Appendix 5B

Economic Analysis of Groundwater Level Minimum Thresholds

Technical Memorandum

To: Glenn and Colusa County Groundwater Authorities

From: ERA Economics

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Subject: Economic Benefit-Cost Analysis of Potential Groundwater Level Minimum Thresholds

Introduction

Sustainable Management Criteria (SMC) for the Colusa Subbasin were established in consultation with the Technical Advisory Committees (TACs) of the Colusa Groundwater Authority (CGA) and Glenn Groundwater Authority (GGA). SMCs consist of the following: the Sustainability Goal adopted for the for the subbasin; Undesirable Results describing significant and unreasonable effects to be avoided; quantitative Minimum Thresholds (MTs) that define conditions that, if exceeded, may cause Undesirable Results; and quantitative Measurable Objectives (MOs) to achieve the Sustainability Goal of the Subbasin. Undesirable Results, MTs, and MOs are all established in relation to the six sustainability indicators referenced in the GSP Emergency Regulations, five of which are applicable in the Colusa Subbasin.

Subbasin MTs were developed with substantial public and technical team input. A total of 13 joint meetings of the TACs were held between May 8, 2020, and June 11, 2021, and SMCs were addressed at 9 of the 13 meetings. This included all 7 meetings held between January 8 and June 11, 2021. Several technical analyses were developed to evaluate potential MTs. This appendix describes an economic analysis of MTs that was developed and presented to the TAC at the May 13, 2021 meeting.

The Subbasin MTs are described in detail in Chapter 5 and Appendix 5A. The general approach to setting MT for Groundwater Levels considered both historical groundwater levels and the distribution of shallow (primarily domestic) well depths. Potential MTs were considered based on a percent margin below historical lows or domestic well depths. These were set to balance avoiding significant and unreasonable impacts to domestic wells while also allowing sufficient flexibility for conjunctive management of Subbasin surface and groundwater supplies.

To support evaluation of MTs, an economic analysis was developed to assess whether it would be cost-effective to set MTs higher (or lower) than the MTs based on the lower of 50% below the historical low groundwater level or 20th percentile of domestic well depths. This appendix briefly describes the economic analysis, assumptions, and results.

Economic Analysis Overview

A benefit-cost analysis was developed to monetize and compare the benefits and costs to groundwater users in the Subbasin under the Groundwater Level MTs. There are additional benefits and costs associated with MTs that relate to other four sustainability indicators defined in the GSP Emergency Regulations that are applicable to the Colusa Subbasin that were not considered in this analysis.

The benefit of higher MTs is the avoided cost of replacing dewatered domestic wells and the avoided cost energy cost due to additional pumping lifts from lower groundwater levels. Dewatered domestic well costs would fall on individual domestic well owners. Additional pumping costs would fall on Subbasin groundwater users in the vicinity of the monitoring well (defined by Thiessen polygons). In contrast, the incremental cost of setting higher MTs is due to more rapid (and larger scale) implementation of projects and management actions. For example, preventing additional declines in groundwater levels may require larger recharge projects, and these projects would need to be implemented more rapidly. This imposes additional costs on groundwater users in the Subbasin.

Having monetized benefits and costs, over the relevant planning horizon (in this case, the 20-year GSP implementation period), the benefit-cost ratio is calculated. When the benefit-cost ratio is greater than 1, the benefits are at least as large as the cost, suggesting it could be cost-effective to make the MTs shallower in selected areas.

The following costs were considered in the economic analysis of groundwater level MTs:

1. Capital cost of replacing or refurbishing potentially dewatered domestic wells. For the purposes of this analysis, a domestic well is defined as dewatered, and completely replaced, when the groundwater level MT is below the total well depth. In practice, pumping impacts would occur earlier depending on the screened interval of the well and other aquifer- and well-specific characteristics. The domestic well inventory in the Subbasin is based on DWR’s Well Completion Report (WCR) data (see GSP Chapter 3).
2. Additional energy costs caused by additional pumping lifts that would affect all groundwater users in the Subbasin. Lower groundwater levels increase the energy cost to pumpers (domestic and agriculture) in the Subbasin.

The following benefits (avoided costs) were considered in the economic analysis of groundwater level MTs:

1. Cost of demand management (reducing pumping) to prevent additional declines in groundwater levels. The cost of demand management is used instead of the cost of specific projects because demand management could be implemented more rapidly than most projects (there is no construction required). Chapter 6 Appendix 6B describes the cost of demand management in the Subbasin. The costs include the direct cost of land idling only, and do not include any additional indirect costs or administrative costs to set up and implement a demand management program.

Existing domestic well infrastructure in the Subbasin is based on WCR available in DWR’s database[1]. The WCR data generally include all historical wells that have been reported in the system, which may include old wells that are no longer operational, or have been refurbished. The domestic well inventory for the Subbasin will be addressed with other data gaps in the Subbasin to support GSP implementation (see Chapter 3).

Economic Analysis of Subbasin MTs

The economic analysis considers the Subbasin groundwater level MTs. It is important to note that the Subbasin will be managed to meet MOs, which are set substantially higher than MTs. The costs and benefits described in this TM are generally conservative, corresponding to Groundwater Level MTs that are lower than current groundwater levels, MOs, and observed historical levels in many areas.

[1] Available at: https://data.cnra.ca.gov/dataset/well-completion-reports

Figure 1 illustrates the aggregate annual cost curve for an example Thiessen polygon (21N03W01R002) in the Subbasin. The same calculations are repeated for the other 47 polygons. A range of groundwater depths including the MT (155 feet bgs.) specified in the GSP are evaluated. Costs increase as depth to groundwater increases. The capital cost of replacing dewatered domestic wells is annualized using a discount rate of 5 percent over a 30-year economic life. Pumping costs are the additional annual energy cost of pumping from a lower depth in that year. The total cost is the sum of the pumping cost and well replacement cost. All costs are additional (incremental) costs in addition to the current pumping costs at current groundwater depths.

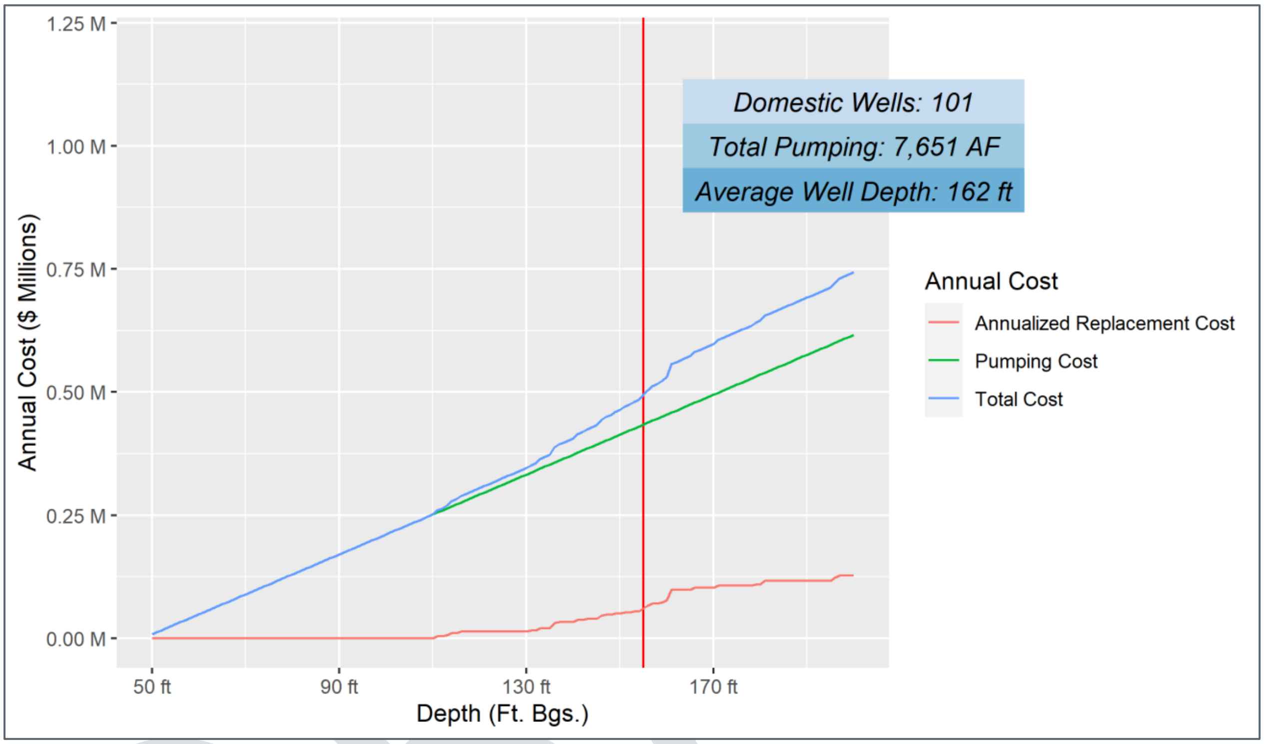
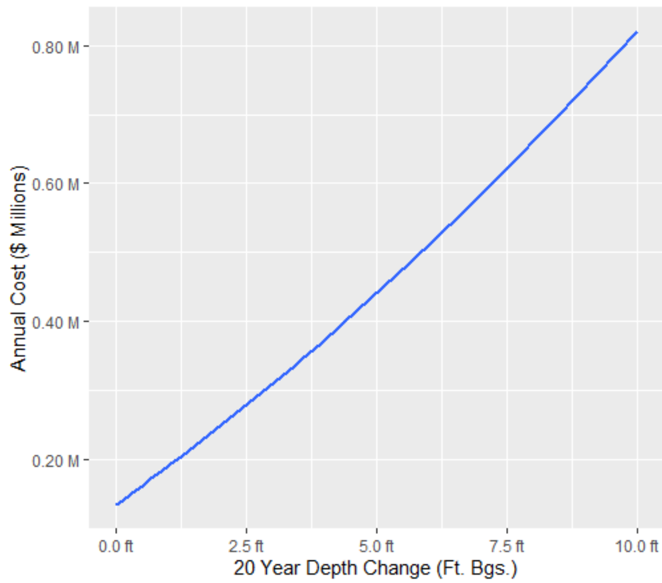


Figure 1. Colusa Subbasin Incremental Annual Cost by Depth to Groundwater

Figure 2 illustrates the benefit (avoided cost) of a change in the MT for the same example Thiessen polygon (21N03W01R002) in the Subbasin (1 of 48 total polygons). In contrast to the static pumping and well replacement costs shown in Figure 1, the benefit is an avoided cost and is therefore expressed as a change in depth to groundwater. A range of projects and management actions that are specified in the GSP could be implemented to achieve a change in groundwater levels across the Subbasin (see Chapter 6). As described above, the cost of demand management to reduce pumping is used to develop the aggregate cost curve shown in Figure 2 (and the individual cost curves for each polygon). The change is shown over the full GSP implementation timeline (20 years).



	Crop	Acres
1	Wheat	480
2	Misc. Grain	96
3	Alfalfa	60
4	Corn	31
5	Almonds	3,654
6	Olives	918

Figure 2. Colusa Subbasin Incremental Demand Management Cost by Depth to Groundwater

As described in Chapter 5 and Appendix 5A, the MT for groundwater levels is set based on the lower of 50 percent below the historical low groundwater level or the 20th percentile of the domestic well depth within each of 48 Thiessen polygons corresponding to the 48 monitoring wells. The benefit-cost analysis evaluates whether an incremental change in the MT would result in a positive benefit-cost ratio in each polygon. The analysis is developed for an incremental increase in the MT of 5 feet.

Table 1 summarizes the benefit-cost analysis of an incremental (defined as 5 feet) increase in the MT. This illustrates the central economic tradeoff: whether a change in the MT (in this case an increase in the MT level by 5 feet) would generate economic benefits for the Subbasin that are greater than the costs that would be incurred. The table summarizes each polygon and the annual benefits, costs, and net benefits. Since the analysis evaluates an incremental increase in the MT, the benefits are defined as the avoided pumping and well replacement cost. Costs are defined as the additional cost of idling land (demand management) to achieve the 5-foot increase in MT. The net benefit shows the absolute difference between benefits and costs, and the final column shows the associated benefit-cost ratio. A benefit-cost ratio greater than 1 shows benefits are greater than costs, implying that a 5-foot shallower MT would generate benefits greater than costs. The aggregate benefit-cost ratio over all polygons is 0.34 (each dollar of cost returns only 34 cents in benefits). There are six polygons where the benefit-cost ratio is slightly greater than 1 (between 1.0 and 2). However, the total annual net benefit across these six polygons is $55,000, which is less than 1% of the -$3.8 million in total annual net benefits across the Subbasin.

Table 1. Benefit-Cost Analysis of an Incremental Increase in MT (by 5 feet bgs)

	Effect of Raising Groundwater Level MT 5 feet Relative to Proposed Groundwater Level MT			
Monitoring Well Polygon	Pump + Well Cost Saving (Annual Benefit in thousands)	Idling Cost (Annual Cost in thousands)	Net Benefit (thousands)	B/C Ratio
13N02W20H002	$25	$579	($554)	0.0
14N02W22A002	$42	$57	($15)	0.7
14N03W24C001	$30	$48	($18)	0.6
14N03W14Q003	$20	$469	($449)	0.0
16N02W25B002	$159	$170	($11)	0.9
15N03W08Q001	$2	$111	($109)	0.0
16N04W02P001	$9	$91	($82)	0.1
16N03W14H003	$13	NA	NA	-
15N03W20Q001	$17	$167	($150)	0.1
17N03W32H001	$5	$157	($152)	0.0
14N02W29J001	$27	$52	($25)	0.5
13N01W07G001	$65	$65	-	0.9
13N01W22P002	$41	$70	($29)	0.6
16N02W05B001	$47	$79	($32)	0.6
14N02W13N001	$45	$59	($14)	0.8
13N02W15J001	$39	$66	($27)	0.6
13N02W12L001	$13	$30	($17)	0.4
14N01W04K003	$117	$145	($28)	0.8
13N01E11A001	$8	$36	($28)	0.2
13N01W13P001	$28	$120	($92)	0.2
14N01E35P001	$38	$42	($4)	0.9
15N02W19E001	$45	$123	($78)	0.4
20N02W18R005	$60	$57	$3	1.1
20N03W07E001	$54	$277	($223)	0.2
19N04W14M002	$41	$198	($157)	0.2
17N03W08R001	$11	$399	($388)	0.0
17N02W09H002	$70	$388	($318)	0.2
21N02W33M001	$47	$45	$2	1.0
21N02W01F001	$57	$43	$14	1.3
21N03W34Q002	$67	$69	($2)	0.9
21N03W23D001	$37	$73	($36)	0.5
21N03W01R002	$31	$29	$2	1.1

Effect of Raising Groundwater Level MT 5 feet Relative to Proposed Groundwater Level MT				
Monitoring Well Polygon	**Pump + Well Cost Saving (Annual Benefit in thousands)**	**Idling Cost (Annual Cost in thousands)**	**Net Benefit (thousands)**	**B/C Ratio**
21N02W04G002	$33	$31	$2	1.1
21N04W12A004	$100	$287	($187)	0.3
15N01W05G001	$79	$130	($51)	0.6
18N02W36B001	$64	$96	($32)	0.7
19N02W33K001	$50	$314	($264)	0.2
18N02W18D001	$25	NA	NA	-
20N02W33B001	$20	NA	NA	-
19N02W08Q001	$47	NA	NA	-
17N02W30J002	$1	NA	NA	-
22N03W24E001	$2	$65	($63)	0.0
20N02W25F001	$44	$184	($140)	0.2
22N02W30H002	$17	$38	($21)	0.4
21N02W36A002	$61	$29	$32	2.1
20N02W11A001	$4	$33	($29)	0.1
21N02W05M001	$11	$26	($15)	0.4
Total	$1,868	$5,547	($3,785)	0.34

Notes: “NA” or missing values reflect polygons with zero acreage or insufficient data to support the benefit-cost calculations.

Discussion

The results indicate that the cost of raising the MT would not be cost effective from a Subbasin-wide perspective, or for most individual polygons. The aggregate benefit-cost ratio of 0.34 shows each dollar of cost from setting MTs incrementally higher returns only 34 cents in benefits across the entire Subbasin. The avoided costs (fewer domestic wells requiring replacement and reduced pumping lifts) would be modest ($1.9 million) relative to the cost of lost agricultural net return from demand management ($5.5 million). The general conclusions are robust to the assumptions used – that is, results are not sensitive to reasonable ranges in key assumptions, including the loss in net return per acre-foot of demand management, additional pumping costs, or the cost of replacing a domestic well.

There are five polygons that show a benefit-cost ratio slightly greater than 1, indicating that benefits would be slightly greater than the costs. The total net benefit is $55,000 across these six polygons. The benefit-cost ratio for these polygons is between 1.1 and 2. These occur in polygons 21N02W36A002, 21N02W04G002, 21N03W01R002, 21N02W01F001, 21N02W33M001, and 20N02W18R005.The total annual net benefit of $55,000 is less than 1% of the -$3.8 million in total annual net benefits across the Subbasin. In addition, the cost of setting higher MT includes the direct cost of demand management only, and does not include other program administrative costs, or potential third-party impacts that may occur in the Subbasin. Including these costs would push the benefit-cost ratio below one in these areas. Finally, it is noted that the inventory of domestic wells for each polygon includes all wells in the DWR WCR database. Many wells are shallower than the historical low groundwater level observed prior to January 1, 2015. These wells would have been dewatered based on historical groundwater levels that occurred in the Subbasin prior to the implementation of SGMA. Removing these wells from the database would reduce the benefit of increasing MT, further reducing the benefit-cost ratio in all polygons.

The conclusion of the economic analysis is that it would not be cost-effective to raise Groundwater Level MTs in the Subbasin. Therefore, the proposed MTs were viewed as an acceptable balance between avoiding significant and unreasonable impacts to domestic (and other shallow) wells and allowing sufficient flexibility for conjunctive management of Subbasin surface and groundwater supplies.

It is important to emphasize again that groundwater levels will be managed for MOs, which are set substantially above MTs. MTs are set below where the Subbasin is expected to be operated, defining the levels that would not be exceeded to avoid increasing risk of Undesirable Results. However, recognizing the importance of protecting domestic wells in the Subbasin, the GSP includes a potential management action in which the GSAs would develop a domestic well impact mitigation program (see Chapter 6). This would provide an additional safety net for domestic well users by providing potential compensation for impacts to domestic wells that are associated with GSP implementation.