COLUSA AND GLENN GROUNDWATER AUTHORITIES

Colusa Subbasin

Joint Technical Advisory Committee

GSP Development

Discussion Topics

- 4.a.—TAC Recommendation Timeline
- 4.b.—Sustainable Management Criteria
- 4.c.—Projects and Management Actions
- 5.—Topics for May 14 Joint TAC Meeting

4.a. TAC Recommendation Timeline

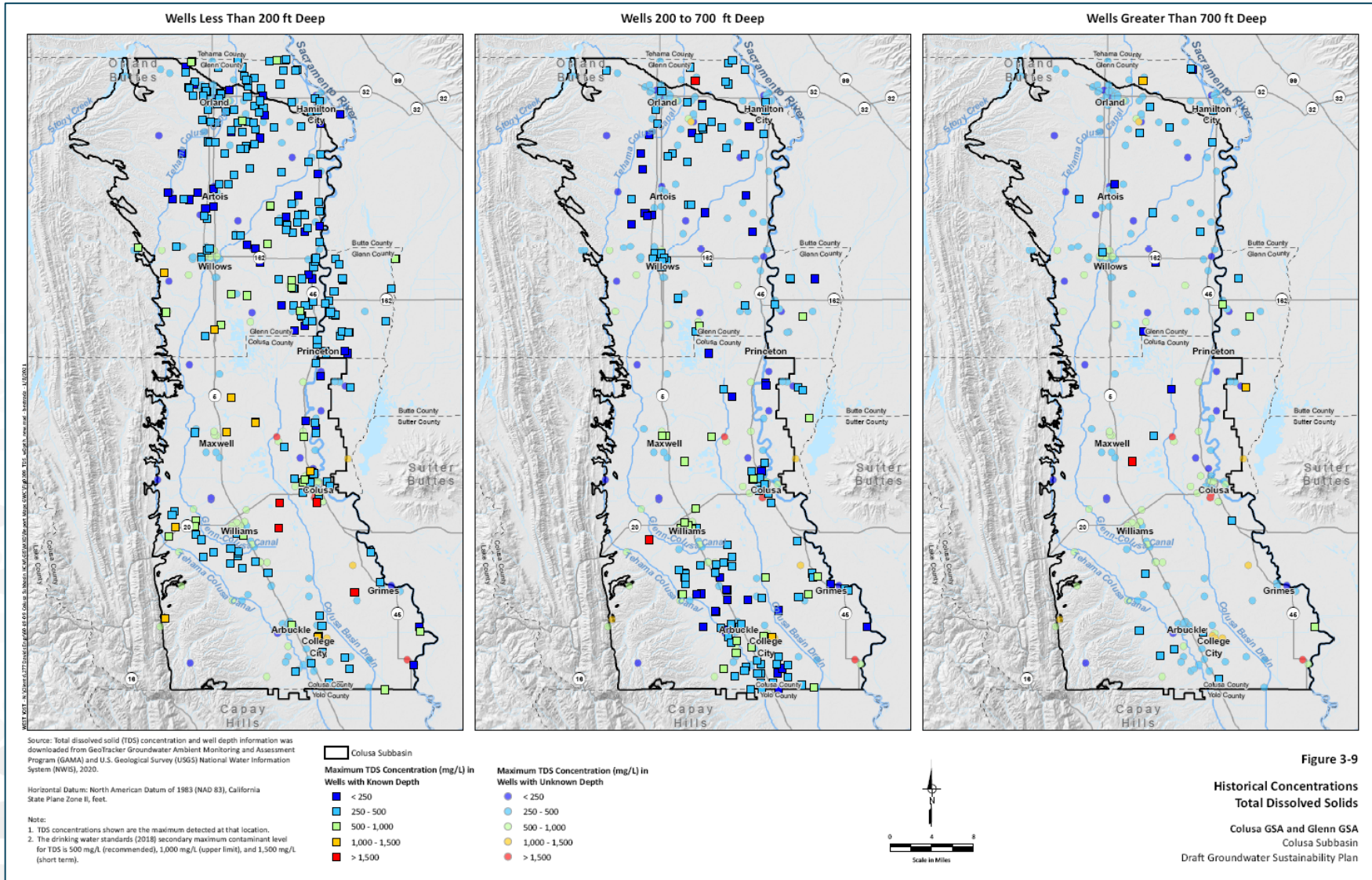
- Preparation of GSP Chapters 6 and 7 depend on TAC decisions
  - Chapter 6—Sustainable Management Criteria
  - Chapter 7—Projects and Management Actions
- Both chapters scheduled for draft review by July 16
- Joint TAC Meetings
  - April 9 (today)—TAC recommendations for Water Quality and Subsidence
  - May 14—TAC recommendations for Groundwater Levels, Groundwater storage, GDEs, and Streamflow Depletion
  - June 11—TAC recommendation for Projects and Management Actions to be included in the GSP
- Possible Need for Extra Meetings

4.b. Sustainable Management Criteria

4.b.i. Groundwater Quality

Saline Groundwater Quality Monitoring

- Total Dissolved Solids
- Inadequate historical data
- Establish a monitoring network for groundwater to monitor upwelling saline water



Groundwater Quality Monitoring Network

- Technical team recommendation:
  - –Establish groundwater quality monitoring network
    - Monitor for TDS
    - Monitor deep zone for upwelling saline waters
  - –Establish salinity thresholds for groundwater quality as part of 2027 GSP update

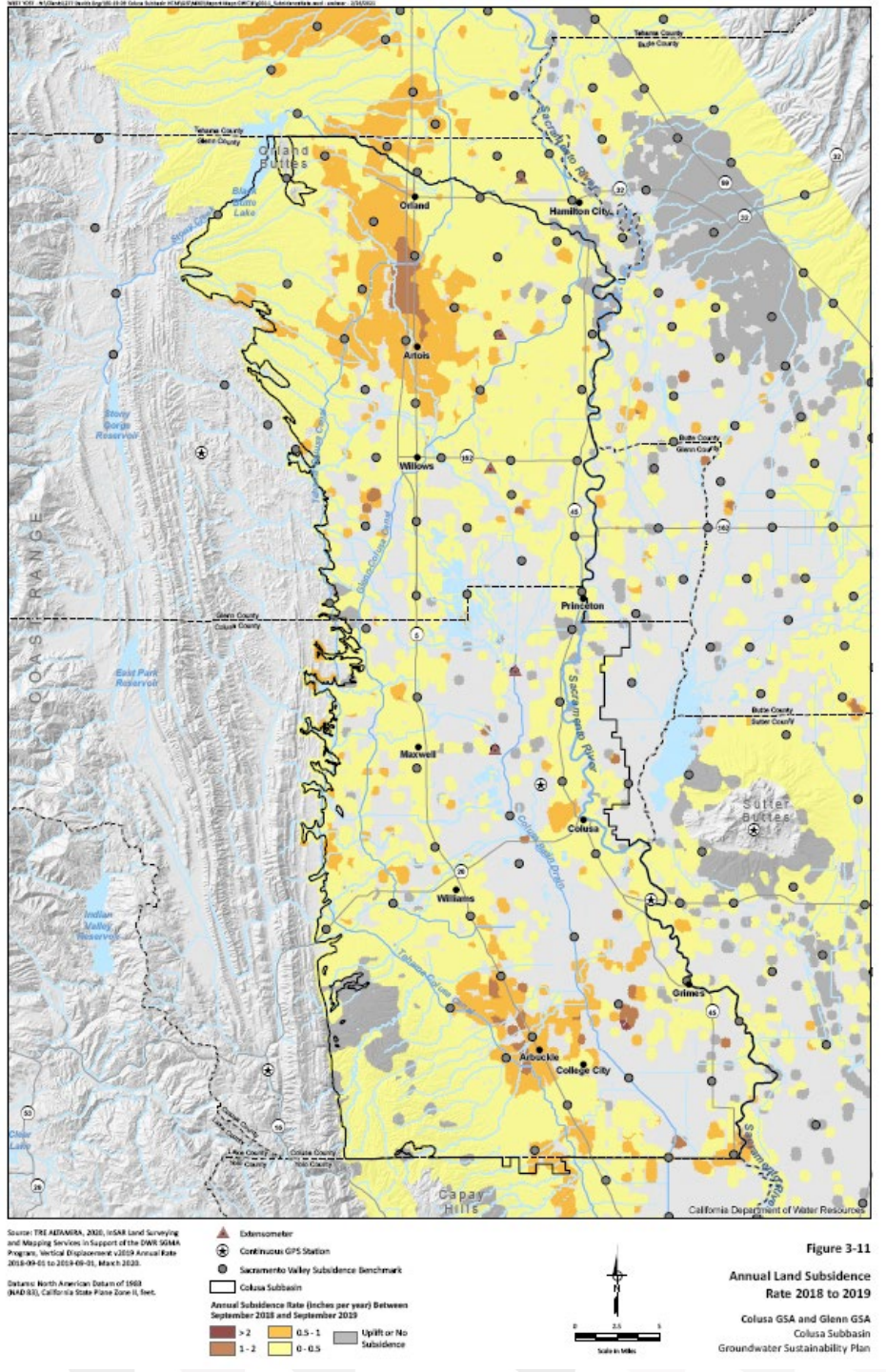
Proposed Action

The Joint TAC recommends that the GSA Boards adopt a GSP policy to conduct monitoring of saline groundwater to support establishing salinity thresholds for groundwater quality as part of the 2027 GSP update.

4.b.ii. Land Subsidence

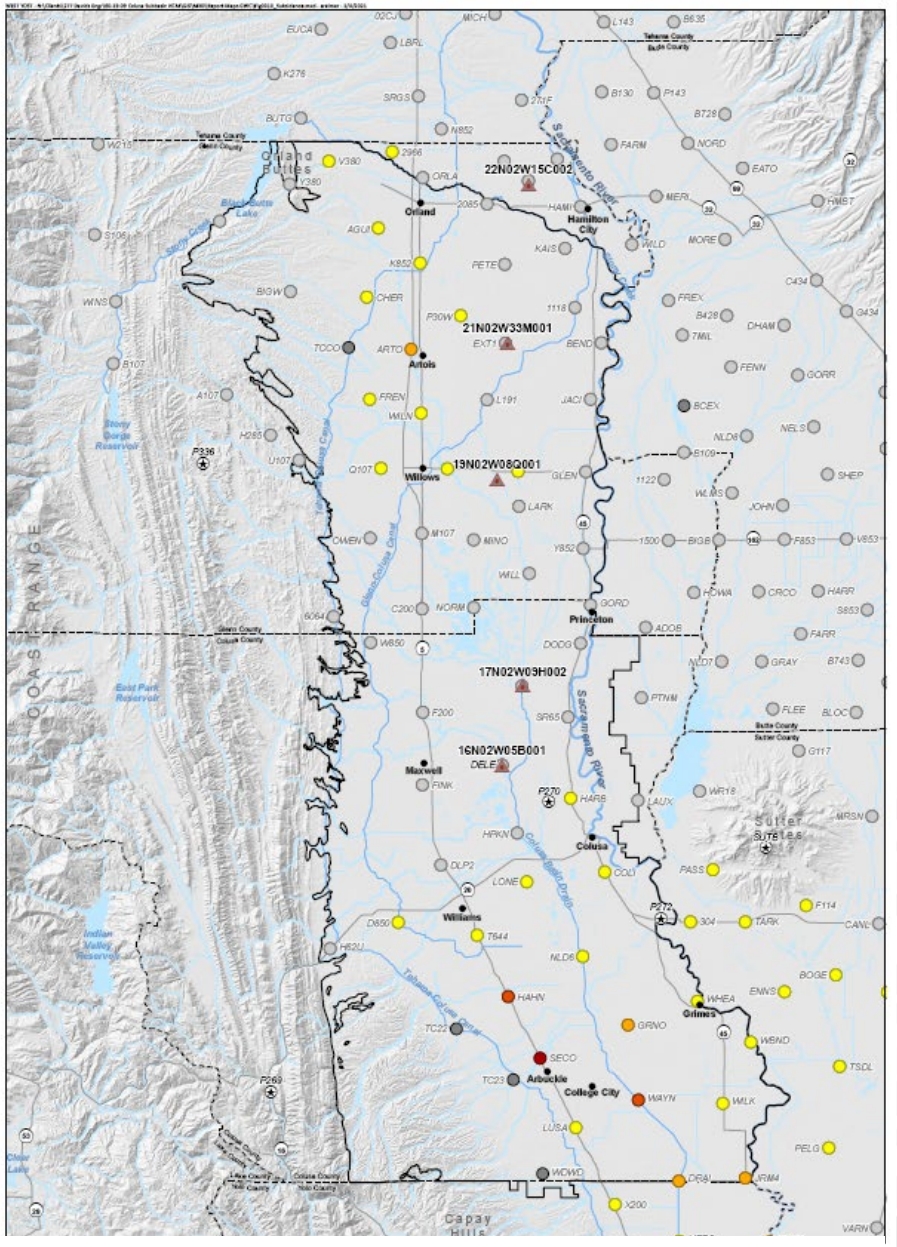
Land Subsidence Approach

- Use Sacramento Valley Height Modernization Project Benchmarks for representative monitoring network
- Continue extensometer monitoring to continue to improve basin understanding
- Thresholds established with consideration of historic subsidence using a maximum rate of subsidence over a five-year period for each station



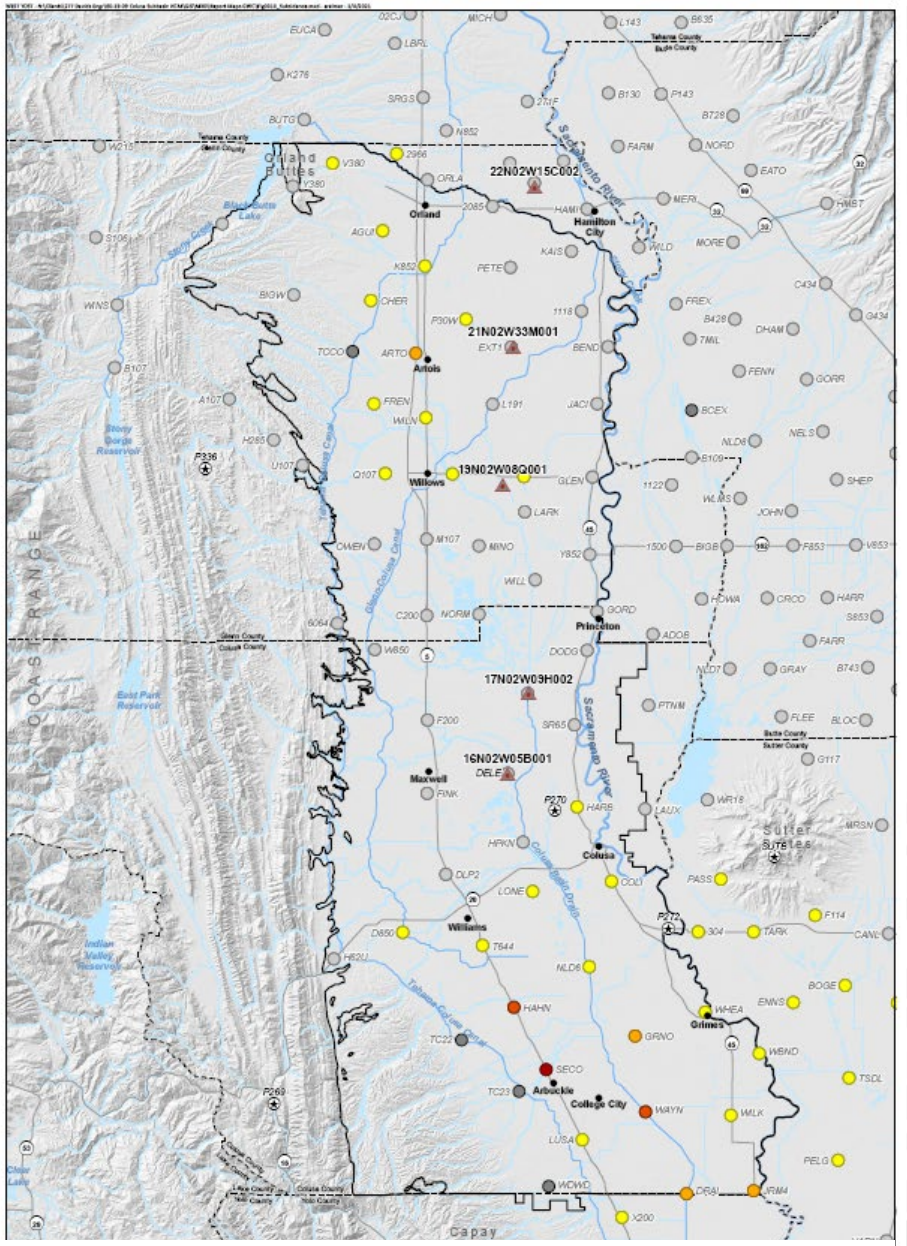
Land Subsidence MT and MO Recommendations

- Thresholds established with consideration of historic subsidence using a maximum rate of subsidence over a five-year period for three groups based on measurements from 2006 to 2017:
- Areas with greater than 1 foot of historical subsidence:
  - Set MT at 0.60 foot/year, set MO at 0.25 feet/year
- Areas with less than 1 foot historical subsidence:
  - Set MT at 0.50 feet/year, set MO at 0.25 feet/year
- Consider adding subsidence monitoring benchmarks



Land Subsidence Undesirable Result Recommendation

- Undesirable Result is detected when:
  - 10% or more (6 or more of 60 representative monitoring sites) experience subsidence rates above the minimum threshold



Proposed Action

The Joint TAC recommends that the GSA Boards adopt the Land Subsidence MTs and MOs presented on Slide 11 and the Land Subsidence Undesirable Results criteria presented on Slide 12

GSA Board Recommendations for TAC Adoption at Next Meeting (5/14/21):

- Groundwater Levels
- Groundwater Storage
- Groundwater Dependent Ecosystems
- Surface Water Depletions

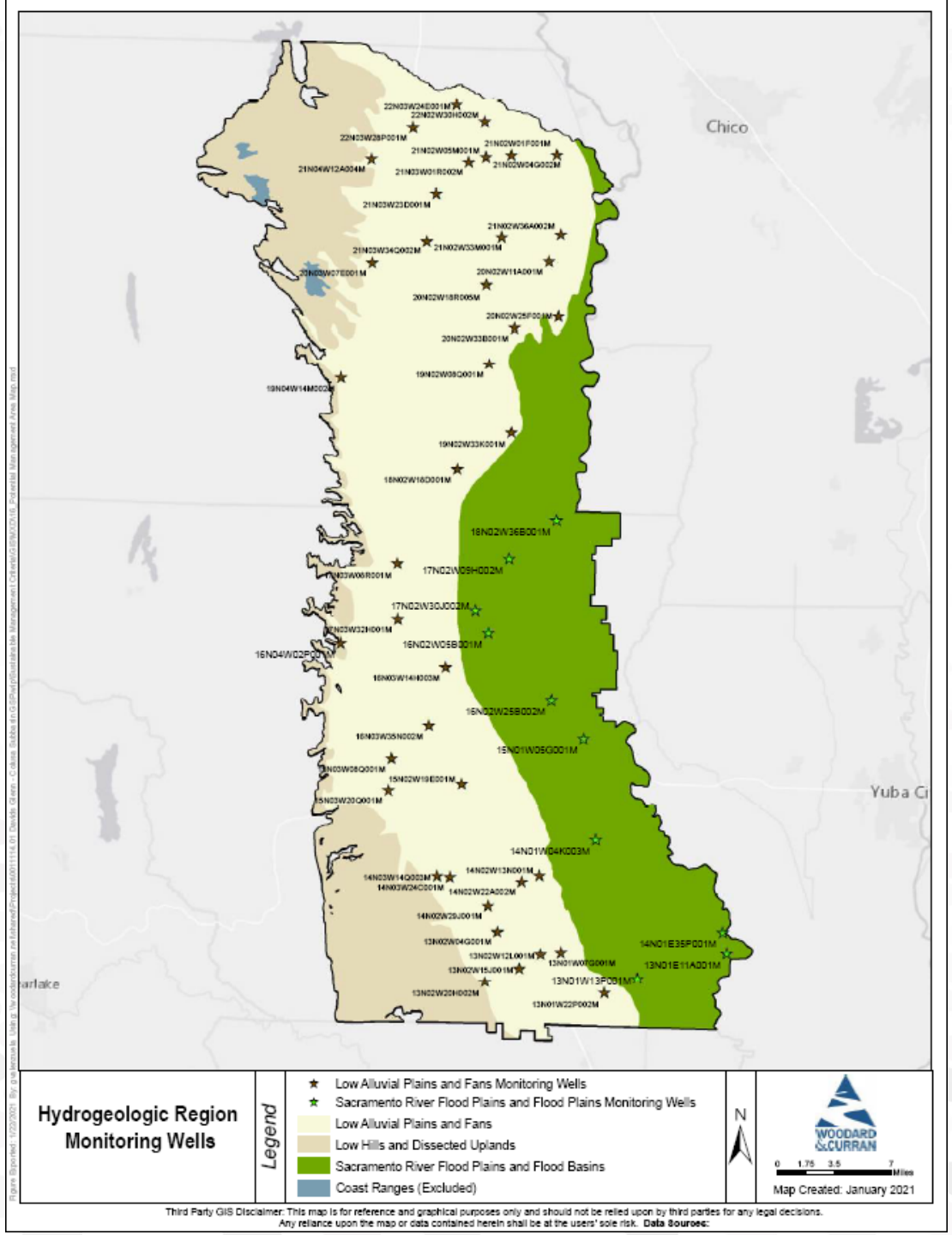
Minimum Thresholds and Multiple Sustainability Indicators

- GSP must manage to avoid undesirable results for all applicable sustainability indicators and beneficial uses
- Need to simultaneously consider minimum thresholds across multiple sustainability indicators because they can be different for:
  - Groundwater Levels
  - Groundwater Dependent Ecosystems
  - Depletions of Interconnected Surface Water
- GSP by necessity will need to manage to keep conditions above the shallowest of the minimum thresholds at each monitoring well

4.b.iii. Groundwater Levels

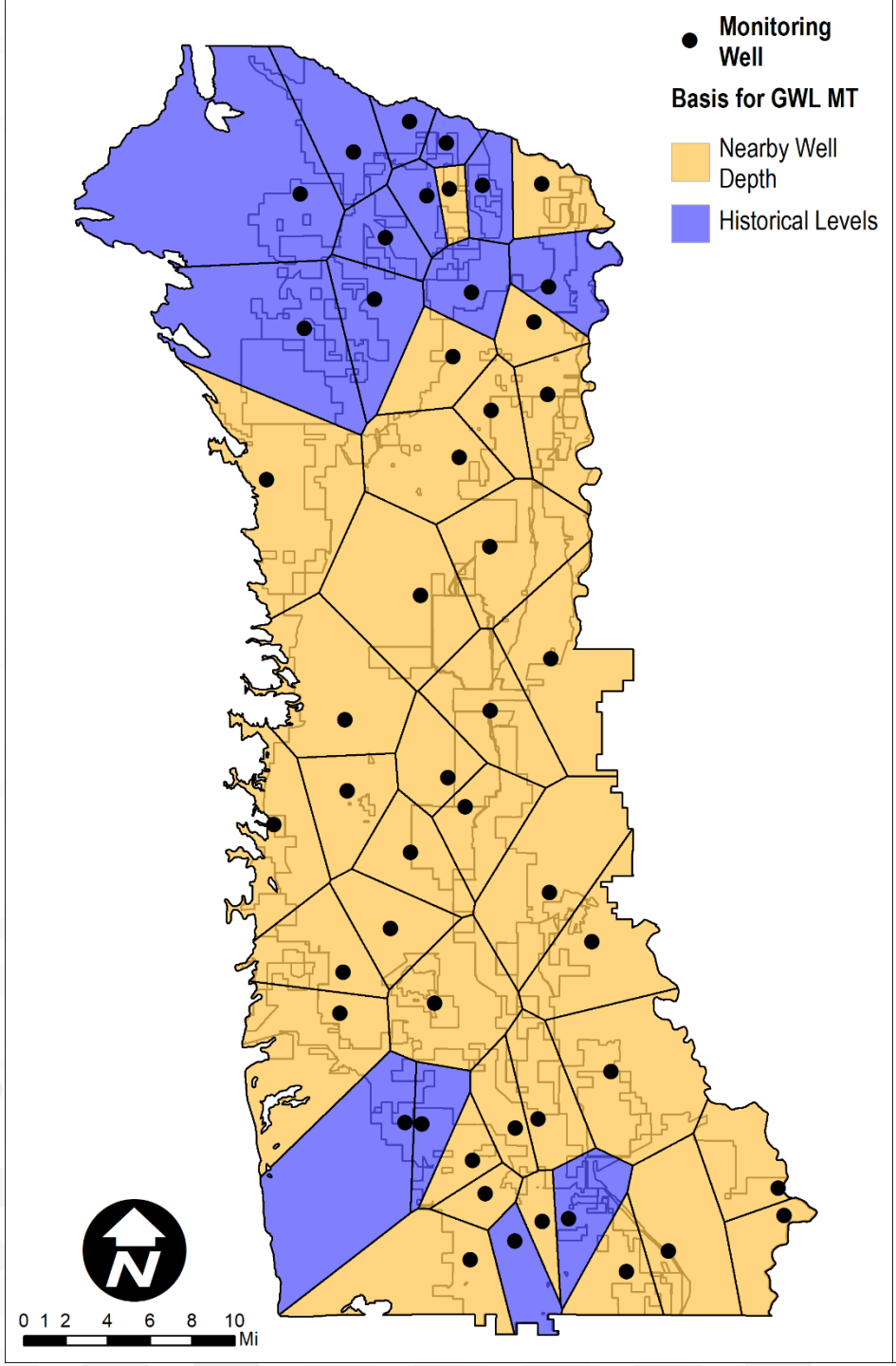
Chronic Lowering of Groundwater Levels

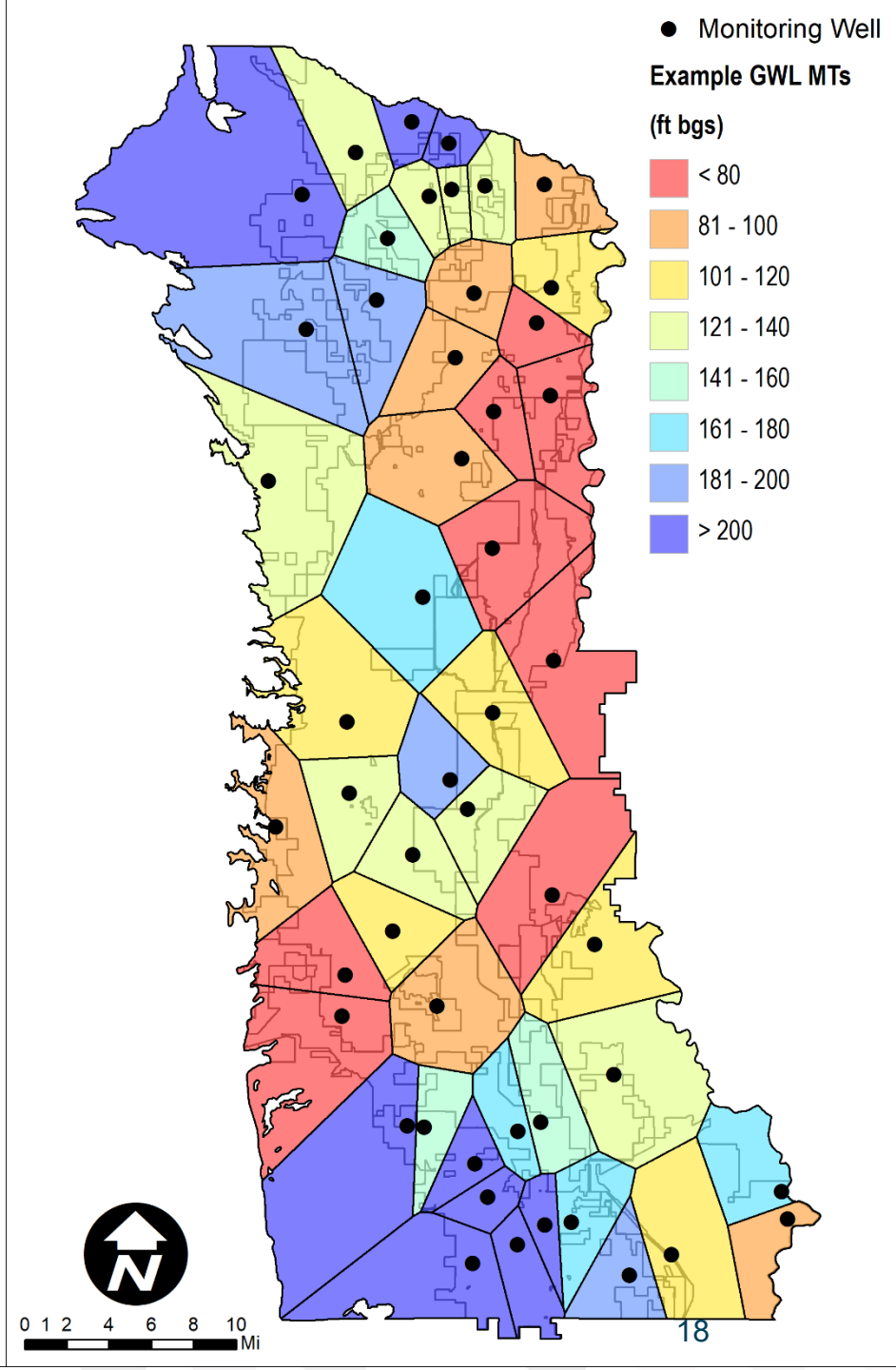
- MT = Lower of:
  - 20% of range below historical low, and
  - The 20th percentile of shallowest domestic wells in the monitoring well's Thiessen polygon
- MO = Mean of last 5 years available measurements
- IMs = TBD based on PMAs



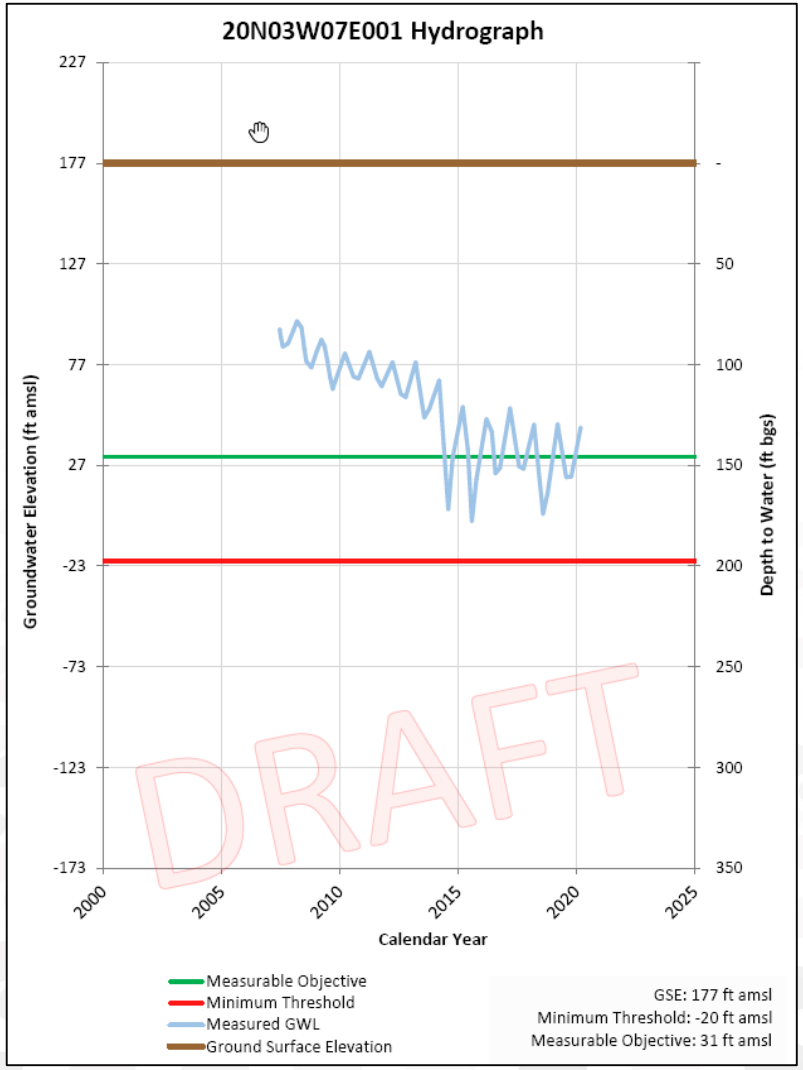
Proposed Approach

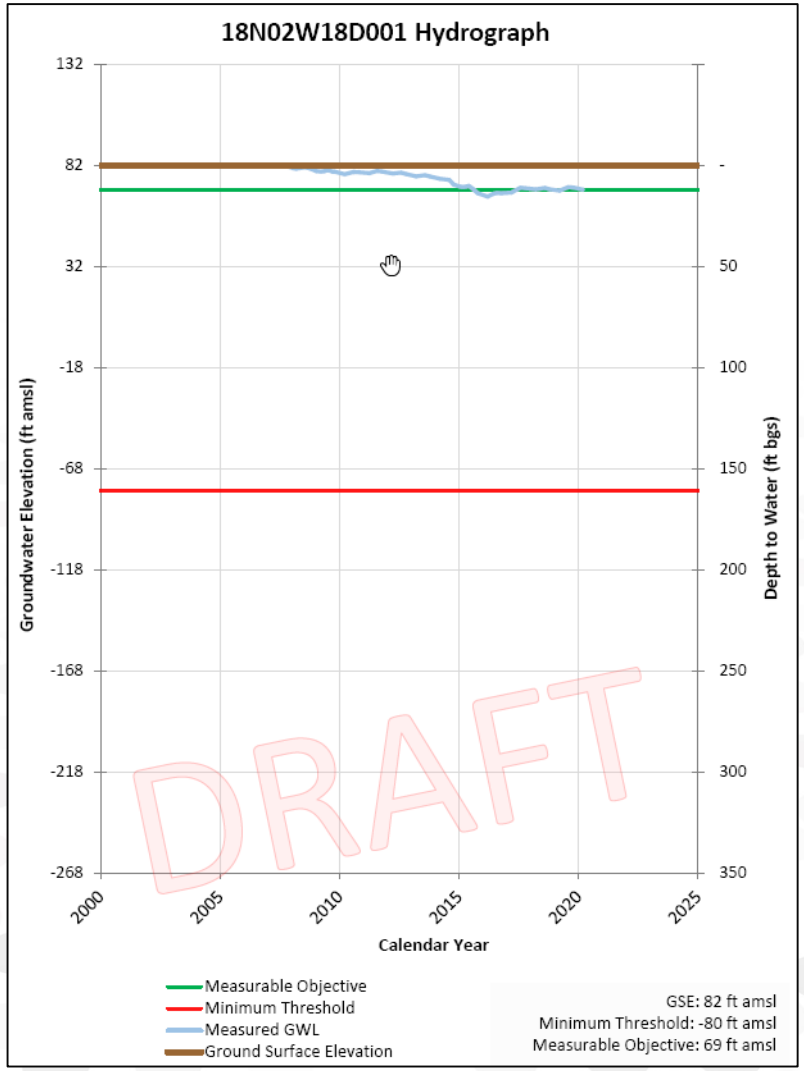
- Set MTs based on lower of historical low plus percent range and percentile depth of nearby wells
- Well depths used to set MTs in most areas
- Historical water levels used to set MTs in areas of greatest drawdown

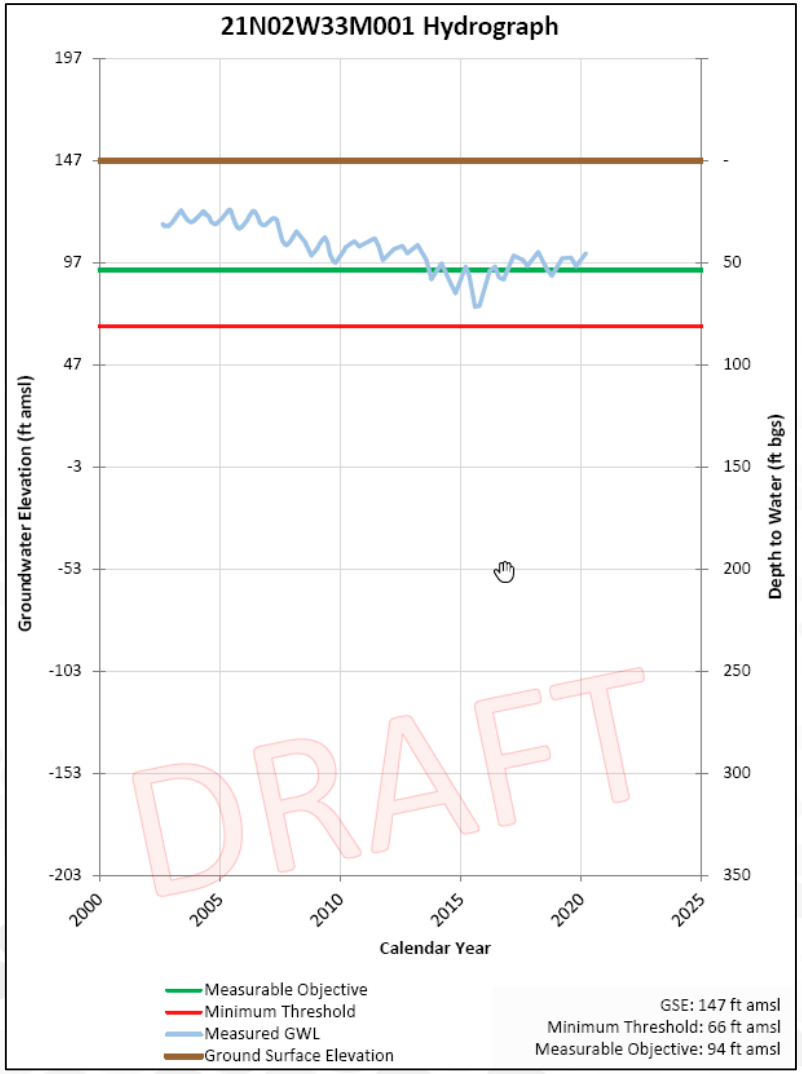




Groundwater Levels: Minimum Threshold, Measurable Objective

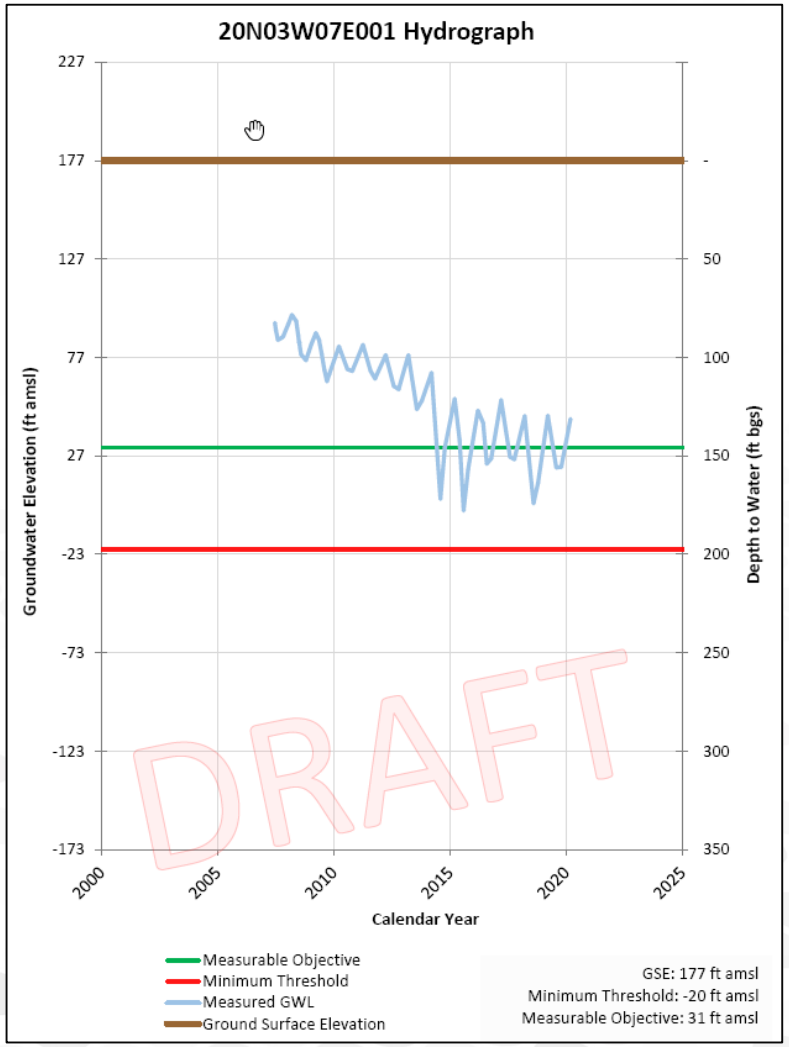






Summary: Groundwater Levels – Minimum Threshold, Measurable Objective

- MT = Lower of:
  - 20% of range below historical low, and
  - The 20th percentile of shallowest domestic wells in the monitoring well's Theissen polygon
- MO = Mean of last 5 years available measurements
- Undesirable Result is detected when:
  - 25% (13 of 50 representative monitoring wells) fall below the minimum threshold for 24 consecutive months

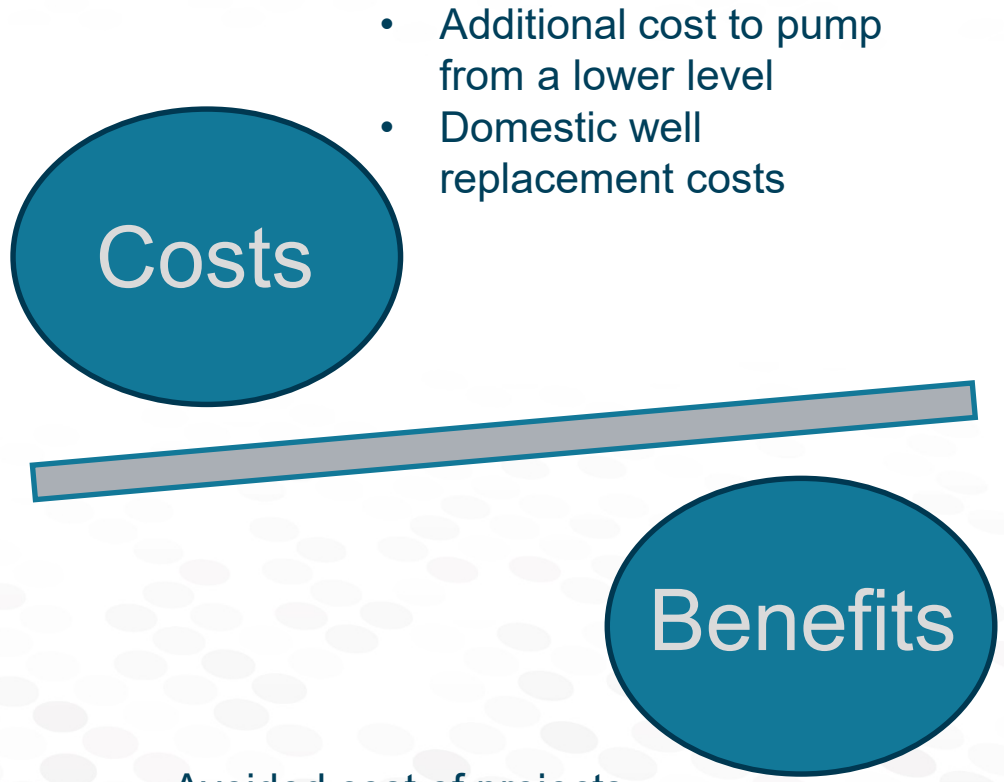


Economic Analysis to Support Setting Groundwater Level MTs/MOs

- The proposed criteria for setting MT is the lesser of 20% below the historical low or 20th percentile of nearby domestic well depths
  1. What are the economic implications of setting higher/lower MT?
  2. Is there an economic rationale for setting MT higher than the proposed criteria?

Economic Analysis Overview

- Quantify, costs, benefits, and tradeoffs of setting MT at different levels
- Reconnaissance-level assessment:
  - Applicable only to regions with MT set based on levels
  - Example analysis only considers monetizable benefits and costs



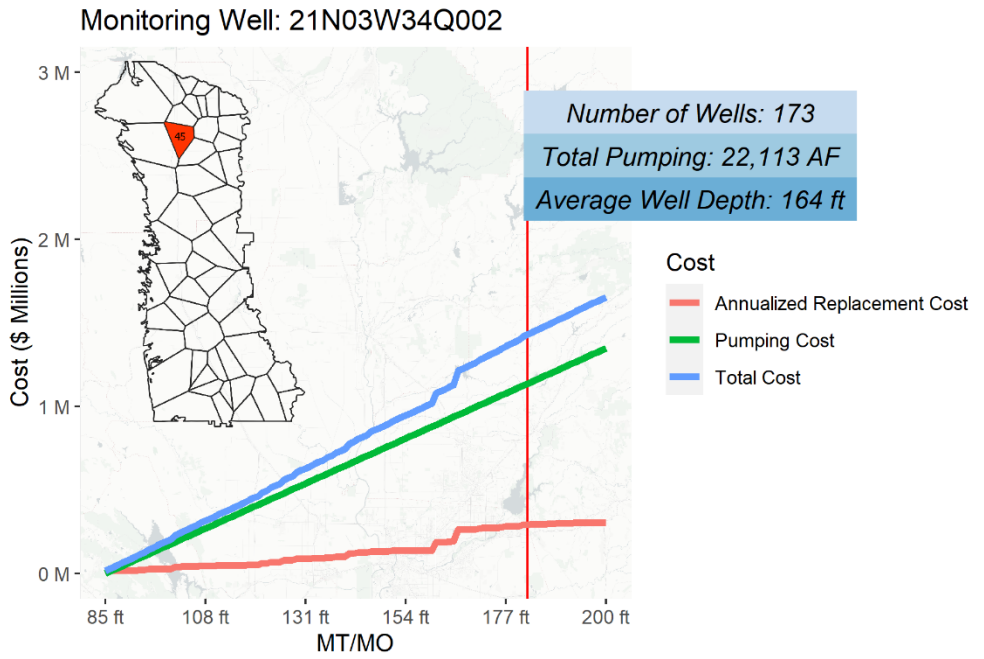
- Additional cost to pump from a lower level
- Domestic well replacement costs

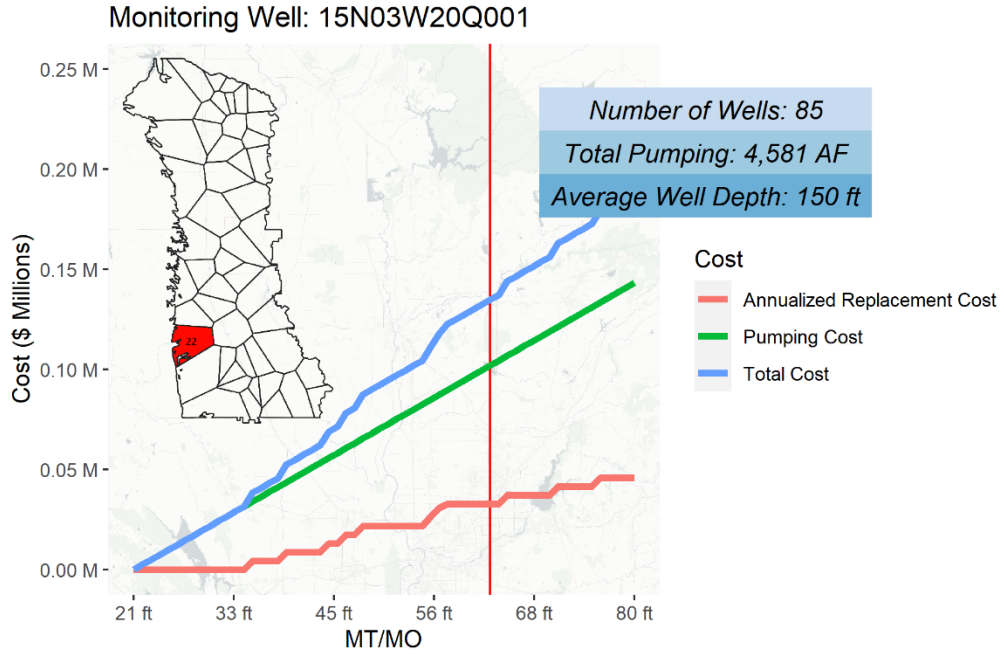
- Avoided cost of projects and management actions

Example Costs

- All costs are annual over a range of possible MT
  - Well replacement
  - Pumping cost

- Annual cost at the proposed MT are generally under $1M per year
- Vary due to:
  - Number of domestic wells
  - Current pumping depth
  - Average annual pumping

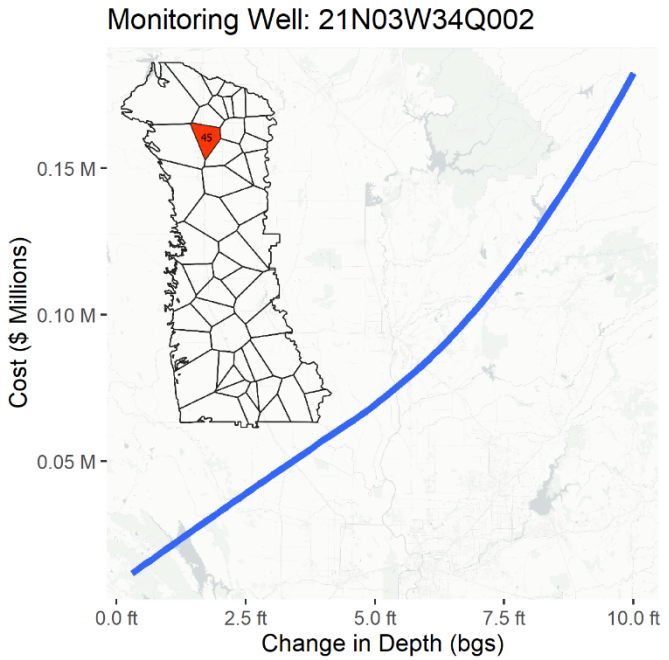




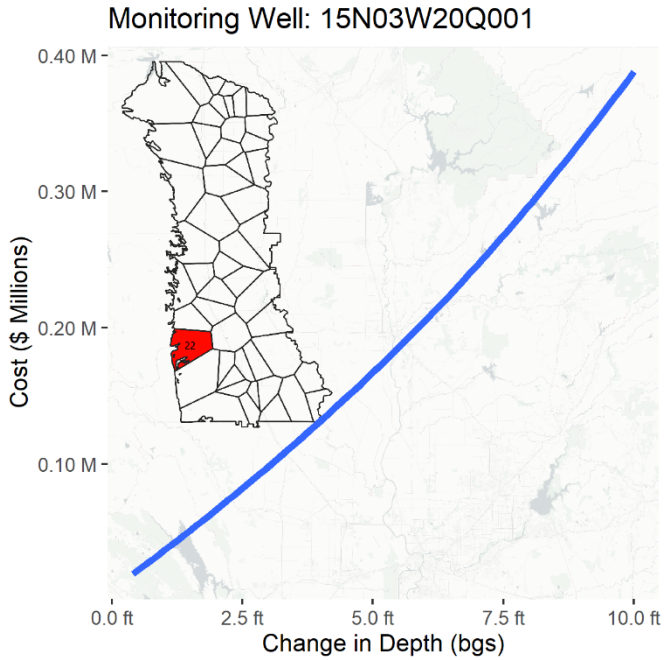
Example Benefits

- Evaluate the avoided-cost of projects/management actions required to keep levels higher
  - This example uses demand management as a proxy cost
  - In practice, projects would be considered

- Annual cost at the proposed MT are generally under $0.75M per year
- Vary due to:
  - Pumping
  - Current crop mix



	Crop	Acres
1	Almonds	247
2	Walnut	842
3	Wheat	270
4	Alfalfa	147
5	Tomatoes	75
6	Sunflower	3,127
7	Olives	396
8	Melons	1,175
9	Other Truck	782

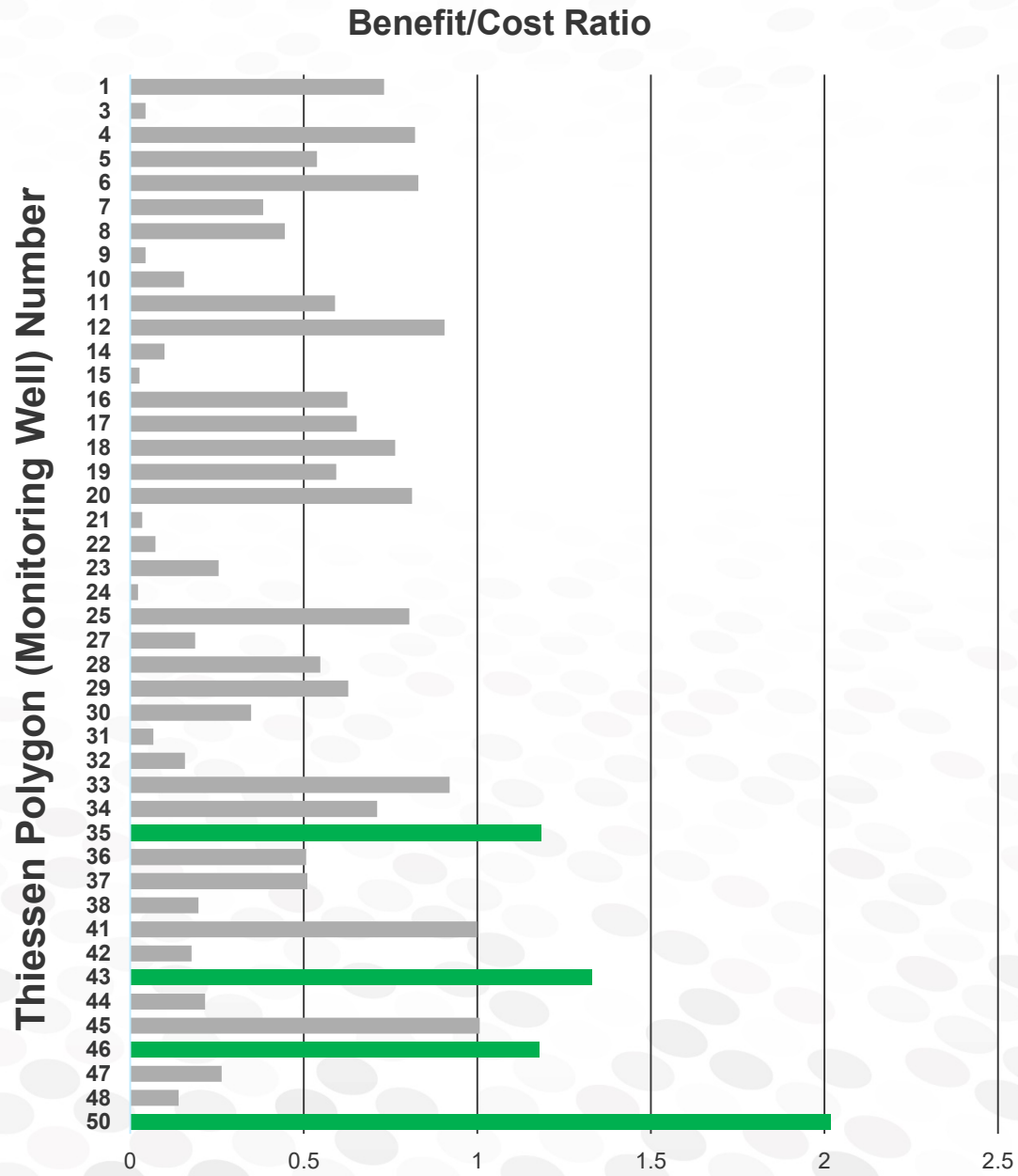


	Crop	Acres
1	Almonds	801
2	Walnut	90
3	Wheat	105
4	Young Perennials	591
5	Alfalfa	57
6	Tomatoes	517
7	Misc. Grain	296
8	Corn	96
9	Sunflower	7,535
10	Olives	61
11	Melons	457
12	Other Truck	12

Benefit Cost Analysis

- Is there an economic rationale for setting MT incrementally higher than the proposed criteria?

- **Summary conclusion**:
  - Example economic analysis shows that the cost of setting higher MT is generally greater than the expected benefits
  - Exceptions are in areas near the river that will set MT based on alternative criteria



4.b.iv. Groundwater Storage

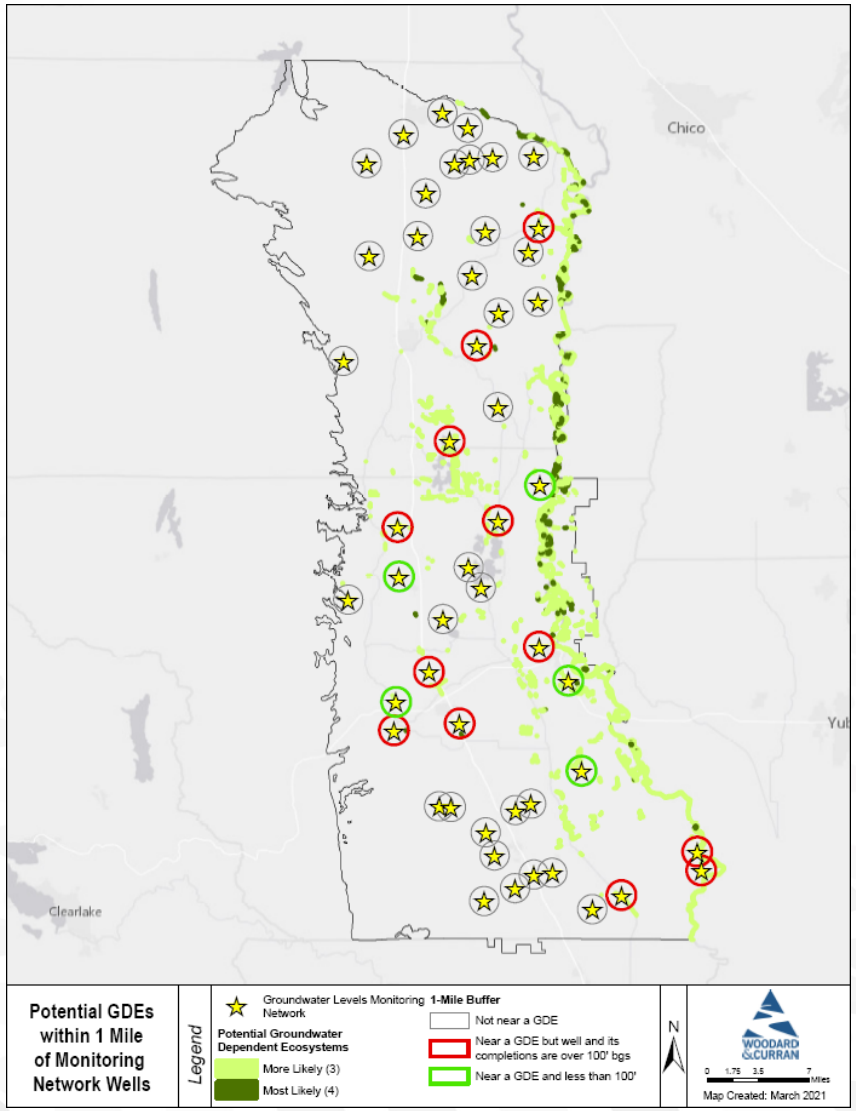
Reduction of Groundwater Storage

- Levels are an appropriate proxy because the limiting factor in accessing storage in the Colusa Subbasin is well infrastructure, not water available in storage.
- Recommendation: Monitor and manage using groundwater level MTs and MOs as a proxy.

4.b.v. Groundwater Dependent Ecosystems (GDEs)

Groundwater Dependent Ecosystems (GDEs)

- Select Representative Network:
  - Shallow monitoring wells (shallower than 100 feet bgs) within one mile of “More Likely (3) and “Most Likely (4)” GDE locations
- Only 5 of the 50 representative sites are both shallower than 100 feet bgs, and within one mile of a GDE
- Minimum threshold consideration - 30 feet bgs (TNC 2018 pp 46, 72, and 75)[1]
- Recommendation: improve GDE classification reliability, expand shallow monitoring network near GDE locations, and establish minimum thresholds in 2027 GSP update.



1. Nature Conservancy. 2018. *Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act*. January.

4.b.vi. Depletions of Interconnected Surface Water

Depletions of Interconnected Surface Water

- Depletion of Interconnected Surface Water Undesirable Result Statement (from 11/13/20 Joint TAC Meeting)
  - The undesirable result for depletions of interconnected surface water is a result that causes significant and unreasonable adverse effects on Beneficial Uses and Users of interconnected surface water **within the Colusa Subbasin** over the planning and implementation horizon of this GSP. (Emphasis added)

Depletions of Interconnected Surface Water

- GSP regulations in places support limiting Undesirable Results analysis to within the Colusa Subbasin
- GSP regulations in places infer that Undesirable Results outside the Colusa Subbasin are included
- Environmental community strongly endorsing that GSPs explicitly protect streamflow depletion
- Other Sacramento Valley subbasins generally taking a position:
  - Acknowledging that the Sacramento River and groundwater are interconnected but the relationship is inadequately understood and influenced by external factors (factors outside the subbasin)
  - Supporting increased monitoring to better understand dynamics

What Does Modeling Reveal About Streamflow Depletion?

- Viewed together, averaged over a 50-year projection, average annual gains and losses from the Sacramento River and Stony Creek are:

Stream Gains and Losses	Future Conditions without Climate Change (TAF)	Future Condition with 2070 Climate Change (TAF)	Change (TAF)	Change (%)
Gains from GW	+349	+323	-26	-7.5
Losses to GW	+231	+253	+22	+9.5
Net Stream Gain	+118	+70	-48	-41

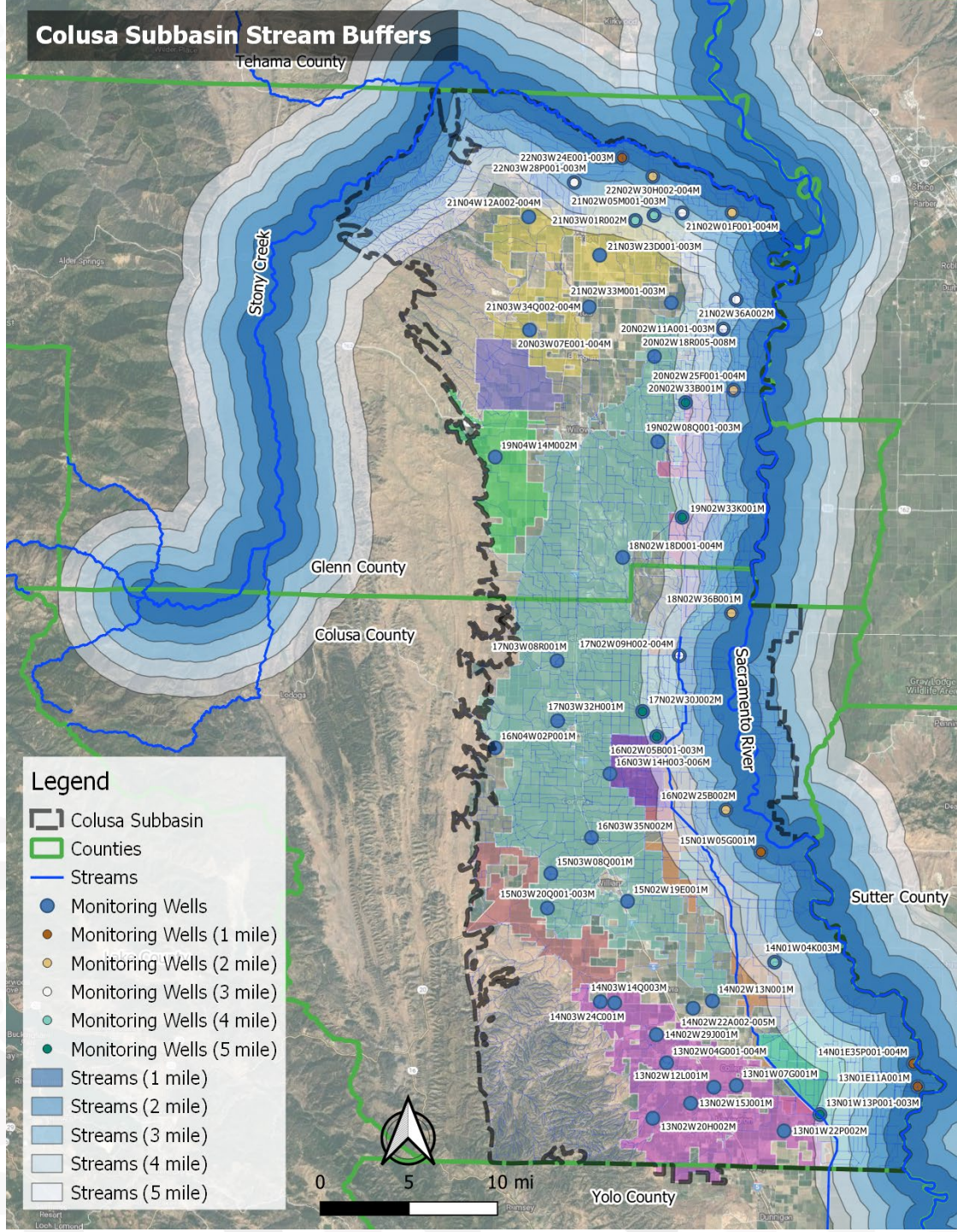
- Why? Primarily increased GW pumping to meet higher crop demands due to climate change
- Modeled values subject to high uncertainty

Depletions of Interconnected Surface Water: Possible Approach for Near-Stream Wells

- Approach Depletions of Interconnected Surface Water using groundwater levels as a proxy
  - Stream gages are not prevalent enough to use for monitoring at this time
  - Investigate adding stream gages and appropriate GW level monitoring
- Set MTs at historical low GW levels to avoid changes to SW gain/loss relative to recent historical (2015) conditions
- Focus on key water bodies:
  - Sacramento River
  - Stony Creek
  - Colusa Basin Drain

Near-Stream Wells

Stream buffer (miles)	Number of monitoring wells within buffer
1	4
2	9
3	14
4	17
5	22

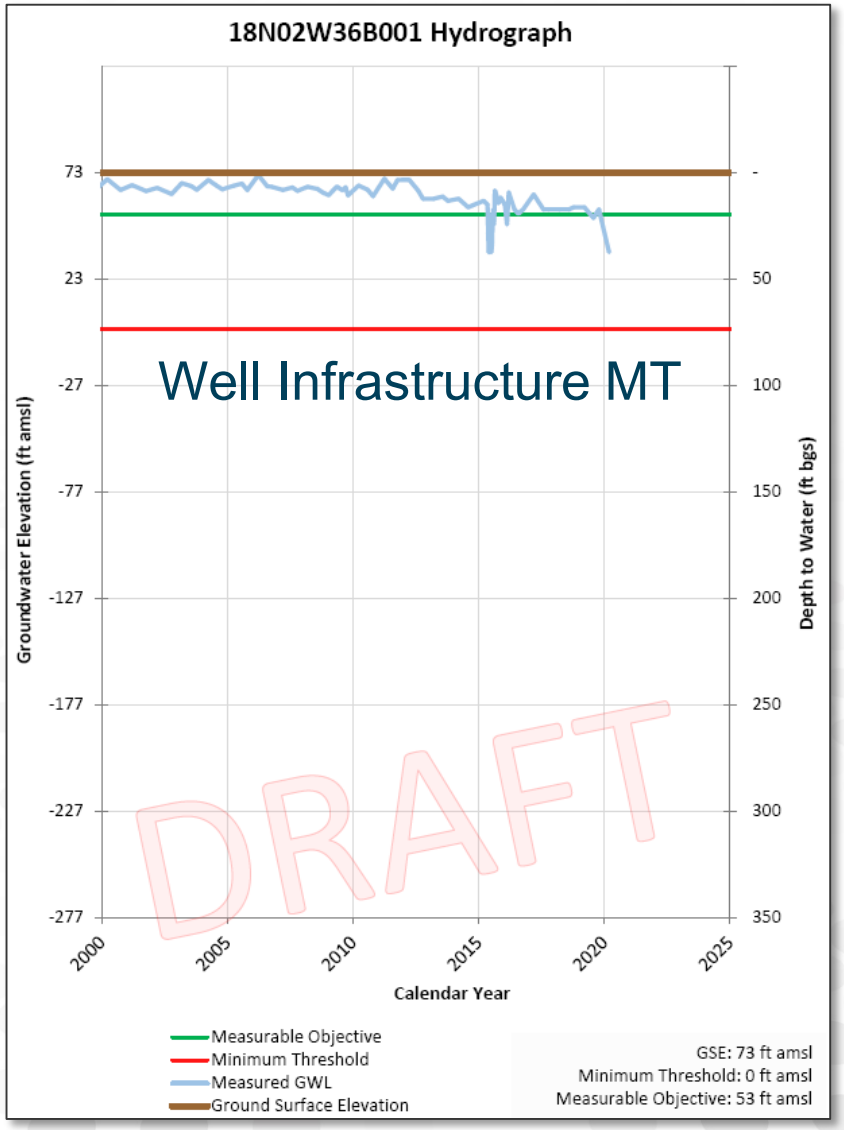


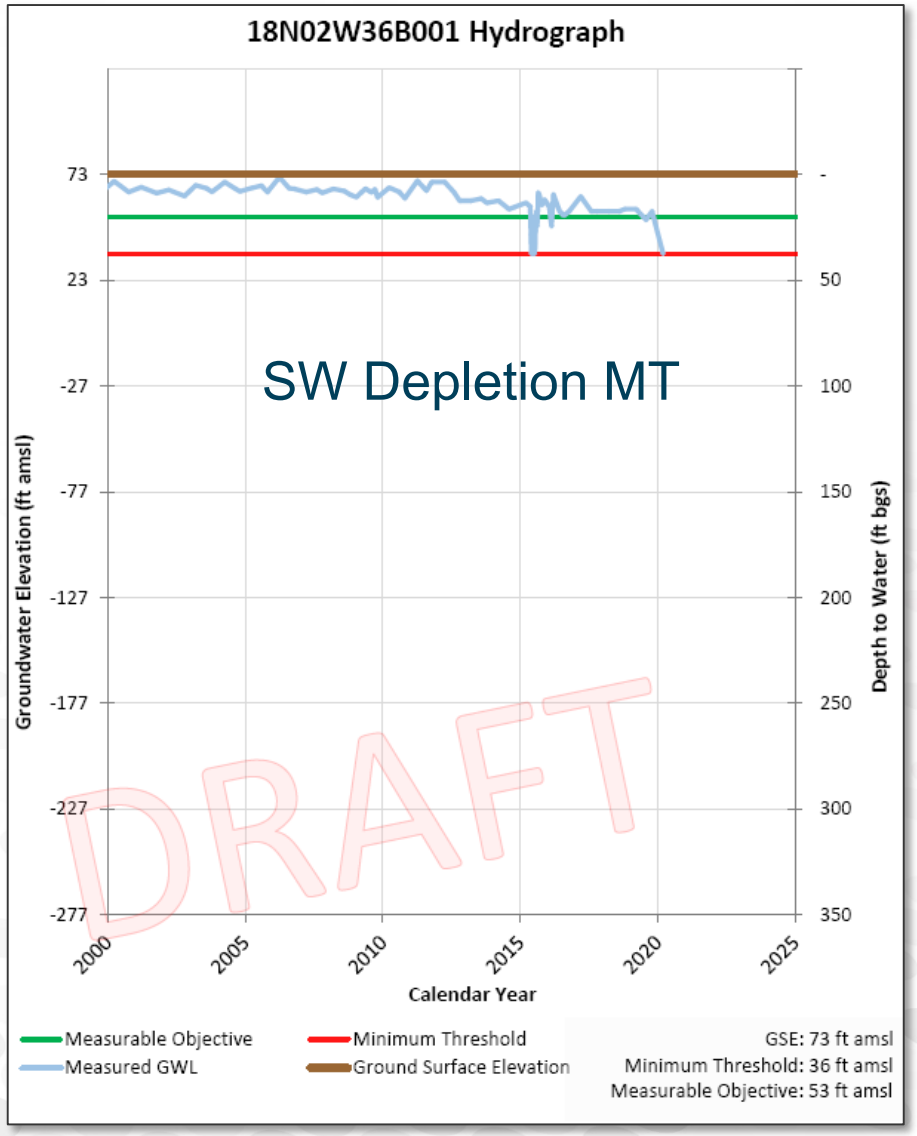
Minimum Thresholds and Multiple Sustainability Indicators

- GSP must manage to avoid undesirable results for all applicable sustainability indicators and beneficial uses
- Need to simultaneously consider minimum thresholds across multiple sustainability indicators because they can be different for:
  - Groundwater Levels
  - Groundwater Dependent Ecosystems
  - Depletions of Interconnected Surface Water
- GSP by necessity will need to manage to keep conditions above the shallowest of the minimum thresholds at each monitoring well

Multiple Sustainability Indicator Minimum Thresholds

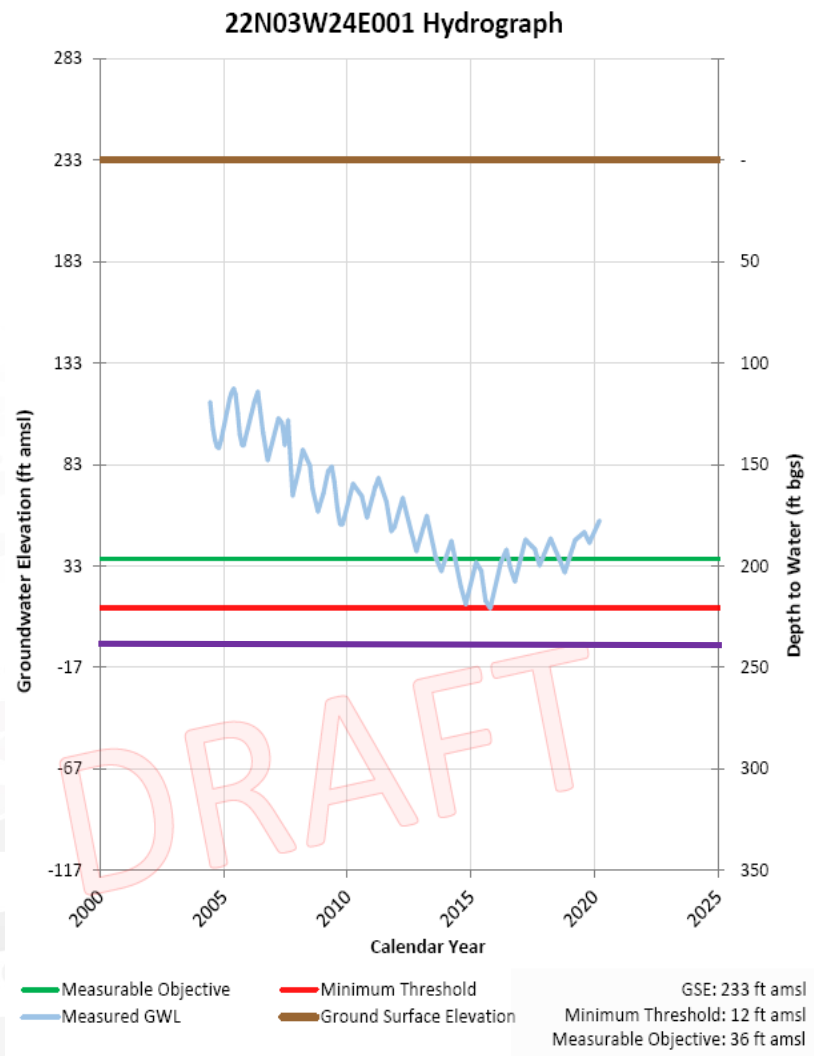
- Surface water depletion MTs are shallower than well infrastructure thresholds

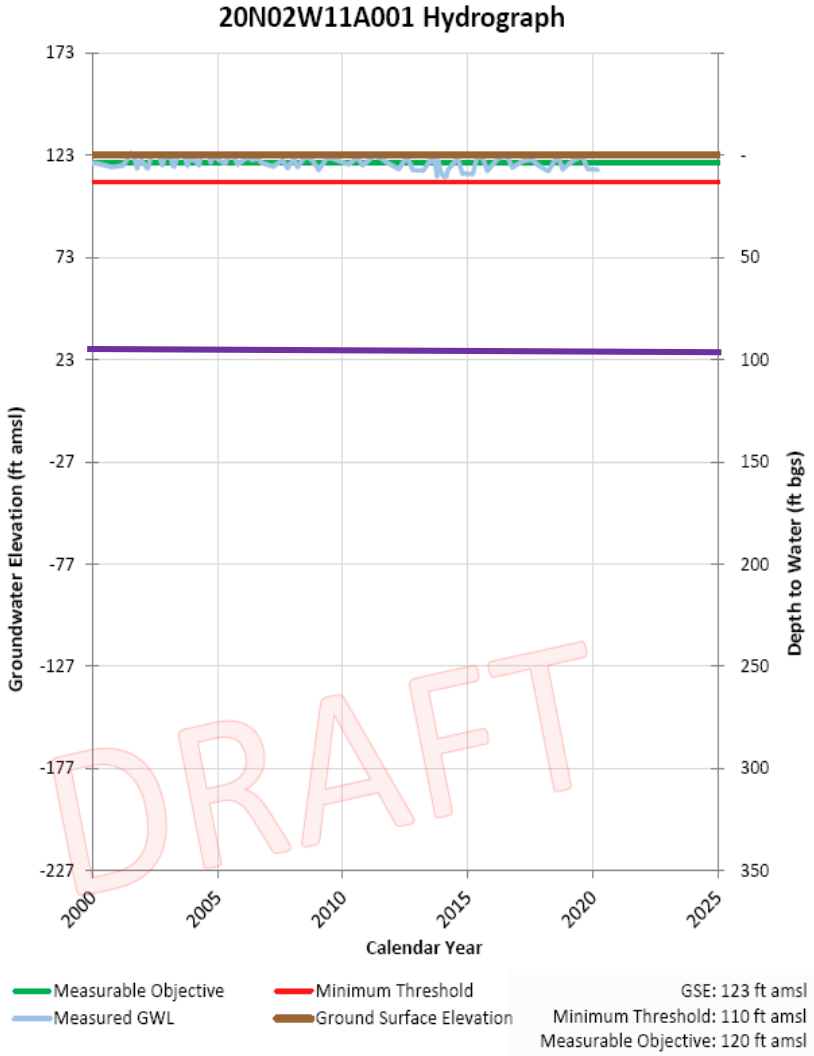


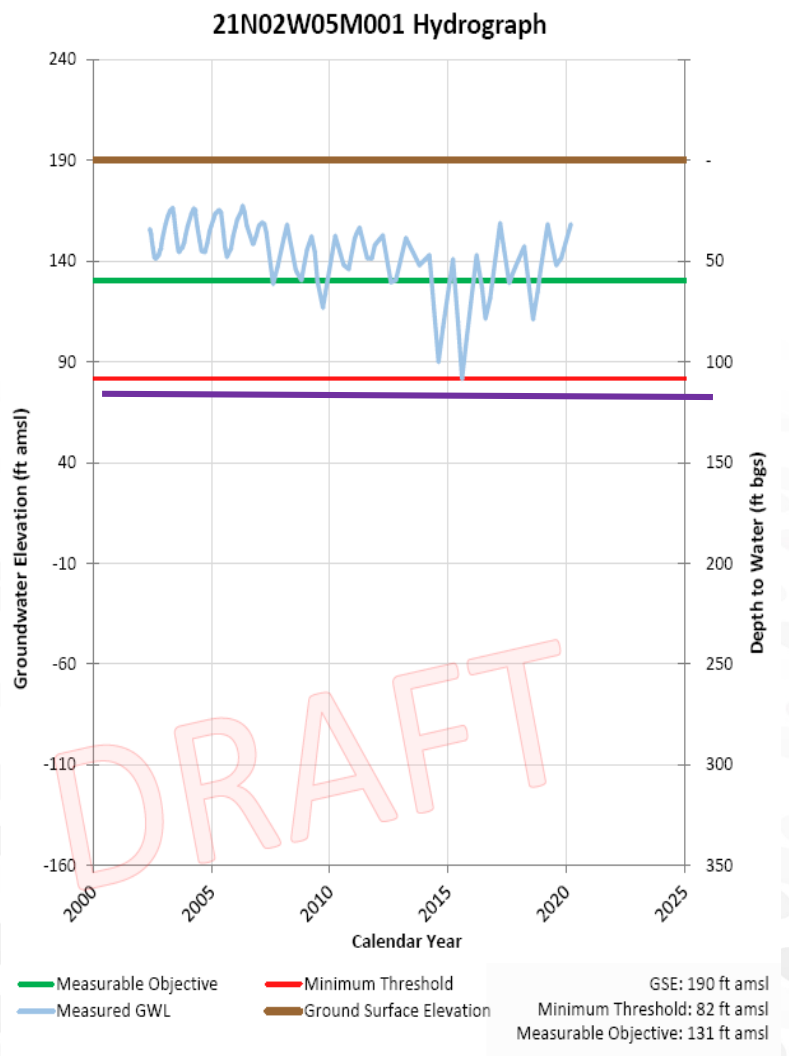


Depletion of Interconnected Surface Water

- Example Hydrographs







Summary and Discussion

- Additional monitoring needed to improve understanding
  - Potential regional approach across Sac Valley subbasins
- MTs based on streamflow depletion are higher and more constraining than those for GW levels
- MTs based on recent historical GW levels would:
  - Allow future GW operations to be about the same as historical
  - Prevent changes in streamflow accretion/depletion relative to historical (avoids significant and unreasonable effects)

4.c. Projects and Management Actions (PMAs)

Projects and Management Actions (PMAs)

- Last addressed at 11/13/20 Joint TAC meeting
  - Reviewed approach to identify, describe, and select PMAs for inclusion in the GSP
- Draft Chapter 6 due for review by July 16
- Targeting completion of technical work by mid-June
- Joint TAC Meetings
  - April 9 (today): Review initial project list/solicit input
  - May 14: Project details and ranking
  - June 11: Adopt recommendation on selected PMAs

PMAs - GSP Regulatory Requirements

- GSP must include projects and management actions (PMAs) ".. to meet the *sustainability goal* for the basin in a manner that can be maintained over the planning and implementation horizon." (§ 354.42)
- Sustainability goal must "… ensure that the basin will be operated within its sustainable yield…" (§ 354.24)
- Information Required (§ 354.44) :
  - List of proposed PMAs
  - Measurable objective(s) that will benefit from the proposed PMAs
  - Description of conditions triggering implementation and decision process
  - Other details

General Project Types

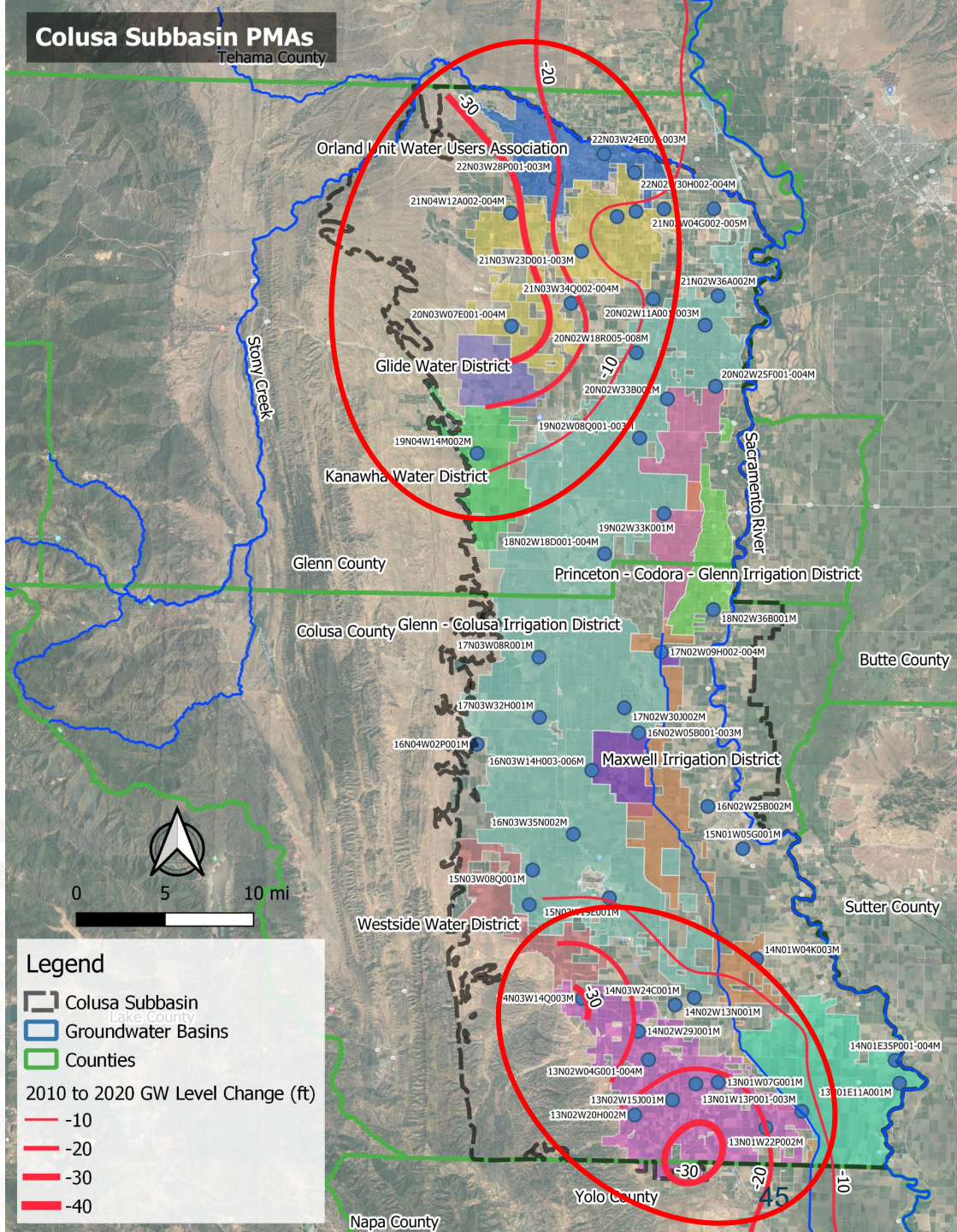
- Recharge
  - In-lieu groundwater recharge
    - Existing conveyance and distribution infrastructure
    - New conveyance and distribution infrastructure, if needed
  - Direct groundwater recharge
    - Winter flooding of ag lands
    - Recharge basins
    - Recharge wells
- Reductions in non-beneficial consumption
- Recharge water supply sources
  - Sacramento River: full use under existing CVP contracts, water transfers, Section 215 water (unmanaged flood flows)
  - Stony Creek
  - Small, local watersheds

Initial PMA Inventory (Project List)

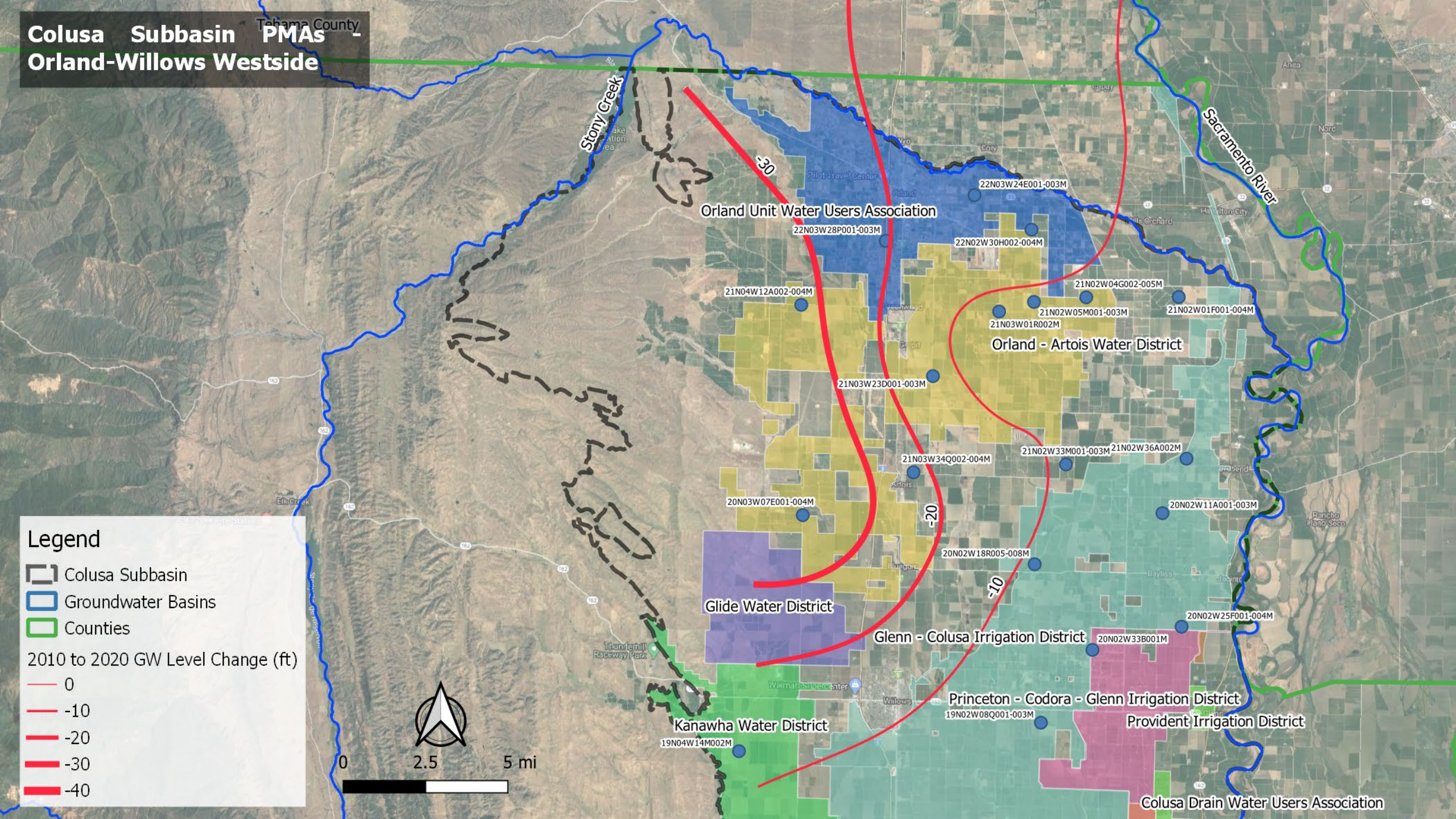
- Solicitation for PMA ideas via this Google Form
  - PDF and Word versions of form on CGA and GGA websites
  - Only one response received to date, possibly another coming
- Sources of project information
  - Existing projects that could be scaled up
  - Previously identified projects
  - Team-identified projects
  - TAC-suggested projects
  - Other
- Focus on projects that could help address areas with sustainability concerns

Areas with Sustainability Concerns

- Orland-Willows Westside
- Williams-Arbuckle Westside



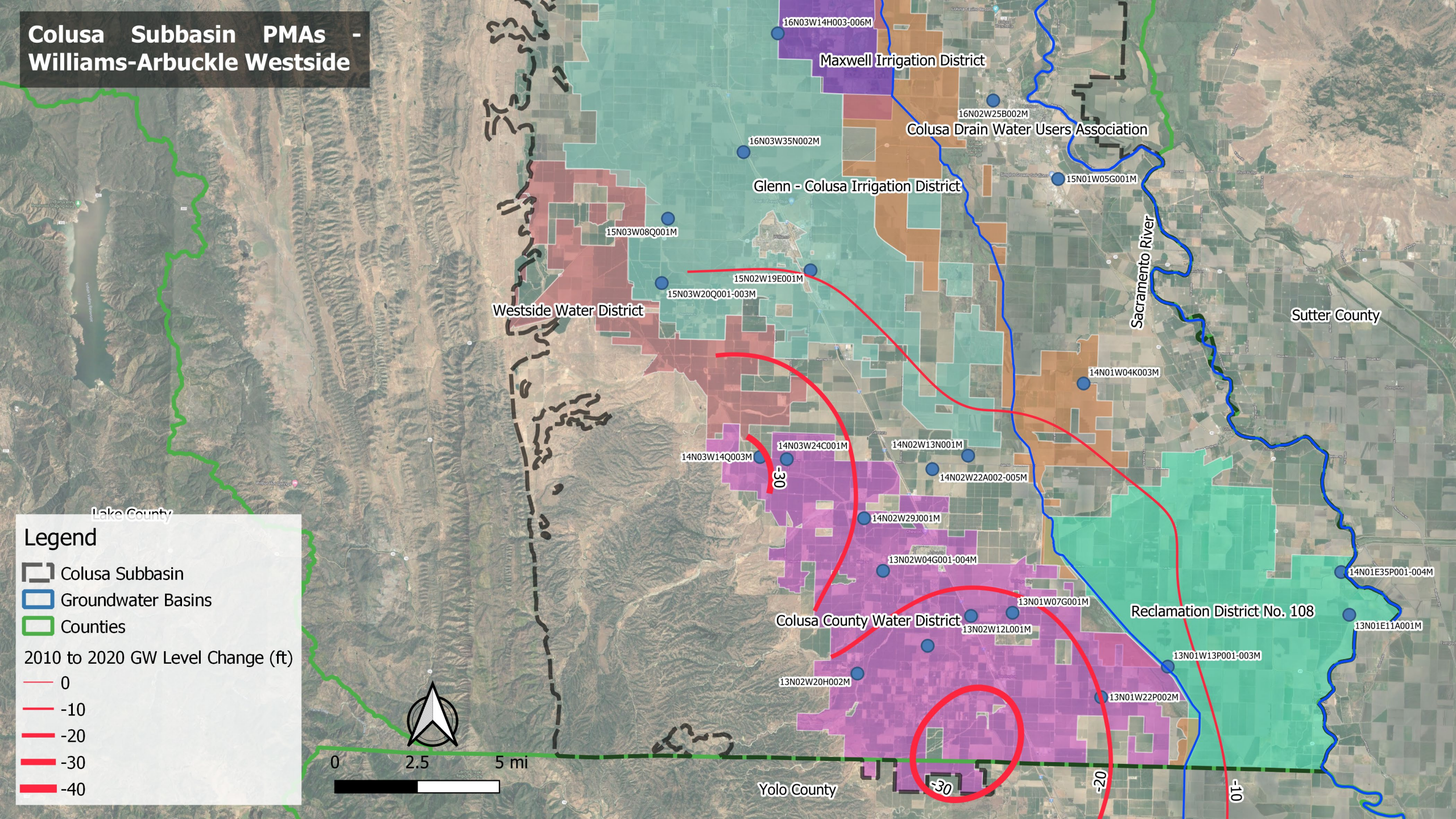
Average 2010 to 2020 change in GW elevation. Source: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels


Colusa Subbasin PMAs - Orland-Willows Westside
Tehama County
Stony Creek
Sacramento River
-30
Orland Unit Water Users Association
22N03W24E001-003M
22N03W28P001-003M
22N02W30H002-004M
21N04W12A002-004M
21N02W04G002-005M
21N02W05M001-003M
21N02W01F001-004M
21N03W01R002M
Orland - Artois Water District
21N03W23D001-003M
21N02W33M001-003M
21N02W36A002M
21N03W34Q002-004M
20N03W07E001-004M
-20
20N02W11A001-003M
20N02W18R005-008M
-10
Glide Water District
20N02W25F001-004M
Glenn - Colusa Irrigation District
20N02W33B001M
Princeton - Codora - Glenn Irrigation District
19N02W08Q001-003M
Provident Irrigation District
Kanawha Water District
19N04W14M002M
Colusa Drain Water Users Association
Legend
Colusa Subbasin
Groundwater Basins
Counties
2010 to 2020 GW Level Change (ft)
0
-10
-20
-30
-40
0
2.5
5 mi

Orland-Willows Westside

- Existing infrastructure
  - Orland-Artois, Glide, and Kanawha Water Districts, Orland Unit Water Users Assn
- In-lieu recharge
  - Within existing service areas
  - Service area expansion
    - OAWD service area “in-fill”
    - Annexations (subject to system capacities)
- Direct recharge
  - Winter spreading on ag lands
  - Voluntary, incentive-driven participation

Many potential configurations


Colusa Subbasin PMAs - Williams-Arbuckle Westside
16N03W14H003-006M
Maxwell Irrigation District
16N02W25B002M
Colusa Drain Water Users Association
16N03W35N002M
Glenn - Colusa Irrigation District
15N01W05G001M
15N03W08Q001M
15N02W19E001M
15N03W20Q001-003M
Westside Water District
Sacramento River
Sutter County
14N01W04K003M
14N03W14Q003M
14N03W24C001M
14N02W13N001M
14N02W22A002-005M
-30
14N02W29J001M
13N02W04G001-004M
14N01E35P001-004M
13N01W07G001M
Colusa County Water District
13N02W12L001M
Reclamation District No. 108
13N01E11A001M
13N01W13P001-003M
13N02W20H002M
13N01W22P002M
Lake County
Yolo County
-30
-20
-10
Legend
Colusa Subbasin
Groundwater Basins
Counties
2010 to 2020 GW Level Change (ft)
0
-10
-20
-30
-40
0
2.5
5 mi

Williams-Arbuckle Westside

- Build on existing arrangements/agreements
- Existing infrastructure
  - Westside and Colusa County WDs
- In-lieu recharge
  - Within existing service areas
  - Service area expansion
    - Annexations (subject to system capacities)
- Direct recharge
  - Winter spreading on ag lands
  - Voluntary, incentive-driven participation

Many potential configurations

Other Identified Projects

1) Multi-benefit On-farm Managed Aquifer Recharge/FloodMAR
   - CGA & GGA partnerships with TNC
   - Increase direct recharge
   - Environmental benefits
2) GCID Main Canal Regulating Reservoir
   - 30,000 to 40,000 AF regulating reservoir on CBD
3) Invasive plant species (Arundo) eradication
   - Reduce shallow GW consumption
4) Sacramento River Water Treatment Facility
   – Treat and deliver high quality drinking water to small communities currently using poor quality groundwater
5) Orland Unit Water Users Assn Recharge
   – Direct recharge of Stony Creek high flows in creeks, ag lands, and dry wells
   – Could be integrated into Orland-Willows Westside project configurations

- Other projects to be identified

PMAs - Next Steps

- Continue to identify viable, effective project concepts
- Use model to establish scale of recharge needed
- Estimate recharge water sources, quantities and timing
- Develop and evaluate alternative projects needed to achieve and maintain sustainability
- Develop project descriptions for GSP

5. Topics and TAC Decisions for Next Meeting

May 14, 2021 Joint TAC Meeting Topics

- Sustainable Management Criteria
  - Make TAC recommendations to GSA Boards for GW levels, GW storage GDEs and streamflow depletion
- Projects and Management Actions
  - Conceptual project configurations
  - Model results (sustainability benefits)
  - Initial cut at most promising projects

Discussion