Appendix B

Loading and Mixing Analysis

FINAL TECHNICAL MEMORANDUM

TO: Sarah Rhodes, Woodard & Curran
Dave Richardson, Woodard & Curran

PREPARED BY: Brian Wickes, Woodard & Curran

REVIEWED BY: Jim Blanke, Woodard & Curran

DATE: November 6, 2020

RE: Harvest Water Loading and Mixing Analysis

1. BACKGROUND

Sacramento Regional County Sanitation District (Regional San) is considering construction of Harvest Water (Program), formerly known as the South Sacramento County Agriculture & Habitat Lands Recycled Water Program, a pressurized recycled water irrigation delivery system south of Elk Grove and north of the Cosumnes River (Program Area or Area). Historically, agricultural irrigation in the area was provided through flood delivery methods via private groundwater pumping. Over the past twenty years or so there has been a shift towards other methods of irrigation, such as sprinklers, drip systems, and micro-sprinklers that provide increased irrigation efficiency, as well as increased efficiency in terms of fertilizer uptake.

Historically, agricultural water discharges have not been subject to the same regulation as other water and wastewater discharges. Agricultural discharges are exempt from the federal Clean Water Act but have been regulated by the State of California since the passage of the 1982 Porter-Cologne Water Quality Control Act by virtue of a waiver of Waste Discharge Requirements (RWQCB 2014). The waiver required agricultural dischargers to minimize sediment in agricultural return water to meet Basin Plan turbidity objectives and prevent concentrations of materials toxic to fish or wildlife. Through additional waivers which require monitoring and outreach, what is known as the Irrigated Lands Regulatory Program (ILRP) was established in 2003. Beginning in 2004, the Central Valley Regional Water Quality Control Board (Regional Water Board) allowed groups of farmers to create coalition groups to implement the requirements of a Conditional Waiver of Waste Discharge Requirements (WDRs) for Discharges from Irrigated Lands, which is what the farmers in this Program Area have done. The Waste Discharge Requirements (General Order R5-2014-0030-06) for the Sacramento Valley Water Quality Coalition, the Third-Party Group with responsibility for agricultural discharges in the Program Area, was last renewed in 2014 as the first step of a long-term ILRP. Under the 2014 General Order, agricultural dischargers can choose to be subject to the General Order and comply with its conditions or submit a report of waste discharge and seek an individual WDR.

The objective of this loading and mixing analysis is to estimate the overall, average, Program-wide water quality changes that may result from build-out of Harvest Water compared to the baseline case of maintaining status quo. Area-specific and farm-specific impacts will be different from the overall, average, Program-wide impacts estimates herein. However, the overall average impact forecast can be used to 1) provide Regional San with a better understanding of how Harvest Water may relate to water quality objectives within the Program Area, as well as 2) assist Regional San with planning its response to potential changes in water quality regulations that may be implemented by the Regional Water Board in the future. The key water quality criteria considered in this Technical Memorandum are nitrate (reported as mg/L of N), and salt (mg/L of TDS) concentrations.

The Regional Water Board has developed water quality standards specific to the Program Area for TDS and nitrate through the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) based on maximum contaminant levels (MCLs). The upper secondary maximum contaminant level for TDS is 1,000 mg/L and the primary MCL for nitrate is 10 mg/L. Goals of the Regional Water Board's CV-SALTS (Central Valley Salinity Alternatives for Long-Term Sustainability) program include developing revised water quality objectives (WQO), if needed, for salinity, and developing means to utilize assimilative capacity. These goals have not been achieved at this time. Revising the WQO for nitrate of 10 mg-N/L is not anticipated because this is a primary Maximum Contaminant Level (MCL) for drinking water supplies established to protect public health.

2. LOADING ANALYSIS

2.1 Loading Analysis and Methodology

Salt and nitrogen loadings for with and without-project conditions during summertime in-lieu recharge were determined using the general methodology outlined below:

- **Define the loading analysis area:** To determine the impacts of the Program, the Program area with a one-mile buffer was analyzed, rather than the entire South-American Subbasin. Figure 1 depicts the area analyzed for this loading analysis. Model inflows and outflows were limited to Layer 1 of the SacIWRM model to represent shallow aquifer conditions. Layer 1 is the shallowest layer of the SacIWRM model, has an average thickness of 186 feet over the Program Area, and an average saturated thickness of approximately 101 feet.
- **Identify the analysis units to be used in the model**: Parcels and land use data from the County of Sacramento, The Freshwater Trust, and Woodard & Curran's 2016 Facility Plan served as the analysis units.
- **Categorize and group land uses**: Land use groups represent land uses that have similar water demand as well as similar salt and nitrogen loading and uptake characteristics. Utilizing The Freshwater Trust's land use database and Woodard & Curran's 2016 Facilities Plan parcel data estimates, land use groups were determined by crop. Each crop was assigned values for percent irrigated, applied water, and applied fertilizer application rates.
- **Identify concentrations of TDS and nitrogen for private groundwater supplies and recycled water**: Concentrations of TDS and nitrate within the Program Area are assumed to be uniform for both of the supply sources – groundwater and recycled water. Concentrations of TDS and nitrate in groundwater are based on data collected from the State Water Board's Groundwater Ambient Monitoring and Assessment Program (GAMA). Concentrations of TDS and nitrate in recycled water are based on data provided by Regional San from the Final Phase 2 Advanced Treatment Technology Pilot Project Report. Program Area demand exceeds the amount of recycled water Regional San proposes to deliver to the Program Area, so for purposes of the analysis a conservative blend of groundwater and recycled water is assumed to be delivered to the Program Area. Irrigation in the one-mile buffer was assumed to remain as it was without project as surface water or groundwater.
- **Identify concentrations of recharge water from the Cosumnes River:** Surface water quality data for the Cosumnes River were obtained to estimate TDS and nitrate loading from recharge in the Program Area.
- **Apply the irrigation water source to the analysis units**: Each analysis unit is assigned a water source with associated concentrations of TDS and nitrogen.
- **Estimate the TDS load applied to each parcel**: TDS load is based on the land use practices, irrigation water source and quantity, and septic load. TDS loading from fertilization and amendments is assumed to be negligible. The loading model makes the conservative assumption that no salt is removed from the system once it enters the system.

- **Estimate the nitrogen load applied to each parcel**: Nitrogen load is based on the land use practices and fertilizer application, irrigation water source and quantity, and septic load. The loading model assumes that a portion of the applied nitrogen is taken up by plants and (in some cases) removed from the system (through harvest of plant material). Additional nitrogen is converted to gaseous forms and lost to the atmosphere. A 10 percent volatilization rate is applied for all land uses other than dairies, where a 20 percent volatilization rate is applied (Bussink & Oenema 1998). Remaining nitrogen is assumed to convert to nitrate and to be subject to leaching.

2.2 Data Sources

2.2.1 Land Use

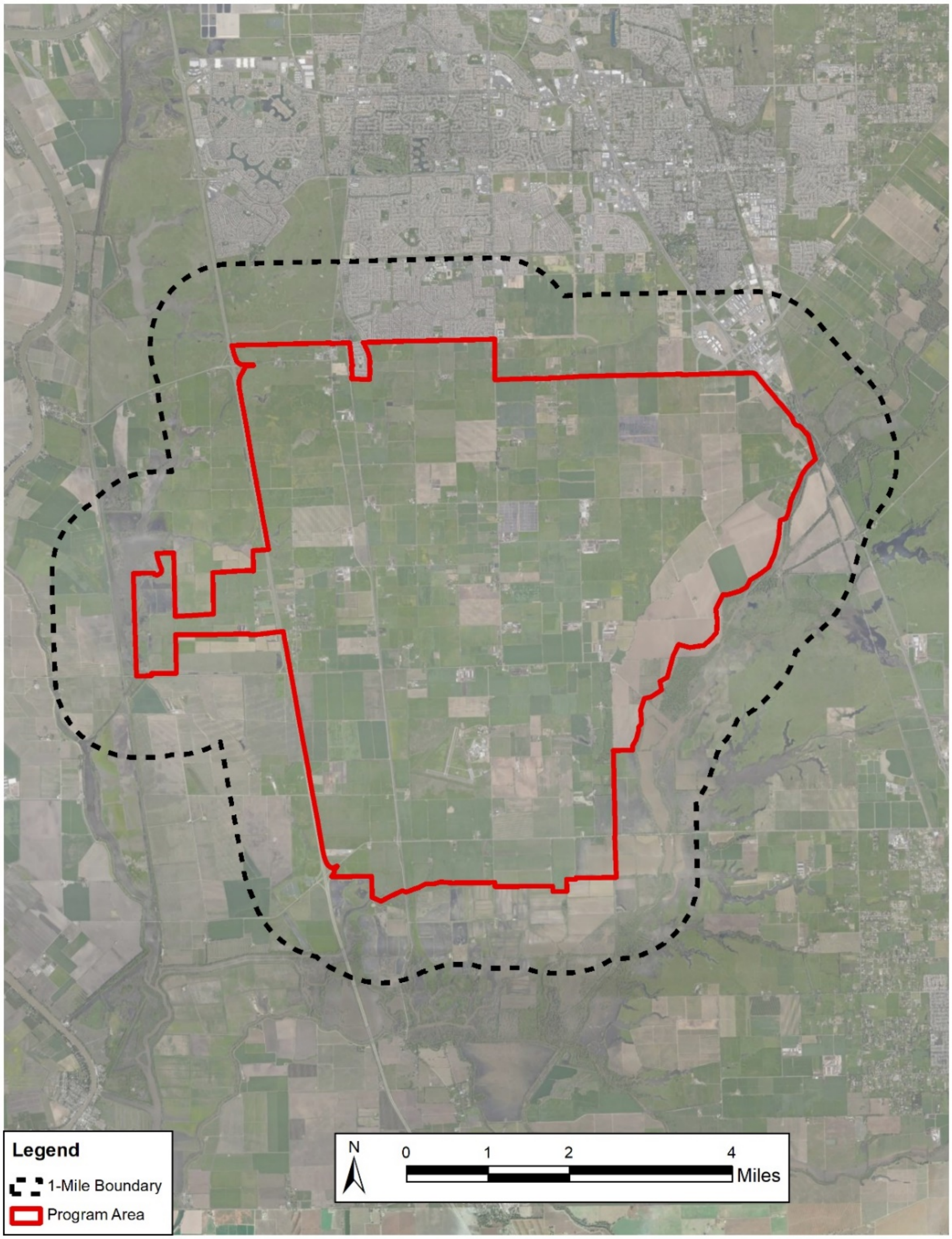
For purposes of the loading analysis, a land use database was developed at a parcel-level basis, using Sacramento County parcel data as well as cropping data from The Freshwater Trust and Woodard & Curran. Woodard & Curran's cropping data was derived from the DWR 2000 Land Use Survey and field-verified by The Freshwater Trust in 2019. Crop types to be analyzed are those with at least 640 acres (1 square mile) within the Program Area. Crops with less than 640 acres within the Program Area and parcel land use that cannot be determined are analyzed conservatively assuming the same loading as the worst-case loading of the crops above 640 acres. Loading for septic systems is also included. The acreages are summarized in Table 1.

Table 1: Land Uses for Loading Analysis[1]

Land Use	Total Area (acres)
Alfalfa	17,700
Corn	1,500
Grapes	5,100
Grassland/Pasture	1,100
Native Riparian Vegetation[2]	6,000
Dairies	1,800
Fallow[2]	3,800
Other/Unknown	6,000
Total	43,000

[1]Includes Program Area and Buffer
[2]Assumed no irrigation

Figure 1: South County Ag Program Loading and Mixing Analysis Footprint



2.2.2 Water Supply Sources

The irrigation water source data input within the Program Area derived from two sources – groundwater and recycled water. Existing groundwater quality was estimated using publicly available groundwater quality data from GAMA. Estimated recycled water quality data were based on the Final Phase 2 Advanced Treatment Technology Pilot Project Report (December 2015). A summary of groundwater data collected is presented in Table 2 and in Figures 2 and 3. Assumed water quality concentrations for water supply sources are presented in Table 3.

Table 2: Groundwater Quality Data Sources

	Number of Wells	
Source	**TDS**	**Nitrate-N**
GeoTracker GAMA	9	12

Table 3: Water Quality Parameters for Loading Model Water Sources

Source	TDS (mg/L)	Nitrate-N (mg/L)
Groundwater – Private Wells[1]	340	0.5
Estimated Recycled Water[2]	503	11

[1]Medan value used from available GAMA data
[2]Average value used from Final NPDES Water Quality Report (Larry Walker Associates 2020)

Figure 2: GAMA Well Location and TDS Concentration

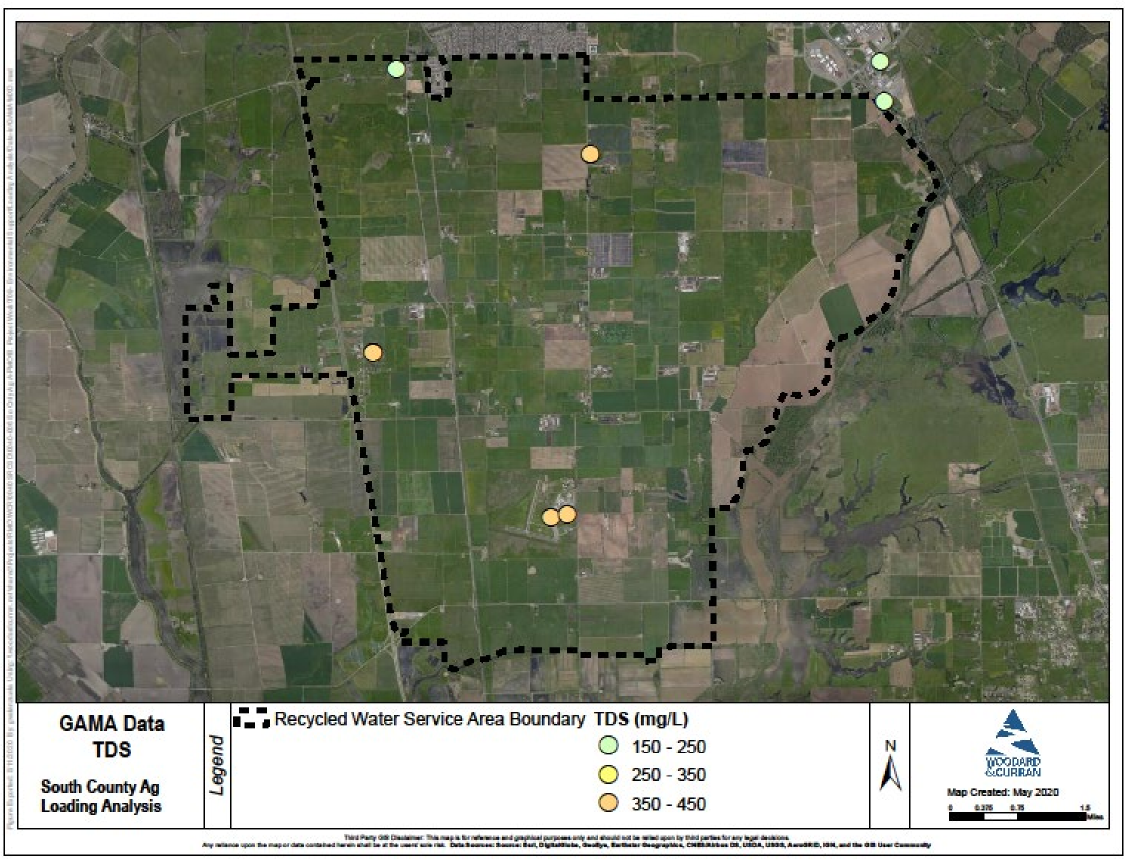
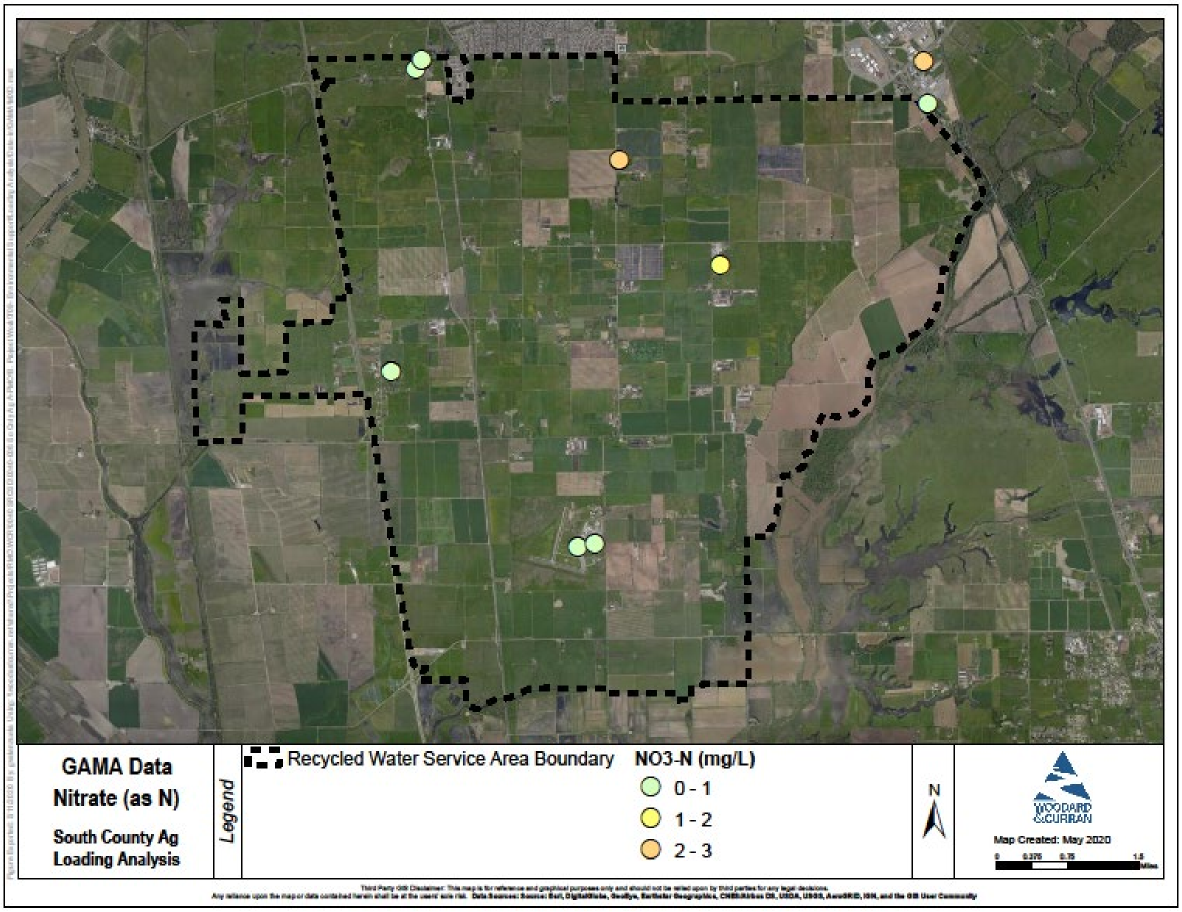
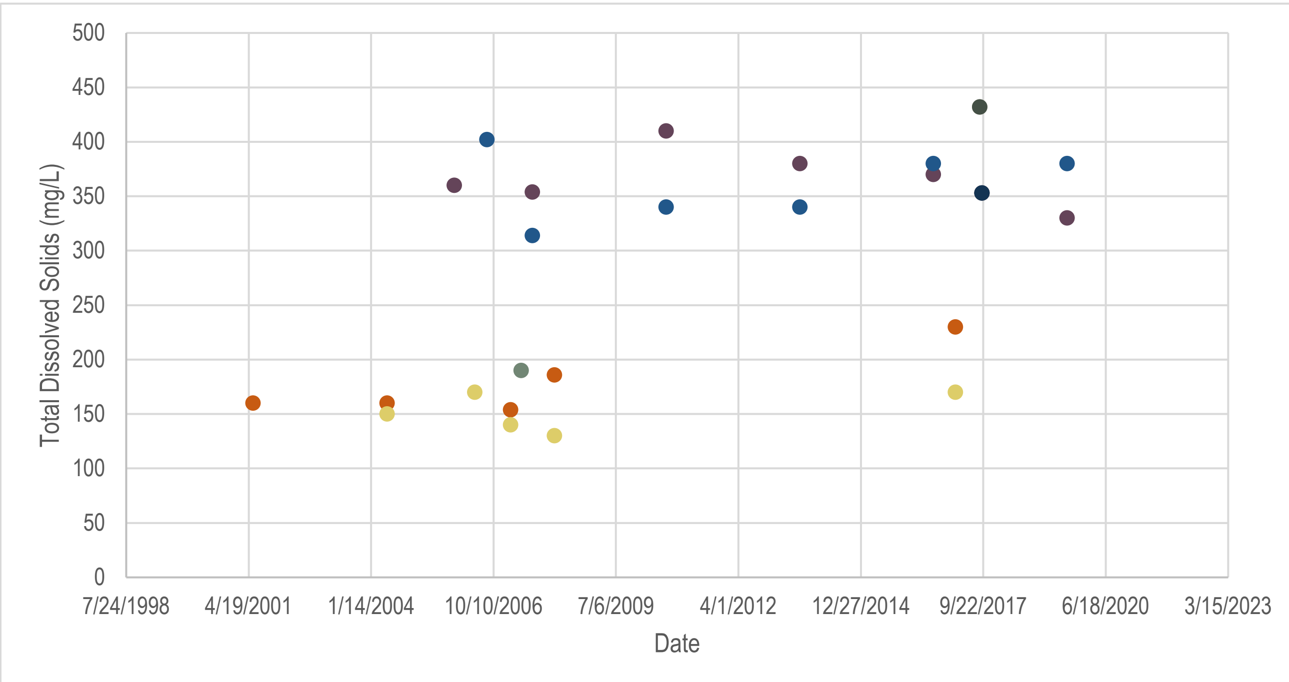


Figure 3: GAMA Well Location and Nitrate (as N) Concentrations



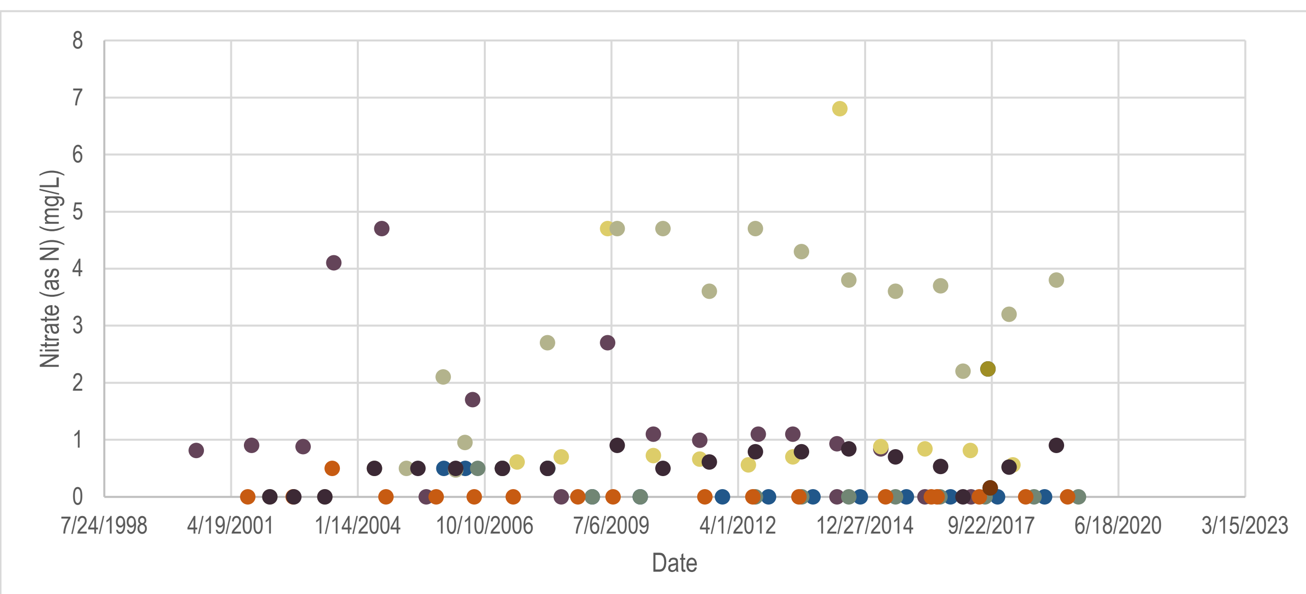
Groundwater TDS concentrations between 1996 and 2019 within the Program Area are presented in Figure 4. Groundwater nitrate (as N) concentrations between 2000 and 2019 are presented in Figure 5. Concentrations from individual wells are color-coded the same. Ambient groundwater TDS and nitrate concentrations are relatively stable in the Program Area.

Figure 4: Groundwater TDS Concentrations within Program Area[1]



[1] Concentrations from individual wells are color-coded the same.

Figure 5: Groundwater Nitrate Concentrations within Program Area[1,2]



[1] Represented values of 0 mg/L are non-detect values, below the laboratory reporting limit.
[2] Concentrations from individual wells are color-coded the same.

2.2.3 Irrigation Loading

This analysis assumes that the proper irrigation methods, tailored to the water, crop, and site conditions, and a high level of management are available to accomplish the efficiencies anticipated in this analysis for agricultural irrigation practices. Residential irrigation systems, on the other hand, are anticipated to have a lower application efficiency. Conveyance efficiency is assumed to be 95 percent while irrigation efficiency varies with the irrigation systems and methods. Conveyance efficiency refers to losses during the delivery of water to the irrigation system.

Salts can accumulate in the root zone if allowed to remain in the soil due to insufficient leaching. Leaching is the process of applying more water to the field than can be retained by the soil such that the excess water drains below the root system, carrying salts with it. The more water that is applied in excess of the crop water requirement, the less salinity remains in the root zone, despite the fact that more salt loading has actually been added to the field. The objective of leaching is to maintain or reduce soil salinity in the root zone to levels that are equal to or less than the threshold for the particular crops selected. Some crops are very sensitive to salts, while others can tolerate much higher concentrations.

Table 4 shows the estimated salt tolerance threshold values (EC_{ct}) for alfalfa, corn, grapes, and pasture, above which yield reductions are likely to begin to occur.

Table 4: Salt Tolerance of Program Area Crops

Crop	Salt Tolerance Threshold EC_{ct}	Salt Tolerance Threshold TDS mg/L	Source
Alfalfa	2.0 milliMohs/cm	1,280	Tanji, K. and N. Keilen, 2002
Corn	1.7 milliMohs/cm	1,088	
Grapes	1.5 milliMohs/cm	960	
Grassland/Pasture	6.0 milliMohs/cm	4,800	

These crop tolerances, along with irrigation efficiency, are used to estimate the leaching fraction. The leaching fraction is the minimum fraction of the applied water that must pass through the crop root zone to prevent a reduction in yield or plant vigor from excessive accumulation of salts. Irrigation efficiency, considered when calculating the gross irrigation requirement, varies by crop type. For instance, turfgrass is irrigated through conventional irrigation methods while high frequency irrigation is more commonly used for tree crops (e.g., almonds).

An average regional Nitrogen Use Efficiency (NUE) between the California average and the practical upper limit of 80 percent can be reasonably expected at the individual parcel level. Thus, for the purposes of this analysis, it is assumed that the NUE is 70 percent. Additionally, for the purposes of this analysis, it is assumed that nitrogen loss through NH_3 volatilization is limited to 10 percent for high frequency Urea-Ammonium Nitrate Solution (UAN) applications. For baseline nitrogen fertilizer application rates, it was assumed to be 34 pounds (lbs.) N/acre–year for alfalfa, 240 lbs. N/acre-year for corn, 72 lbs. N/acre-year for grapes, and 240 lbs. N/acre-year for grassland/pasture. The Grassland/Pasture land-use category is a broad category that encompasses a range of similar land-use types. It is known that not all parcels in this land-use category have applied fertilizer; the approach is a conservative approach that assumes a constant fertilizer application rate.

2.2.4 Irrigation Related Loading Factors

Based on the land use characterization and the irrigation and fertigation assumptions described herein, loading factors were associated with each land use type. These loading factors are summarized in Table 5 and Table 6.

Table 5: Baseline Crop Loading Factors, Groundwater[1]

Crop Type Category	Leachate Volume (inches/year)	Leachable TDS (lbs/acre-year)	Leachable Nitrogen (lbs/acre-year)
Alfalfa	14.5	4,214	9.4
Corn	20.9	5,992	65.1
Grapes	10.6	2,924	19.6
Grassland/Pasture	14.1	4,444	65.0

[1]Estimates based on ET, applied water, and applied fertilizer rates.

Table 6: With-Project Crop Loading Factors, Recycled Water[1]

Crop Type Category	Leachate Volume (inches/year)	Leachable TDS (lbs/acre-year)	Leachable Nitrogen (lbs/acre-year)
Alfalfa	15.3	5,351	11.3
Corn	22.5	7,558	67.7
Grapes	11.6	3,751	20.9
Grassland/Pasture	14.2	5,568	67.0

[1]Estimates by Woodard & Curran based on ET, applied water, and applied fertilizer rates.

2.2.5 Dairies

Due to the significance of dairies as a source of salts and nutrients within the Program Area, some additional consideration was applied to dairy parcels. To better reflect land use practices, the applied, used, and leachable nitrogen characteristics and the applied TDS characteristic were further subdivided into production areas, ponds, and land application areas. Leachable nitrogen was calculated the same way as for the other land use groups except that gaseous loss was assumed to be 20 percent as opposed to the 10 percent assumed loss for other land use groups. Table 7 summarizes the assumed dairy characteristics, which were developed with literature reviews and best-known practices, to best reflect the typical operations of local dairies. Dairies were identified using aerial imagery and are often within the same parcel as alfalfa farming practices. Conservative estimates were assumed for the entire parcel.

Table 7: Assumed Characteristic Dairy Values for the Loading Model[1]

Dairy Subdivision Designation	Applied TDS (lbs/acre-year)	Applied Nitrogen (lbs/acre-year)	Used Nitrogen (lbs/acre-year)	Leachable Nitrogen (lbs/acre-year)
Production Area	82	20	0	8
Ponds	933	141	0	113
Land Application Area	1,280	367	352	30

[1]Data retrieved from the City of Santa Rosa Salt and Nutrient Management Plan and was developed with review and input from representatives of Western United Dairymen.

2.2.6 Septic Systems

Each parcel with a septic system is assumed to leach 244 gallons per day (gpd), based on 75 gallons per capita per day (gpcd) with an average of 3.25 people per system. The 75 gpcd estimate is based on domestic use quantity estimates contained in the CCR, Title 23, Section 697. An estimate of 3.25 persons per household is a conservative estimate which assumes that the average household size for homes with septic systems is larger than that of average homes within the Program Area[1]. TDS concentrations in septic system effluent are assumed to be 540 mg/L across the Program Area, based on the groundwater quality plus a typical addition of 200 mg/L for urban uses. Nitrate-N concentrations were assumed to be 30 mg/L, based on typical wastewater concentrations for medium strength wastewater of 40 mg/L minus an assumed volatilization rate of 25 percent within the septic system (Metcalf & Eddy, 2003). There is no domestic use for recycled water within the Program Area.

2.2.7 Summary of Loading Analysis Results for Baseline Conditions

Based on the loading parameters and methodology described above, TDS and nitrate-N loading rates across the Program Area were estimated under existing conditions. Results are summarized in Table 8.

Table 8: Baseline Conditions TDS and Nitrate-N Loading Results

Land Use Category	Total Area (acres)	TDS (lbs/year)	Nitrogen (lbs/year)
Alfalfa	17,700	54,518,000	60,000
Corn	1,500	7,019,000	37,000
Grapes	5,100	11,863,000	39,000
Grassland/Pasture	1,100	2,936,000	24,000
Dairies	1,800	7,257,000	118,000
Other	6,000	20,514,000	102,000
Septic	N/A	17,000	960
Native Riparian Vegetation	6,000	0	0
Fallow	3,800	0	0
TOTAL	43,000	104,124,000	380,960

2.2.8 Summary of Loading Analysis Results with Project for Summertime Irrigation

Based on the loading parameters and methodology described above, the loading model was used to estimate TDS and nitrate-N loading rates across the Program Area replacing groundwater with recycled water and assuming irrigation under agronomic rates. Results are summarized in Table 9.

[1] Persons per household is 2.77 in Sacramento County (U.S. Census).

Table 9: Summertime Irrigation with Recycled Water TDS and Nitrate-N Loading Results

Land Use Category	Total Area (acres)	TDS (lbs/year)	Nitrogen (lbs/year)
Alfalfa	17,700	66,614,000	70,000
Corn	1,500	8,009,000	38,000
Grapes	5,100	13,755,000	41,000
Grassland/Pasture	1,100	3,578,000	25,000
Dairies	1,800	9,196,000	125,000
Other	6,000	21,287,000	103,000
Septic	N/A	17,000	960
Native Riparian Vegetation	6,000	0	0
Fallow	3,800	0	0
TOTAL	43,000	122,456,000	402,960

2.2.9 Summary of Loading Analysis Results with Project for Wintertime Application

Based on the loading parameters and methodology described above, the loading model was used to estimate TDS and nitrate-N loading rates across the Program Area replacing groundwater with recycled water during winter months. Recycled water is expected to be used in winter for ecological benefits, including roosting habitat. Approximately 17,500 AFY will be supplied. Results are summarized in Table 10 and assumes a percolation rate of 100% and a nitrogen loss of 20% through soil denitrification and volatilization (Huang et al 2017).

Table 10: Wintertime Application with Recycled Water TDS and Nitrate-N Loading Results

Land Use Category	Volume (AFY)	TDS (lbs/year)	Nitrogen (lbs/year)
Winter Application	17,500	23,937,000	419,000

2.2.10 Summary of Loading Analysis Results with Project for Full Project Implementation

Based on the loading parameters and methodology described above, the loading model was used to estimate TDS and nitrate-N loading rates across the Program Area replacing groundwater with recycled water and assuming irrigation under agronomic rates. Results are summarized in Table 11.

Table 11: Full Project Implementation with Recycled Water TDS and Nitrate-N Loading Results

Land Use Category	Total Area (acres)	TDS (lbs/year)	Nitrogen (lbs/year)
Alfalfa	17,700	66,614,000	70,000
Corn	1,500	8,009,000	38,000
Grapes	5,100	13,755,000	41,000
Grassland/Pasture	1,100	3,578,000	25,000
Dairies	1,800	9,196,000	125,000
Other	6,000	21,287,000	103,000
Septic	N/A	17,000	960
Native Riparian Vegetation	6,000	0	0
Fallow	3,800	0	0
Winter Application	N/A	23,937,000	419,000
TOTAL	43,000	146,393,000	821,960

TDS and nitrate loadings by crop type are shown in Figures 6 and 7, respectively.

Figure 6: TDS Loading by Crop Type

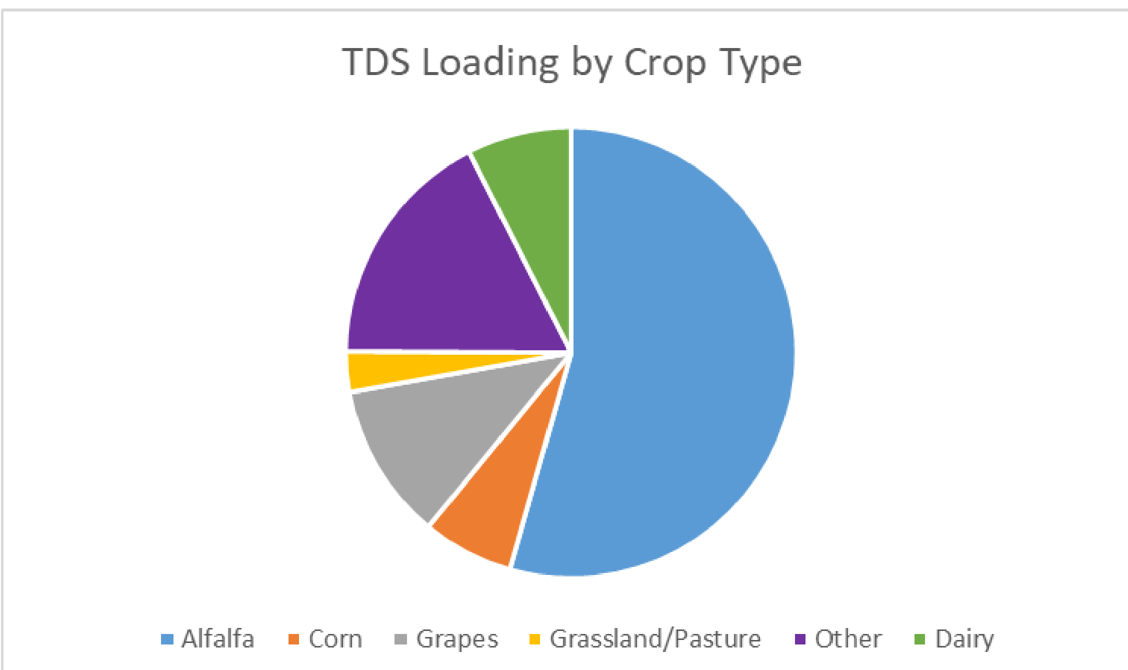
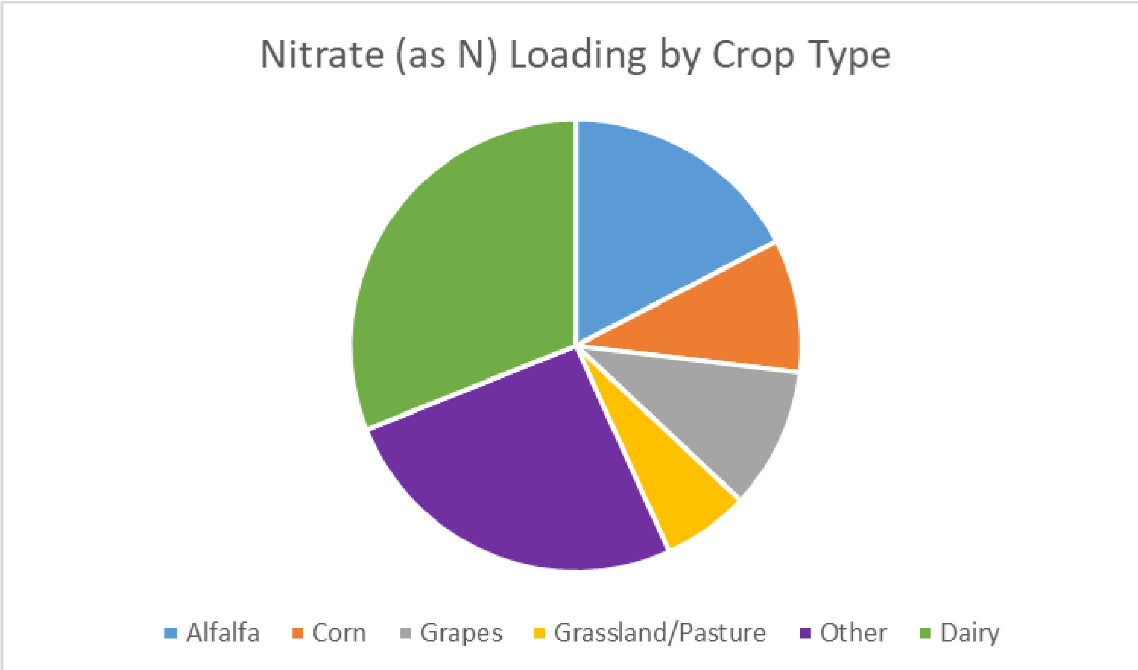


Figure 7: Nitrate Loading by Crop Type



3. TREND ANALYSIS

A mass-balance mixing model was developed to evaluate constituent trends in groundwater concentrations over a 25-year planning horizon within the Program Area considering four scenarios – present land and water uses (reflecting baseline or present-day conditions), with-project summertime irrigation only, with-project wintertime application only, and full-project implementation. This model considered the volume of groundwater in storage and water qualities in the Program Area, and it evaluated the impact of the Program Area inflows and outflows on groundwater quality.

Inflows and outflows in the model include the following components:

- Deep percolation includes deep percolation of precipitation, agricultural irrigation return flows, and septic discharges
- Subsurface inflows or outflows from other basins
- Inflows and outflows to/from deeper portions of the aquifer
- River discharge
- Groundwater pumping

As previously discussed, existing water quality of the Program Area has been evaluated as part of this analysis based on available data. Average constituent concentrations and loading assumptions for the analysis area are summarized in Section 2.

Groundwater quality concentrations for TDS and nitrate-N were estimated using a spreadsheet-based mass balance model. To simulate the effect of current and future loading on groundwater quality, the spreadsheet model calculated the loading factors of each component based on the conditions at the simulated time step. Under this model, each flow component listed in the groundwater budget was combined with its respective concentration of either TDS or nitrate-N to estimate loading from the constituent's mass. These transfers of mass were then assumed to completely mix with groundwater in the shallow-aquifer system on an annual time-step to determine the resulting concentrations in the Program Area. This mixing was assumed to occur only within the upper portions of the aquifer system, approximately to a depth of 186 feet, representing approximately 101 feet of saturated aquifer. As available surface and subsurface water quality data are limited, future revisions of this analysis should confirm or revise constituent concentrations based on additional available data.

The surface and aquifer loading, used to determine water quality, was calculated utilizing the following equations:

Surface Loading:

$$X_t = X_{t-1} + \sum_{j=1}^{m} Q_{t_j} C_{t-1_j}$$

Aquifer Loading:

$$M_t = M_{t-1} + \sum_{i=1}^{n} Q_{t_i} C_{t-1_i}$$

$$C_t = M_t / S_t$$

Where: $\mathbf{X_t}$ is the mass of the constituent in the root zone available for deep percolation.

$\mathbf{M_t}$ is the mass of the constituent in the aquifer at timestep t.

m is the total number of budgetary flow components (j) experienced by the root zone (applied water, fertilizers and septic systems).

n is the total number of budgetary flow components (i) experienced by the groundwater system (deep percolation, subsurface boundary flows, and groundwater pumping).

$\mathbf{Q_t}$ is the flow into, out of, or between adjacent basins at timestep t.

$\mathbf{C_t}$ is the concentration of the constituent at timestep t.

$\mathbf{S_t}$ is the end-of-year storage in the groundwater system at timestep t.

3.1 Mass Balance Model Inputs

The inputs to the mass balance model are summarized in Table 10 for the Baseline Conditions. The inputs to the mass balance model are summarized in Table 11 for the with-project conditions.

Table 10: Estimated Volume and Concentration of Inflows and Outflows for Groundwater Quality Trend Analysis for Baseline Conditions

Item	Volume in Storage or Flow (AF or AFY)	TDS (mg/L)	Nitrate (as N) (mg/L)	Basis for Volume Estimate
Initial Groundwater in Storage	300,500			From IWFM Baseline Model.
Initial Concentrations in Groundwater		340	0.5	Based on existing groundwater conditions as describe in Section 2.
Inflows				
Subsurface Inflow	19,000	340	0.5	From IWFM Baseline Model
Deep Percolation of Irrigation (Leachate)	29,600	2,275	4.0	Leachate volume, and TDS and Nitrogen loads are calculated based on loading analysis discussed in Section 2.
Deep Percolation of Precipitation	2,900	0	0	Deep percolation of precipitation is based on a recharge coefficient of 0.1.
Vertical Inflow	60	340	0.5	From IWFM Baseline Model
Stream Seepage	30,500	65	0.05	From IWFM Baseline Model
Septic Systems	12	540	30	
Outflows				
Groundwater Production	51,900	Variable	Variable	From IWFM Baseline Model
Subsurface Outflow	8,700	Variable	Variable	From IWFM Baseline Model
Vertical Outflow	8,700	Variable	Variable	From IWFM Baseline Model

Table 11: Estimated Volume and Concentration Inflows and Outflows for Groundwater Quality Trend Analysis for With-Project Conditions

Item	Volume in Storage or Flow (AF or AFY)	TDS (mg/L)	Nitrate (as N) (mg/L)	Basis for Volume Estimate
Initial Groundwater in Storage	300,500			From IWFM Baseline Model.
Initial Concentrations in Recycled Water		476	8.2	Based on conditions as describe in Section 2.
Inflows				
Subsurface Inflow	4,400	340	0.5	From IWFM Project Scenario 2030 Climate Change
Deep Percolation of Irrigation (Leachate)	31,200	2,527	4.84	Leachate volume, and TDS and Nitrogen loads are calculated based on loading analysis discussed in Section 2.
Deep Percolation of Precipitation	2,900	0	0	Deep percolation of precipitation is based on a recharge coefficient of 0.1 and average precipitation.
Vertical Inflow	58	340	0.5	From IWFM Project Scenario 2030 Climate Change
Stream Seepage	16,000	65	0.05	From IWFM Project Scenario 2030 Climate Change
Winter Application	17,500	476	6.5	Nitrate value assuming 20% loss.
Septic Systems	12	540	30	
Outflows				
Groundwater Production	22,500	Variable	Variable	From IWFM Project Scenario 2030 Climate Change
Subsurface Outflow	18,200	Variable	Variable	From IWFM Project Scenario 2030 Climate Change
Vertical Outflow	8,700	Variable	Variable	From IWFM Project Scenario 2030 Climate Change

3.2 Mass Balance Model Results

Results from the mass balance model are summarized in Table 12 as well as Figures 8 and 9. Analysis of existing Program Area-wide groundwater quality conditions indicates that the current groundwater quality has been stable over the previous 20 years, is lower than the SMCL for TDS (recommended SMCL is 500 mg/L, upper SMCL is 1,000 mg/L), and is well below the MCL for nitrate-N, 10 mg/L-N. Baseline concentrations are estimated to be 340 mg/L TDS and 0.5 mg/L-N nitrate. Therefore, there is assimilative capacity in the basin for both TDS and nitrate. With-project concentrations are estimated to increase TDS and nitrate concentrations in the Program Area to 540 mg/L TDS and 2.8 mg/L-N nitrate.

Table 12: Estimated Groundwater Concentrations from Project Implementation over 25-Year Implementation Period

Parameter	MCL	Baseline Conditions	Estimated Increase from Project	Estimated Groundwater Concentrations
TDS (mg/L)	500 – 1,000	340	+200	540
Nitrate as N (mg/L)	10	0.5	+2.3	2.8

The results of the groundwater quality trend and loading analyses, based on the assumptions described above and over a 25-year planning horizon, indicate that Program Area-wide average TDS concentrations are estimated to increase with the project but still fall below the upper SMCL of 1,000 mg/L. Nitrate-N concentrations are also estimated to increase but will be well below the 10 mg/L-N MCL. The rate of increase for TDS and nitrate decreases near the end of the planning horizon as the basin approaches equilibrium.

Figure 8: Estimated Change in TDS Concentrations over Baseline

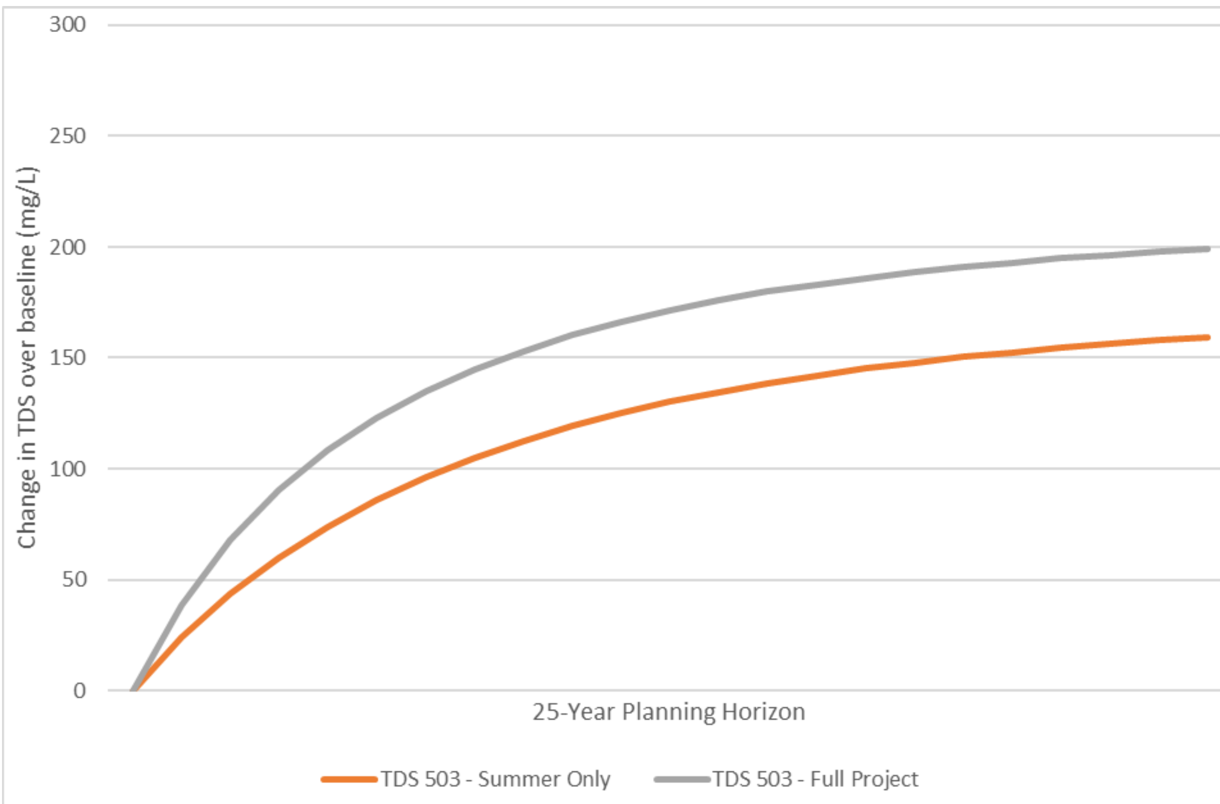
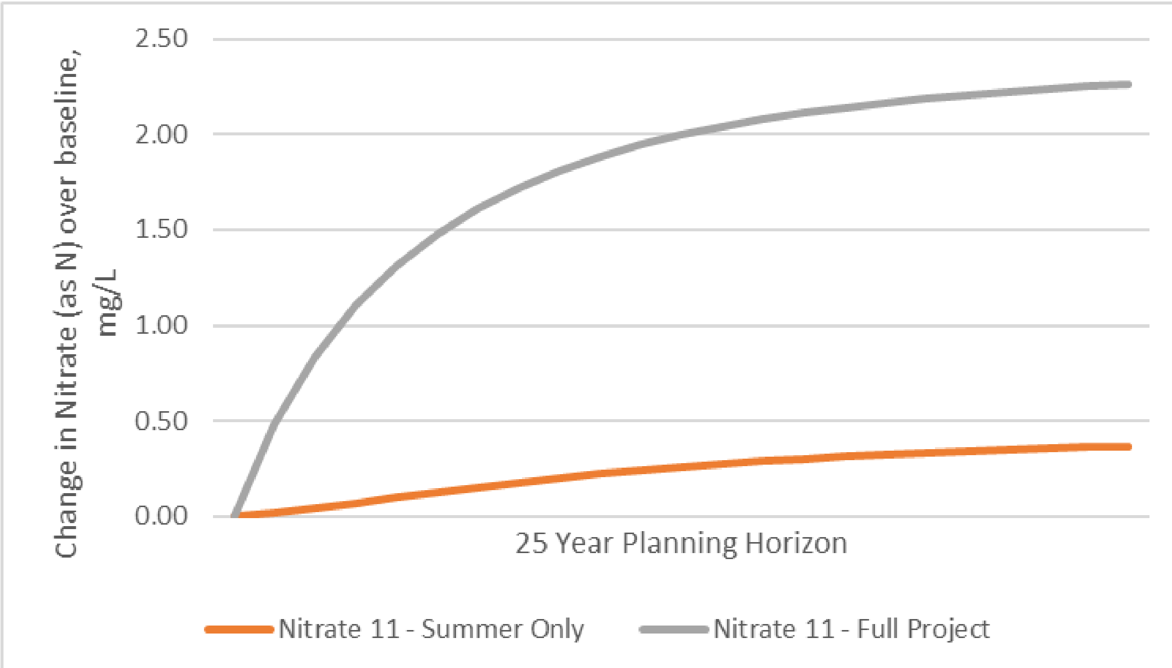


Figure 9: Estimated Change in Nitrate Concentrations over Baseline



4. REFERENCES

"Amendments to the 1994 Water Quality Control Plan for the Sacramento River and San Joaquin River Basins." https://www.waterboards.ca.gov/Centralvalley/water_issues/basin_plans/Sacsjr.pdf, 2014.

Bussink, D.W. and O. Oenema. 1998. *Ammonia volatilization from dairy farming systems in temperate areas: a review*. Nutrient Cycling in Agroecosystems 51, 19-33.

Huang, et al. 2017. *Nitrate leaching in a winter wheat-summer maize rotation on a calcareous soil as affected by nitrogen and straw management*.

Tchobanoglous, George, Franklin L. Burton, H. David Stensel. *Wastewater Engineering Treatment and Reuse, Fourth Edition.* Metcalf & Eddy, Inc. https://ptabdata.blob.core.windows.net/files/2017/IPR2017-01468/v22_FWS1016%20-%20Metcalf.pdf.

WOODARD &CURRAN COMMITMENT & INTEGRITY DRIVE RESULTS