Attachment D-4 (DRAFT)

Methodology to Prioritize Groundwater Basins/ Subbasins Based on Water Quality Factors

D4.1 Overview

The SNMP recognizes that given the large area covered by the Central Valley Region, it is impractical and unreasonable to expect that the SNMP's nitrate management requirements will be implemented by everyone, everywhere, at the same time. Instead, as described in Section 4.3.2.1, the SNMP recommended a process and criteria for the Central Valley Water Board to utilize in determining what areas of the Central Valley floor should be prioritized for implementation of the nitrate management requirements. The recommended process directs the Central Valley Water Board to consider both water quality-based factors and other relevant information in a two-step process. Step 1, *Initial Prioritization Using Water Quality Factors*, was completed as part of the development of this SNMP. Step 2, *Additional Analysis*, will be completed as part of the implementation of the SNMP. The purpose of this attachment is to describe the methodology to complete Step 1 (see Section D4.2), and provide an example of how a local/subregional evaluation of nitrate data in the CV-SALTS database may be used to inform the Step 2 process (see Section D4.3).

D4.2 Methodology & Results

Three water quality-based factors were used to initially identify higher priority areas for implementation of SNMP nitrate management requirements:

- Ambient nitrate water quality in the upper zone, calculated as a volume-weighted average nitrate concentration (as N) in each square mile grid-cell in the upper zone;[1]
- Predicted nitrate water quality in 50 years in the upper zone, calculated as a volume-weighted average nitrate concentration in each square mile grid-cell; and
- Ambient nitrate water quality in the upper zone, calculated as an arithmetic average nitrate concentration of wells in each groundwater basin/subbasin. The arithmetic average nitrate concentration was then assigned to each square mile grid.

Luhdorff & Scalmanini, and LWA (2016a) completed groundwater quality analyses for the Central Valley Region using high resolution techniques. Water quality analyses were completed and maps developed for three defined groundwater zones (upper, lower, and production zones).[2] The

[1] See SNMP Section 3.2 and Figure 3-5 for additional discussion and illustration of the use of grid cells for evaluating Central Valley water quality.

[2] See SNMP Section 3.3.1.1 for discussion and illustration of vertical zones used in the characterization of groundwater basins/subbasins in the Central Valley Region.

outcome of this effort was the most refined and accurate characterization of the ambient groundwater quality available for use in the development of the SNMP.

The findings from Luhdorff & Scalmanini, and LWA (2016a) provided the basis for the initial prioritization of groundwater basins/subbasins. Specific data used include:

- One-square mile grid shapefile that covers the groundwater basins/subbasins underlying the Central Valley floor.
- Estimated ambient nitrate (as N) concentrations for each of the one-square mile grid cells.
- Model-projected nitrate (as N) concentrations for each of the one-square mile grid cells for the year 2066 (50-year projection).
- The mean concentration of nitrate in the upper zone of each groundwater basin based on well data from 2000 to 2016.

For each of the water quality factors, the average volume-weighted nitrate concentration (current ambient, projected or average) was assigned to each of the one-square mile grids in the upper zone of each groundwater basin/subbasin. Where the basin/subbasin boundaries split a grid cell, an area-weighted average was assigned to that grid.

For the purpose of calculating an Initial Prioritization Score the following procedure was followed (**Table D4-1**):

- For each data set (current ambient, projected, and well average) a rank score of 1 to 5 was assigned based on the nitrate concentration of that cell.
- The three resulting rank scores were then averaged for the grid cell to obtain a Nitrate Prioritization Score for that cell. **Figure D4-1** illustrates the results for the Central Valley floor.
- The Nitrate Prioritization Scores for each of the grid cells for each groundwater basin/subbasin were averaged to develop an aggregate score for each groundwater basin/subbasin (**Figure D4-2**). As before, if a groundwater basin/subbasin boundary split a grid cell, an area-weighted average was assigned to that grid.

Table D4-2 provides the resulting Initial Prioritization Scores for the Central Valley floor basins/subbasins. These scores provide the outcome of Step 1 – Initial Prioritization Using Water Quality Factors.

D4.3 Nitrate Data Considerations

The CV-SALTS database is the source of the data used to establish the initial prioritization score (Luhdorff & Scalmanini and LWA 2014). This database includes data from all well types in the Central Valley Region, including those used for remediation monitoring. As such, as part of Step 2 of the process to establish the priority and schedule for implementation of the SNMP nitrate management requirements, a closer examination of the data used to estimate ambient nitrate concentrations in the upper zone may be warranted under Step 2. Below is an example of how

further evaluation of nitrate data in the CV-SALTS database can provide additional information to the prioritization process under Step 2. This information is provided as an illustration only of how stakeholders may use the CV-SALTS database to inform the prioritization process.

Within the Delta-Mendota groundwater basin in the San Joaquin Hydrologic Region (No. 5-22.07) there is a regulated facility site (SL205324280)[3] that mixes liquid and dry fertilizers. The site is being remediated for nitrate and a variety of other contaminants (Dichlorodiphenyltrichloro-ethane [DDT] and its breakdown products Dichlorodiphenyldichloroethane (DDD) and Dichlorodiphenyldichloroethylene (DDE), dieldrin, dinoseb, endosulfan II, endrin, and other chlorinated hydrocarbons, pesticides/herbicides).

The CV-SALTS database includes data for 19 wells at this regulated facility, with average nitrate concentrations ranging from 0.2 to 602 mg/L as N for the period 2006-2010, which is within the period used to estimate upper zone ambient nitrate concentrations (2000-20016) (Luhdorff & Scalmanini and LWA 2016a). Within the CV-SALTS database, wells that are categorized as "regulated facility" are considered to be shallow wells. Therefore, for the purposes of Step 1 analysis of water quality factors, these wells are included in the upper zone calculations for volume-weighted or average nitrate concentrations.

Inclusion of the upper zone regulated facility wells in Step 1 has the greatest impact on the average nitrate concentration of all wells. For example, the average upper zone nitrate concentration for the 478 wells located in the Delta Mendota groundwater subbasin would be calculated as 13.67 mg/L as N (as shown in SNMP Table 3-12). When the 19 wells at the regulated facility site are removed and taking into account the spatial clustering of wells, the average nitrate concentration is much lower at 7.3 mg/L as N. Differences of this nature caused by the inclusion of monitoring wells at a specific facility would be an important consideration during the Step 2 of the prioritization process.

Table D4-1. Example Scoring System Used to Develop a Nitrate Prioritization Score for Each Groundwater Basin/Subbasin Based on Water Quality Factors.

Current Ambient Nitrate		Model Predicted Nitrate		Well Average Nitrate		Initial Prioritization Score
Nitrate Concentration Range (mg/L)	Score	Nitrate Concentration Range (mg/L)	Score	Nitrate Concentration Range (mg/L)	Score	
< 2.50	1	< 2.50	1	< 2.50	1	Average of Three Scores (see text)
2.51–5.00	2	2.51–5.00	2	2.51–5.00	2	
5.01–7.50	3	5.01–7.50	3	5.01–7.50	3	
7.51–10.0	4	7.51–10.0	4	7.51–10.0	4	
> 10 mg/L	5	> 10 mg/L	5	> 10 mg/L	5	

[3] https://geotracker.waterboards.ca.gov/profile_report?global_id=SL205324280)

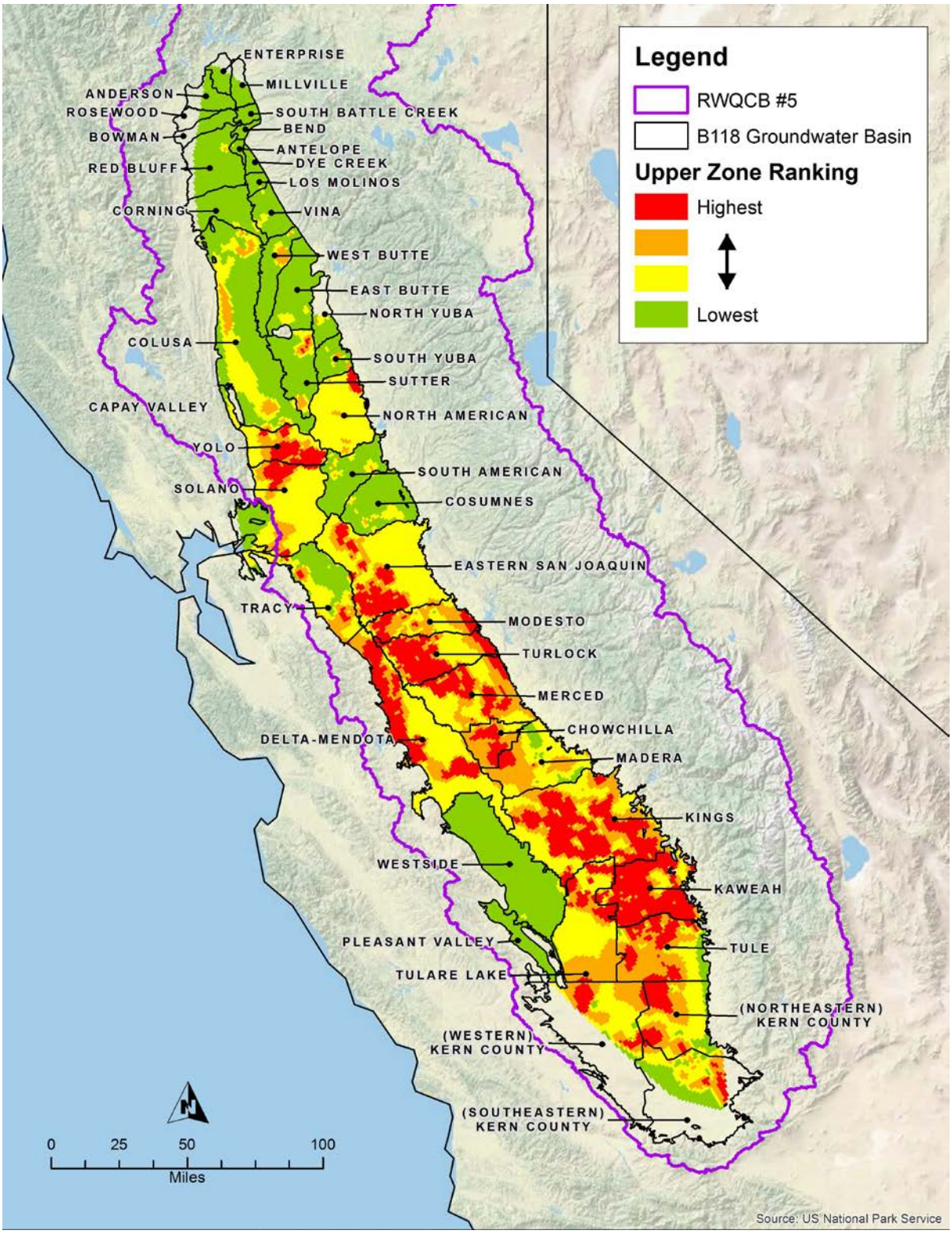

Figure D4-1. TENTATIVE - Illustration of Initial Prioritization Scores from Low to High Based on One-Square Mile Grid Data Based on Three Water Quality Factors

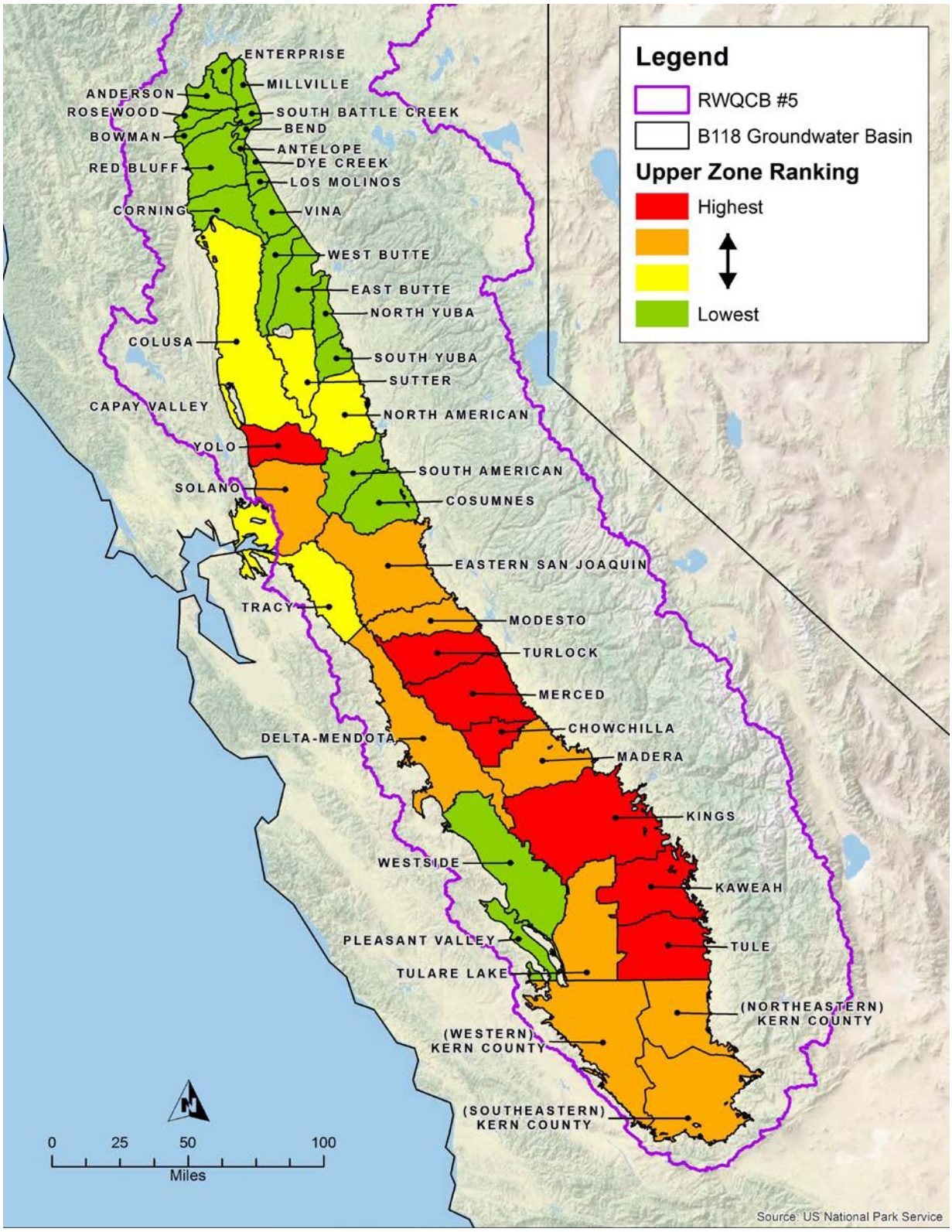

Figure D4-2. TENTATIVE - Illustration of Initial Prioritization Scores from Low to High Based on Aggregated Data for Groundwater Basins/Subbasins Using Three Water Quality Factors

Table D4-2. TENTATIVE - Initial Identification of Higher Priority Areas for Implementation of Nitrate Management Requirement Based Solely on the Three Water Quality Factors

Groundwater Basin/Subbasin (DWR Bulletin 118)[1]		Initial Prioritization Score
No.	Name	
5-22.11	Kaweah	4.47
5-22.03	Turlock	4.08
5-22.08	Kings	3.78
5-22.05	Chowchilla	3.78
5-21.67	Yolo	3.64
5-22.13	Tule	3.64
5-22.04	Merced	3.62
5-22.02	Modesto	3.56
5-22.14	Kern County (Western)	3.36
5-22.07	Delta-Mendota	3.33
5-22.12	Tulare Lake	3.32
5-22.14	Kern County (Northeastern)	3.29
5-22.01	Eastern San Joaquin	3.22
5-22.06	Madera	3.07
5-21.66	Solano	2.97
5-22.14	Kern County (Southeastern)	2.79
5-21.64	North American	2.66
2-4	Pittsburg Plain	2.60
5-22.15	Tracy	2.51
2-5	Clayton Valley	2.20
5-21.62	Sutter	2.14
2-3	Suisun-Fairfield Valley	2.13
5-21.68	Capay Valley	2.05
5-21.52	Colusa	2.01
2-6	Ygnacio Valley	1.95
5-21.61	South Yuba	1.86
5-22.16	Cosumnes	1.80
5-21.57	Vina	1.77
5-21.65	South American	1.76
5-21.58	West Butte	1.66
5-21.54	Antelope	1.44
5-21.50	Red Bluff	1.43
5-21.60	North Yuba	1.39
5-21.56	Los Molinos	1.35
5-21.51	Corning	1.32
5-21.53	Bend	1.31
5-22.10	Pleasant Valley	1.31
5-21.55	Dye Creek	1.30
5-21.59	East Butte	1.29
5-6.02	Rosewood	1.25
5-22.09	Westside	1.17
5-6.01	Bowman	1.07
5-6.03	Anderson	1.02
5-6.06	South Battle Creek	1.01
5-6.04	Enterprise	1.01

[1] The Kern County subbasin is split into three parts to be consistent with the Tulare Lake Basin Plan.