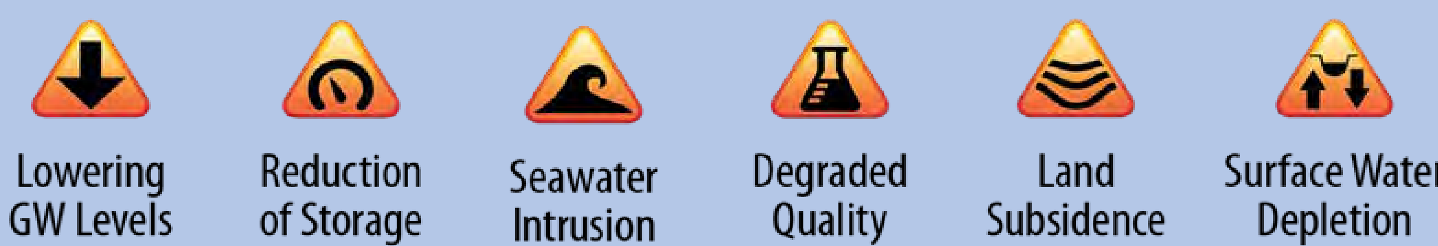
- "Sustainable groundwater management" must be occurring by 2040 for the entire subbasin
  - Today through 2039 – focus on implementation
  - 2040 and beyond must be sustainable, with no "undesirable results"

SGMA Requirements (cont.)

- "*Sustainable groundwater management*" means the management and use of groundwater in a manner that can be maintained…without causing undesirable results. [*CWC §10721(v)*]

SGMA Requirements (cont.)

- Where "*Undesirable Results*" means one or more of the following effects caused by groundwater conditions occurring throughout the basin [*CWC §10721(x)*]:
  - (1) Chronic lowering of groundwater levels
  - (2) Significant and unreasonable reduction of groundwater storage
  - (3) Significant and unreasonable seawater intrusion
  - (4) Significant and unreasonable degraded water quality
  - (5) Significant and unreasonable land subsidence
  - (6) Depletions of interconnected surface water



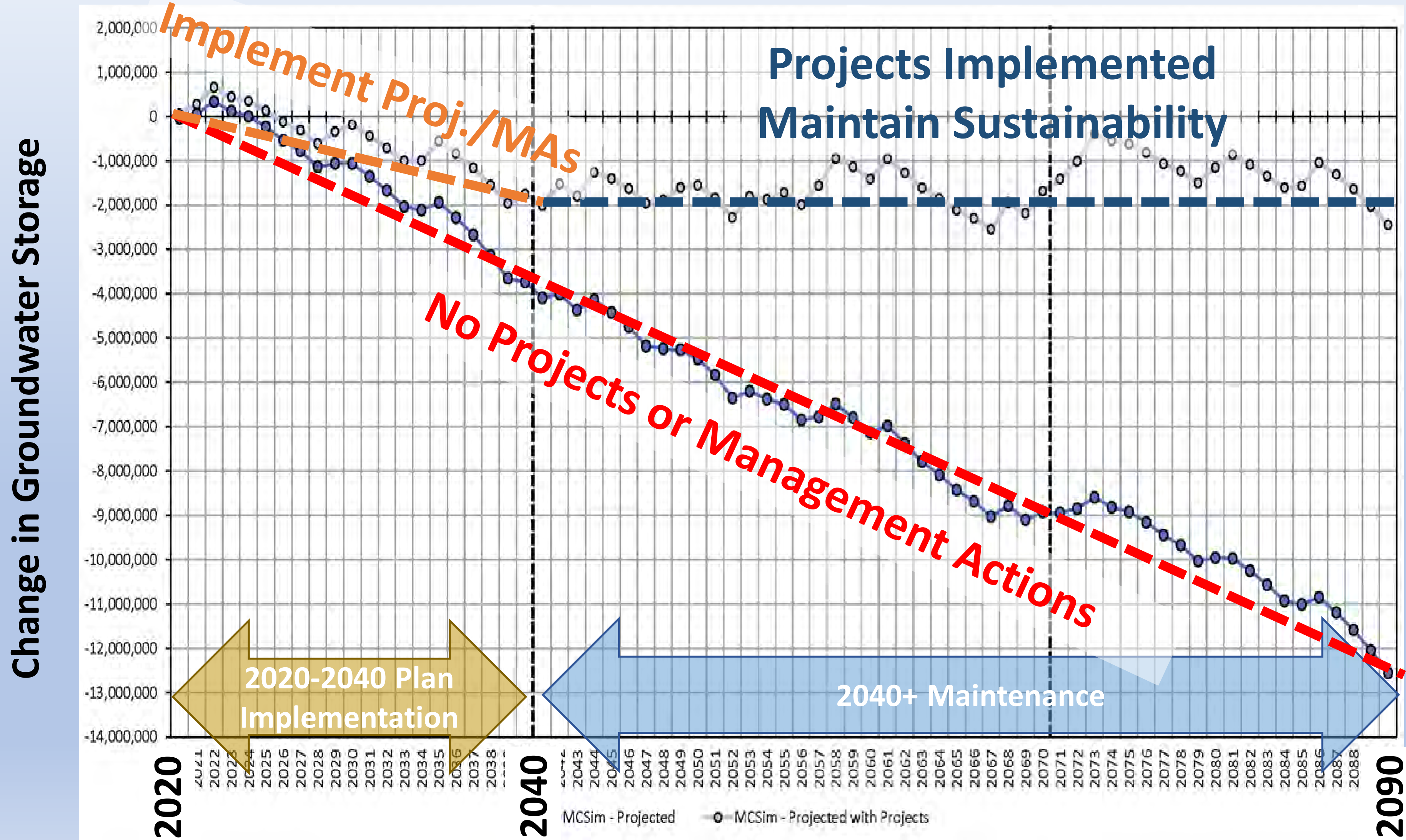
Minimum Thresholds (MT) and Measurable Objectives (MO)

1) MT/MO are numeric values and specific quantifiable goals
2) MT used to define undesirable results
3) MO reflect basin's desired groundwater conditions
4) Projects and Management Actions designed to meet MO
5) MT/MO set to allow reasonable margin of flexibility to accommodate drought, climate change, conjunctive use ops, GW management
6) MT/MO need to be established for each relevant sustainability indicator
7) MT/MO reflect a certain monitoring location and aquifer, and can vary regionally

Minimum Thresholds: Required Components

1) Information and criteria relied upon
2) Relationship between MT for each sustainability indicator
3) How selected MT avoids causing undesirable results in adjacent basins
4) How MTs affect beneficial uses/users, land uses, property interests
5) How state, federal, and local standards relate to sustainability indicators
6) How each MT will be quantitatively measured

MO and MT - Demonstrating Path to Sustainability



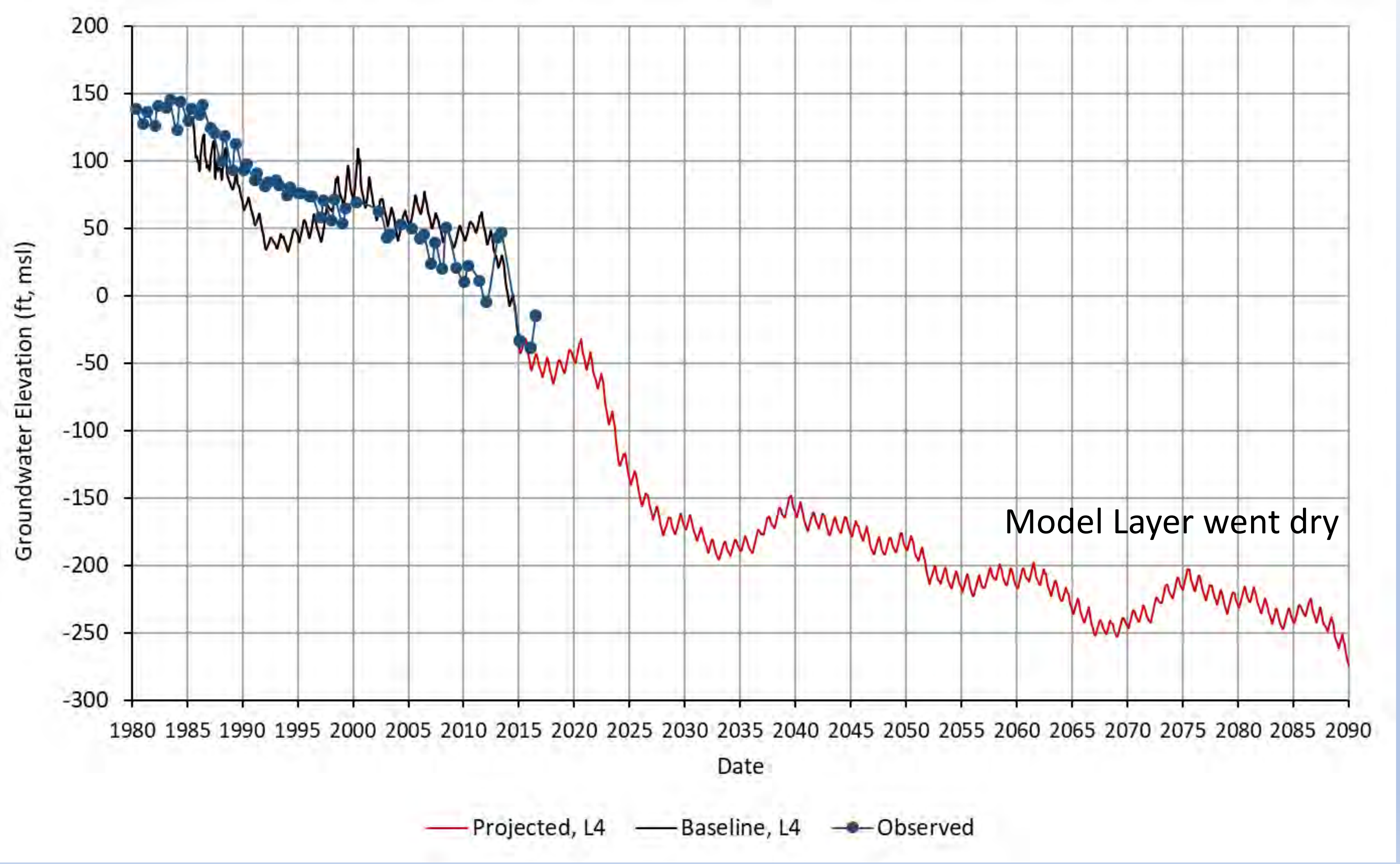
Example/Potential MT and MO – With and Without Projects by GSA

- Without Projects model runs assumes no increased inflow from surrounding subbasins in the future
  - When model layers go dry, pumping from that layer ceases and model shows water level flattening out
- With Projects model runs assume adjacent subbasins implement projects
  - Model domain GHB water levels cease declining and flatten out as adjacent basins implement projects (subsurface inflow/outflow can occur along model domain boundaries)

Example/Potential MT and MO – With and Without Projects

- Hydrograph slides for selected wells showing with and without projects (2020-2090)

Example Well 1 MT/MO –No Projects, No Inflow Increase



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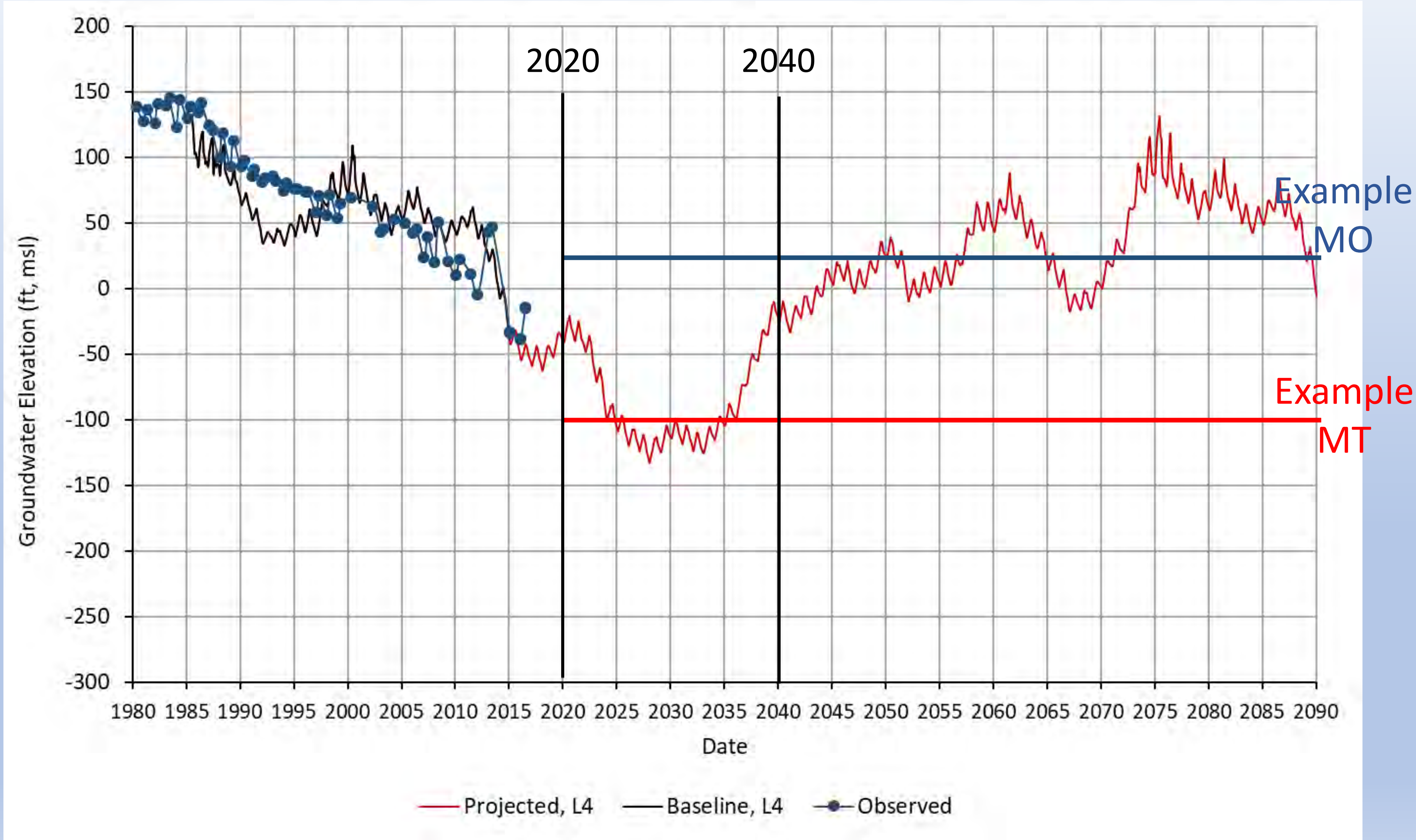
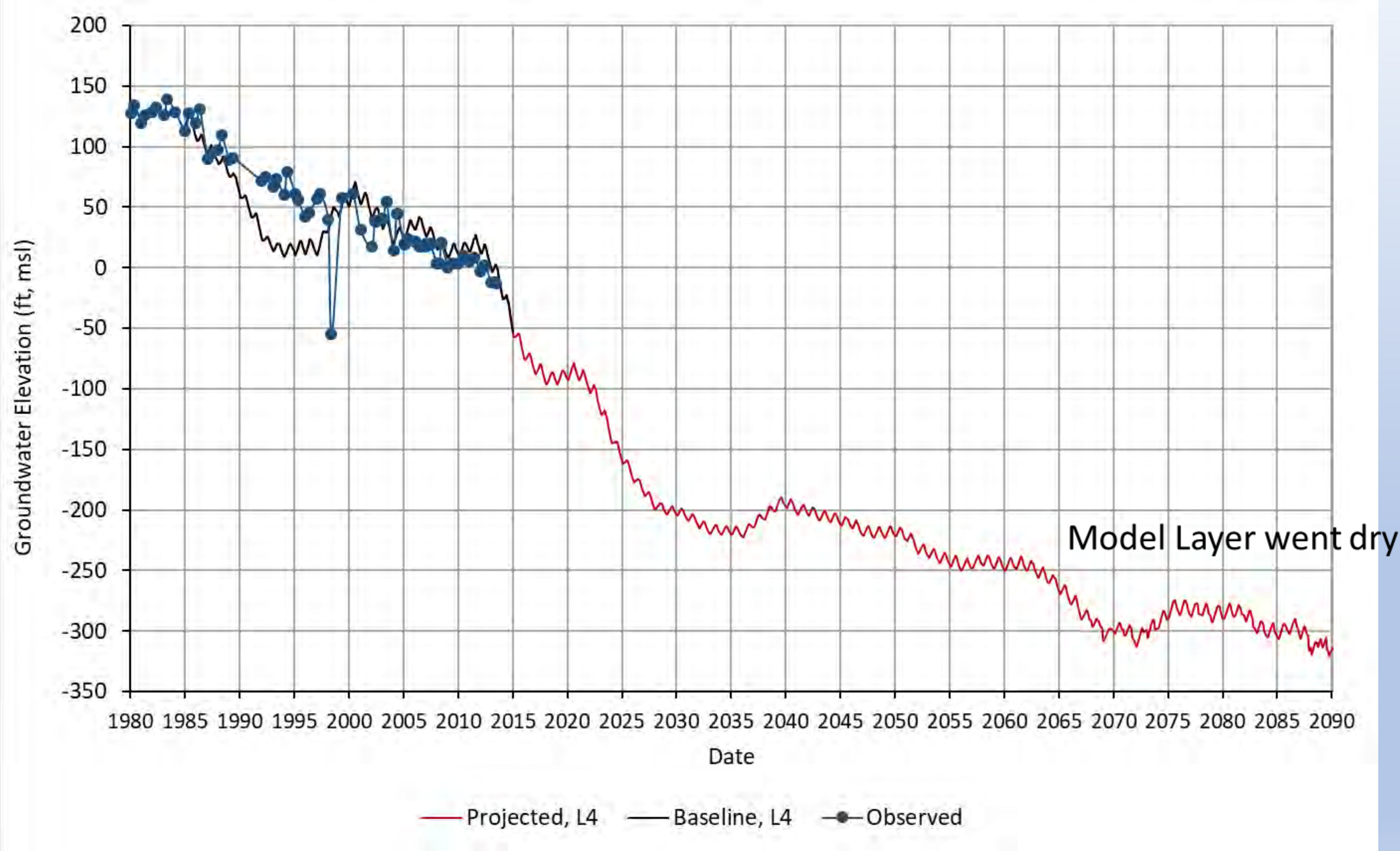
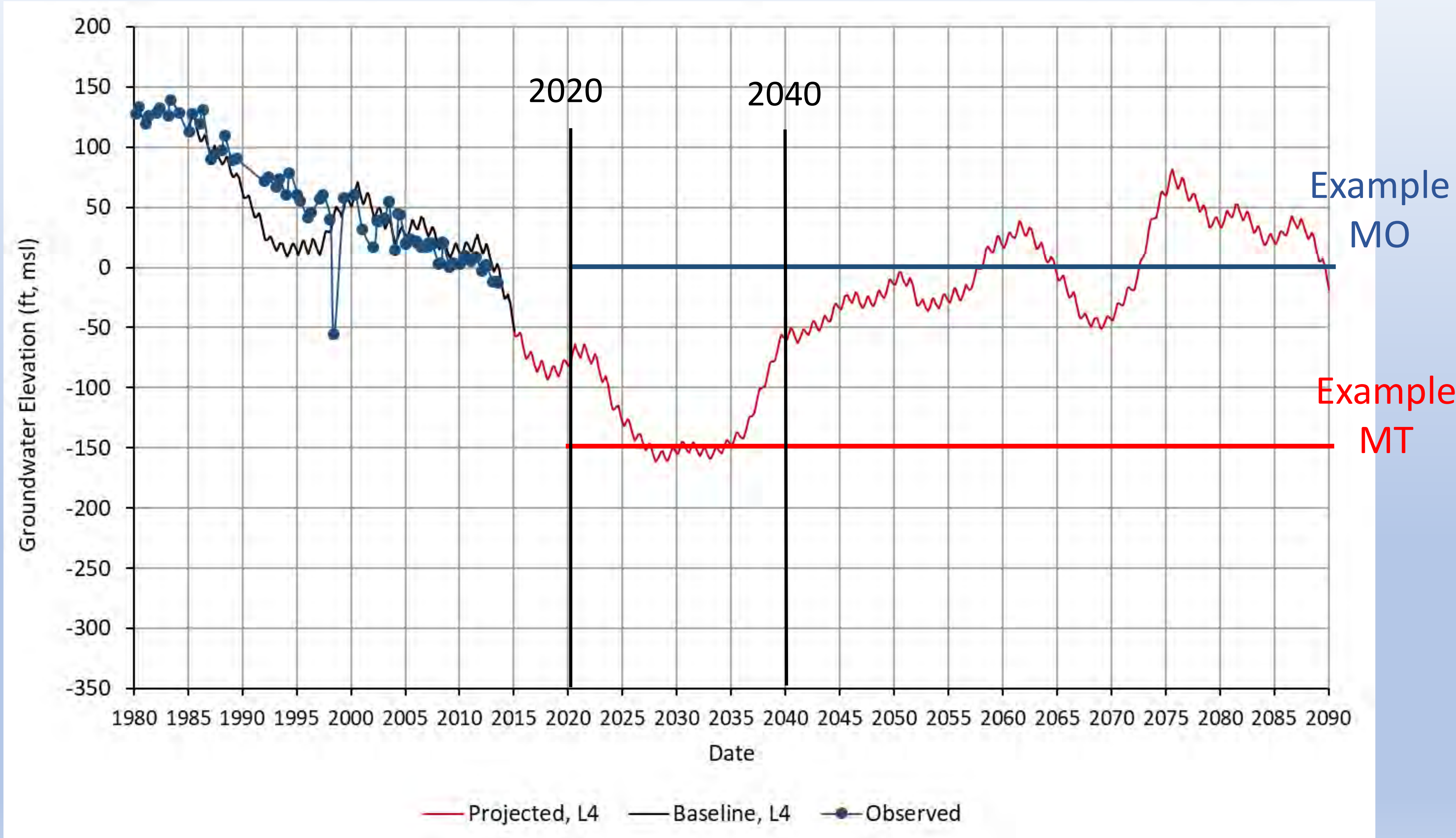
Example Well 1 MT/MO – with Projects



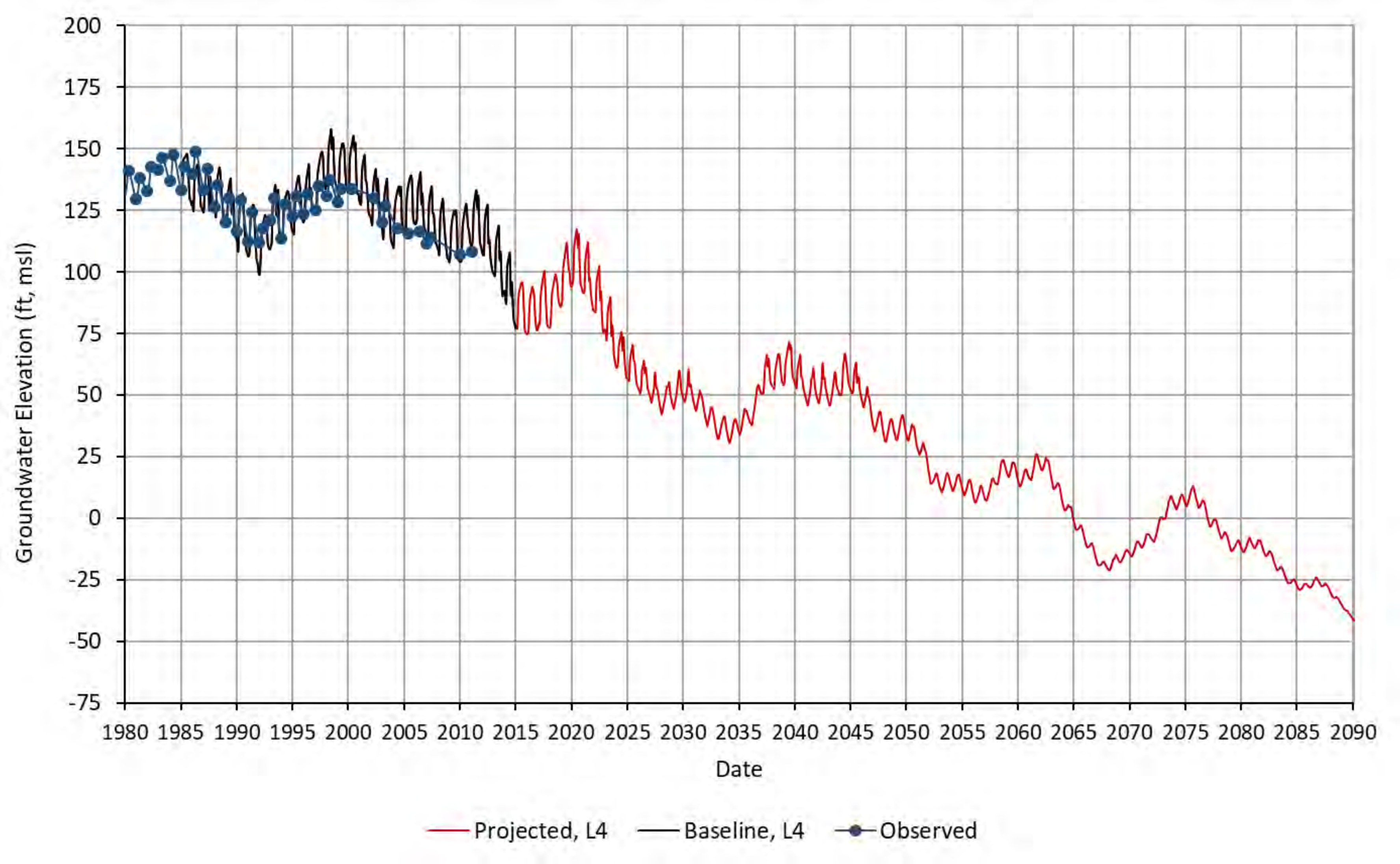
Example Well 2 MT/MO – no projects, no inflow increase



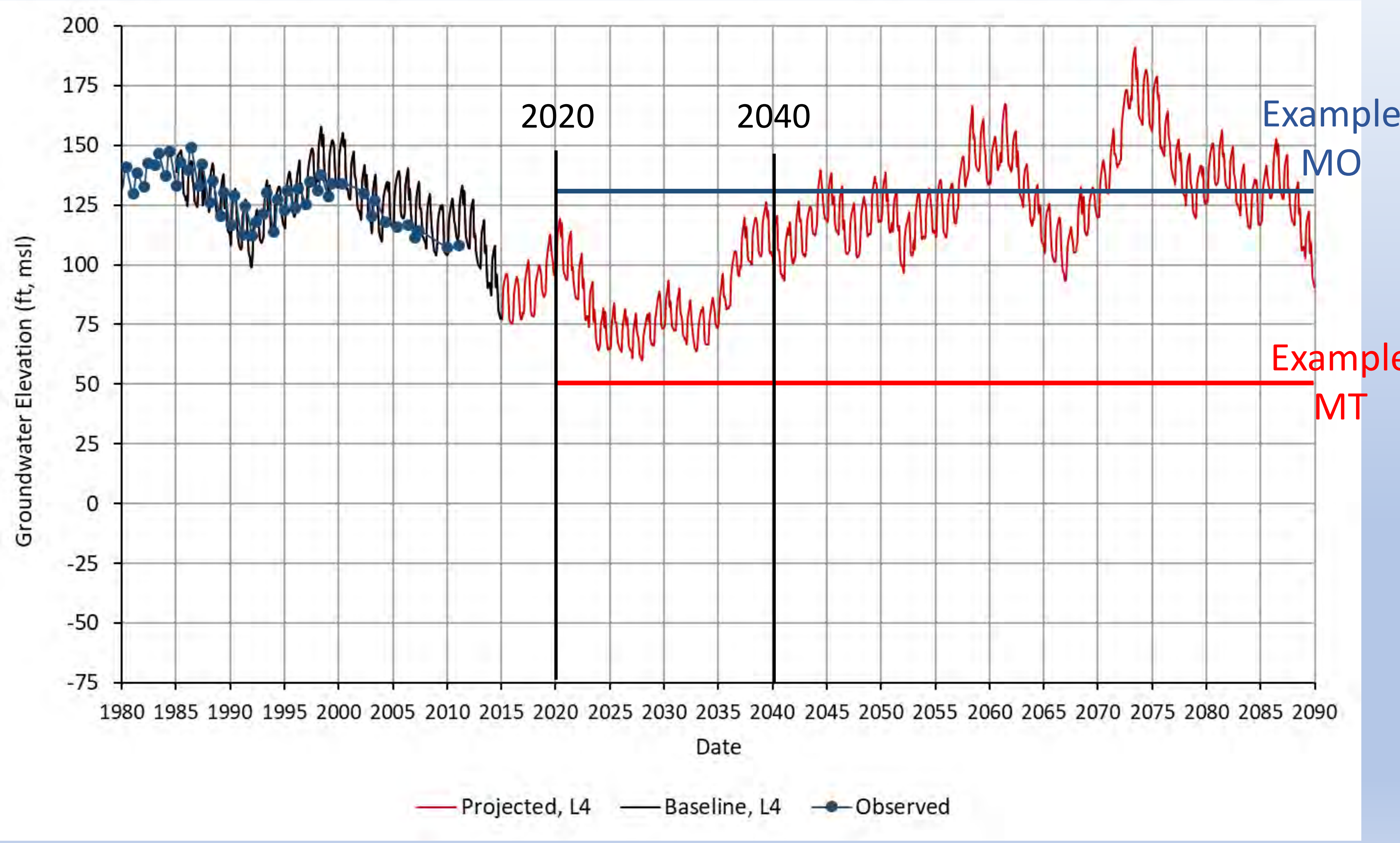
Example Well 2 MT/MO – with projects



Example Well 3 MT/MO – no projects, no inflow increase



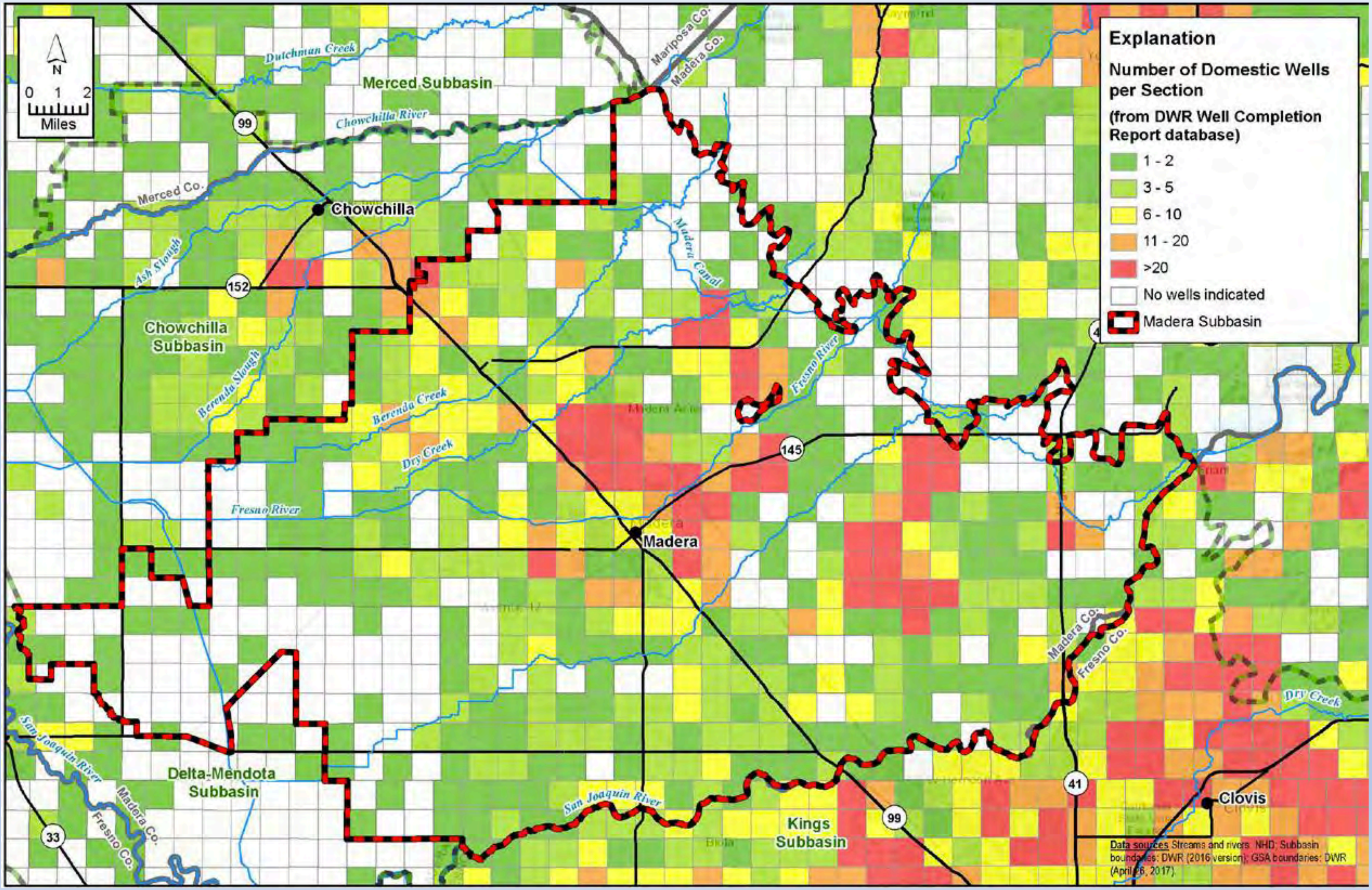
Example Well 3 MT/MO – with projects



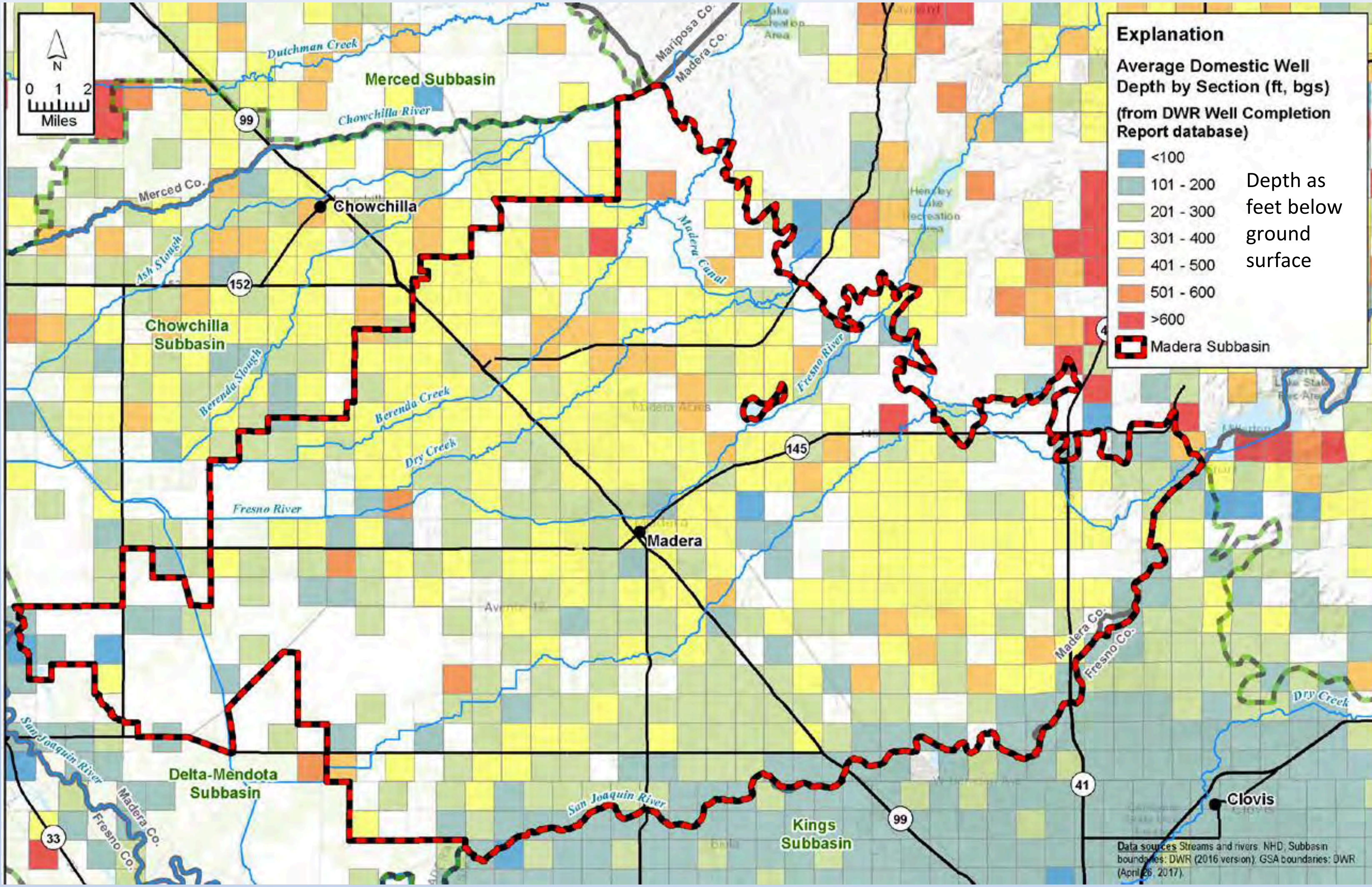
GW Levels: MT Considerations

1) Historical GW conditions
2) Model results
3) Well depths and screen intervals (domestic wells typically shallowest) – exposure of well screens
4) Pumping lift/costs
5) Aquifer Zone and Corcoran Clay – Different MTs?
6) Interbasin groundwater flow; adjacent basin MT
7) Land subsidence
8) Depletion of interconnected surface water/GDEs

GW Levels MT Considerations: Domestic Well Locations



GW Levels MT Considerations: Domestic Well Depths



Land Subsidence: MT Considerations

1) Aquifer material susceptible to subsidence
2) Historical/current/projected GW levels; especially historic lows
3) Historic rate/extent of subsidence
4) Land uses/property interests
5) Location of infrastructure/facilities susceptible to subsidence
6) Adjacent basin MT
7) Need to establish relationship between subsidence and GW levels
   - Upper vs Lower Aquifer
   - Critical head (historical low water level)
8) Elastic versus inelastic subsidence

MT and MO Questions

- Are these example MT levels too low?
- What undesirable results may occur if GW levels decline to the "with project" levels?
- How many wells need to exceed MT for what length of time to define undesirable result?
- Can these undesirable results be avoided?
- If there are no undesirable results at the GW levels estimated through the modeling of the projects on the modeled schedule:
  - Set MTs and MOs at these levels
  - Write GSP

MT and MO Next Steps

- Need to select specific wells to use as sustainability indicator wells
- Need to select proposed MTs and MOs at each sustainability indicator well
- Need to address each relevant sustainability indicator
- Need to decide if GW levels can serve as proxy for certain sustainability indicators
- Need to define undesirable results; how many MTs can be exceeded for how long before undesirable result is triggered

Next Steps

- Sustainability goal
- Propose criteria for minimum thresholds and measurable objectives for all sustainability indicators
- Select monitoring wells