JORDAN RIVER MODELING THROUGH THE WATER QUALITY ASSESSMENT SIMULATION PROGRAM (WASP): MODEL REPORT

IN SUPPORT OF EPA PROJECT NUMBER 835866-01: PREDICTION OF NONLINEAR CLIMATE VARIATIONS IMPACTS ON EUTROPHICATION AND ECOSYSTEM PROCESSES AND EVALUATION OF ADAPTATION MEASURES IN URBAN AND URBANIZING WATERSHEDS

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NOMECLATURE

The following definitions have been employed and implemented throughout this model calibration report over the Jordan River WASP.

- AWQMS = Ambient Water Quality Monitoring System
- BOD = Biochemical Oxygen Demand
- BOD (5-day) = Biochemical Oxygen Demand, 5-day/Standard Conditions
- BODU = Ultimate Biochemical Oxygen Demand
- CBOD = Carbonaceous Biochemical Oxygen Demand
- CBOD (5-day) = Carbonaceous Biochemical Oxygen Demand, 5-day/Standard Conditions
- CBODU = Ultimate Carbonaceous Biochemical Oxygen Demand
- DIP = Dissolved Inorganic Phosphate-Phosphorus
- DMR = Discharge Monthly Report
- DO = Dissolved Oxygen
- DON = Dissolved Organic Nitrogen
- DOP = Dissolved Organic Phosphate-Phosphorus
- DP = Dissolved Phosphate/Dissolved Phosphate-Phosphorus
- IPCC = Intergovernmental Panel on Climate Change
- NAD = North American Datum
- NH_3-N = Ammonia-Nitrogen
- NO_2-NO_3-N = Nitrite-Nitrate Nitrogen/Nitrate-Nitrite Nitrogen
- PHYTO = Phytoplankton Chlorophyll-a
- POC = Particulate Organic Carbon/Detrital Carbon
- POM = Particulate Organic Matter/Total Detritus
- PON = Particulate Organic Nitrogen/Detrital Nitrogen
- POP = Particulate Organic Phosphate/Detrital Phosphate
- RCP = Representative Concentration Pathway
- SLC = Salt Lake County
- TKN = Total Kjeldahl Nitrogen
- TMDL = Total Maximum Daily Load
- TN = Total Nitrogen
- TP = Total Phosphate/Total Phosphate-Phosphorus
- TSS = Total Suspended Solids
- UDWQ = Utah Division of Water Quality
- UDWR = Utah Division of Water Rights
- UTM = Universal Transverse Mercator
- WASP = Water Quality Assessment Simulation Program
- WRDB = Water Resources Database
- WWTP = Wastewater Treatment Plant

1 INTRODUCTION

This section provides the general background of the project for which this model work falls under and describes the relevance of the model (e.g., model objectives). Discussions over the model background (e.g., general theory, previous studies, etc.) concludes this section of the report.

1.1 PROJECT BACKGROUND

The model calibration work is conducted in part of the University of Utah Project "Prediction of Nonlinear Climate Variations Impacts on Eutrophication and Ecosystem Processes and Evaluation of Adaptation Measures in Urban and Urbanizing Watersheds", under EPA Project 835866-01. One primary goal of this project involves assessing the performance of the Jordan River watershed under existing and futuristic climate change characteristics followed by land use projections (Barber et al. 2016). The project employs the Jordan River watershed, which involves the shallow lake (Utah Lake) that discharges into the Jordan River, as the case study for analyzing the following questions (Barber et al. 2016).

1) How does drought (seasonal and prolonged), exacerbated by extreme weather and climate change, affect water quality and the availability of surface water and groundwater?
2) How do subsequent drought-related events, such as changes in surface runoff and wildfire, lead to additional changes in water quality and availability?
3) How can changes in water quality driven by other variations in the hydrological cycle related to drought, such as changes in the timing and intensity of spring snowmelt and runoff, affect water quality?
4) What adaptive management strategies and innovative, cost-effective technologies provide communities and ecosystems with protection and resilience against direct and secondary drought-related impacts exacerbated by climate change?
5) How can the proposed management strategies and technologies be demonstrated in different communities to facilitate adoption of sustainable water management?

For addressing the five project questions above, the project implements several models, involving the Distributed Hydrologic Soil-Vegetation Model (DHSVM) for simulating water quantity from mountainous non-urban watersheds, the Stormwater Management Model (SWMM) for simulating water quantity and nutrient loadings from stormwater/urban sub-catchments, the GoldSim model for simulating agricultural outflows and return flows based on wastewater and water demand, the combined in-lake model for simulating water quality through the Water Quality Assessment Simulation Program (WASP) linked with the Environmental Fluid Dynamics Code (EFDC) for simulating hydrodynamics, and the river WASP model for simulating in-stream water quality processes. The results among the distinct models are integrated for deriving and suggesting linkages among existing and futuristic land use and climate change upon both the water quality and quantity performance. Meanwhile, the project integrates the experimental analyses over Utah Lake for evaluating the environmental processes subject to climate change and land use development with assessments over the public perspective upon the water quantity and quality characteristics of the Jordan River watersheds. Such integration is implemented for addressing several project objectives and outcomes highlighted in Barber et al. (2016).

1.2 MODEL OBJECTIVES

The Jordan River in Salt Lake City, UT that serves as the effluent from Utah Lake has been indicated under the State of Utah's 303(d) for several water quality constituents, primarily water temperature and dissolved oxygen. In particular, the Jordan River is often subject to low flows with elevated water temperature during the summer, suggesting linkages with low DO levels along portions of the Jordan River downstream of the Surplus Canal. On the other hand, previous TMDL studies over the Jordan River employ the Qual2K models developed over the system, which serve as steady-state models and only run over a 1-week time frame. Hence, a WASP model is developed along the Jordan River for addressing the following objectives.

1. Extend previous studies conducted over the Jordan River from the steady-state Qual2K models to the unsteady-state/dynamic continuous simulations
2. Assess the water quality performance of the Jordan River over time, primarily over the summer months under elevated water temperatures and low flows
3. Develop and suggest potential linkages among the water quality performance of the Jordan River against the effluent quantity and quality from Utah Lake
4. Develop and suggest potential linkages among the water quality performance of the Jordan River subject to historical and potentially futuristic land use, such as urbanization
5. Develop and suggest potential linkages among the water quality performance of the Jordan River subject to historical and potentially futuristic climate characteristics (e.g., climate change projections through the representative concentration pathways (RCPs), etc.)

1.3 MODEL BACKGROUND

The Water Quality Assessment Simulation Program (WASP), Version 8.2 and above (June 2018 version and after), is employed for the development and simulation of the Jordan River WASP. WASP generally implements segmentation and simulates water quality concentrations as a flexible boxed model; in other words, the user can define the flow segmentation along a set of segments that are applied as boxes in WASP through any method desired. Meanwhile, the Jordan River WASP implements the Advanced Eutrophication routine, which simulates the following constituents.

- **Dissolved Nitrogen Species:** Ammonia-Nitrogen (NH_3-N), Inorganic Nitrogen (Nitrate and Nitrite) (NO_2-NO_3-N), Dissolved Organic Nitrogen (DON)
- **Dissolved Phosphorus Species:** Dissolved Inorganic Phosphate-Phosphorus (DIP), Dissolved Organic Phosphate-Phosphorus (DOP)
- **Oxygen:** Ultimate Carbonaceous Biochemical Oxygen Demand (CBODU; up to 5 Groups), Dissolved Oxygen (DO), Sediment Oxygen Demand (SOD)
- **Phytoplankton:** Chlorophyll-a (up to 5 Groups)
- **Macroalgae/Benthic Algae:** Chlorophyll-a, Nitrogen, Phosphate Components (up to 3 Groups); can be transported (Macro Algae) or non-transported (Benthic Algae)
- **Particulate Organic Matter (only 1 group allowed for each):** Particulate Organic Matter/Total Detritus (POM), Particulate Organic Carbon/Detrital Carbon (POC), Particulate Organic Nitrogen/Detrital Nitrogen (PON), Particulate Organic Phosphate/Detrital Phosphate (POP)
- **Others:** Water Temperature, Total Suspended Solids (up to 10 Groups), pH, Alkalinity

Meanwhile, under the Advanced Eutrophication routine, WASP simulates nutrient fluxes among the water column and sediment through sediment diagenesis. According to Martin and Wool (2017), the user can specify or have WASP simulate the following nutrient fluxes through the sediment diagenesis routines: benthic ammonia flux, benthic phosphate flux, and sediment oxygen demand (SOD). The nutrient fluxes being inputted by the user manually are only altered based on water temperature-correction coefficients implemented into WASP (e.g., water temperature correction of 1.07 for SOD, etc.). In other words, WASP does not combine the user-specified nutrient fluxes (e.g., prescribed nutrient fluxes, such as prescribed SOD) with those simulated through the sediment diagenesis routines.

Previous versions of WASP (e.g., prior to WASP 8 that is released in August 2016) are employed by previous studies for analyzing the performance of systems of interest. Applications of previous versions of WASP involve assessing the eutrophication characteristics of Lake Okeechobee, FL through WASP 5 (Jin et al. 1998), along employing WASP 6 for supporting TMDL studies along the Neuse River Estuary, NC (Wool et al. 2003). Meanwhile, WASP Version 5 is further implemented for assessing the sorption of heavy metals to suspended solids and the phytoplankton growth limitation toward analyzing water quality concerns along the Saale River in Germany (Lindenschmidt et al. 2007). On the other hand, the version implemented for this exercise, Version 8.3 that is released in December 2018, appears to currently not exhibit significant studies that have applied such version for applications of interest (e.g., evaluating system performance, assessing water quality impairment, etc.).

1.4 CONSTITUENTS FOR THE JORDAN RIVER WASP

One significant advantage of employing WASP Version 8.3 for the Jordan River modeling involves the capability for simulating water temperature without the need of an outside model (e.g., HeatSource). Previous versions of WASP prior to WASP 8 that is released in August 2016 require the user to input water temperature into the model, simulating water temperature through outside models. For instance, WASP 7 requires the user to input water temperature as time-series data into the model, allowing a maximum of 4 sets of time series and hence requiring the user to make approximations accordingly for populating water temperature into several model segments (e.g., over 50 segments, etc.). Hence, along with several other observed advantages of WASP Version 8.3 as compared to previous versions, WASP 8.3 has been employed for the Jordan River model. The following constituents are simulated by the Jordan River WASP.

- **Dissolved Nitrogen Species:** Ammonia-Nitrogen (NH_3-N), Inorganic Nitrogen (Nitrate and Nitrite) (NO_2-NO_3-N), Dissolved Organic Nitrogen (DON)
- **Dissolved Phosphorus Species:** Dissolved Inorganic Phosphate-Phosphorus (DIP), Dissolved Organic Phosphate-Phosphorus (DOP)
- **Oxygen:** Dissolved Oxygen
- **Ultimate Carbonaceous Biochemical Oxygen Demand (CBODU):** 4 groups with the same kinetics- 1) WWTP CBOD (CBOD from WWTP inflows), River CBOD (main Jordan River stream CBOD), Tributary CBOD (CBOD from tributary inflows), Storm Drain and Groundwater CBOD (CBOD from storm drains, conduits, groundwater, etc.)
- **Phytoplankton:** Chlorophyll-a (1 Group only)
- **Macroalgae/Benthic Algae:** Chlorophyll-a, Nitrogen, Phosphate Components (1 Group); Non-Transported (Benthic Algae)
- **Particulate Organic Matter (only 1 group allowed for each):** Particulate Organic Matter/Total Detritus (POM), Particulate Organic Carbon/Detrital Carbon (POC), Particulate Organic Nitrogen/Detrital Nitrogen (PON), Particulate Organic Phosphate/Detrital Phosphate (POP)
- **Others:** Water Temperature, Total Suspended Solids (1 Group), pH, Alkalinity

2 MODEL BUILD

This section summarizes the model structure/segmentation and the input data implemented for the Jordan River WASP.

2.1 MODEL STRUCTURE

The Jordan River WASP model segmentation follows the Jordan River Qual2Kw models developed for the TMDL studies (Stantec Consulting Ltd. 2010). Hence, the Jordan River WASP involves 166 surface water segments with the most upstream segment exhibiting 200 meters (0.2 kilometers) in segment length followed by all other segments with each exhibiting 500 meters in segment length, yielding a total reach length of approximately 83.4 km (approximately 51.8 mi). The model is developed to exhibit several outflows from wastewater treatment plants (WWTPs), tributary outfalls, diversions, etc., which is visually described in the following figure (Figure 1).

Figure 1. Inflows and Segmentation of the Jordan River WASP Model

As displayed in Figure 1, the Jordan River WASP model exhibits an upstream boundary as the effluent from Utah Lake while the most downstream boundary is located at Burton Dam, which is approximately 7.5 km (4.6 mi) downstream of the South Davis South WWTP. The list of WWTP outfalls, tributary outfalls, storm drains/conduits, and diversions along the Jordan River WASP is described in the following table (Table 1).

Table 1. Inflows and Diversions Defined in the Jordan River WASP

INFLOW/OUTFLOW TYPE	CORRESPONDING SEGMENTS (DEFINED AS INFLOW/DIVERSION NAME (SEGMENT #)); ORGANIZED FROM MOST UPSTREAM TO MOST DOWNSTREAM PER INFLOW/OUTFLOW TYPE
DIVERSION	Turner Dam (Segment 32), Joint Dam (Segment 37), North Jordan Canal (Segment 73), Brighton Canal (Segment 98), Surplus Canal (Segment 115), UP&L Diversion (Segment 129)
WASTEWATER TREATMENT PLANT	Jordan Basin (Segment 55), South Valley (Segment 84), Central Valley (Segment 111), South Davis South (Segment 151)
TRIBUTARY/CREEK	Rose Creek (Segment 49), Corner Canyon Creek (Segment 52), Midas Creek (Segment 65), Willow Creek (Segment 66), Dry Creek (Segment 74), Bingham Creek (Segment 81), Little Cottonwood Creek (Segment 97), Big Cottonwood Creek (Segment 100), Millcreek (Segment 111)
STORM DRAINS, CONDUITS	9000 South Conduit (Segment 76), 7800 South Drain (Segment 82), 5400 South Drain (Segment 92), Kearns-Chesterfield Drain (Segment 112), 1300 South Conduit (Segment 122), North Temple Conduit (Segment 130)

The following sub-section describes the sources of data employed for populating the inflow and outflow data for the Jordan River model, along with pertinent meteorological data and segment parameters implemented for the exercise.

2.2 MODEL INPUTS

For this exercise, the Jordan River model is implemented over 5 water years, extending from October 1, 2006 to September 30, 2011. This sub-section describes the sources of data employed for populating the pertinent meteorological time-series data, inflow quantity and quality, diversion, and other model parameters needed for running the Jordan River WASP.

2.2.1 METEOROLOGICAL, SOLAR RADIATION, SHADING

For this exercise, several meteorological parameters are required for populating and running the Jordan River WASP Model as such inputs affect the performance of several water quality constituents, primarily water temperature due to lighting routines, nutrients due to phytoplankton growth and algal photosynthetic followed by respiration processes, and dissolved oxygen due to reaeration. The following table summarizes the list of meteorological parameters required for the Jordan River WASP, the units employed by the WASP model for each parameter, relevant processes in WASP affected by the meteorological parameter, and the water quality constituents for which the parameter appears to exhibit significant effects upon. All meteorological parameters listed in the following table (Table 2) are required to be inputted as time-series data for the Jordan River WASP covering the entire model calibration time frame.

Table 2. Required Meteorological Parameters for the Jordan River WASP

Meteorological Parameter	Units in the Jordan River WASP	Significance upon Jordan River WASP (List of Relevant Processes, Nutrients, etc.)	Water Quality Constituents in WASP Appearing to be Most Affected by Meteorological Parameter
Solar Radiation	Watts per Square Meter	Lighting Attenuation, Phytoplankton Growth, Algal Photosynthetic and Respiration, etc.	Water Temperature
Air Temperature	Degrees Celsius	Water Temperature Model (Lighting Attenuation), Nutrient Kinetics, etc.	Water Temperature
Dewpoint Temperature	Degrees Celsius	Relative Humidity, Water Temperature Model	Water Temperature
Wind Speed	Meters per Second	Reaeration	Dissolved Oxygen
Cloud Cover	Fraction (Dimensionless)	Light Blockage	Water Temperature
Topography and Canopy Shading	Fraction (Dimensionless)	Light Blockage	Water Temperature
CO_2 Atmospheric Abundance	Atmospheres (atm)	Speciation among $H_2CO_3^*$ and CO_2 (e.g., open system vs. closed system; dissociation through Henry's Law; etc.)	pH, Alkalinity, Total Inorganic Carbon (TIC)

For this exercise, three data sources have been employed for retrieving inputs needed for the meteorological parameters described in Table 2. The data source, weblink of reference (if any), site(s) of interest for the meteorological data, and relevant parameters retrieved for the data source have been summarized in the following table (Table 3).

Table 3. Sources of Data for Meteorological Parameters in the Jordan River WASP

Data Source	Weblink for Data Source (if applicable)	Site(s) Retrieved (with Coordinates)	Relevant Parameters	Average Temporal Resolution of Input Data
University of Utah Mesowest Database	https://mesowest.utah.edu/index.html	KSLC for Salt Lake International Airport ($40°47'18"$ N, $-111°58'40"$ W)	Air Temperature, Relative Humidity, Wind Speed, Cloud Cover	Hourly
SOLRAD FTP Database	ftp://aftp.cmdl.noaa.gov/data/radiation/solrad/slc/	Site "slc" for Salt Lake City, UT ($40.77220°$N, $-111.95495°$W)	Solar Radiation	3-minute
UDWQ	N/A	Riparian Vegetation Layer over the Jordan River for August 2009	Topography/Canopy Shading	N/A
IPCC	IPCC (2013). https://www.ipcc.ch/report/ar5/wg1/	Global	Carbon Dioxide Atmospheric Abundance from 2000 to 2020; RCP 8.5 employed for Carbon Dioxide Atmospheric Abundance in 2020	10-year; Approximated as January of each year (e.g., 01/2000, 01/2010, 01/2020)

For this exercise, particular meteorological parameters are calculated based on the input data retrieved from the data sources described in Table 3, with approximations implemented accordingly for populating such inputs needed for the Jordan River WASP.

- **Dewpoint Temperature:** This parameter is calculated based on relationships among air temperature and relative humidity, along with vapor pressure. For this exercise, the saturated vapor pressure in Pascal, e_S is calculated from air temperature in degrees Celsius, *T*, through the following relationship.

$$e_S = 611 \exp\left(\frac{17.27T}{237.3 + T}\right) \tag{1}$$

Then, the vapor pressure, e, is calculated based on saturated vapor pressure, e_S, and relative humidity, R_h, by the following relationship.

$$e = e_S R_h \tag{2}$$

The vapor pressure, e, serves as a function of dewpoint temperature and exhibits a similar form as Equation 1 for computing saturated vapor pressure. Hence, the dewpoint temperature is calculated from vapor pressure derived from Equations 1 and 2 through the following relationship.

$$T_d = \frac{237.3 \ln\left(\frac{e}{611}\right)}{17.27 - \ln\left(\frac{e}{611}\right)} \tag{3}$$

Equations 1 to 3 have been implemented for calculating and populating dewpoint temperature data needed for the Jordan River WASP based on air temperature and relative humidity data provided.

- **Cloud Cover:** The cloud cover data appear to be provided as qualitative data, with identifiers describing the overall cloud cover. The University of Utah's Mesowest Database provides cloud cover data under 3 vertical atmospheric layers, yielding identifiers describing the overall cloud cover per vertical layer. For this exercise, the following table (Table 4) is implemented for approximating the fraction cloud coverage for the different identifiers from the Mesowest Database for describing the overall cloud cover.

Table 4. Approximated Fractions for Cloud Coverage based on Identifiers from the University of Utah's Mesowest Database

Identifier from the University of Utah Mesowest Database	Identifier Definition	Approximated Fraction of Cloud Coverage
0	Missing	0
1	Clear	0
2	Scattered	0.1
3	Broken	0.3
4	Overcast	0.95
5	Obscured	1
6	Thin Scattered	0.05
7	Thin Broken	0.25
8	Thin Overcast	0.9
9	Thin Obscured	0.97

Such fractions of cloud coverage described in Table 4 are derived for distinguishing each identifier against other identifiers (e.g., scattered vs. thin scattered, overcast vs. thin overcast, etc.). For this exercise, the cloud coverage fractions are approximated based on the maximum fractions among the 3 vertical atmospheric layers per time step. For instance, if a time step yields approximated cloud coverage fractions of 0.1 (for code 2 = scattered), 0.97 (for code 9 = thin obscured), and 0.3 (for code 3 = broken) for cloud cover layers 1, 2, and 3, respectively, then a cloud cover of 0.97 (the coverage at layer 2) is populated for the cloud coverage fraction for that time step.

- **Solar Radiation:** The FTP database employed for retrieving solar radiation data exhibits 3-minute observed data organized as separate DAT files per Julian Day, per year, and per site for which only 1 site for Salt Lake City is implemented for the exercise. Consequently, since retrieving and processing such data as individual DAT files, along with removing any missing data, needed for the Jordan River WASP for solar radiation manually appears rather time-consuming and inefficient, an R script (sample script provided in Appendix C.1: R Script for solar radiation data) has been developed and implemented for retrieving such data, removing any missing data, and combining the processed data into a single set of time-series data (e.g., as a single CSV file) that can be directly inputted into the Jordan River WASP.
- **Topography and Canopy Shading:** The Jordan River WASP requires the user to specify the canopy and topography shading as fraction light blockage due to segment topography and canopy. Hence, the riparian vegetation layer provided by the Utah Division of Water Quality is employed for approximating fraction coverage and is representative over the Jordan River in August 2009. For this exercise, two open-source programs from the Washington Department of Ecology (https://ecology.wa.gov/Research-Data/Data-resources/Models-spreadsheets/Modeling-the-environment/Models-tools-for-TMDLs) are implemented for approximating canopy and topography shading.
    1. **TTools**, originally developed by the Oregon Department of Environmental Quality as a VBA program but then re-derived as a Python version by the Washington Department of Ecology, is an ArcGIS extension that derives topographic and riparian vegetation characteristics (e.g., slope, azimuth, curvature, etc.) based upon the riparian vegetation layer that defines the height and density for distinct land uses. This program yields an ArcGIS layer that defines such topographic and riparian vegetation characteristics per river segment
    2. The **Shade** program serves as an Excel/VBA tool employed for calculating topography and canopy shading per segment, employing the results for topographic and riparian vegetation characteristics from TTools. The program yields hourly time-series data for each river segment over 1 year and is based on the time period for which the riparian vegetation layer is developed. For this exercise, since the Jordan River riparian vegetation layer is representative of August 2009, the hourly canopy and topography shading per segment is computed over a 365-day time period, with day 1 as August 1. (Hence, since the canopy and topography shading are computed based on the riparian vegetation layer from August 2009, the model calibration period has been selected so that the time period centers at Water Year 2009, thus implementing 2 years before and after this water year.)

Meanwhile, since the Jordan River WASP allows the user to input a maximum of 4 time functions for defining canopy and topography shading rather than 1 time function per river segment (e.g., 166 time functions), the topography and canopy shading calculated by the Shade program is combined among multiple segments for yielding 4 groups of segments. Such grouping is implemented for following the Jordan River segmentation defined by Diffuse Sources documented by Stantec Consulting Ltd. (2010) for the development of the Jordan River Qual2Kw models, which is described in the following table (Table 5). (For each group, the time series for canopy and topography shading from the Shade Program is averaged among all segments involved in the group.)

Table 5. Topography and Canopy Shading Segmentation and Grouping for the Jordan River WASP

Topography/Canopy Time Function	Diffuse Source Segments in TMDL Qual2K	Jordan River WASP Segments	Jordan River Segment (Geography)
1	8 and 7	1 to 45	**Most Upstream (Utah Lake Effluent)** to **2 km Upstream of Rose Creek**
2	6 and 5	46 to 86	**1.5 km Upstream of Rose Creek** to **Upstream of 6400 South Weir (includes South Valley WWTP)**
3	4 and 3	87 to 129	**6400 South Weir** to **UP&L Diversion**
4	2 and 1	130 to 166	**North Temple Conduit** to **Burton Dam**

The following figure (Figure 2) provides the spatial coverage of 4 canopy and topography time functions for the Jordan River WASP.

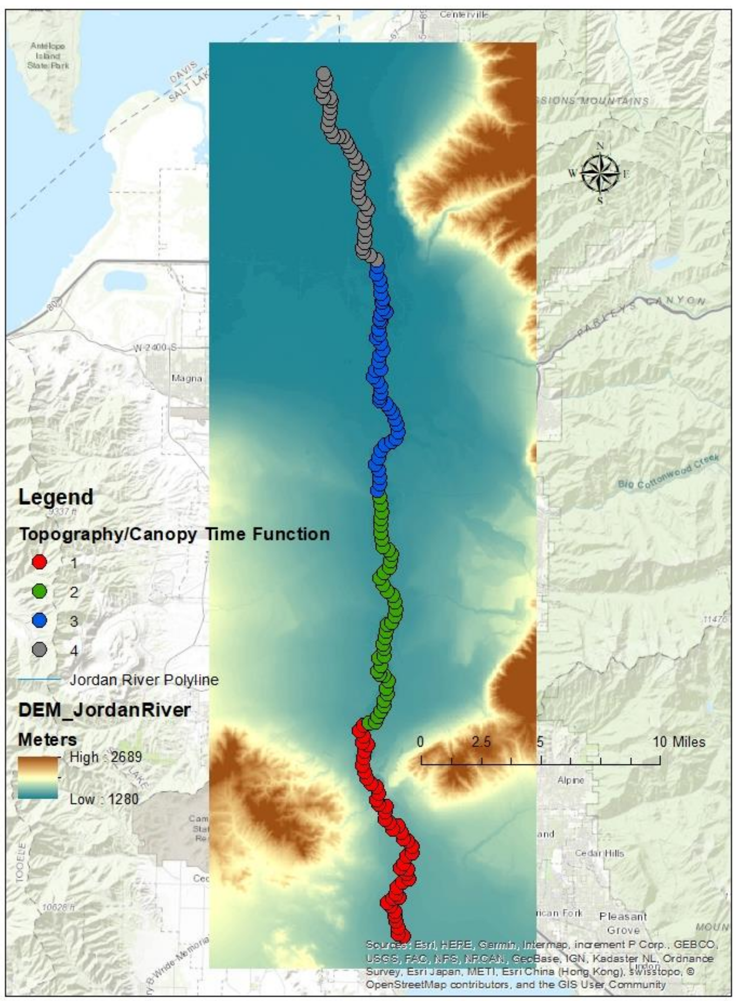

Figure 2. Canopy and Topography Shading Time Function Spatial Coverage over the Jordan River

2.2.2 INFLOW AND OUTFLOW QUANTITY DATA

For this exercise, several sources have been implemented for populating inflow quantity data and outflow diversion for populating several inflows into the Jordan River WASP (Figure 1 for list of inflows and outflows), involving the Ambient Water Quality Monitoring System (AWQMS) database for the Utah Division of Water Quality (UDWQ), the Utah Division of Water Rights (UDWR), and the Salt Lake County (SLC) Tributary Inflows. At the same time, several of the inflows and outflows for the Jordan River WASP have been interpolated for ensuring that no single segment yields zero segment outflow, which such characteristic instigates WASP to shut down. The following table (Table 6) lists the inflow/property/segment, the source of data, the corresponding site, and any interpolations applied upon implementing the inflow data. (Note: The following table does not include sources for groundwater inflow quantity data into the Jordan River WASP, which one should refer to Section 2.2.4 for descriptions regarding the groundwater inflow quantity and quality data into the model.)

Table 6. List of Inflow Quantity Data Sources for Inflows/Outflows for the Jordan River WASP Organized from Most Upstream to Most Downstream

Segment	Segment Name in WASP	Data Source	Site(s) (Blank = Not Applicable)	Notes (if any; Blank = Not Applicable)
Inflow from Utah Lake	JR1	UDWR; System "Utah Lake/Jordan River"	Utah Lake Outflow (Monthly) 05 Jordan River Narrows (Total)	Daily Values Interpolated based on Data from Utah Lake Outflow (Monthly), with data for this site applied for time period from October 1, 2006 to December 31, 2008; Site 05 Jordan River Narrows (Total) applied for January 1, 2009 and after as site not operating until this time period
Turner Dam; Diversion	JR32	UDWR; System "Utah Lake/Jordan River"	05.01.07 Jordan Valley Water Conservancy Dist 06.02 Utah & Salt Lake Canal 06.01 Utah Lake Distributing (59-13) 06.03 East Jordan Canal (Total)	Summation of 05.01.07, 06.02, 06.01, 06.03; total flows diverted adjusted to maintain a minimum flow of 0.5 m^3/s along this Jordan River WASP segment for model flow stability
Joint Dam; Diversion	JR37	UDWR; System "Utah Lake/Jordan River"	07.01 Jordan & Salt Lake Canal (SLC) (57-7624) 07.02 South Jordan Canal (Total)	Summation of 07.01, 07.02; total flows diverted adjusted to maintain a minimum flow of 0.5 m^3/s along this Jordan River WASP segment for model flow stability
Rose Creek	JR49	No Data		
Corner Canyon Creek	JR52	No Data		
Jordan Basin WWTP	JR55	No Data		WWTP not installed and operating until after model calibration period (WWTP installed in 2012)
Midas Creek	JR65	UDWQ; AWQMS	4994420 (Butterfield/Midas Ck ab Jordan River)	

Willow Creek	JR66	No Data		
North Jordan Canal; Diversion	JR73	UDWR; System "Utah Lake/Jordan River"	10 North Jordan Canal	Total flows diverted adjusted to maintain a minimum flow of 0.5 m^3/s along this Jordan River WASP segment for model flow stability
Dry Creek	JR74	No Data		
9000 South Conduit	JR76	No Data		
Bingham Creek	JR81	UDWQ	4994190 (Bingham Ck at 1300 West)	
7800 South Drain	JR82	UDWR	05.01.07 Jordan Valley Water Conservancy Dist 06.01 Utah Lake Distributing Canal (59-13)	Summation of 10% of 05.01.07, 20% of 06.01 for representing as Return Flow for this segment
South Valley WWTP	JR84	UDWQ Discharge Monthly Reports (DMRs)	South Valley	
5400 South Drain	JR92	No Data		
Little Cottonwood Creek	JR97	SLC	SLC 290 (Little Cottonwood Creek at 300 West)	
Brighton Canal; Diversion	JR98	No Data		
Big Cottonwood Creek	JR100	SLC	SLC 390 (Big Cottonwood Creek at 300 West)	
Millcreek and Central Valley WWTP	JR111	Central Valley WWTP: UDWQ Discharge Monthly Reports (DMRs) Millcreek before Central Valley WWTP: SLC	Central Valley WWTP: Central Valley Millcreek before Central Valley WWTP: SLC 490 (Mill Creek @460 West)	Summation of Central Valley, SLC 490
Kearns-Chesterfield Drain	JR112	UDWR; System "Utah Lake/Jordan River"	07.02 South Jordan Canal (Total) 10 North Jordan Canal (Total)	Summation of 20% of 07.02, 20% of 10 for indicating as Return Flow for this segment
Surplus Canal; Diversion	JR115	UDWR; System "Lower Jordan River"	At 17th South	Flow Diverted from the Jordan River to the Surplus Canal adjusted to have flows correspond to the UDWR site "At 17th South"; total flows diverted adjusted to maintain a minimum flow of 0.5 m^3/s along this Jordan River WASP segment for model flow stability
1300 South	JR122	SLC	SLC 520 (Parley's Creek	Summation of SLC 520, SLC 620, SLC

Conduit			at Suicide Rock) SLC 620 (Emigration Creek at Canyon Mouth) SLC 740 (Red Butte Creek at 1600 East)	740
UP&L Diversion; Diversion	JR129	No Data		
North Temple Conduit	JR130	SLC	SLC 820 (City Creek at Memory Grove Park)	
South Davis South WWTP	JR151	UDWQ Discharge Monthly Reports (DMRs)	South Davis South	

As indicated in Table 6 above, several approximations, approaches, etc. have been implemented for populating inflow/outflow quantity data for the Jordan River WASP. Such approaches, approximations, etc. that are applied for this exercise are explained as follows.

- **Inflows/Outflows with Missing Data:** Several inflows/outflows along the Jordan River appear to not exhibit any data that can be retrieved as input quantity into the Jordan River model. Hence, no inflow quantity data have been populated for these segments though flow functions are inputted into the Jordan River WASP for indicating inflows into such segments.
- **Time Stamp for the Discharge Monthly Reports (DMRs) for WWTPs:** WASP requires all inflow quantity and quality data specified to exhibit corresponding time stamps. Hence, since the Discharge Monthly Reports (DMRs) retrieved for populating inflow quantity and quality data for WWTP outfalls do not exhibit a time stamp (e.g., only date is provided), a time stamp of 12 PM is implemented for the exercise.
- **Minimum Flow along Segments in Jordan River WASP:** WASP requires all model segments to exhibit non-zero inflow/outflow quantity throughout the model simulation period. At the same time, WASP applies relatively small time steps (e.g., less than 1 second) if flows along a single segment approaches 0 during the simulation period. Hence, for this exercise, all the flows diverted along the indicated segments described in Table 6 above are adjusted for yielding a minimum flow of 0.5 m^3/s along all Jordan River WASP segments.
- **R Script for Processing Inflow Data from Salt Lake County (SLC) Tributary Historical Database:** The Salt Lake County (SLC) Tributary Historical Data provides inflow quantity that are organized as individual TXT files based on per SLC site and per water year. For instance, one retrieving inflow quantity data for Little Cottonwood Creek from the Salt Lake County Tributary Historical Database will exhibit 5 TXT files for 5 water years. Hence, due to the output format of the inflow sites retrieved from the Salt Lake County (SLC) Tributary Historical Data, an R Script (sample script provided in C.2: R Script for obtaining inflow data from Salt Lake County) has been developed for processing and combining the inflow data into a single CSV file that can be directly inputted into the Jordan River WASP Model.

2.2.3 INFLOW QUALITY DATA

For this exercise, the Utah Division of Water Quality (UDWQ), through the AWQMS database or through the DMRs, is employed as the data source for retrieving inflow quality data for the Jordan River WASP. The following table (Table 7) lists the inflow, corresponding WASP segment, and the AWQMS/DMR site for populating quality data.

Table 7. Data Sources and Sites for Inflow Quality Data for Inflows into the Jordan River WASP Organized from Most Upstream to Most Downstream

Inflow	Segment Name in WASP	UDWQ AWQMS, DMR, or No Data	Site ID (and Name; Blank = Not Applicable)
Utah Lake Outflow	JR1	AWQMS	4994790 (Jordan R at Utah L Outlet U121 Xing)
Rose Creek	JR49	No Data	
Corner Canyon Creek	JR52	No Data	
Jordan Basin WWTP	JR55	No Data; see note in Table 6	
Midas Creek	JR65	AWQMS	4994420 (Butterfield/Midas Ck ab Jordan River)
Willow Creek	JR66	No Data	
Dry Creek	JR74	No Data	
9000 South Conduit	JR76	No Data	
Bingham Creek	JR81	AWQMS	4994190 (Bingham Ck at 1300 West)
7800 South Drain	JR82	AWQMS	4994170 (Jordan at 7800 S Xing Ab S Valley WWTP)
South Valley WWTP	JR84	DMR	South Valley
5400 South Drain	JR92	No Data	
Little Cottonwood Creek	JR97	AWQMS	4993580 (Little Cottonwood Ck 4900 S 600 W SLC)
Big Cottonwood Creek	JR100	AWQMS	4992970 (Big Cottonwood Ck Ab Jordan R @ 500 W 4200 S)
Millcreek and Central Valley WWTP	JR111	AWQMS	4992480 (Millcreek Ab Confl/Jordan River Bl Central Valley WWTP Discharge)
Kearns-Chesterfield Drain	JR112	AWQMS	4992390 (Decker Pond Outflow Ab Jordan R)
1300 South Conduit	JR122	AWQMS	4992070 (Jordan River at 1300 S Storm Sewer Mouth)
North Temple Conduit	JR130	AWQMS	4991920 (City Ck/North Temple Conduit Ab Jordan R)
South Davis South WWTP	JR151	DMR	South Davis South

At the same time, distinct sets of inflow data are retrieved depending on whether such inflow quality data are obtained from AWQMS sites or from DMRs. The water quality parameters by species and the temporal resolution of the inflow data for DMRs as compared to the AWQMS sites is summarized in the following table (Table 8).

Table 8. Water Quality Constituents for Inflow Data from DMRs vs. AWQMS Sites

Species of Interest	Constituents from DMRs (N/A = Not Applicable)	Constituents from AWQMS sites
Nitrogen	NH_3-N, NO_2-NO_3-N	NH_3-N, NO_2-NO_3-N, DON, TKN
Phosphorus	TP	DP, TP
Temperature	Water Temperature	Water Temperature
BOD	BOD (5-day)	BOD (5-day), CBOD (5-day)
Oxygen	DO	DO
Solids	N/A	TSS
Chlorophyll-a	N/A	PHYTO (Limited Data only)
Others	N/A	pH, Alkalinity

For this exercise, several approximations and approaches are implemented for populating inflow quality data for the segments along the Jordan River WASP indicated in Table 7. These approximations and approaches have been explained below.

- **Qual2K Jordan River Models as Supplemental Inflow Quality Data:** The DMRs and the AWQMS sites generally exhibit inadequate data for populating inflow quality data, primarily POM and phytoplankton chlorophyll-a (limited data). For instance, as indicated in Table 8, none of the DMRs exhibit inflow quality data for TSS, pH, alkalinity, and DON. Hence, Qual2K models are obtained from the UDWQ for the Jordan River and are employed for supplementing such data. Particularly, the Qual2K Jordan River steady-state models are obtained from the UDWQ for the following time periods: 1) October 2006, 2) February 2007, 3) September 2007, 4) August 2009, and 5) July 2014. Since the Qual2K Jordan River models cover the model calibration period (October 1, 2006 to September 30, 2011), all the inflow quality loadings that can be provided by the Qual2K models have been populated into the Jordan River WASP.
- **Initial Conditions from Qual2K Jordan River Model:** For this exercise, the Qual2K October 2006 steady-state Jordan River model is simulated for yielding concentrations for distinct water quality constituents. The concentrations yielded by the Qual2K October 2006 Jordan River model at time t = 0 for each Jordan River segment are implemented as initial conditions for the Jordan River WASP, approximating time t = 0 for the Qual2K October 2006 model as October 1, 2006.
- **Total Phosphorus Speciation:** Since WASP requires the user to specify influent quality concentrations for each of DIP and DOP, the AWQMS sites and the DMRs yielding TP and/or only DP data can not be directly populated into the Jordan River WASP. Hence, the following approximations are implemented for yielding DIP and DOP inflow loadings from TP or DP concentrations provided by the DMRs and the AWQMS sites.
    - **DMR DIP and DOP from TP Influent Concentration:** The Qual2K Jordan River steady-state models provided by UDWQ exhibit inflow concentrations for both DIP and DOP for each WWTP. For this exercise, such values are applied for deriving the ratios DIP-to-TP followed by DOP-to-TP, which such ratios are further implemented as the ratio for the corresponding month. For instance, the Qual2K Jordan River October 2006 model is implemented for deriving DIP/TP and DOP/TP ratios for all WWTPs that are represented as the ratios for October. The ratios derived from each Qual2K Jordan River model are multiplied by the DMR TP concentration per WWTP for yielding DIP (TP * DIP/TP ratio per month) and DOP (TP * DOP/TP ratio per month) concentrations for each WWTP.
    - **AWQMS DOP Derived from DP and TP:** The AWQMS sites provide influent concentrations for DP and for TP, which the approach described by Stantec Consulting Ltd. (2010) is implemented for deriving DIP and DOP influent concentrations. For this exercise, the DP concentrations from the AWQMS sites are applied as DIP concentrations while DOP concentrations are derived by subtracting the TP by the DP concentration.
- **CBODU/BODU Concentrations from CBOD/BOD (5-day):** Since WASP requires the user to specify the ultimate CBOD (CBODU) influent concentration rather than the 5-day CBOD (CBOD (5-day)), the following relationship is implemented for deriving the CBODU concentrations from CBOD (5-day) influent concentrations provided by the DMRs and the AWQMS sites.

$$\mathrm{L}_0 = \frac{\mathrm{L}_t}{1 - \exp(-kt)} \tag{4}$$

As indicated in Equation 4, the CBODU concentration L_0 is calculated based on the CBOD concentration at time t, L_t, with the CBOD decay rate k that is approximated as 0.2 per day. For this exercise, Equation 4 is applied upon all CBOD/BOD influent concentrations from the DMRs and AWQMS sites.

- **DON Concentrations from AWQMS Sites:** For this exercise, since TKN serves as the concentration of all nitrogen species without nitrate-nitrite nitrogen (NO_2-NO_3-N), TKN influent data for each AWQMS site per time step is subtracted by the interpolated ammonia-nitrogen (NH_3-N) concentration, which the result is approximated as representing the DON concentration per time step. Such interpolations among NH_3-N data appear needed due to the relatively coarse temporal resolution of the TKN data (e.g., only a few TKN measurements throughout the model calibration period) as compared to NH_3-N.
- **Combined Millcreek and Central Valley WWTP:** The Central Valley WWTP discharges into Millcreek that then discharges into the Jordan River, which elemental mass balances are typically employed through WASP for inputting influent quantity and quality from Millcreek into the Jordan River. On the other hand, since no hydraulic dimensions for Millcreek (e.g., bottom width, channel slope, etc.) have been provided or can be retrieved, Millcreek is combined with the Central Valley WWTP into a single segment (JR111) for the Jordan River WASP. At the same time, while the UDWQ DMR can be implemented for defining influent concentrations for the Central Valley WWTP, no sites (e.g., AWQMS sites) that exhibit data within the model calibration time period can be obtained for representing Millcreek before the discharge from the Central Valley WWTP toward applying such elemental mass balance. Due to such characteristics, the AWQMS site 4992480 that is located along Millcreek downstream of the Central Valley WWTP discharge is employed for populating influent concentrations for this inflow, unlike the approach applied for populating inflow quantity (Table 6) for which the inflows are implemented separately among Central Valley WWTP and Millcreek.

2.2.4 GROUNDWATER INFLOW QUANTITY

In addition to the inflow quantity and quality from WWTPs, tributaries, and storm drains, collaborations are conducted with the UDWQ for applying groundwater inflow quantity and quality into the Jordan River modeling work. For this exercise, groundwater flow quantity data are retrieved from the UDWQ, which such data are estimated under the “Jordan River Return Flow Study” (2005). In this exercise, groundwater inflow quantity data are applied as monthly outflows with a single groundwater outflow value per month along an indicated portion of the Jordan River. For the Jordan River WASP modeling work, similar methodologies as those applied for the Jordan River Qual2K models (Stantec Consulting Ltd 2010) are applied for populating groundwater inflow quantity along the Jordan River, implementing 8 diffuse source segments with river mileage and corresponding segments described in the following table (Table 9).

Table 9. Groundwater Segmentation from the Jordan River Qual2K into Jordan River WASP, with Diffuse Source Segmentation/Regions Organized from Most Upstream to Most Downstream along the Jordan River

Groundwater Diffuse Source Region	Upstream Region Distance from Downstream (km)	Approximated Corresponding Most Upstream Segment in Jordan River WASP	Downstream Region Distance from Downstream (km)	Approximated Corresponding Downstream Segment in Jordan River WASP
8	82.7	JR1	67.5	JR31
7	67.5	JR32	60.5	JR45
6	60.5	JR46	42.5	JR81
5	42.5	JR82	40	JR86
4	40	JR87	25.5	JR115
3	25.5	JR116	18.5	JR129
2	18.5	JR130	11.5	JR143
1	11.5	JR144	0	JR166

For this exercise, several approximations are applied for populating groundwater quantity data into the Jordan River WASP, based on data provided by the UDWQ through the "Jordan River Return Flow Study" (2005) report.

- **Implementation of Monthly Groundwater Inflow as Time-Series Data along Model Calibration Period:** The Jordan River WASP requires the groundwater inflow quantity populated as time-series data covering the entire model calibration period (e.g., from October 1, 2006 to September 30, 2011). Meanwhile, the groundwater inflow quantity data provided by UDWQ yields only inflows per diffuse source segment per month (e.g., one groundwater inflow for Diffuse Source Segment 8 for January overall, for February overall, etc.). Hence, for this exercise, such groundwater inflow quantity data are applied for yielding uniform inflow quantity per diffuse source segment for the same month for each year. For instance, the groundwater inflow quantity for Diffuse Source Segment 8 for January 2007 equates to the groundwater inflow quantity for the same corresponding diffuse source segment (e.g., Segment 8) for January 2008, January 2009, etc. At the same time, such groundwater monthly outflow data per diffuse source segment are implemented as the end of each month (e.g., September groundwater outflow indicated with time stamp of 09/30 of each year along the model calibration period).
- **Distribution of Monthly Groundwater Inflow Quantity along Jordan River WASP Segments:** For this exercise, each monthly groundwater inflow quantity value per diffuse source region is distributed among the Jordan River WASP segments by having each monthly inflow value divided by the number of WASP segments included in each diffuse source segment indicated in Table 9. In other words, the monthly groundwater inflow quantity per WASP segment is re-calculated through the following relationship.

$$GW_{t,j,DS} = \frac{GW_{t,DS}}{\sum_j DS_j} \tag{5}$$

As indicated in Equation 5 above, the groundwater inflow quantity per time *t* and per WASP segment *j* along each diffuse source region *DS*, $GW_{t,j,DS}$, is calculated by dividing the monthly groundwater inflow quantity per time *t* and diffuse source region *DS*, $GW_{t,DS}$, by the number of segments within the diffuse source region, $\sum_j DS_j$. The following table displays the application of Equation 5 per groundwater diffuse source region for populating monthly groundwater inflow quantity data for each WASP segment.

Table 10. Application of Groundwater Inflow Quantity into each WASP Segment per Diffuse Source Region

Groundwater Diffuse Source Region	Most Upstream WASP Segment	Most Downstream WASP Segment	Formulation for Groundwater Inflow Quantity per WASP Segment
8	JR1	JR31	$GW_{t,j,8} = \frac{GW_{t,8}}{31}$
7	JR32	JR45	$GW_{t,j,7} = \frac{GW_{t,7}}{14}$
6	JR46	JR81	$GW_{t,j,6} = \frac{GW_{t,6}}{36}$
5	JR82	JR86	$GW_{t,j,5} = \frac{GW_{t,5}}{36}$
4	JR87	JR115	$GW_{t,j,4} = \frac{GW_{t,4}}{29}$
3	JR116	JR129	$GW_{t,j,3} = \frac{GW_{t,3}}{14}$
2	JR130	JR143	$GW_{t,j,2} = \frac{GW_{t,2}}{14}$
1	JR144	JR166	$GW_{t,j,1} = \frac{GW_{t,1}}{23}$

- **Implementation of Groundwater Inflow Quantity along Jordan River Segments with vs. without any Point Sources, Tributaries, etc.:** Several segments along the Jordan River WASP are indicated as exhibiting inflows from WWTPs, tributaries, etc. (Table 1). Due to the characteristics of the Jordan River WASP, applying groundwater inflow quantity followed by quality data along a single segment requires the user to conduct elemental mass balance calculations for each water quality constituent per segment, which appears rather time-consuming and thus inefficient. Therefore, the groundwater inflow quantity data re-calculated based on the number of segments per diffuse source region are adjusted for selected segments, as described in the following table (Table 11).

Table 11. Adjustment of Monthly Groundwater Inflow Quantity into Selected Jordan River WASP Segments from Most Upstream to Most Downstream

Jordan River WASP Segment	Adjustment upon Groundwater Quantity Data	Notes
JR2	$GW_{t,2,8} = 2GW_{t,j,8}$	Doubled for including Groundwater into JR1 (Utah Lake Effluent), with JR1 as most upstream segment for Diffuse Source Region 8
JR48	$GW_{t,48,6} = 2GW_{t,j,6}$	Doubled for including Groundwater into JR49 (Rose Creek)
JR51	$GW_{t,51,6} = 2GW_{t,j,6}$	Doubled for including Groundwater into JR52 (Corner Canyon Creek)
JR54	$GW_{t,54,6} = 2GW_{t,j,6}$	Doubled for including Groundwater into JR55 (Jordan Basin WWTP)
JR64	$GW_{t,64,6} = 3GW_{t,j,6}$	Tripled for including Groundwater into JR65 (Midas Creek) and JR66 (Willow Creek)
JR73	$GW_{t,73,6} = 2GW_{t,j,6}$	Doubled for including Groundwater into JR74 (Dry Creek)
JR75	$GW_{t,75,6} = 2GW_{t,j,6}$	Doubled for including Groundwater into JR76 (9000 South Conduit)
JR80	$GW_{t,80,6} = 2GW_{t,j,6}$	Doubled for including Groundwater into JR81 (Bingham Creek)
JR83	$GW_{t,83,5} = 3GW_{t,j,5}$	Tripled for including Groundwater into JR82 (7800 South Drain), with JR82 as the most upstream segment for Diffuse Source Region 5, and into JR84 (South Valley WWTP)
JR91	$GW_{t,91,4} = 2GW_{t,j,4}$	Doubled for including Groundwater into JR92 (5400 South Drain)
JR96	$GW_{t,96,4} = 2GW_{t,j,4}$	Doubled for including Groundwater into JR97 (Little Cottonwood Creek)
JR99	$GW_{t,99,4} = 2GW_{t,j,4}$	Doubled for including Groundwater into JR100 (Big Cottonwood Creek)
JR110	$GW_{t,110,4} = 2GW_{t,j,4}$	Doubled for including Groundwater into JR111 (Millcreek and Central Valley WWTP)
JR121	$GW_{t,121,3} = 2GW_{t,j,3}$	Doubled for including Groundwater into JR122 (1300 South Conduit)
JR131	$GW_{t,131,2} = 2GW_{t,j,2}$	Doubled for including Groundwater into JR130 (North Temple Conduit), with JR130 as the most upstream segment for Diffuse Source Region 2
JR150	$GW_{t,150,1} = 2GW_{t,j,1}$	Doubled for including Groundwater into JR151 (South Davis South WWTP)

As indicated in Table 11 above, adjustments upon the monthly groundwater inflow quantity per segment computed through Equation 5 are applied upon selected segments so that no elemental mass balance calculations upon the water quality constituents are needed along a single segment. For this exercise, even segments with inflows that do not exhibit any data (e.g., segments with data sources indicated as "No Data" in Table 7) are incorporated for such adjustments. All other segments that are not included in Table 11 above have the groundwater monthly inflow quantity populated through the application of Equation 5.

2.2.5 GROUNDWATER INFLOW QUALITY

For this exercise, the Jordan River Qual2K models under diffuse sources (Stantec Consulting Ltd. 2010) are applied for populating groundwater inflow quality. The following table (Table 12) describes each Qual2K model, date/time implemented into the Jordan River WASP, and the water quality constituents retrieved.

Table 12. Groundwater Inflow Quality Data Sources for the Jordan River WASP

Qual2K Model	Date/Time Implemented into Jordan River WASP	Water Quality Constituents Retrieved for Groundwater Inflow Quality
October 2006	10/1/2006 at 12:00 AM	Water Temperature, TSS, NH_3-N, NO_2-NO_3-N, DON, DIP, DOP, CBODU (assumed as Slow CBOD + Fast CBOD)
February 2007	2/28/2007 at 12:00 PM	Water Temperature, TSS, NH_3-N, NO_2-NO_3-N, DON, DIP, DOP, CBODU (assumed as Slow CBOD + Fast CBOD)
September 2007	9/4/2007 at 12:00 PM	Water Temperature, TSS, NH_3-N, NO_2-NO_3-N, DON, DIP, DOP, CBODU (assumed as Slow CBOD)
August 2009	8/19/2009 at 12:00 PM	Water Temperature, TSS, NH_3-N, NO_2-NO_3-N, DON, DIP, DOP, CBODU (assumed as Slow CBOD)
July 2014	7/22/2014 at 12:00 PM	Water Temperature, TSS, NH_3-N, NO_2-NO_3-N, DON, DIP, DOP, CBODU (assumed as Slow CBOD)

In this exercise, the groundwater inflow quality data described in Table 12 above are applied as time-series data into each Jordan River WASP segment. Since each Qual2K Jordan River model only includes groundwater inflow quality data for each diffuse source region, the groundwater inflow quality data for each diffuse source region are applied uniformly among all Jordan River WASP segments within each diffuse source region. For instance, all the Jordan River WASP segments, except those with inflows other than groundwater, within Diffuse Source Region 8 exhibit uniform groundwater inflow quality for each time period (e.g., uniform values for 10/1/2006 at 12:00 AM, 2/28/2007 at 12:00 PM, etc.). For this exercise, no additional groundwater inflow quality data are referenced and implemented into the Jordan River WASP.

2.2.6 MODEL SEGMENT PARAMETERS

For this exercise, the Jordan River Qual2K models (Stantec Consulting Ltd 2010) retrieved from UDWQ are implemented for defining segment characteristics. The list of segment parameters, organized by topic, retrieved from the Jordan River Qual2K applied into the Jordan River WASP is described in the following table (Table 13).

Table 13. List of Model Segment Parameters and Constants Retrieved from the Qual2K Models for the Jordan River WASP Segments

Major Property	List of Model Segment Parameters from Qual2K
Hydraulic Characteristics	Bottom Width, Segment Length Segment Elevation, Channel Roughness (e.g., Manning's Friction Factor), Average Water Velocity, Average Segment Depth, Channel Slope
Macro/Benthic Algae	Fraction of Segment Bottom Covered by Benthic Algae
Settling Rates	Solids Settling Rate, Phytoplankton Settling Rate, Detritus/POM Settling Rate
Lighting Coefficients	Background Light Extinction, POM and Solids Light Extinction (as POM Light + Solids Light)

The following section, Section 3, describes the sensitivity approaches implemented for assessing the performance of the Jordan River WASP subject to distinct model parameter inputs.

3 MODEL SENSITIVITY

This section describes the analyses, example plots, and methodologies implemented for conducting the sensitivity analyses upon the Jordan River WASP.

3.1 SENSITIVITY METHODOLOGY

WASP requires input for time-series, constants, multipliers, etc. for simulating several processes that affect water quality nutrients under the advanced eutrophication routines described in Section 1.4. Hence, not all input parameters are selected for conducting such sensitivity analyses upon the Jordan River WASP, which only those that appear to exhibit significant effects upon model performance are incorporated for the exercise. The following table (Table 14) describes the list of parameters, which are organized based on major nutrient/process, for which sensitivity analyses are conducted upon for the Jordan River WASP.

Table 14. Model Input Parameters subject to Sensitivity Analyses upon the Jordan River WASP

Constituent	WASP Model Parameters (Units, Methodology); Methodology indicated as "Method A" = by Percentage/Fraction or "Method B" = by Value
Water Temperature	• Coefficient for Bottom-Heat Exchange (W/m^2-°C; Method A) • Sediment Ground Temperature (°C; Method B)
Nitrogen (NH_3-N, NO_2-NO_3-N, DON)	• Nitrification Rate at 20°C (per day; Method A) • Half-Saturation Constant for Nitrification Oxygen Limit (mg O_2/L; Method B) • Denitrification Rate at 20°C (per day; Method A) • Half-Saturation Constant for Denitrification Oxygen Limit (mg O_2/L; Method B) • Dissolved Organic Nitrogen Mineralization Rate at 20°C (per day; Method A)
Phosphorus (DOP)	• Dissolved Organic Phosphate Mineralization Rate at 20°C (per day; Method A)
CBOD	• CBOD Half-Saturation Oxygen Limit (mg O_2/L; Method B) • Fraction of CBOD Carbon Source for Denitrification (dimensionless; Method B)
DO	• Maximum Allowable Calculated Reaeration Rate (per day; Method B)
Phytoplankton, Macro/Benthic Algae	• Phytoplankton Maximum Growth Rate at 20°C (per day; Method A) • Phytoplankton Respiration Rate at 20°C (per day; Method A) • Phytoplankton Death Rate (Non-zooplankton Predation) at 20°C (per day; Method A) • Phytoplankton Half-Saturation for Mineralization Rate (mg Phyto C/L; Method B) • Phytoplankton Settling Rate (m/day; Method A) • Macro Algae Respiration Rate (per day; Method A) • Macro Algae O_2:C Production (mg O_2/mg C; Method B) • Fraction of Segment Covered by Algae (dimensionless; Method A)
Solids (TSS)	• Solids Settling Rate (m/day; Method A)
pH/Alkalinity	• CO_2 Partial Pressure (atm; Method B)
POM/Sediment Diagenesis	• POM/Detritus Settling Rate (m/day; Method A) • Initial POC Sediment Condition (mg O_2 equivalents/g sediment; Method B) • Initial PON Sediment Condition (mg N/g sediment; Method B) • Initial POP Sediment Condition (mg P/g sediment; Method B) • Fraction of PON/POP/POC in Class G1 Labile (dimensionless; Method B) • Fraction of PON/POP/POC in Class G2 Refractory (dimensionless; Method B) • Fraction of PON/POP/POC in Class G3 Inert (dimensionless; Method B)
Lighting	• Background Light Extinction Coefficient (1/m; Method A) • Detritus/POM and Solids Light Extinction Coefficient (1/m; Method A) • DOC Light Extinction Coefficient (1/m; Method A)

For this exercise, sensitivity analyses are conducted upon the Jordan River WASP by altering a single value of a selected parameter (described in Table 14 above). A separate WASP model (e.g., input WIF file) is created and renamed based on the selected model parameter and the indicated value. For instance, if the POM settling rate has been altered to 1 m/day with the original model POM settling rate specified as 0.1 m/day, then a separate WASP model will be created and renamed as "…_POMSettlingRate1.wif" to indicate that a POM settling rate of 1 m/day is employed in the WIF file instead. The created WIF file based on the model parameter and value is then run for generating a separate BMD2 file with results that are compared against the output BMD2 file from the original WASP model for which default values are applied. Meanwhile, for the sensitivity analyses conducted upon the Jordan River WASP, the following two sensitivity methods (indicated as "Method A" and "Method B" in Table 14 above) are employed in this exercise.

- **Method A** employs a specified percentage to a model parameter for which the value is known and/or retrieved from measured data/previous models (e.g., Qual2K). For this exercise, this method alters the value of the input parameter by the following percentages: $\pm$50% (e.g., increase by 50%, decrease by 50%), doubled (increased by a factor of 2), increased/reduced by a factor of 10 (e.g., decreased by 90%, increased by 10 times the amount), and increased/reduced by a factor of 100 (e.g., decreased by 99%, increased by 100 times the amount).
- **Method B** is implemented to a model parameter for which the value is NOT retrieved from measured data/previous models (e.g., Qual2K). At the same time, the literature researched for retrieving such values toward populating such model parameters appear to yield a range of values for the indicated parameter, or no credible literature can be identified for retrieving such values for populating these model parameters. For this exercise, this method alters the value of the input parameter to a particular value rather than by a percentage. For instance, the half-saturation constant for nitrification oxygen limit can be altered to 20 mg O_2/L, then 100 mg O_2/L, etc. with a defined value for this parameter (e.g., 2 mg O_2/L).

The list of values employed in the sensitivity analyses per model input parameter described in Table 14 is provided in Appendix A.1: Sensitivity Parameters and Methodology.

3.2 OBSERVATIONS FROM MODEL SENSITIVITY ANALYSES

Based on the sensitivity analyses and approaches implemented upon the Jordan River WASP (as described in Section 3.1Sensitivity Methodology), the variability of several input parameters appears to yield variation upon the simulated nutrient concentrations. Example plots that display the effects of the sensitivity for each selected input parameter upon the model performance (e.g., nutrient concentration, DO concentration, water temperature, etc.) over randomly-selected segments in the Jordan River WASP are provided in Appendix A.2: Sensitivity Plots. The general observed effects of each input parameter upon the WASP Jordan River model performance are described as follows and are organized based on constituent. (Note: Only input parameters that appear to exhibit at least observable effects upon model performance are discussed in this sub-section.)

- <u>Nutrient and Constituent Kinetics:</u> Example plots over the sensitivity of nutrient and constituent kinetics are provided in Appendix A.2.1: Nutrient Kinetics.
    - <u>Nitrification, Denitrification, Organic Mineralization Rates:</u> Based on the sensitivity analyses conducted upon the nutrient kinetics, significantly large values relative to the originally-inputted, non-calibrated values (Section A.1: Sensitivity Parameters and Methodology) appear required for observing effects upon the model performance. For instance, the denitrification rate at 20°C is required to increase by a factor of 100 relative to the originally-inputted value (e.g., from 0.05 per day to 5 per day) for observing decreases upon the NO_2-NO_3-N concentration (Section A.2.1:

Nutrient Kinetics). Since such values appear significantly beyond the typical range provided by Ambrose and Wool (2017), the input parameters for nutrient kinetics appear generally insensitive toward the model performance.

  - Phytoplankton Growth and Respiration Rates: Based on the sensitivity analyses conducted, increasing the maximum growth rate seems to increase the phytoplankton chlorophyll-a while increasing the respiration rate appears to decrease the phytoplankton chlorophyll-a. On the other hand, both the phytoplankton growth and respiration rates appear to exhibit relatively minor effects upon the nitrogen and phosphorus concentrations. (Note: The Jordan River WASP links phytoplankton to the nitrogen and phosphorus species through specifying 1) fraction of phytoplankton respiration to DON/DOP and 2) fraction of phytoplankton death to PON/POP.)
  - Macro/Benthic Algae Growth and Respiration Rates: Based on the sensitivity analyses conducted, increasing the maximum growth rate for macro/benthic algae generally increases both the macro/benthic algae chlorophyll-a and DO concentrations. Meanwhile, increasing the respiration rate for macro/benthic algae generally decreases both the macro/benthic algae chlorophyll-a and DO concentrations. These characteristics appear to hold if positive values are specified under the input parameter Macro/Benthic Algae O_2:C Production, which exhibiting negative values for this parameter yields decreasing DO concentrations with increasing Algae chlorophyll-a.
- Half-Saturation Constants: The half-saturation constants (e.g., half-saturation for nitrification, half-saturation for denitrification, half-saturation for CBOD, half-saturation for phytoplankton mineralization, etc.) appear to require significant values (e.g., 1000 mg-O_2/L) for one to observe effects upon the model performance (e.g., reduction upon the DO concentration, nutrient concentrations, etc.). On the other hand, small values for nutrient and phytoplankton half-saturation constants (e.g., nearly 0 mg-O_2/L) appear to be applied toward such water quality models and seem to be typically derived through empirical relationships (e.g., Lung and Larson 1995; Son and Fujino 2003; Camacho et al. 2015). Hence, due to relatively minor effects upon the WASP Jordan River model performance (e.g., nutrient concentrations, etc.), generally default values (e.g., 2 mg O_2/L for nitrification and denitrification, 0.5 mg O_2/L for CBOD, etc.) are implemented for the exercise. (Note: Due to the relatively minor effects of the half-saturation constants upon the WASP Jordan River model performance, sensitivity plots based on half-saturation constants are not included in this report.)
- Settling Rates: Example plots over the sensitivity of distinct settling rates upon selected constituents along selected segments over the Jordan River WASP are provided in Section A.2.2: Settling Rates.
  - TSS and Phytoplankton Settling Rates: Based on the sensitivity analyses conducted, relatively high settling rates for Solids and Phytoplankton appear required for observing significant decreases upon the TSS and phytoplankton chlorophyll-a concentrations as compared to the uncalibrated values specified in Section A.1: Sensitivity Parameters and Methodology.
  - POM/Detritus Settling Rate: Increasing the POM/Detritus Settling Rate appears to decrease the particulate species (POC, PON, POP) and DO concentrations. On the other hand, similar to TSS and phytoplankton settling rates, the POM settling rate appears to need to be increased to relatively high values (e.g., 1 m/day, 10 m/day) for yielding significant decreases upon the DO and particulate species concentrations.
- Light Extinction Coefficients: Example plots for assessing the sensitivity of distinct light extinction coefficients upon the Jordan River WASP performance are provided in Appendix A.2.3: Lighting.
  - Background Light Extinction: Increasing the background light extinction coefficient appears to decrease the phytoplankton chlorophyll-a. On the other hand, relatively small effects upon other water quality constituents (e.g., TN, TP, DO, macro/benthic algae chlorophyll-a, etc.) appear observed when altering the background light extinction.

- POM/Detritus and Solids Light Extinction: Based on the sensitivity analyses conducted upon this input parameter, generally small effects appear observed upon the model performance (e.g., PON, POP, DO, TSS, etc.) when altering the POM and solids light extinction.
- DOC Light Extinction: Generally small effects appear observed upon the model performance (e.g., CBOD, DO, etc.) when altering the DOC light extinction.

- Sediment Diagenesis Routines: Example plots for assessing the sensitivity of sediment diagenesis input parameters described in Table 14 are provided in Appendix A.2.4: Sediment Diagenesis Routines.
  - Initial POP, PON, POC Sediment Conditions: For this exercise, although the user may specify the initial POP, PON, and POC sediment conditions separately per segment and per constituent (e.g., 1 value per segment for POC, 1 value per segment for PON, etc.), sensitivity analyses are conducted through altering the values of all initial sediment conditions simultaneously for assessing the effects upon DO. Based on the sensitivity analyses conducted upon this input parameter, increasing the initial POC/PON/POP sediment conditions for all model segments simultaneously appears to increase the PON and POP concentrations and decrease the DO concentration initially. On the other hand, such effects upon the PON, POP, and DO concentrations appear to decrease over time, exhibiting generally negligible effects upon the model performance near the end of the model simulation (e.g., model performance during Water Year 2011). Such characteristics seem to suggest that altering the initial POC, PON, and POP sediment conditions only affects the model performance initially. For instance, relatively high values for these input parameters (e.g., 96 mg/g sediment, 150 mg/g sediment, etc.) appear required for observing such significant effects upon the water quality constituents throughout the model simulation period.
  - Fraction of POC, PON, and POP into Classes G1 (Labile), G2 (Refractory), and G3 (Inert): Since WASP requires that the summation of fractions into Classes G1, G2, and G3 equate to 1, one is required to alter fractions of at least 2 of the 3 classes simultaneously. (Note: The fraction into each G class is implemented upon POC, PON, and POP simultaneously in WASP rather than per constituent.) For instance, if the user decreases the fraction into Class G1 by 0.05, then either the fraction into Class G2 or the fraction of Class G3 must be increased by 0.05 to avoid WASP from crashing due to the sediment diagenesis routines (e.g., crashing due to $f_{G1} + f_{G2} + f_{G3} \neq 1$). For this exercise, sensitivity upon the fraction distributions into Classes G1, G2, and G3 is conducted upon all model segments simultaneously for assessing the effects upon the water quality constituents over the entire system although the user can specify fraction distribution per segment. Generally, based on the analyses conducted upon the fractions of distinct G classes, the distribution of such fractions appears to exhibit variable effects upon the peak TN, TP, SOD, and minimal DO concentrations that occur within the first water year (e.g., Water Year 2007). On the other hand, the fraction distribution of POC, PON, and POP into Classes G1, G2, and G3 seems to exhibit relatively minor effects upon the DO concentration as compared to those upon TN, TP, and SOD. Meanwhile, the following relationships among the fraction into each class against the water quality constituent performance appear to be observed.
    - Fraction into Class G1: Increasing the fraction of POC, PON, and POP into Class G1 (Labile) appears to increase the TN and TP concentrations while also increasing SOD.
    - Fraction into Class G2: Increasing the fraction of POC, PON, and POP into Class G2 (Refractory) appears to increase the TN and TP concentrations while also increasing SOD though such increase seems to decrease the peak concentrations and the peak SOD.
    - Fraction into Class G3: Increasing the fraction of POC, PON, and POP into Class G3 (Inert) appears to decrease the TN and TP concentrations while also decreasing SOD.

- Water Temperature Routines: Example plots over the water temperature performance based on input parameters are provided in Appendix A.2.5: Water Temperature Parameters.
    - Bottom Heat Exchange: Increasing the bottom heat exchange appears to decrease the fluctuations upon water temperature and hence suggest decreasing relationships among the temperature gap among the winter and summer months. For instance, if high values are specified for this input parameter (e.g., at 600 W/m^2-℃, at 6000 W/m^2-℃, etc.), then generally constant water temperature appears to be yielded for the entire model simulation period. Similarly, if low values are specified for this input parameter (e.g., at 10 W/m^2-℃, at 0.5 W/m^2-℃, etc.), then significant fluctuations upon water temperature, yielding high temperatures over the summer months followed by low temperatures over the winter months, appear observed. Since water temperature affects the nutrient kinetics (e.g., nitrification, denitrification, reaeration, BOD oxidation, etc.), the coefficient for bottom-heat exchange seems to serve as a relatively sensitive parameter.
    - Sediment Ground Temperature: Altering the sediment ground temperature seems to generally shift the water temperature results for the Jordan River WASP. For instance, increasing the sediment ground temperature seems to increase the water temperature throughout the model simulation (e.g., shift the water temperature results for all segments upward). Meanwhile, specifying negative values for the sediment ground temperature appear to be treated as 0 degrees Celsius in WASP. Due to the linkages among water temperature and other water quality constituents in WASP (e.g., nutrient kinetics, etc.), the sediment ground temperature appears as a relatively sensitive parameter for the Jordan River WASP.

3.3 SUMMARY OF SENSITIVITY ANALYSES UPON MODEL

Based on the observed effects upon the model performance described in Section 3.2, one can potentially rank the sensitivity for each input parameter. The following table (Table 15) displays the general ranking, which can vary from user to user of the Jordan River WASP, observed per model input parameter. For this exercise, each parameter is ranked based on how the variability of each parameter directly affects the performance of a constituent in WASP (e.g., nitrification rate upon NH_3-N and NO_2-NO_3-N concentrations, bottom-heat exchange upon water temperature, POM settling upon POC/PON/POP concentrations, etc.), employing the following scale.

- Rank of 1 = Generally Insensitive; parameter appears to yield little or negligible effect upon model performance. Meanwhile, parameters for which relatively high values are required as compared to the non-calibrated values (Section A.1: Sensitivity Parameters and Methodology) inputted (e.g., values at magnitudes of 10 to 100 greater than the non-calibrated value) are also ranked with this value.
- Rank of 2 = Somewhat sensitive; parameter appears to yield small effects upon the constituent for which the parameter corresponds to (e.g., nitrification upon NH_3-N, nitrification upon NO_2-NO_3-N etc.) but seems to yield little to negligible effects upon other constituents not as pertinent (e.g., nitrification upon DO, etc.).
- Rank of 3 = Generally sensitive; parameter appears to yield observable effects upon the constituent for which the parameter corresponds to (e.g., nitrification upon NH_3-N, etc.) and small-to-observable effects upon other constituents not as pertinent.
- Rank of 4 = Significantly sensitive; altering the value of this parameter seems to significantly alter the resulting performance of the constituent for which the parameter corresponds to (e.g., phytoplankton growth upon phytoplankton chlorophyll-a) and also appears to yield observable effects upon other constituents not as pertinent.

- Rank of 5 = Highly sensitive; altering the value of this parameter seems to alter the performance of the model as a whole, affecting the results for most to all constituents simulated.

Table 15. Ranking of Sensitivity per Model Input Parameter over the Jordan River WASP

Model Input Parameter	Units	Water Quality Constituent(s) Affected	Sensitivity Ranking (1 = Generally insensitive; 5 = Highly Sensitive)
Coefficient for Bottom-Heat Exchange	W/m^2-°C	Water Temperature	4
Sediment Ground Temperature	°C	Water Temperature	4
Nitrification Rate at 20°C	1/day	NH_3-N, NO_2-NO_3-N	2
Half-Saturation Constant for Nitrification Oxygen Limit	mg-O_2/L	NH_3-N, NO_2-NO_3-N	1
Denitrification Rate at 20°C	1/day	NO_2-NO_3-N	2
Half-Saturation Constant for Denitrification Oxygen Limit	mg-O_2/L	NO_2-NO_3-N	1
Dissolved Organic Nitrogen Mineralization Rate at 20°C	1/day	DON	2
Dissolved Organic Phosphorus Mineralization Rate at 20°C	1/day	DOP	2
CBOD Half-Saturation Oxygen Limit	mg-O_2/L	CBOD	1
Fraction of Carbon Source of CBOD to Denitrification	None	CBOD, NO_2-NO_3-N	1
Maximum Allowable Reaeration Rate	1/day	DO	2 (only if small values of this parameter are employed, such as 2 per day); 1 (otherwise)
Phytoplankton Maximum Growth Rate at 20°C	1/day	Phytoplankton Chlorophyll-a	2
Phytoplankton Respiration Rate at 20°C	1/day	Phytoplankton Chlorophyll-a	2
Phytoplankton Half-Saturation for Mineralization Rate	mg-Phyto-C/L	Phytoplankton Chlorophyll-a	1
Phytoplankton Settling Rate	m/day	Phytoplankton Chlorophyll-a	2
Macro/Benthic Algae Respiration Rate	1/day	Macro/Benthic Algae	2
Algae O_2:C Production	mg-O_2/mg-C	Macro/Benthic Algae, DO	3
Fraction of Segment Covered by Benthic/Macro Algae	None	Macro/Benthic Algae	1
Solids Settling Rate	m/day	TSS	2
CO_2 Partial Pressure	atm	pH, Alkalinity	2
Detritus Settling Rate	m/day	POM	2
Initial POC Sediment Condition	mg-O_2/g-sediment	POC, DO	2
Initial PON Sediment Condition	mg-N/g-sediment	PON, DO	2
Initial POP Sediment Condition	mg-P/g-sediment	POP, DO	2

Fraction of POC/PON/POP into G1 (Labile)	None	POC, PON, POP, DO	3
Fraction of POC/PON/POP into G2 (Refractory)	None	POC, PON, POP, DO	3
Fraction of POC/PON/POP into G3 (Inert)	None	POC, PON, POP, DO	3
Background Light Extinction Coefficient	1/m	Lighting	2
Detritus and Solids Light Extinction Coefficient	1/m	Lighting, POM, TSS	2
DOC Light Extinction Multiplier	1/m	Lighting, CBOD	2

4 MODEL CALIBRATION

This section summarizes the methods and results of calibration of model parameters.

4.1 CALIBRATION PROCEDURES

This sub-section describes the methodology employed for the model calibration over the Jordan River WASP, based on input data employed and the sensitivity analyses conducted. This sub-section also describes the sources of data employed as measured data for the model calibration. Since separate data sources are implemented for the measured data for assessing the Jordan River WASP performance, separate sub-sections are developed for describing the data sources for measured flow data (Section 4.1.1), discussing the data sources and approximations upon obtaining measured water quality data (Section 4.1.2), and providing an overview of the calibration measures employed for assessing the Jordan River model performance for both water quantity and quality (Section 4.1.3)

4.1.1 MEASURED DATA- WATER QUANTITY

For this exercise, the UDWR sites along the Jordan River that represent in-stream flow data are employed as sites with measured flow quantity for comparing the simulated results against the Jordan River WASP. The list of UDWR sites, the geographical coordinates that exhibit only northing and easting values under the NAD83 geographical coordinate system followed by the UTM Zone 12N projection (indicated as "NAD_1983_UTM_Zone_12N"), and the approximated segment mapping is provided in the following table (Table 16). (Note: Since UDWR appears to not provide a site ID for all the sites involved for measured flow data, some of the site IDs are defined specifically for this exercise and do not represent the site IDs provided by UDWR. For instance, the UDWR sites "At 17th South" and "5th North Gaging Station" appear to not exhibit a unique UDWR site ID, so such site IDs are redefined for this exercise.)

Table 16. UDWR Sites for Measured Water Quantity Data

UDWR Site ID (or Redefined ID)	Site Name	UDWR Distribution System	Northing (m)	Easting (m)	Approximated River Mile (km)	Corresponding WASP Segment
04.01.02	Jordan River Station No.1	Utah Lake/Jordan River	4477483.742	421802.165	67.5	JR32
09.05	Jordan River at 90th South Gage Station (Manual)	Utah Lake/Jordan River	4493385.047	422780.936	45.5	JR76
17	At 17th South	Lower Jordan River	4509597.961	422038.101	24.5	JR118
5	5th North Gaging Station	Lower Jordan River	4514794.887	420836.772	17	JR133

For the segment mapping upon the UDWR sites presented in Table 16Table 17 above, the corresponding segment is selected based on the location of the Jordan River WASP segment that appears closest to each UDWR site, which the downstream WASP segment is employed if a UDWR site appears to be located at the midpoint between two Jordan River WASP segments. The locations for all UDWR sites employed for this exercise and the corresponding

WASP segments along the Jordan River that are displayed in tabular format in Table 16 are provided in the following figure (Figure 3).

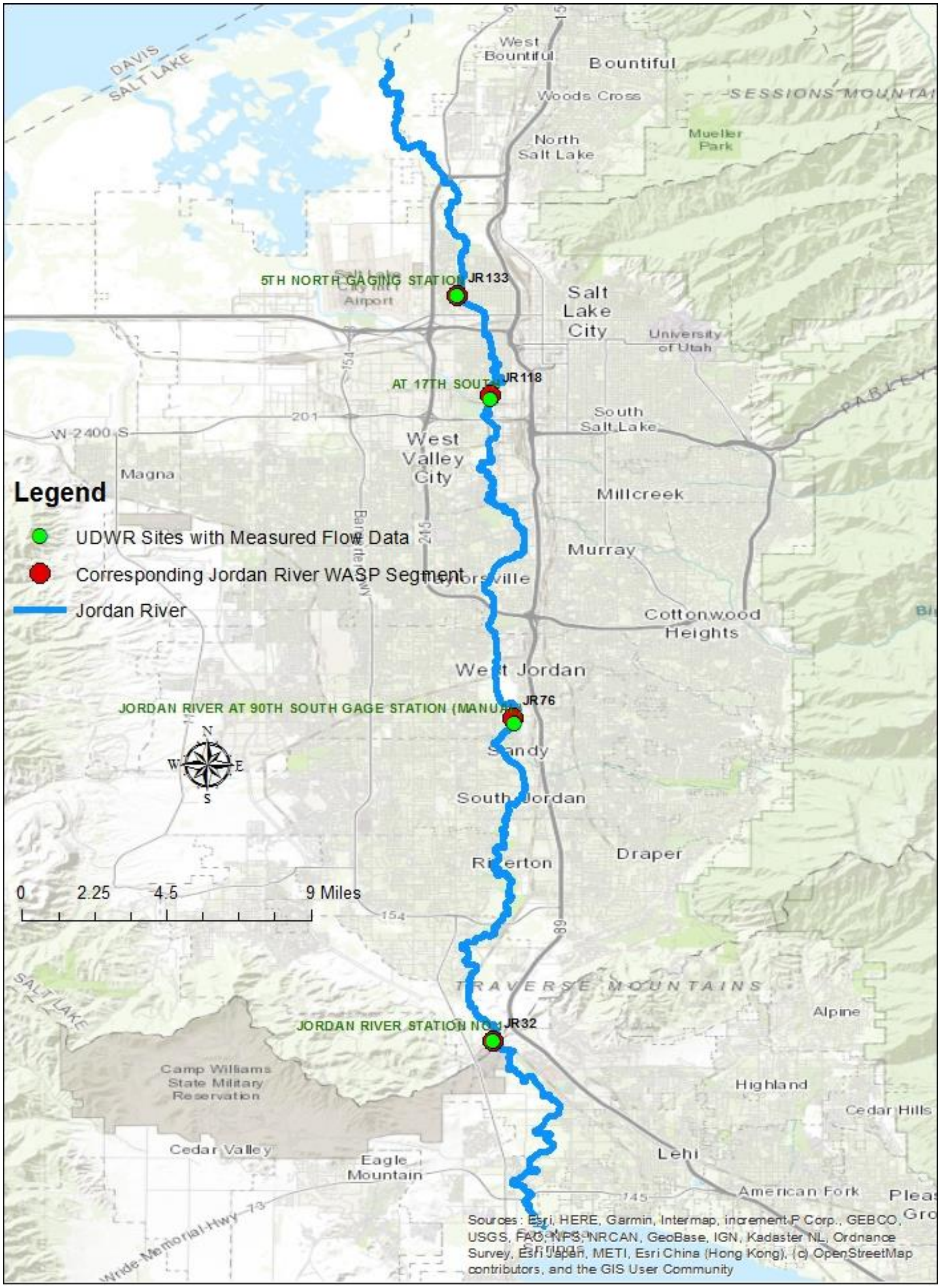

Figure 3. Map of UDWR Sites for Measured Flow Data and Corresponding Jordan River WASP Segments

4.1.2 MEASURED DATA- WATER QUALITY

For this exercise, UDWQ sites along the Jordan River from the AWQMS database are employed as sites with measured data for comparing the simulated results from the Jordan River WASP. The list of UDWQ sites from AWQMS, geographical coordinates, and the approximated segment mapping is provided in the following table (Table 17).

Table 17. UDWQ Sites from AWQMS Database for Measured Water Quality Data

UDWQ Site ID	Site Name	Latitude	Longitude	Approximated River Mile (km)	Corresponding WASP Segment
4994790	JORDAN R AT UTAH L OUTLET U121 XING	40.361	-111.899	82.7	JR1
4994720	JORDAN R AT NARROWS - PUMP STATION	40.443	-111.923	68	JR31
4994600	JORDAN R AT BLUFFDALE ROAD XING	40.486	-111.936	61.5	JR44
4994520	Jordan R at Bangerter Highway Xing	40.497	-111.920	59	JR49
4994500	JORDAN R BELOW 123RD SOUTH	40.530	-111.920	54	JR59
4994370	JORDAN R AT 10600 S	40.559	-111.908	49.5	JR68
4994270	JORDAN R AT 9000 S XING	40.587	-111.913	45.5	JR76
4994170	JORDAN R AT 7800 S XING AB S VALLEY WWTP	40.609	-111.921	42.5	JR82
4994100	JORDAN R AT 6400 S XING	40.631	-111.923	40	JR87
4994090	JORDAN R AB 5400 S AT Pedestrian Bridge	40.652	-111.924	38	JR91
4992890	JORDAN R 3900/4100 S XING	40.686	-111.921	32	JR103
4992880	JORDAN R AT 3300 S XING	40.699	-111.925	30	JR107
4992320	JORDAN R 1100 W 2100 S	40.726	-111.926	26	JR115
4992290	JORDAN R AT 1700 S AB DRAIN OUTFALL	40.734	-111.924	24.5	JR118
4992055	JORDAN R. at 900 S.	40.750	-111.920	21.5	JR124
4991940	Jordan R @ 400 South	40.760	-111.923	20	JR127
4991910	JORDAN R BL GADSBY PLANT 001 OUTFALL AT N TEMPLE	40.772	-111.926	18.5	JR130
4991900	JORDAN R. AT 300 N.	40.777	-111.935	17.5	JR132
4991890	JORDAN R AT 500 N XING	40.780	-111.938	17	JR133
4991880	JORDAN R AT 10th N XING	40.791	-111.936	15.5	JR136
4991860	JORDAN R 1800 N XING REDWOOD RD BDG	40.807	-111.939	13.5	JR140
4991820	JORDAN R AT CUDAHY LANE AB S DAVIS S WWTP	40.842	-111.951	8.5	JR150
4991800	JORDAN R 1000FT BL S DAVIS S WWTP	40.845	-111.953	8	JR151
4990890	JORDAN R AB BURNHAM DAM AND STATE CANAL	40.871	-111.964	3	JR161

For the segment mapping upon the UDWQ sites presented in Table 17 above, the corresponding segment is selected based on the location of the Jordan River WASP segment that appears closest to each UDWQ site, which the downstream WASP segment is employed if a UDWQ site appears to be located at the midpoint between two

Jordan River WASP segments. The locations for all UDWQ sites employed for this exercise and the corresponding WASP segments along the Jordan River are provided in the following figure (Figure 4).

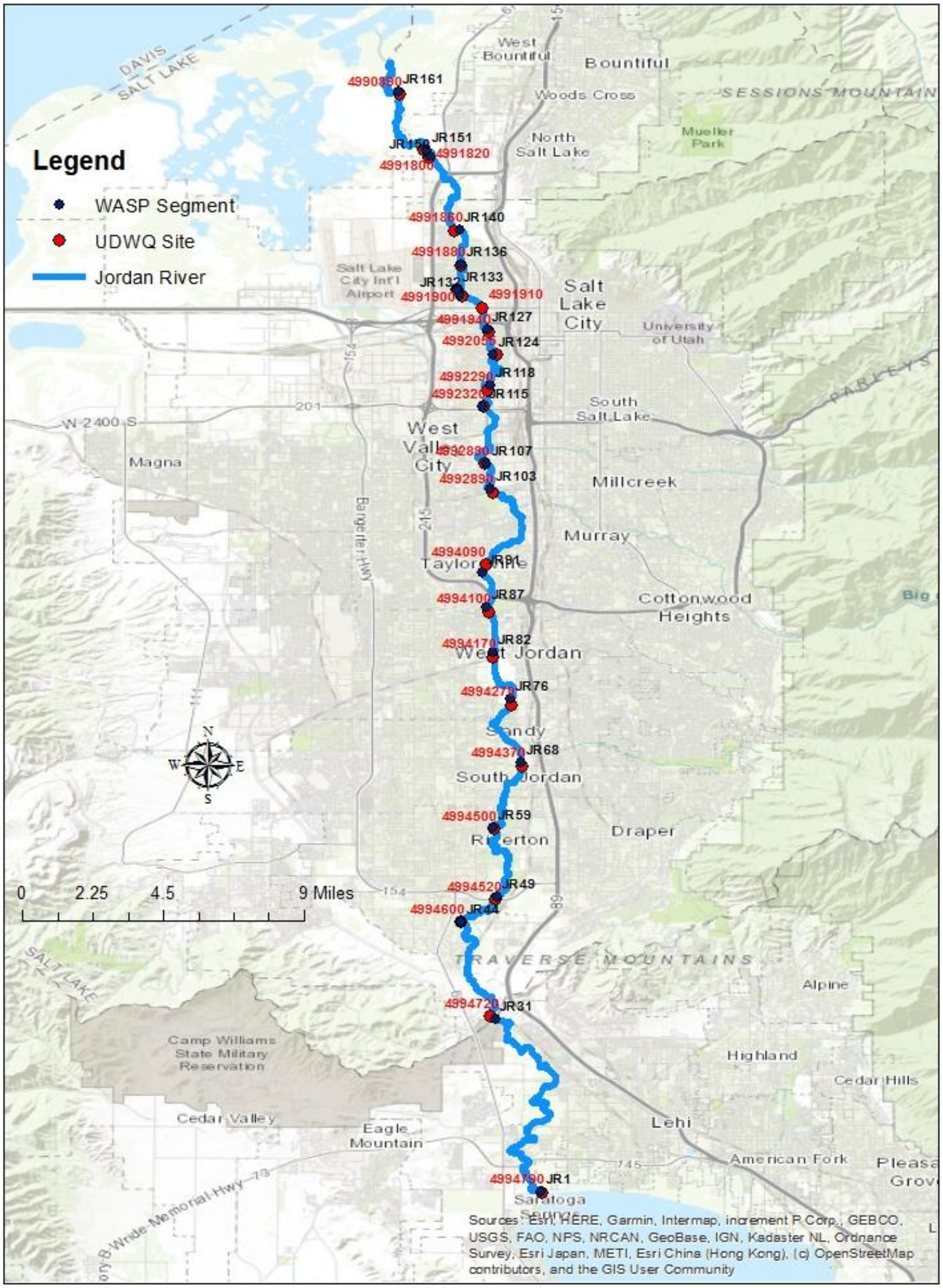

Figure 4. Locations of UDWQ AWQMS Sites along the Jordan River for WASP Model Calibration

For this exercise, the measured data from the AWQMS UDWQ sites (Table 17, Figure 4) are compared against the simulated results for distinct constituents from the Jordan River WASP. The following table (Table 18) presents the constituent mapping among the simulated results from the Jordan River WASP and the measured data from the AWQMS UDWQ sites. The measured data for the AWQMS UDWQ sites are implemented into a separate SDB database file through the Water Resources Database (WRDB), with non-detects approximated as 85% of the Lower Quantification Limit or of the Method Detection Level (if the Lower Quantification Limit is not provided).

Table 18. Constituent Mapping among Jordan River WASP and AWQMS UDWQ Sites

Water Quality Constituent by the Jordan River WASP	**Corresponding Constituent (and corresponding label (e.g., PCode)) from AWQMS UDWQ Sites**
Water Temperature	Temperature, Water (TempW)
pH	pH (pH)
Alkalinity	Alkalinity (ALK)
Total Solids	Total Suspended Solids (TSS)
Dissolved Oxygen	Dissolved Oxygen (DO)
Ammonia Nitrogen	Ammonia-Nitrogen (NH3N)
Nitrate Nitrogen	Inorganic Nitrogen: Nitrate and Nitrite (NO2NO3N)
Dissolved Organic Nitrogen	Organic Nitrogen, Dissolved (DON)
Total Phosphorus	Total Phosphate-Phosphorus (TP)
Phytoplankton Chlorophyll-a	Chlorophyll-a, corrected for pheophytin (PHYTO)
Total CBOD	BOD, ultimate approximated from standard conditions (5-day) through an oxidation rate of 0.2 per day (BOD)

4.1.3 CALIBRATION METRICS

For this exercise, the model calibration performance metrics upon the Jordan River WASP against the measured data applied as a separate SDB file are based on the following criteria/approaches. (Note: The model calibration upon the Jordan River WASP is primarily focused on the water quality component only.)

- **Graphical Approaches:** The time-series of the simulated results per constituent from a Jordan River WASP segment are plotted against the measured data for the corresponding constituent for water quality (Table 18) of the approximated AWQMS UDWQ site (Table 17) and against measured flow data of the approximated UDWR site (Table 16).
- **Statistical Approaches:** The statistical parameters that are provided through WRDB Graph are employed for assessing the calibration performance of the Jordan River WASP. The following statistical parameters and the indicated notation by WRDB are reviewed based on the simulated results against the measured data per constituent toward assessing the performance of the Jordan River WASP.
    - Descriptive Statistics (Mean, Median, 25th Percentile, 75th Percentile)
    - Coefficient of Determination, R^2
    - Mean Absolute Error (Mean Abs Err)
    - Root-Mean Square Error (RMS Err)
    - Normalized Root-Mean Square Error (Norm RMS Err)
    - Index of Argument (Index of Argmt)

For this exercise, the Jordan River WASP is rerun based on modifications upon selected input parameters that appear generally sensitive upon the model performance (as summarized in Table 15). Then, both graphical and statistical approaches are implemented for comparing the performance of the simulated results against the measured data from the UDWQ AWQMS sites. In this exercise, the Jordan River WASP model calibration is implemented by attempting to minimize the statistical parameters mean absolute error and the root-mean square error for all Jordan River WASP segments being compared against the measured data (Table 17). (Note: No auto-calibration tools, approaches, etc. have been implemented for the Jordan River WASP model calibration work, which such calibration is applied manually.)

4.2 CALIBRATION PERFORMANCE

Graphical and statistical results among the Jordan River WASP against the measured data for the UDWQ AWQMS sites are provided in Appendix B: Model Calibration Plots and Results. Based on the graphical (provided in Section B.1: Graphical Results (Time-Series)) and statistical (provided in Section B.2: Statistical Results), the following characteristics upon the Jordan River WASP model calibration performance for flow quantity and each water quality constituent appear to be observed. (Note: Such descriptions over the model calibration performance focus on the simulated results for the Jordan River segments other than JR1 (Utah Lake effluent). For instance, the measured data for the UDWQ AWQMS site 4994790 (JORDAN R AT UTAH L OUTLET U121 XING) are employed for populating inflow quality along segment JR1, hence generally yielding agreement among the simulated results against the measured data for this segment.)

- **Flow Quantity:** The Jordan River WASP model exhibits general agreement among the simulated results against the measured flow data though the model underpredicts flow along segment JR32 (Turner Dam) and JR76 (9000 South Conduit) from 2006 to 2008, which the UDWR "Utah Lake outflow" site is employed for such timeframe (Table 6) with Turner Dam indicated as removing flows along this segment (JR32). (Note: Such approaches upon the flow quantity along Turner Dam (e.g., segment JR32) are implemented for ensuring flow being diverted out of the Jordan River along this segment. Employing the UDWR site "Jordan River Station No.1" for defining flows diverted along the Jordan River at this segment (e.g., similar methodologies as those for the Surplus Canal) appears to yield positive inflows into the Jordan River at this segment (JR32) for Turner Dam, which appears rather not representative of this diversion.)
- **Water Temperature:** Generally, the Jordan River WASP model exhibits agreement among the simulated results against the measured data though the model appears to underpredict water temperature during the beginning water years (Water Years 2007 and 2008) for particular WASP segments (e.g., JR82 (7800 South Drain), JR91, etc.). On the other hand, the Jordan River WASP appears to yield near-freezing to below-freezing water temperatures during the January months (e.g., January 2007, January 2008, January 2009, etc.) for particular segments (e.g., JR31, JR44, JR49, etc.).
- **pH:** For segments upstream of the Surplus Canal (e.g., JR115), the Jordan River WASP appears to exhibit agreement among the simulated results against the measured data although such characteristics and evaluations may need to be analyzed due to the significant noise observed upon both the simulated results and the observed data. Meanwhile, for segments downstream of the Surplus Canal (e.g., JR115), particularly downstream of 1300 South Conduit (e.g., JR122), the Jordan River WASP model appears to yield a more basic system as compared to the measured data, exhibiting higher pH values than those measured.
- **Alkalinity:** The Jordan River WASP model appears to yield general agreement among the simulated results against the measured data, particularly for segments upstream of JR132 that is located approximately 1 km downstream of the North Temple Conduit (segment JR130). For segments downstream of JR132, the Jordan River WASP model appears to slightly overpredict alkalinity as compared to the measured data.

- **TSS:** Generally, the Jordan River WASP model exhibits agreement among the simulated results against the measured data though the model seems to not capture the observed variation among the measured TSS data for several UDWQ AWQMS sites.
- **DO:** For segments upstream of the Surplus Canal (Segment JR115), the Jordan River WASP model exhibits general agreement among the simulated results against the measured data for DO for segments JR1 and JR31. Meanwhile, for segments downstream of Joint Dam (JR37) but upstream of 5400 South (JR92), the Jordan River WASP appears to underpredict the DO concentration, particularly before Water Year 2009 (e.g., before October 1, 2009). For segments downstream of the Surplus Canal (JR115), the Jordan River WASP model appears to slightly overpredict the DO concentration as compared to the measured data. Such overprediction of DO after the Surplus Canal may be due to the simulated SOD values through the sediment diagenesis routine. For instance, the simulated SOD values, which WASP yields results for this parameter under a daily time step, appear to be significantly lower than those observed by Hogsett (2015). Hence, investigations appear recommended for adjusting the model input parameters that simulate the sediment diagenesis routines, which are described in Table 14, toward potentially increasing SOD values followed by decreasing DO concentrations yielded by WASP, particularly downstream of the Surplus Canal. Meanwhile, DO concentrations simulated by WASP appear to be heavily affected by the model input parameter O_2:C Production by Macro Algae. For instance, inputting a positive value for the input parameter O_2:C Production by Macro Algae (e.g., > 0) generally yields higher DO concentrations. Therefore, due to the generally low SOD values simulated by WASP (plots in Section A.2.4: Sediment Diagenesis Routines for SOD based on the sensitivity of different sediment diagenesis input parameters) and the observed dependence of DO upon Macro/Benthic Algae, the DO concentrations appearing overpredicted along segments downstream of the Surplus Canal (JR115) by the Jordan River WASP may be expected. Such overprediction suggests underlying processes that appear to not be captured by the Jordan River WASP.
- **Nitrogen Species:** Distinct characteristics appear observed over the performance of the Jordan River WASP against the measured data for each nitrogen species, as discussed below. (Note: Such descriptions focus on the model calibration over the dissolved forms of nitrogen only.)
    - **NH_3-N:** The Jordan River WASP appears to generally underpredict the NH_3-N concentrations as compared to the measured data. At the same time, sensitivity analyses conducted upon the input parameters that appear to directly affect NH_3-N (Table 14) seem to exhibit rather insignificant effects upon the NH_3-N concentration (e.g., as shown in Appendix A.2.1: Nutrient Kinetics). Meanwhile, the simulated sediment NH_3-N benthic fluxes through the WASP sediment diagenesis routines appear lower than those measured by Hogsett (2015), exhibiting simulated values of less than 50 mg/m^2-day as compared to measured values of between 50 and 100 mg/m^2-day. Hence, such underprediction suggests potential underlying processes affecting NH_3-N that appear to not be captured by the Jordan River WASP.
    - **NO_2-NO_3-N:** The Jordan River WASP appears to generally underpredict the simulated concentrations as compared to the measured data, particularly along segments upstream of JR87. On the other hand, for segments downstream of JR87 (e.g., JR91, JR103 JR115, etc.), general agreement among the simulated results against the measured data appears observed, particularly after October 1, 2008 (e.g., Water Year 2009 and after) although the Jordan River WASP seems to not capture the observed variation among the measured data.
    - **DON:** Meanwhile, the Jordan River WASP appears to exhibit general agreement for DON against the measured data for segments upstream of JR91, which the model underpredicts DON downstream of JR91. On the other hand, such characteristics may need to be investigated due to the quality of the measured data for DON.

- **Total Phosphate:** The Jordan River WASP appears to generally overpredict the TP concentrations for segments upstream of the Groundwater Diffuse Source Region 4 (e.g., upstream of segment JR87). On the other hand, for segments downstream of JR87, the Jordan River WASP appears to yield general agreement among the simulated results against the measured data, disregarding any observed potential outliers upon the measured data.
- **Phytoplankton Chlorophyll-a:** Except for a few Jordan River WASP segments for which the measured data appears to exhibit one single phytoplankton chlorophyll-a high measurement (e.g., at least 250 μg/L), general agreement appears observed among the simulated results from the Jordan River WASP against the measured data for phytoplankton chlorophyll-a.
- **Ultimate CBOD:** General agreement appears observed among the simulated results for CBOD against the ultimate BOD measured data from the UDWQ AWQMS sites. On the other hand, such calibration performance upon the Jordan River WASP for CBOD may require more analyses due to the quality of the UDWQ AWQMS site measured data, which exhibits significant non-detects that have been approximated. (Note: All the measured BOD data from the UDWQ AWQMS sites that exhibit values of approximately 4.03 mg/L represent approximated non-detects.)

4.3 MODEL PARAMETERIZATION

Several values that are different from defaults implemented by WASP have been applied toward the Jordan River WASP model, based on sensitivity analyses and the observed model calibration performance of the Jordan River WASP. The following table (Table 19) provides the list of input parameters, the values employed, and commentary over the sources of such values for the dissolved inorganic and organic nitrogen and phosphorus species for which values other than those defaulted by WASP are implemented. (Note: Several values are implemented as "best" calibrated values, which are defined as those that appear to yield the minimum mean absolute error and RMSE results over the Jordan River segments against the measured data. Meanwhile, this sub-section focuses on model parameterization pertinent for water quality constituents only, which no separate tables affecting flow quantity are included in this exercise.)

Table 19. Model Parameterization for Nitrogen and Phosphorus Species (Non-POM)

Nutrient WASP Input Parameter	Units	Value Employed	Data Source
Nitrification Rate at 20 degrees Celsius	Per day	0.1	"Best" Calibrated Value
Temperature-Correction for Nitrification	None	1.07	Stantec Consulting Ltd (2010)
Half-Saturation for Nitrification	mg-O_2/L	2	Maximum value recommended by WASP
Denitrification Rate at 20 degrees Celsius	Per day	0.05	"Best" Calibrated Value
Temperature-Correction for Denitrification	None	1.07	Stantec Consulting Ltd (2010)
Half-Saturation for Denitrification	mg-O_2/L	2	Maximum value recommended by WASP
Mineralization Rate for DON at 20 degrees Celsius	Per day	0.4	Stantec Consulting Ltd (2010)
Temperature-Correction for DON Mineralization	None	1.07	Stantec Consulting Ltd (2010)
Mineralization Rate for DOP at 20 degrees Celsius	Per day	0.5	Stantec Consulting Ltd (2010)
Temperature-Correction for DOP Mineralization	None	1.07	Stantec Consulting Ltd (2010)

The following table (Table 20) provides the list of input parameters, the values employed, and commentary over the sources of such values for CBOD and DO for which values other than those defaulted by WASP are applied.

Table 20. Model Parameters for CBOD and DO

CBOD/DO WASP Input Parameter	Units	Value Employed	Data Source
CBOD Decay Rate Constant at 20 degrees Celsius	Per day	0.2	Stantec Consulting Ltd (2010)
Temperature-Correction for CBOD Decay	None	1.047	Stantec Consulting Ltd (2010)
Half-Saturation Limit for CBOD	mg-O_2/L	5	"Best" calibrated value
Fraction of Detritus Dissolution to CBOD	None	1	"Best" calibrated value
Fraction of CBOD Carbon Source for Denitrification	None	1	"Best" calibrated value
Maximum Allowable Reaeration Rate	Per day	5	"Best" calibrated value
Temperature-Correction for Reaeration	None	1.024	Stantec Consulting Ltd (2010)

The following table (Table 21) provides the input parameters, the values, and commentary over the sources of such values for POM and sediment diagenesis for which values other than those defaulted by WASP are applied.

Table 21. Model Parameters for Sediment Diagenesis Routines and POM/Detritus

POM/Sediment Diagenesis WASP Input Parameter	Units	Value Employed (and segments involved, if any)	Data Source
Initial POC Sediment Condition	mg-O_2 equivalents/g-sediment	20 (JR1 to JR114); 40 (JR115 to JR166)	"Best" calibrated value
Initial PON Sediment Condition	mg-N/g-sediment	2 (JR1 to JR114); 10 (JR115 to JR166)	"Best" calibrated value
Initial POP Sediment Condition	mg-P/g-sediment	2 (JR1 to JR114); 10 (JR115 to JR166)	"Best" calibrated value
Fraction of POC/PON/POP into Class G1 (Labile)	None	0.45	"Best" calibrated value
Fraction of POC/PON/POP into Class G2 (Refractory)	None	0.45	"Best" calibrated value
Fraction of POC/PON/POP into Class G3 (Inert)	None	0.1	"Best" calibrated value
POM Dissolution Rate at 20 degrees Celsius	Per day	0.1	Stantec Consulting Ltd (2010)
Temperature-Correction for POM Dissolution	None	1.07	Stantec Consulting Ltd (2010)

The following table (Table 22) provides the list of input parameters, the values employed, and commentary over the sources of such values for Phytoplankton for which values other than those defaulted by WASP are applied.

Table 22. Model Parameters for Phytoplankton

Phytoplankton WASP Input Parameter	Units	Value	Data Source
Maximum Growth Rate at 20 degrees Celsius	Per day	2	Stantec Consulting Ltd (2010)
Temperature-Correction for Phytoplankton Growth	None	1.07	Stantec Consulting Ltd (2010)
Phytoplankton Carbon to Chlorophyll-a Ratio	mg-C/mg-Chla	40	Martin et al. (2006); based on the ratio 100 g dry weight:40 g-C:7200 mg-N:1000 mg P
Respiration Rate at 20 degrees Celsius	Per day	0.1	Stantec Consulting Ltd (2010)
Temperature-Correction for Phytoplankton Respiration	None	1.07	Stantec Consulting Ltd (2010)
Death Rate (Non-zooplankton Predation) at 20 degrees Celsius	Per day	0.1	Stantec Consulting Ltd (2010)
Optimal Light Saturation as Photosynthetically-Active Radiation	W/m^2	12.831	Stantec Consulting Ltd (2010)
Half-Saturation for Mineralization Rate	mg-Chla/L	100	“Best” calibrated value
Half-Saturation Constant for N Uptake	mg-N/L	0.015	Stantec Consulting Ltd (2010)
Half-Saturation Constant for P Uptake	mg-P/L	0.002	Stantec Consulting Ltd (2010)
Fraction Phytoplankton Respiration Recycled to Organic N	None	0.5	“Best” calibrated value
Fraction Phytoplankton Respiration Recycled to Organic P	None	0.5	“Best” calibrated value
Phytoplankton Detritus/POM to Carbon Ratio	mg-D (dry weight)/mg-C	2.5	Martin et al. (2006); based on the ratio 100 g dry weight:40 g-C:7200 mg-N:1000 mg P

The following table (Table 23) provides the input parameters, the values employed, and commentary over the sources of such values for Benthic/Macro Algae for which values other than those defaulted by WASP are applied.

Table 23. Model Parameters for Macro/Benthic Algae

Macro/Benthic Algae WASP Input Parameter	Units	Value	Data Source
Maximum Growth Rate at 20 degrees Celsius	Per day	50	Stantec Consulting Ltd (2010)
Carrying Capacity for First-Order Model	$g\text{-}D/m^2$	50	Stantec Consulting Ltd (2010)
Respiration Rate at 20 degrees Celsius	Per day	0.042	Stantec Consulting Ltd (2010)
Internal Nutrient Excretion Rate Constant	Per day	0.1	Stantec Consulting Ltd (2010)
Temperature-Correction for Internal Nutrient Excretion	None	1.05	Stantec Consulting Ltd (2010)
Death Rate at 20 degrees Celsius	Per day	0.1	Stantec Consulting Ltd (2010)
Half-Saturation Uptake for Extracellular Nitrogen	mg-N/L	0.163	Stantec Consulting Ltd (2010)
Half-Saturation Uptake for Extracellular Phosphorus	mg-P/L	0.048	Stantec Consulting Ltd (2010)
Light Constant for Growth	Langley/day	50	Stantec Consulting Ltd (2010)
Ammonia Preference	mg-N/L	0.001	Stantec Consulting Ltd (2010)
Minimum Cell Quota of Internal Nitrogen for Growth	mg-N/gD	30	Stantec Consulting Ltd (2010)
Minimum Cell Quota for Internal Phosphorus for Growth	mg-P/gD	0.4	Stantec Consulting Ltd (2010)
Maximum Nitrogen Uptake Rate	mg-N/gD-day	447	Stantec Consulting Ltd (2010)
Maximum Phosphorus Uptake Rate	mg-P/gD-day	114	Stantec Consulting Ltd (2010)
Half-Saturation Uptake for Intracellular Nitrogen	mg-N/gD	2.9	Stantec Consulting Ltd (2010)
Half-Saturation Uptake for Intracellular Phosphorus	mg-P/gD	1.8	Stantec Consulting Ltd (2010)
O_2:C Production	mg-O_2/mg-C	0.5	“Best” calibrated value
Fraction of Macro Algae Recycled to Organic N	None	0.5	“Best” calibrated value
Fraction of Macro Algae Recycled to Organic P	None	0.5	“Best” calibrated value

The following table (Table 24) provides the input parameters, the values employed, and commentary over the sources of such values for other pertinent constituents (e.g., geographical coordinates, lighting, etc.) for which values other than those defaulted by WASP are applied.

Table 24. Model Parameters for Global Constants and Lighting

Lighting/Global WASP Input Parameter	Units	Value	Data Source
Latitude	Degrees	40.3602777777778	Stantec Consulting Ltd (2010); Location of Segment JR1
Longitude	Degrees	-111.898055555556	Stantec Consulting Ltd (2010); Location of Segment JR1
Background Light Extinction Coefficient	1/m	0.2	Stantec Consulting Ltd (2010)
Detritus and Solids Light Extinction Coefficient	1/m	0.034	Stantec Consulting Ltd (2010); Summation of Detritus Light Extinction and Solids Light Extinction
DOC Light Extinction	1/m	0.34	Ambrose and Wool (2017)

5 MODEL VALIDATION

No independent validation of the model calibration performance was conducted.

6 MODEL UNCERTAINTY

No uncertainty analyses (e.g., Monte-Carlo simulations, etc.) have been conducted upon the Jordan River WASP Model.

7 MODEL USER GUIDANCE

Please note the following characteristics over running the Jordan River WASP.

- **Time Step of Output:** The time step of output into the BMD2 file is inputted manually in **days** by the user in WASP and affects the simulation time for running the entire model calibration period (October 1, 2006 to September 30, 2011) over the Jordan River, along with the size of the output BMD2 file. The Jordan River WASP currently outputs results for **every 3 hours**, or **0.125 days**, yielding a BMD2 file size of approximately **2 GB**. The user can refine the time step of output for the model, which increases the size of the output BMD2 file and may significantly increase the simulation time required.
- **WASP Yielding Messages regarding Time Step during Simulation:** During the model simulation, WASP may yield messages regarding the simulation time step employed by the program, such as "WASP requires a time step of [a program-defined amount], which is less". Such messages may/may not affect the performance of the Jordan River WASP simulation, which the one can either simply note the messages (e.g., not make any adjustments or modifications upon the model accordingly) or adjust the minimum time step. The minimum time step is currently set at **0.0001 days**, or approximately **8.64 seconds**, which the user can specify a minimum value of $1 * 10^{-5}$ days (e.g., 0.864 seconds) for this parameter.
- **Model Parameters for Output:** Several output parameters have been selected to have results written as time-series data into the BMD2 file generated per model simulation for all Jordan River WASP Segments (e.g., from JR1 to JR166). Specifically, the following output parameters (grouped based on segment characteristics, water quality constituents, etc.) are currently written into the BMD2 file from a model simulation of the Jordan River WASP, which one can add additional output parameters to-be-written into the BMD2 file.
    - **Transport:** Mass Check (Should = 1; Dimensionless), Volume (m^3), Flow into Segment (m^3/s), Flow out of Segment (m^3/s), Segment Depth (m), Water Velocity (m/s), Maximum Time Step (days), Calculational Time Step Used (days)
    - **Water Temperature:** Water Temperature (℃), Ice Thickness (meters)
    - **Nitrogen:** NH_3-N (mg/L), Ammonia Benthic Flux (mg/m^2-day), NO_2-NO_3-N (mg/L), DON (mg/L), PON (mg/L), TN (mg/L), TKN (mg/L)
    - **Phosphorus:** DIP (mg/L), DIP Benthic Flux (mg/m^2-day), DOP (mg/L), POP (mg/L), TP (mg/L)
    - **CBOD:** WWTP CBODU (mg/L), River CBODU (mg/L), Tributary CBODU (mg/L), Storm Drain and Groundwater CBODU (mg/L), Total CBODU (mg/L), POC (mg/L)
    - **Dissolved Oxygen:** DO (mg/L), DO Saturation Concentration (mg/L), Reaeration Rate (per day), SOD (g/m^2-day)
    - **Phytoplankton and Macro/Benthic Algae:** Phytoplankton Chlorophyll-a (μg/L), Macro/Benthic Algae Chlorophyll-a (μg/L)
    - **pH and Alkalinity:** pH (dimensionless), Alkalinity (mg/L as $CaCO_3$)
    - **Solids:** TSS (mg/L)
    - **Light:** Light Top Segment (W/m^2)
- **Sediment Diagenesis Failing to Converge:** Since the Jordan River WASP employs the **sediment diagenesis routines** for simulating sediment oxygen demand (SOD) and nutrient fluxes, the user will likely encounter issues with the sediment diagenesis routines failing to converge that hence leads to WASP shutting down. The user will need to rerun the model repeatedly until such messages over the sediment diagenesis failing to converge no longer appear.
- **SOD Restart File:** WASP develops a SOD Restart File at the end of each model run that is read by the succeeding runs, which consecutive runs of the Jordan River model tend to be implemented for the

sediment diagenesis routines to approach equilibrium against the nutrient loadings into the water column and along the sediment layers developed by WASP. Hence, if a modification upon the Jordan River WASP has been implemented, especially upon the inputs relevant for the sediment diagenesis routines, then the user will need to remove the existing/previous SOD Restart File and rerun the Jordan River WASP for avoiding the rerun from reading in the previous SOD Restart File, which may instigate the sediment diagenesis routines to fail to converge and hence instigate the model to crash.

- **Linux Version of WASP:** The model currently runs on the Windows Version of WASP and can be opened interchangeably (e.g., no conversions needed) under Linux Machines. On the other hand, the Linux Version of WASP appears to currently exhibit issues with running/executing WIF input files, which may be due to potential bugs within the Linux Version of WASP. The user will only be able to open and edit the input WIF file if the user is accessing the Linux Version of WASP.

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APPENDIX A: MODEL SENSITIVITY PARAMETERS

This appendix provides the results and methodologies applied for sensitivity analyses conducted upon the Jordan River WASP.

A.1: SENSITIVITY PARAMETERS AND METHODOLOGY

This sub-section provides the list of model input parameters, the values employed in the original/non-calibrated version of the Jordan River WASP, the method employed (e.g., by percentage/ratio, by value, etc.), and the range of values implemented for the sensitivity analyses, as described in the following table.

Model Input Parameter	**Units**	**Water Quality Constituent(s) Affected**	**Original Non-Calibrated Value**	**Method for Sensitivity**	**Values Employed for Sensitivity**
Coefficient for Bottom-Heat Exchange	W/m^2-°C	Water Temperature	60	Percentage/Ratio	0.6, 6, 30, 90, 120 600, 6000
Sediment Ground Temperature	°C	Water Temperature	14	Value	5, 10, 15, 20, 25, 30
Nitrification Rate at 20°C	1/day	NH_3-N, NO_2-NO_3-N	2	Percentage/Ratio	0.02, 0.2, 1, 3, 4, 20, 200
Half-Saturation Constant for Nitrification Oxygen Limit	mg-O_2/L	NH_3-N, NO_2-NO_3-N	2	Value	20, 200, 2000
Denitrification Rate at 20°C	1/day	NO_2-NO_3-N	0.05	Percentage/Ratio	0.0005, 0.005, 0.025, 0.075, 0.1, 0.5, 5
Half-Saturation Constant for Denitrification Oxygen Limit	mg-O_2/L	NO_2-NO_3-N	2	Value	20, 200, 2000
Dissolved Organic Nitrogen Mineralization Rate at 20°C	1/day	DON	0.4	Percentage/Ratio	0.004, 0.04, 0.2, 0.6, 0.8, 4, 40
Dissolved Organic Phosphorus Mineralization Rate at 20°C	1/day	DOP	0.5	Percentage/Ratio	0.005, 0.05, 0.25, 0.75, 1, 5, 50
CBOD Half-Saturation Oxygen Limit	mg-O_2/L	CBOD	0.5	Value	5, 50
Fraction of Carbon Source of CBOD to Denitrification	None	CBOD, NO_2-NO_3-N	1 (total)	Value	0.25, 0.5
Maximum Allowable Reaeration Rate	1/day	DO	50	Value	2, 5, 10, 25, 100
Phytoplankton Maximum Growth	1/day	Phytoplankton Chlorophyll-a	2	Percentage/Ratio	0.02, 0.2, 1, 4, 20

Rate at 20℃					
Phytoplankton Respiration Rate at 20℃	1/day	Phytoplankton Chlorophyll-a	0.1	Percentage/Ratio	0.001, 0.01, 0.05, 0.15, 0.2, 1, 10
Phytoplankton Half-Saturation for Mineralization Rate	mg-Phyto-C/L	Phytoplankton Chlorophyll-a	100	Value	1, 10, 1000
Phytoplankton Settling Rate	m/day	Phytoplankton Chlorophyll-a	0.05	Percentage/Ratio	0.0005, 0.005, 0.025, 0.075, 0.1, 0.5, 5
Macro/Benthic Algae Respiration Rate	1/day	Macro/Benthic Algae	0.042	Percentage/Ratio	0.00042, 0.0042, 0.021, 0.063, 0.084, 0.42, 4.2
Algae O_2:C Production	mg-O_2/mg-C	Macro/Benthic Algae, DO	0.5	Value	-4, -2.5, -1, -0.5, 0, 1, 2.5, 4
Fraction of Segment Covered by Benthic/Macro Algae	None	Macro/Benthic Algae	Varies among Segment	Percentage/Ratio	Increase by 50%, Decrease by 50%, Increase by 100%, Decrease by 90%
Solids Settling Rate	m/day	TSS	0.001	Percentage/Ratio	0.00001, 0.0001, 0.0005, 0.0015, 0.002, 0.01, 0.1
CO_2 Partial Pressure	atm	pH, Alkalinity	$3 * 10^{-6}$ (if no time-series applied)	Value	$2.5 * 10^{-6}$, $4.5 * 10^{-6}$, $6.5 * 10^{-6}$, $1 * 10^{-5}$
Detritus Settling Rate	m/day	POM	0.1	Percentage/Ratio	0.001, 0.01, 0.05, 0.15, 0.2, 1, 10
Initial POC Sediment Condition	mg-O_2/g-sediment	POC, DO	24	Value	6, 12, 18, 30, 36, 42…, 120 by multiples of 6
Initial PON Sediment Condition	mg-N/g-sediment	PON, DO	24	Value	6, 12, 18, 30, 36, …, 120 by multiples of 6
Initial POP Sediment Condition	mg-P/g-sediment	POP, DO	24	Value	6, 12, 18, 30, 36, …, 120 by multiples of 6
Fraction of POC/PON/POP into G1 (Labile)	None	POC, PON, POP, DO	0.1	Value	0, 0.05, 0.15, 0.25, 0.4, 0.7
Fraction of POC/PON/POP into G2 (Refractory)	None	POC, PON, POP, DO	0.3	Value	0, 0.15, 0.2, 0.25, 0.35, 0.4, 0.6, 0.9
Fraction of POC/PON/POP into G3 (Inert)	None	POC, PON, POP, DO	0.6	Value	0, 0.3, 0.45, 0.5, 0.55, 0.65, 0.7, 0.75, 0.9
Background Light Extinction Coefficient	1/m	Lighting	0.2	Percentage/Ratio	0.002, 0.02, 0.1, 0.3, 0.4, 2, 20
Detritus and Solids Light Extinction Coefficient	1/m	Lighting, POM, TSS	0.034	Percentage/Ratio	0.00034, 0.0034, 0.017, 0.051, 0.068, 0.34, 3.4

DOC Light Extinction Multiplier	1/m	Lighting, CBOD	0.34	Percentage/Ratio	0.0034, 0.034, 0.17, 0.51, 0.68, 3.4, 34

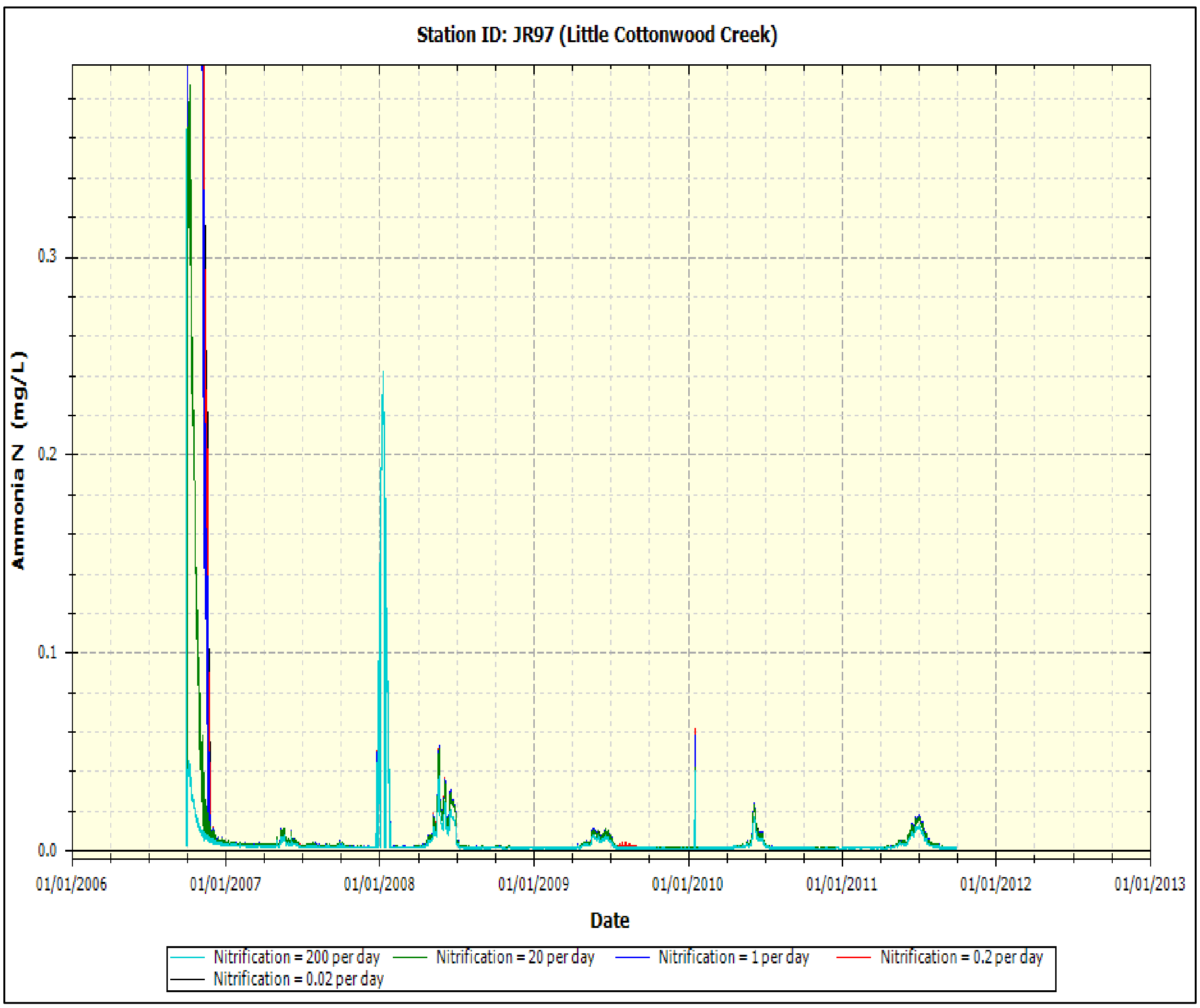
A.2: SENSITIVITY PLOTS

This sub-section provides example plots for assessing the variability of several model input parameters described in A.1: Sensitivity Parameters and Methodology upon the WASP Jordan River model performance. The results for all segments based upon all input parameters are NOT included in this sub-section, which the plots are displayed for providing insight regarding the variability of particular input parameters upon the model simulations.

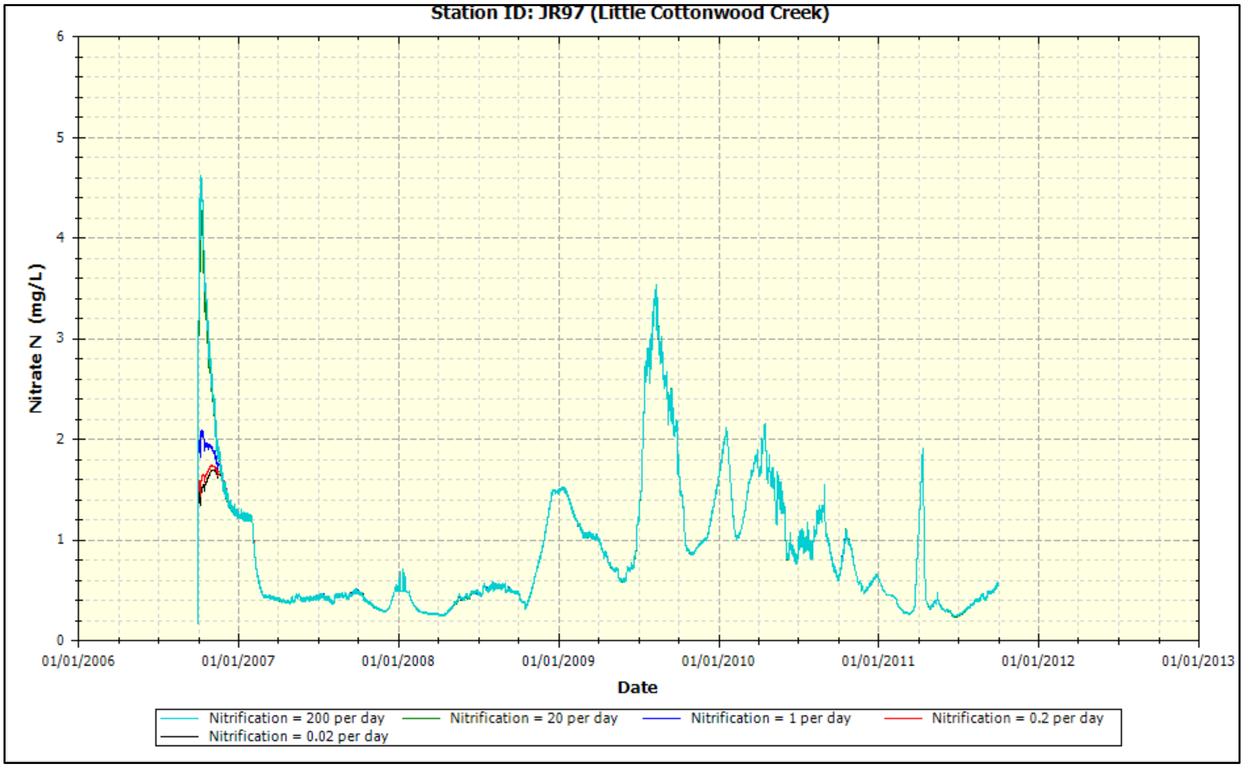
A.2.1: NUTRIENT KINETICS

The following example plots provide the variability of different input parameters that focus on the nutrient kinetics upon the Jordan River WASP.

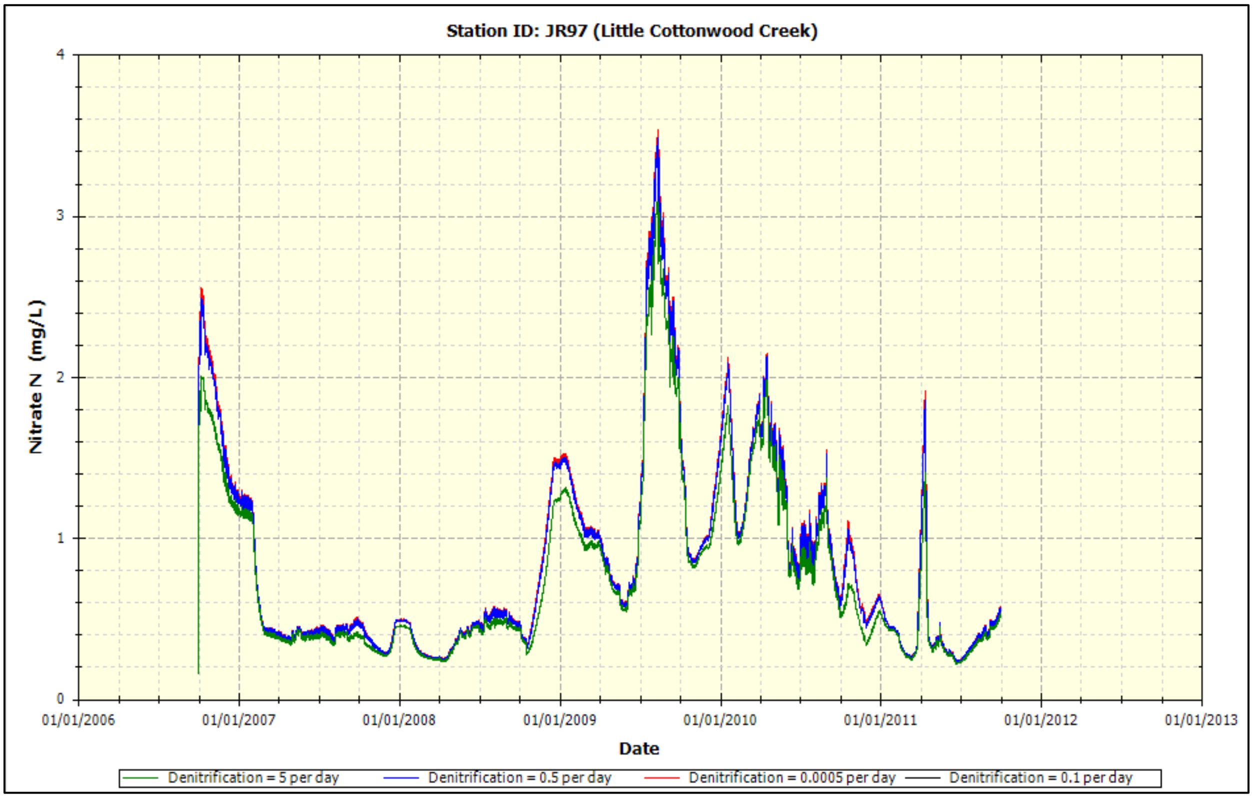
- Nitrification Rate at 20 degrees Celsius (per day)
  - Example Plot on Nitrification Rate upon NH_3-N



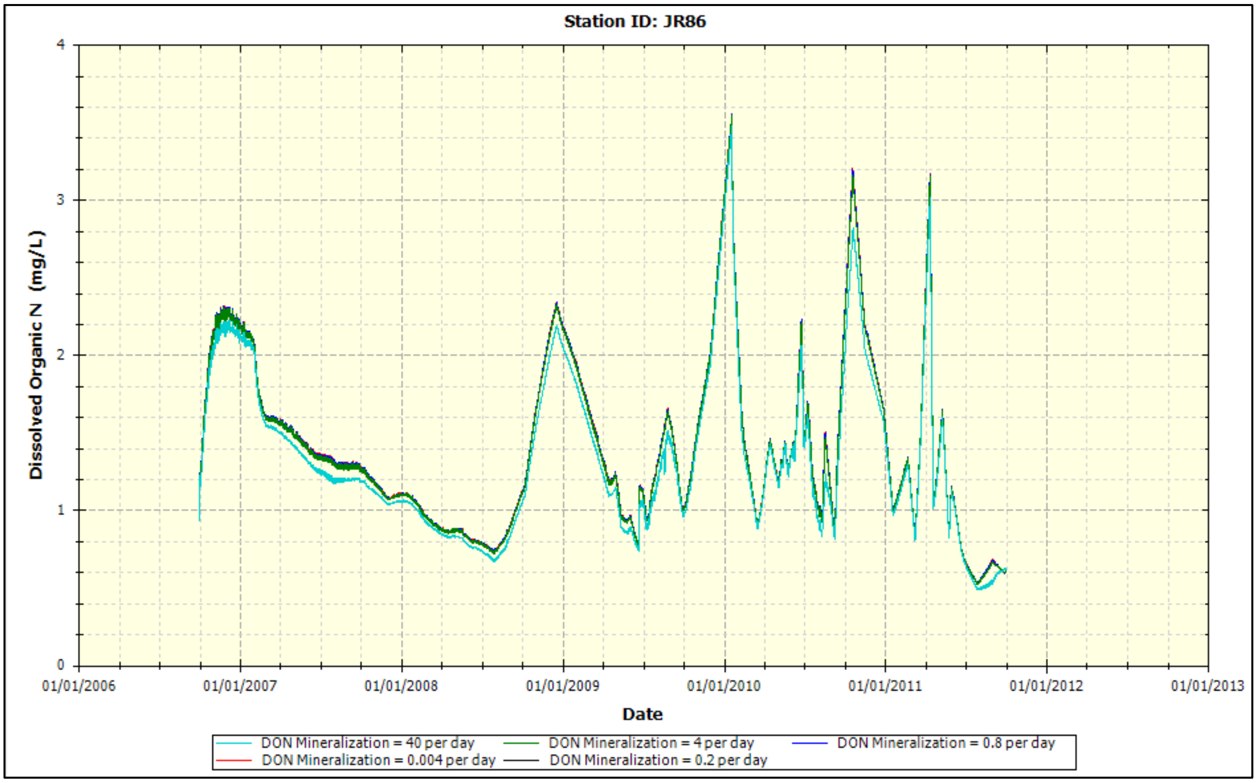
- Example Plot on Nitrification Rate upon NO_2-NO_3-N (same segment)



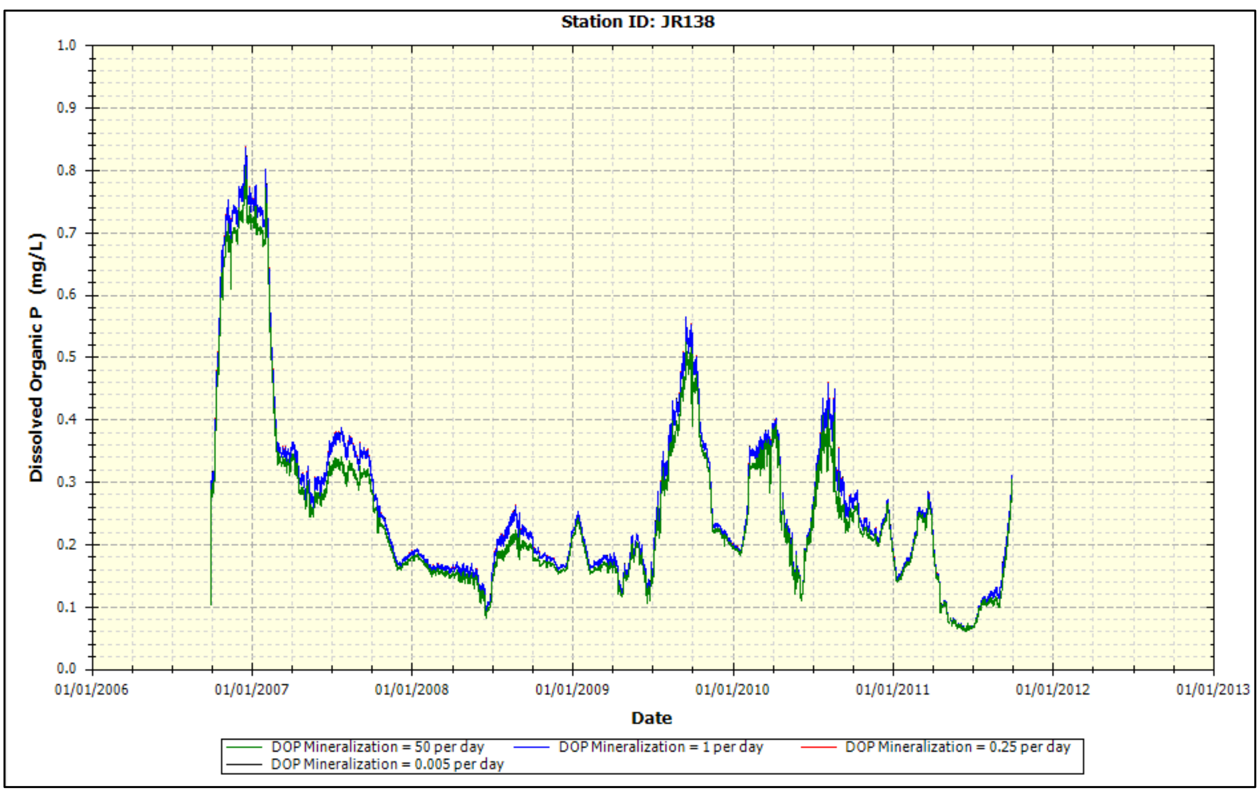
- Denitrification Rate at 20 degrees Celsius (per day) upon NO_2-NO_3-N



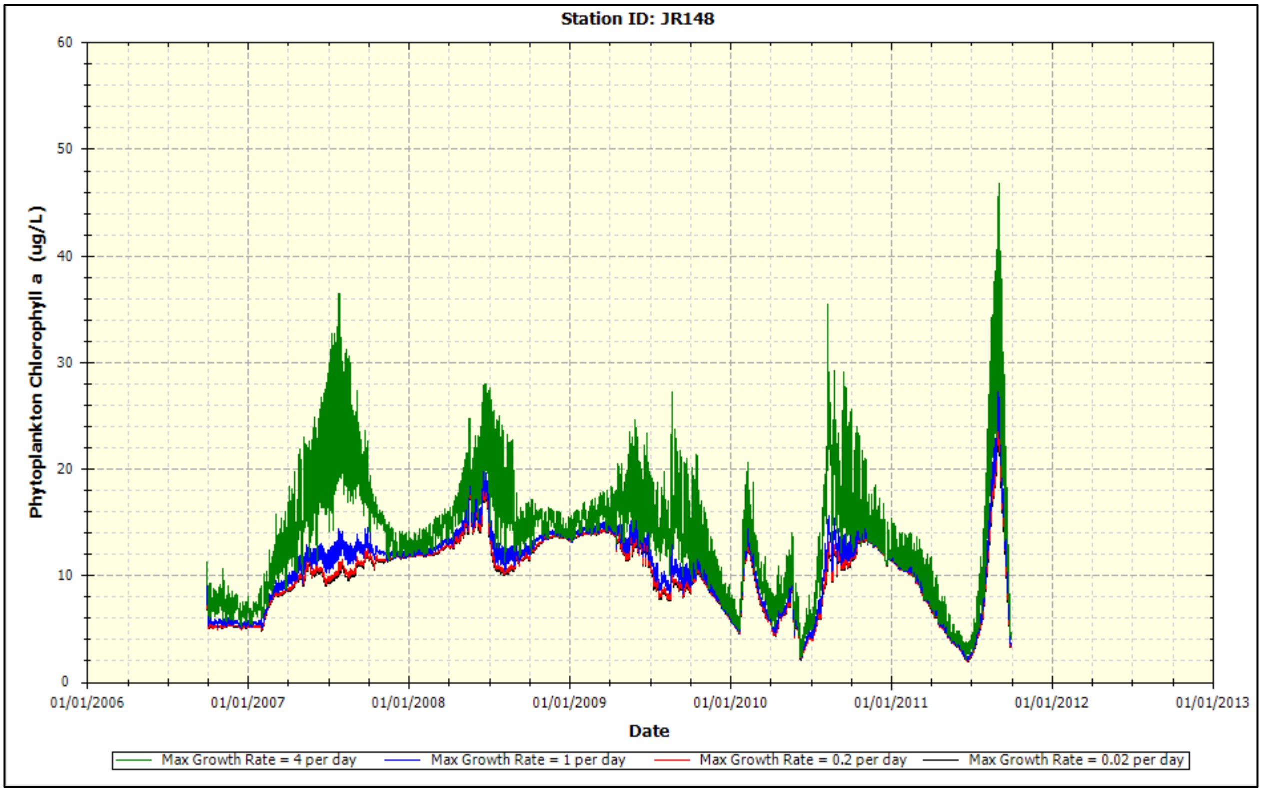
- Dissolved Organic Nitrogen Mineralization Rate at 20 degrees Celsius (per day) upon DON



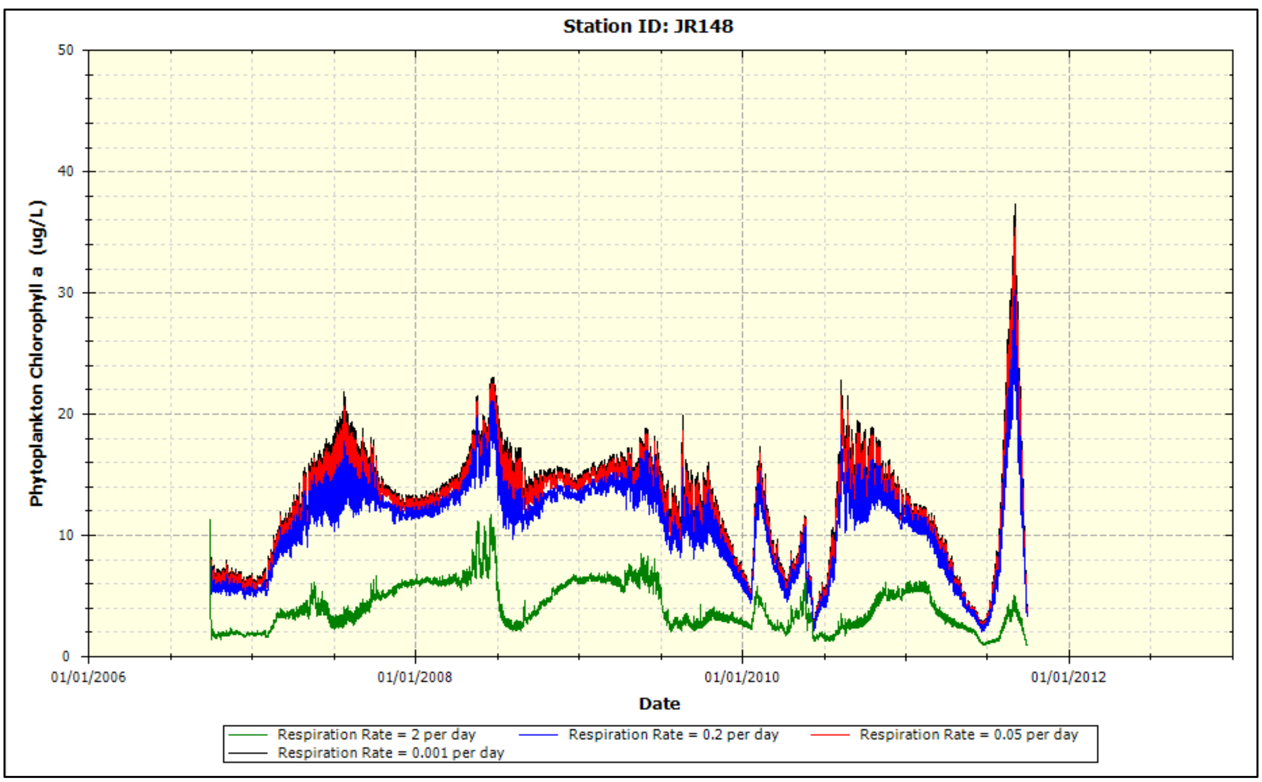
- Dissolved Organic Phosphate-Phosphorus Mineralization Rate at 20 degrees Celsius (per day) upon DOP



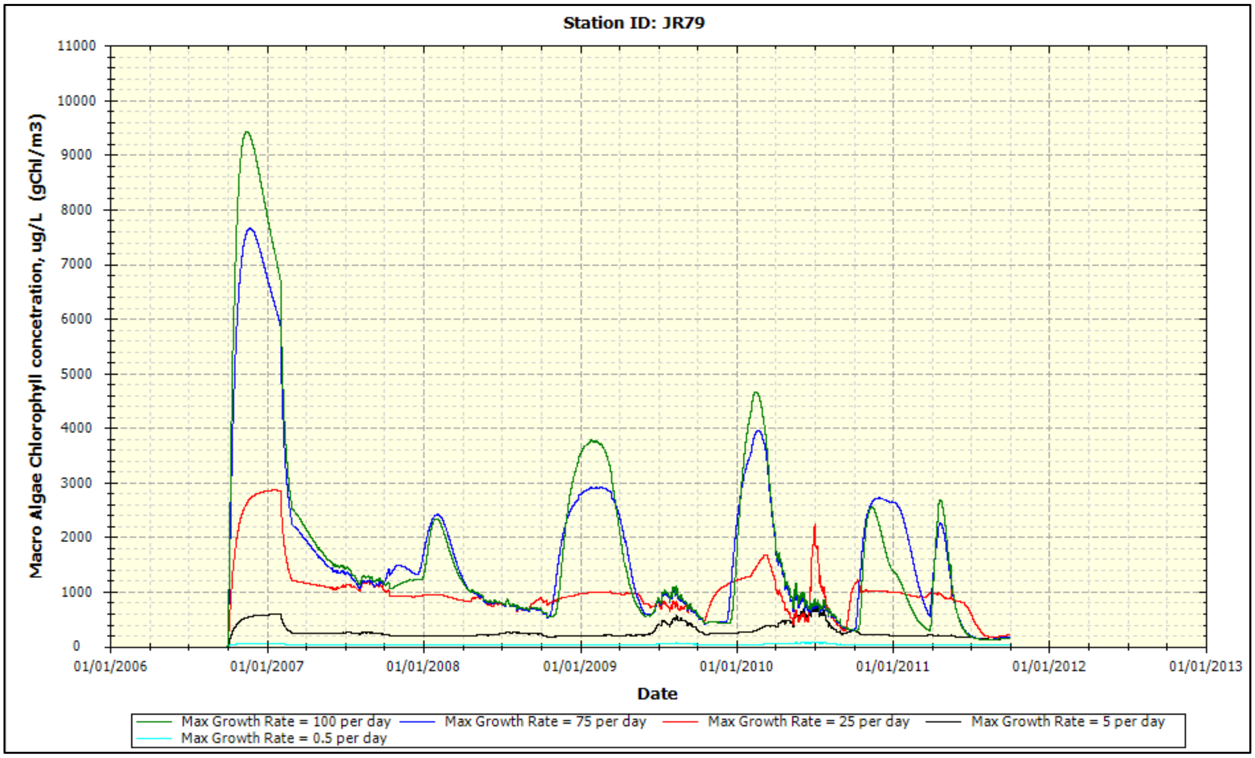
- Phytoplankton Maximum Growth Rate at 20 degrees Celsius (per day) upon Phytoplankton Chlorophyll-a



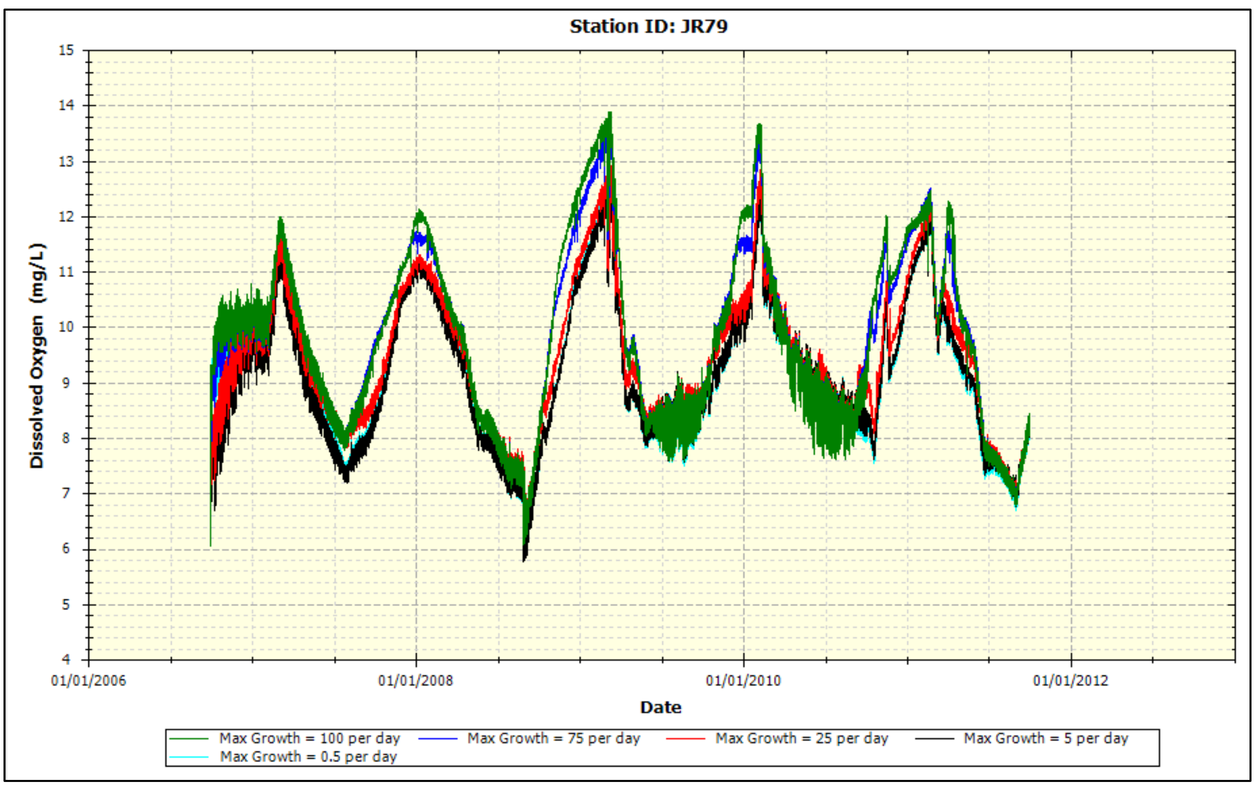
- Phytoplankton Respiration Rate at 20 degrees Celsius (per day) upon Phytoplankton Chlorophyll-a



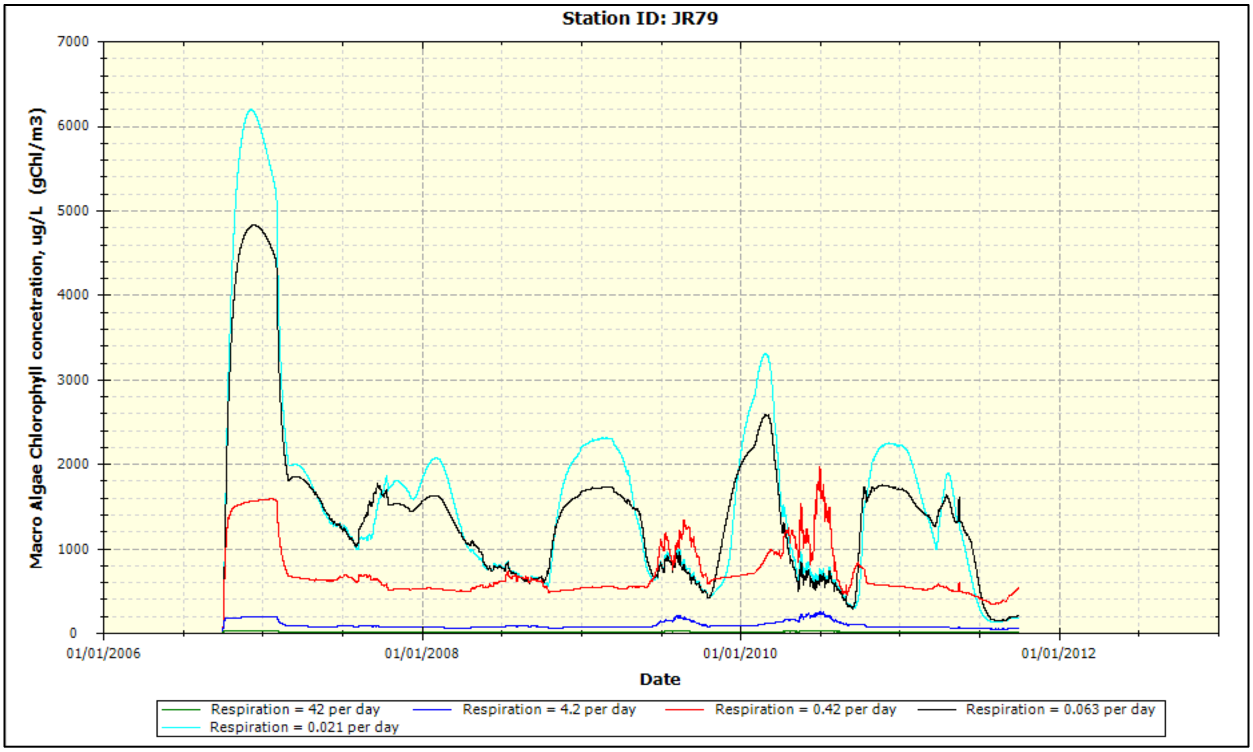
- Macro Algae Maximum Growth Rate at 20 degrees Celsius (per day)
    - Maximum Growth Rate upon Macro Algae Chlorophyll-a (μg/L)



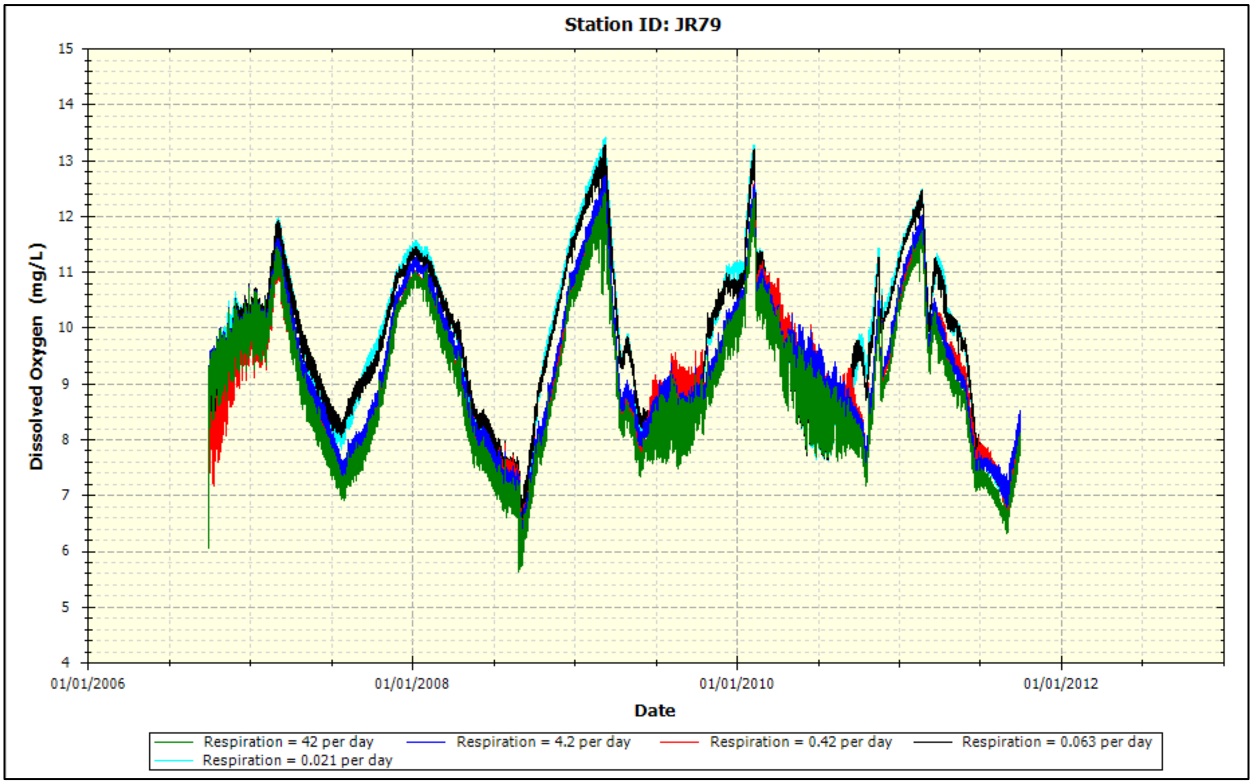
    - Maximum Growth Rate upon DO (same segment)



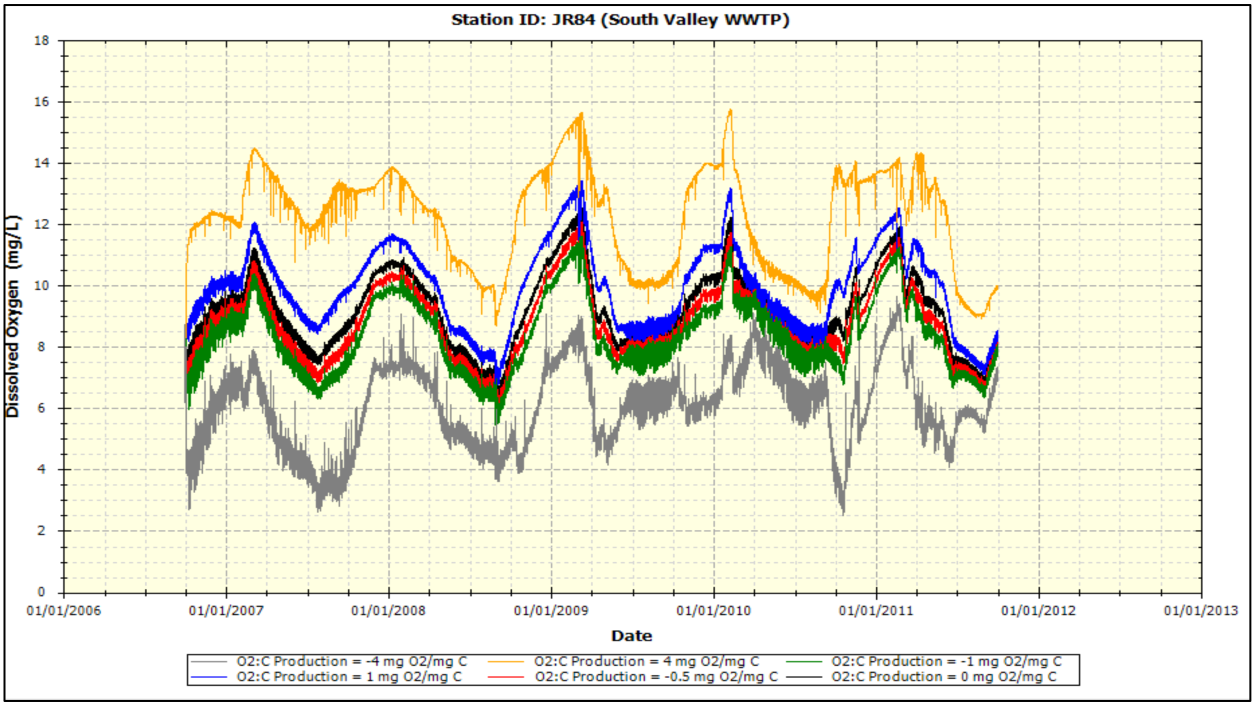
- Macro Algae Respiration Rate at 20 degrees Celsius (per day)
    - Respiration Rate upon Macro Algae Chlorophyll-a (μg/L)



- Respiration Rate upon DO (same segment)



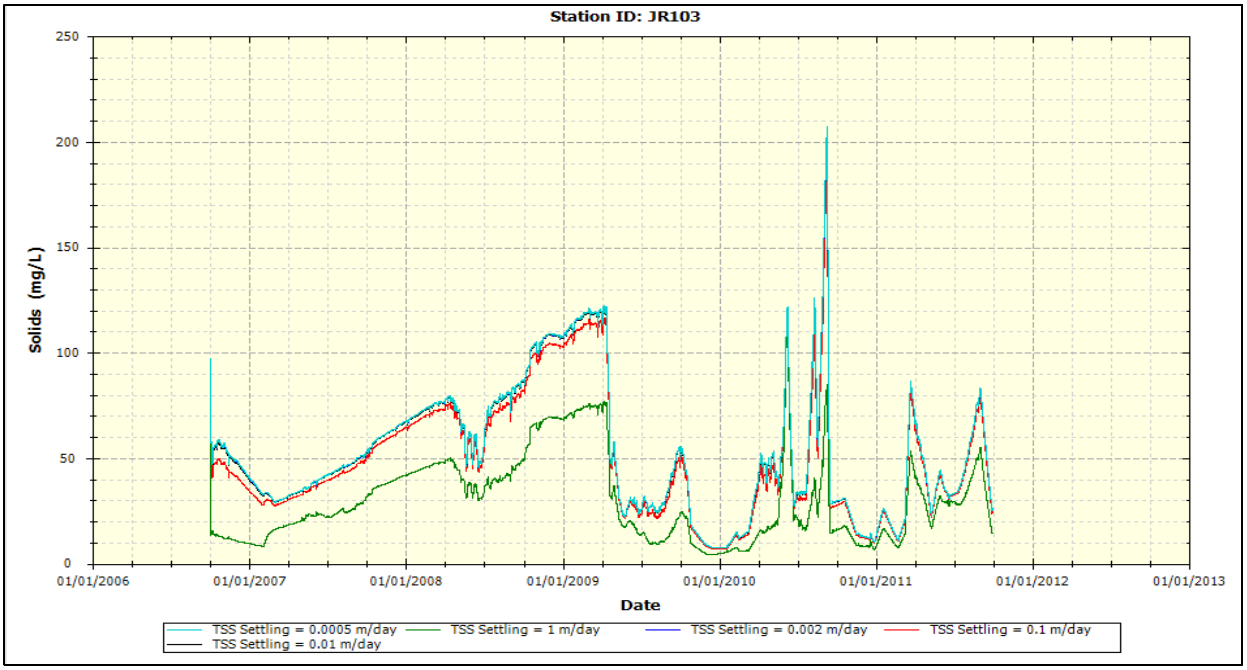
- Macro Algae O_2:C Production (mg O_2/mg C) upon DO



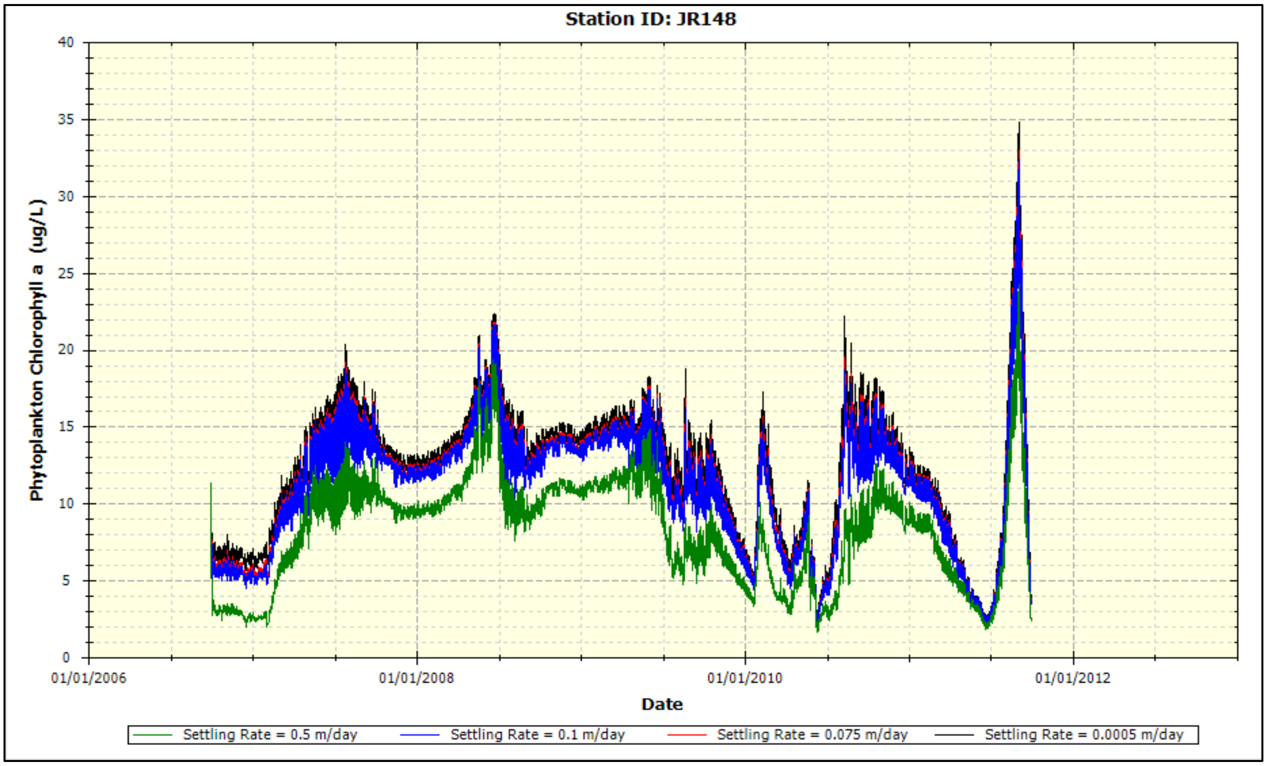
A.2.2: SETTLING RATES

The following example plots provide the variability of different input parameters that focus on settling rates upon the Jordan River WASP.

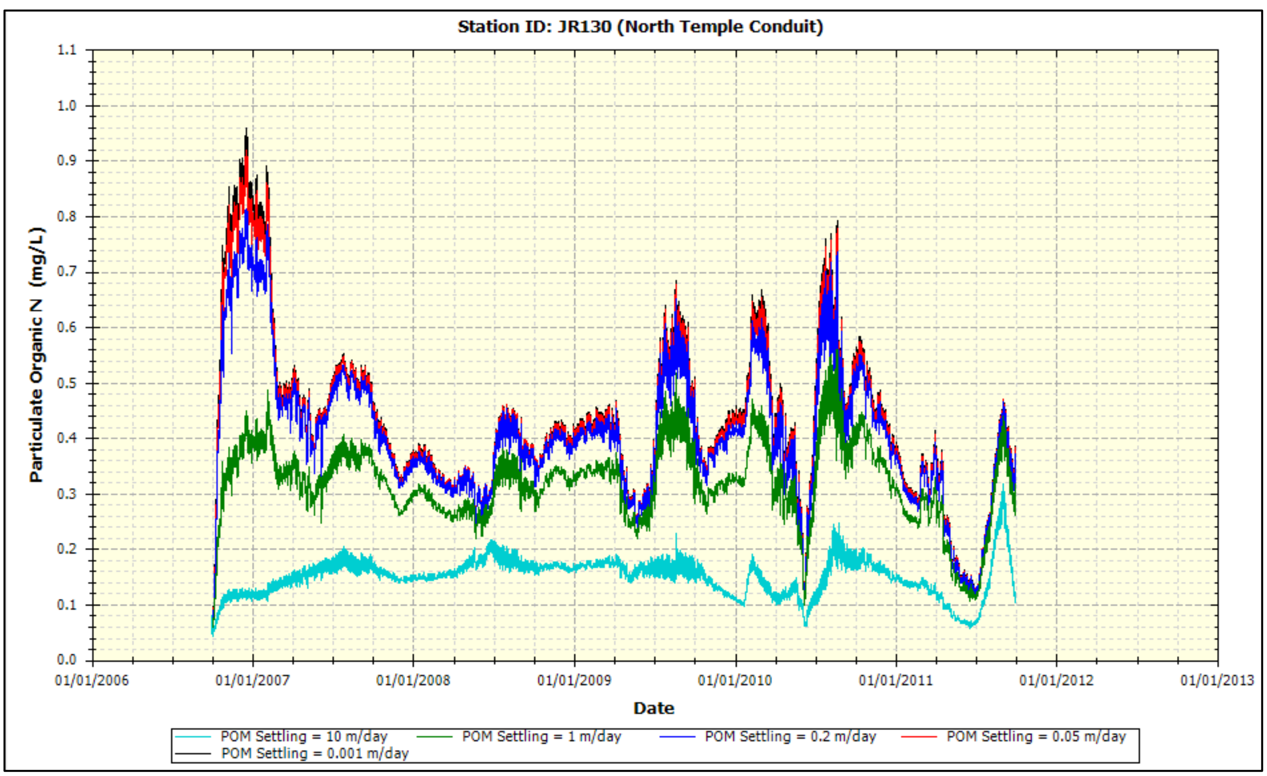
- Solids Settling Rate (m/day) upon TSS



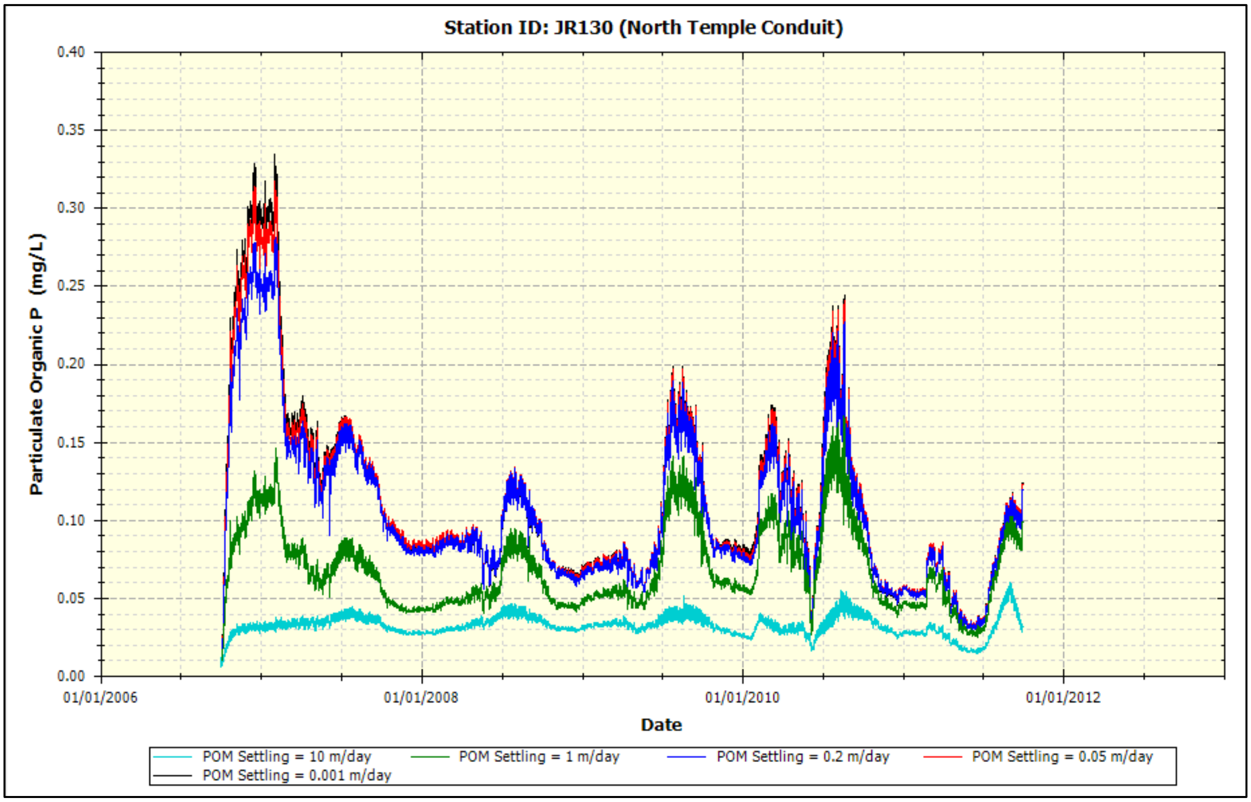
- Phytoplankton Settling Rate (m/day) upon Phytoplankton Chlorophyll-a



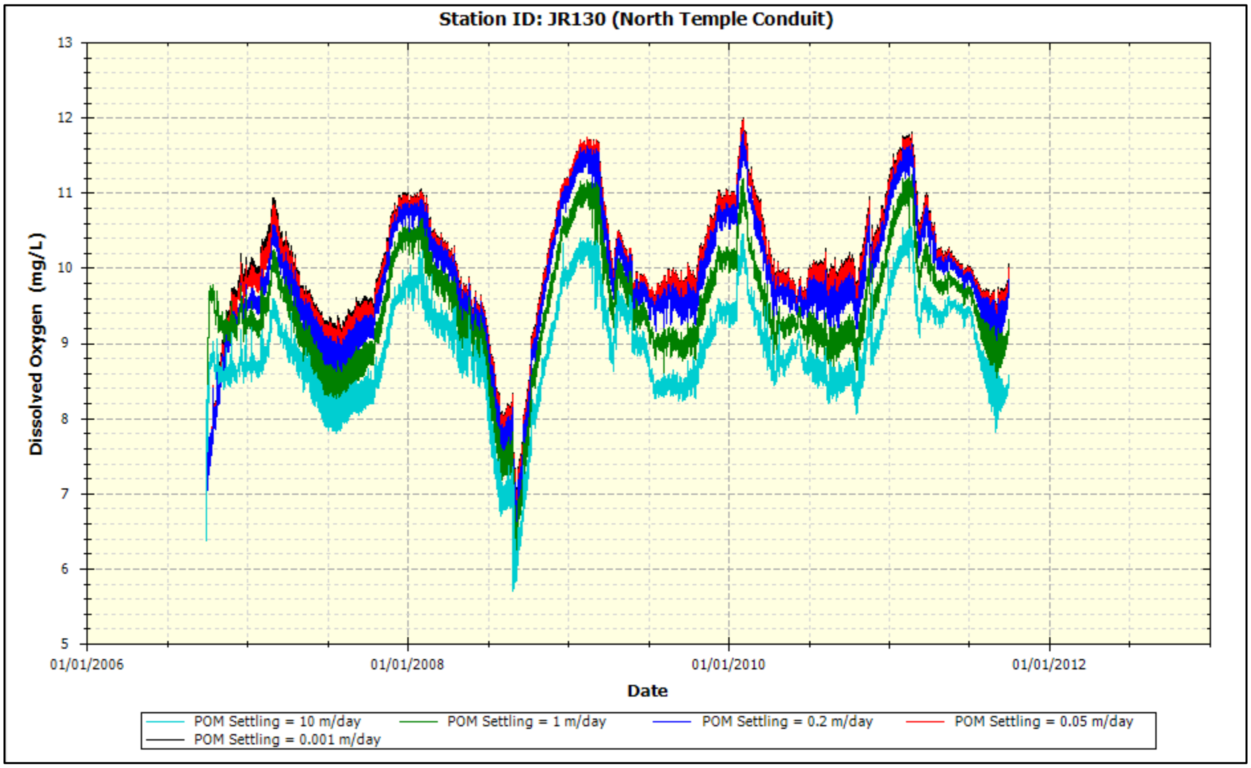
- Detritus/POM Settling Rate (m/day)
    - POM Settling Rate upon PON



- POM Settling Rate upon POP



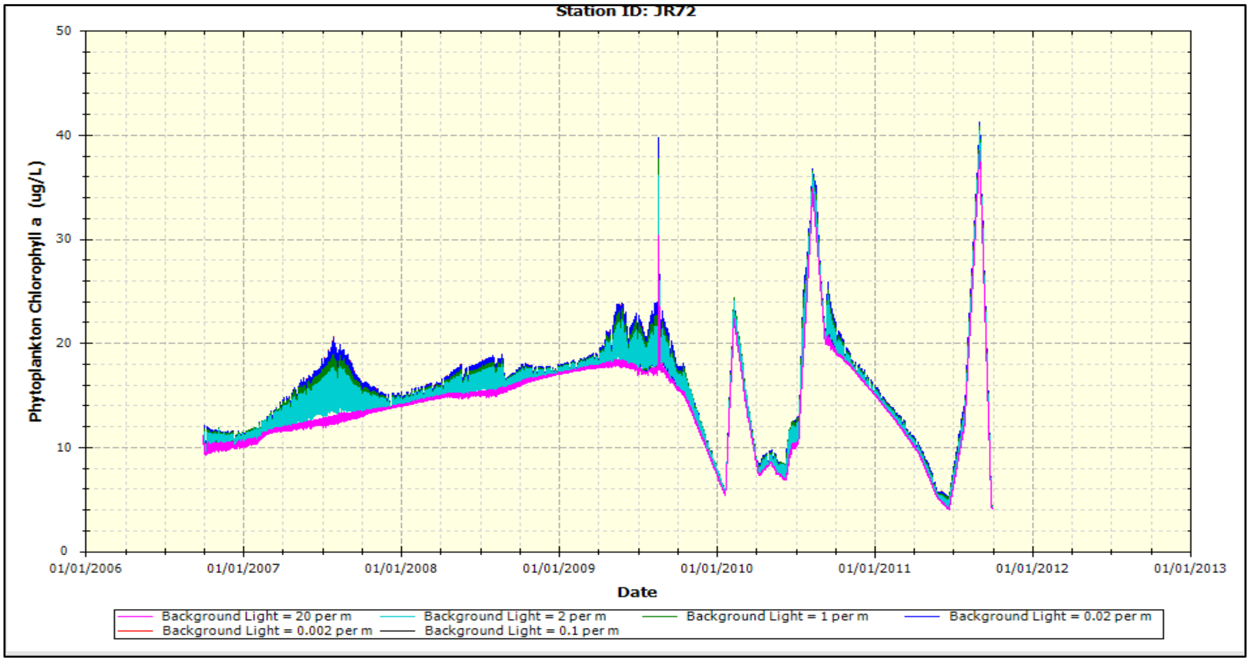
- POM Settling Rate upon DO



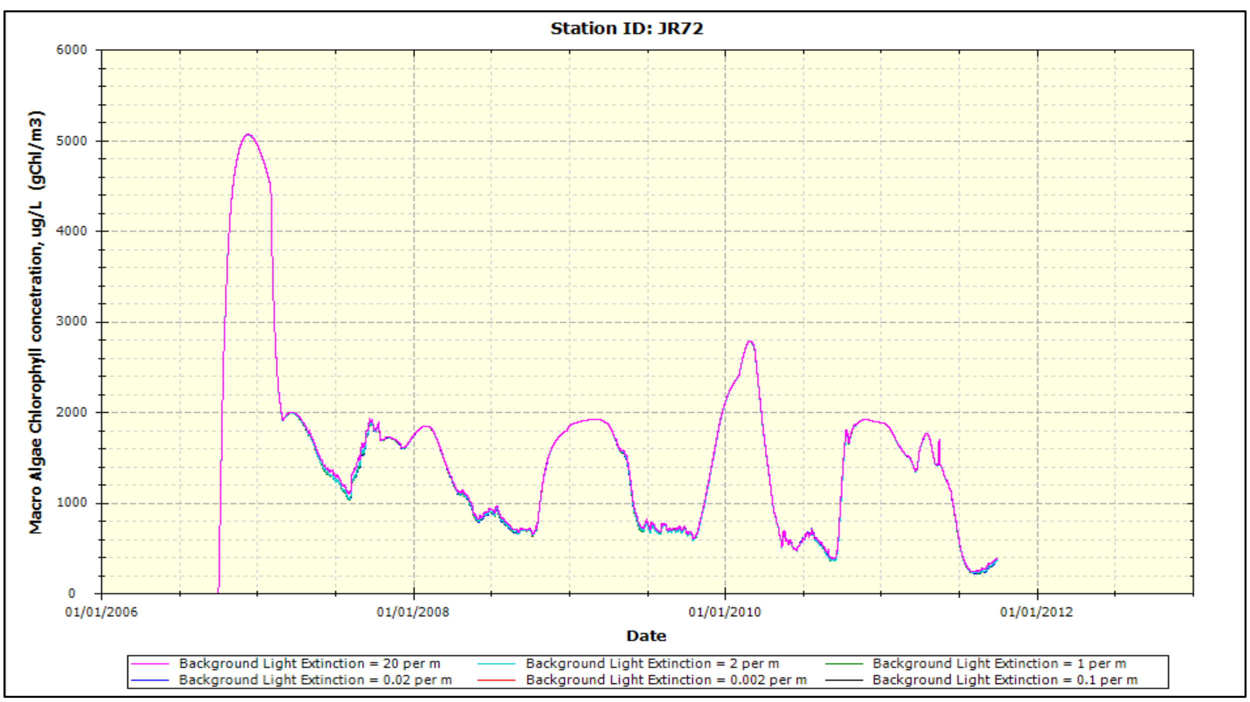
A.2.3: LIGHTING

The following example plots provide the variability of different input parameters that focus on lighting upon the Jordan River WASP.

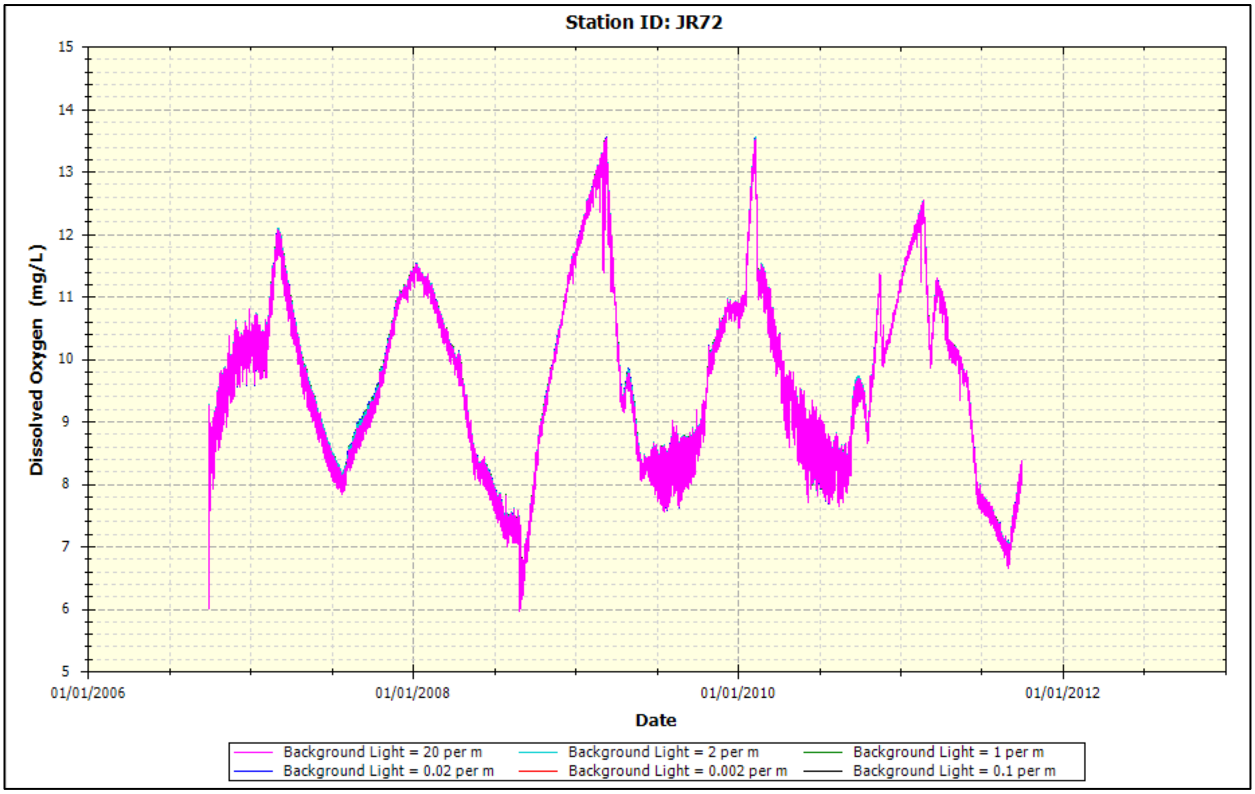
- Background Light Extinction Coefficient (1/m)
    - Background Light upon Phytoplankton Chlorophyll-a



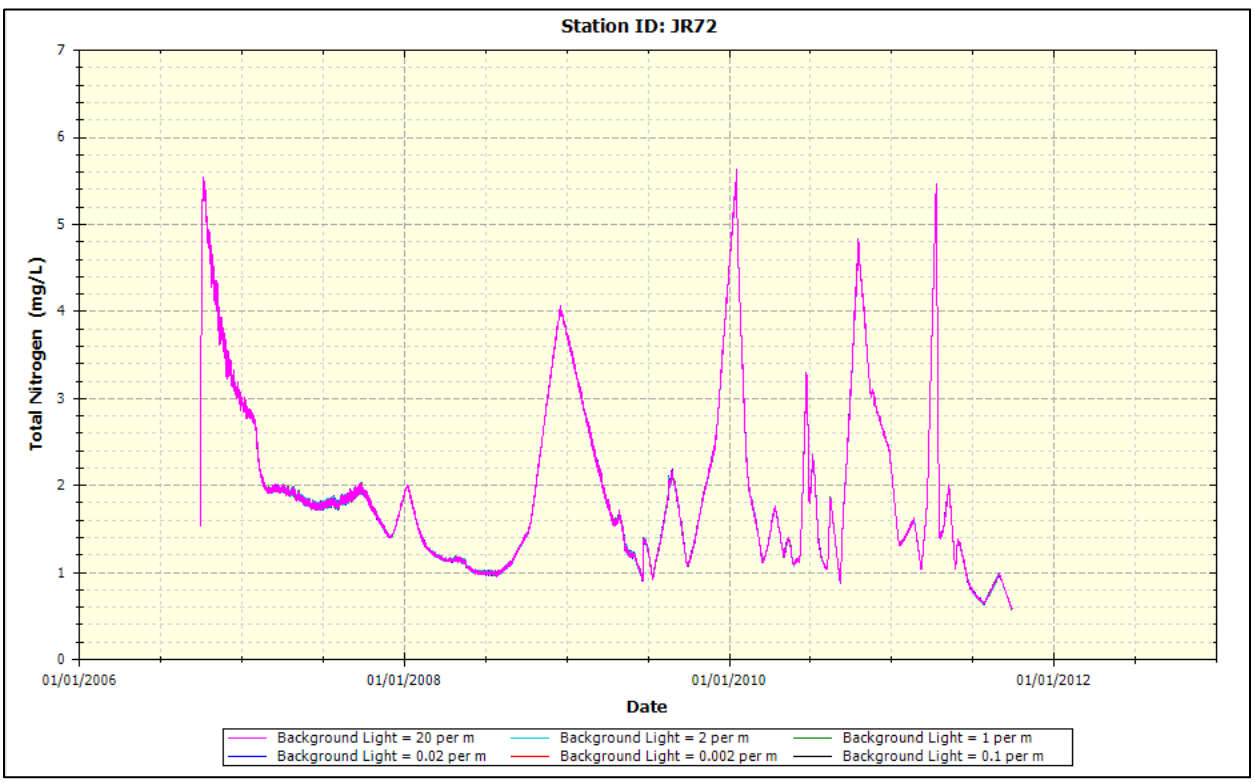
- Background Light Extinction upon Macro/Benthic Algae Concentration (same segment)



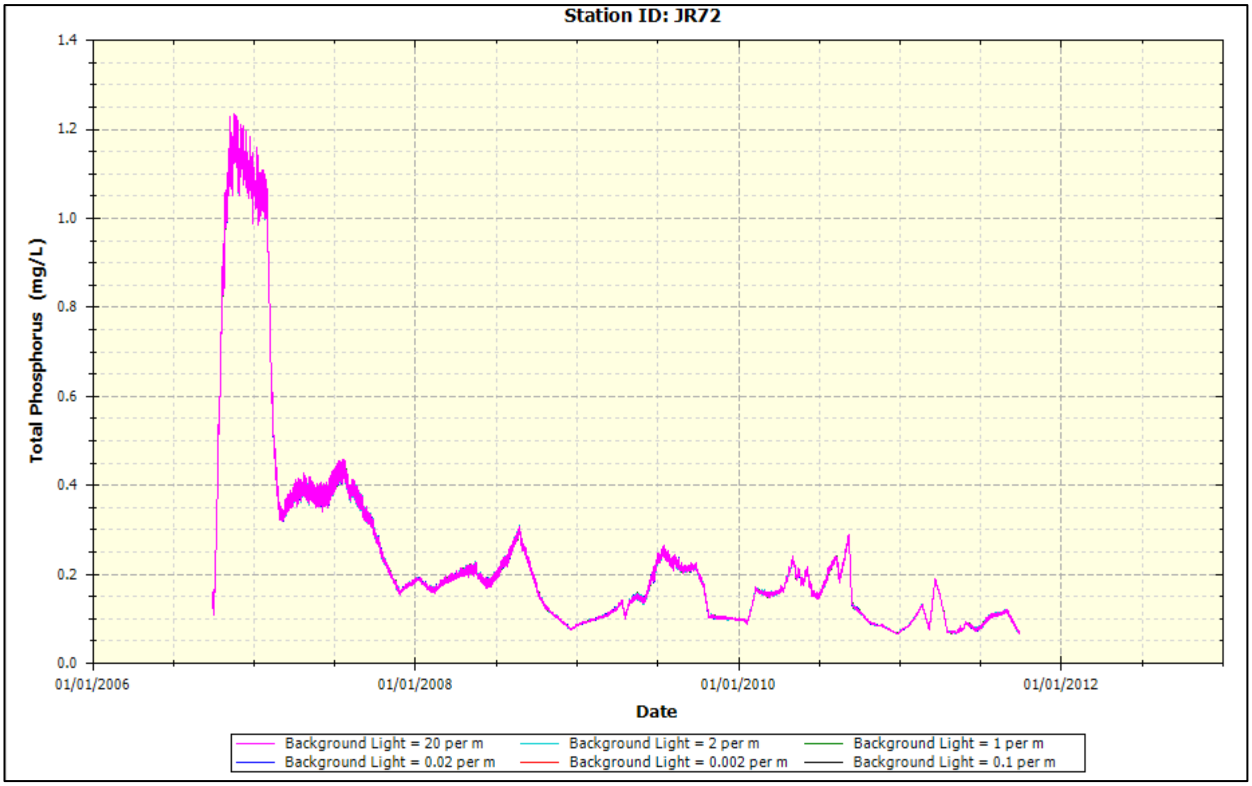
- Background Light Extinction upon DO



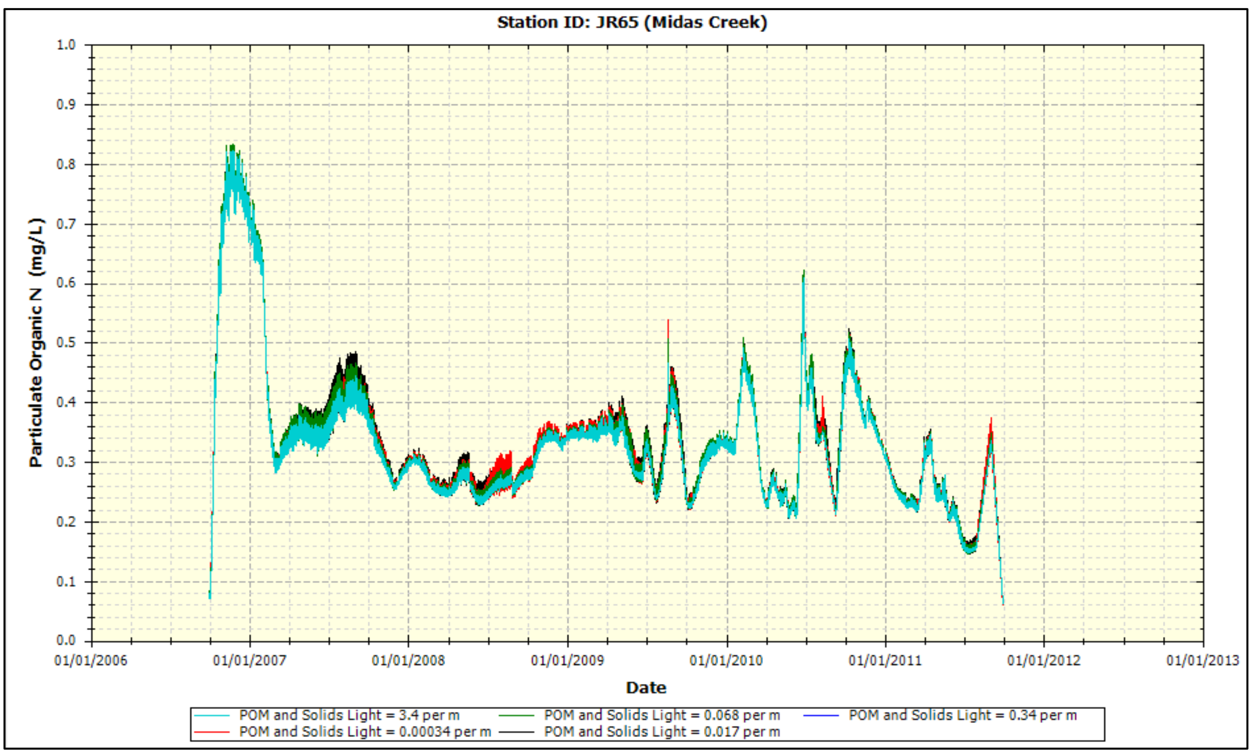
- Background Light upon TN Concentration (same segment)



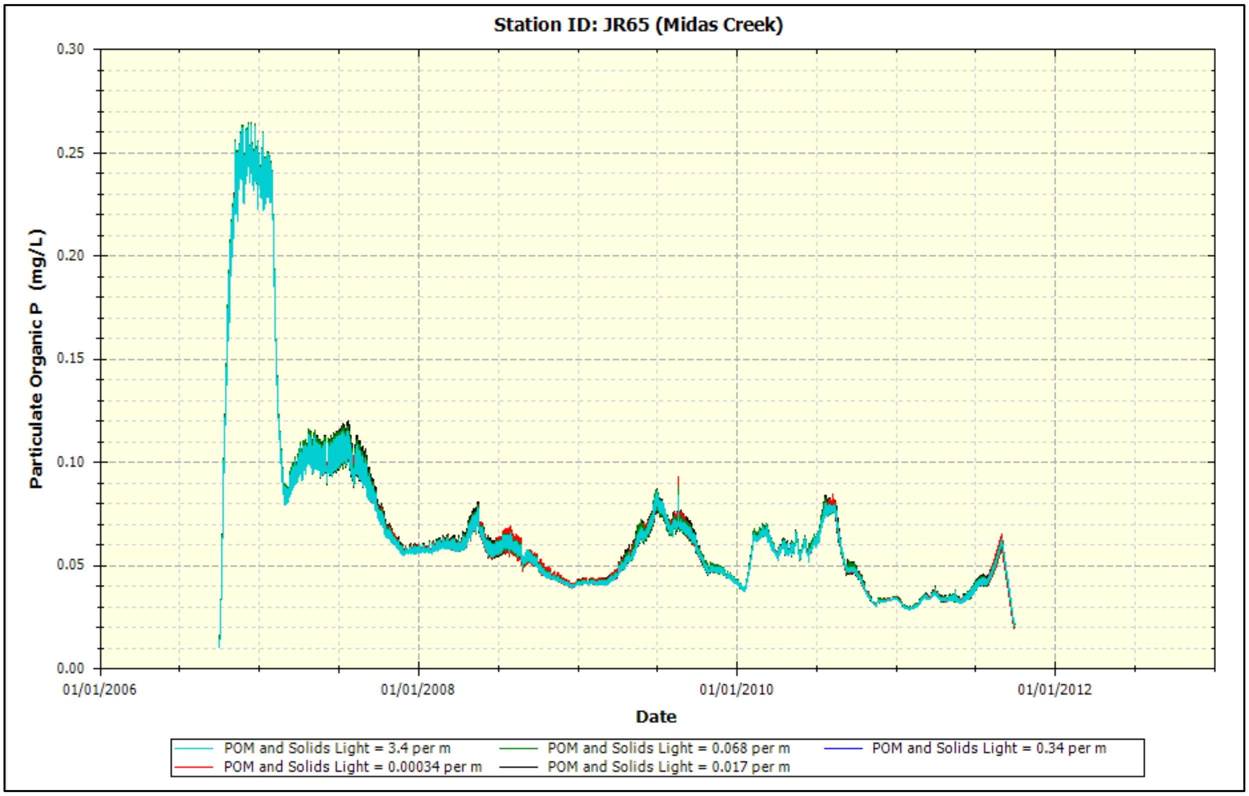
- Background Light upon TP Concentration (same segment)



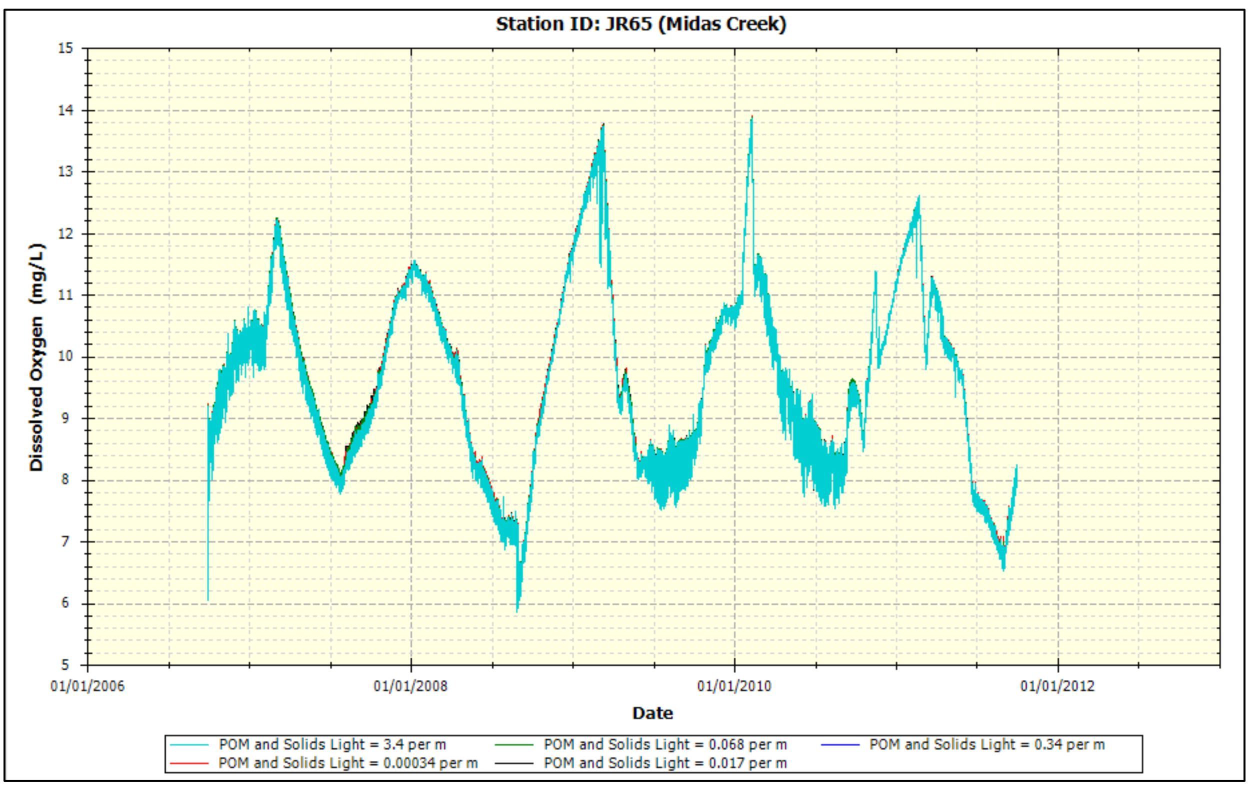
- Detritus/POM and Solids Light Extinction Coefficient (1/m)
  - POM and Solids Light upon PON



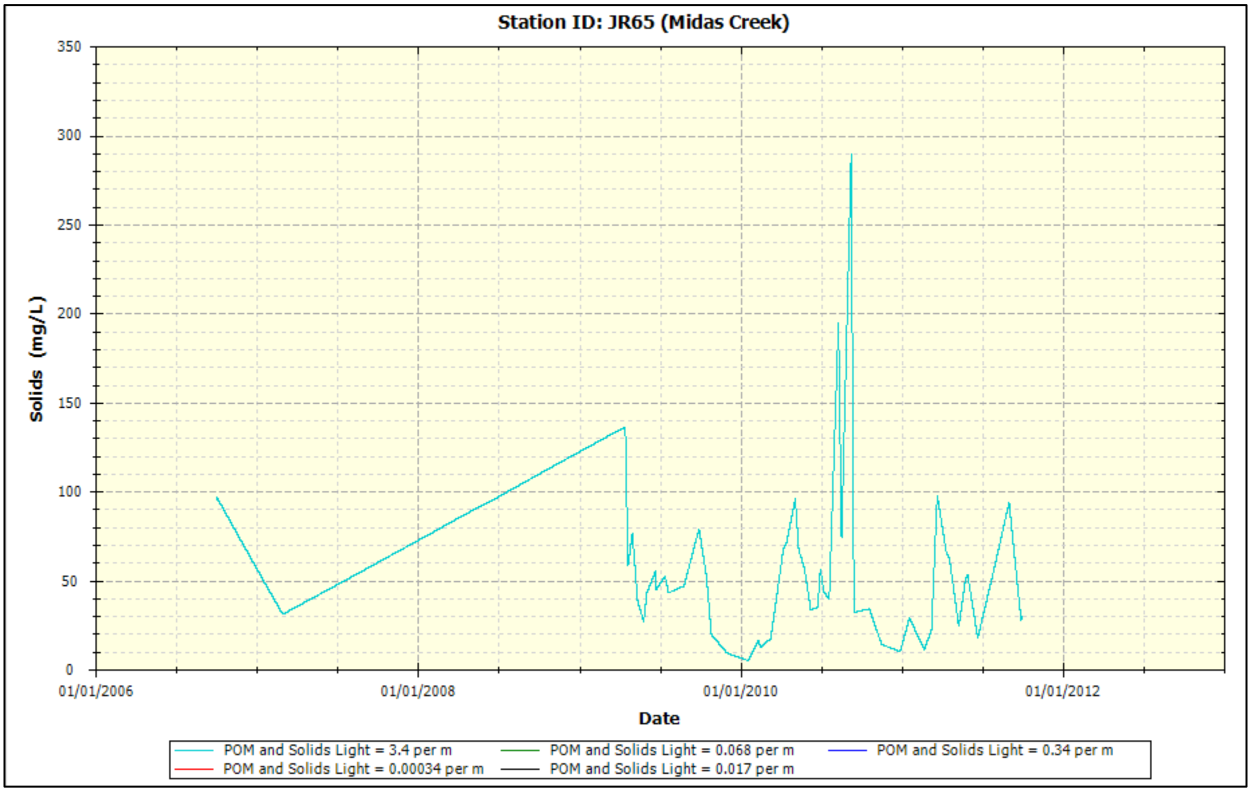
- POM and Solids Light upon POP



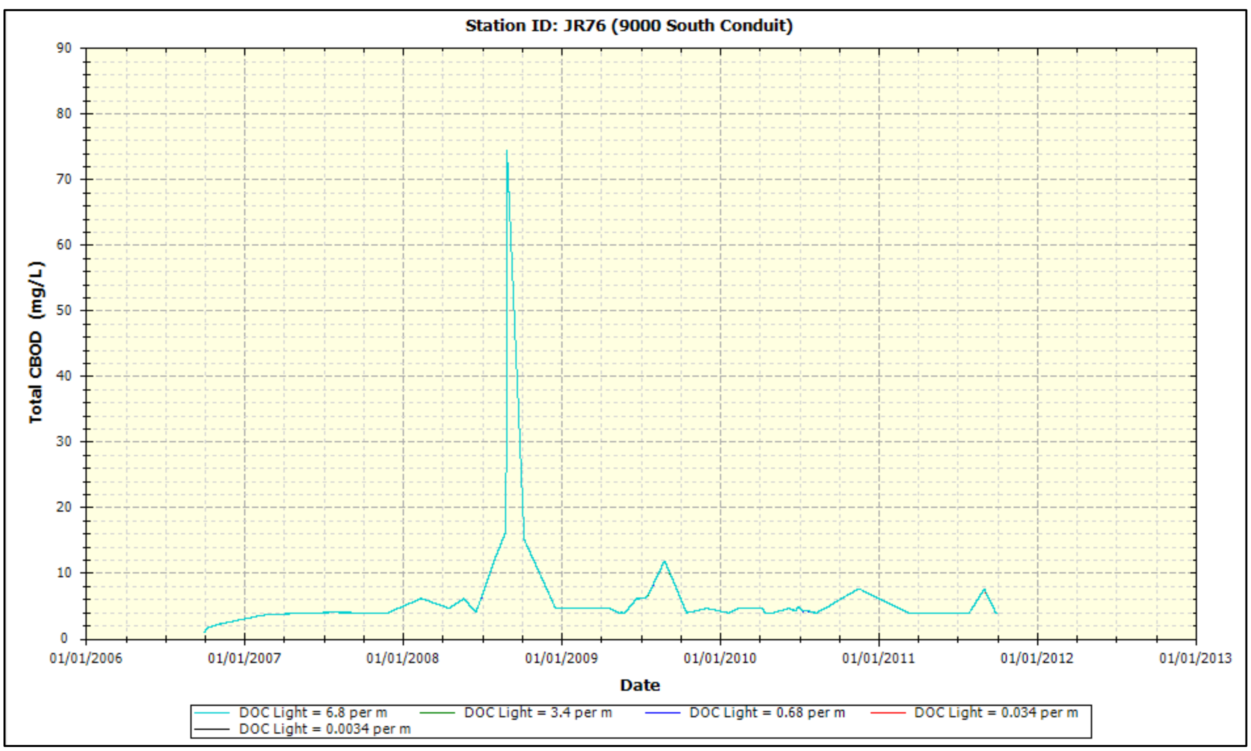
- POM and Solids Light upon DO



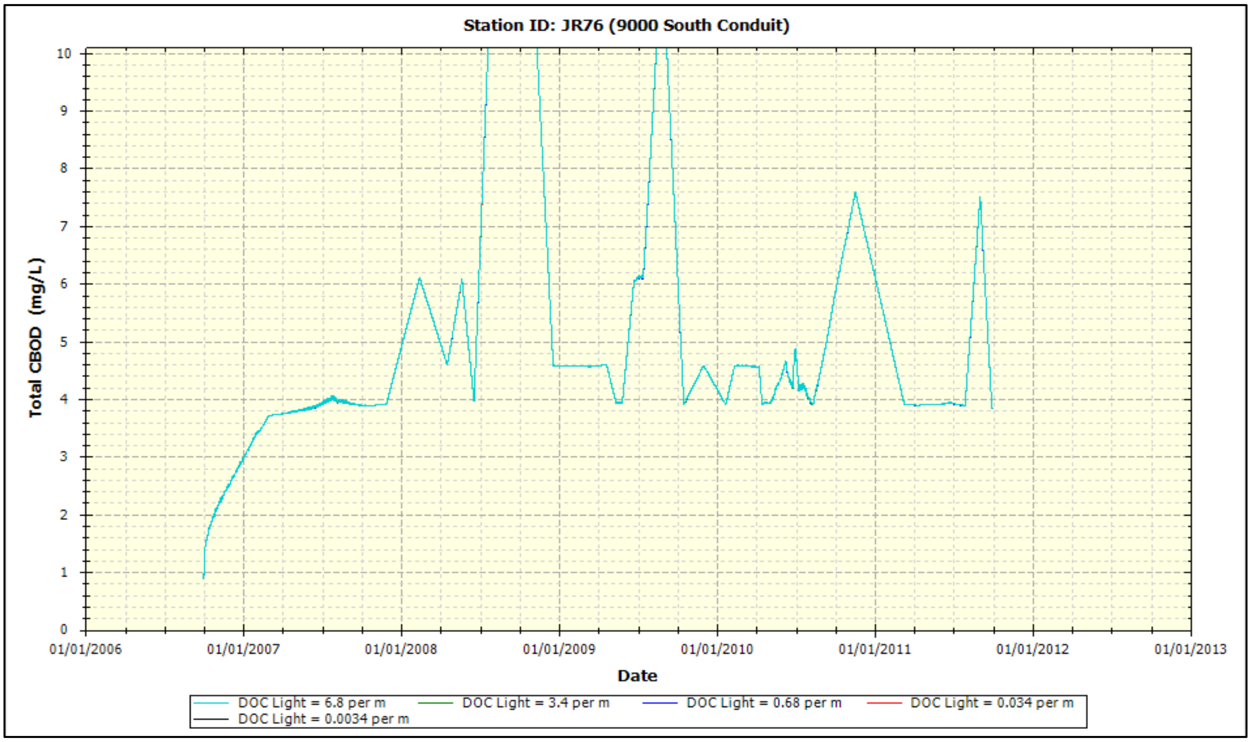
○ POM and Solids Light upon TSS



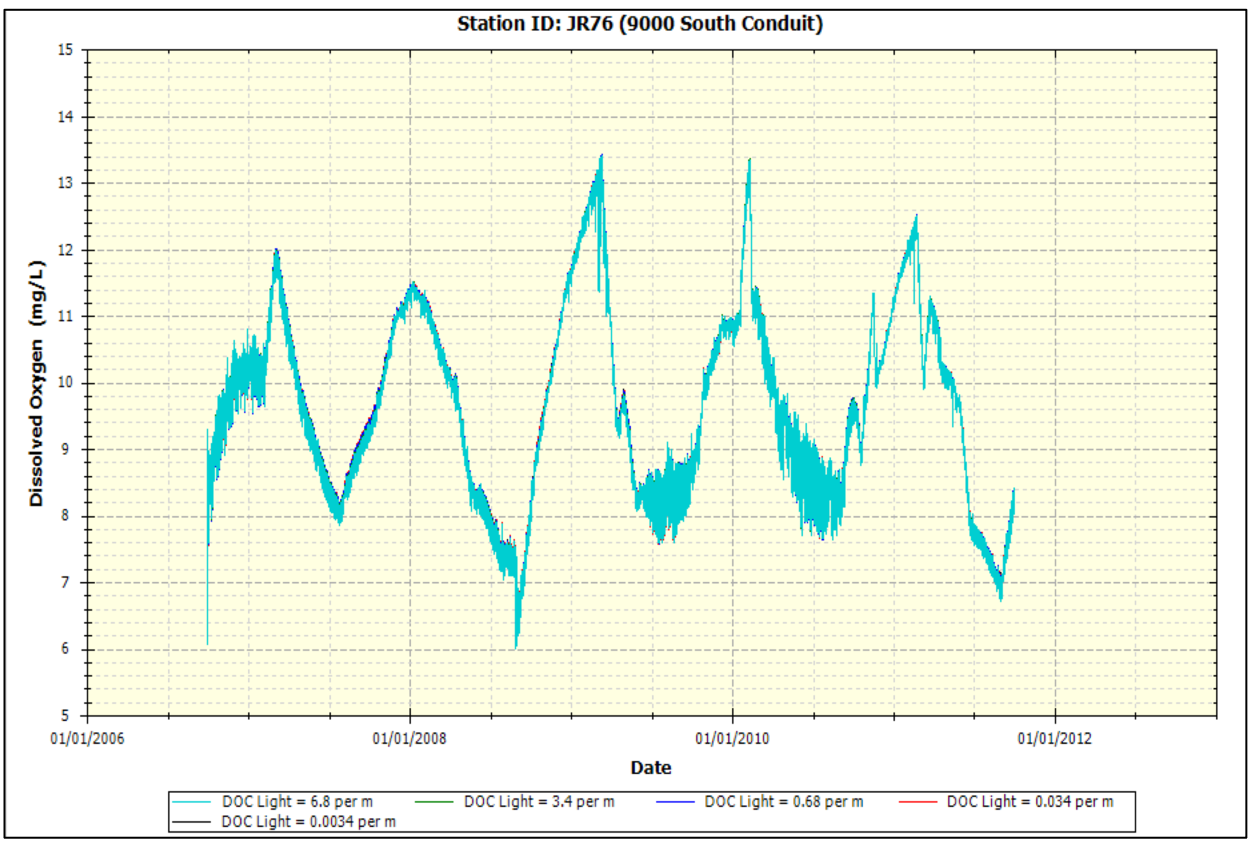
- DOC Light Extinction Coefficient (1/m)
    ○ DOC Light upon CBOD



- DOC Light upon CBOD (same segment; zoomed-into within 10 mg/L)



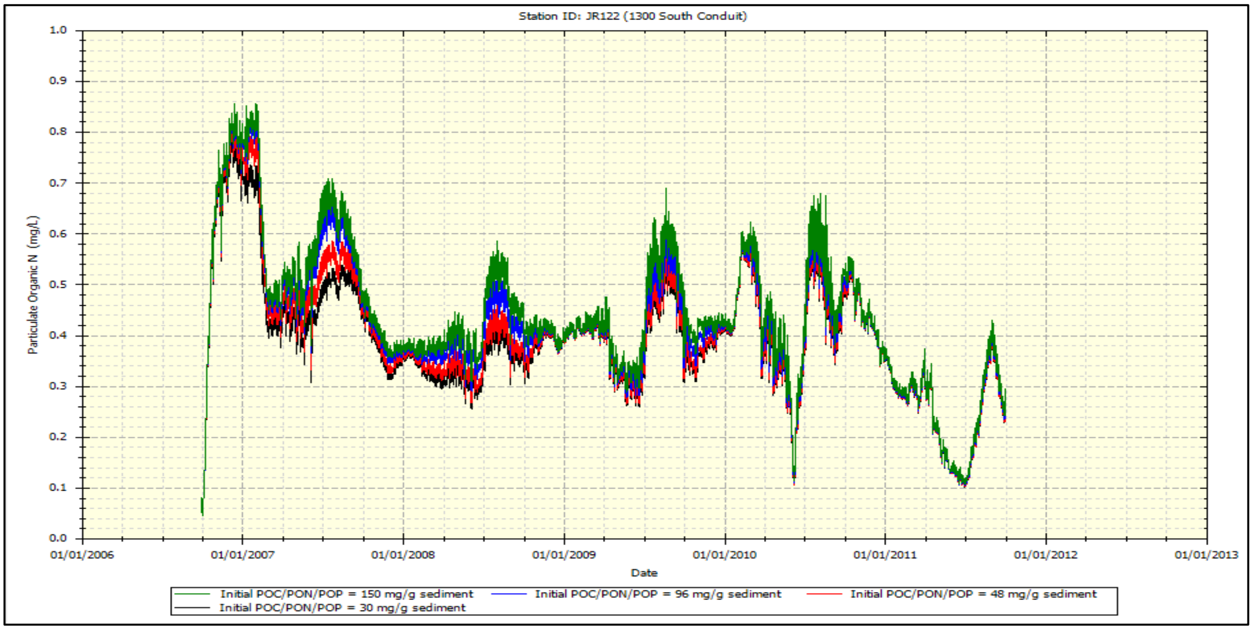
- DOC Light upon DO (same segment)



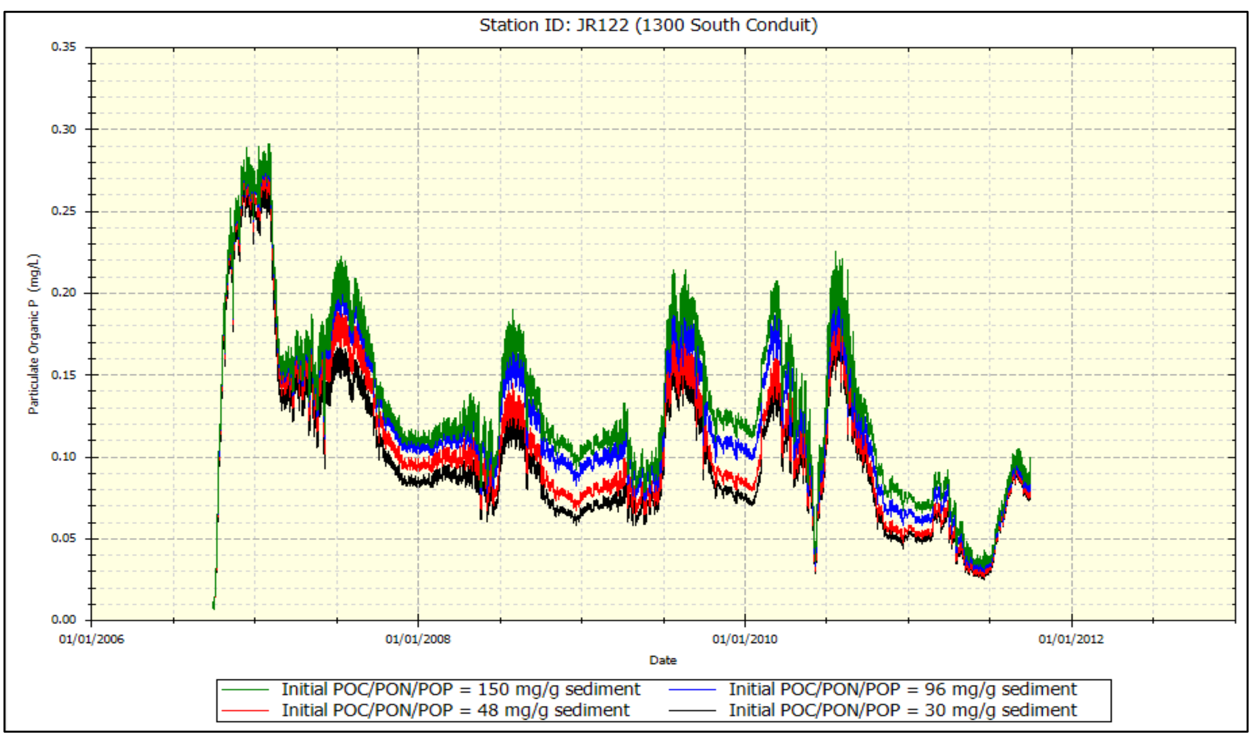
A.2.4: SEDIMENT DIAGENESIS ROUTINES

The following example plots provide the variability of different input parameters that focus on sediment diagenesis routines upon the Jordan River WASP.

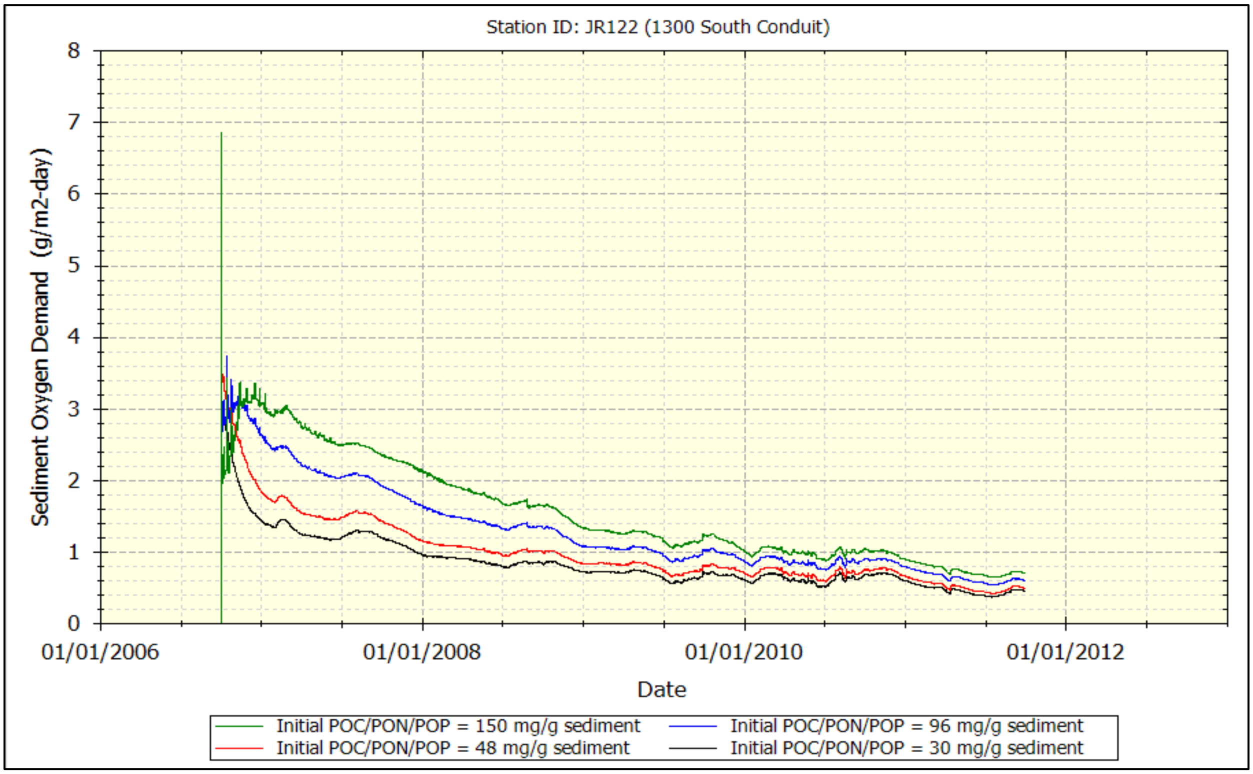
- Initial POC, PON, and POP Sediment Conditions (mg/g sediment)
    - Initial POC, PON, and POP Conditions upon PON



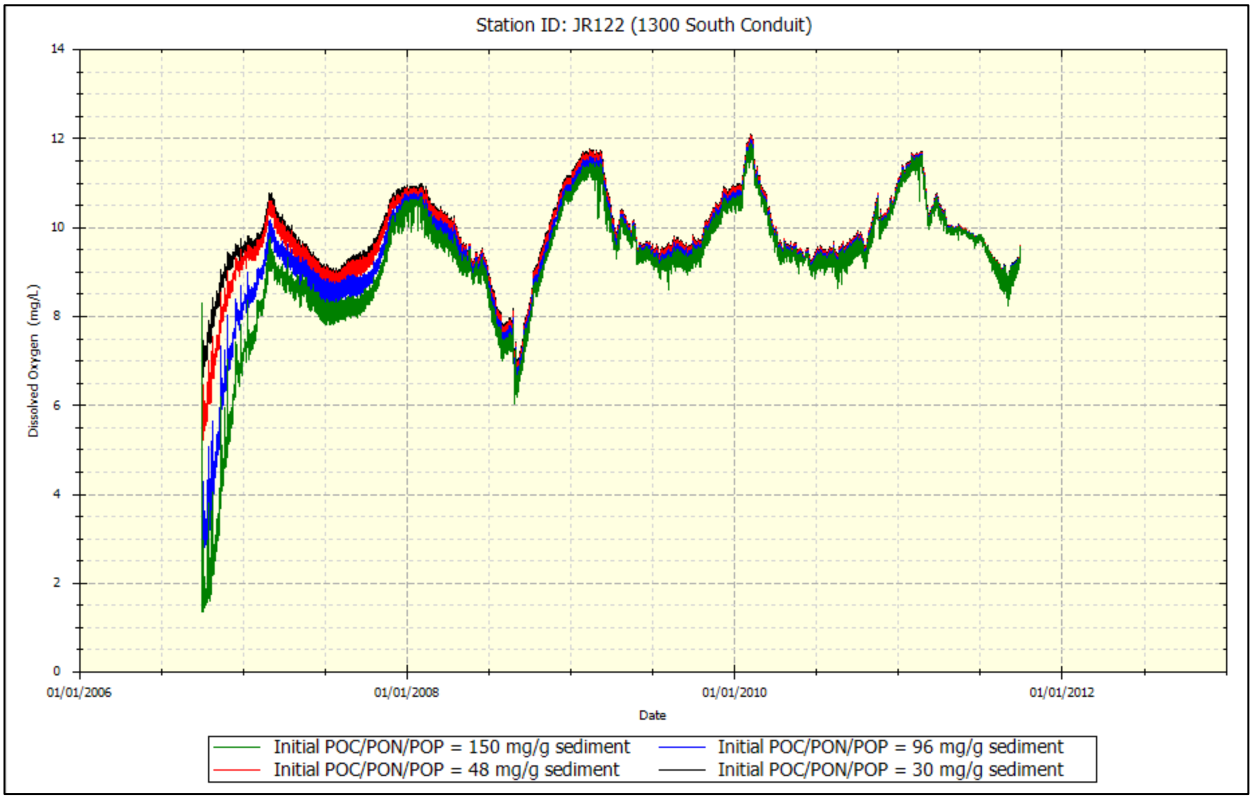
- Initial POC, PON, and POP Conditions upon POP (same segment)



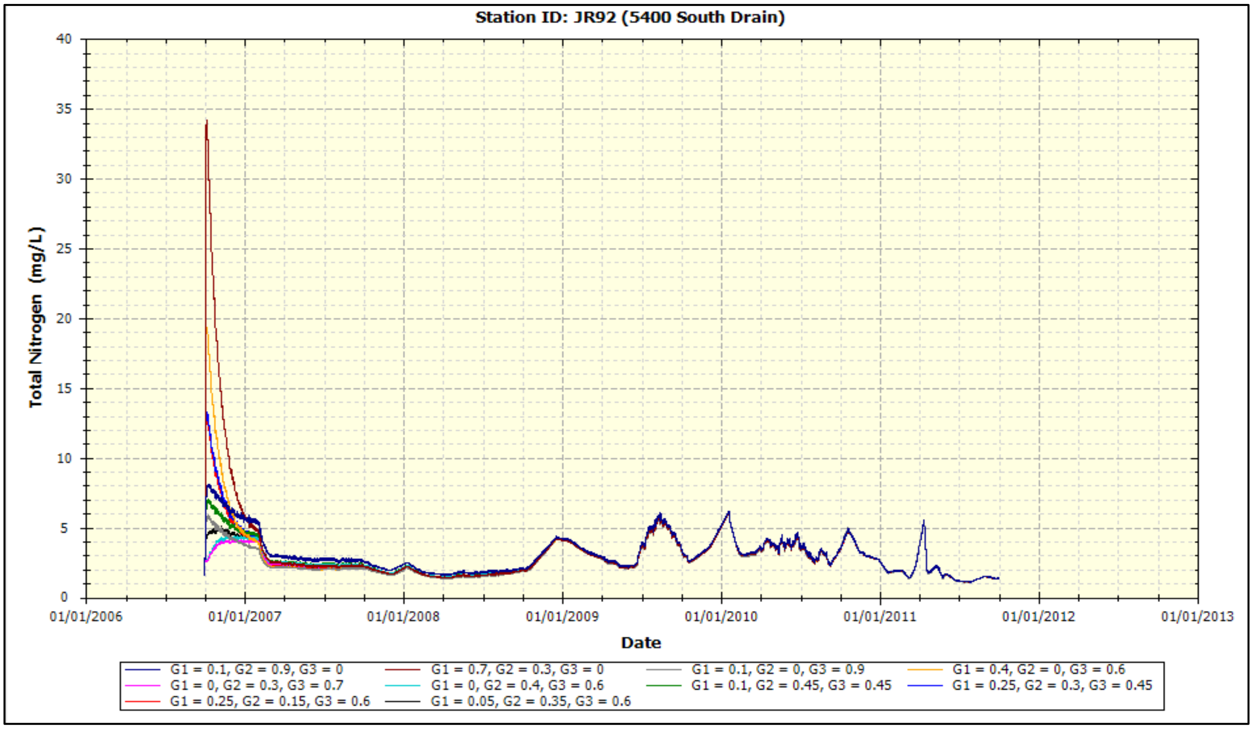
- Initial POC, PON, and POP Conditions upon SOD (same segment)



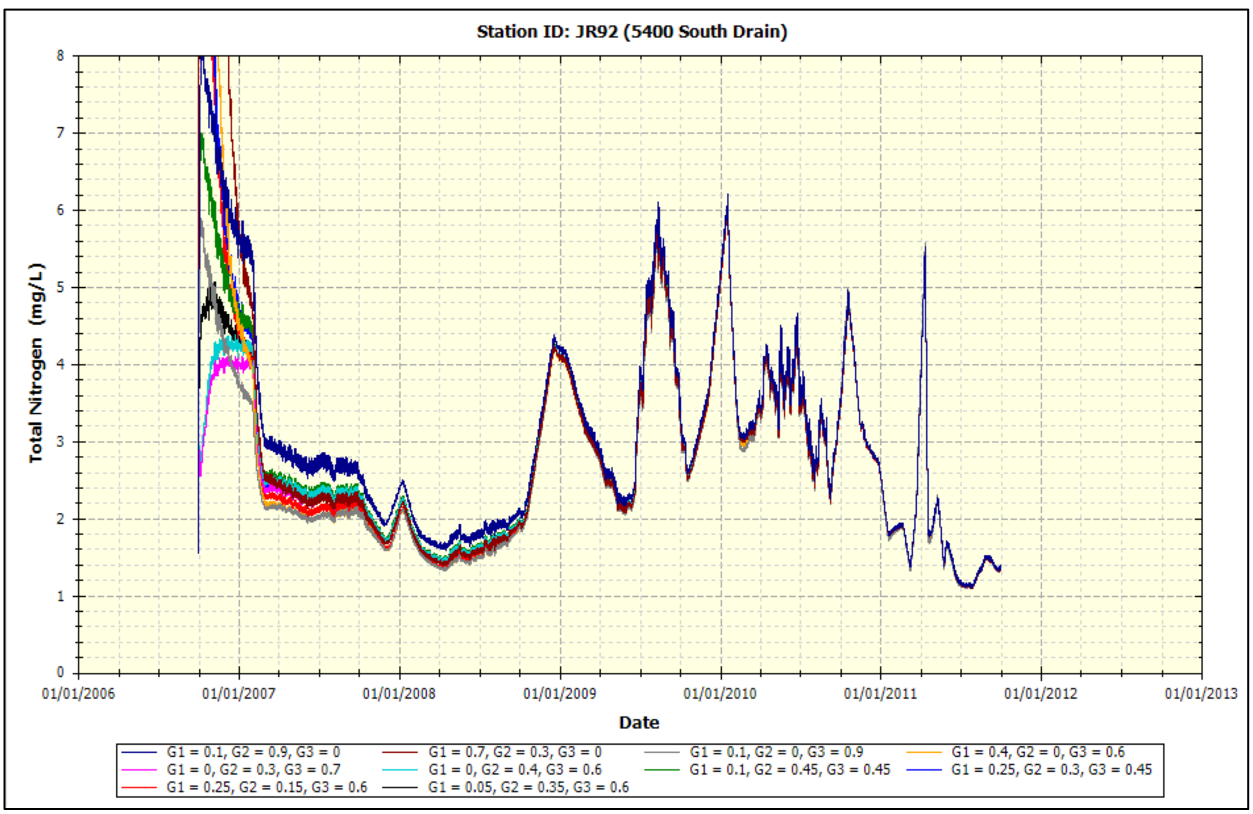
- Initial POC, PON, and POP Conditions upon DO (same segment)



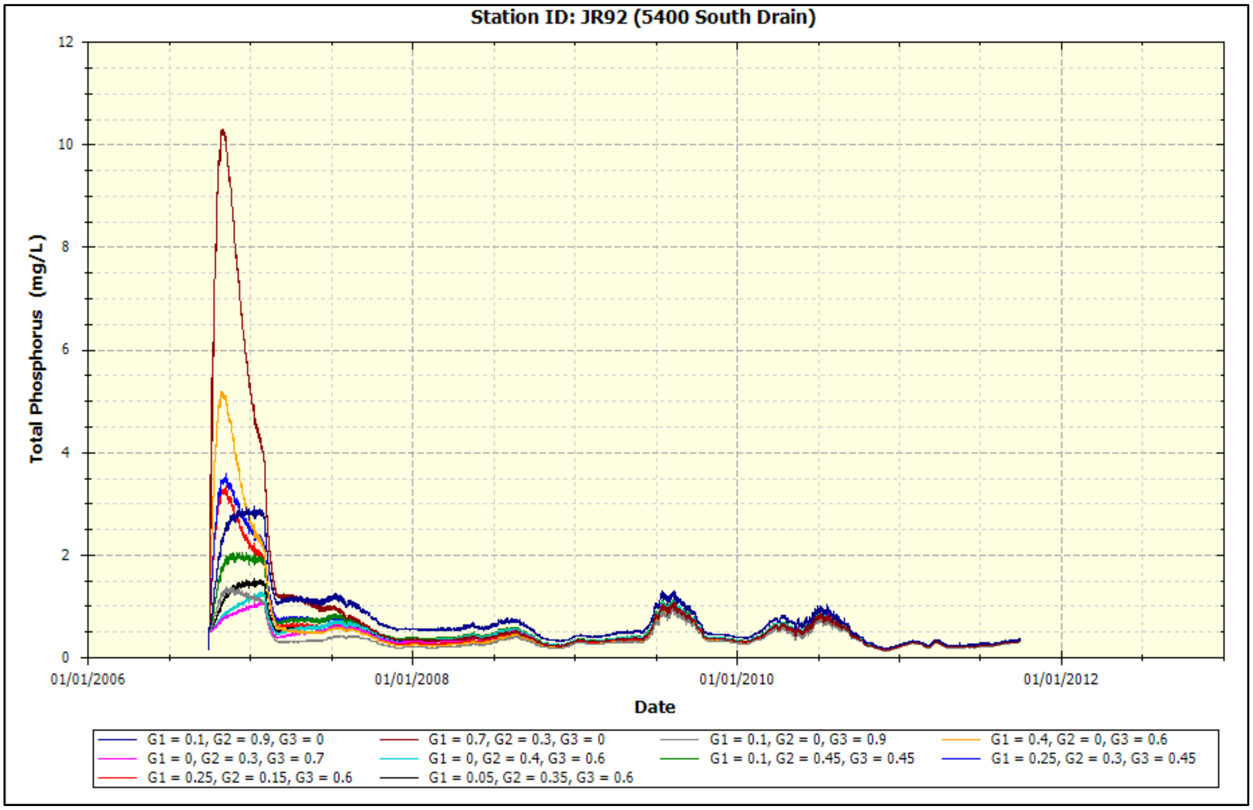
- Fraction of POC/PON/POP into Classes G1 (Labile), G2 (Refractory), G3 (Inert)
    - Distinct Distribution of Fractions upon TN



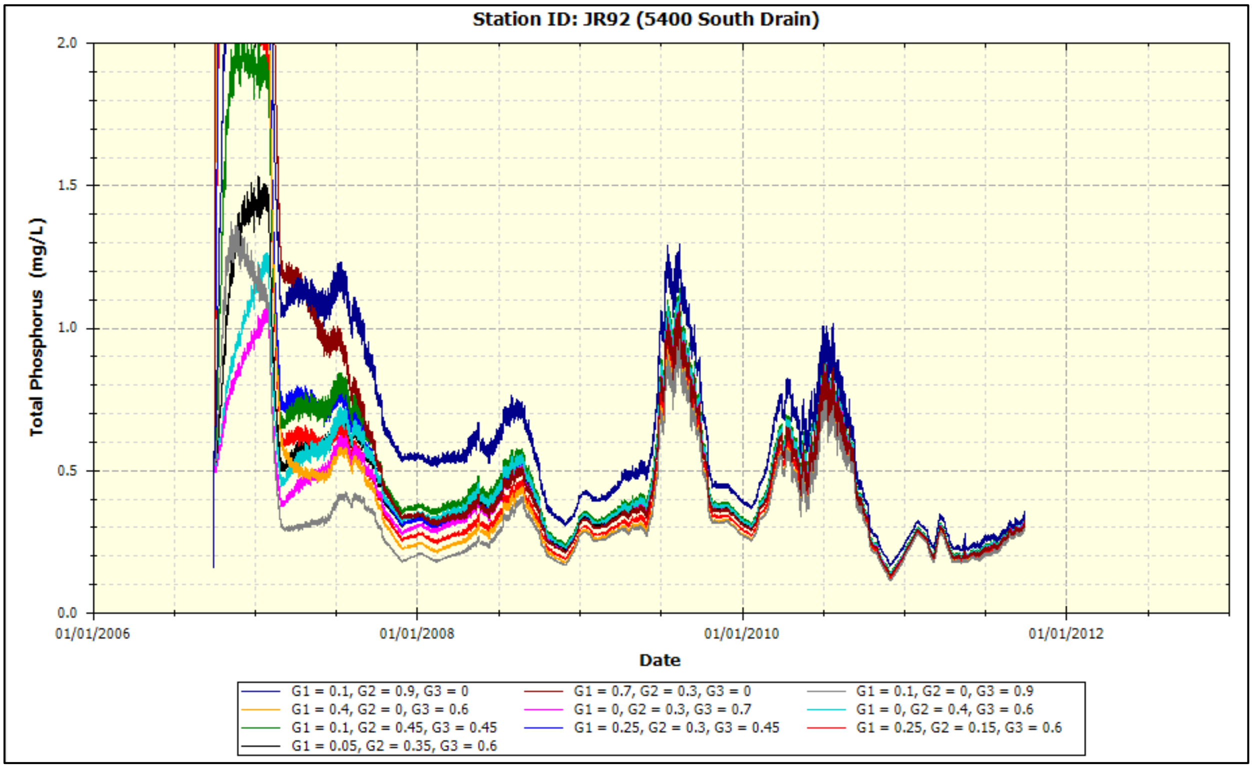
    - Distinct Distribution of Fractions upon TN (same segment; zoomed into within 8 mg/L)



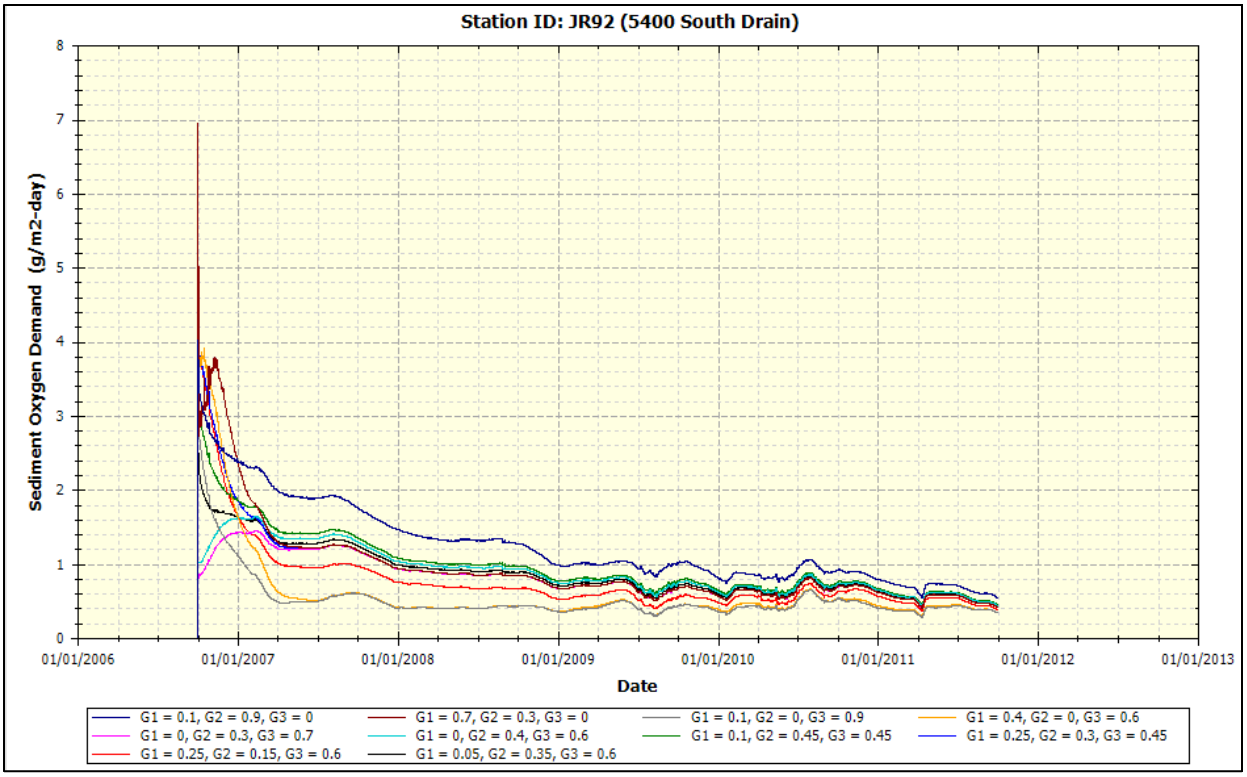
- Distinct Distribution of Fractions upon TP (same segment)



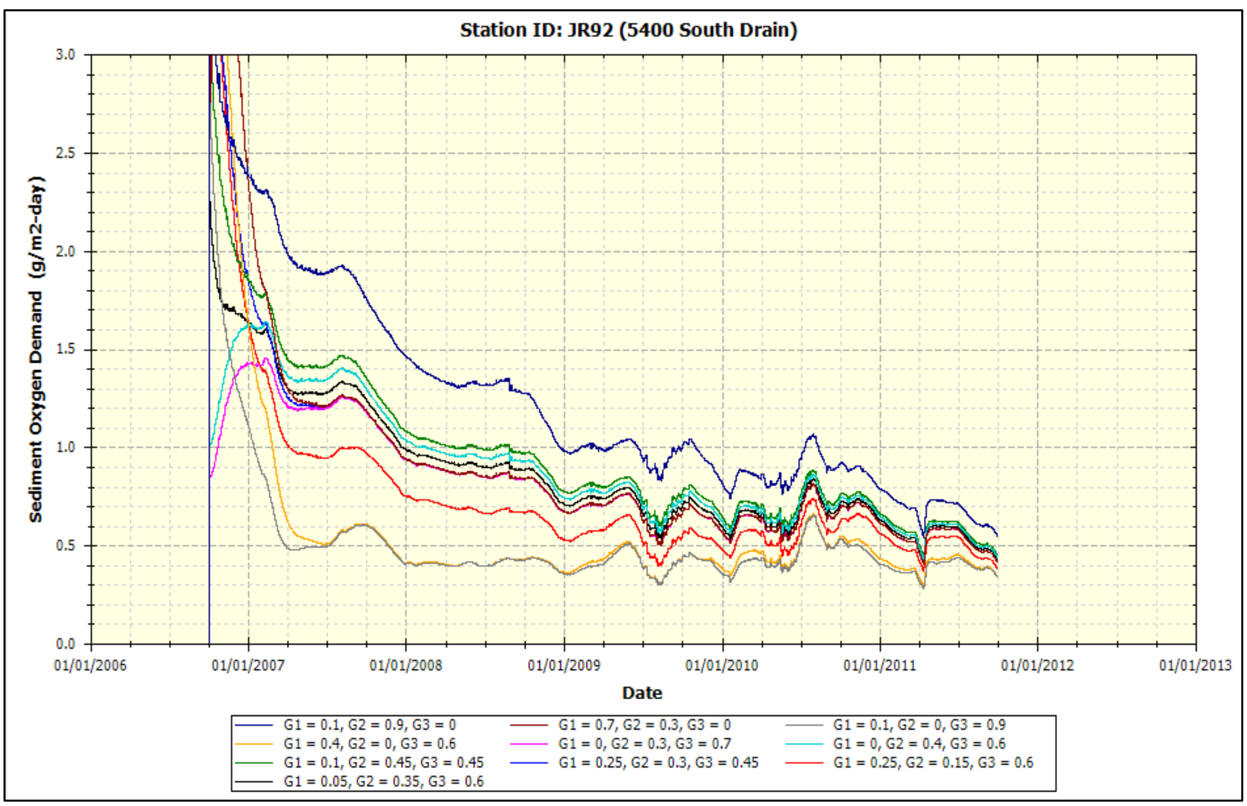
- Distinct Distribution of Fractions upon TP (same segment; zoomed into within 2 mg/L)



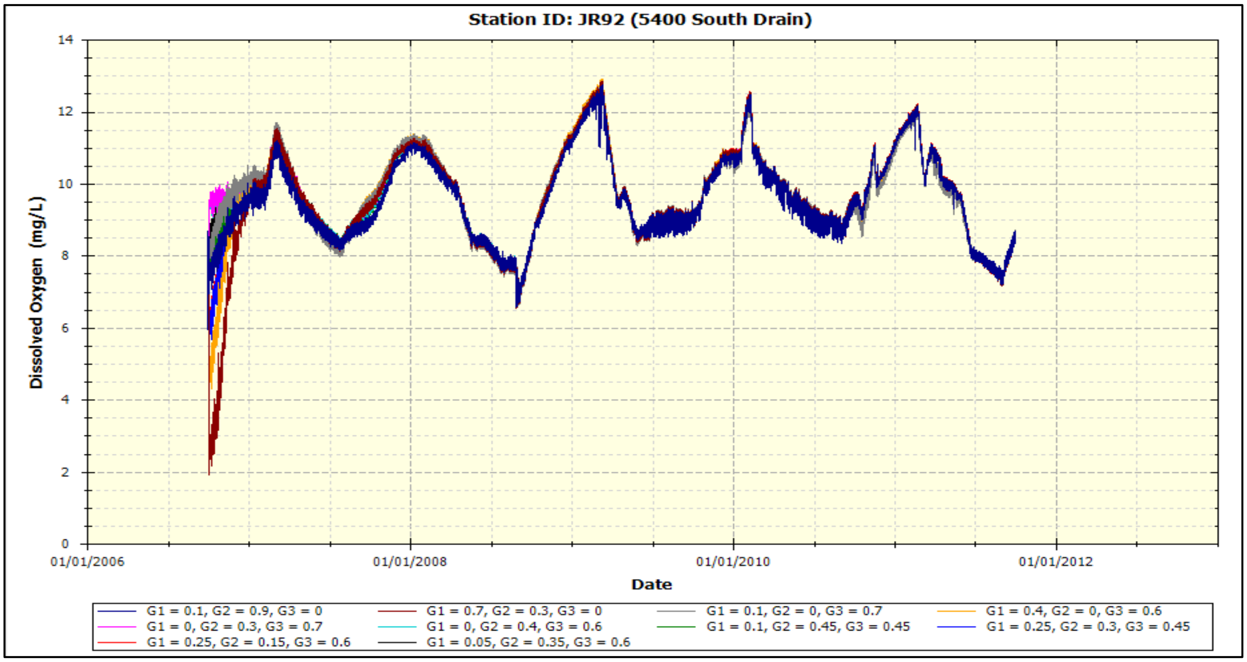
- Distinct Distribution of Fractions upon SOD (same segment)



- Distinct Distribution of Fractions upon SOD (same segment; zoomed into within 3 g/m^2-day)



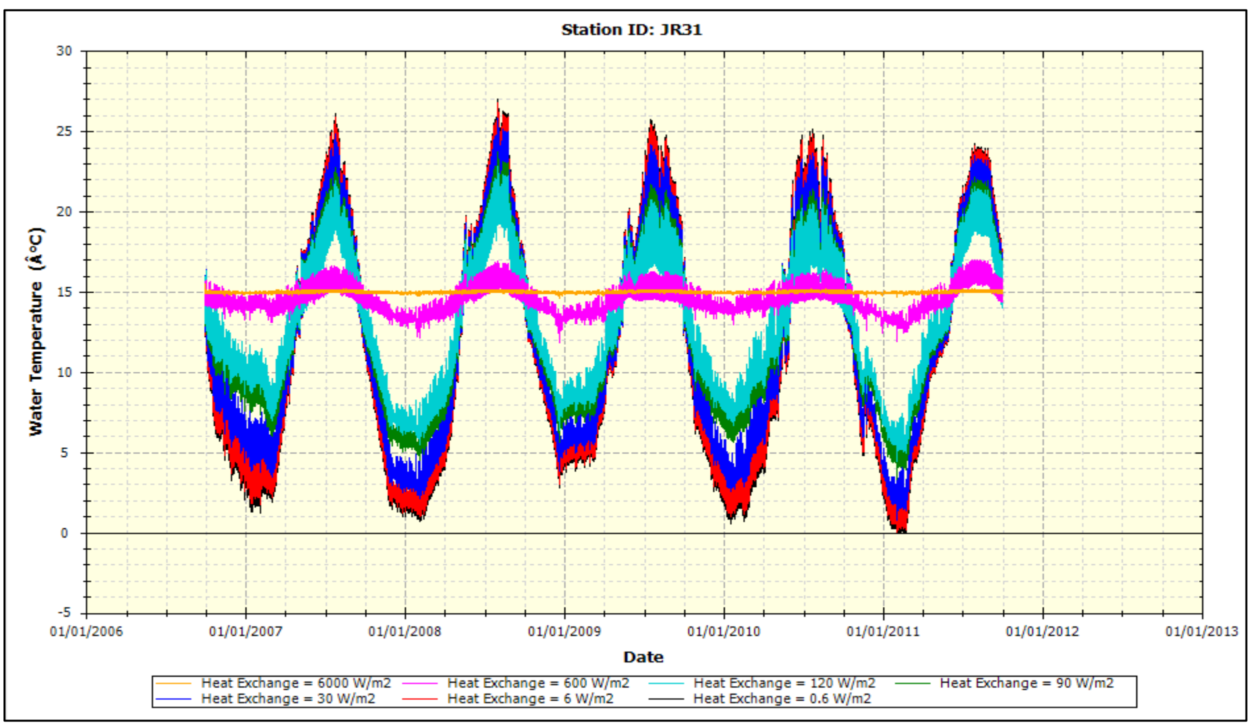
- Distinct Distribution of Fractions upon DO (same segment)



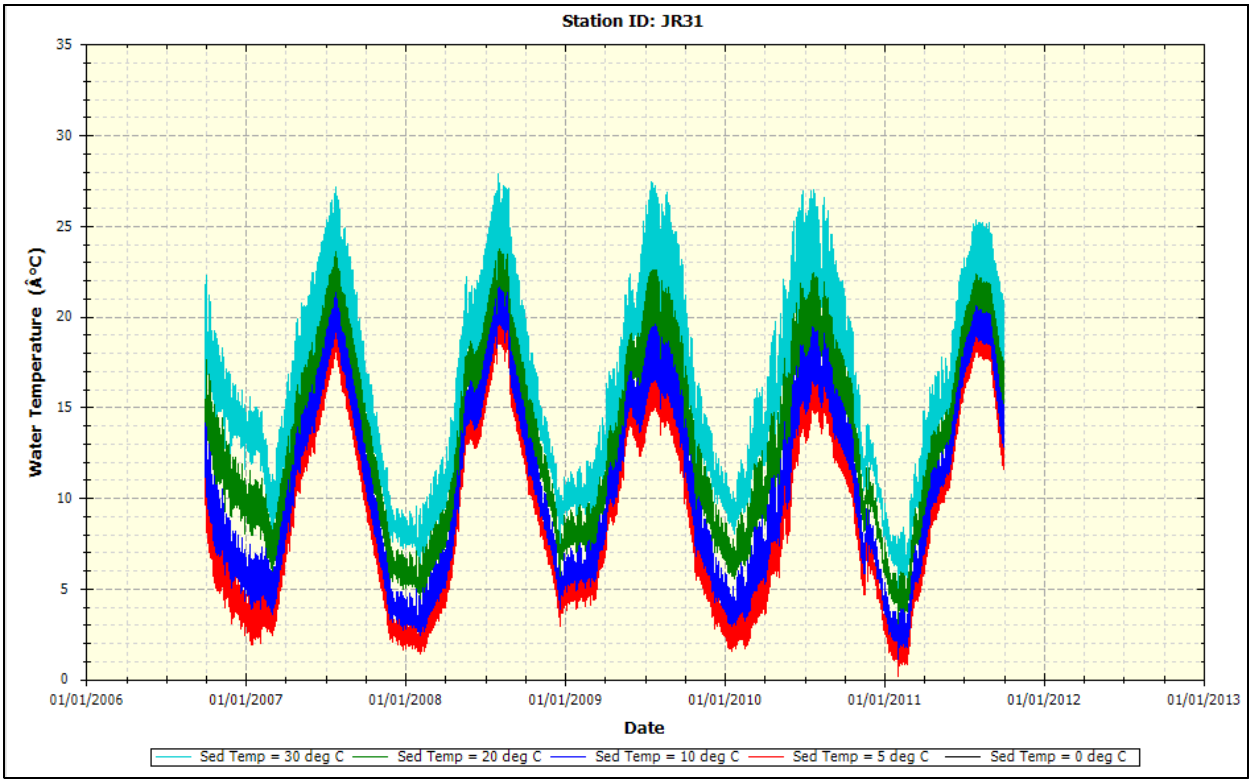
A.2.5: WATER TEMPERATURE PARAMETERS

The following example plots provide the variability of different input parameters that focus on those that directly affect the water temperature upon the Jordan River WASP.

- Coefficient for Bottom-Heat Exchange (W/m^2-°C) upon water temperature



- Sediment Ground Temperature (℃) upon water temperature (same segment)



APPENDIX B: MODEL CALIBRATION PLOTS AND RESULTS

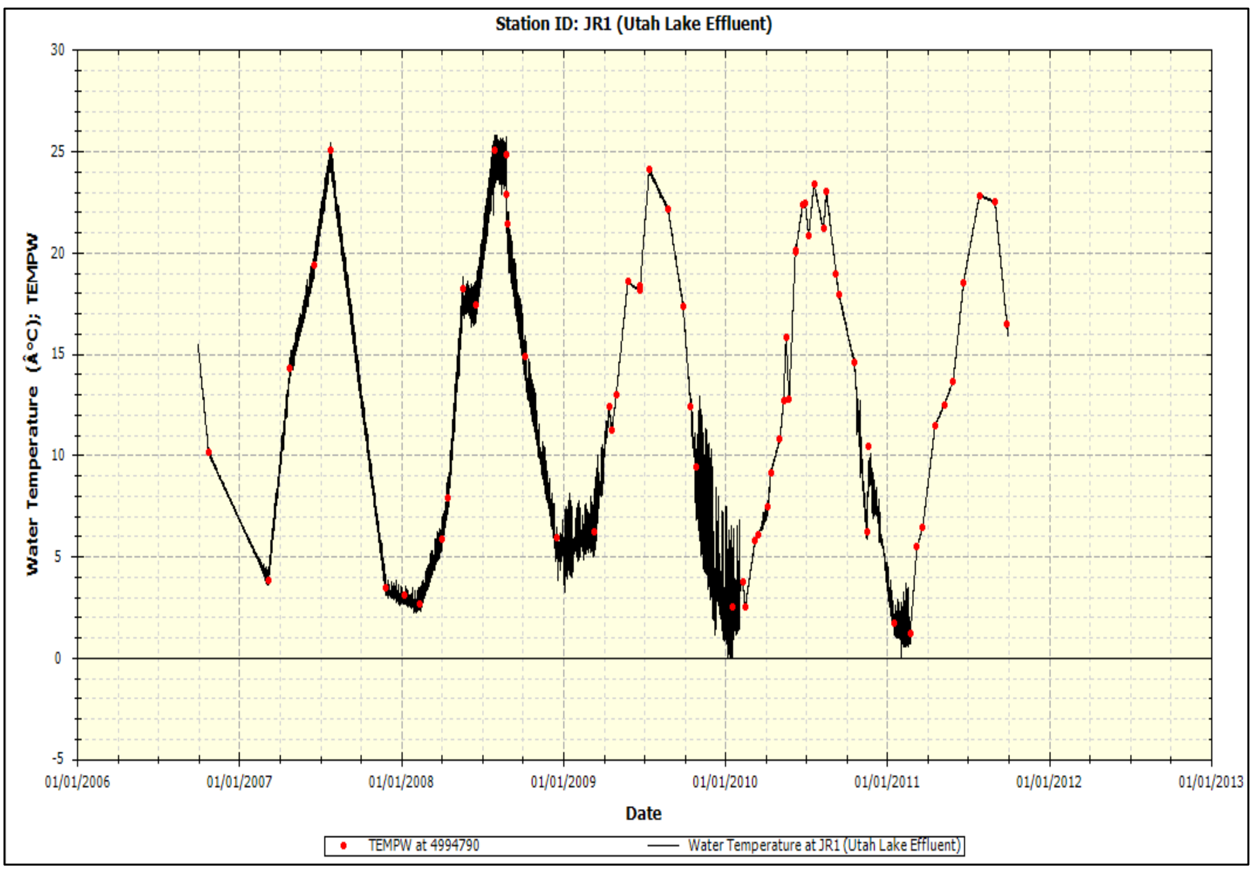
This appendix provides the time-series plots among the results for distinct water quality constituents simulated by the Jordan River WASP against the measured data employed for the exercise. Meanwhile, this section includes statistical results (R^2, RMSE, etc.) for each water quality constituent for which model calibration has been conducted upon. Please refer to the following tables for the following components.

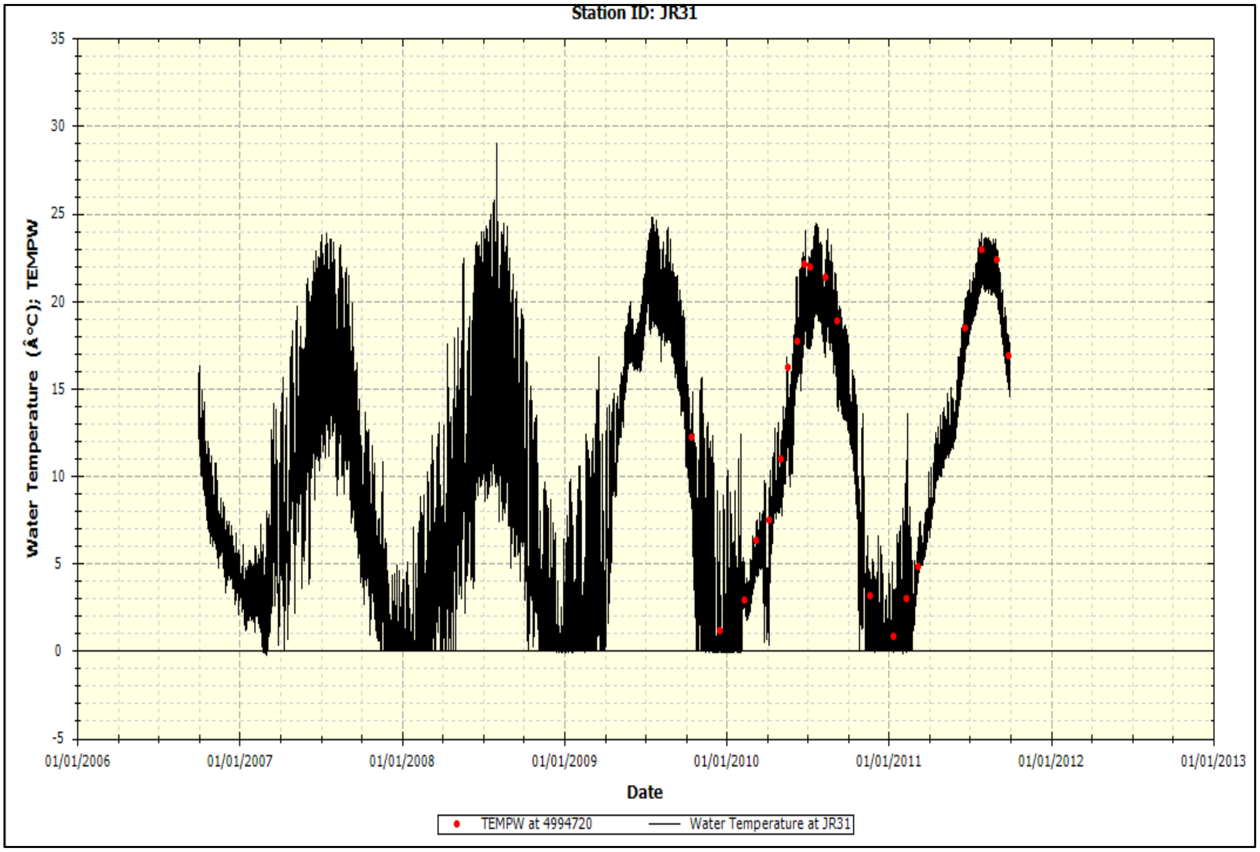
- UDWQ AWQMS site mapping upon the WASP Jordan River segments: Table 17
- Constituent Mapping among WASP water quality constituents against UDWQ AWQMS sites measured data parameters: Table 18

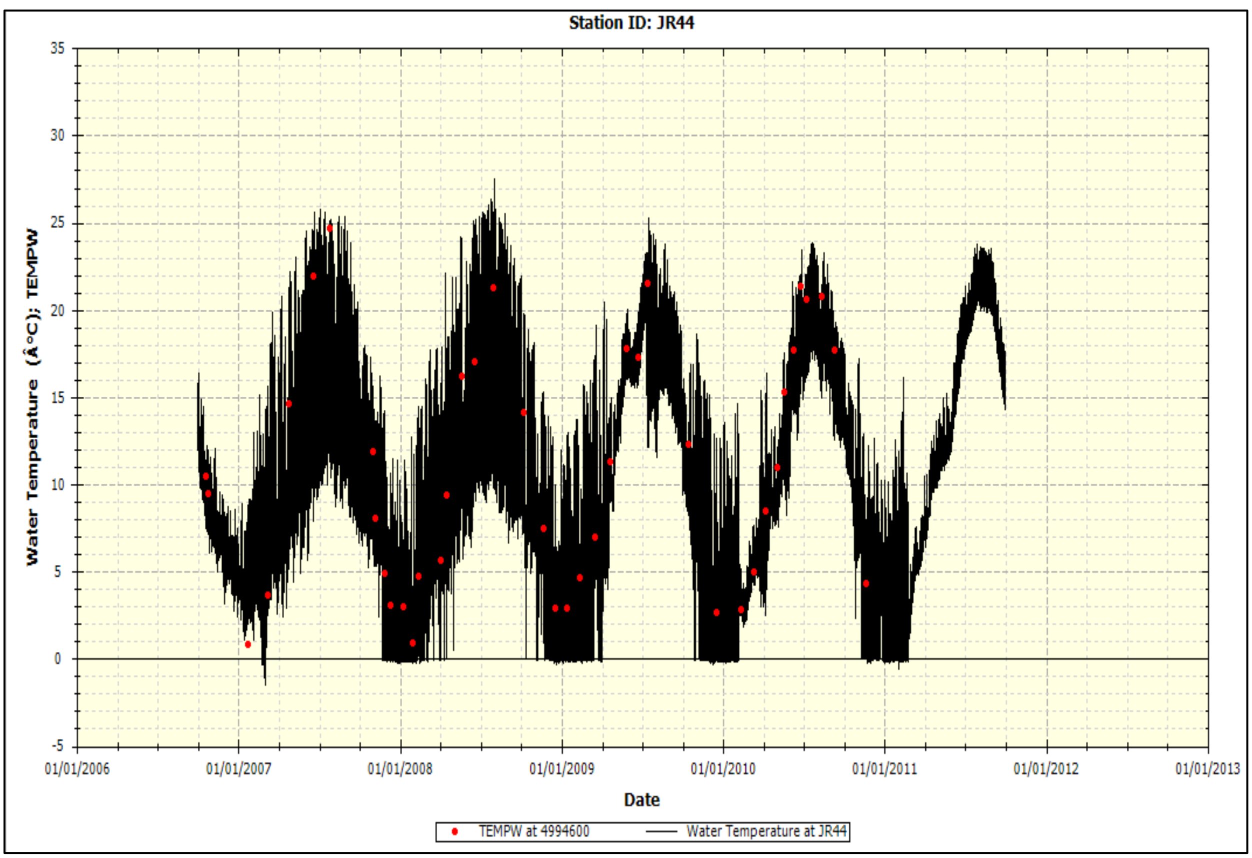
B.1: GRAPHICAL RESULTS (TIME-SERIES)

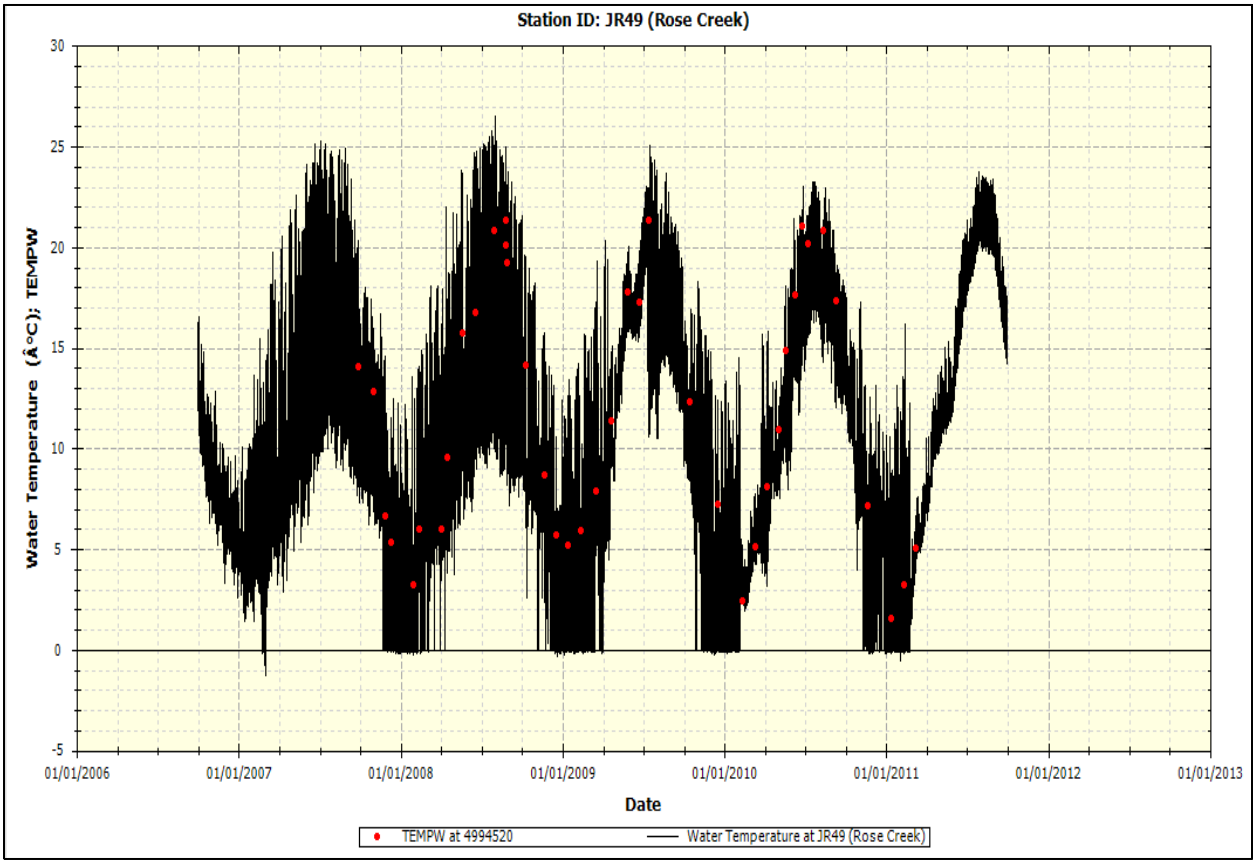
This sub-section provides time-series simulated results against the measured data for each segment (segment indicated in chart title per plot) and is organized into separate sub-sections based on water quality constituent. The time-series for all WASP segments for which the UDWQ AWQMS site exhibits measured data are included in this sub-section per water quality constituent. The corresponding WASP segment for which the time-series plot displays is provided in the chart title, such as "JR1" referring to Segment 1 (Utah Lake Effluent). The UDWQ AWQMS site ID for the corresponding WASP segment for each plot is provided in the graph legend within each figure.

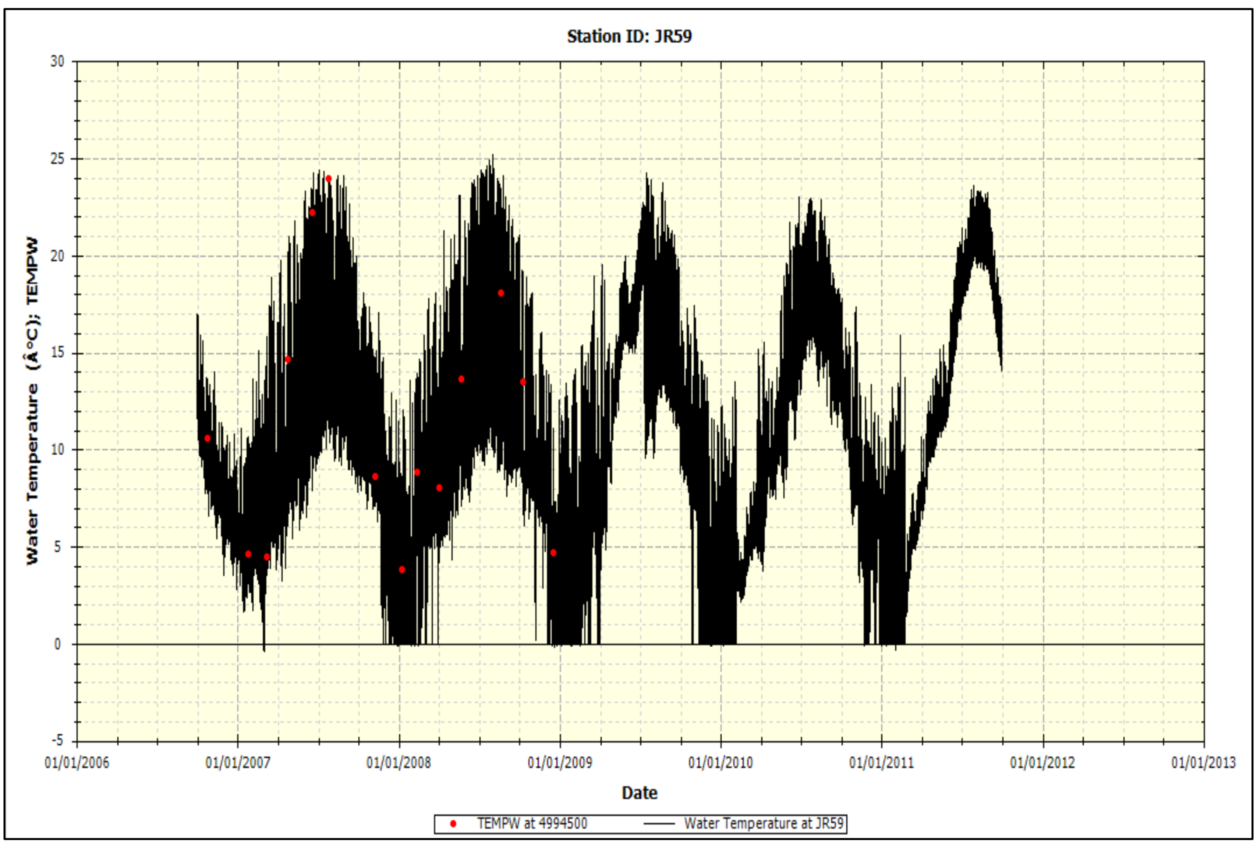
B.1.1: WATER TEMPERATURE

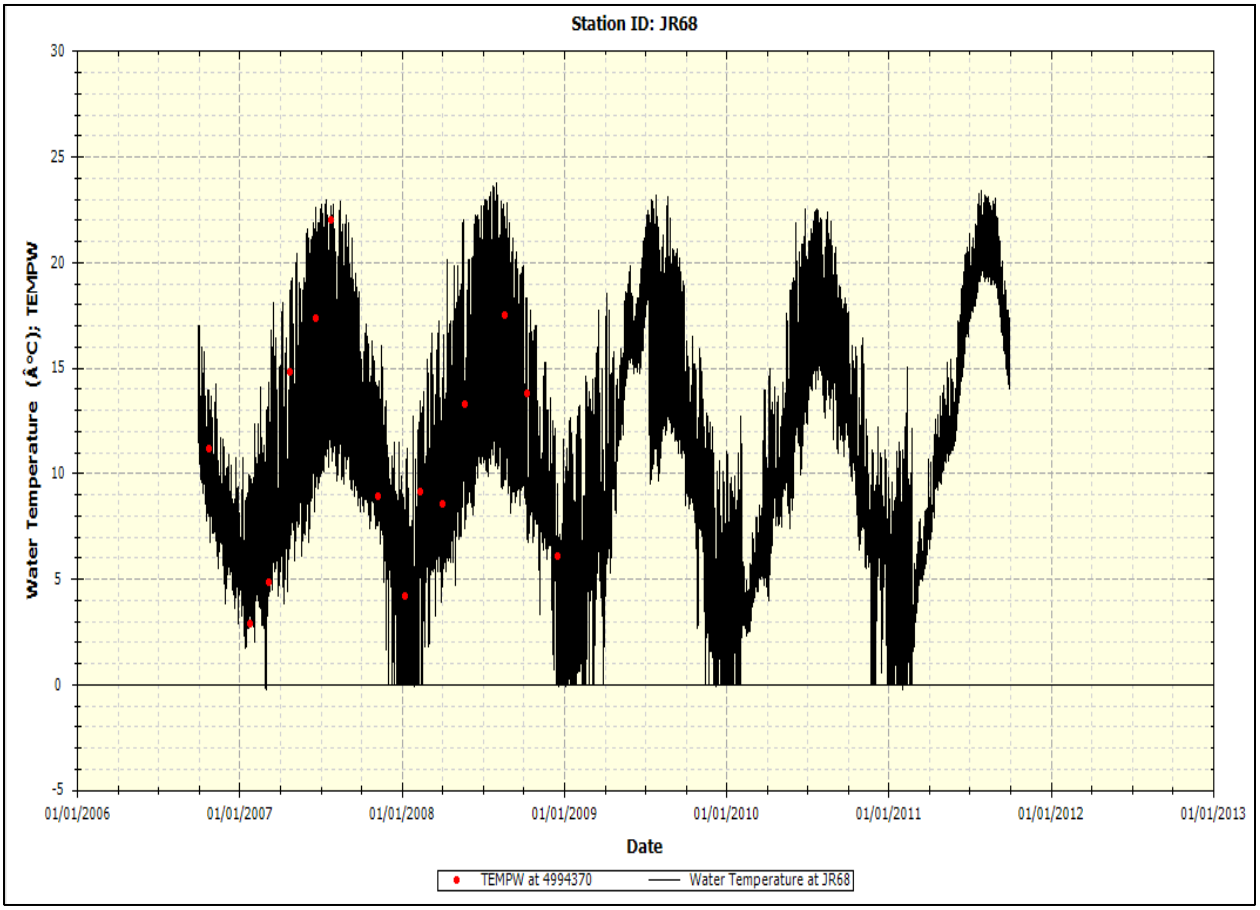



Station ID: JR31
35
30
25
20
15
10
5
0
-5
Water Temperature (Â°C); TEMPW
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4994720
Water Temperature at JR31

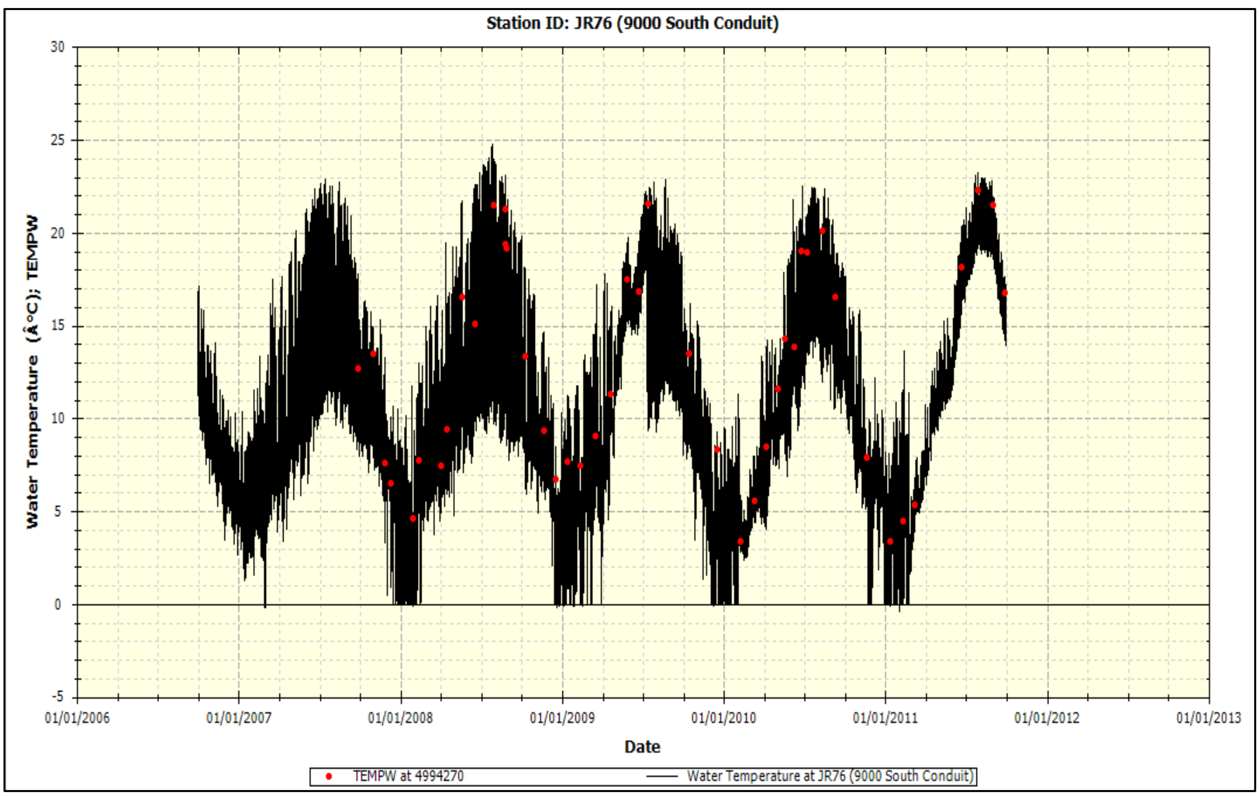

Station ID: JR44
35
30
25
20
15
10
5
0
-5
Water Temperature (Â°C); TEMPW
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4994600
Water Temperature at JR44


Station ID: JR49 (Rose Creek)
Water Temperature (Â°C); TEMPW
30
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4994520
Water Temperature at JR49 (Rose Creek)

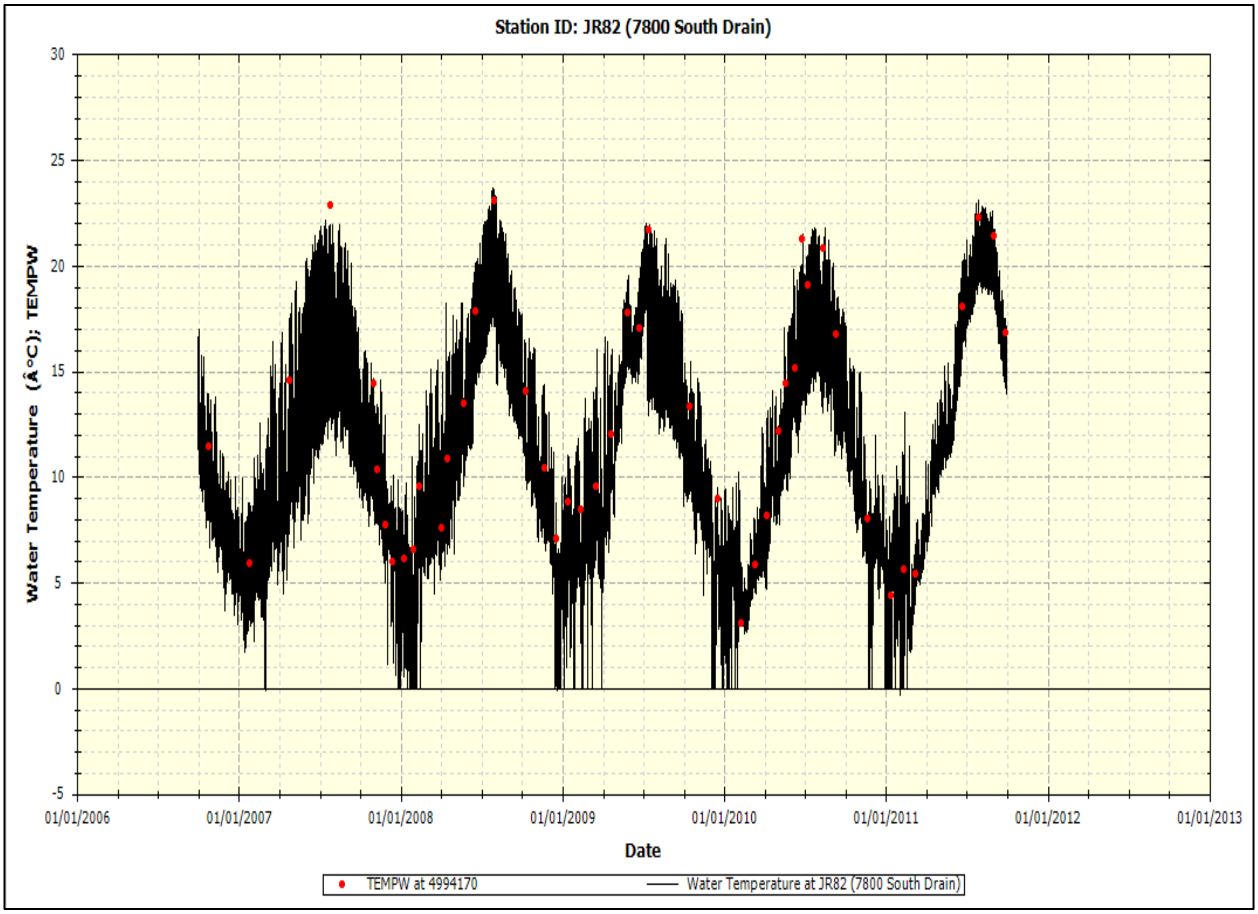

Station ID: JR59
Water Temperature (Â°C); TEMPW
30
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4994500
Water Temperature at JR59

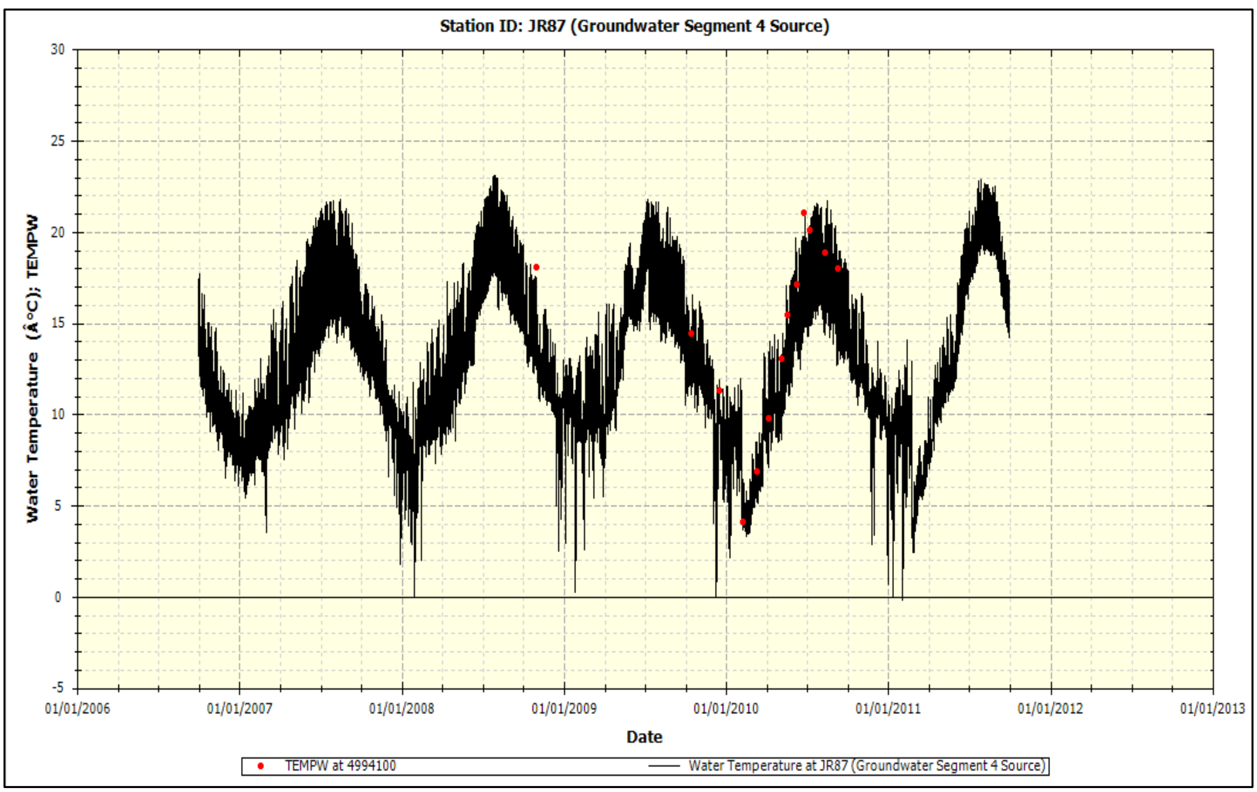


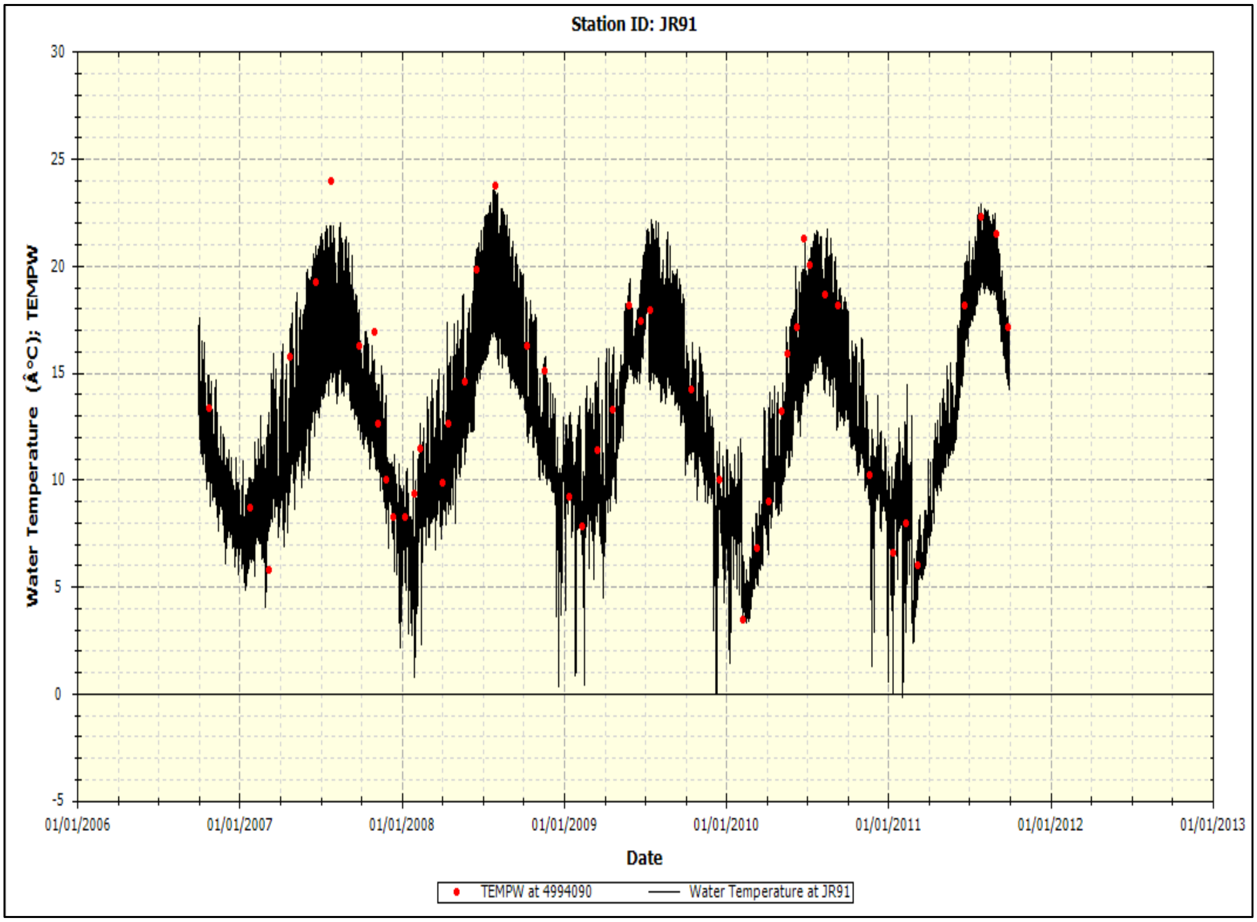
Station ID: JR68
Water Temperature (Â°C); TEMPW
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
30
25
20
15
10
5
0
-5
TEMPW at 4994370
Water Temperature at JR68

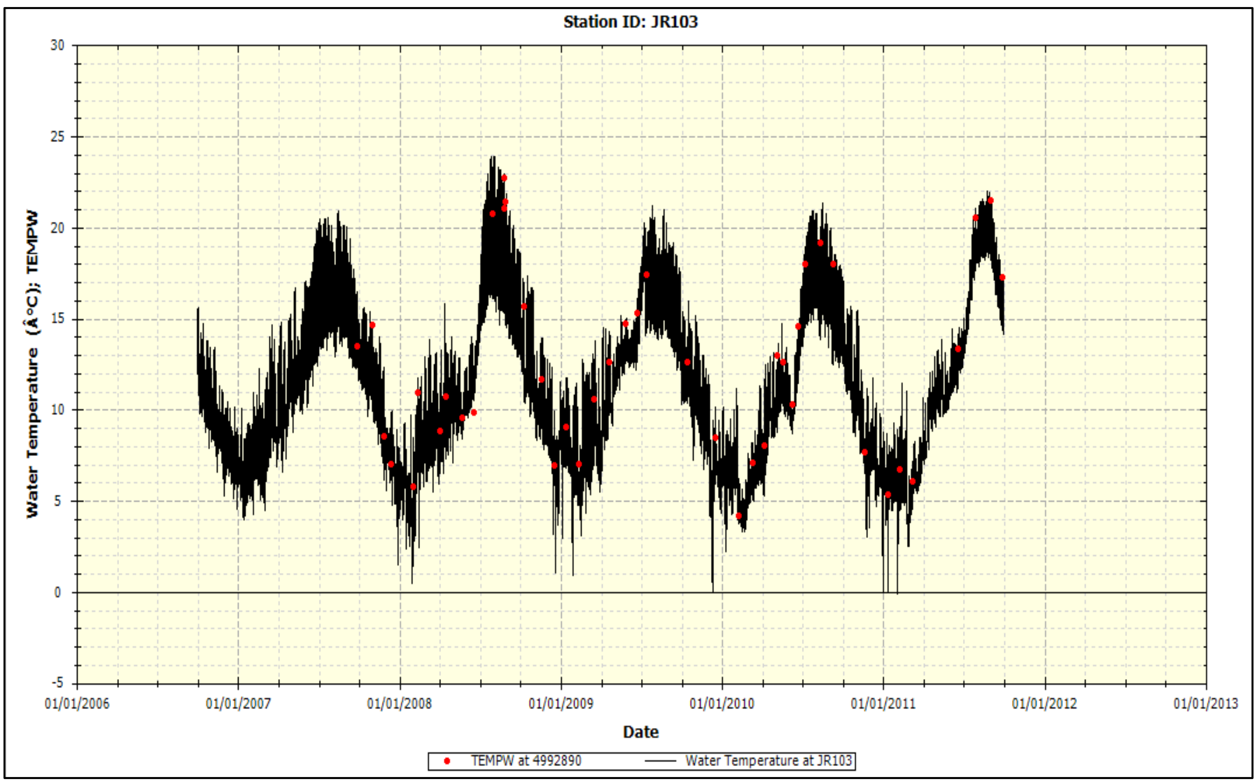


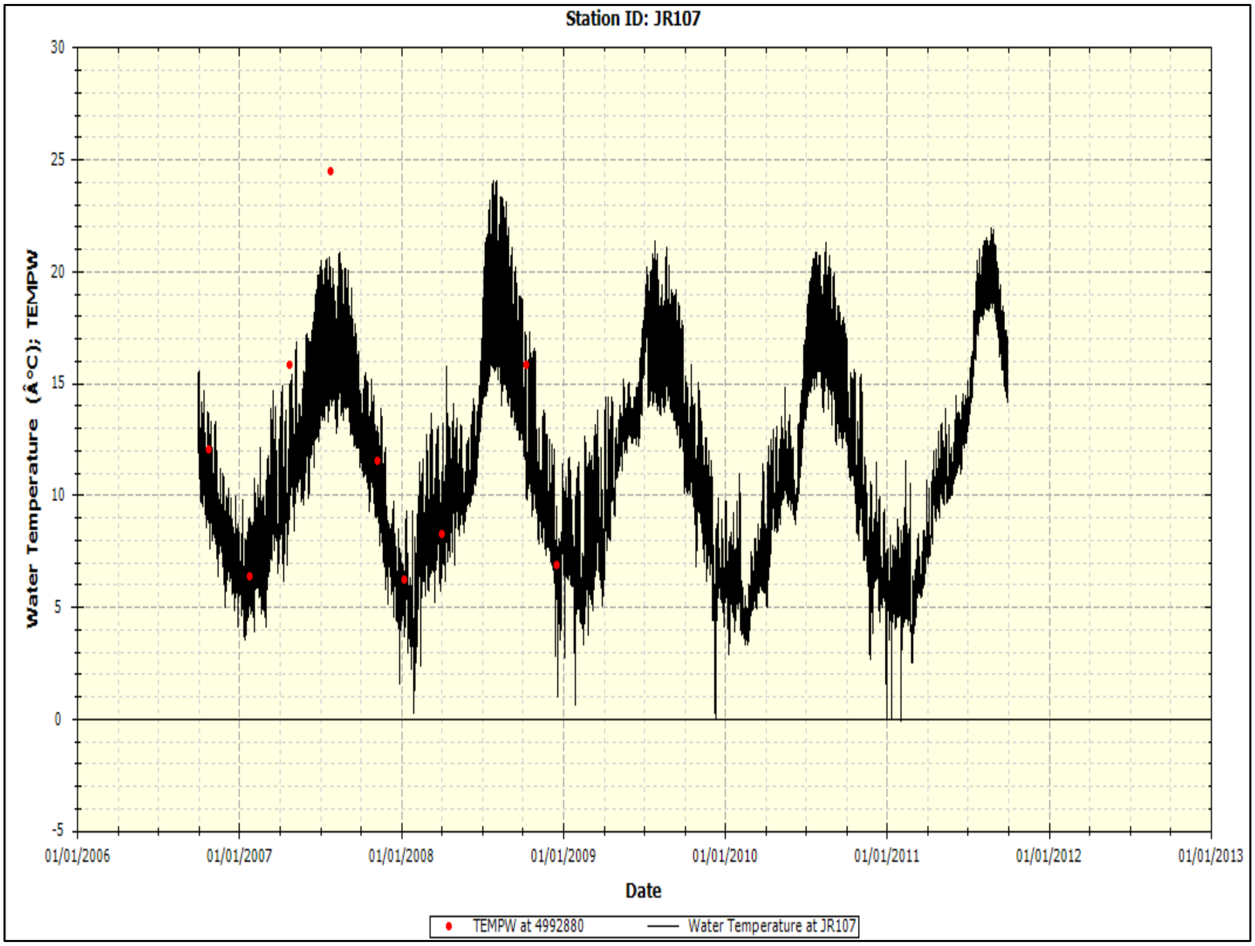
Station ID: JR76 (9000 South Conduit)
Water Temperature (Â°C); TEMPW
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
30
25
20
15
10
5
0
-5
TEMPW at 4994270
Water Temperature at JR76 (9000 South Conduit)


Station ID: JR82 (7800 South Drain)
Water Temperature (Â°C); TEMPW
Date
30
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TEMPW at 4994170
Water Temperature at JR82 (7800 South Drain)

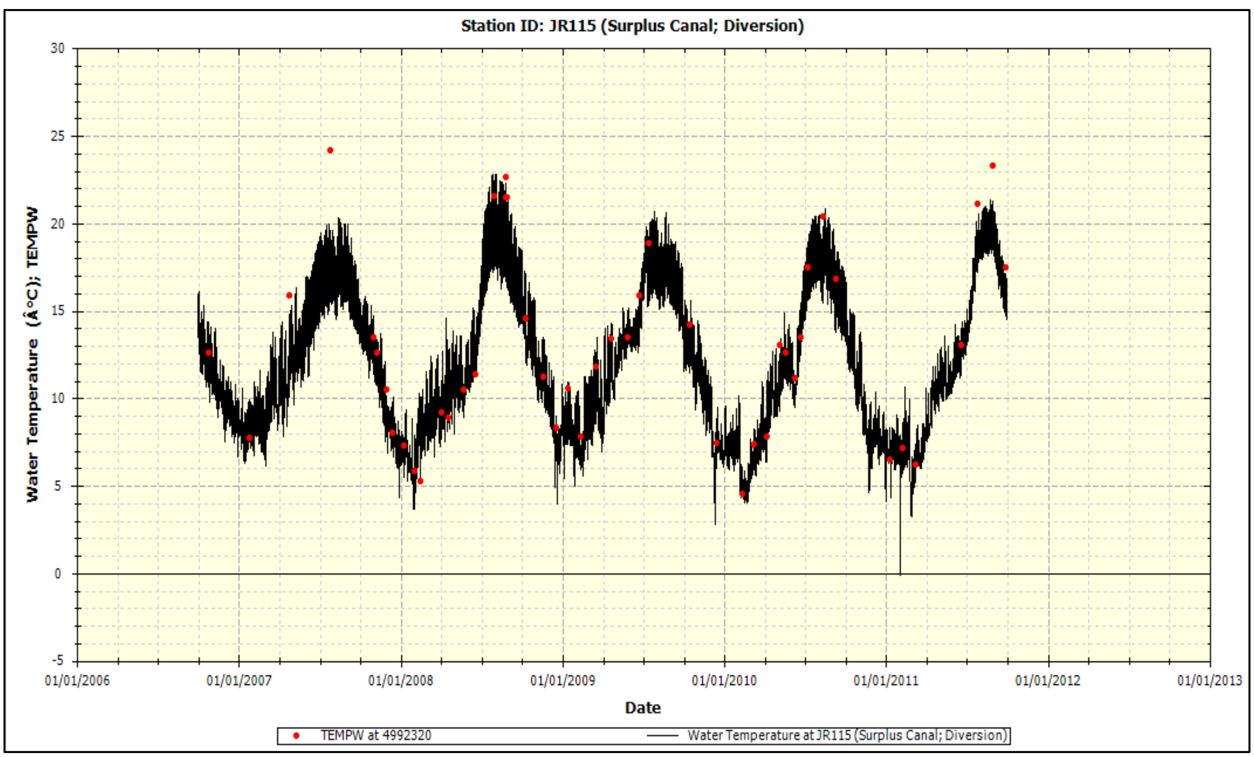

Station ID: JR87 (Groundwater Segment 4 Source)
Water Temperature (Â°C); TEMPW
Date
30
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TEMPW at 4994100
Water Temperature at JR87 (Groundwater Segment 4 Source)


Station ID: JR91
Water Temperature (Â°C); TEMPW
Date
TEMPW at 4994090
Water Temperature at JR91
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013

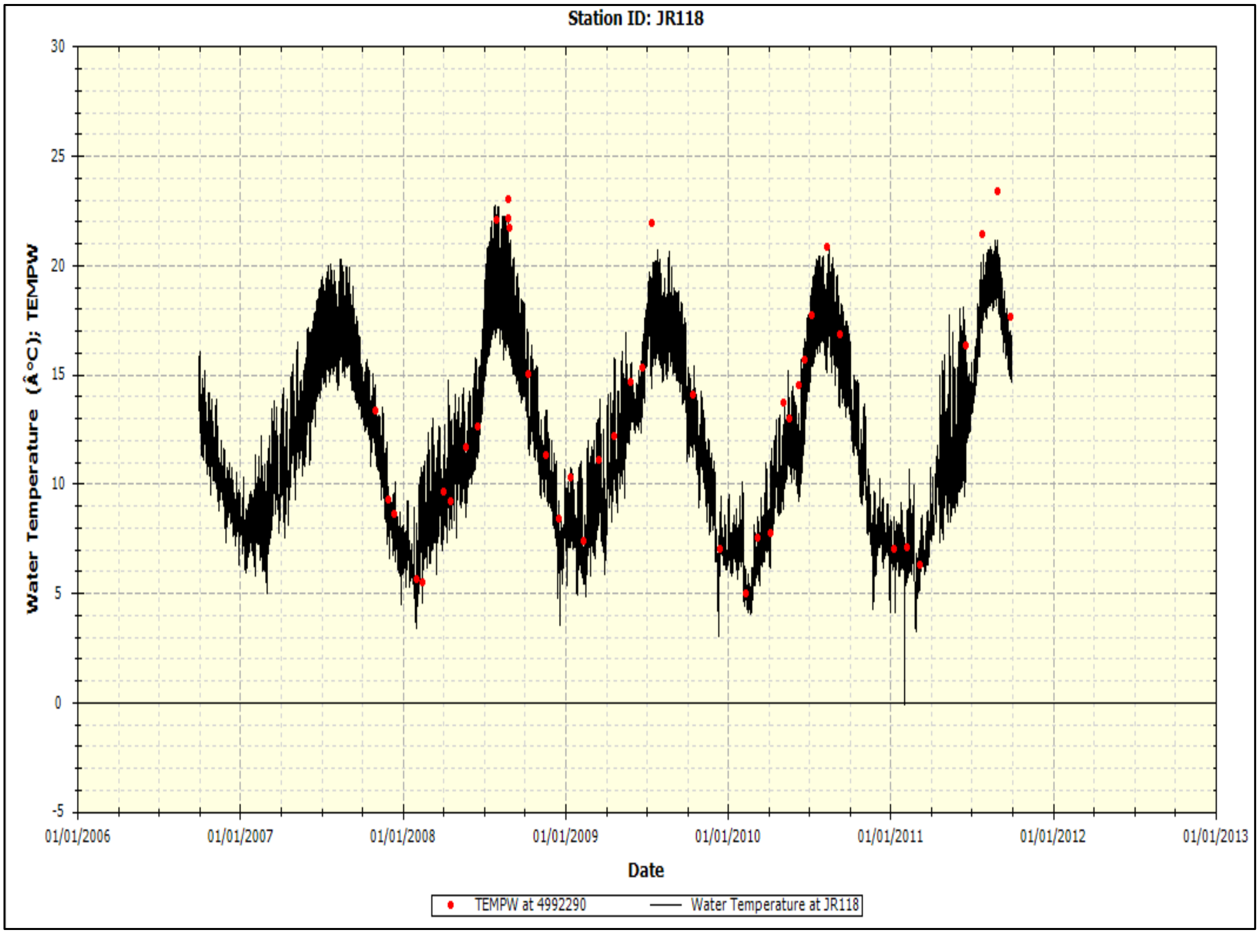

Station ID: JR103
Water Temperature (Â°C); TEMPW
Date
TEMPW at 4992890
Water Temperature at JR103
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013



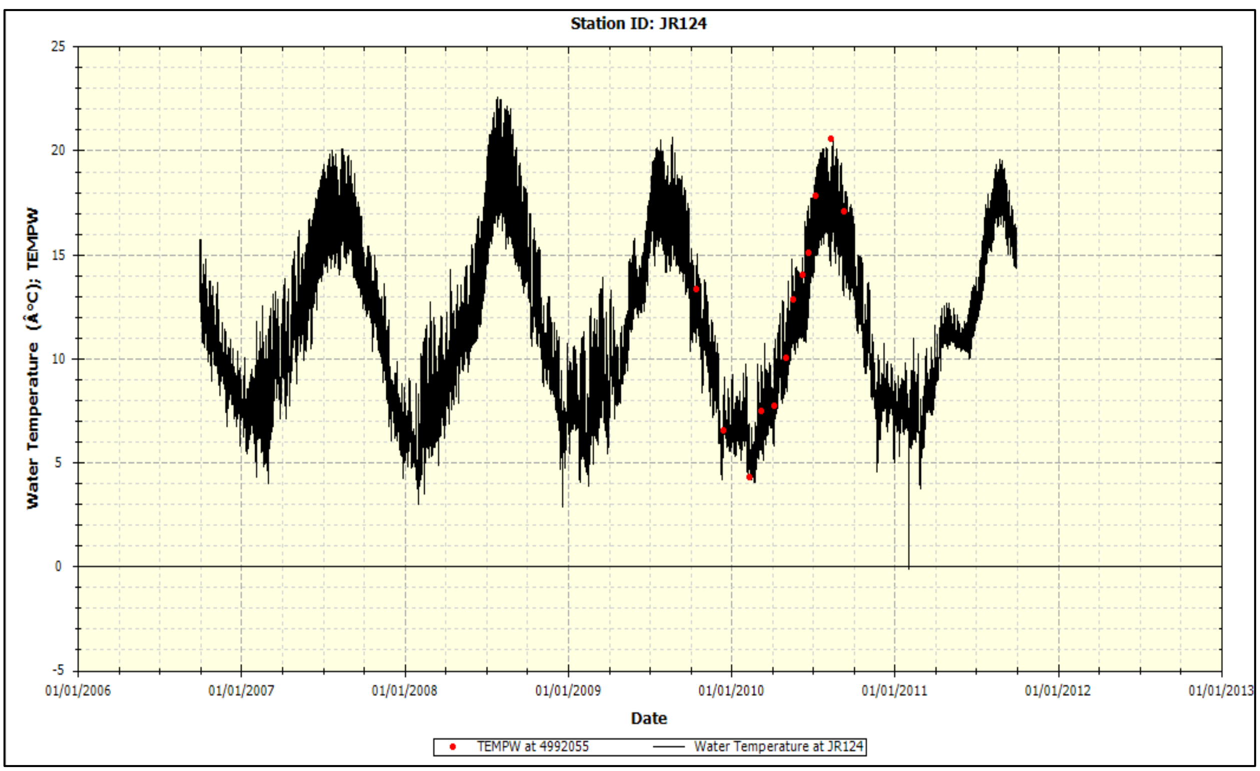
Station ID: JR107
Water Temperature (Â°C); TEMPW
30
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4992880
Water Temperature at JR107



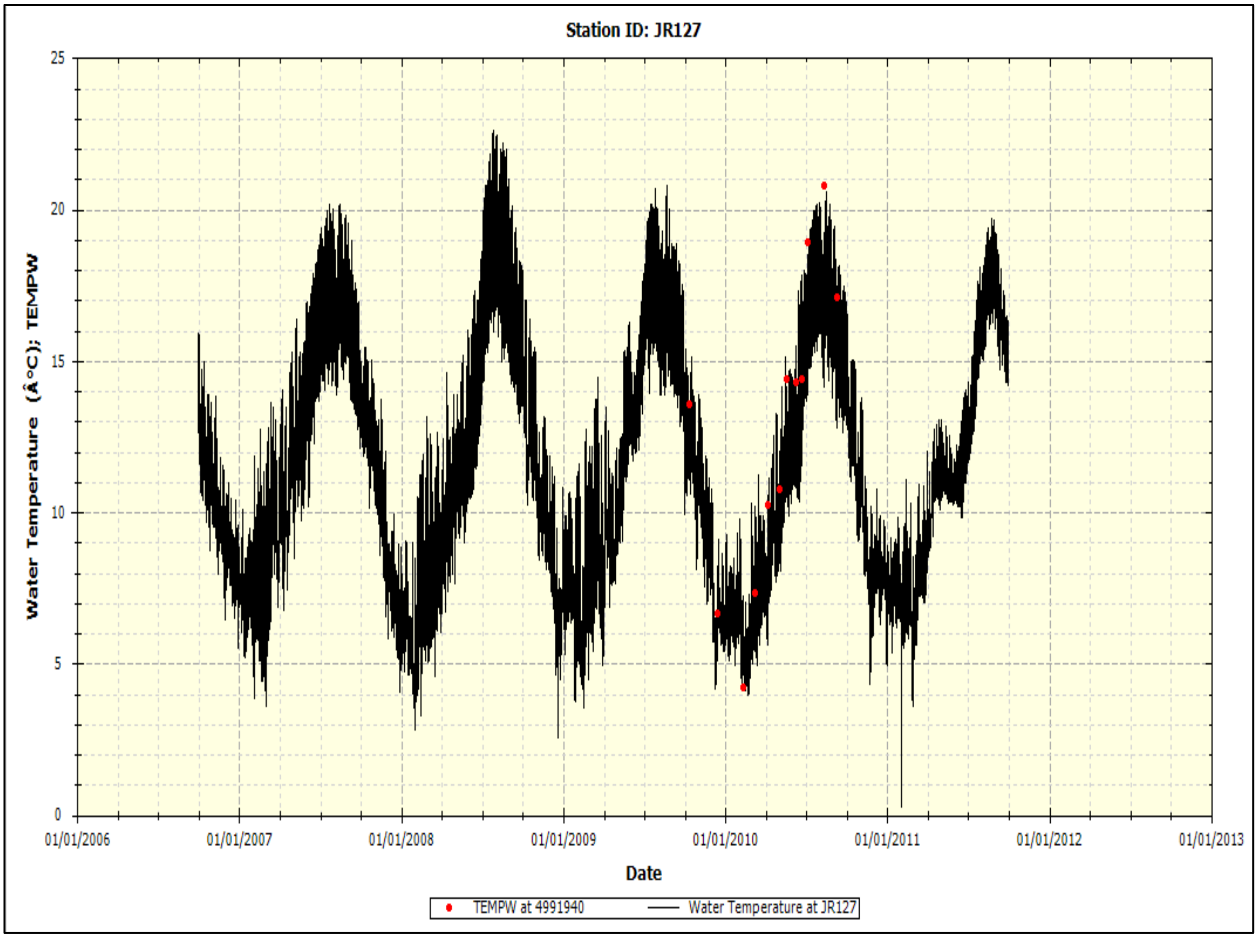
Station ID: JR115 (Surplus Canal; Diversion)
Water Temperature (Â°C); TEMPW
30
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4992320
Water Temperature at JR115 (Surplus Canal; Diversion)

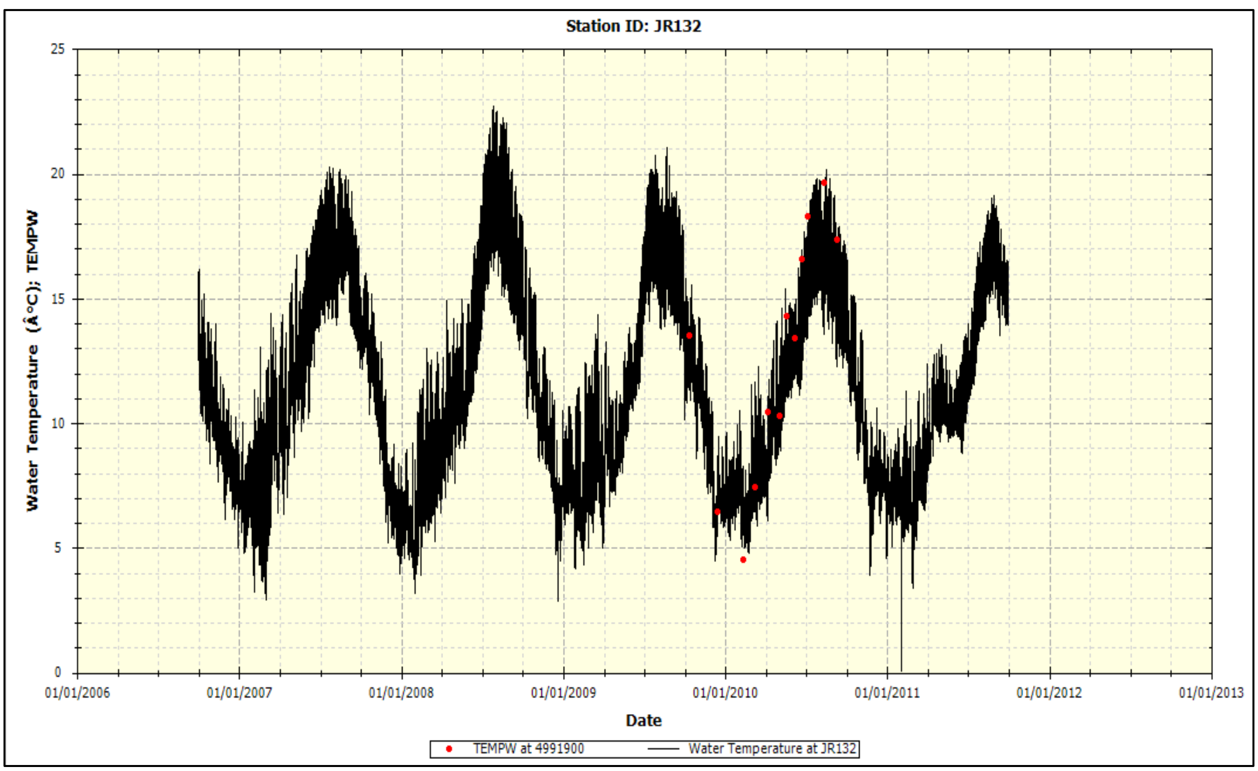


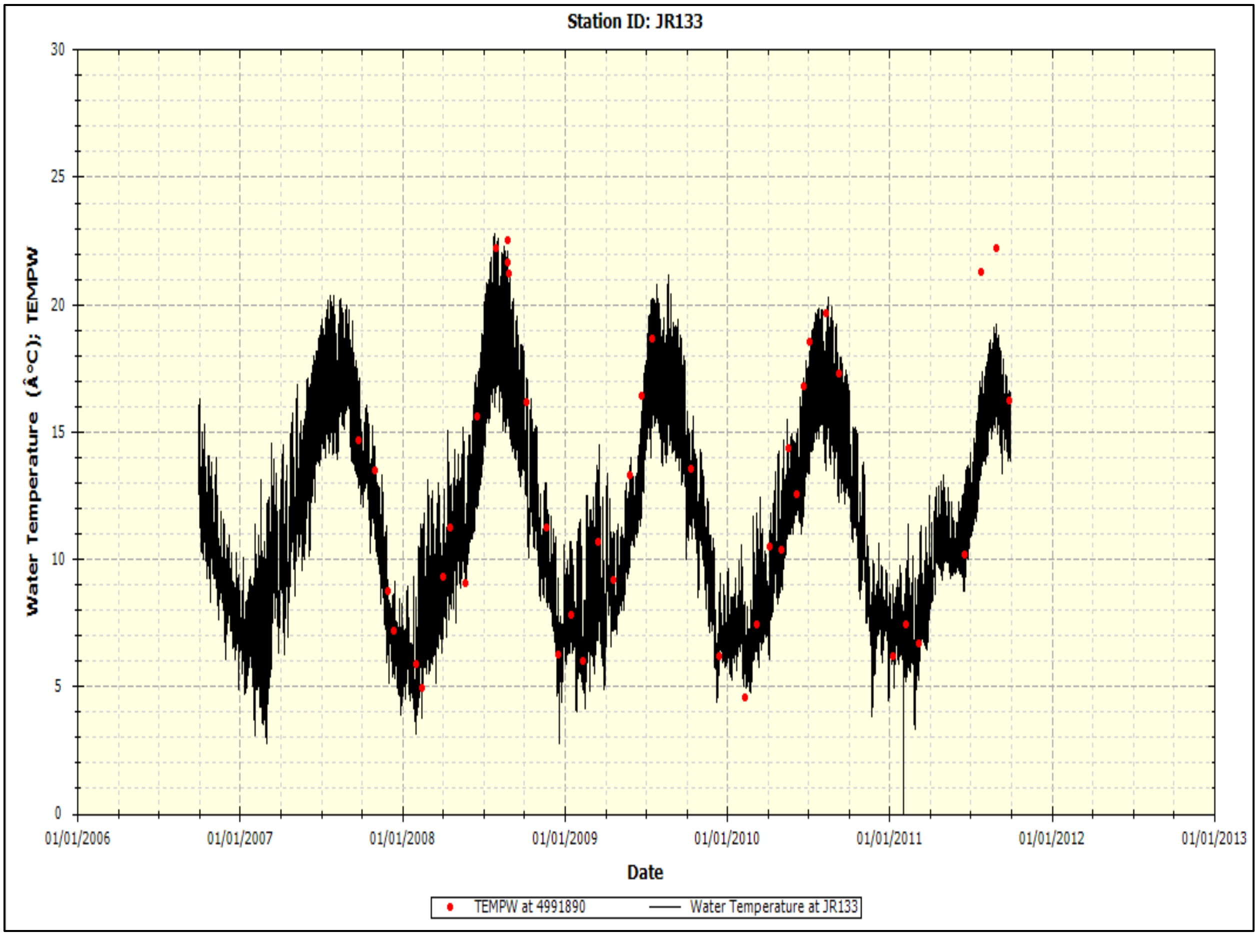
Station ID: JR118
Water Temperature (Â°C); TEMPW
30
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4992290
Water Temperature at JR118

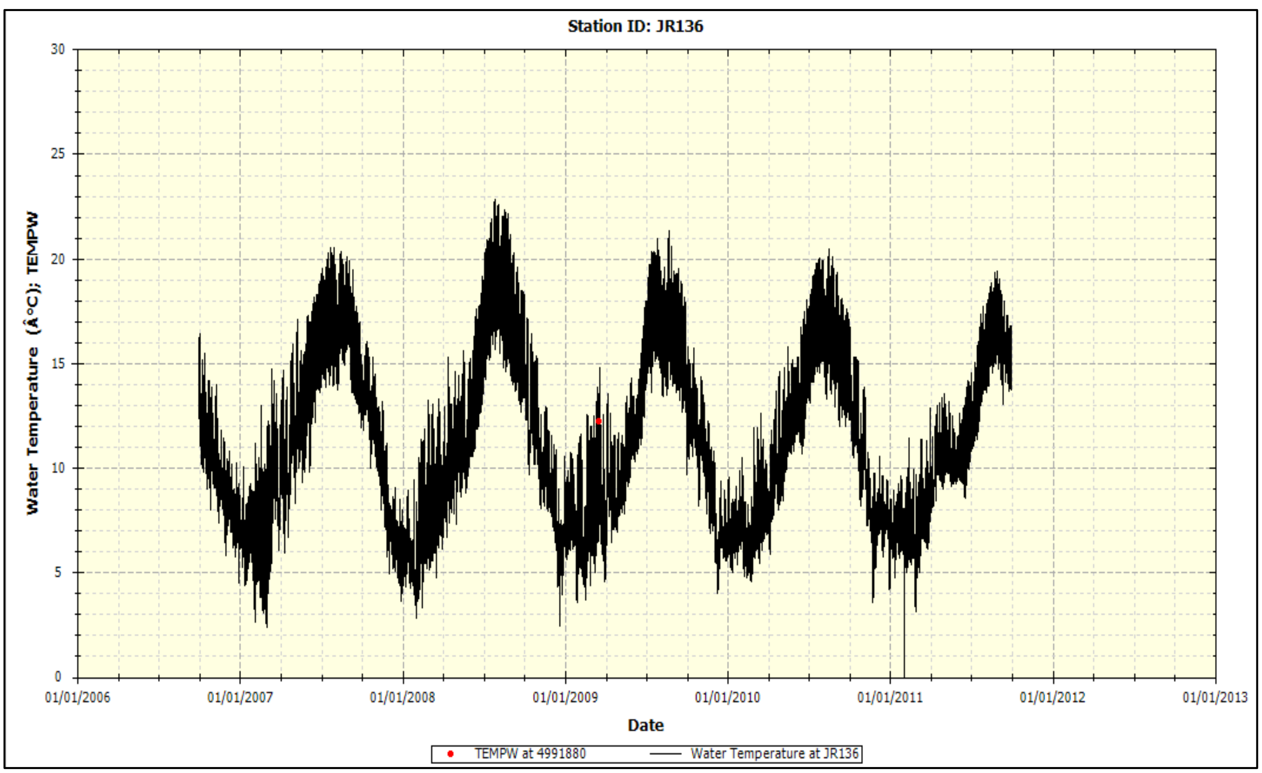


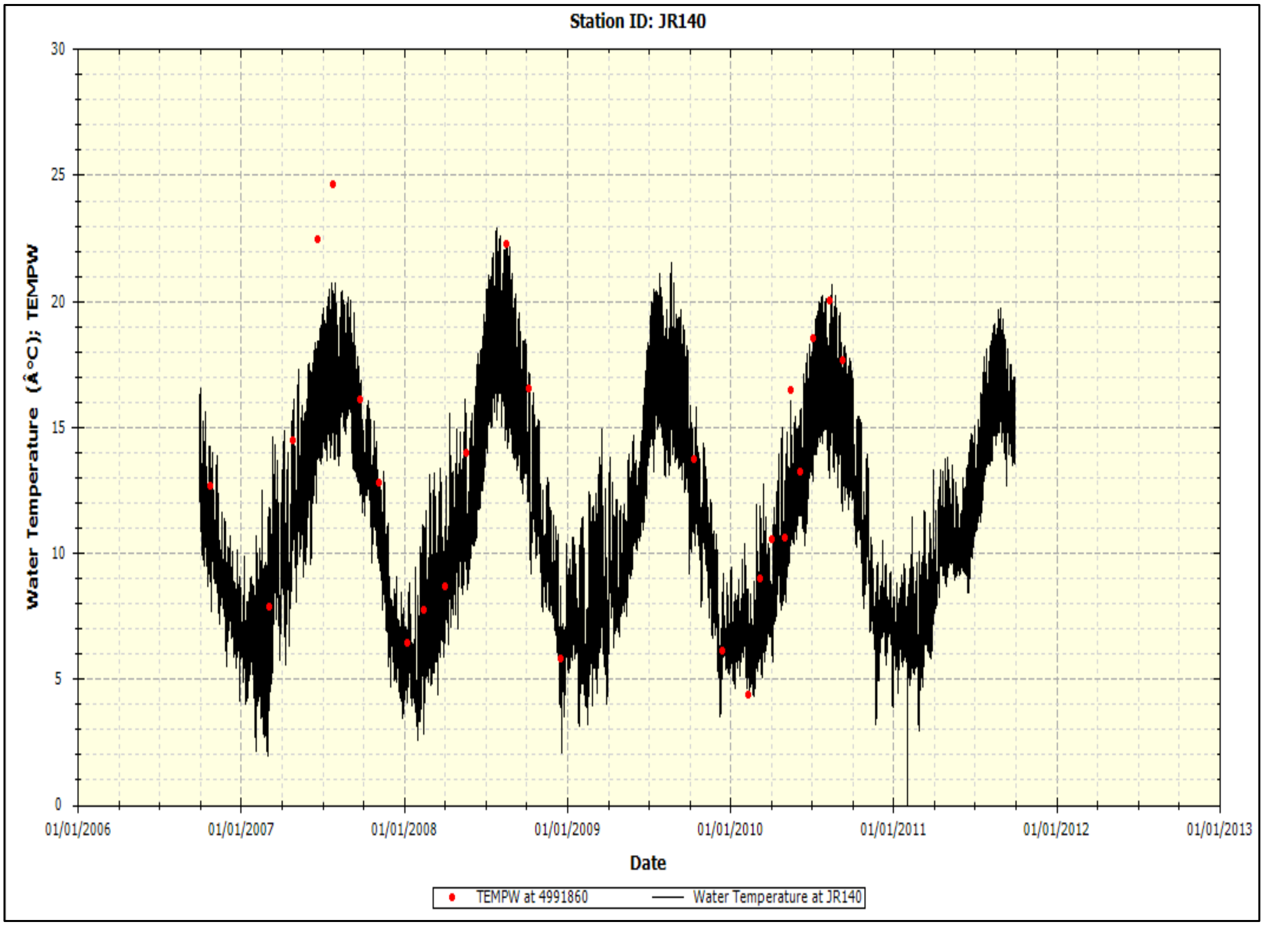
Station ID: JR124
Water Temperature (Â°C); TEMPW
25
20
15
10
5
0
-5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4992055
Water Temperature at JR124


Station ID: JR127
Water Temperature (Â°C); TEMPW
25
20
15
10
5
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4991940
Water Temperature at JR127

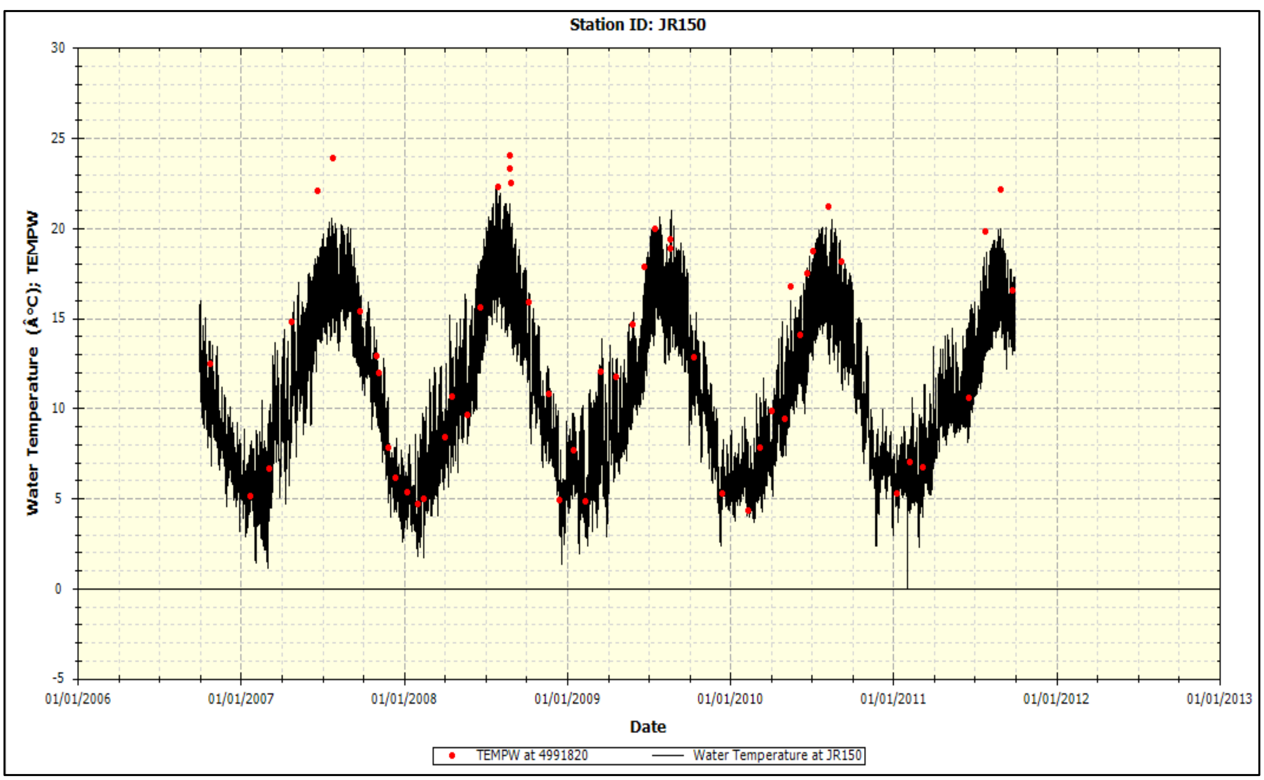

Station ID: JR132
Water Temperature (Â°C); TEMPW
25
20
15
10
5
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4991900
Water Temperature at JR132


Station ID: JR133
Water Temperature (Â°C); TEMPW
30
25
20
15
10
5
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4991890
Water Temperature at JR133

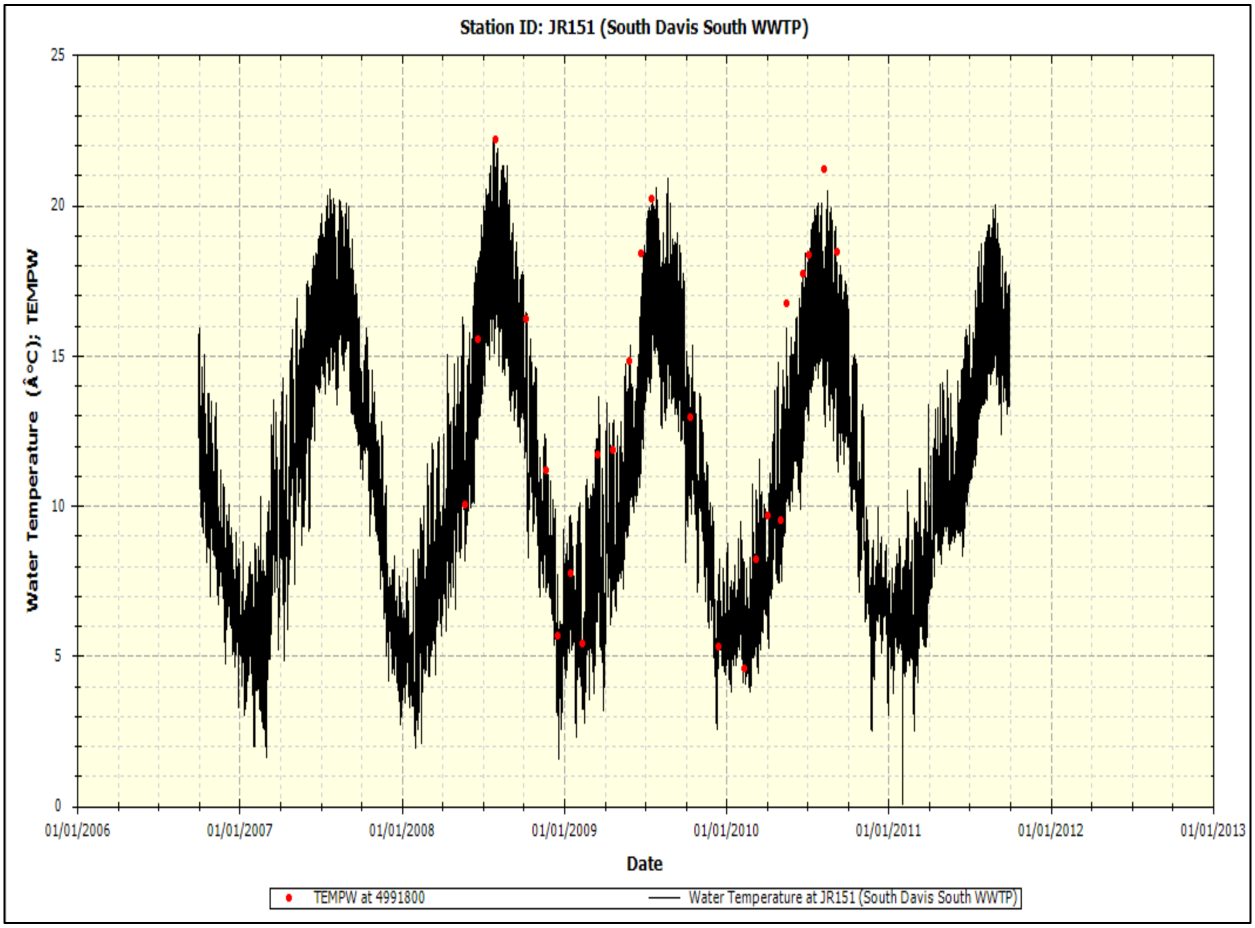

Station ID: JR136
Water Temperature (Â°C); TEMPW
30
25
20
15
10
5
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TEMPW at 4991880
Water Temperature at JR136

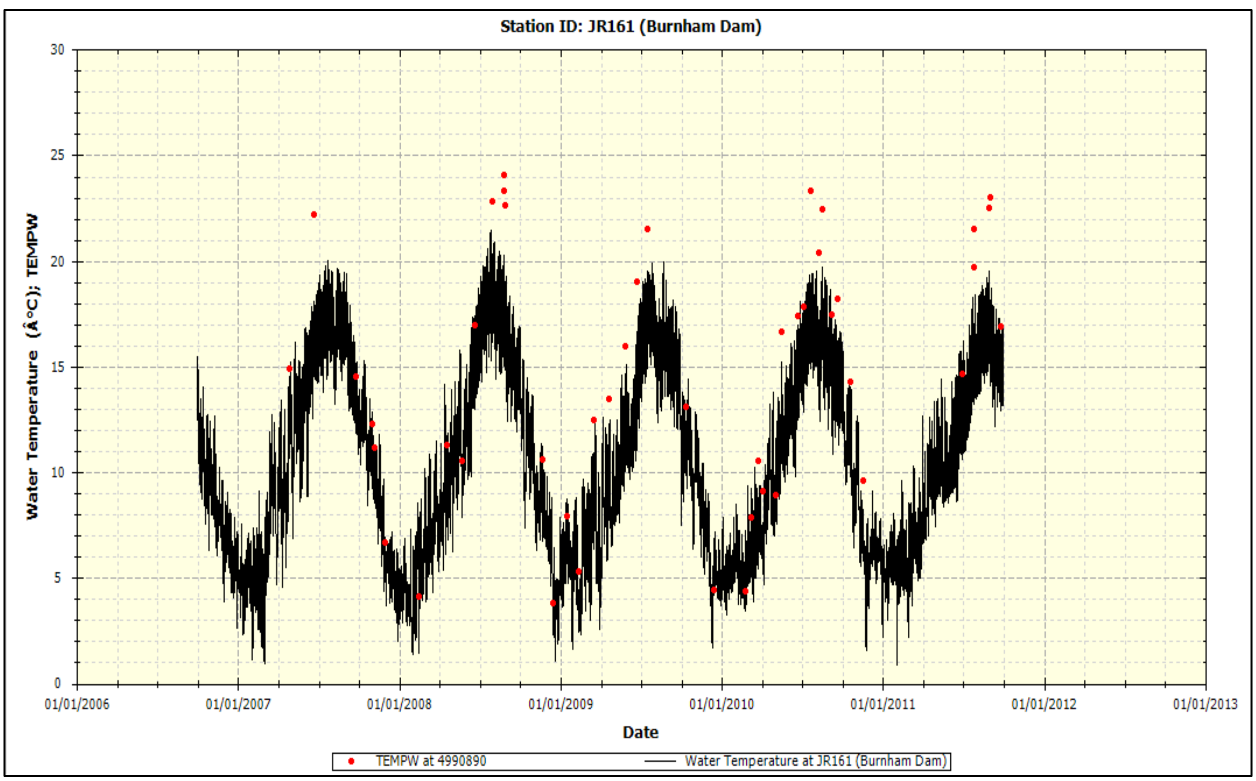


Station ID: JR140
Water Temperature (Â°C); TEMPW
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TEMPW at 4991860
Water Temperature at JR140

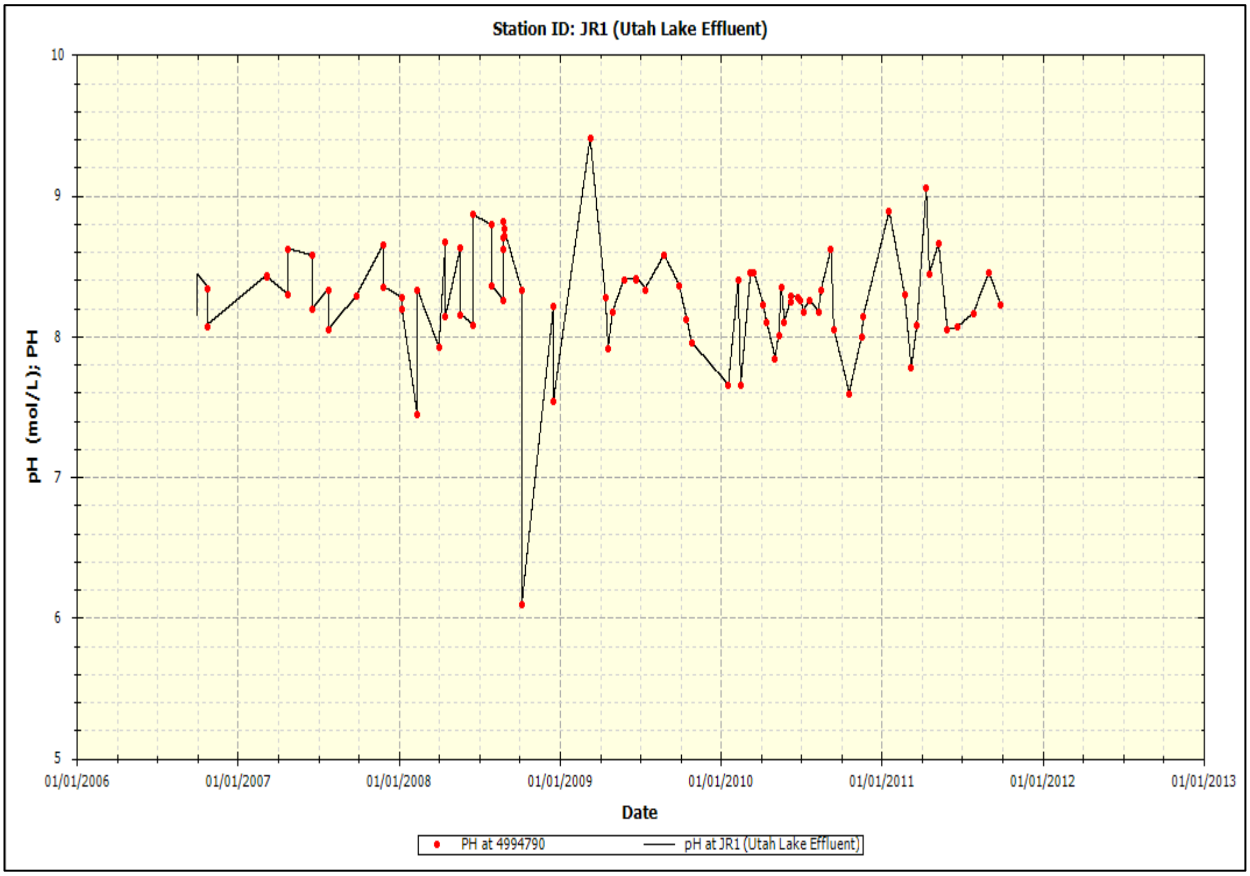


Station ID: JR150
Water Temperature (Â°C); TEMPW
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TEMPW at 4991820
Water Temperature at JR150

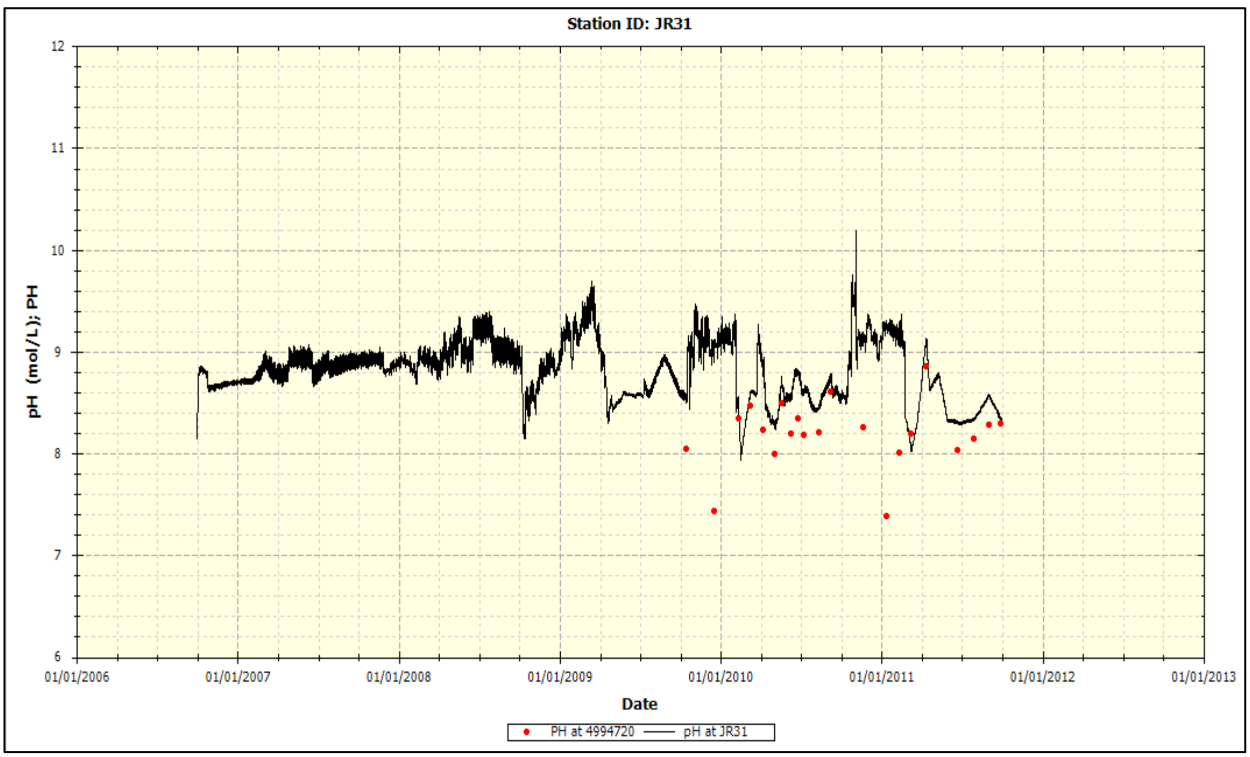

Station ID: JR151 (South Davis South WWTP)
Water Temperature (Â°C); TEMPW
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
0
5
10
15
20
25
TEMPW at 4991800
Water Temperature at JR151 (South Davis South WWTP)


Station ID: JR161 (Burnham Dam)
Water Temperature (Â°C); TEMPW
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
0
5
10
15
20
25
30
TEMPW at 4990890
Water Temperature at JR161 (Burnham Dam)

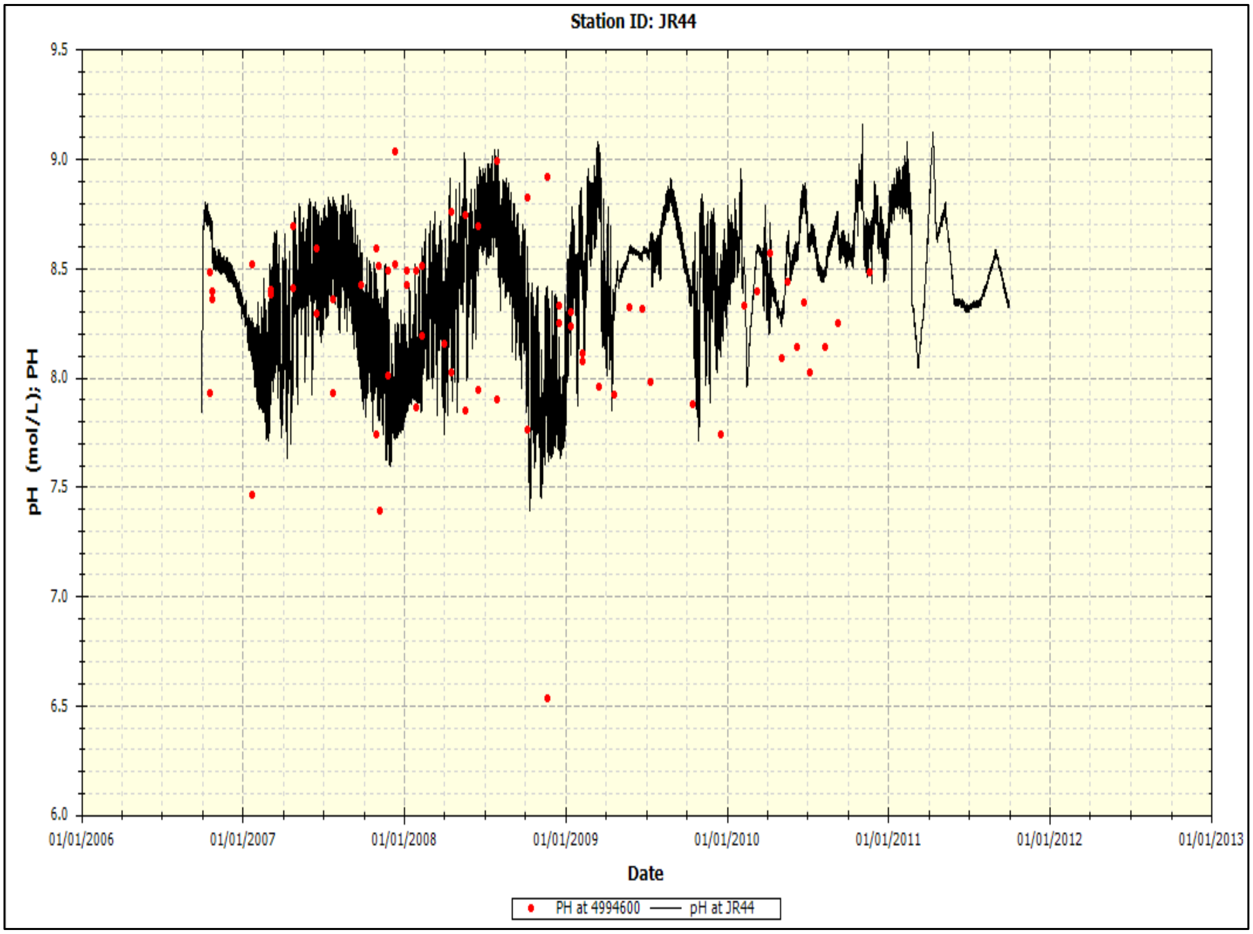
B.1.2: PH



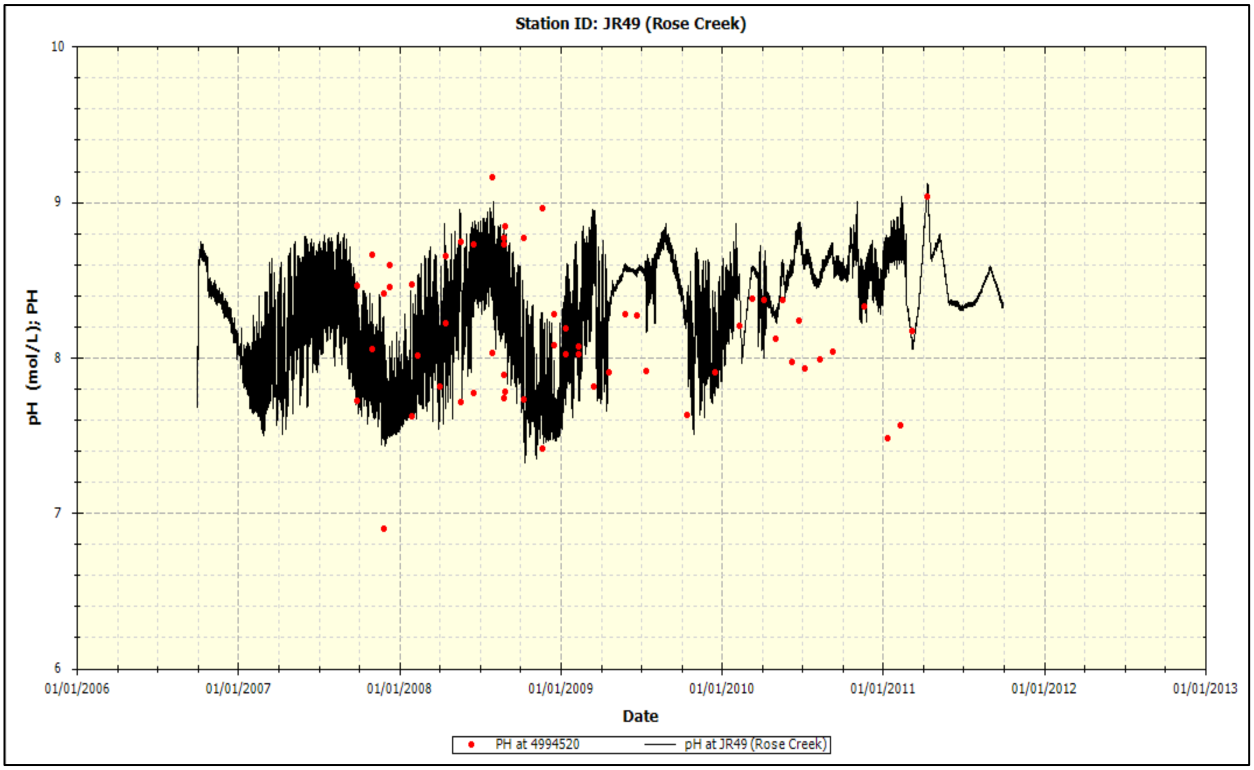
Station ID: JR1 (Utah Lake Effluent)
pH (mol/L); PH
10
9
8
7
6
5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994790
pH at JR1 (Utah Lake Effluent)



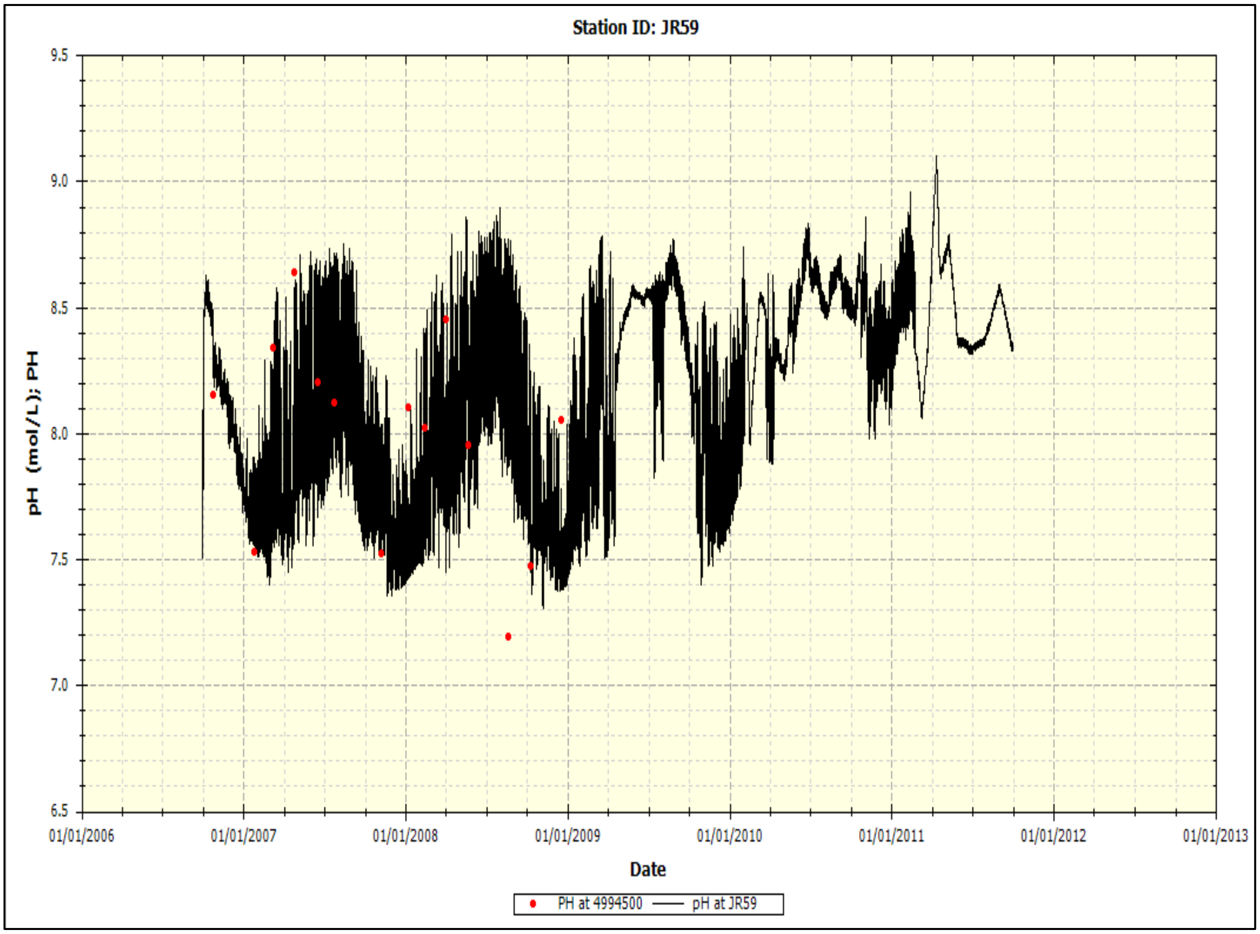
Station ID: JR31
pH (mol/L); PH
12
11
10
9
8
7
6
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994720
pH at JR31

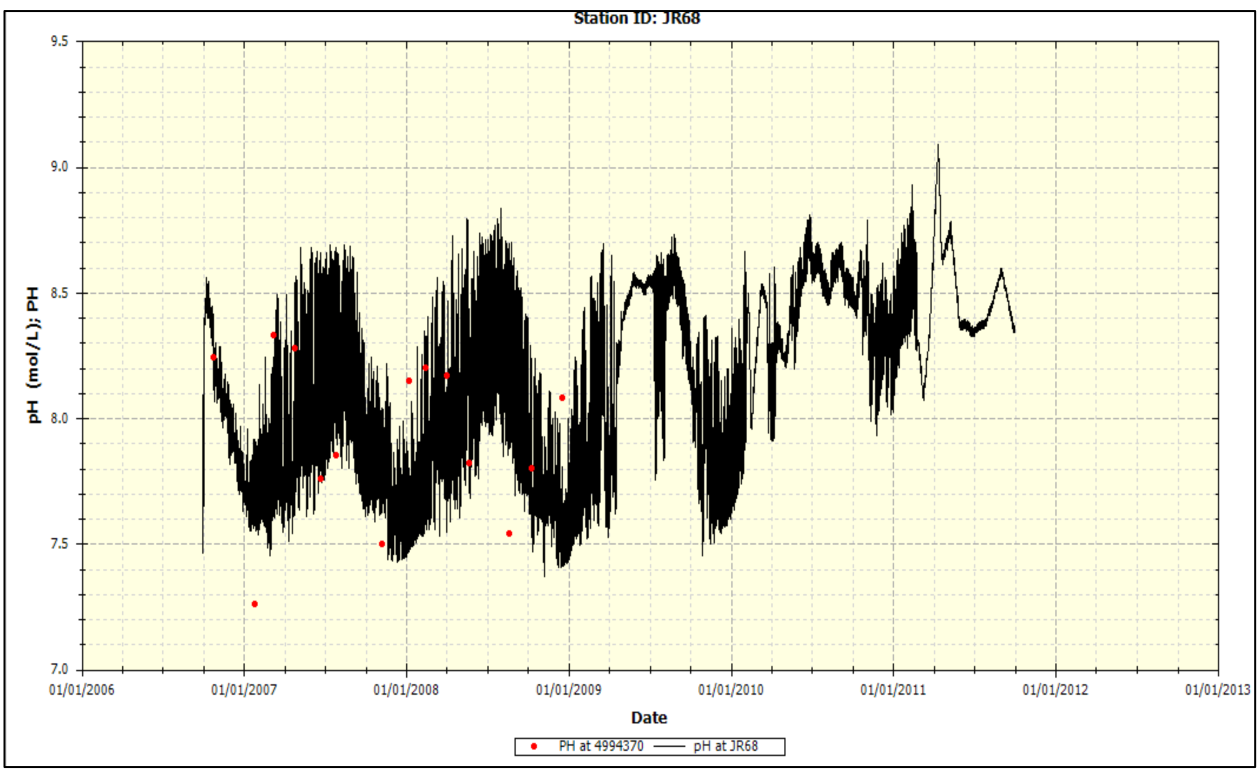


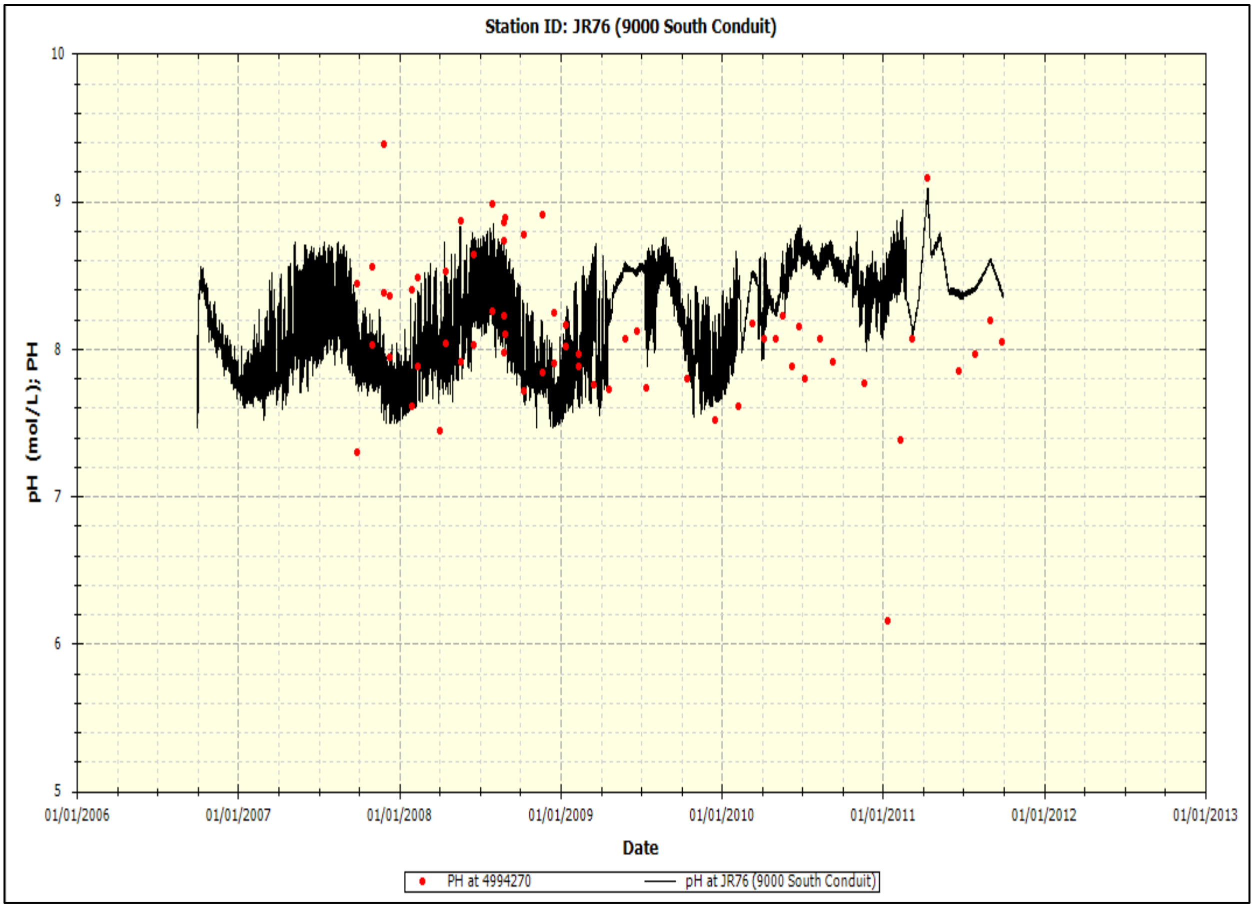
Station ID: JR44
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994600
pH at JR44

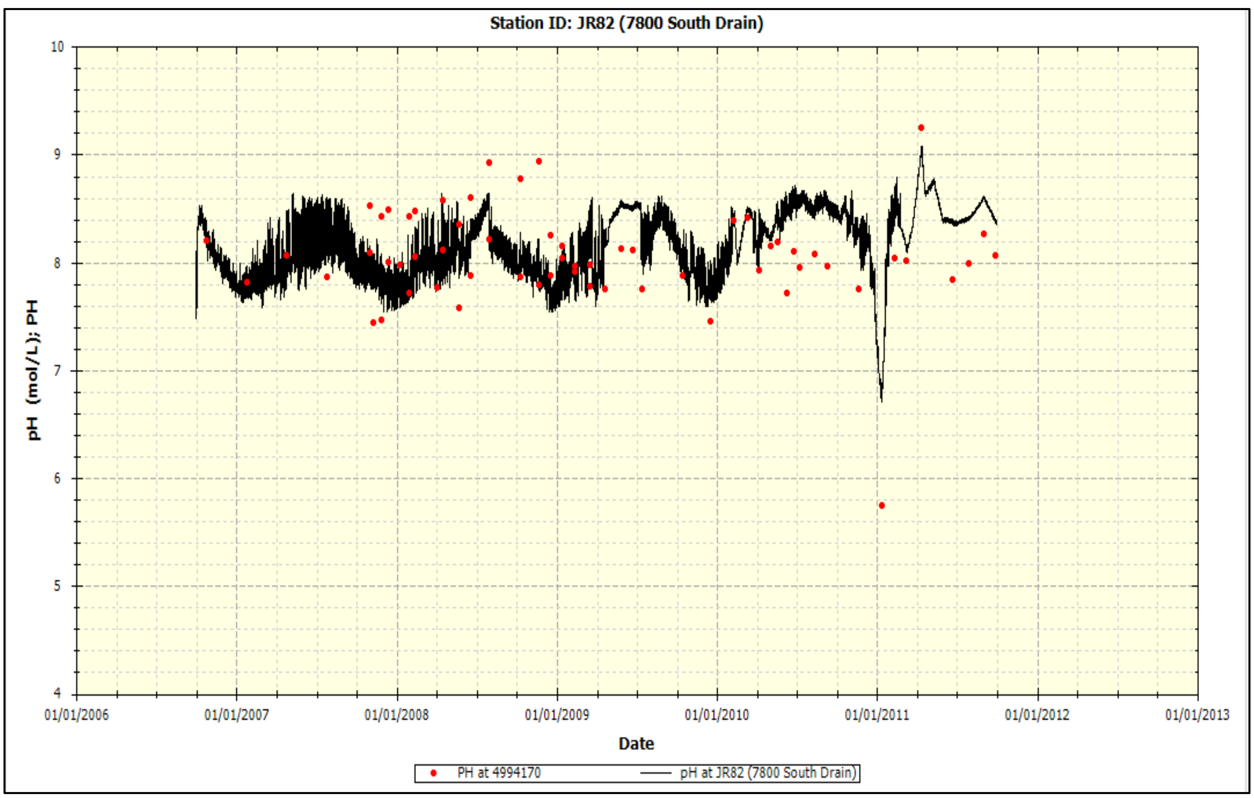


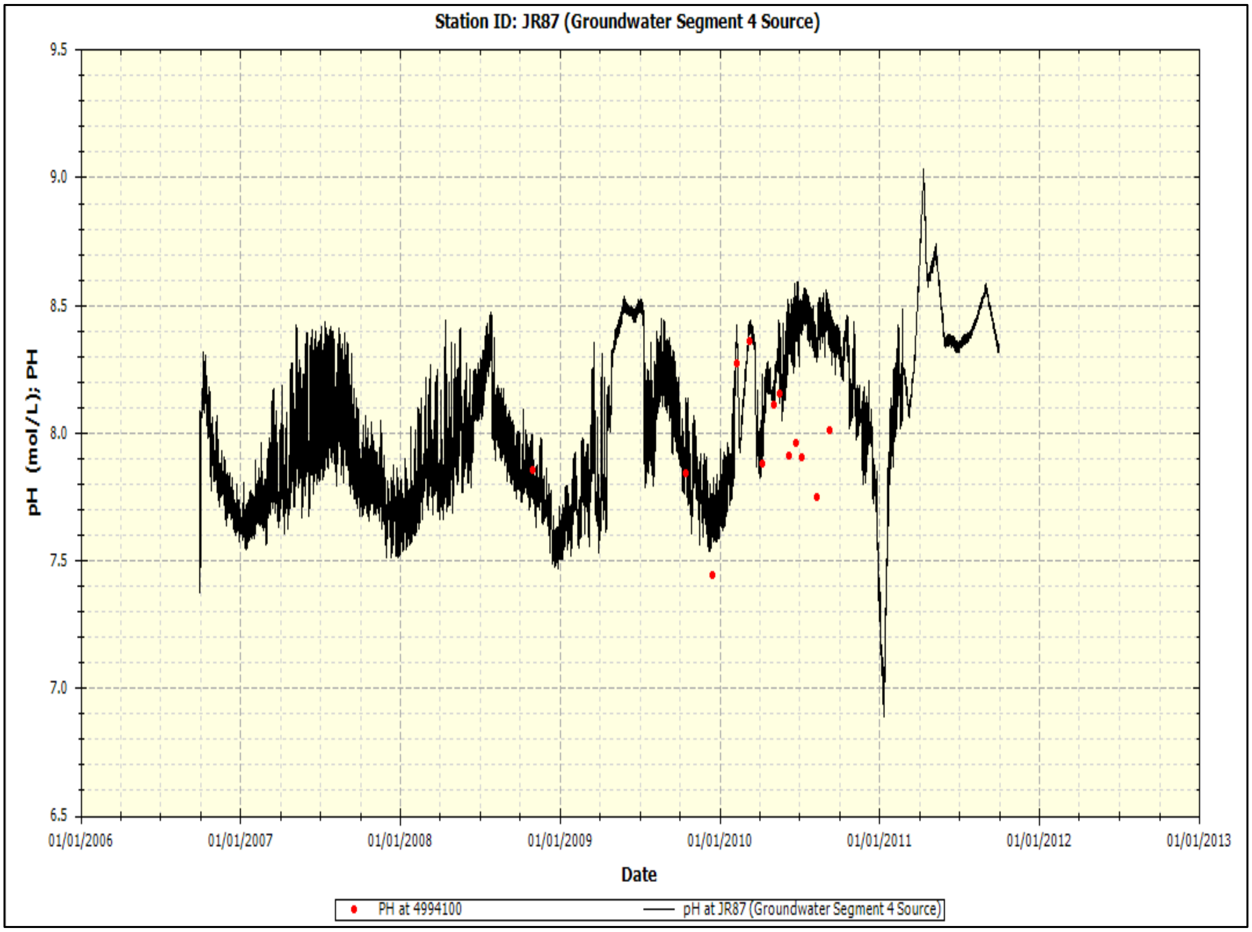
Station ID: JR49 (Rose Creek)
10
9
8
7
6
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994520
pH at JR49 (Rose Creek)

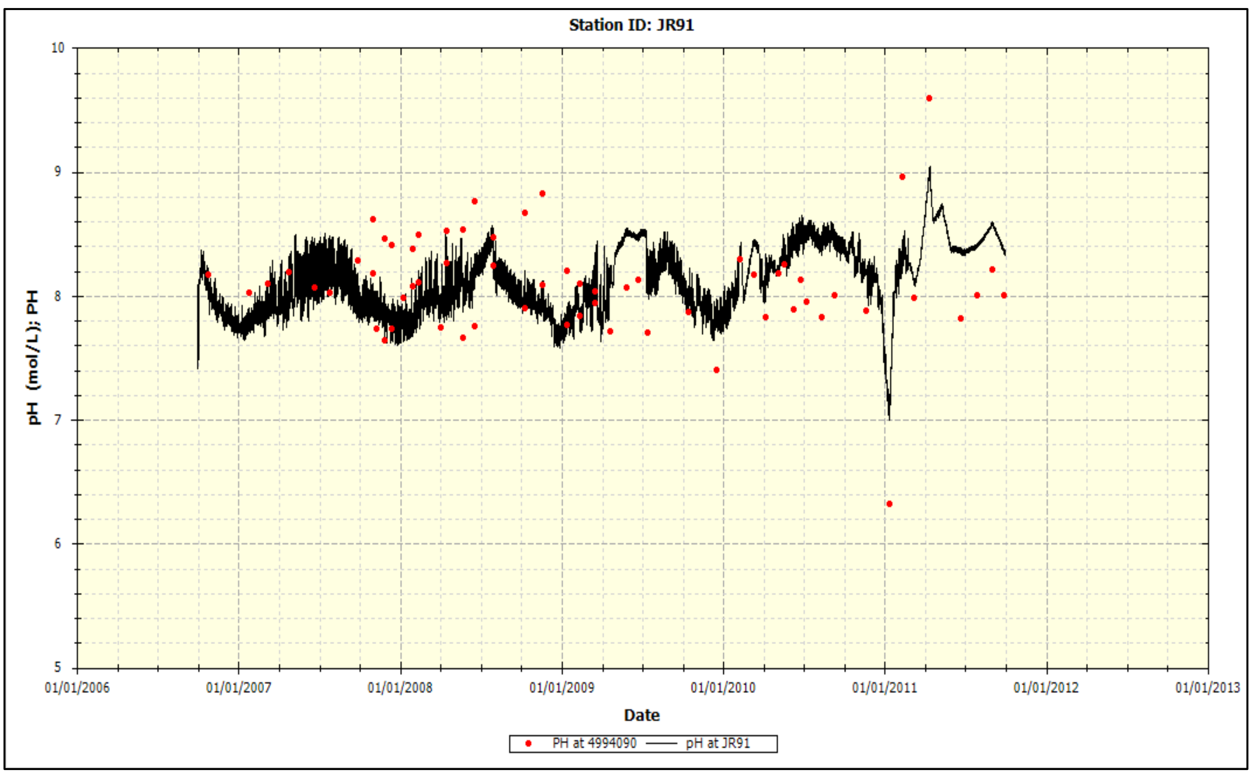

Station ID: JR59
9.5
9.0
8.5
8.0
7.5
7.0
6.5
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994500
pH at JR59

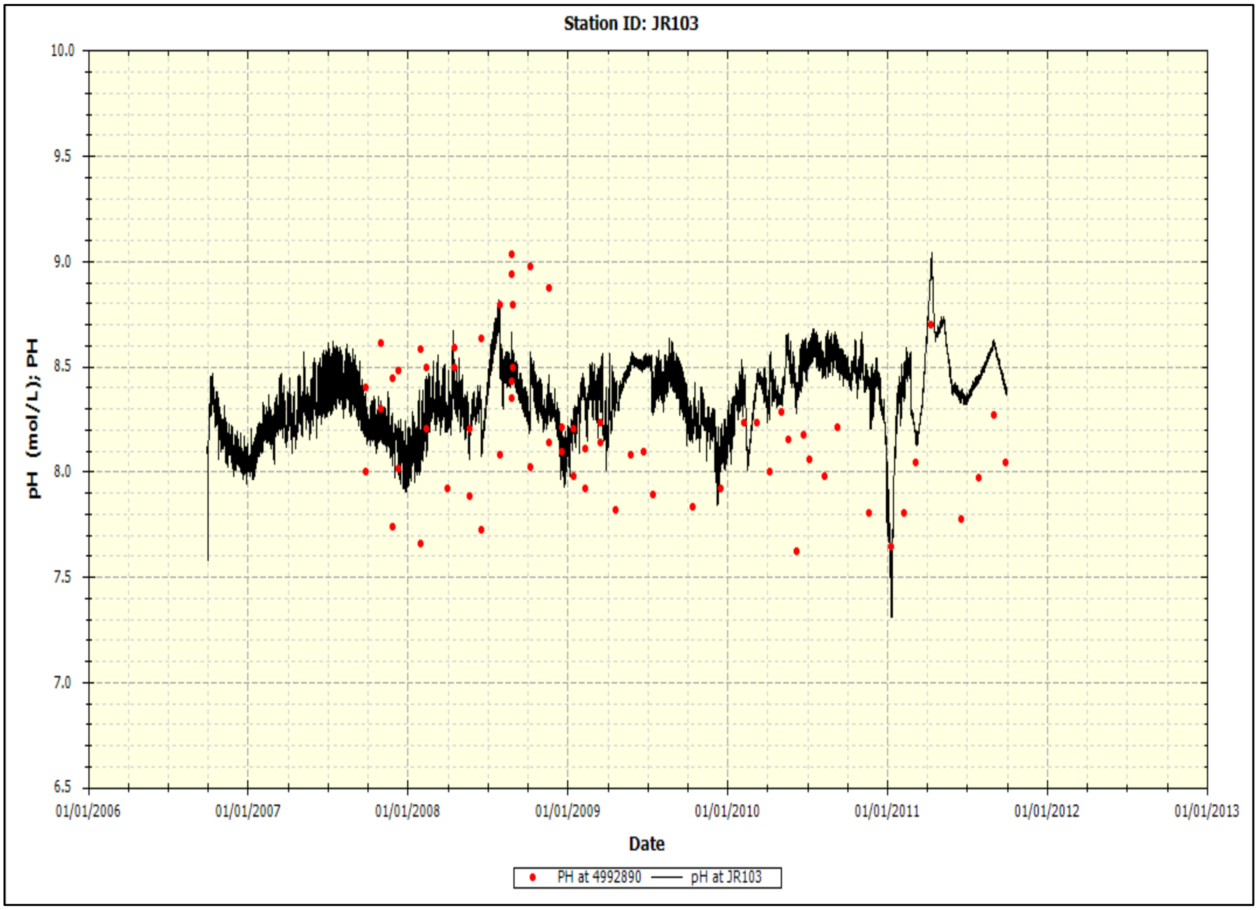

Station ID: JR68
9.5
9.0
8.5
8.0
7.5
7.0
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994370
pH at JR68

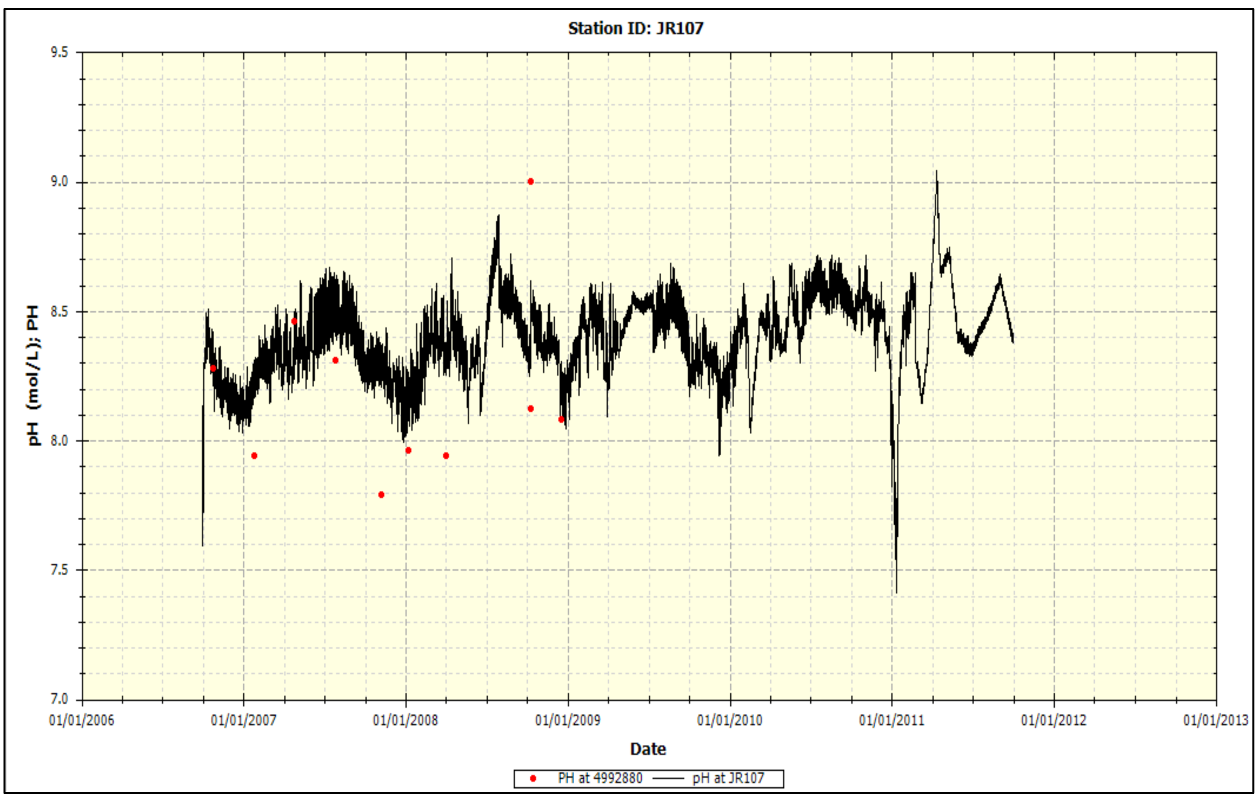

Station ID: JR76 (9000 South Conduit)
pH (mol/L); PH
Date
PH at 4994270
pH at JR76 (9000 South Conduit)

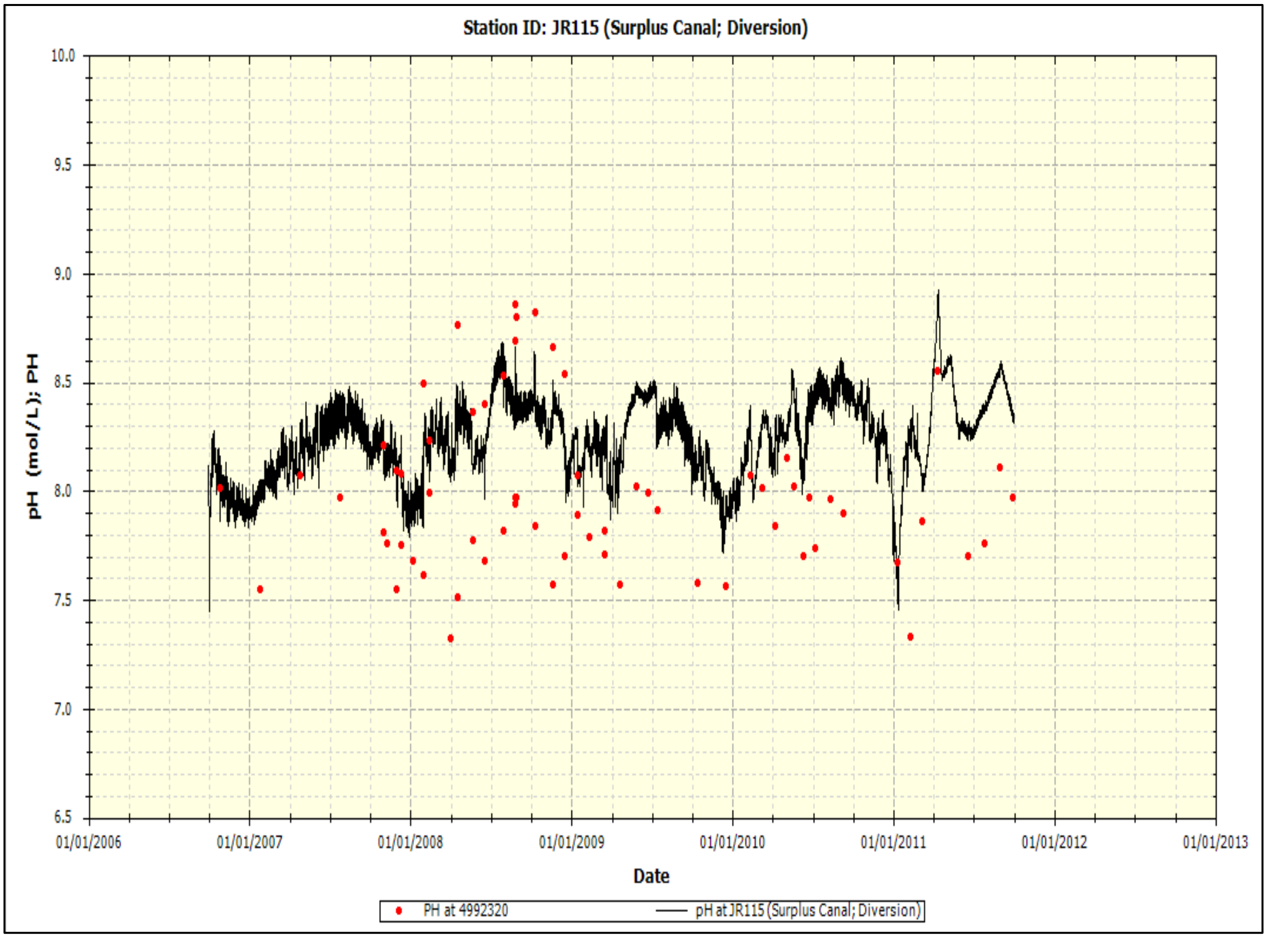

Station ID: JR82 (7800 South Drain)
pH (mol/L); PH
Date
PH at 4994170
pH at JR82 (7800 South Drain)

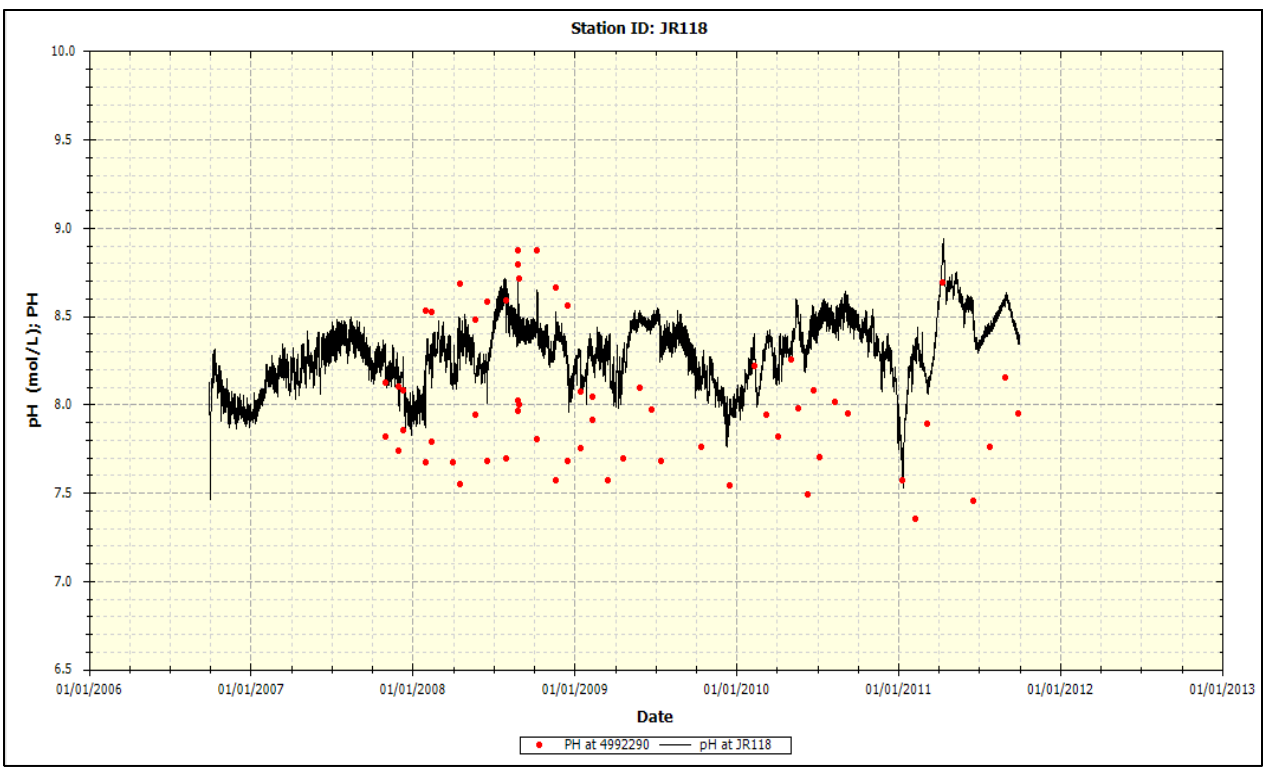

Station ID: JR87 (Groundwater Segment 4 Source)
pH (mol/L); PH
9.5
9.0
8.5
8.0
7.5
7.0
6.5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994100
pH at JR87 (Groundwater Segment 4 Source)

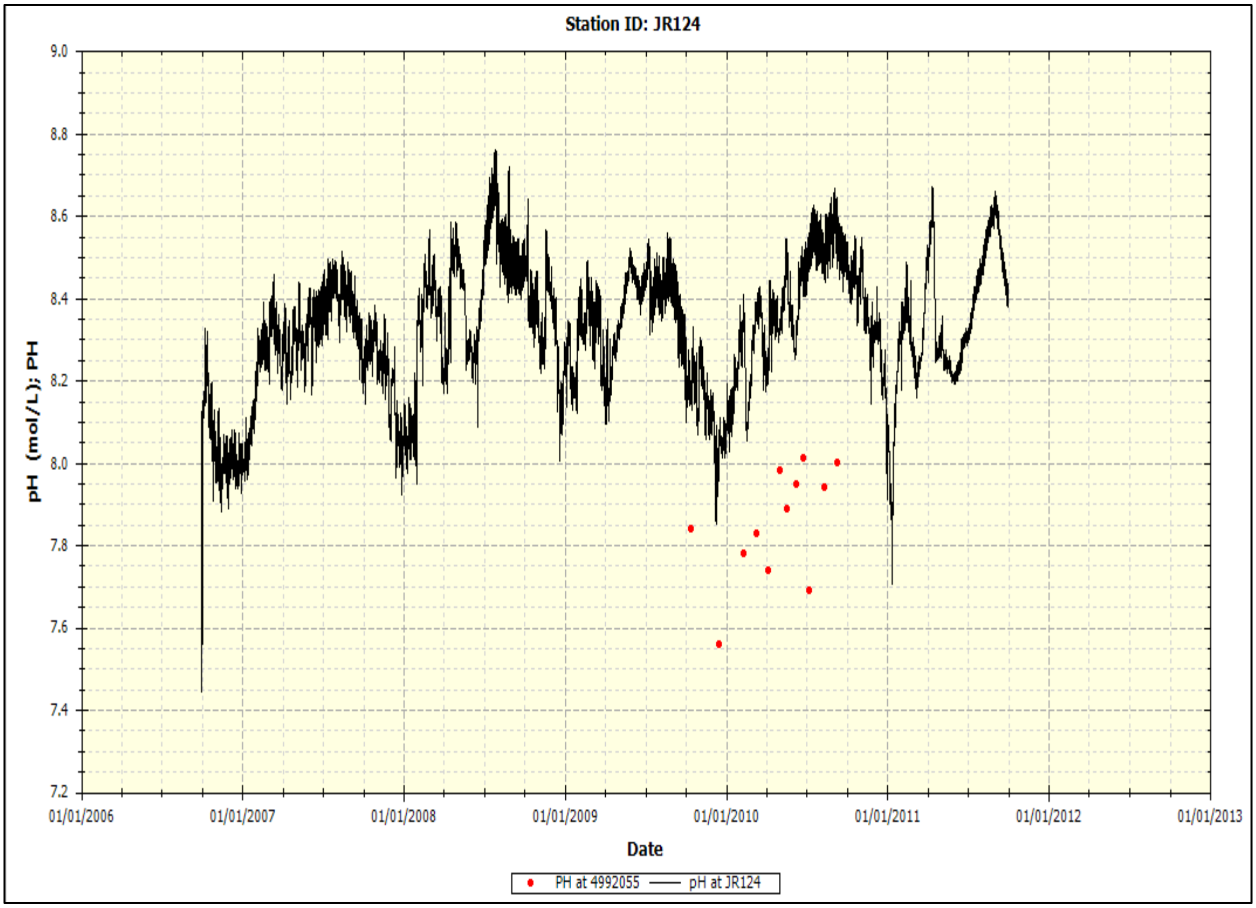

Station ID: JR91
pH (mol/L); PH
10
9
8
7
6
5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4994090
pH at JR91

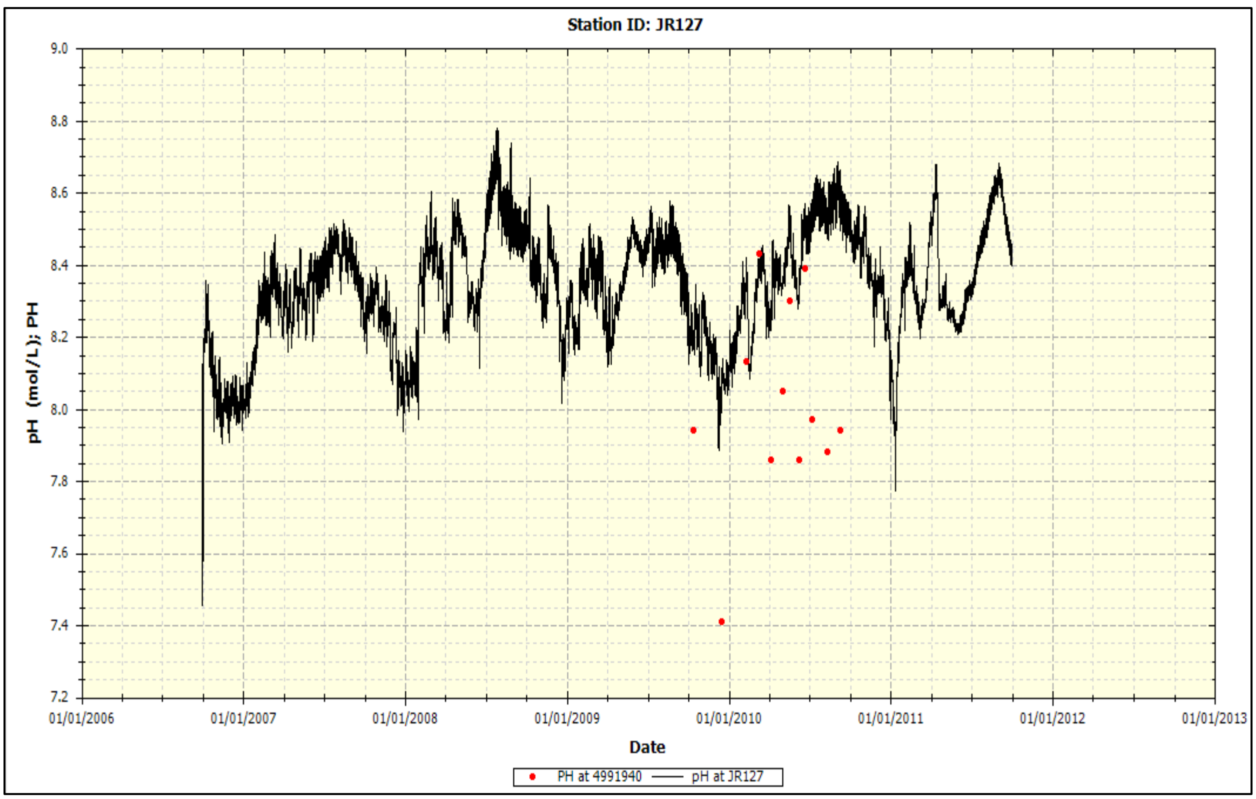

Station ID: JR103
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4992890
pH at JR103

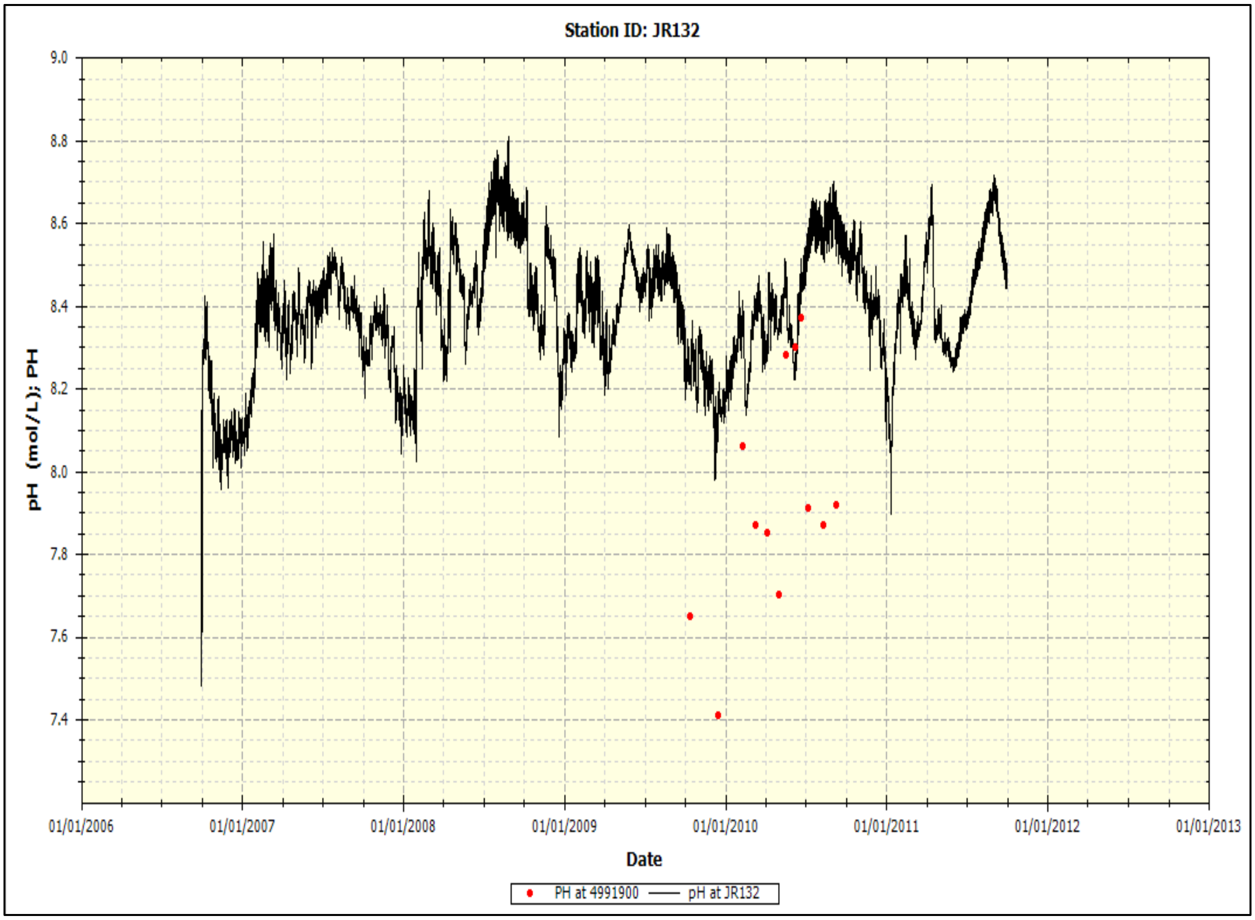

Station ID: JR107
9.5
9.0
8.5
8.0
7.5
7.0
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4992880
pH at JR107

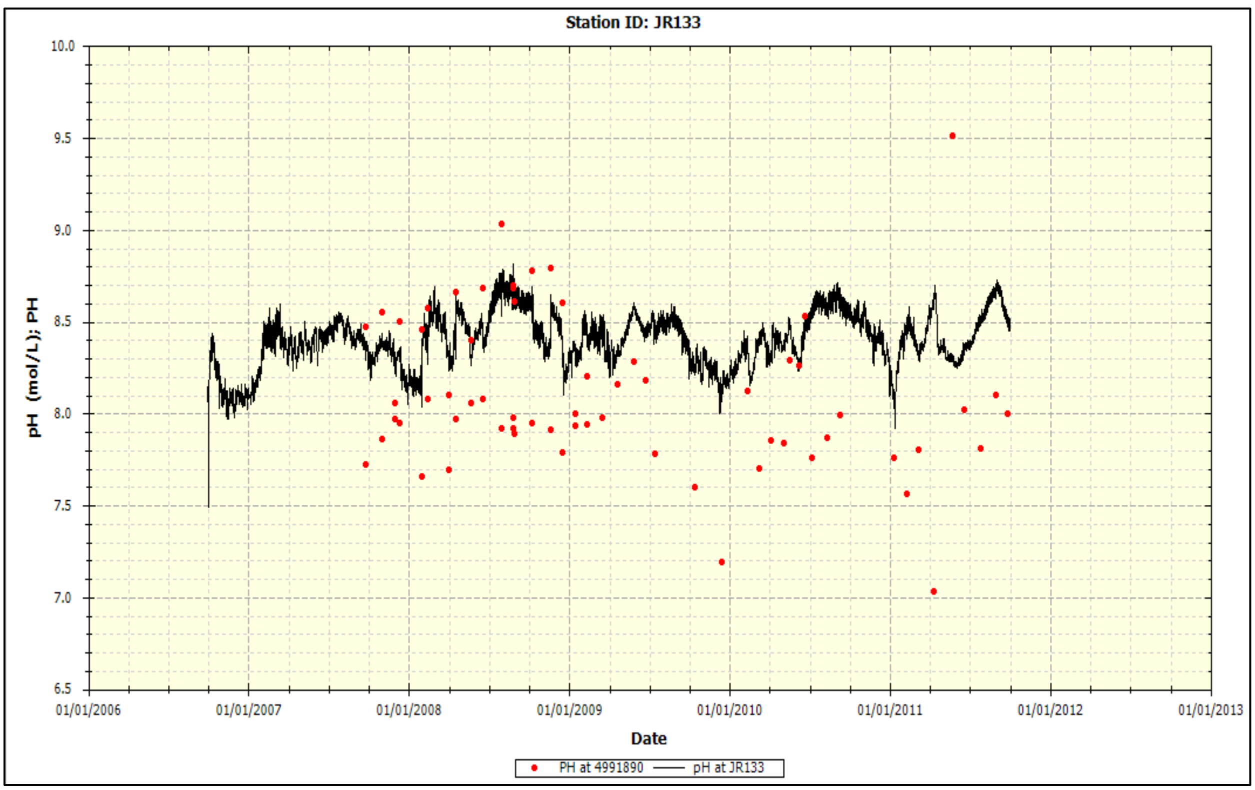

Station ID: JR115 (Surplus Canal; Diversion)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4992320
pH at JR115 (Surplus Canal; Diversion)

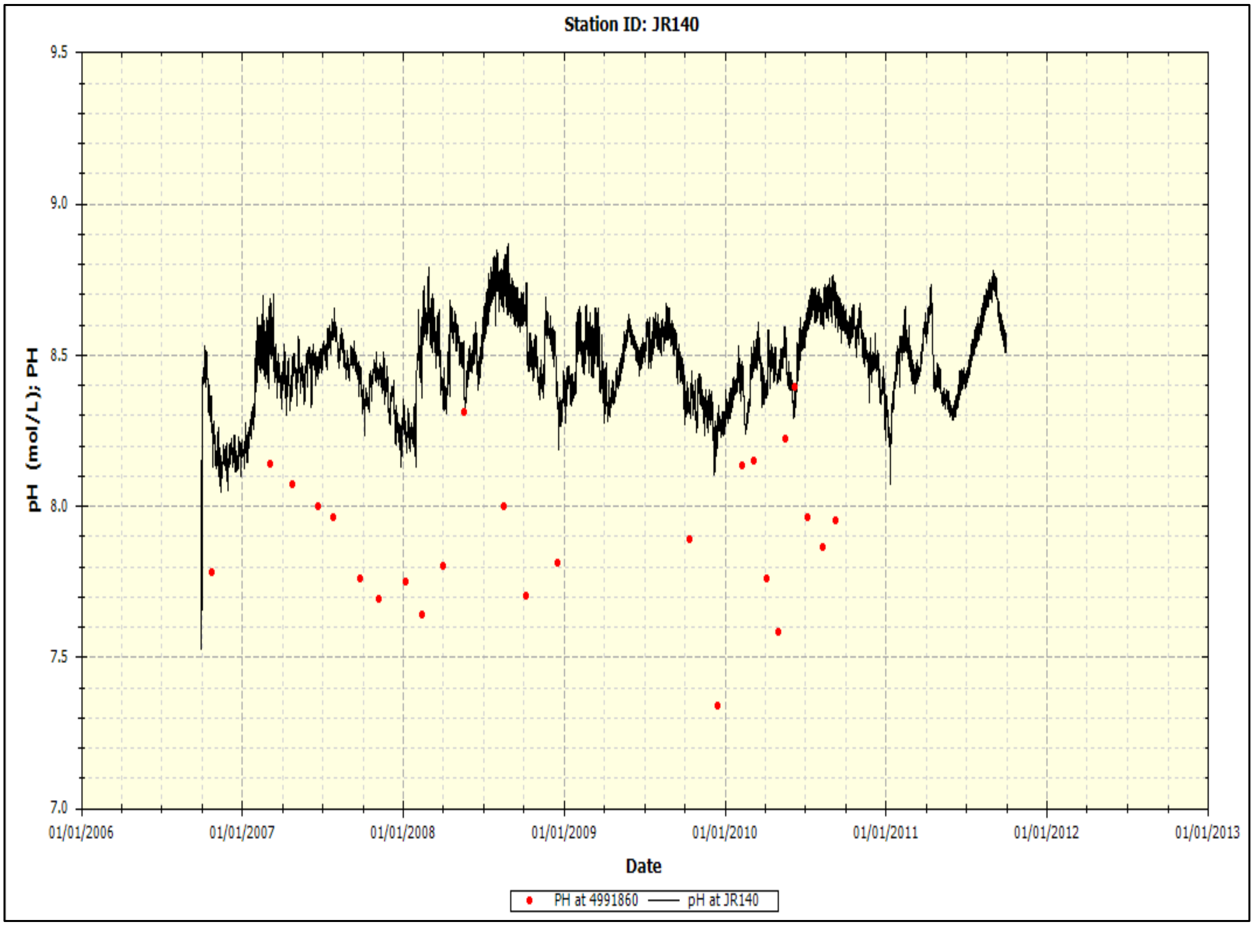

Station ID: JR118
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4992290
pH at JR118

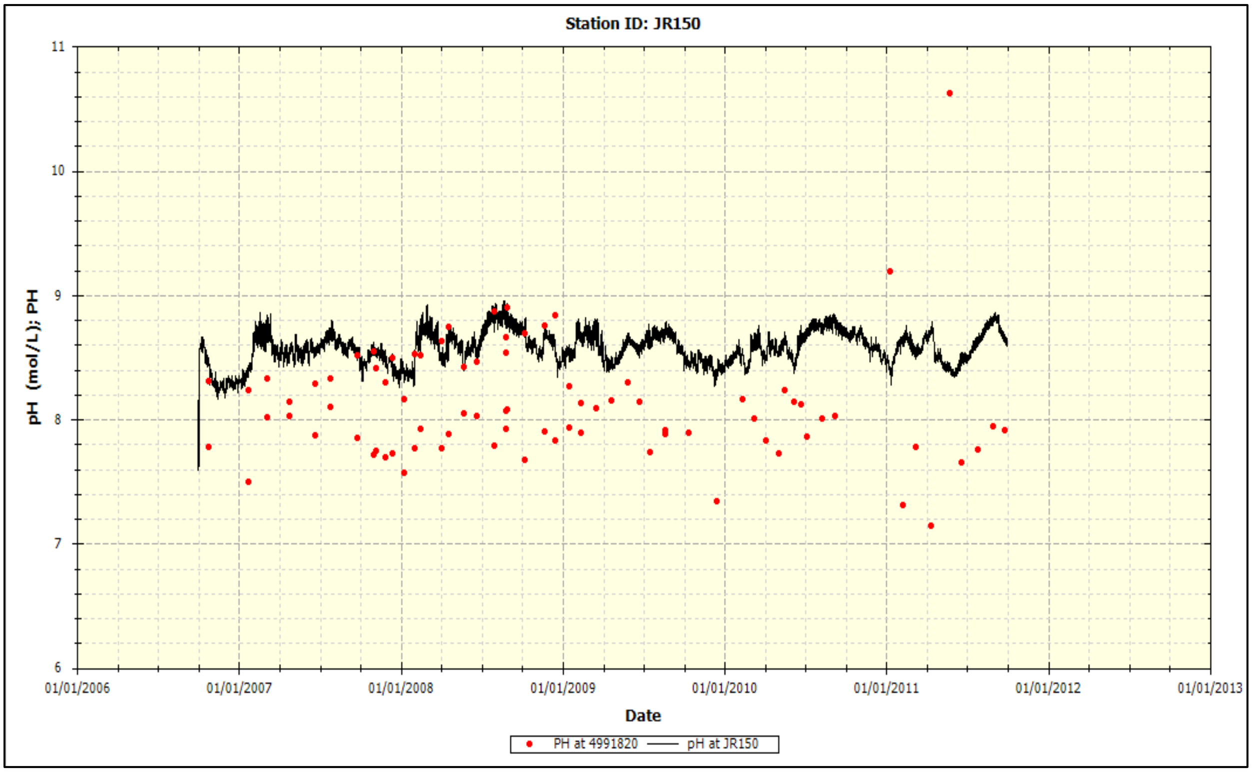

Station ID: JR124
pH (mol/L); PH
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4992055
pH at JR124

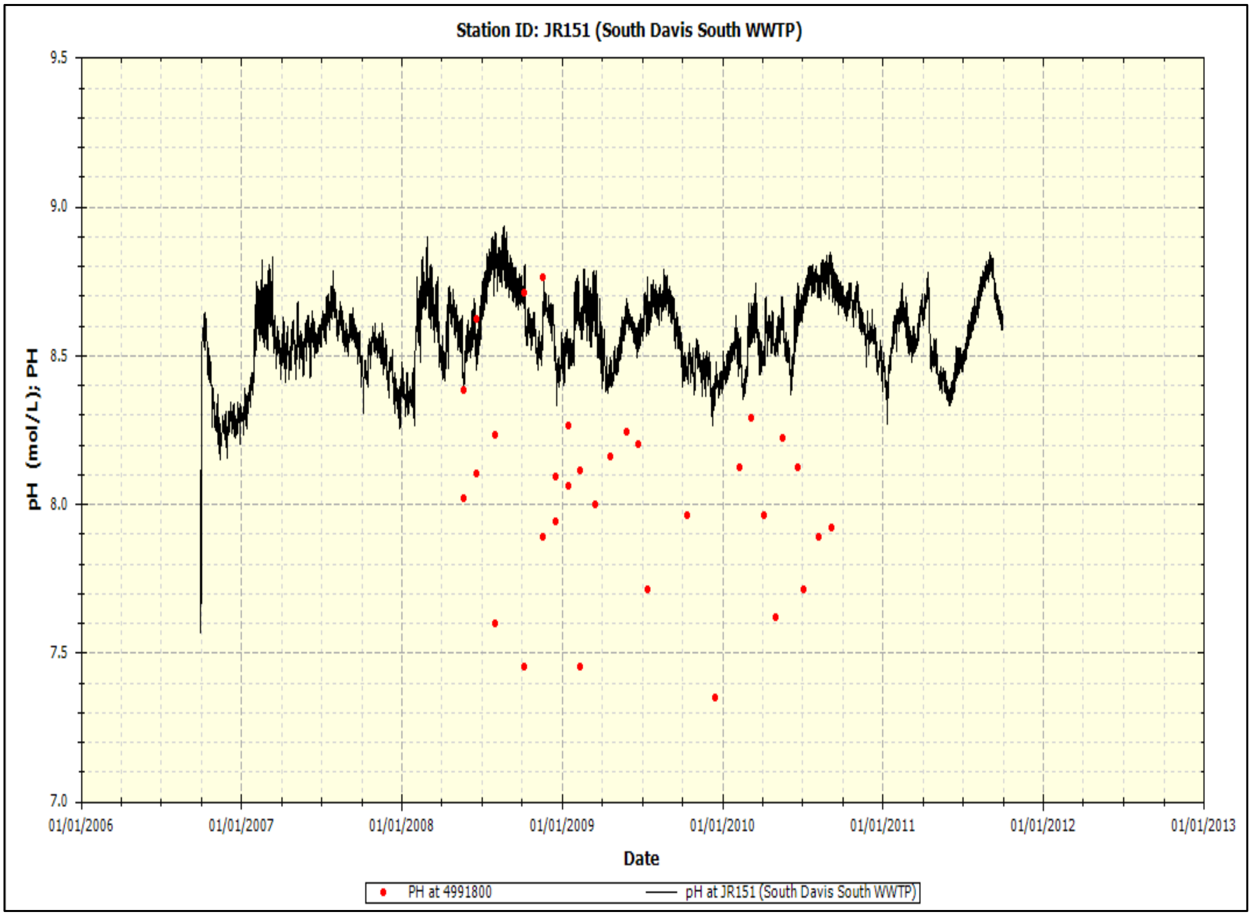

Station ID: JR127
pH (mol/L); PH
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4991940
pH at JR127

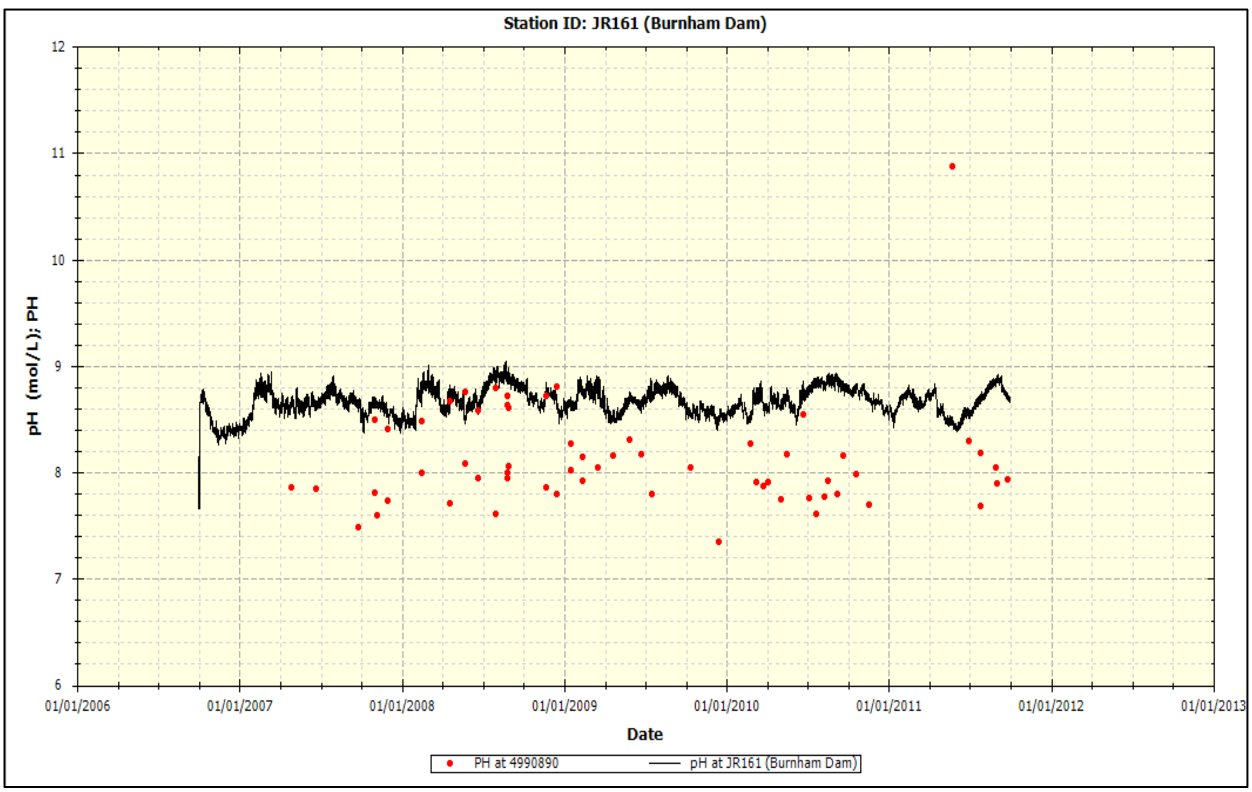

Station ID: JR132
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4991900
pH at JR132


Station ID: JR133
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4991890
pH at JR133

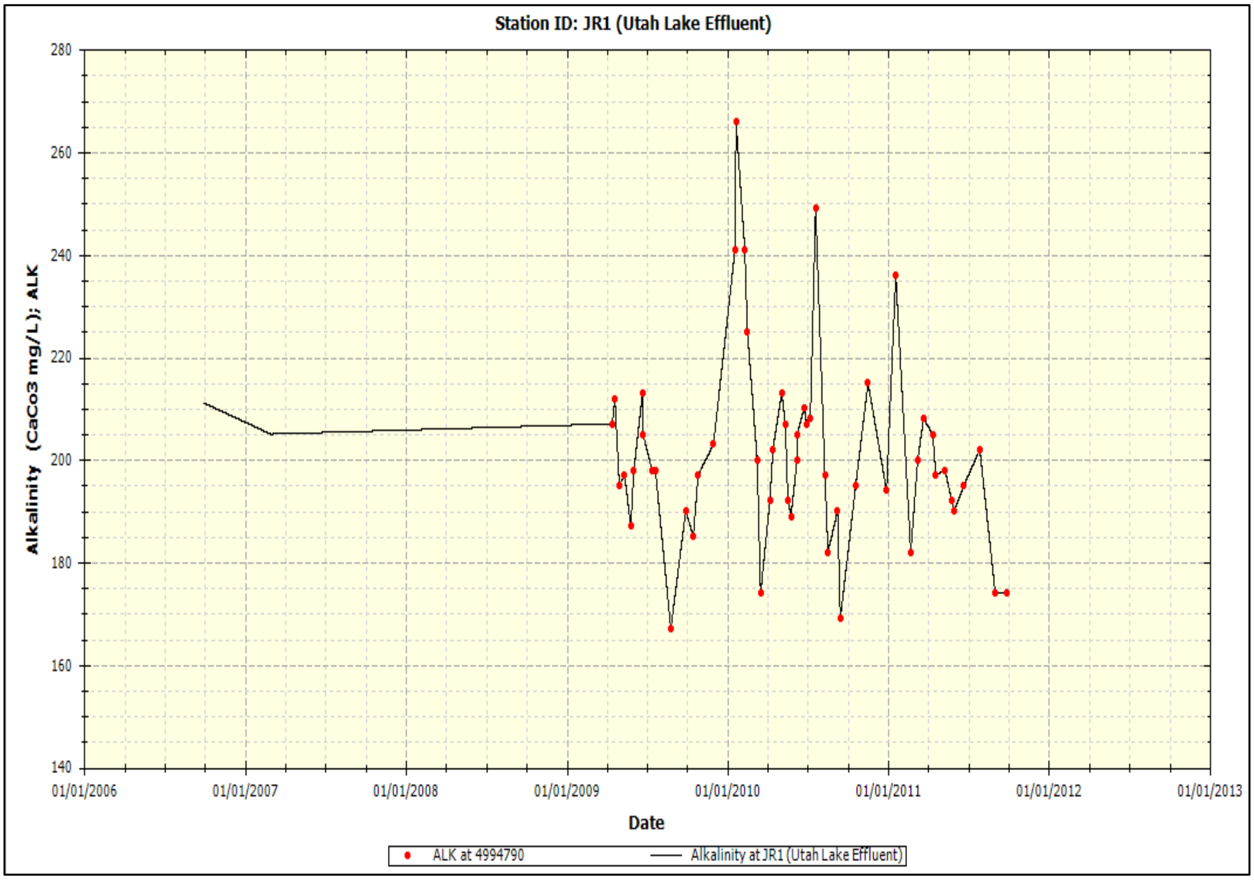

Station ID: JR140
9.5
9.0
8.5
8.0
7.5
7.0
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4991860
pH at JR140

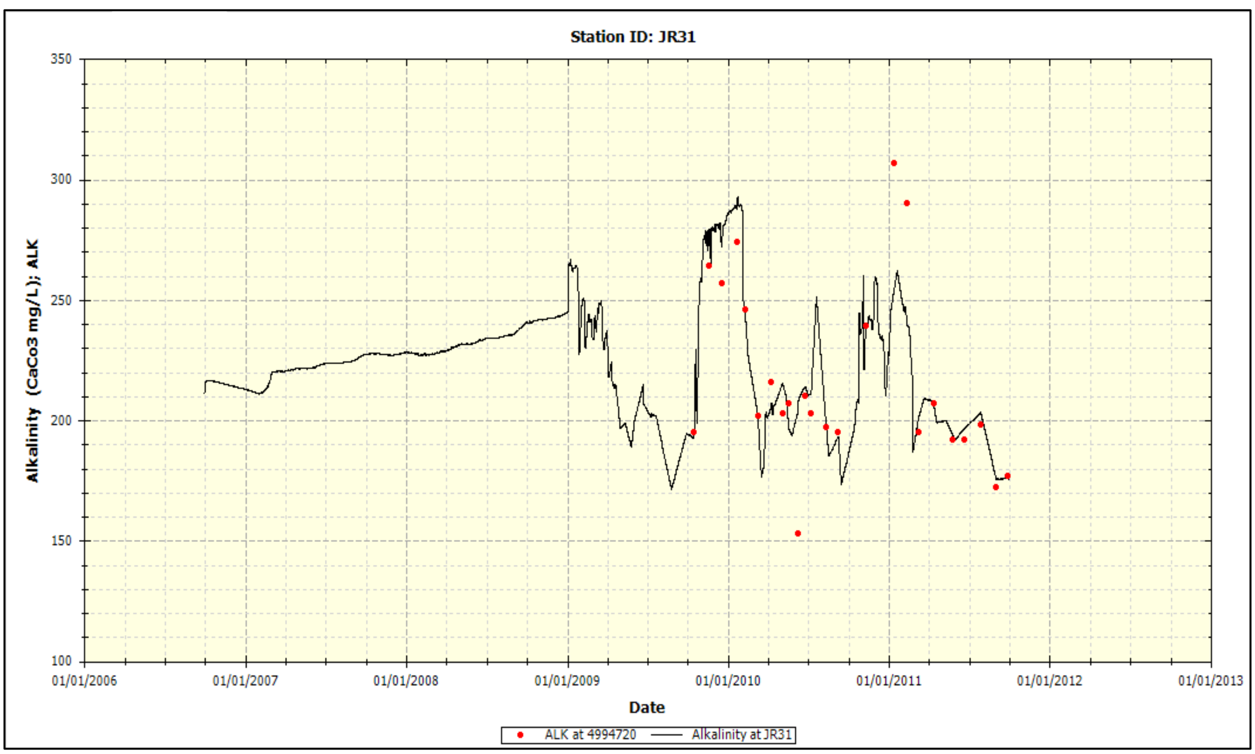

Station ID: JR150
11
10
9
8
7
6
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4991820
pH at JR150

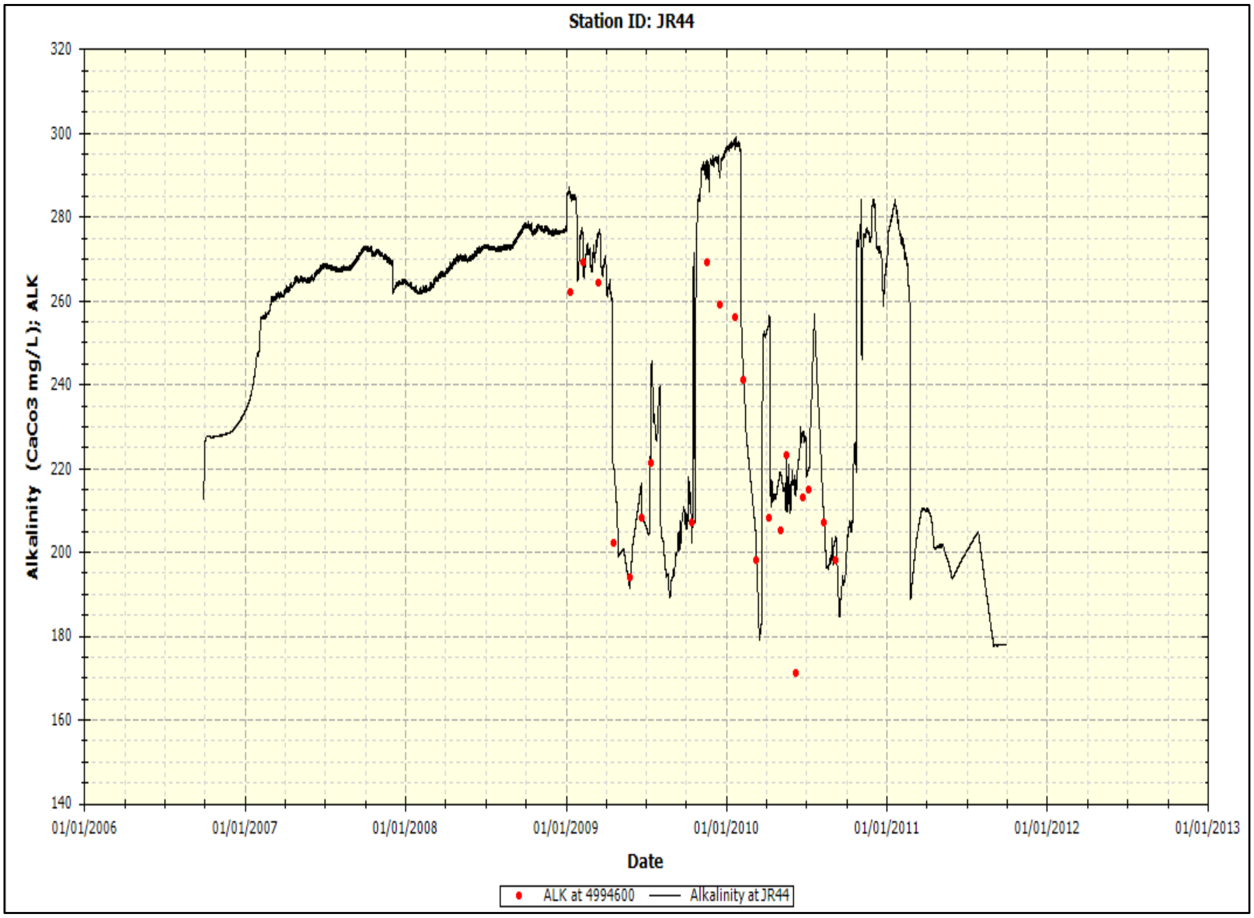

Station ID: JR151 (South Davis South WWTP)
9.5
9.0
8.5
8.0
7.5
7.0
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4991800
pH at JR151 (South Davis South WWTP)

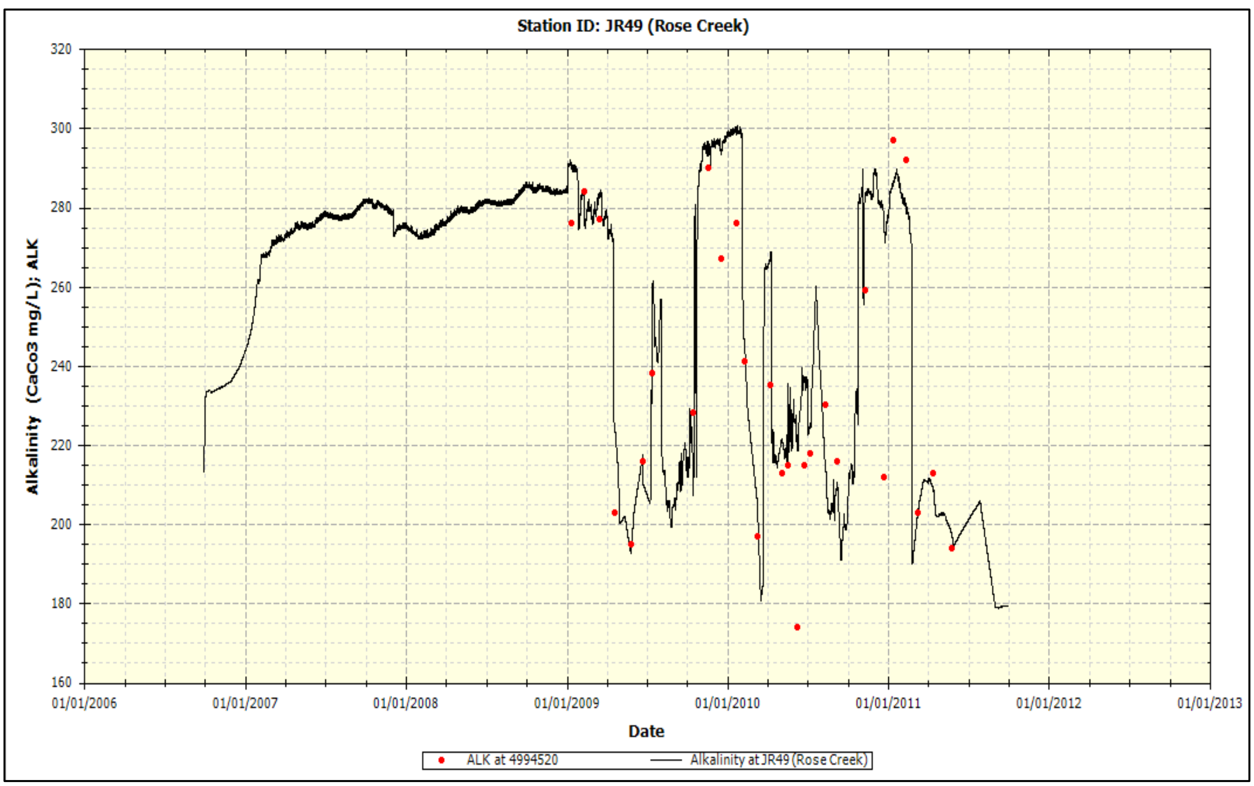

Station ID: JR161 (Burnham Dam)
12
11
10
9
8
7
6
pH (mol/L); PH
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PH at 4990890
pH at JR161 (Burnham Dam)

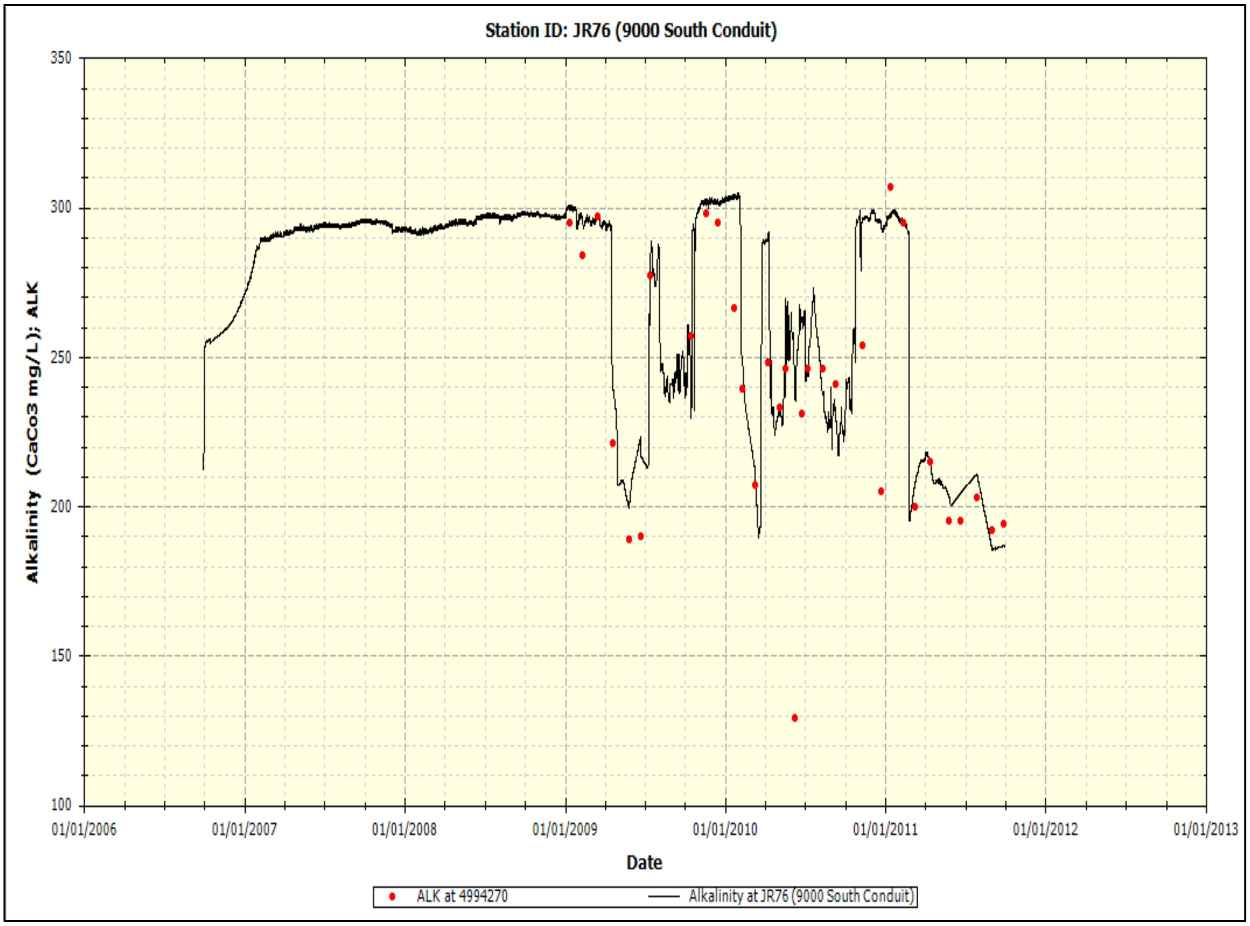
B.1.3: ALKALINITY

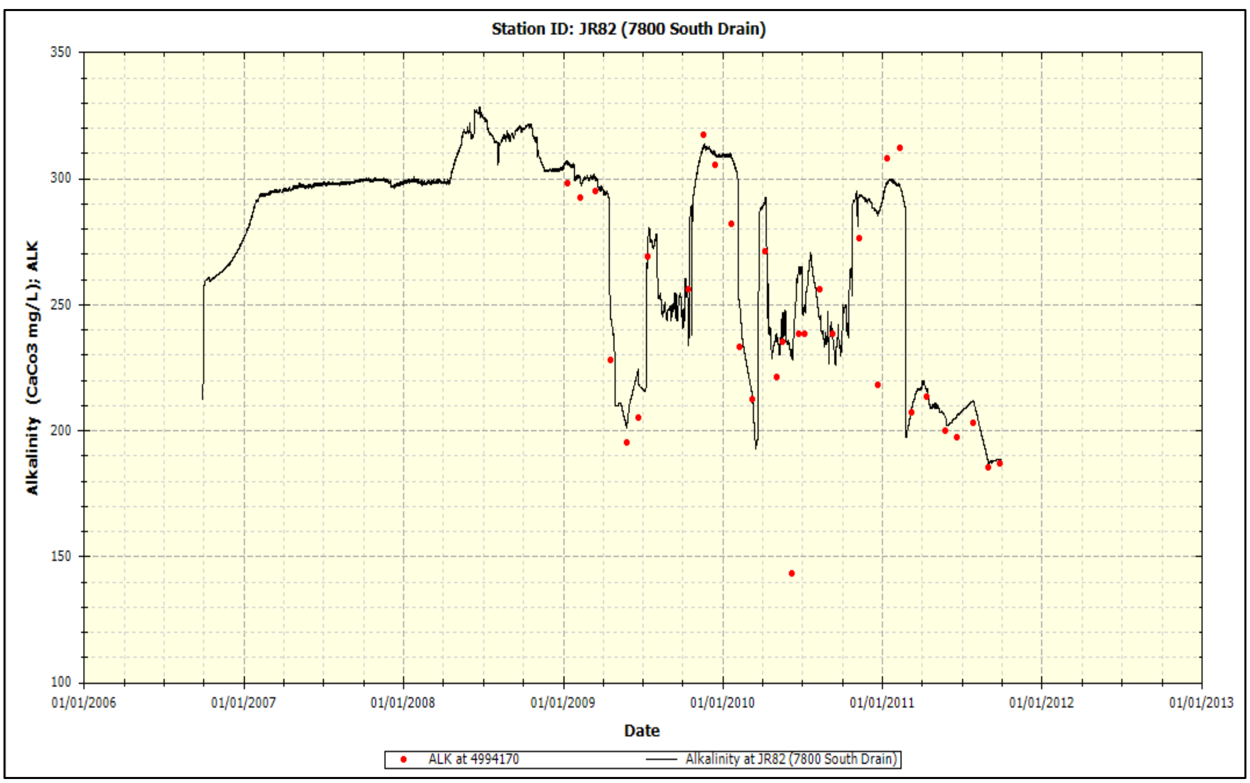


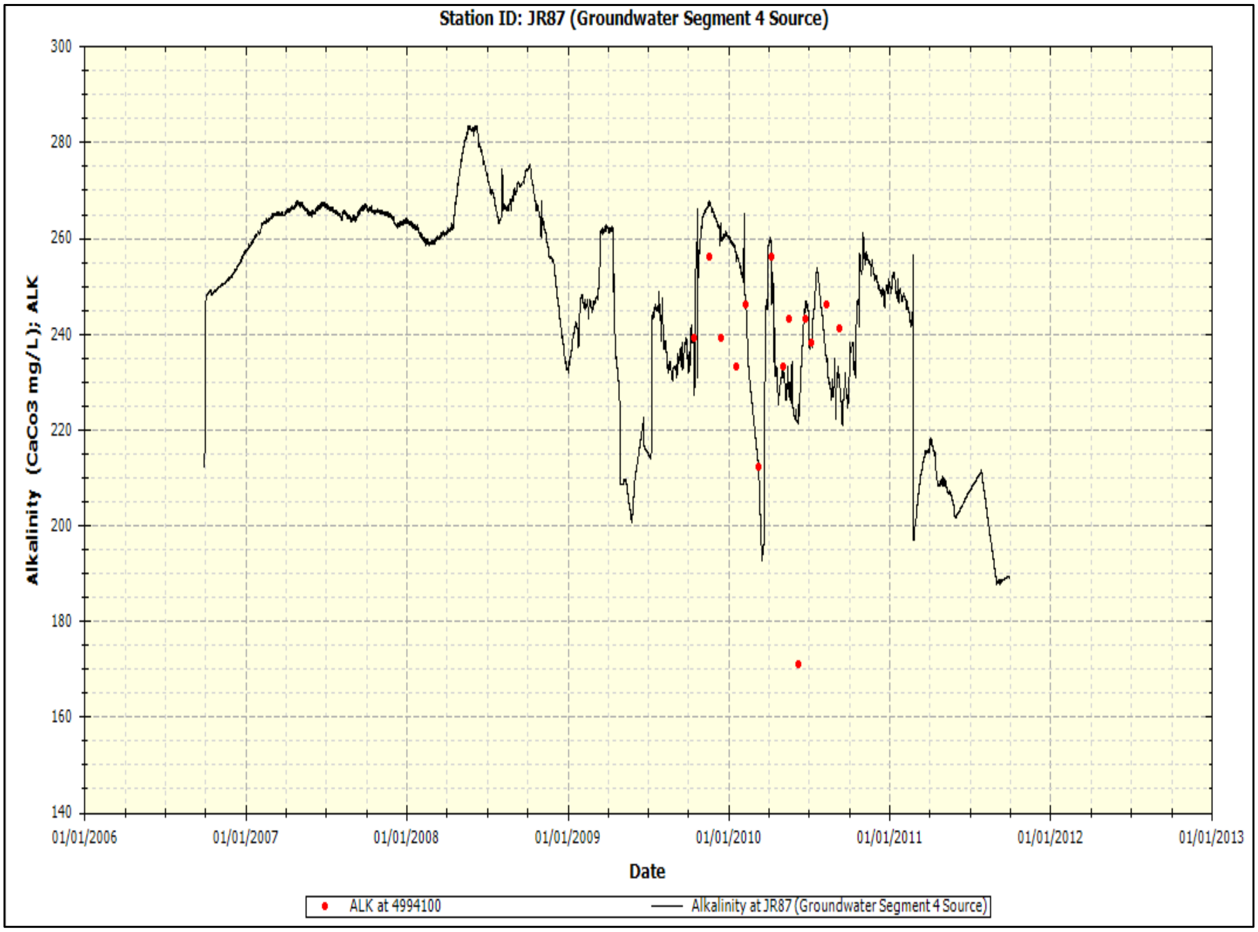



Station ID: JR44
Alkalinity (CaCo3 mg/L); ALK
320
300
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4994600
Alkalinity at JR44

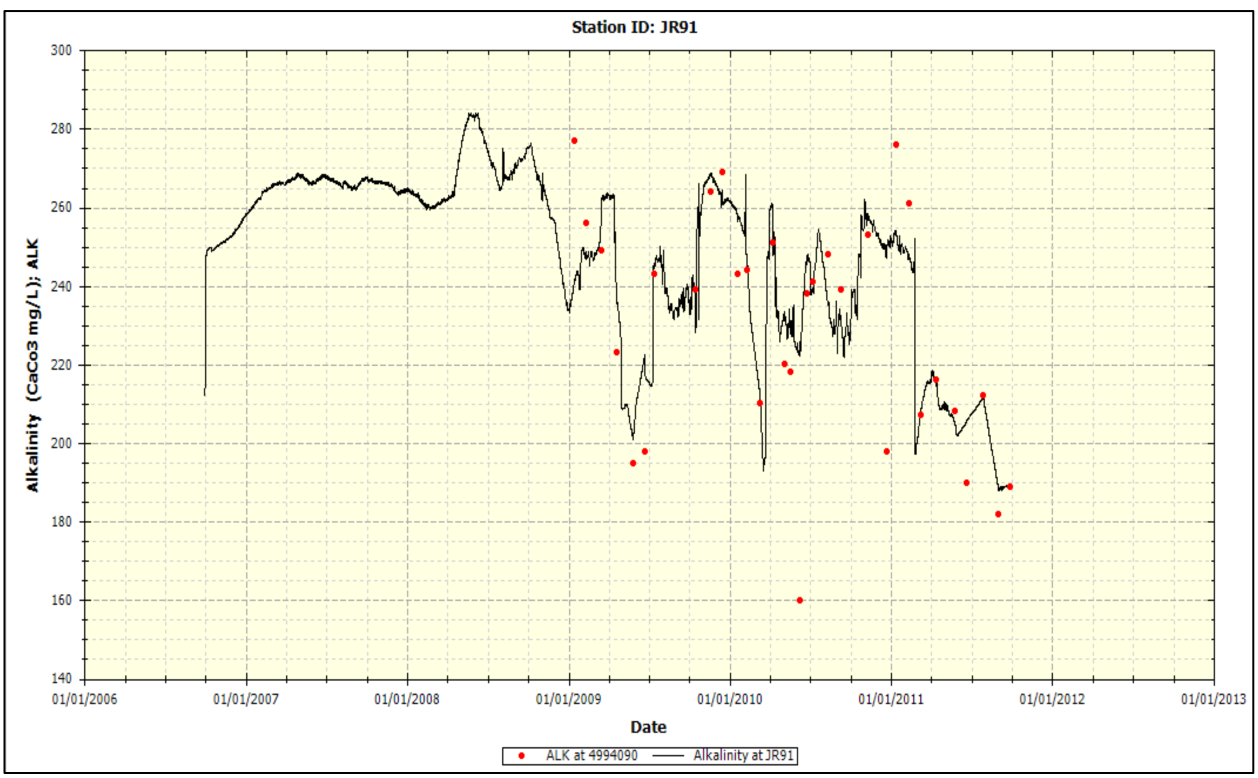

Station ID: JR49 (Rose Creek)
Alkalinity (CaCo3 mg/L); ALK
320
300
280
260
240
220
200
180
160
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4994520
Alkalinity at JR49 (Rose Creek)


Station ID: JR76 (9000 South Conduit)
Alkalinity (CaCo3 mg/L); ALK
350
300
250
200
150
100
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4994270
Alkalinity at JR76 (9000 South Conduit)

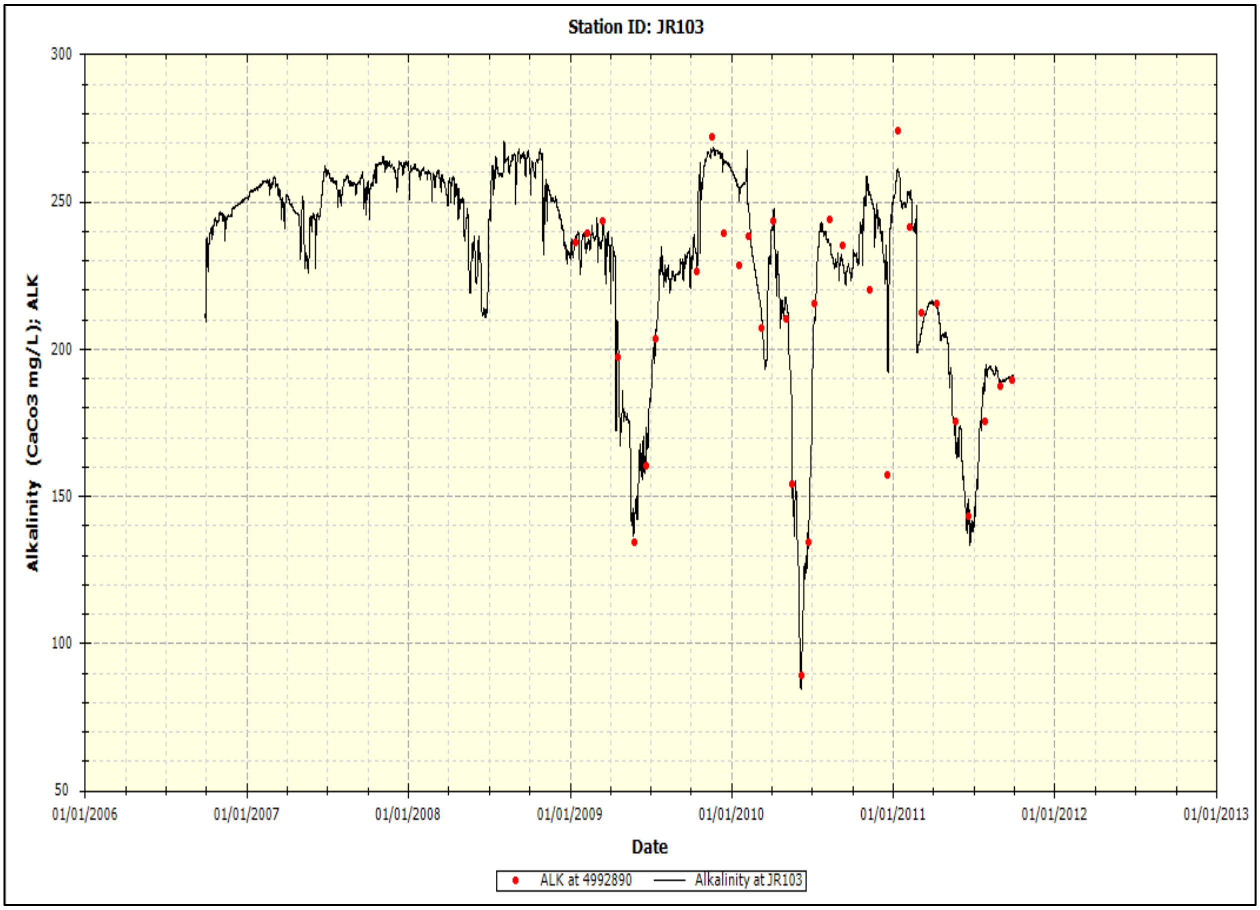

Station ID: JR82 (7800 South Drain)
Alkalinity (CaCo3 mg/L); ALK
350
300
250
200
150
100
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4994170
Alkalinity at JR82 (7800 South Drain)

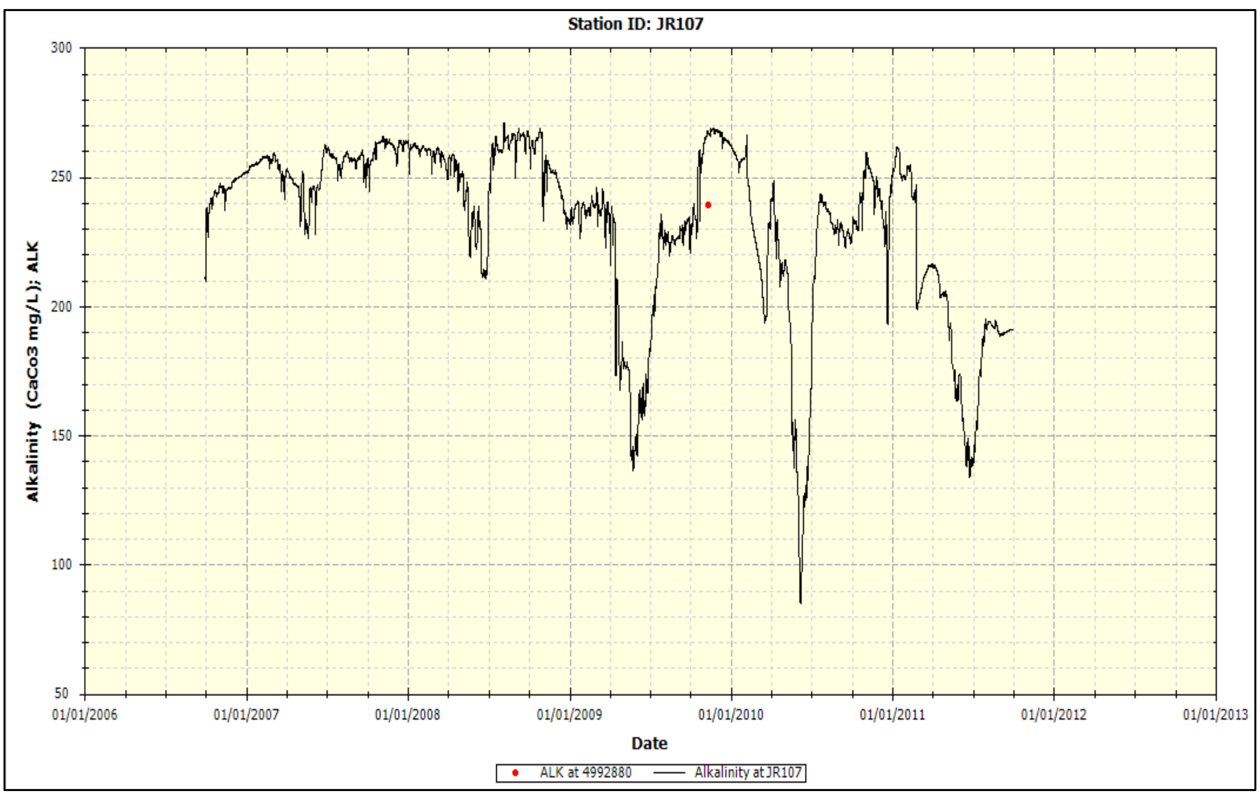


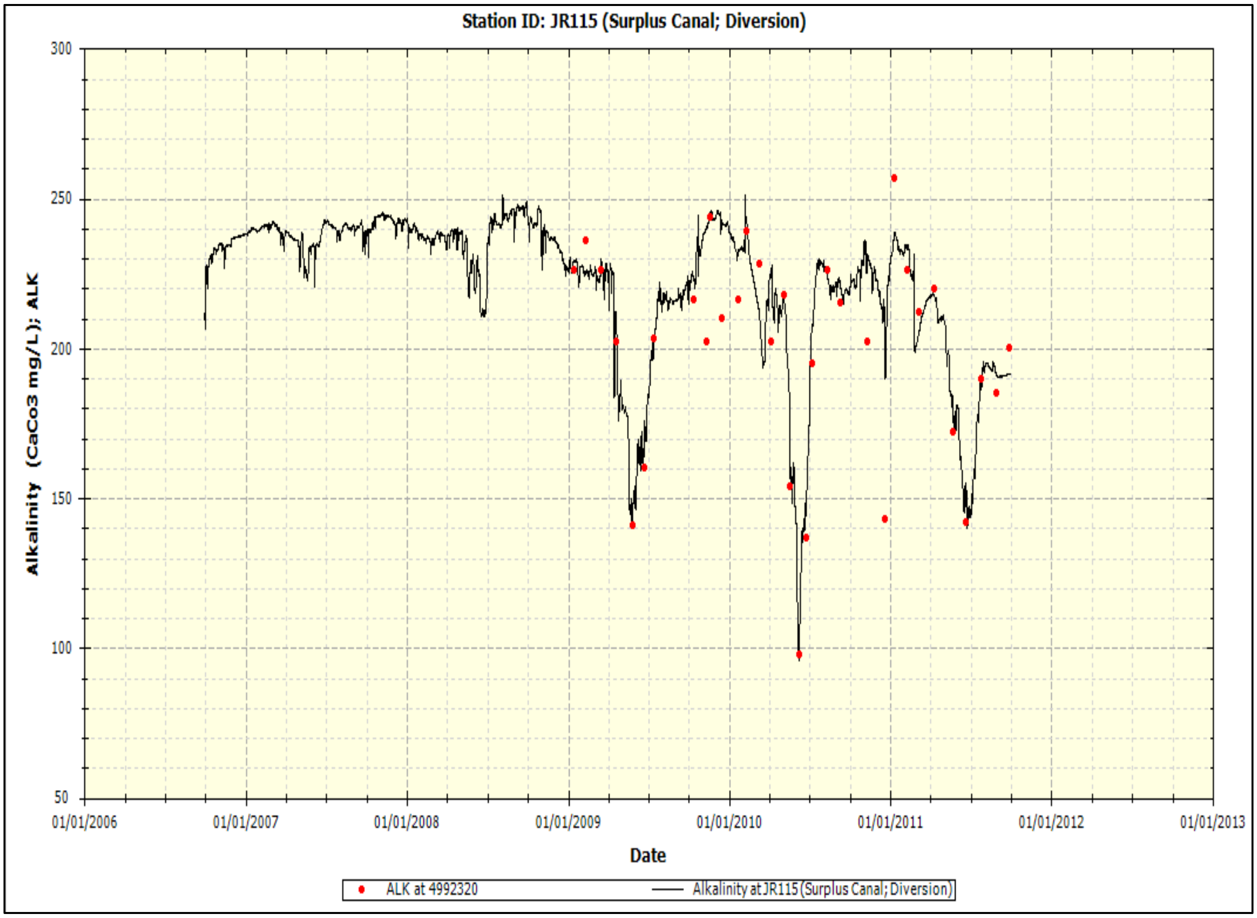
Station ID: JR87 (Groundwater Segment 4 Source)
Alkalinity (CaCo3 mg/L); ALK
300
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4994100
Alkalinity at JR87 (Groundwater Segment 4 Source)

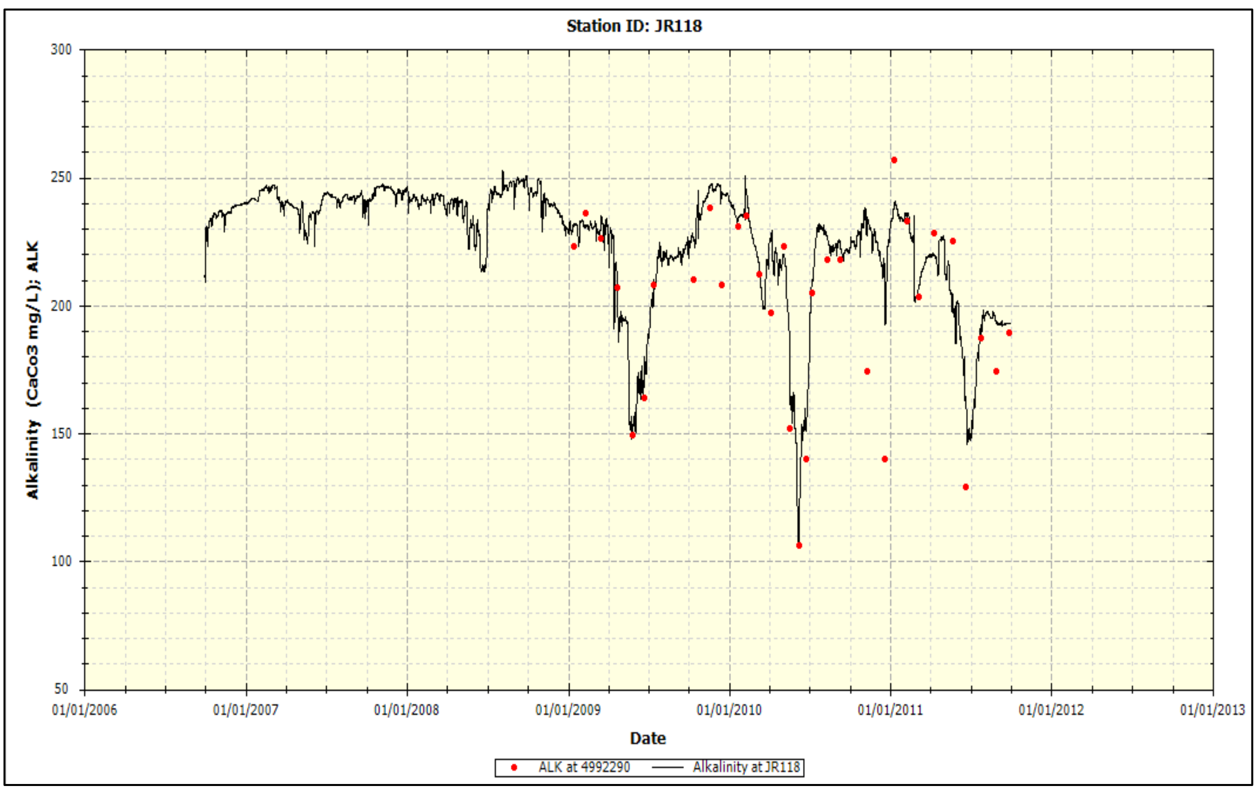


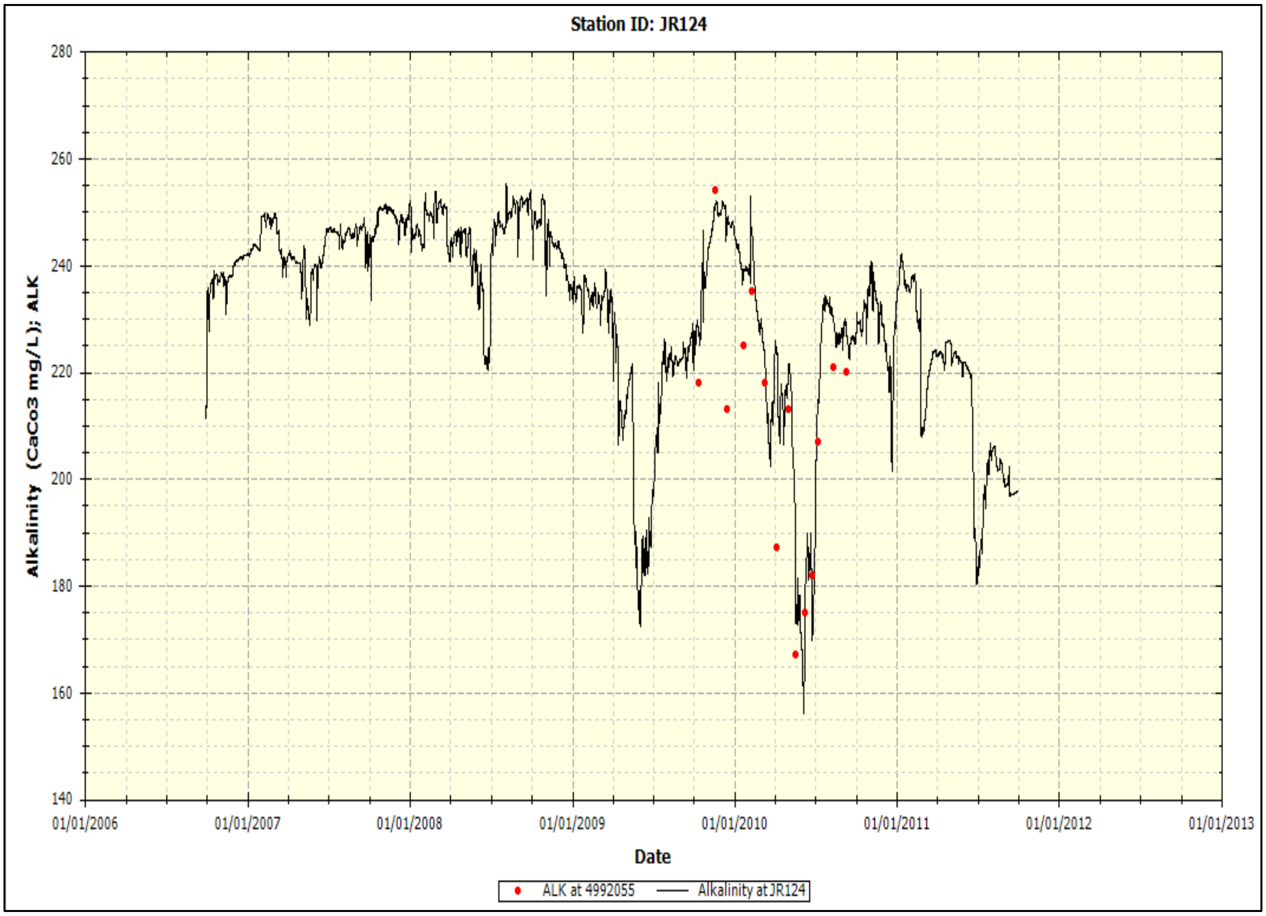
Station ID: JR91
Alkalinity (CaCo3 mg/L); ALK
300
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4994090
Alkalinity at JR91


Station ID: JR103
300
250
200
150
100
50
Alkalinity (CaCo3 mg/L); ALK
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4992890
Alkalinity at JR103

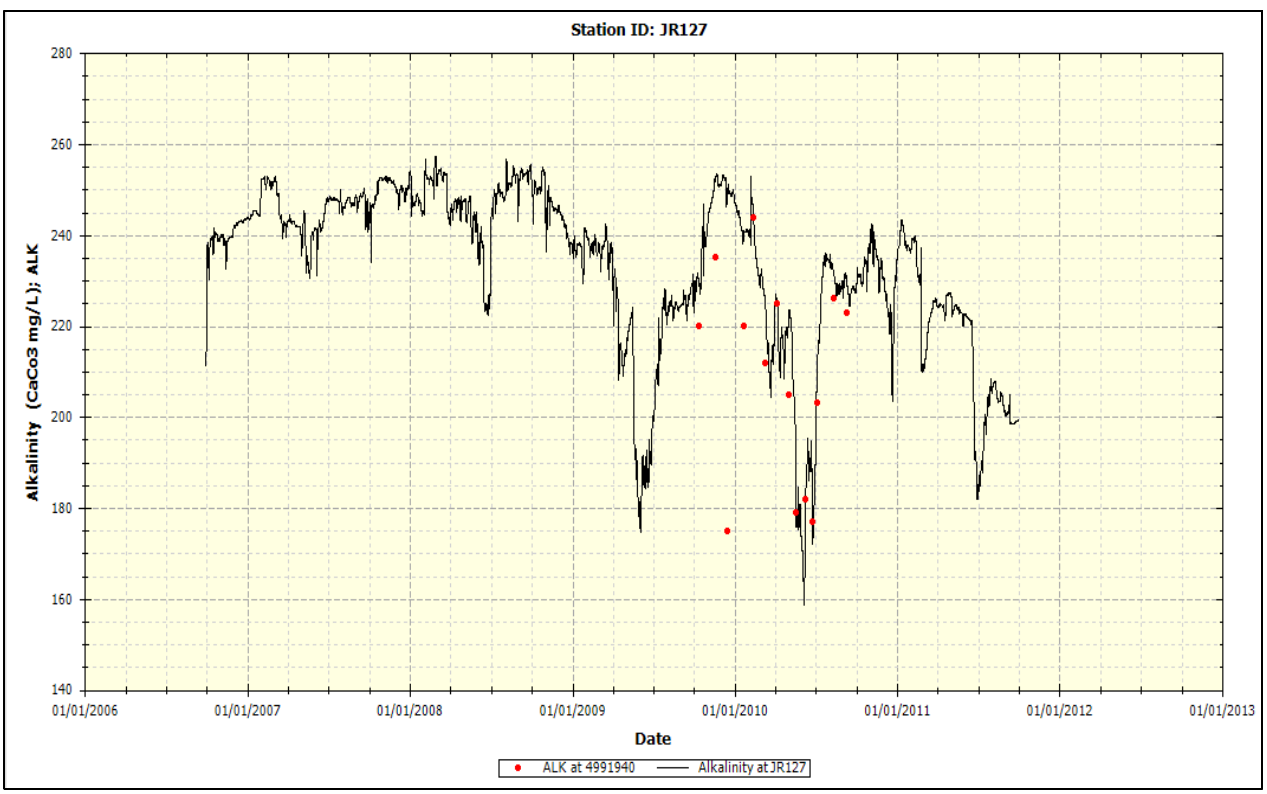

Station ID: JR107
300
250
200
150
100
50
Alkalinity (CaCo3 mg/L); ALK
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4992880
Alkalinity at JR107


Station ID: JR115 (Surplus Canal; Diversion)
Alkalinity (CaCo3 mg/L); ALK
300
250
200
150
100
50
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4992320
Alkalinity at JR115 (Surplus Canal; Diversion)

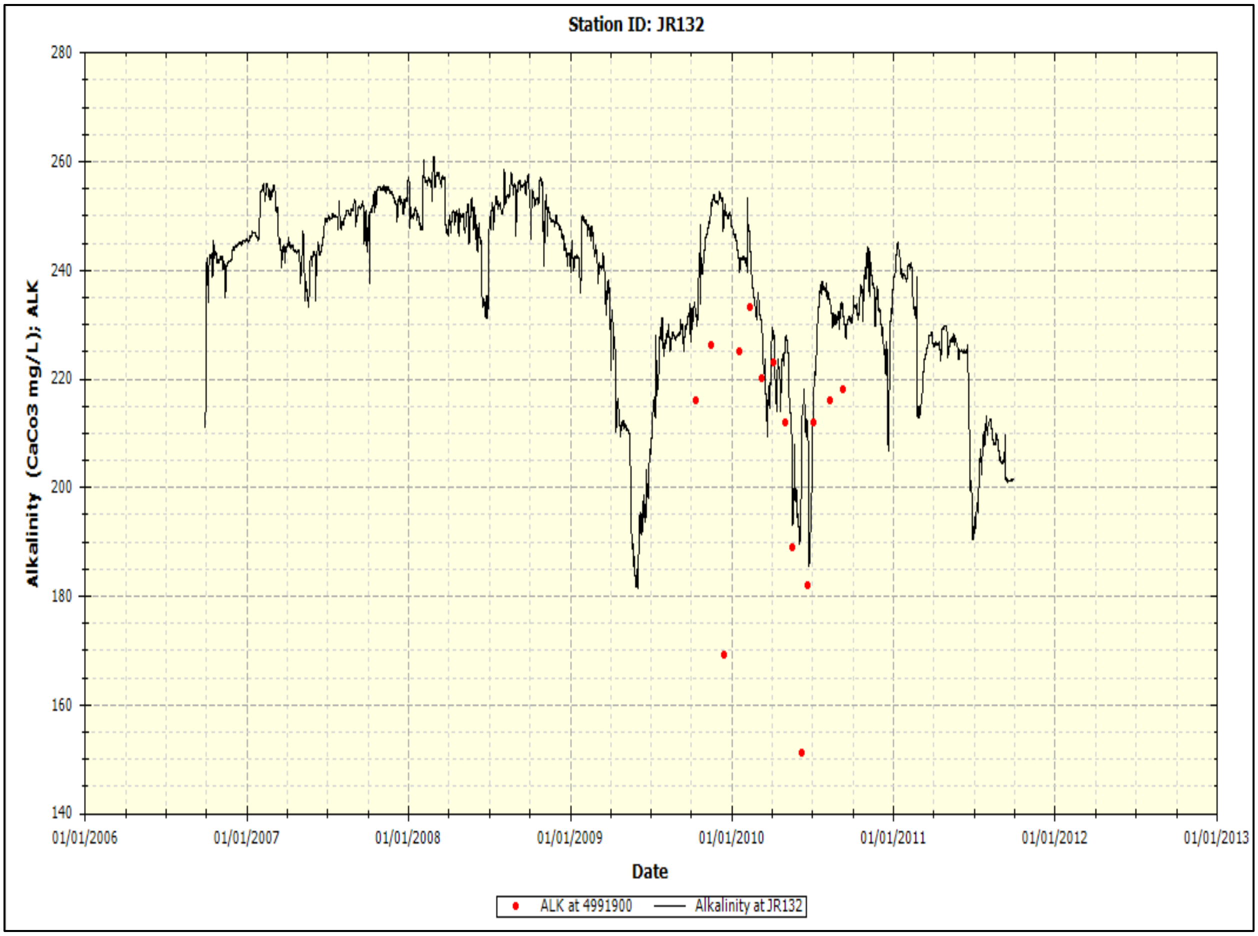

Station ID: JR118
Alkalinity (CaCo3 mg/L); ALK
300
250
200
150
100
50
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4992290
Alkalinity at JR118

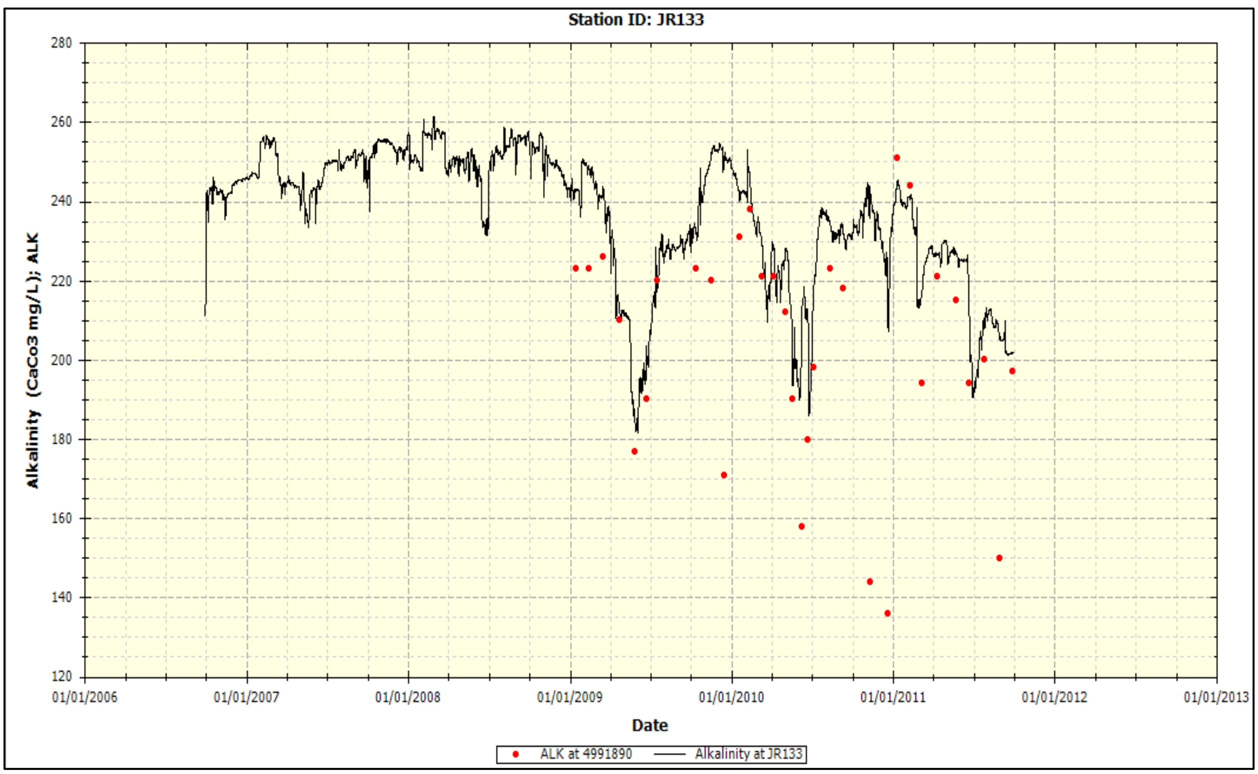


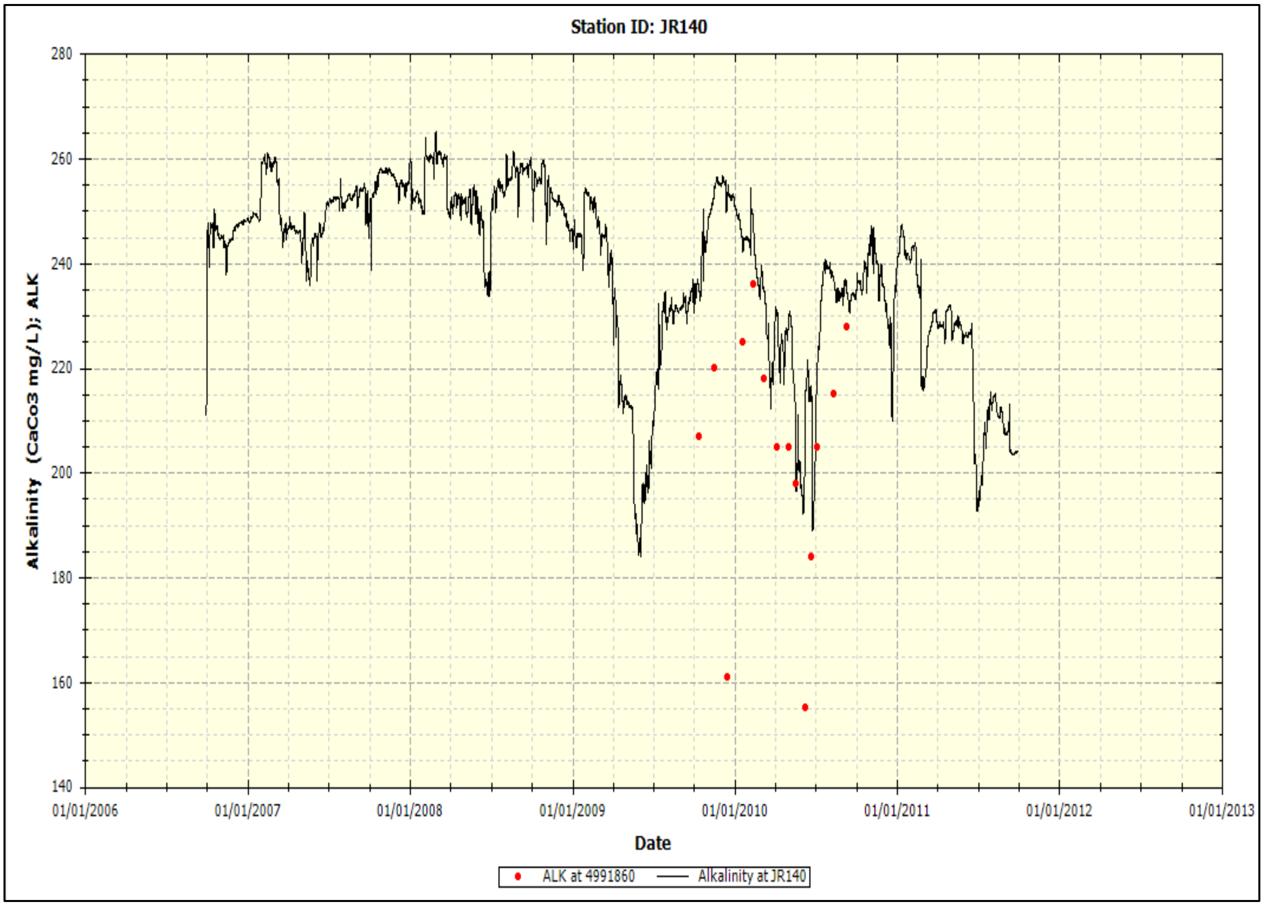
Station ID: JR124
Alkalinity (CaCo3 mg/L); ALK
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4992055
Alkalinity at JR124



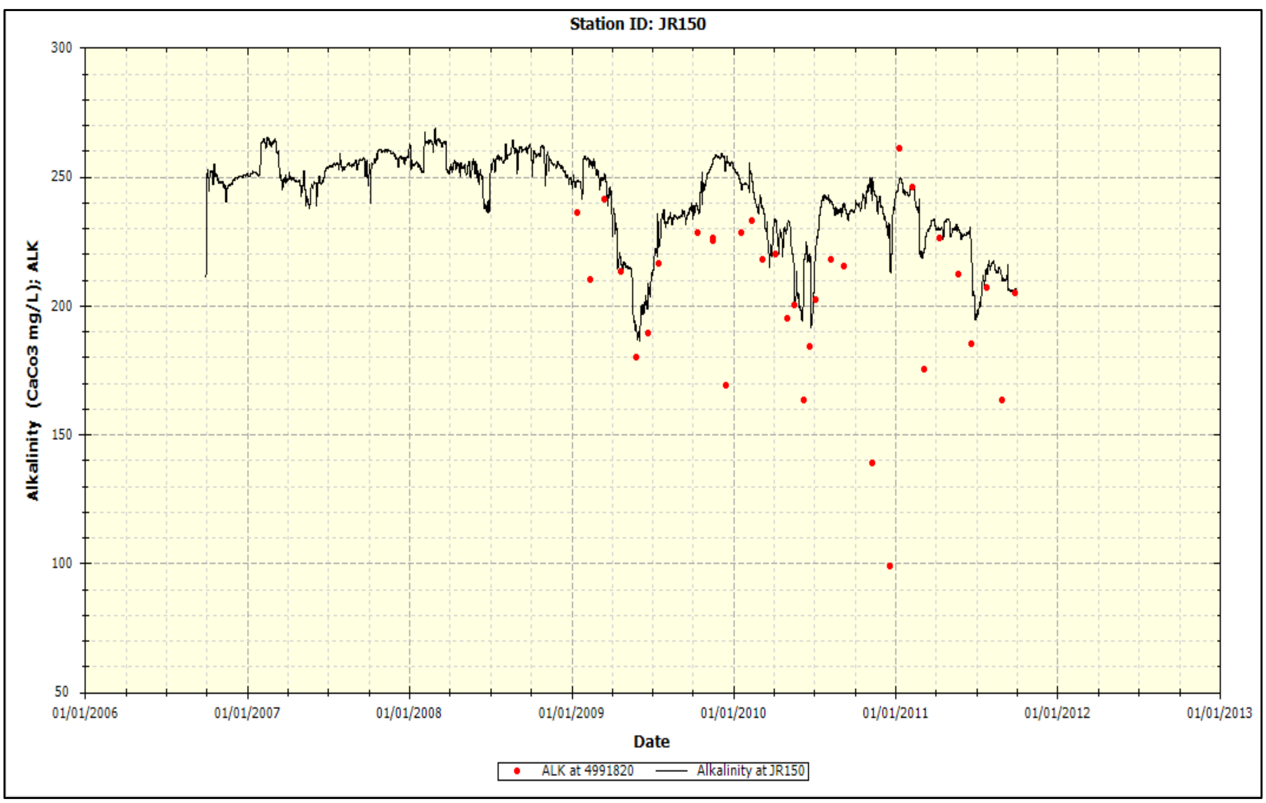
Station ID: JR127
Alkalinity (CaCo3 mg/L); ALK
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4991940
Alkalinity at JR127


Station ID: JR132
Alkalinity (CaCo3 mg/L); ALK
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4991900
Alkalinity at JR132

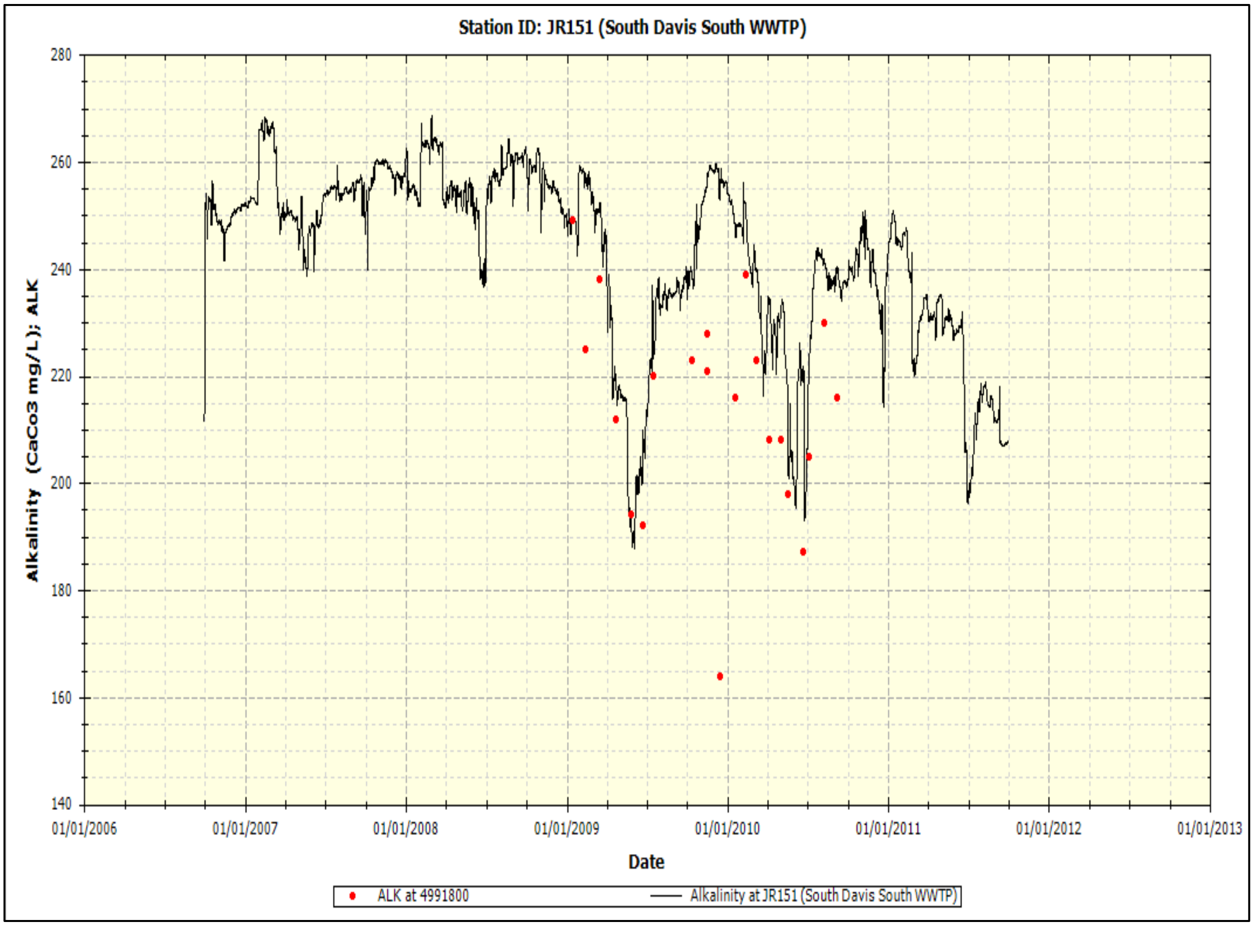

Station ID: JR133
Alkalinity (CaCo3 mg/L); ALK
280
260
240
220
200
180
160
140
120
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4991890
Alkalinity at JR133

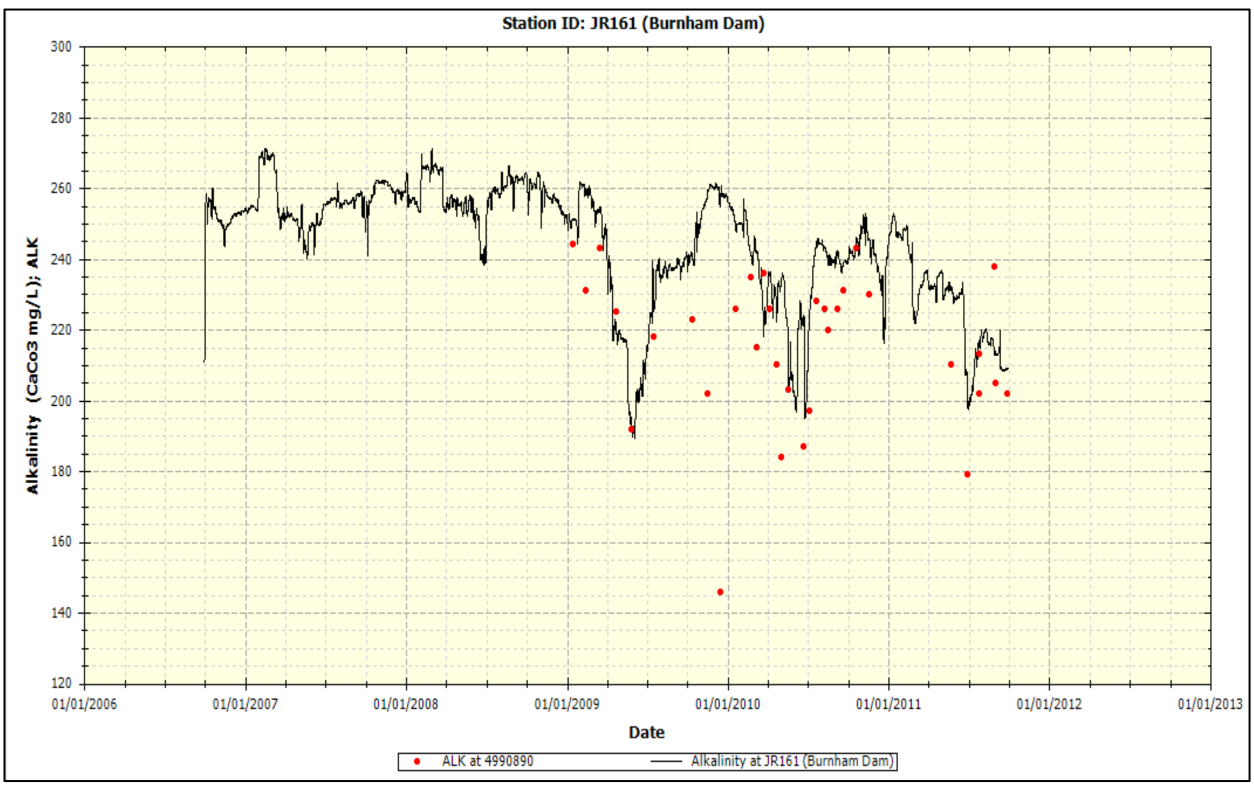


Station ID: JR140
Alkalinity (CaCo3 mg/L); ALK
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4991860
Alkalinity at JR140

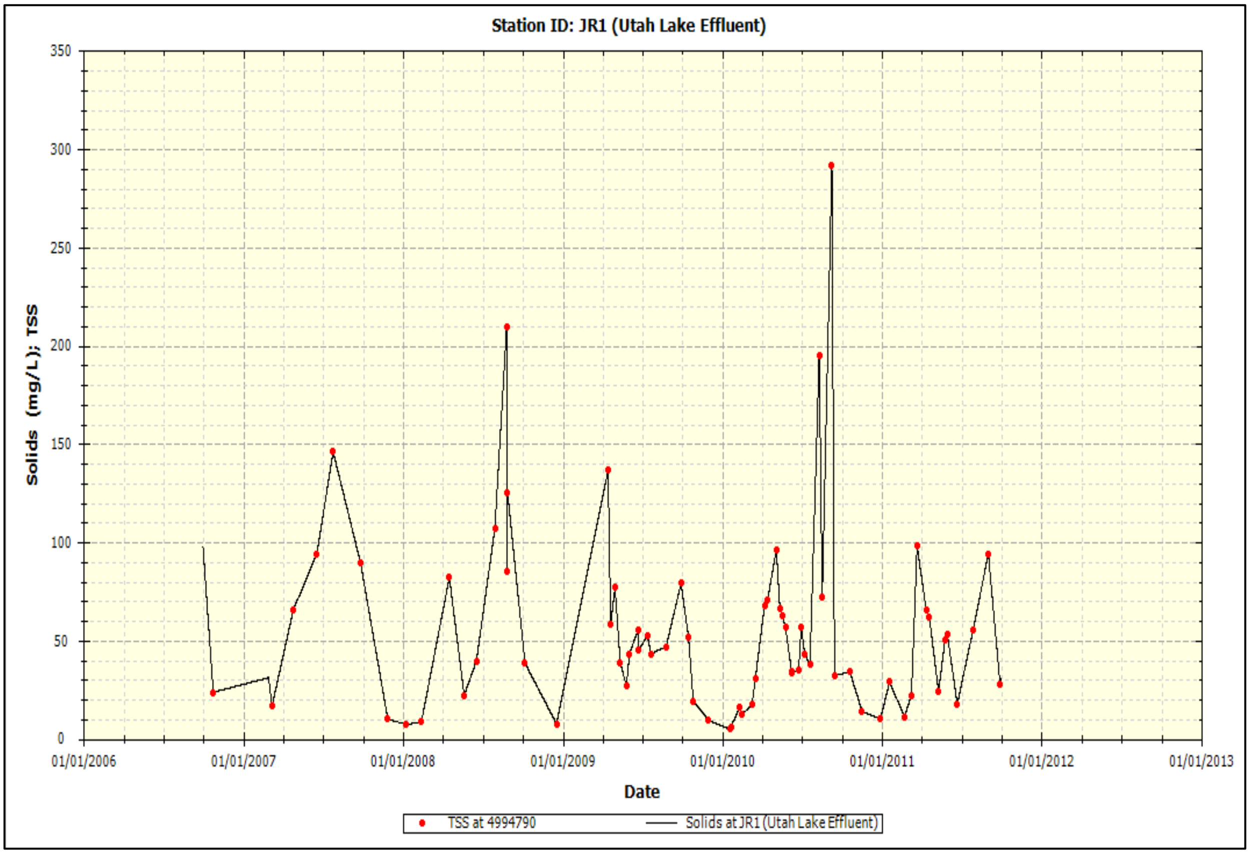


Station ID: JR150
Alkalinity (CaCo3 mg/L); ALK
300
250
200
150
100
50
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4991820
Alkalinity at JR150

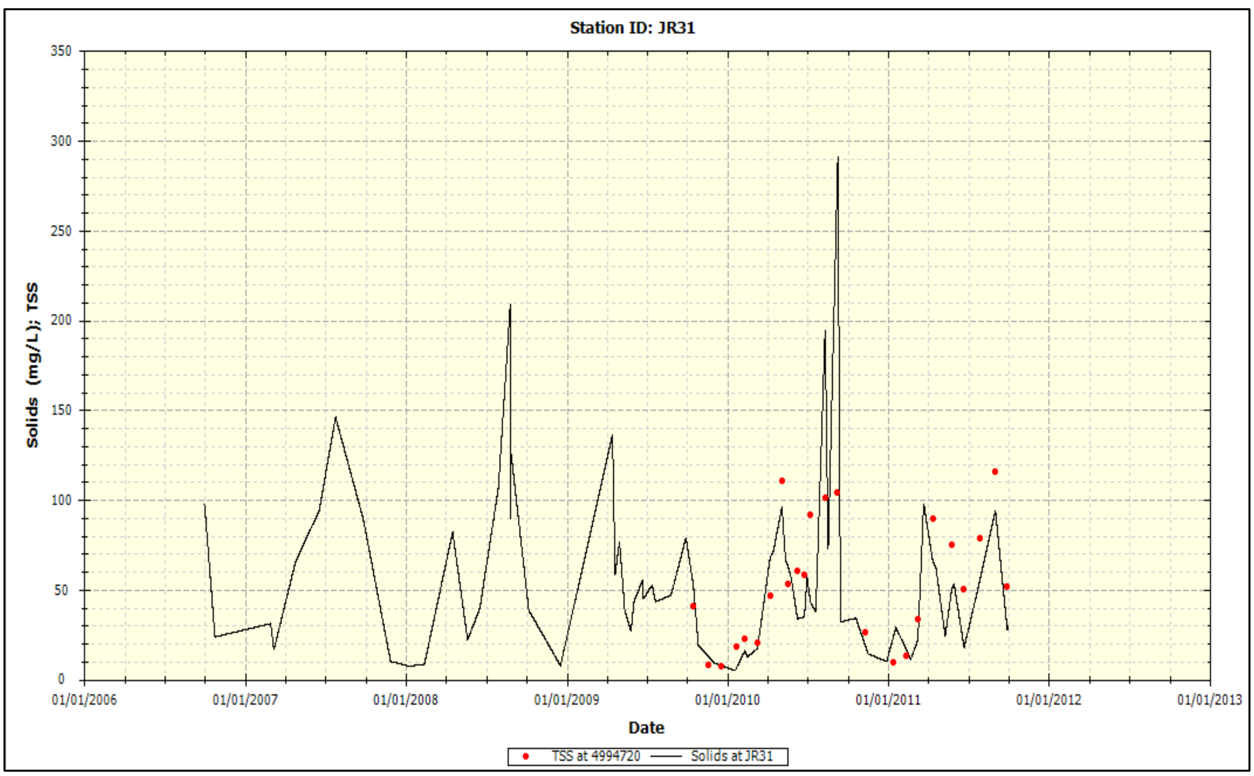

Station ID: JR151 (South Davis South WWTP)
Alkalinity (CaCo3 mg/L); ALK
280
260
240
220
200
180
160
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4991800
Alkalinity at JR151 (South Davis South WWTP)


Station ID: JR161 (Burnham Dam)
Alkalinity (CaCo3 mg/L); ALK
300
280
260
240
220
200
180
160
140
120
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
ALK at 4990890
Alkalinity at JR161 (Burnham Dam)

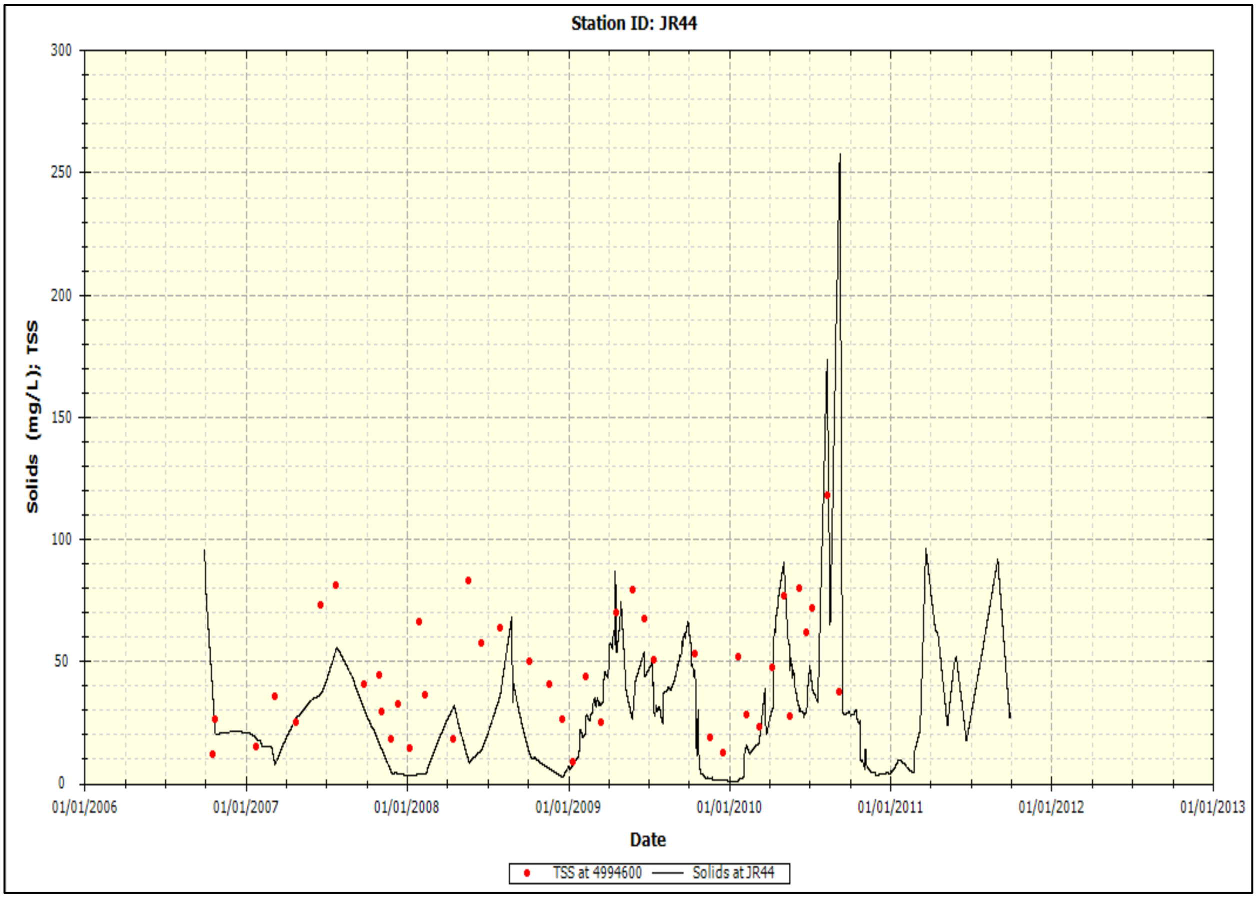
B.1.4: TSS

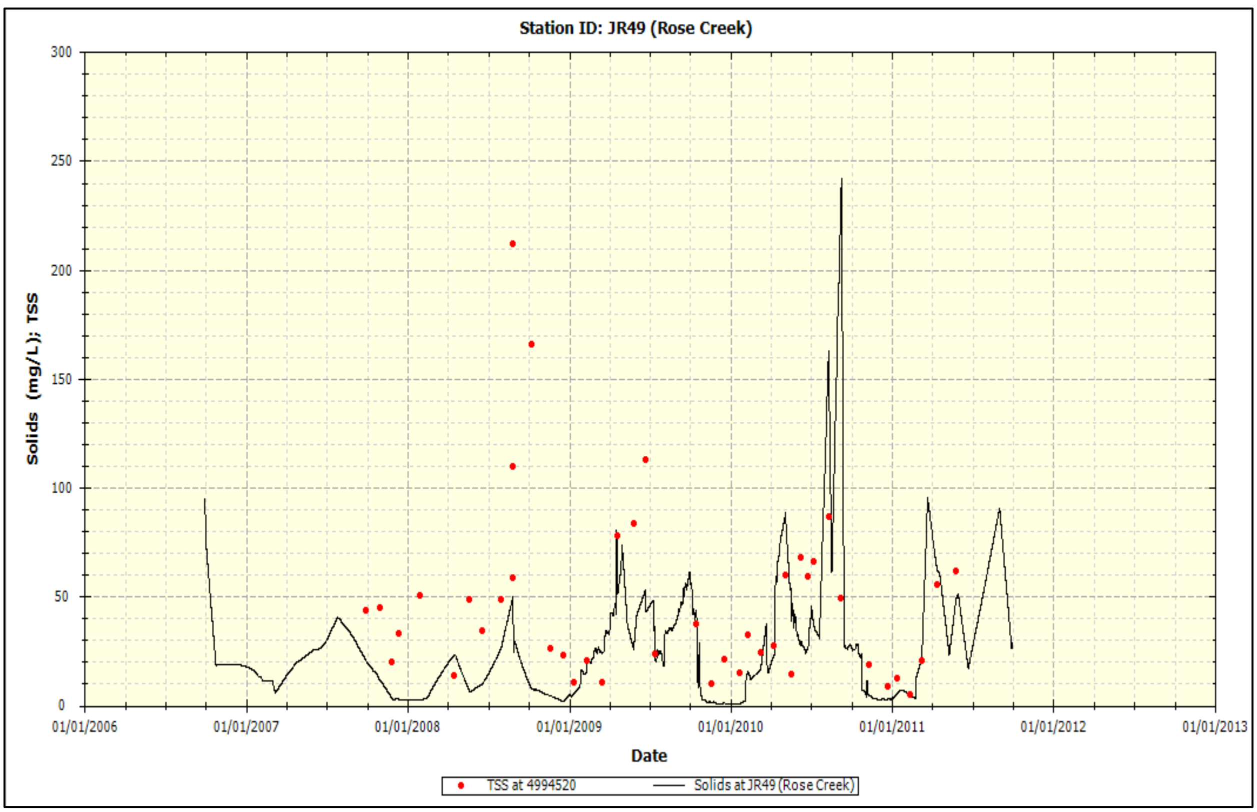


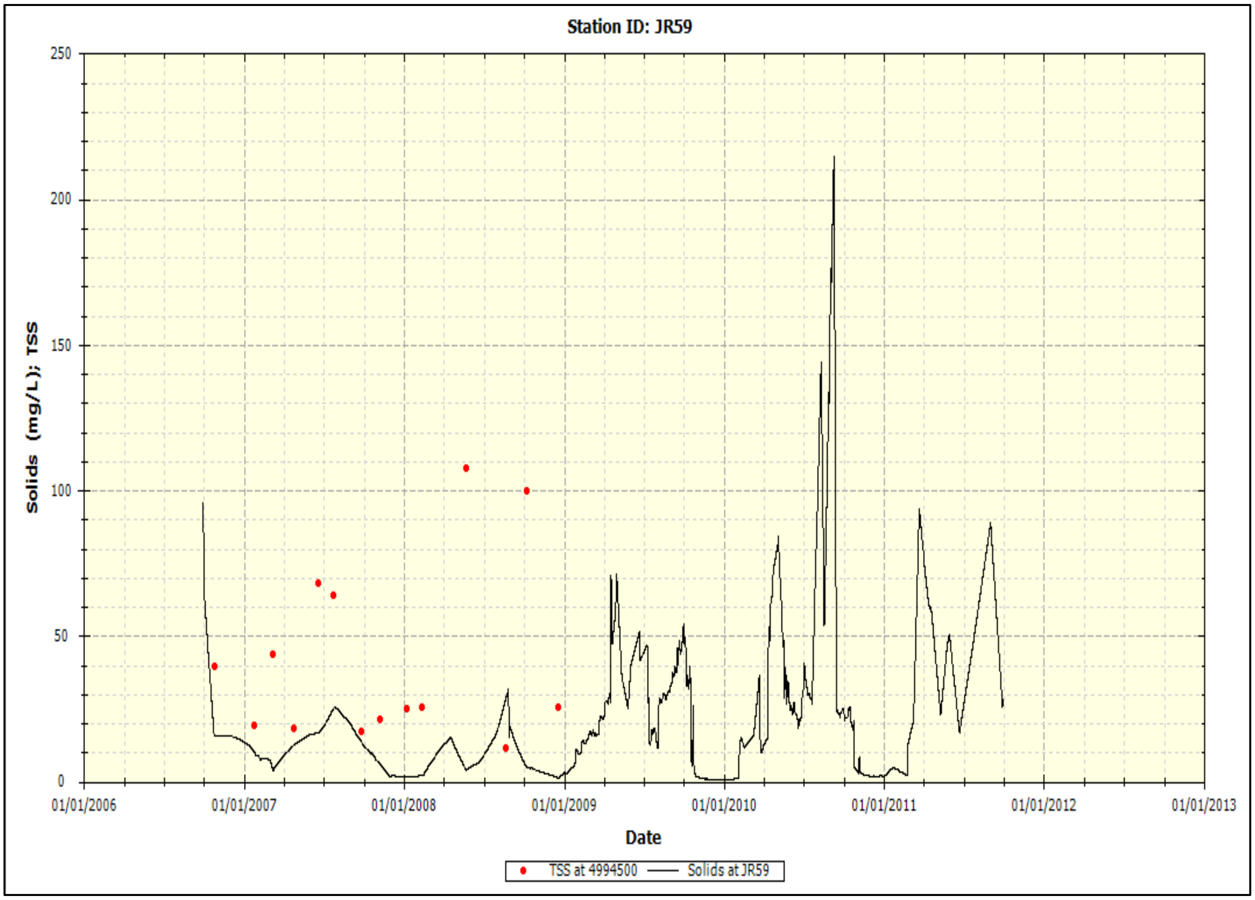
Station ID: JR1 (Utah Lake Effluent)
350
300
250
200
150
100
50
0
Solids (mg/L); TSS
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994790
Solids at JR1 (Utah Lake Effluent)

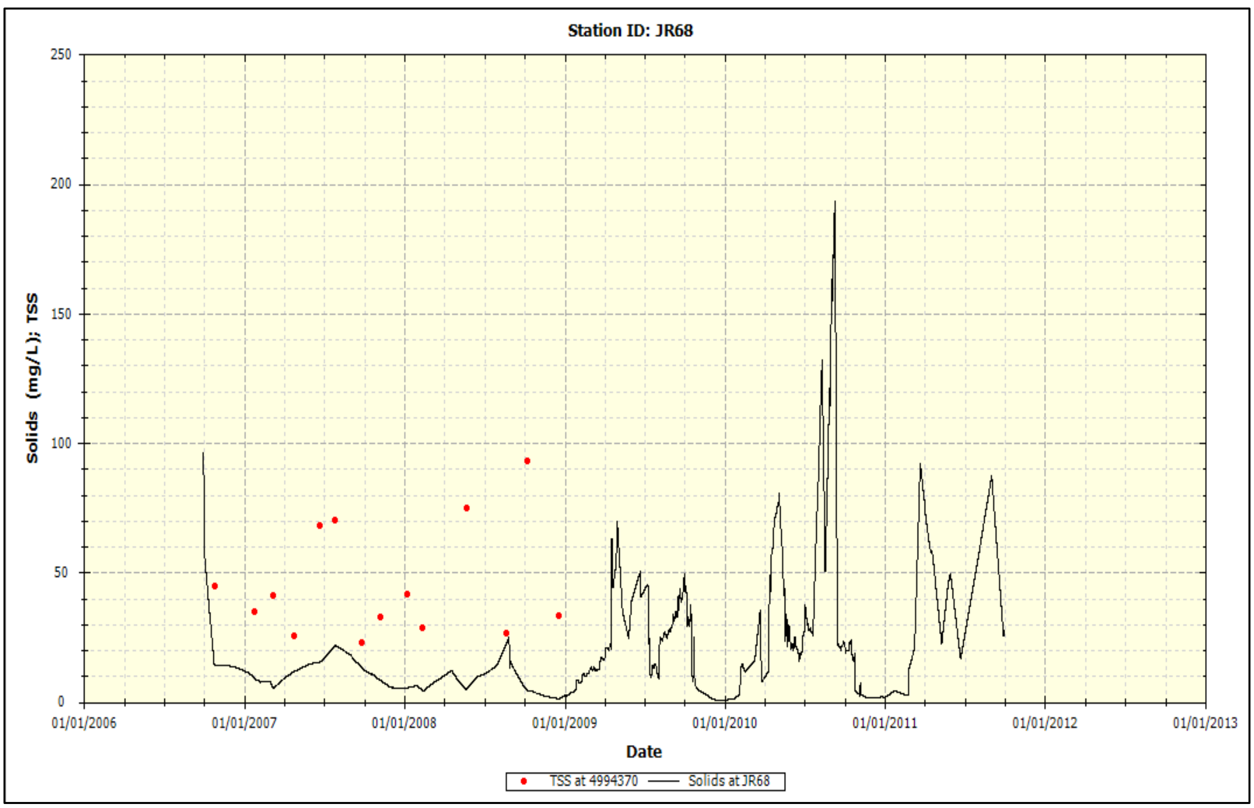


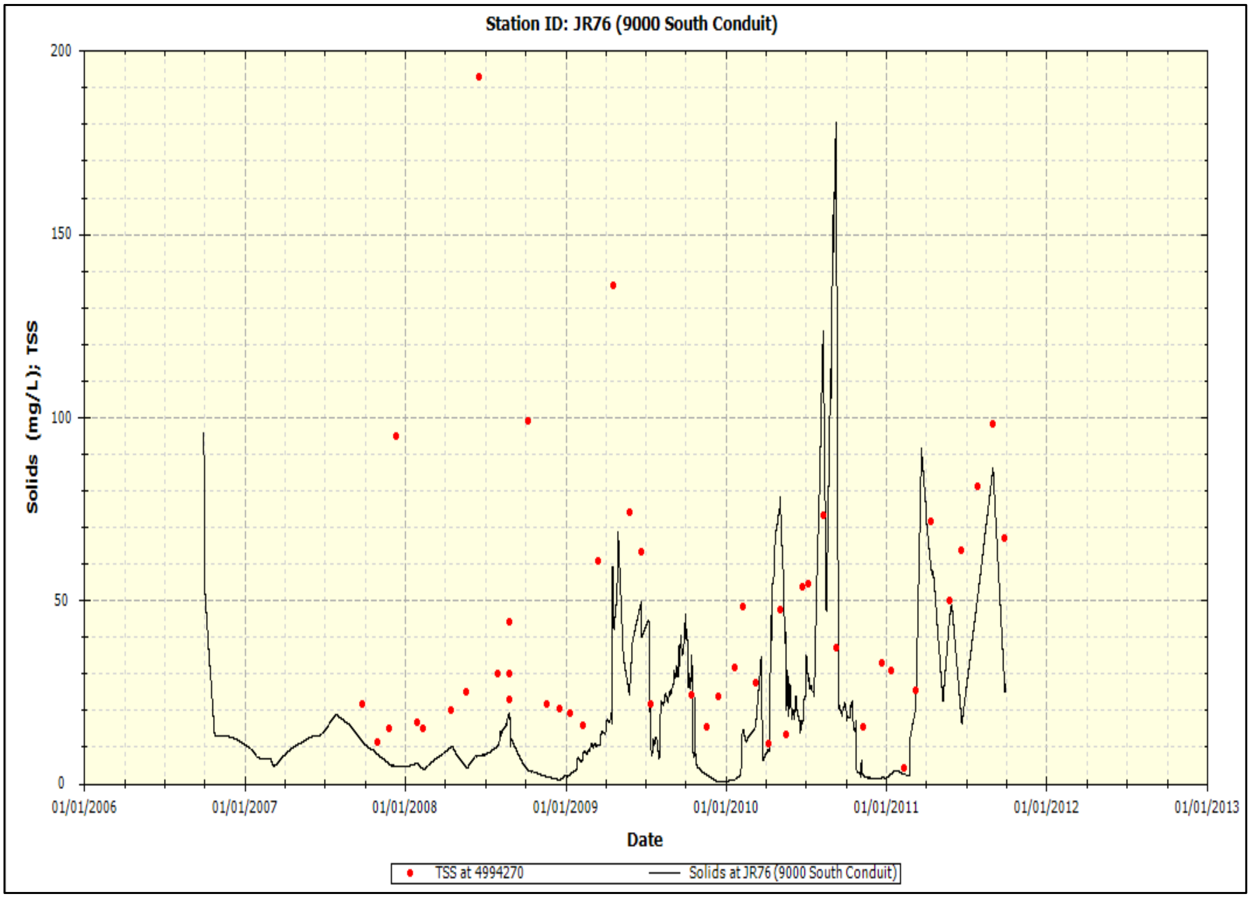
Station ID: JR31
350
300
250
200
150
100
50
0
Solids (mg/L); TSS
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994720
Solids at JR31

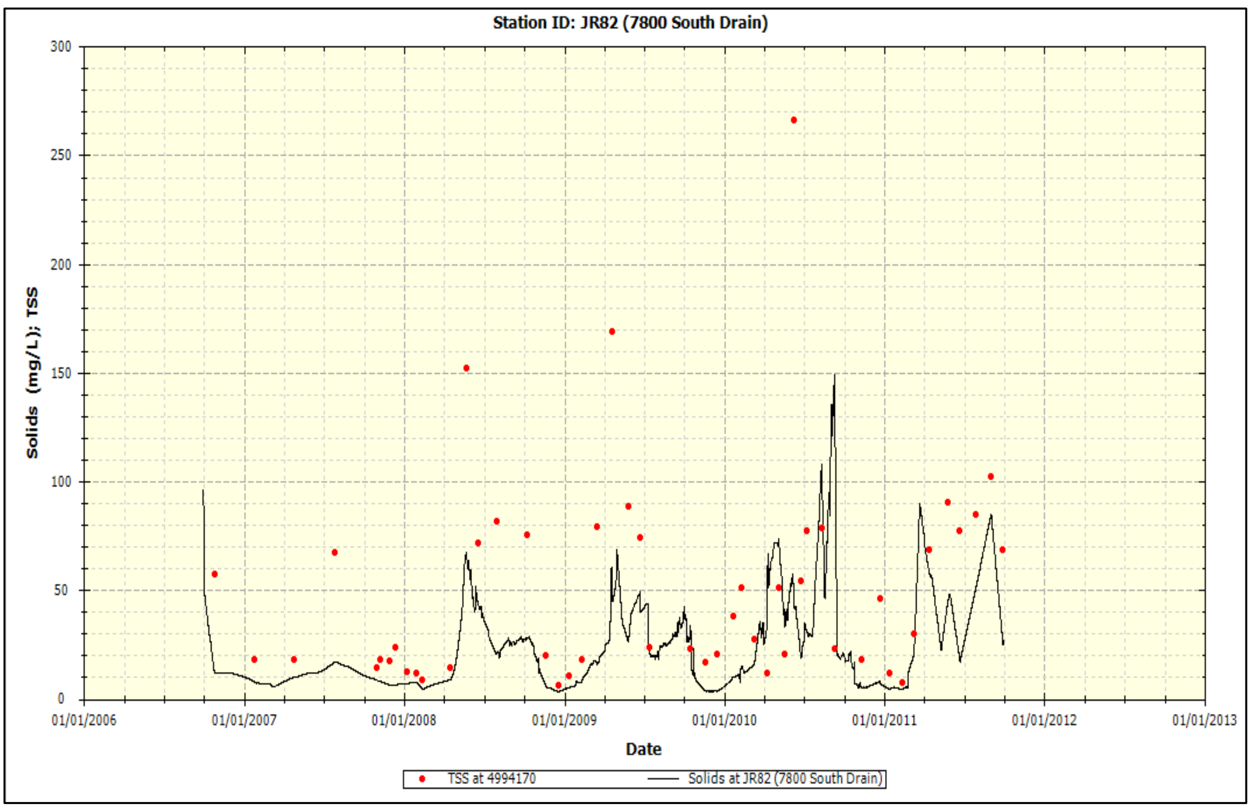

Station ID: JR44
Solids (mg/L); TSS
300
250
200
150
100
50
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994600
Solids at JR44

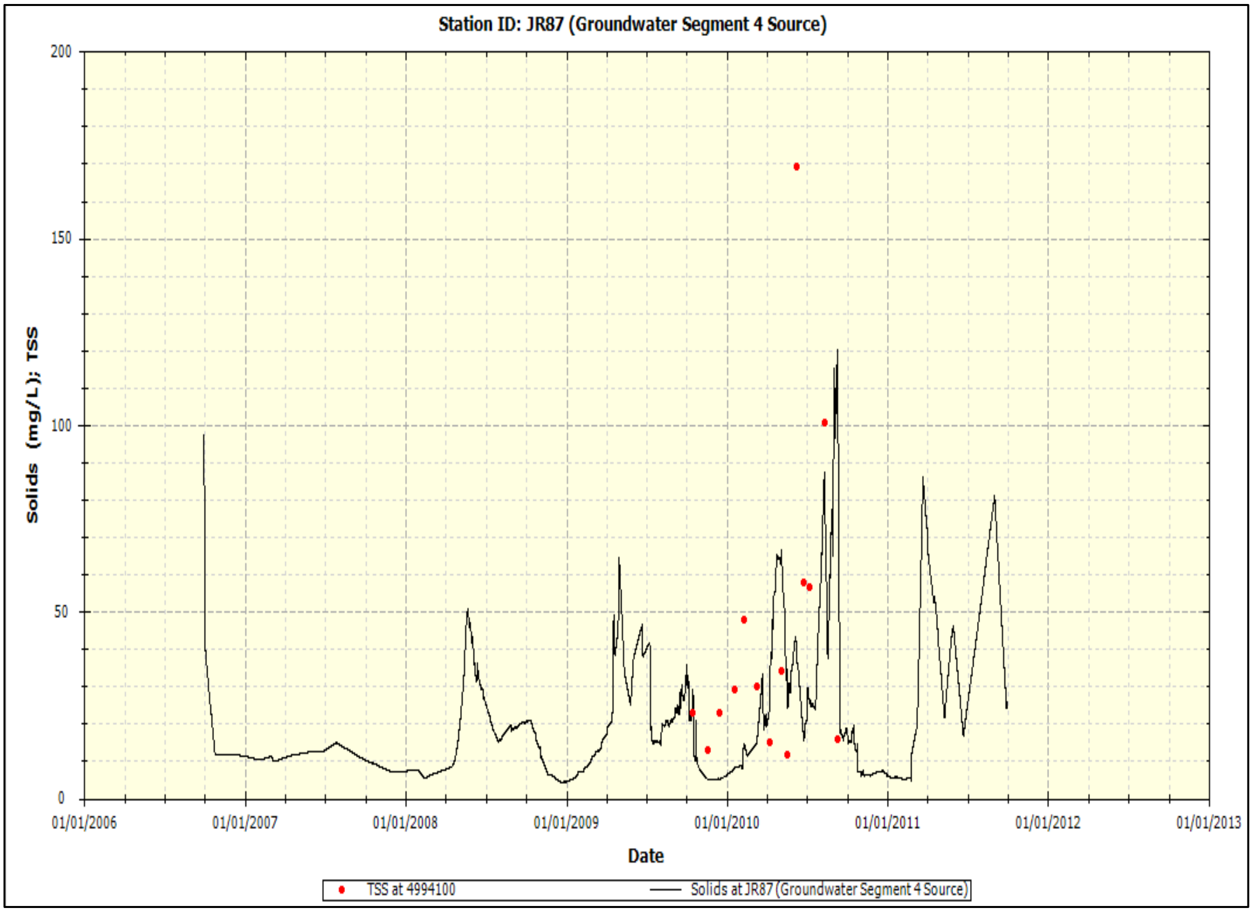

Station ID: JR49 (Rose Creek)
Solids (mg/L); TSS
300
250
200
150
100
50
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994520
Solids at JR49 (Rose Creek)


Station ID: JR59
Solids (mg/L); TSS
250
200
150
100
50
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994500
Solids at JR59

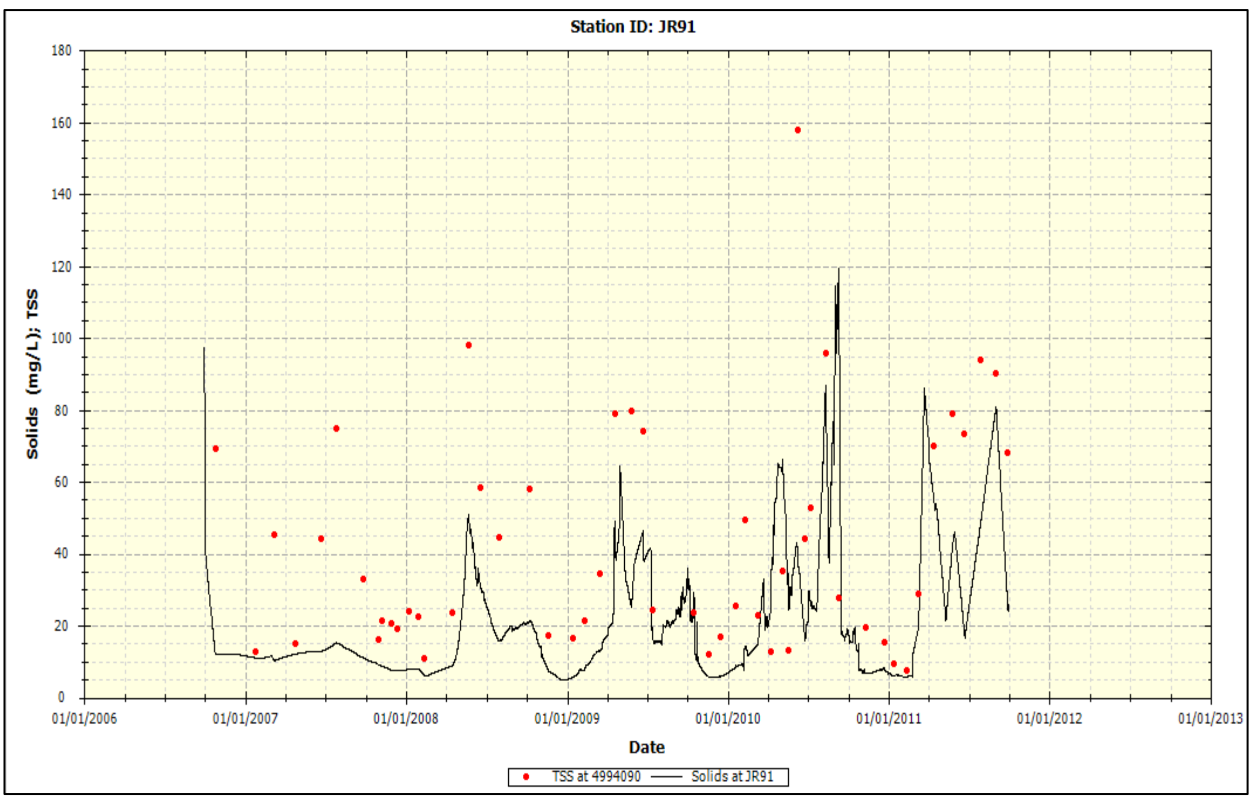

Station ID: JR68
Solids (mg/L); TSS
250
200
150
100
50
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994370
Solids at JR68


Station ID: JR76 (9000 South Conduit)
Solids (mg/L); TSS
0
50
100
150
200
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994270
Solids at JR76 (9000 South Conduit)

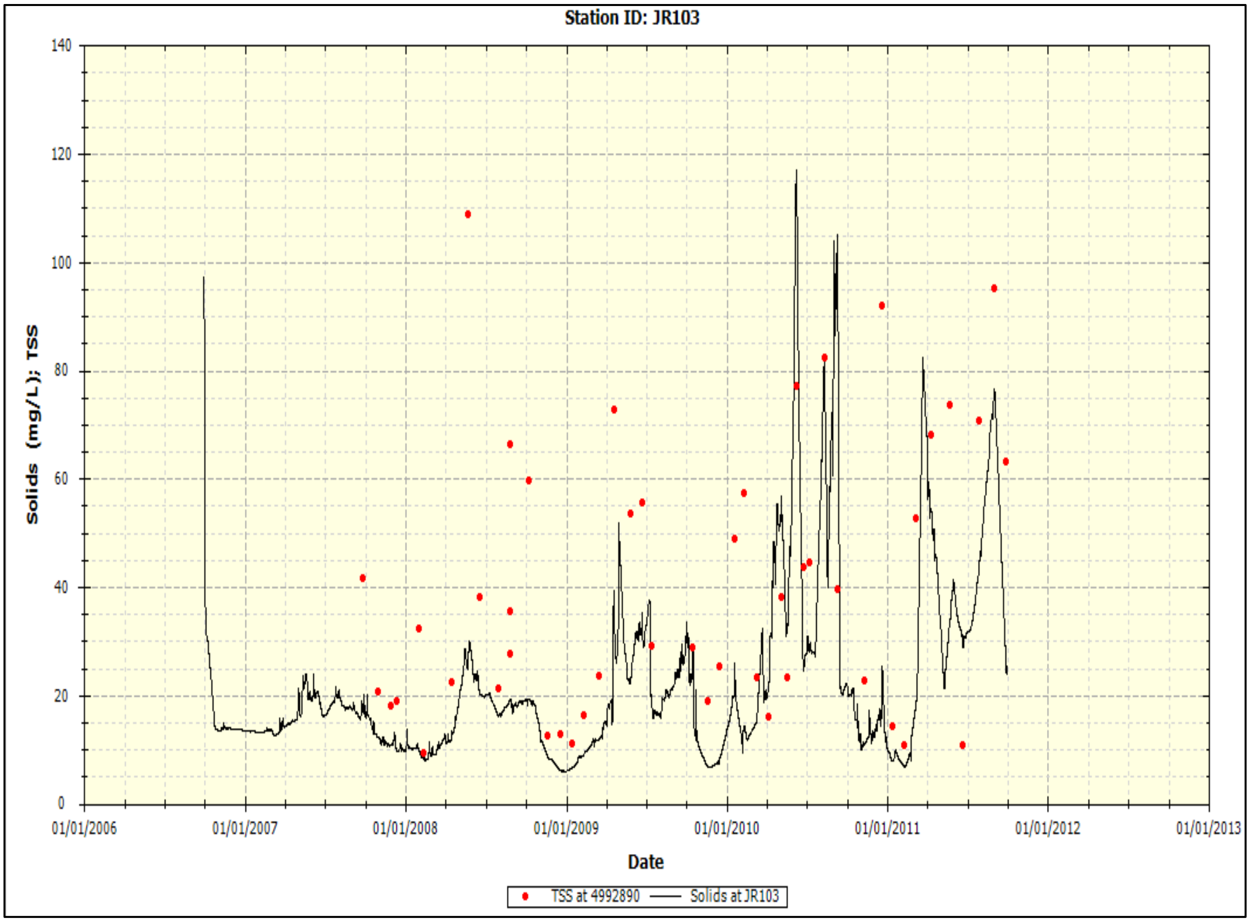

Station ID: JR82 (7800 South Drain)
Solids (mg/L); TSS
0
50
100
150
200
250
300
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994170
Solids at JR82 (7800 South Drain)



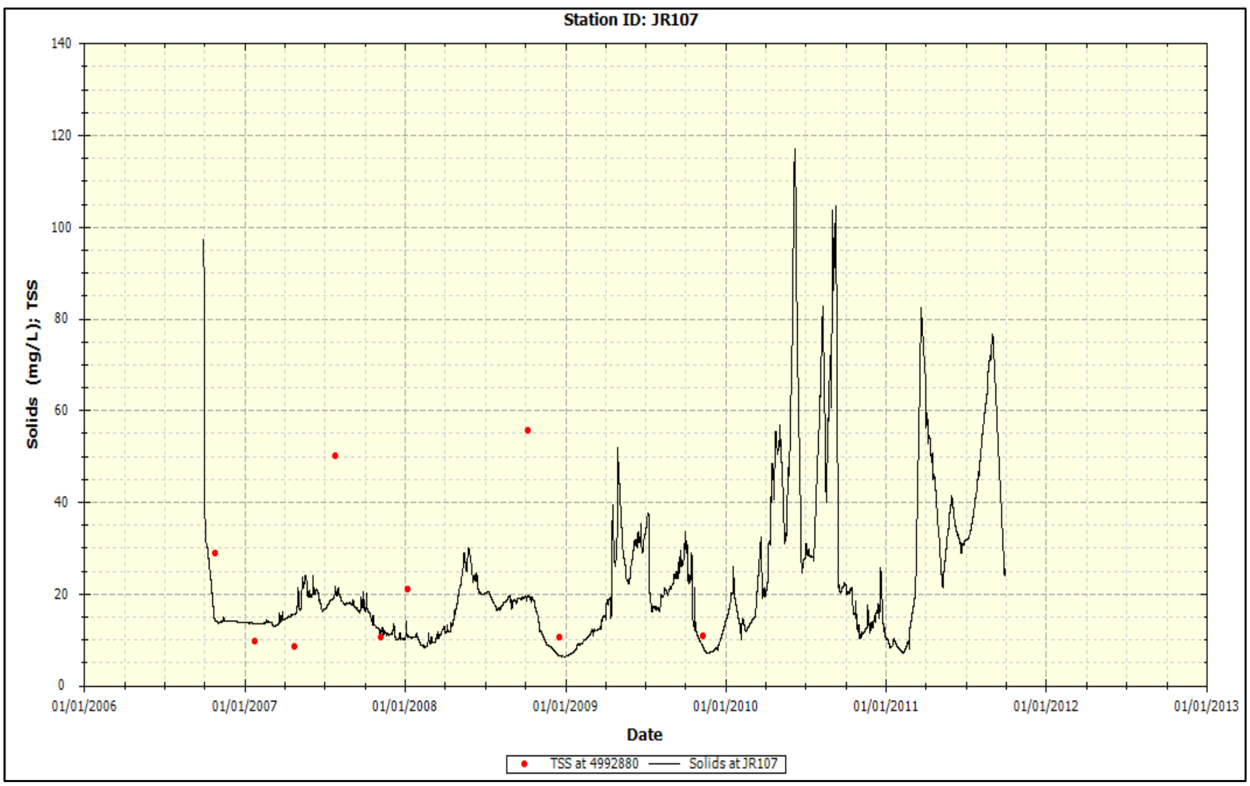
Station ID: JR87 (Groundwater Segment 4 Source)
Solids (mg/L); TSS
200
150
100
50
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994100
Solids at JR87 (Groundwater Segment 4 Source)



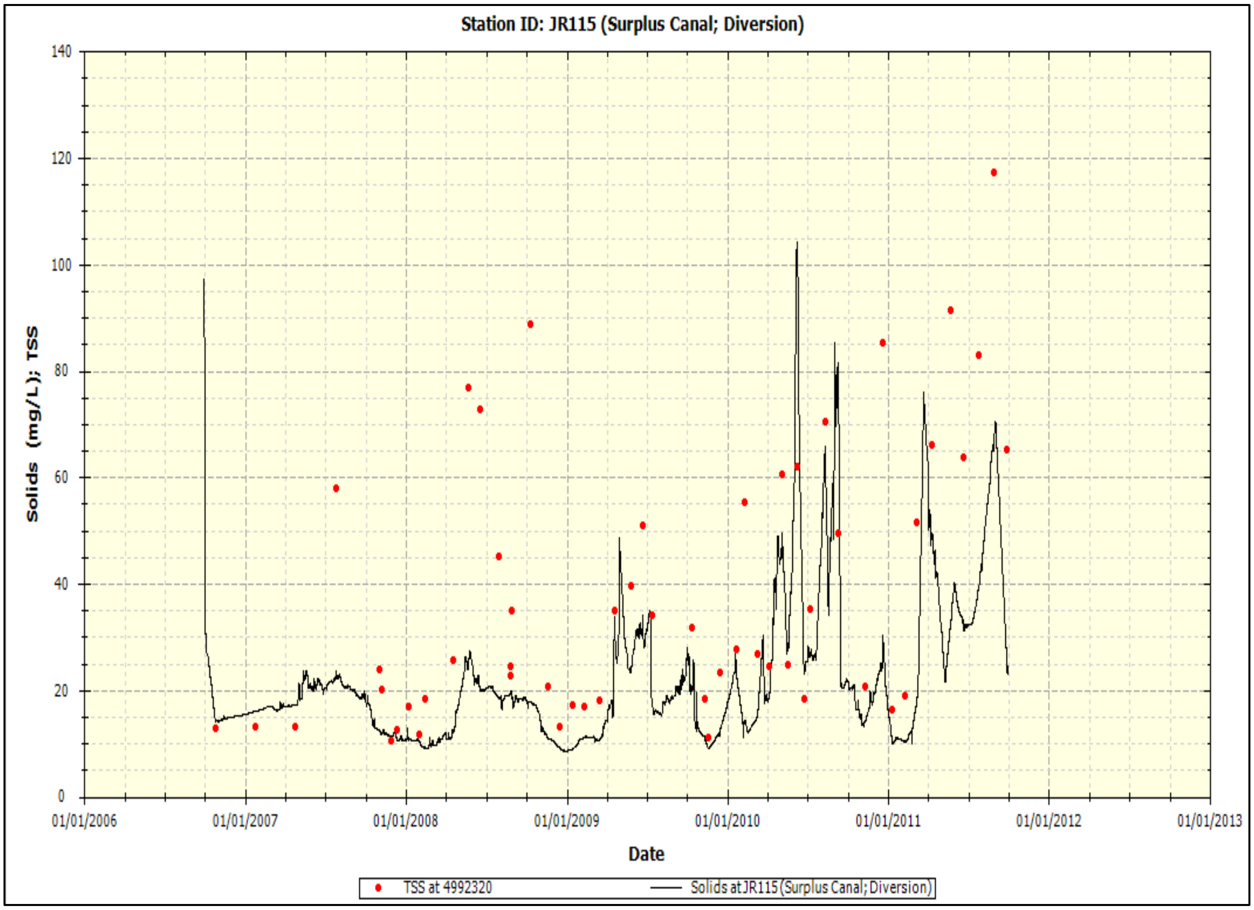
Station ID: JR91
Solids (mg/L); TSS
180
160
140
120
100
80
60
40
20
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4994090
Solids at JR91

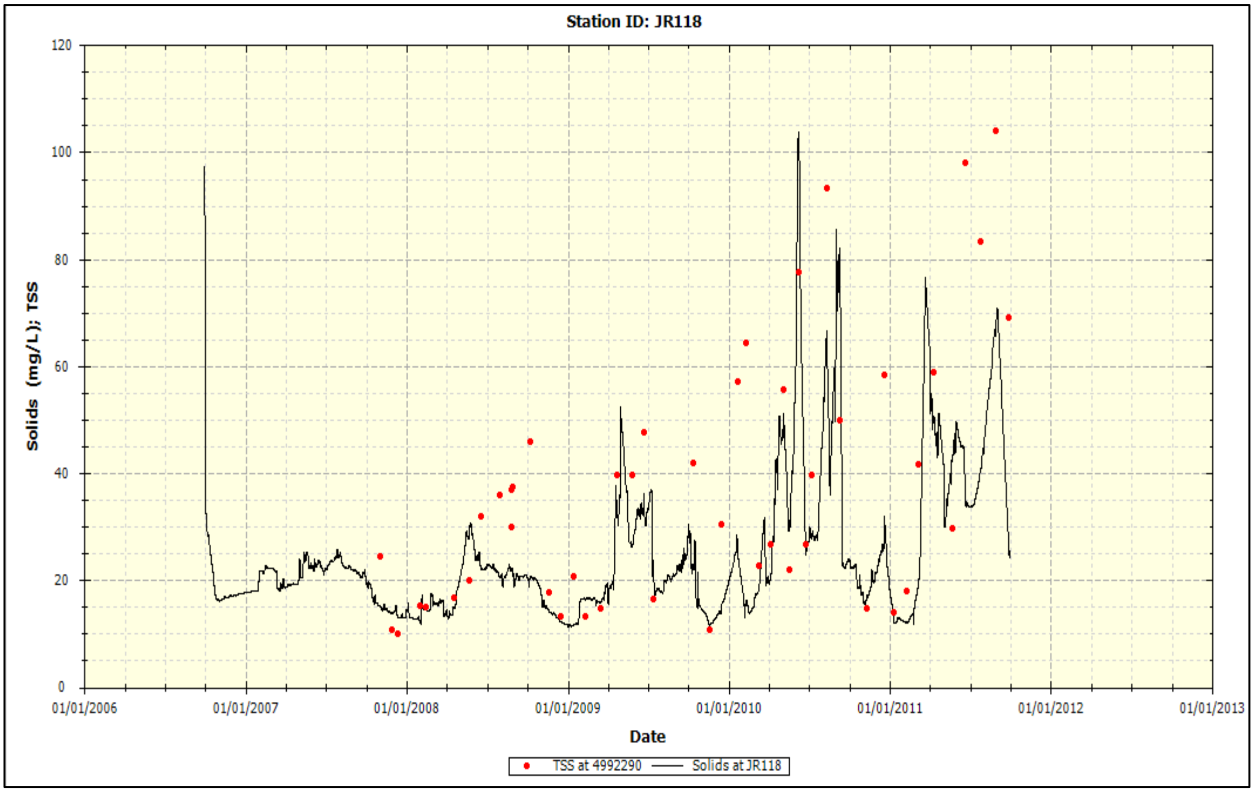


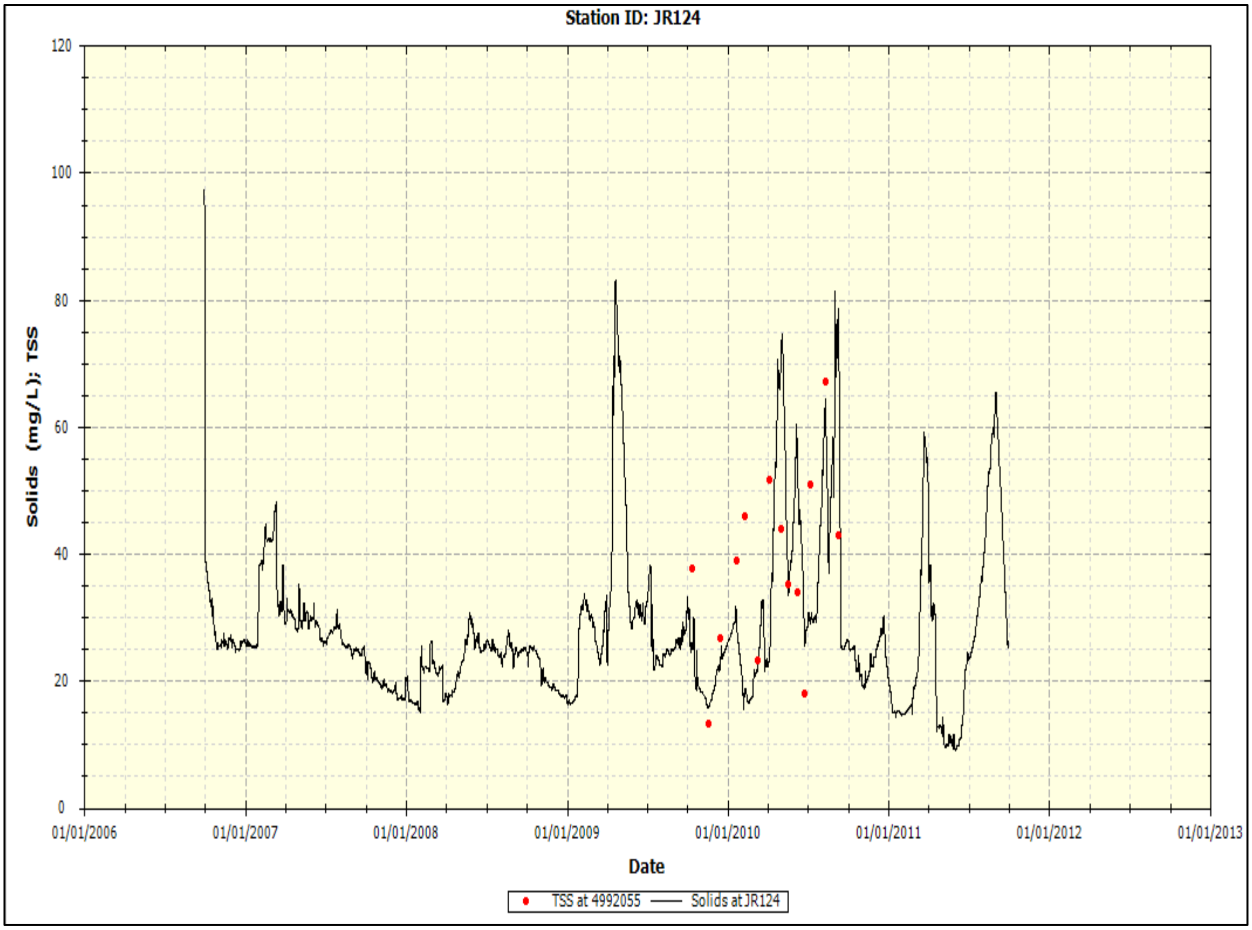
Station ID: JR103
Solids (mg/L); TSS
Date
TSS at 4992890
Solids at JR103

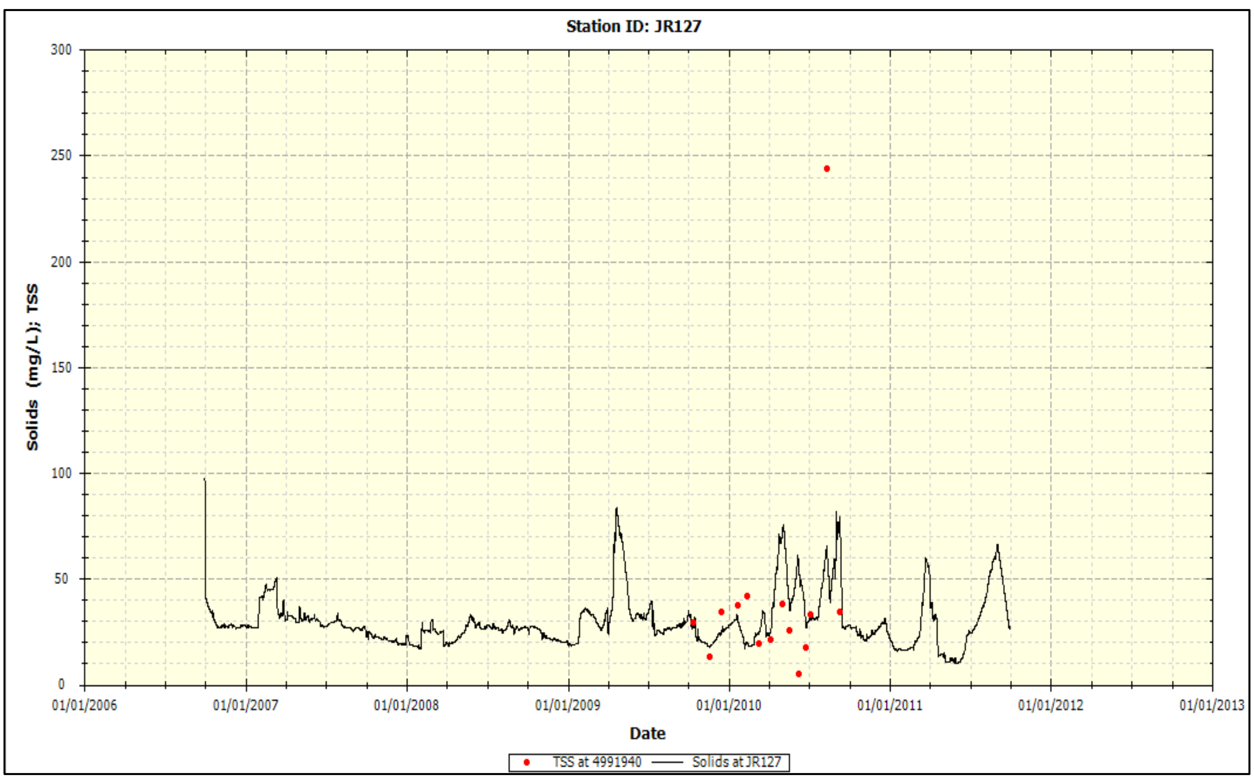


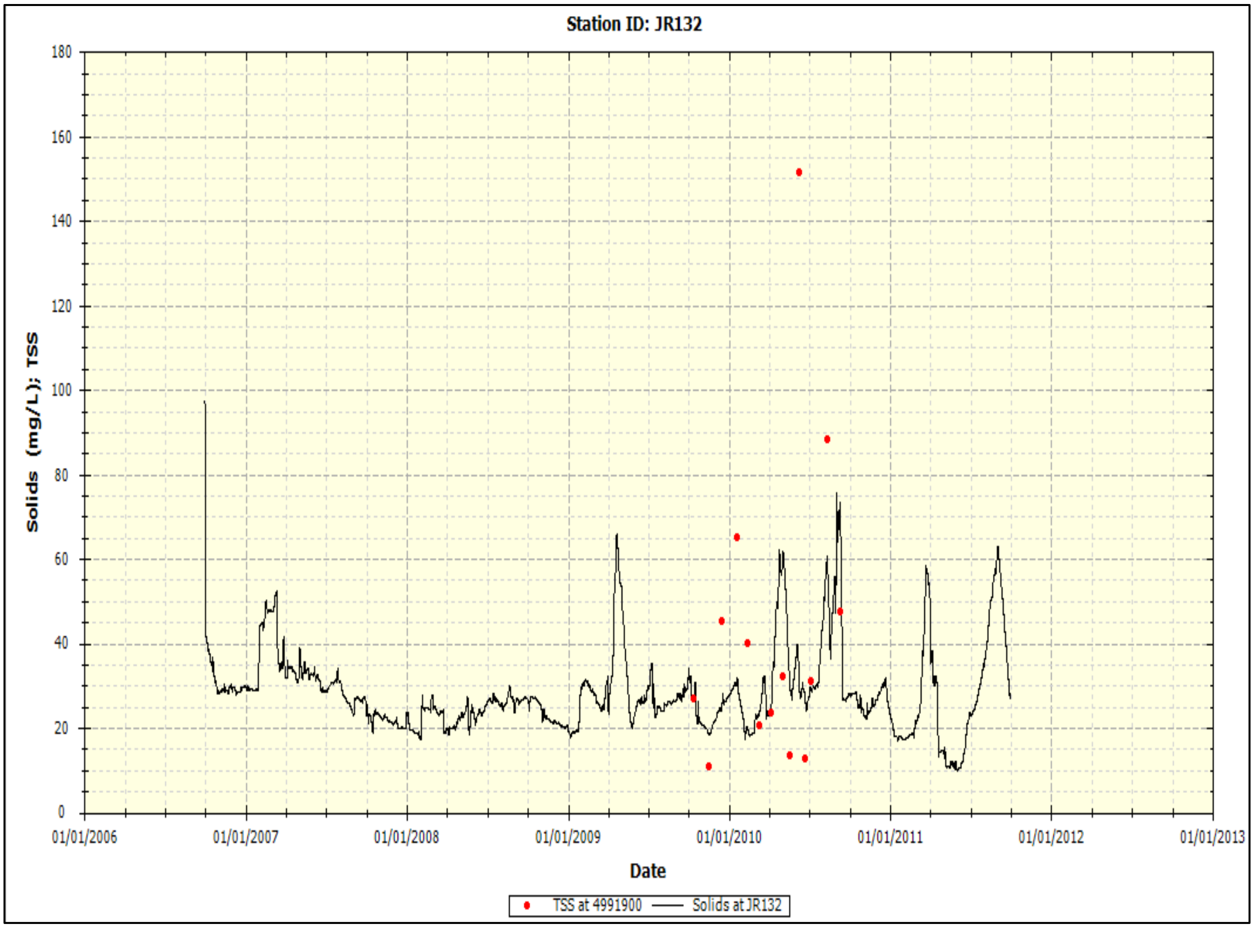
Station ID: JR107
Solids (mg/L); TSS
Date
TSS at 4992880
Solids at JR107

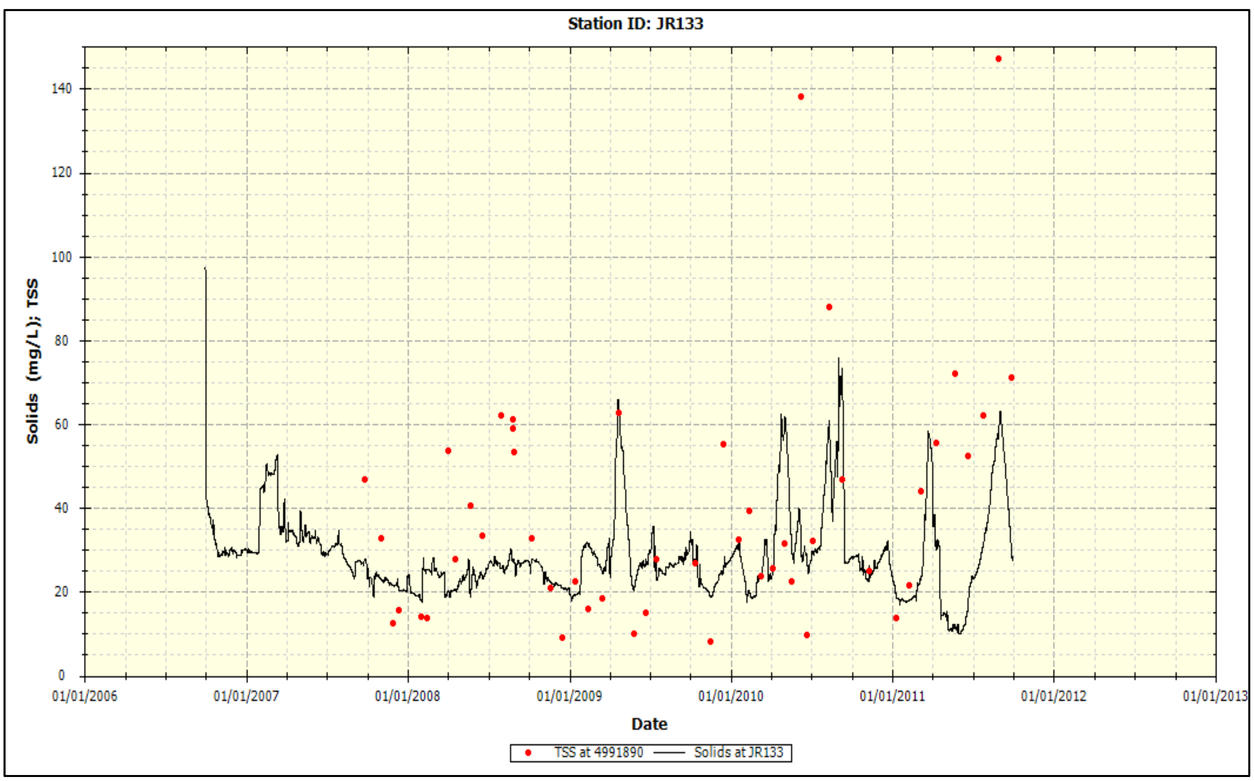

Station ID: JR115 (Surplus Canal; Diversion)
Solids (mg/L); TSS
Date
0
20
40
60
80
100
120
140
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TSS at 4992320
Solids at JR115 (Surplus Canal; Diversion)

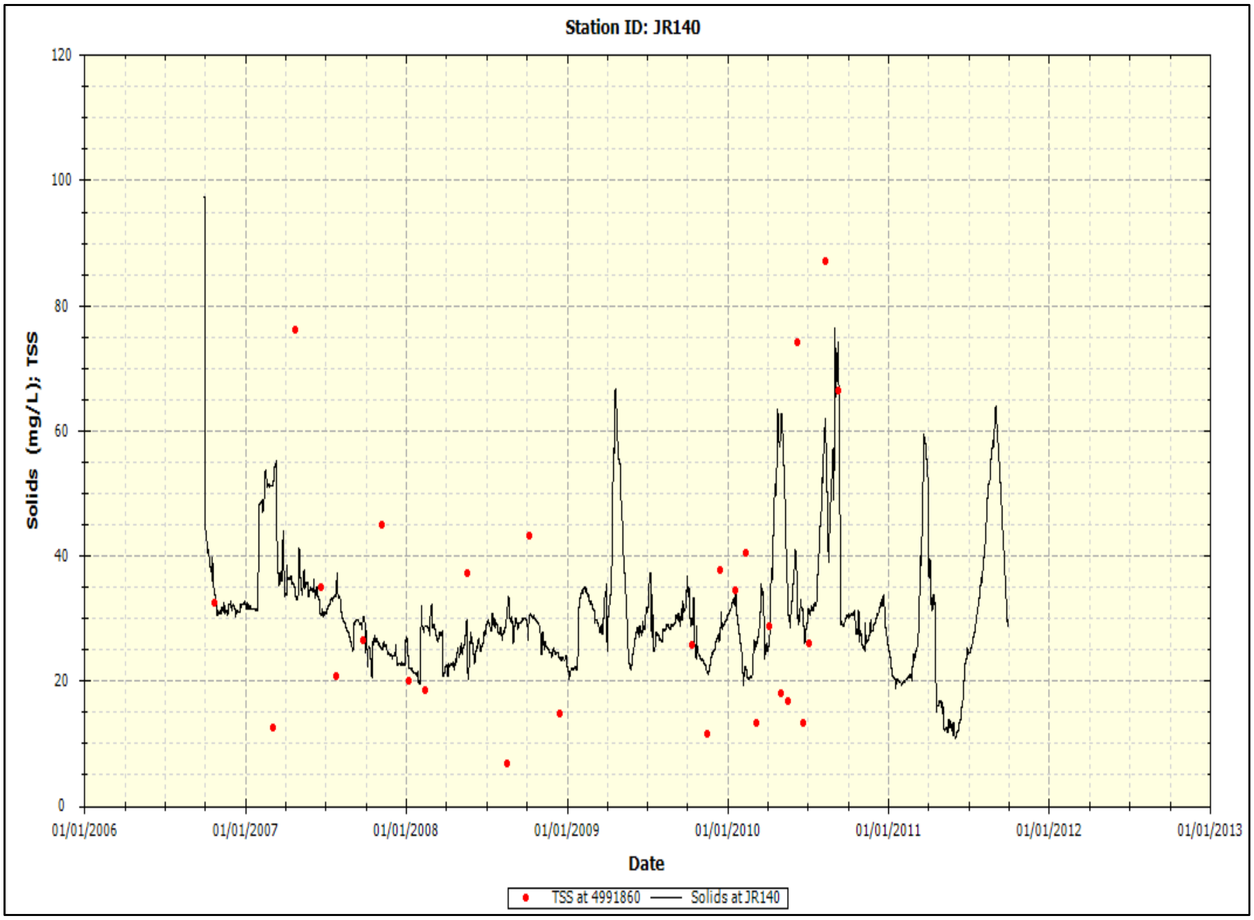

Station ID: JR118
Solids (mg/L); TSS
Date
0
20
40
60
80
100
120
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TSS at 4992290
Solids at JR118

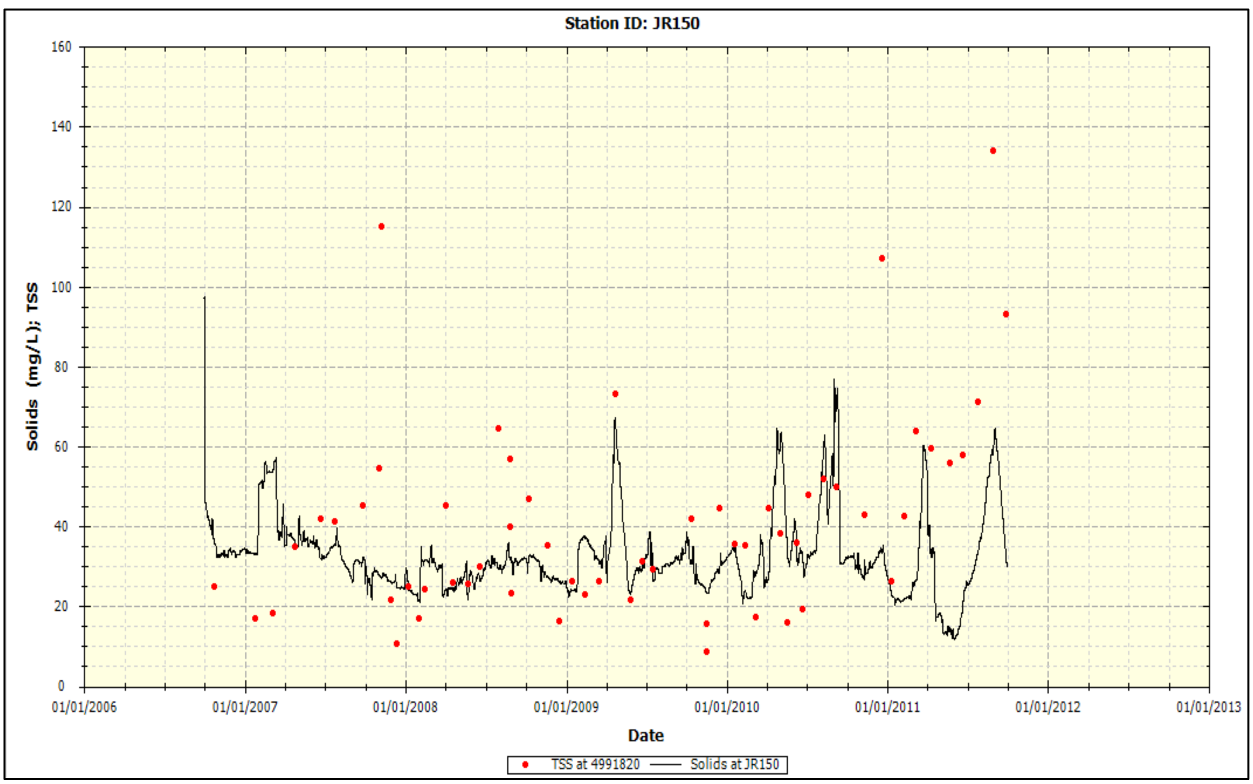

Station ID: JR124
120
100
80
60
40
20
0
Solids (mg/L); TSS
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4992055
Solids at JR124

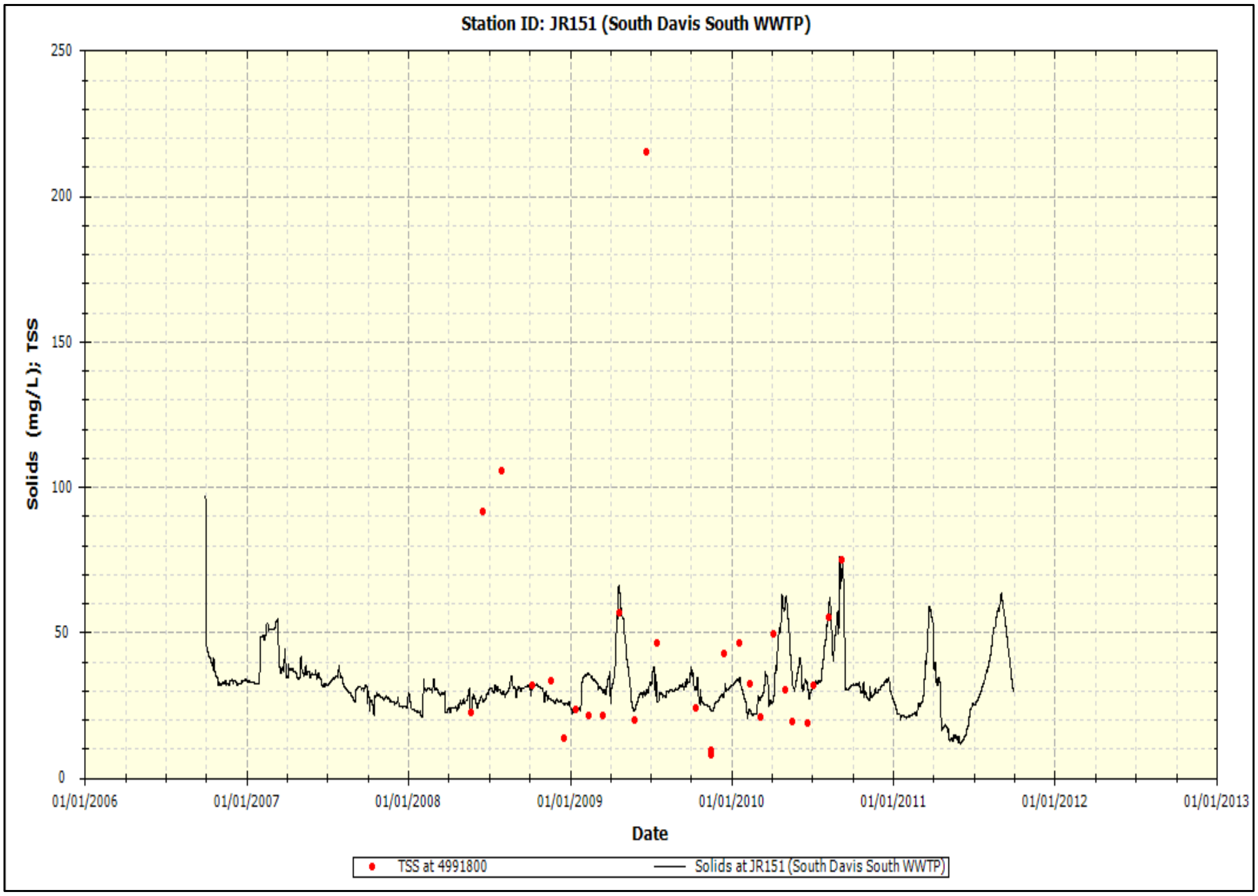

Station ID: JR127
300
250
200
150
100
50
0
Solids (mg/L); TSS
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4991940
Solids at JR127


Station ID: JR132
Solids (mg/L); TSS
180
160
140
120
100
80
60
40
20
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4991900
Solids at JR132

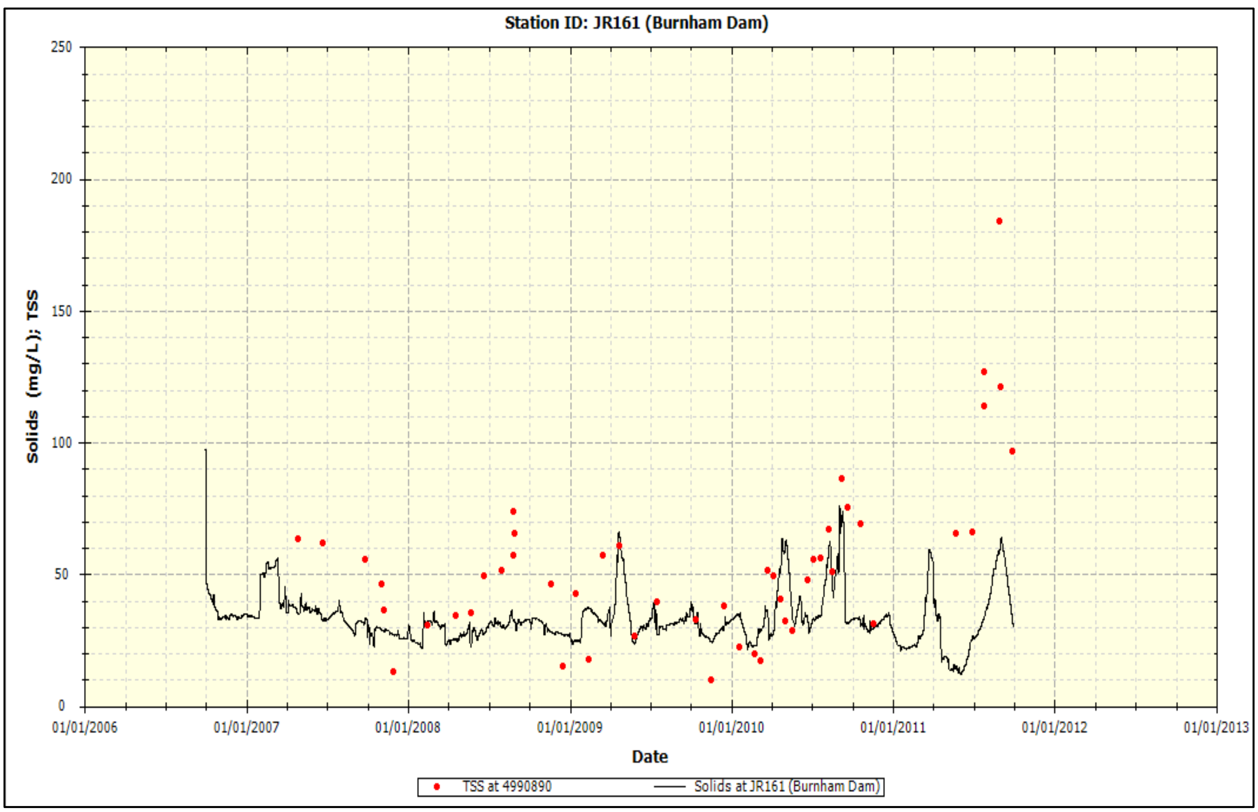

Station ID: JR133
Solids (mg/L); TSS
140
120
100
80
60
40
20
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TSS at 4991890
Solids at JR133


Station ID: JR140
Solids (mg/L); TSS
Date
0
20
40
60
80
100
120
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TSS at 4991860
Solids at JR140


Station ID: JR150
Solids (mg/L); TSS
Date
0
20
40
60
80
100
120
140
160
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
TSS at 4991820
Solids at JR150

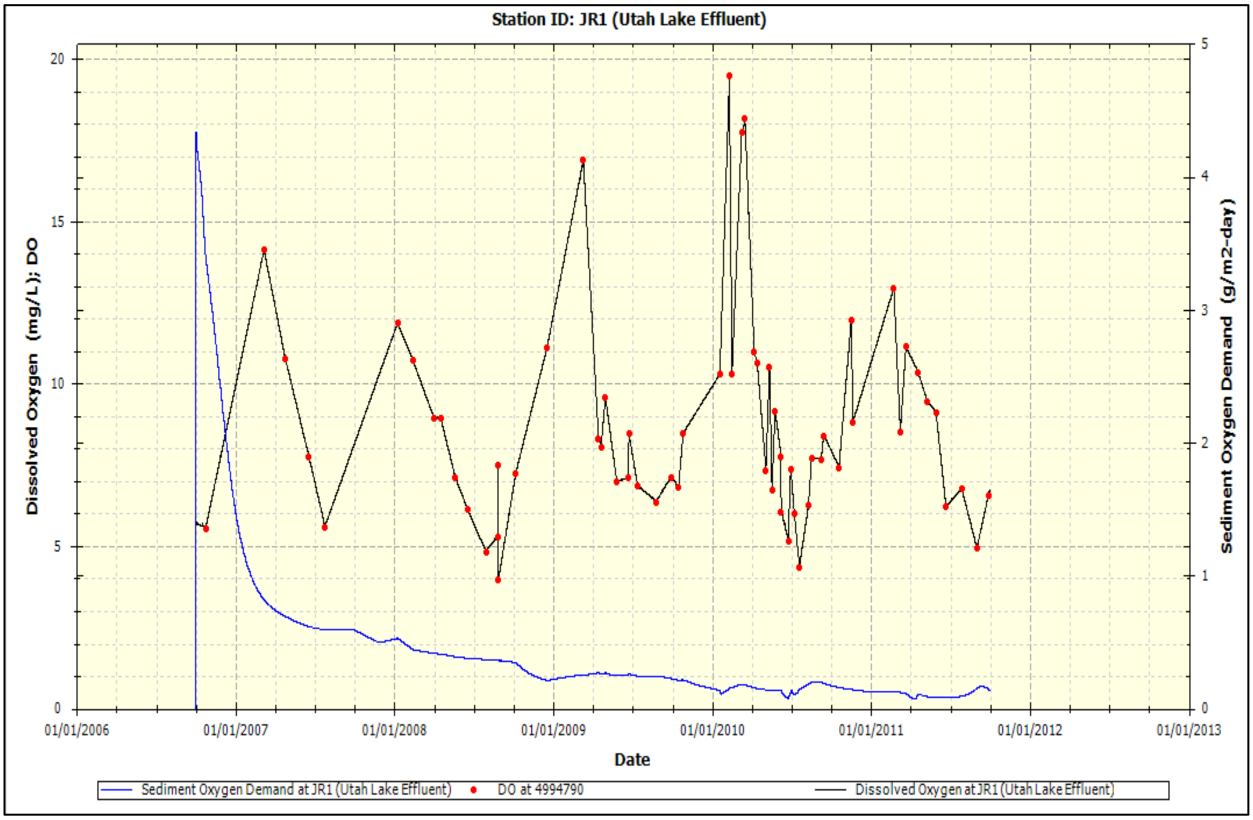


Station ID: JR151 (South Davis South WWTP)
Solids (mg/L); TSS
Date
TSS at 4991800
Solids at JR151 (South Davis South WWTP)

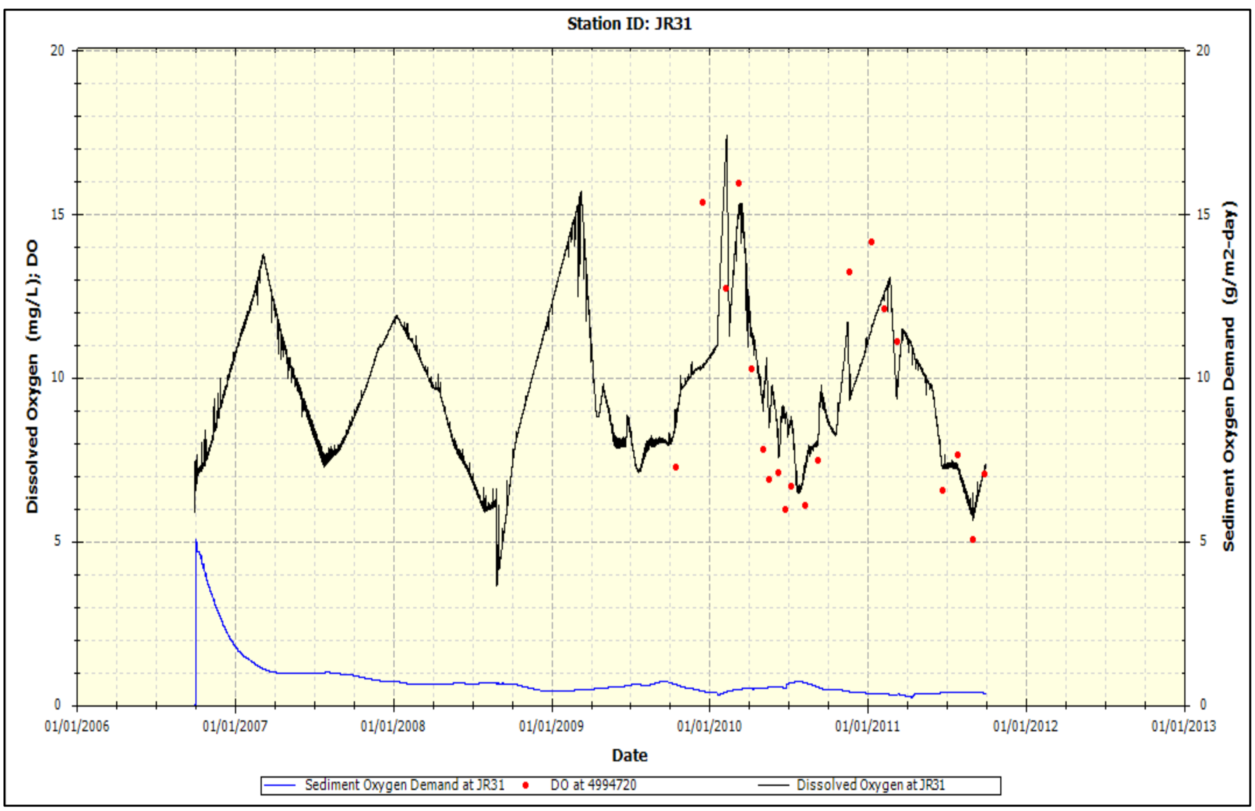


Station ID: JR161 (Burnham Dam)
Solids (mg/L); TSS
Date
TSS at 4990890
Solids at JR161 (Burnham Dam)

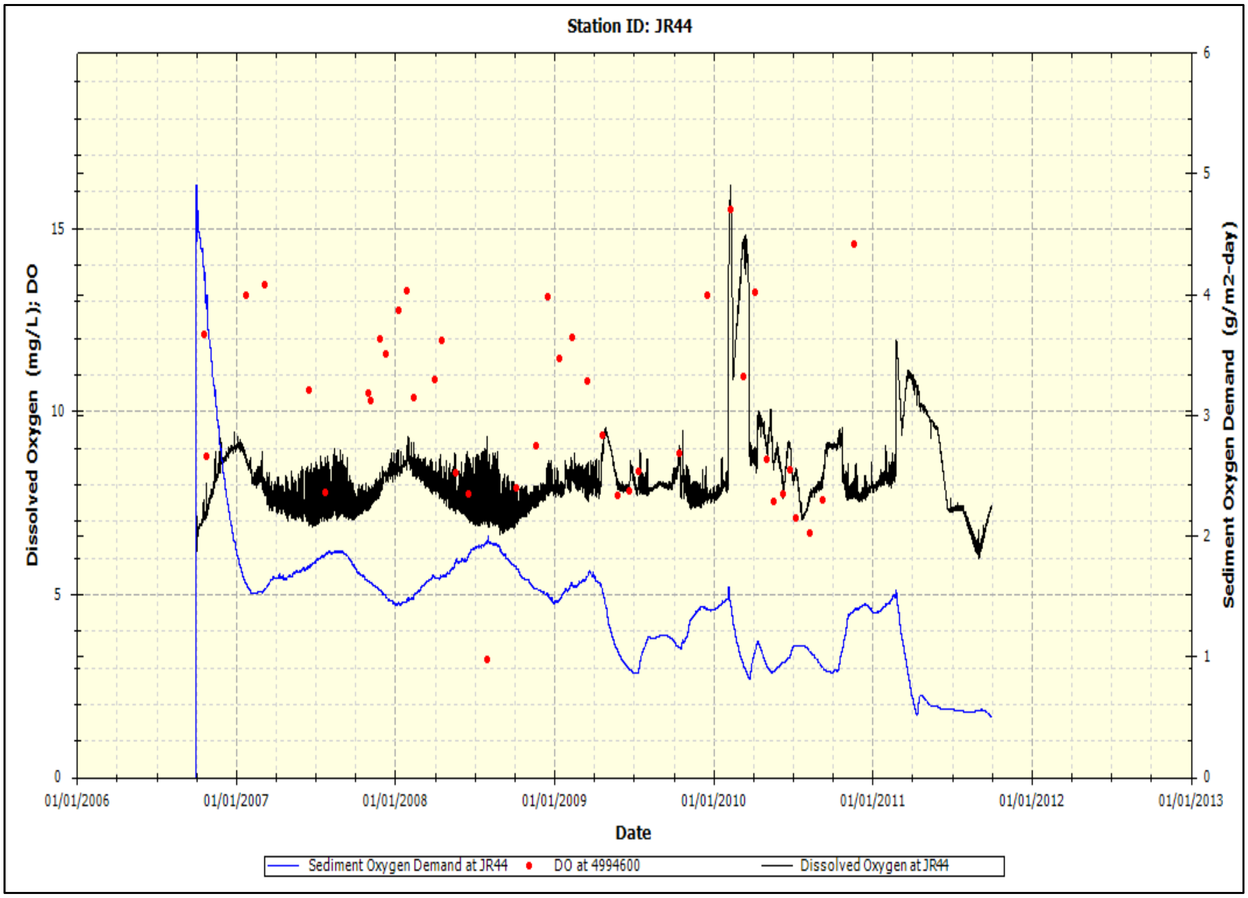
B.1.5: DO

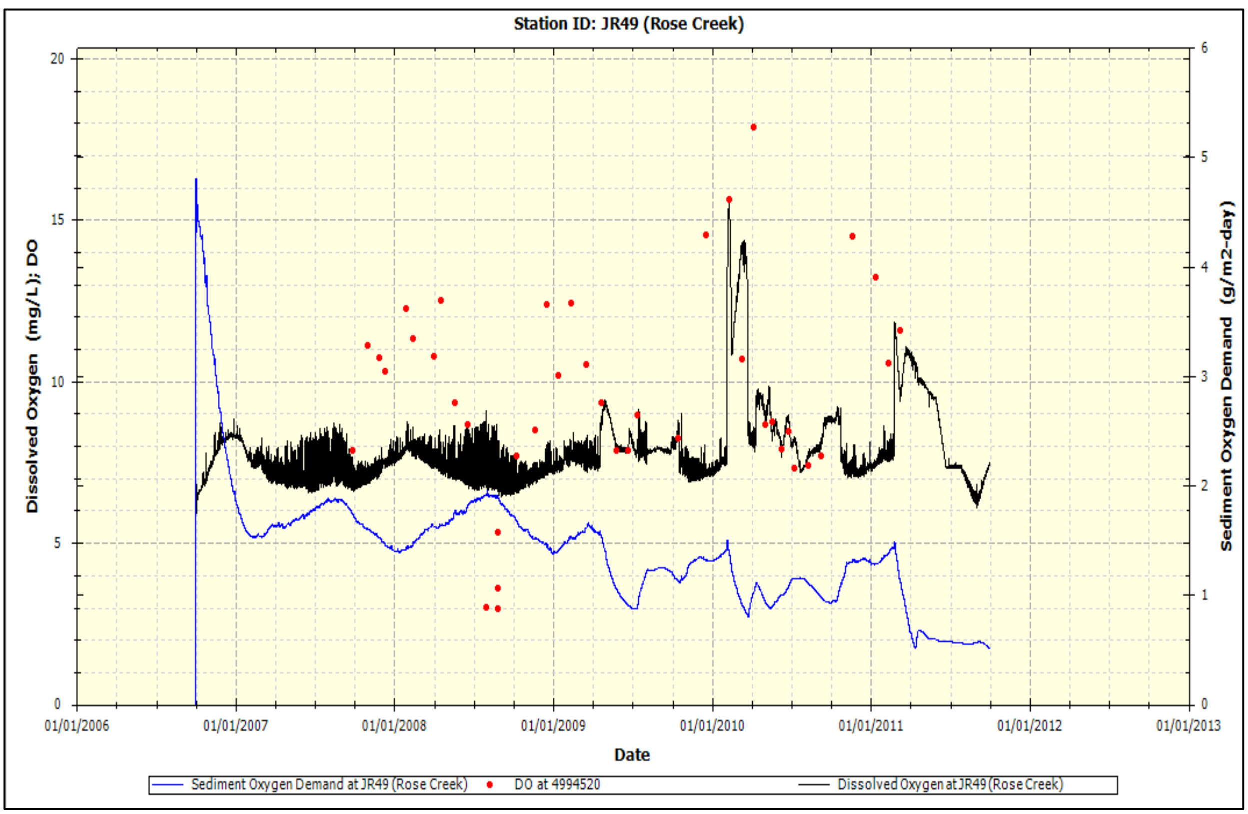


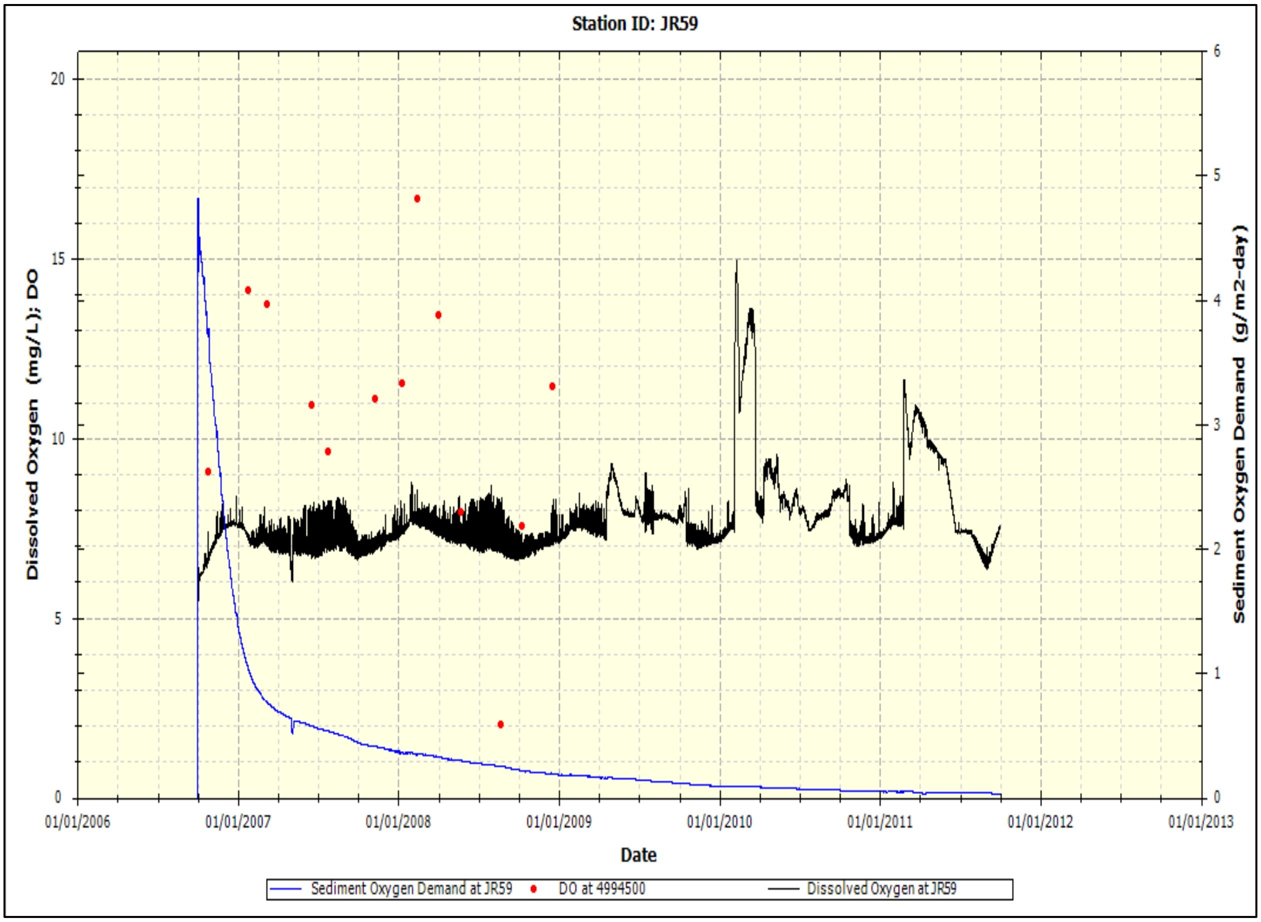
Station ID: JR1 (Utah Lake Effluent)
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
0
5
10
15
20
0
1
2
3
4
5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR1 (Utah Lake Effluent)
DO at 4994790
Dissolved Oxygen at JR1 (Utah Lake Effluent)



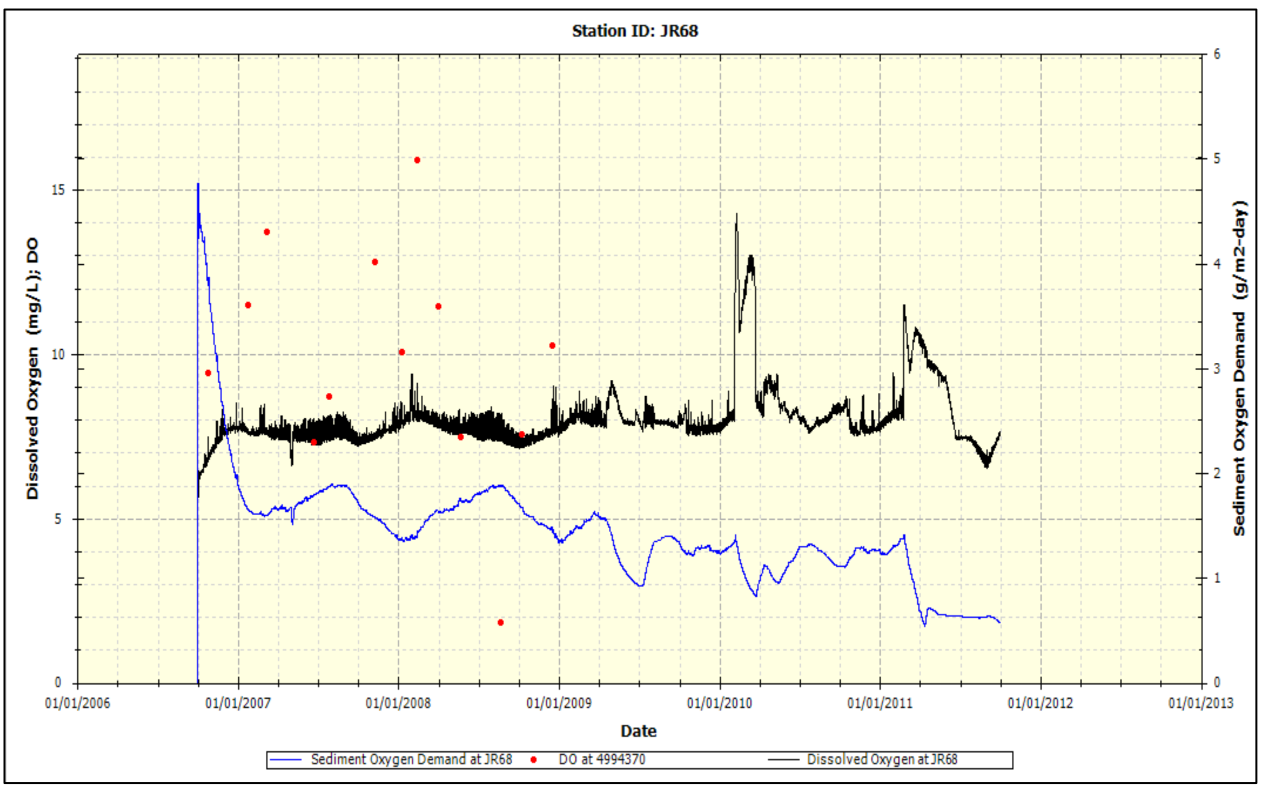
Station ID: JR31
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
0
5
10
15
20
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR31
DO at 4994720
Dissolved Oxygen at JR31


Station ID: JR44
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
0
5
10
15
0
1
2
3
4
5
6
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Sediment Oxygen Demand at JR44
DO at 4994600
Dissolved Oxygen at JR44

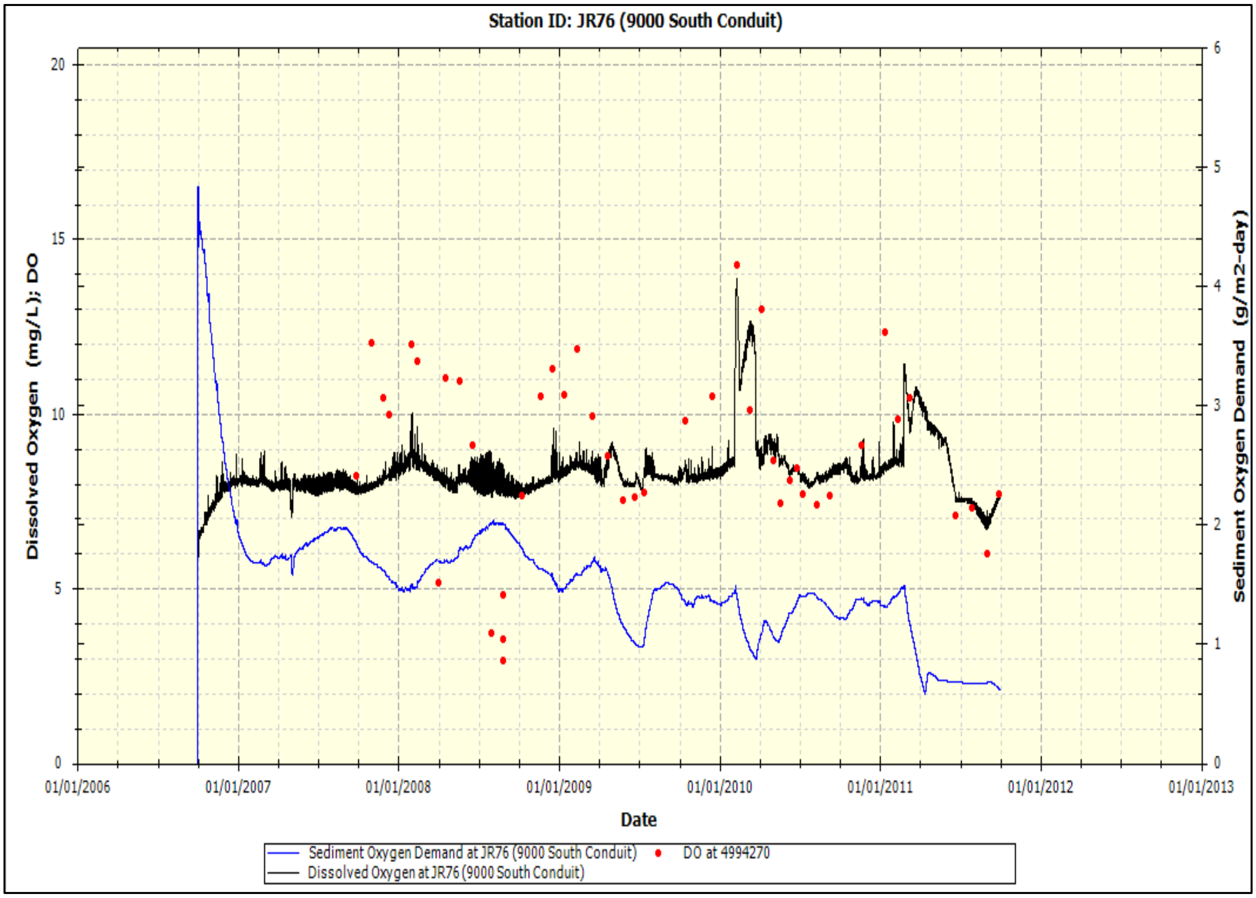

Station ID: JR49 (Rose Creek)
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
0
5
10
15
20
0
1
2
3
4
5
6
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Sediment Oxygen Demand at JR49 (Rose Creek)
DO at 4994520
Dissolved Oxygen at JR49 (Rose Creek)

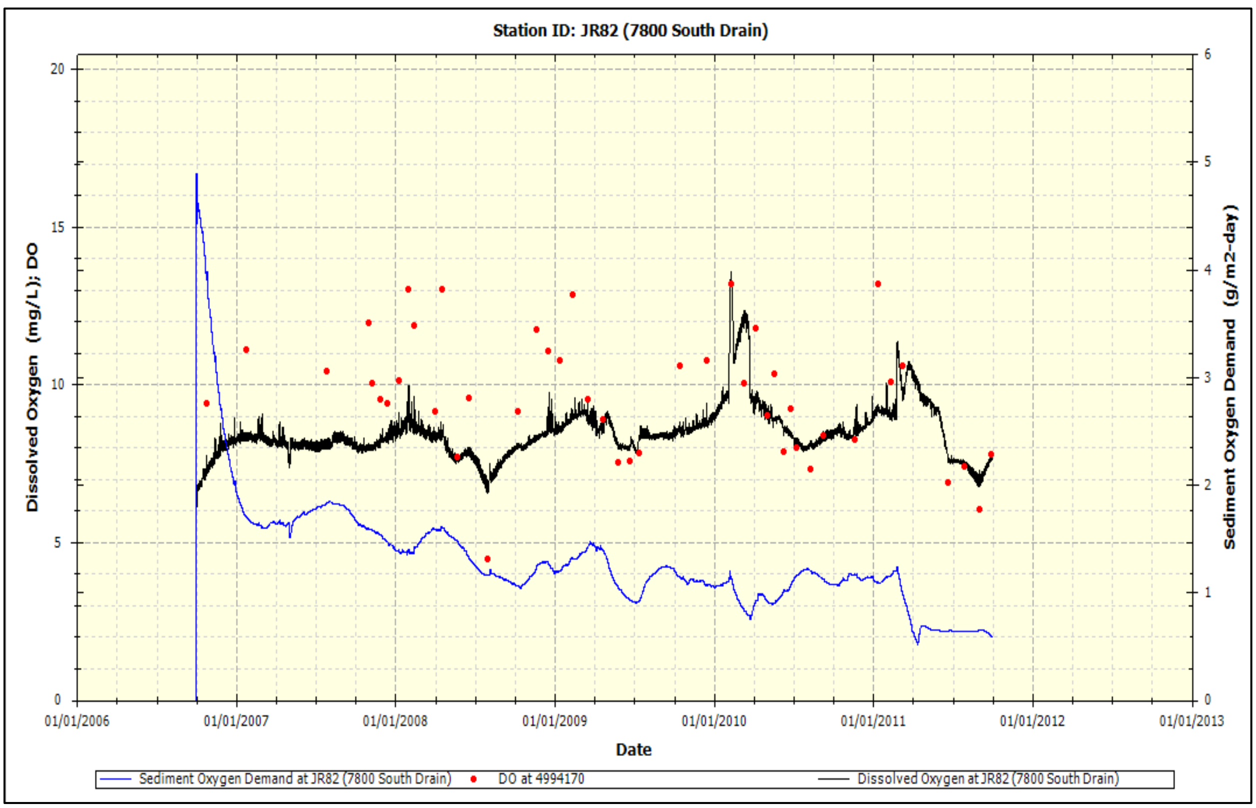


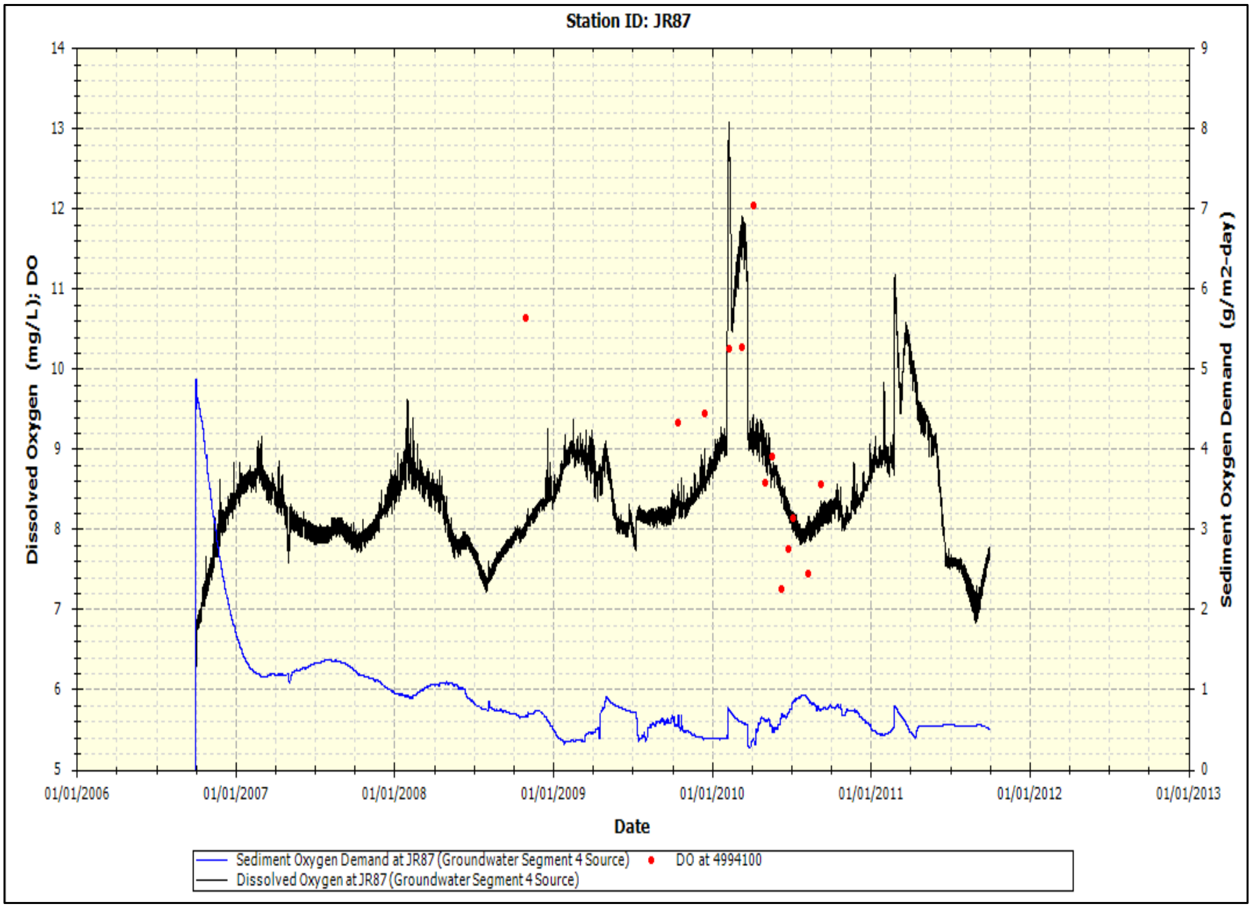
Station ID: JR59
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
0
5
10
15
20
0
1
2
3
4
5
6
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR59
DO at 4994500
Dissolved Oxygen at JR59

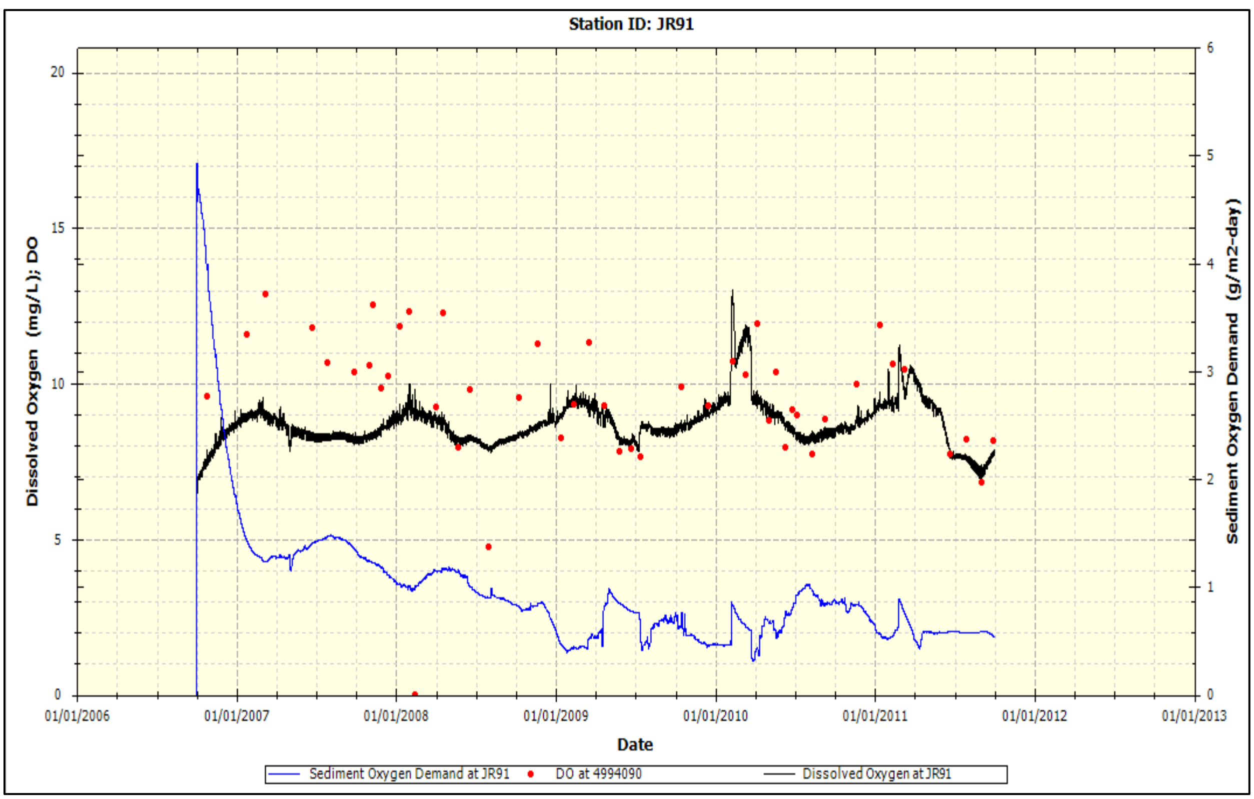


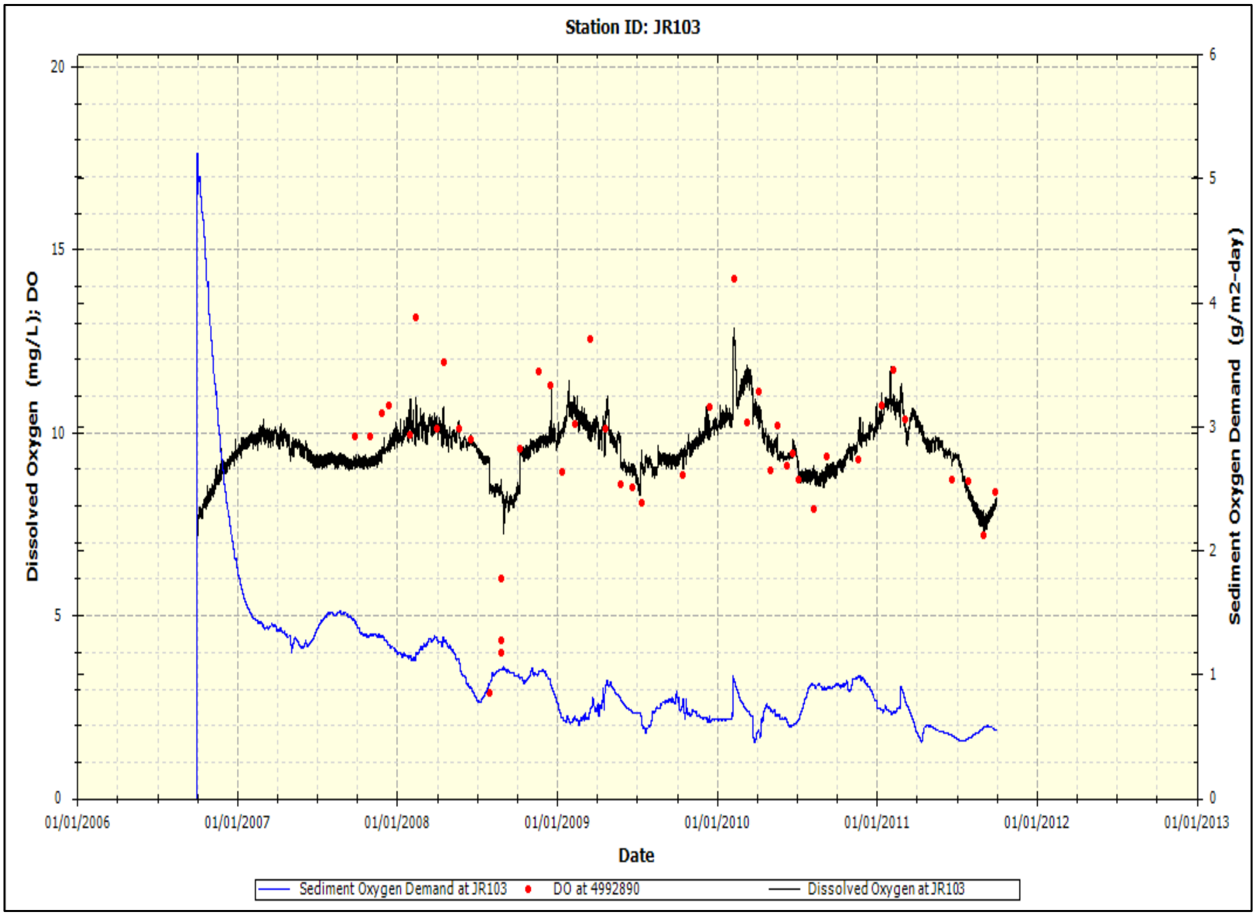
Station ID: JR68
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
0
5
10
15
0
1
2
3
4
5
6
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR68
DO at 4994370
Dissolved Oxygen at JR68

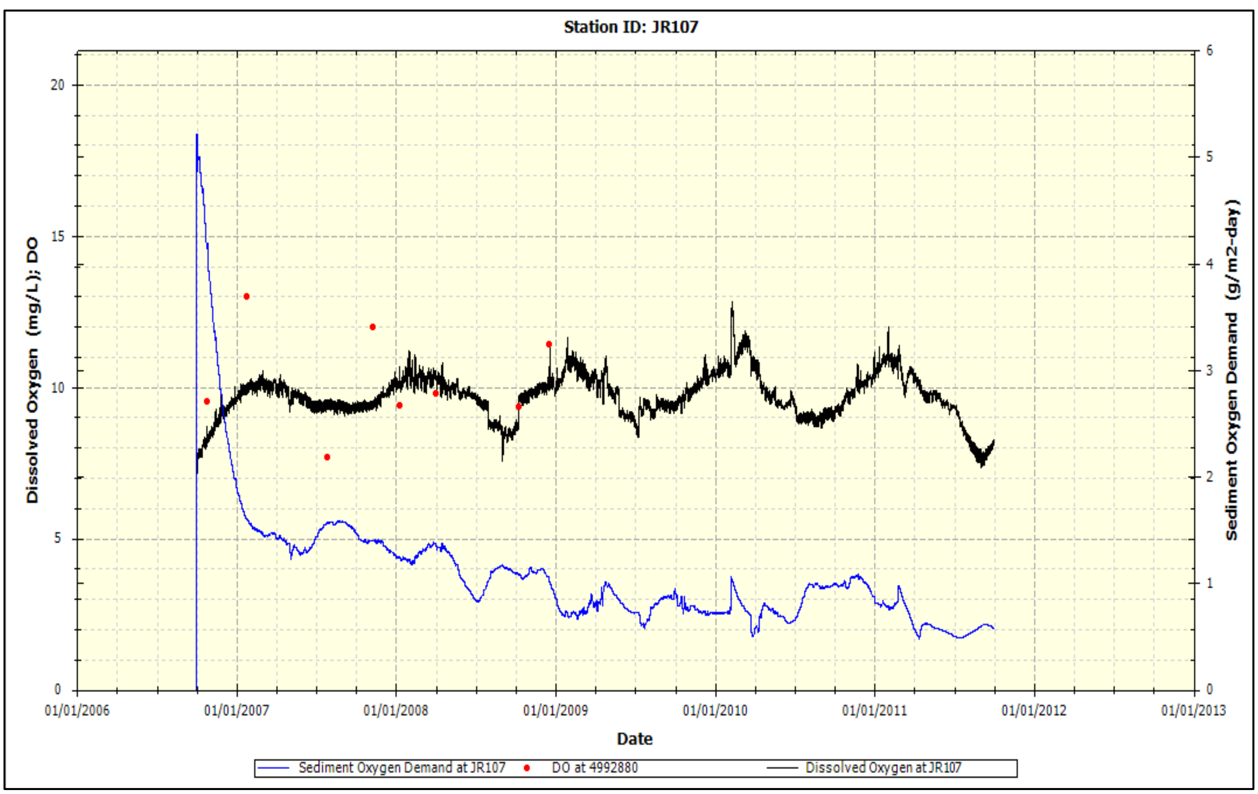

Station ID: JR76 (9000 South Conduit)
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR76 (9000 South Conduit)
DO at 4994270
Dissolved Oxygen at JR76 (9000 South Conduit)

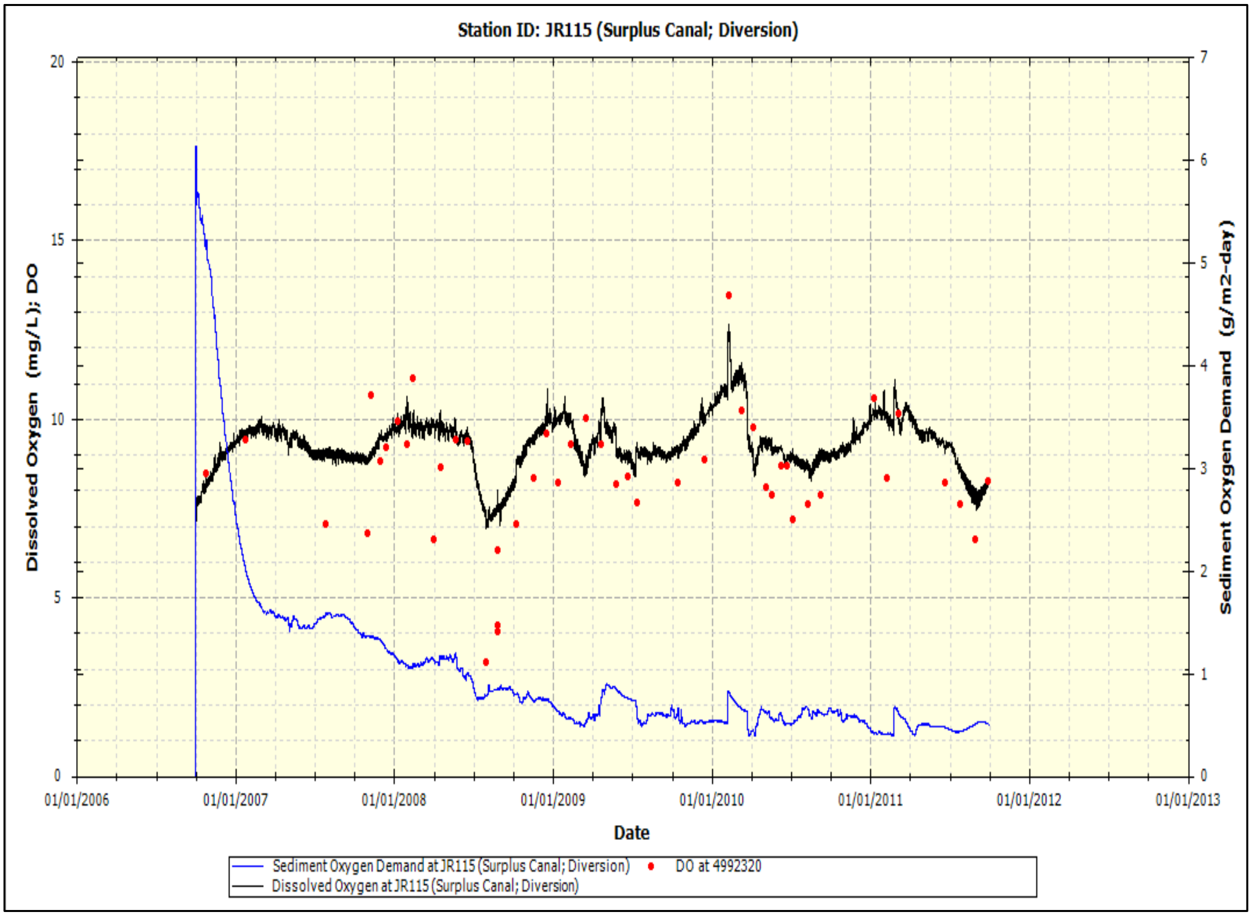

Station ID: JR82 (7800 South Drain)
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR82 (7800 South Drain)
DO at 4994170
Dissolved Oxygen at JR82 (7800 South Drain)


Station ID: JR87
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR87 (Groundwater Segment 4 Source)
DO at 4994100
Dissolved Oxygen at JR87 (Groundwater Segment 4 Source)

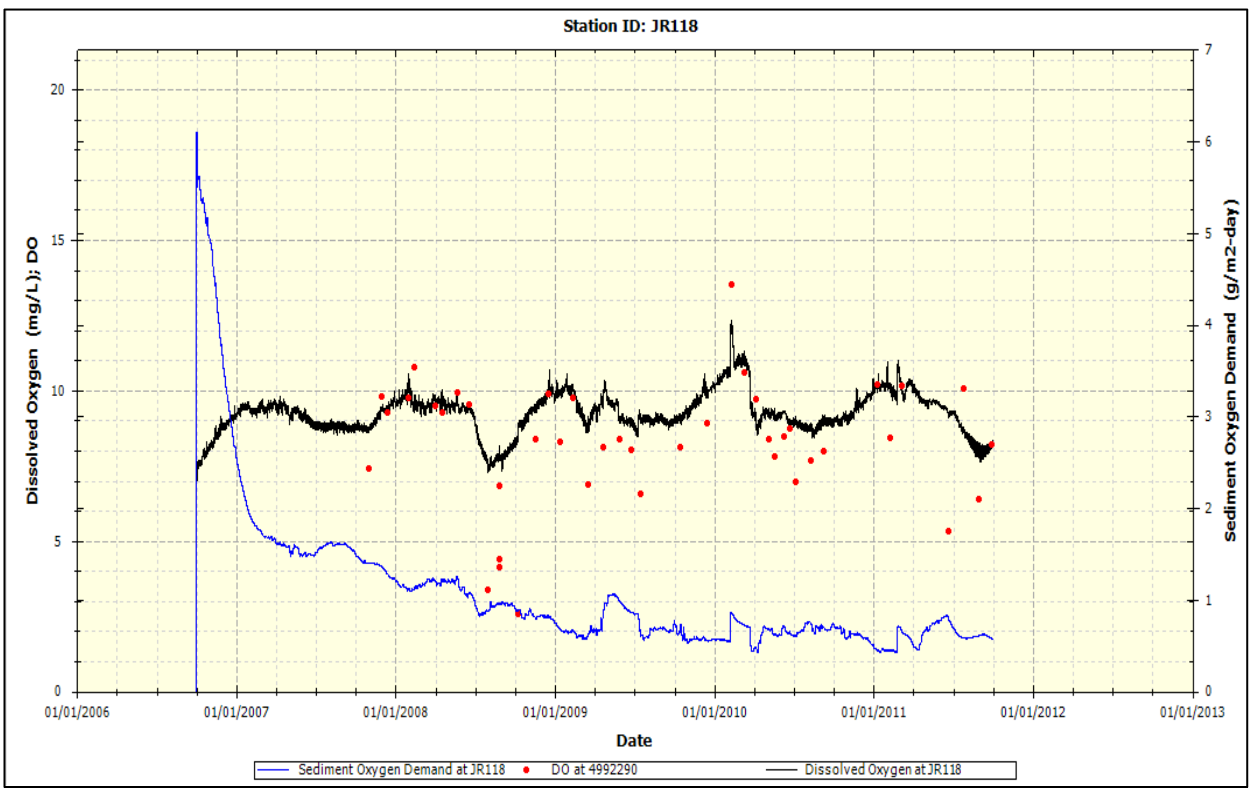

Station ID: JR91
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR91
DO at 4994090
Dissolved Oxygen at JR91


Station ID: JR103
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR103
DO at 4992890
Dissolved Oxygen at JR103

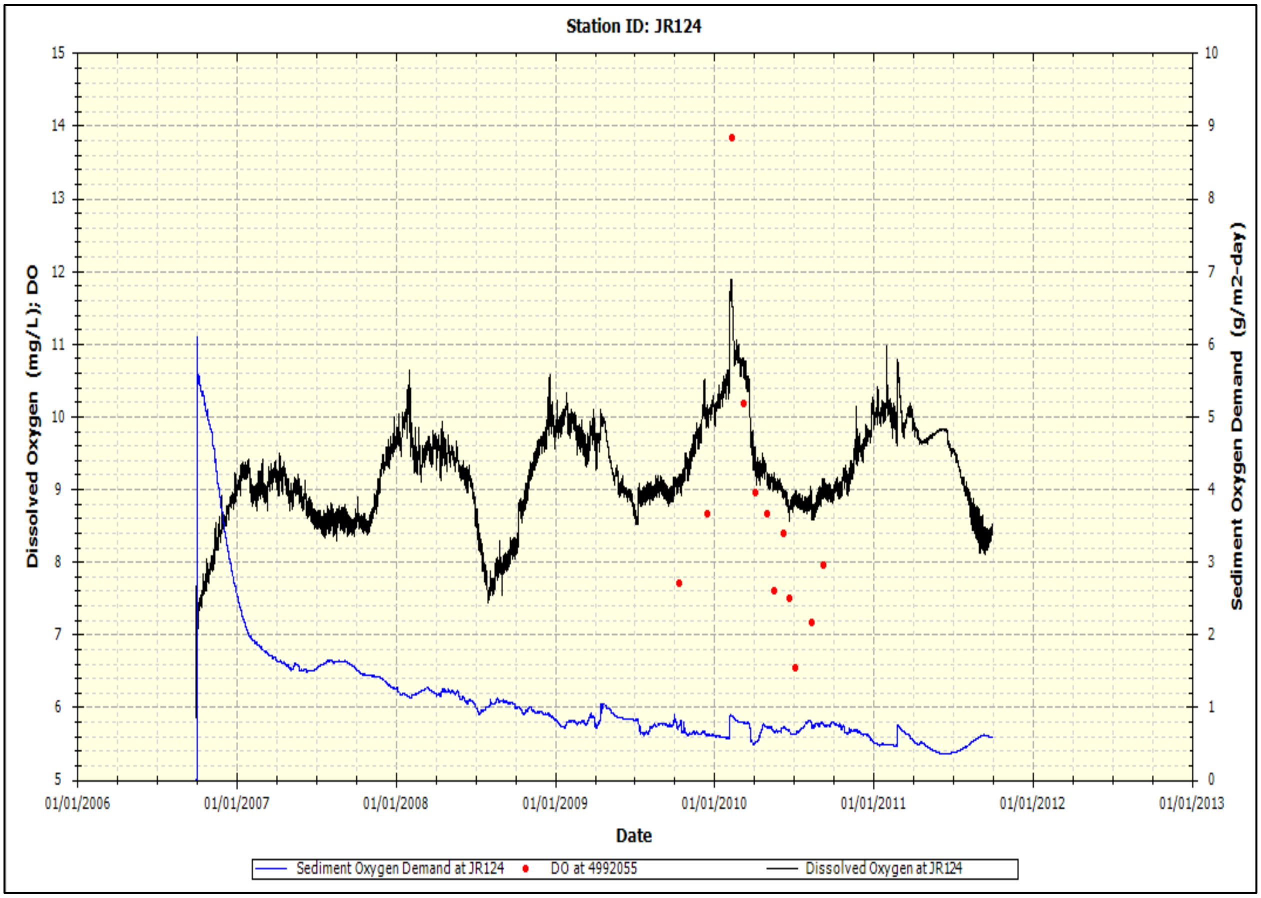

Station ID: JR107
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR107
DO at 4992880
Dissolved Oxygen at JR107

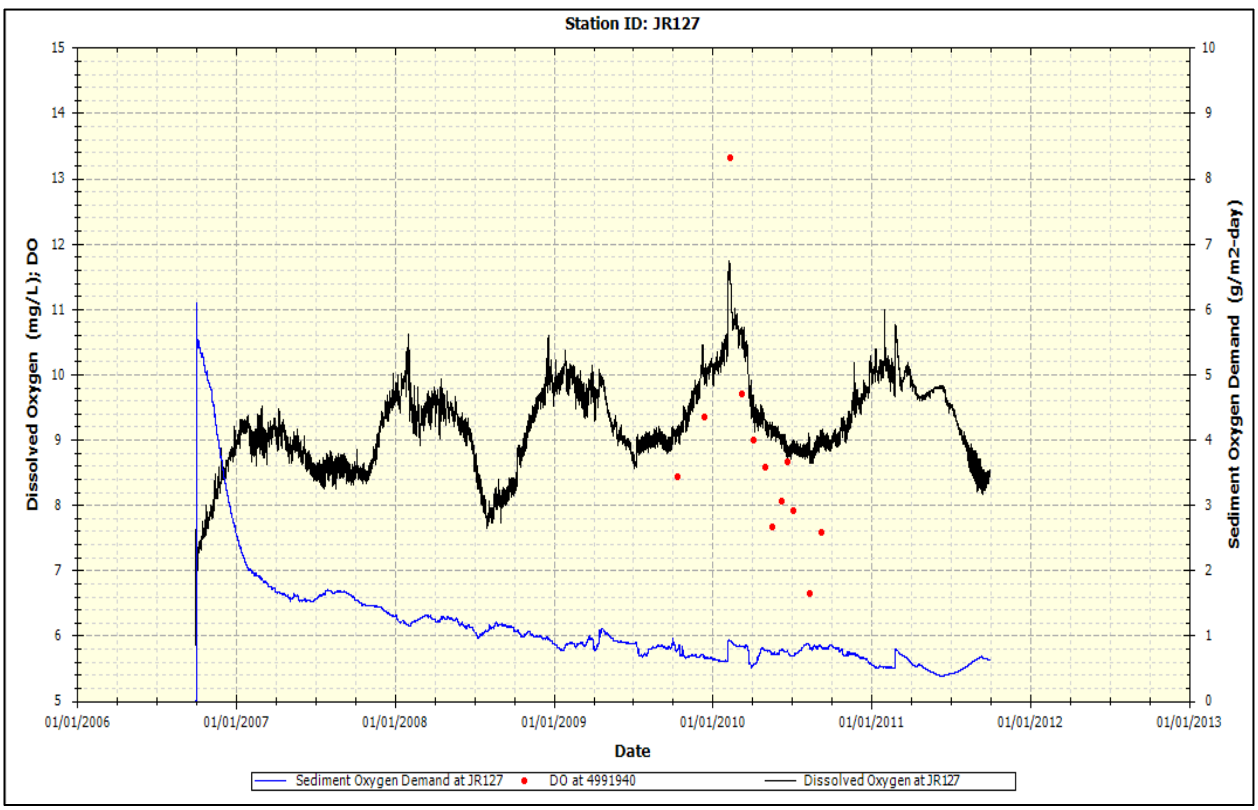


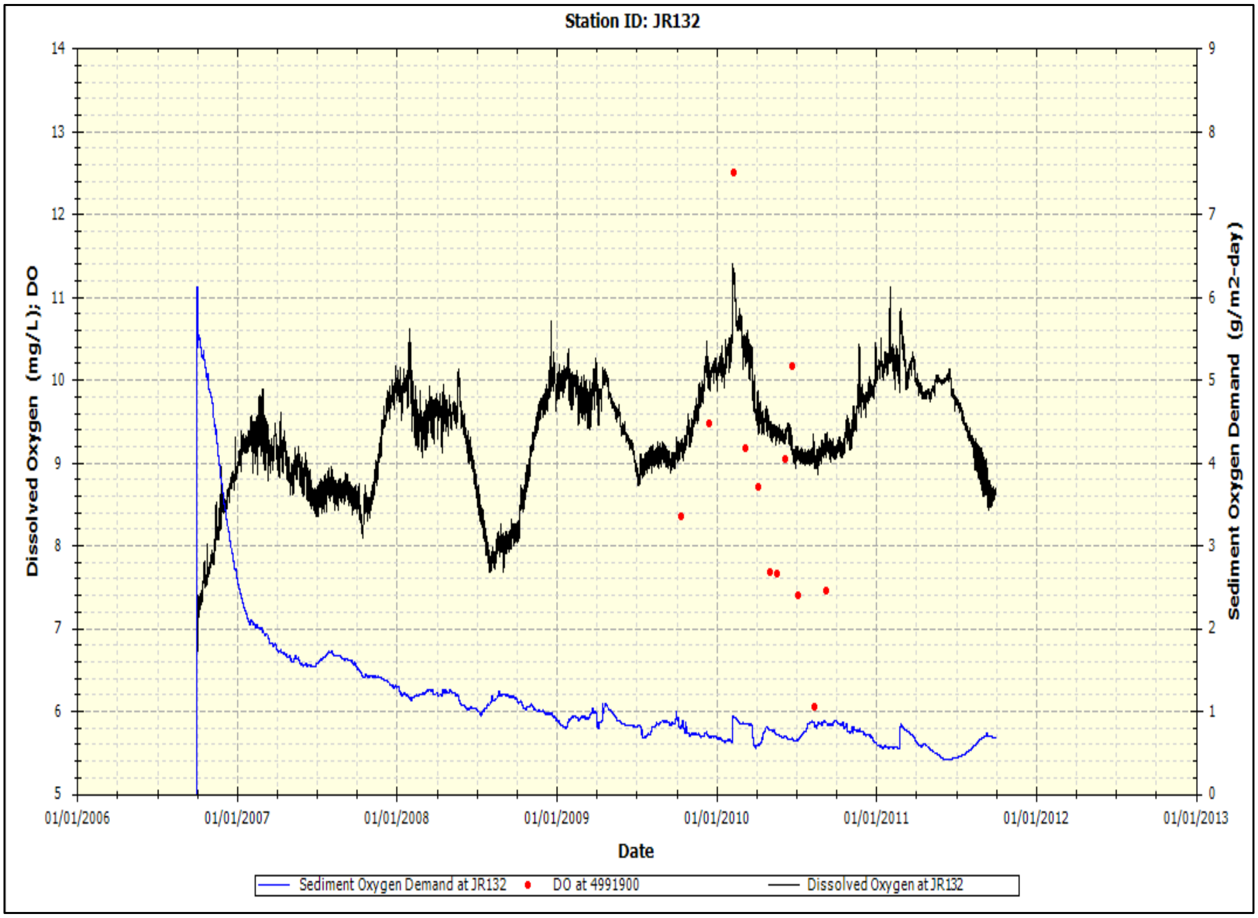
Station ID: JR115 (Surplus Canal; Diversion)
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR115 (Surplus Canal; Diversion)
DO at 4992320
Dissolved Oxygen at JR115 (Surplus Canal; Diversion)

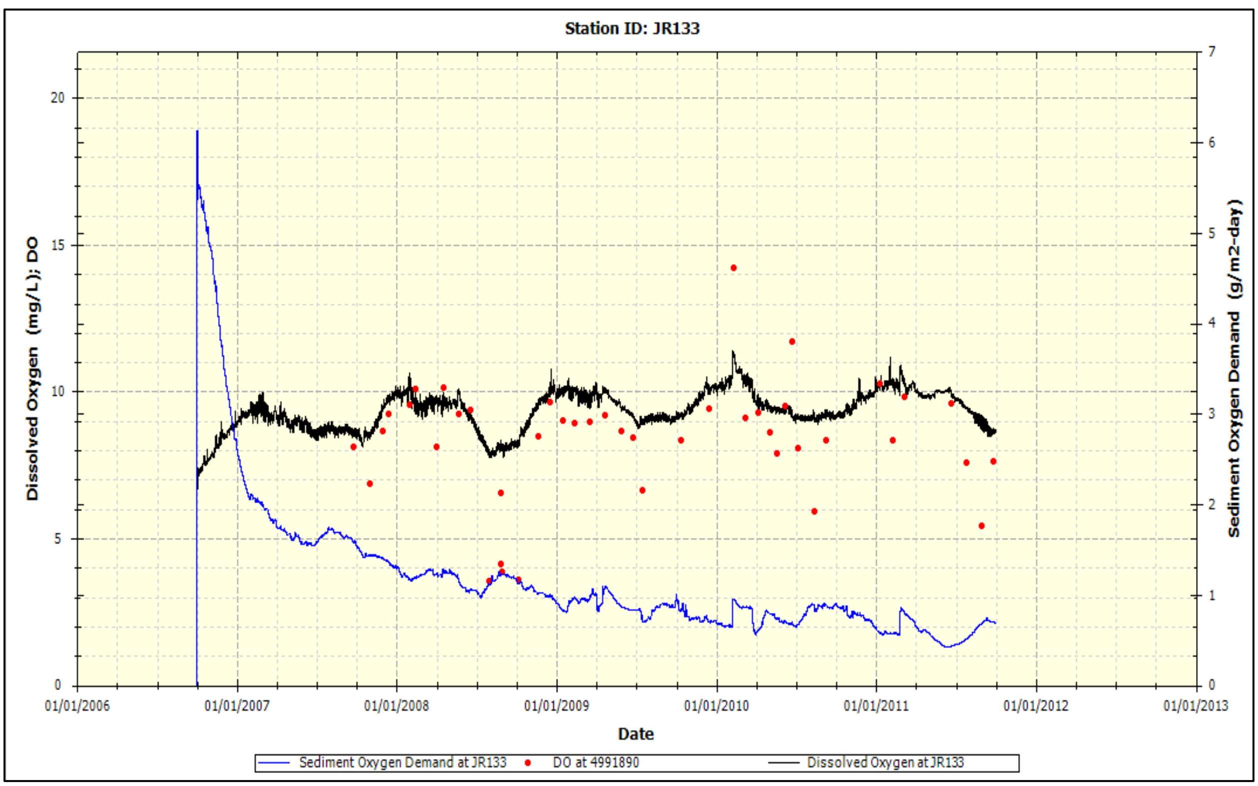


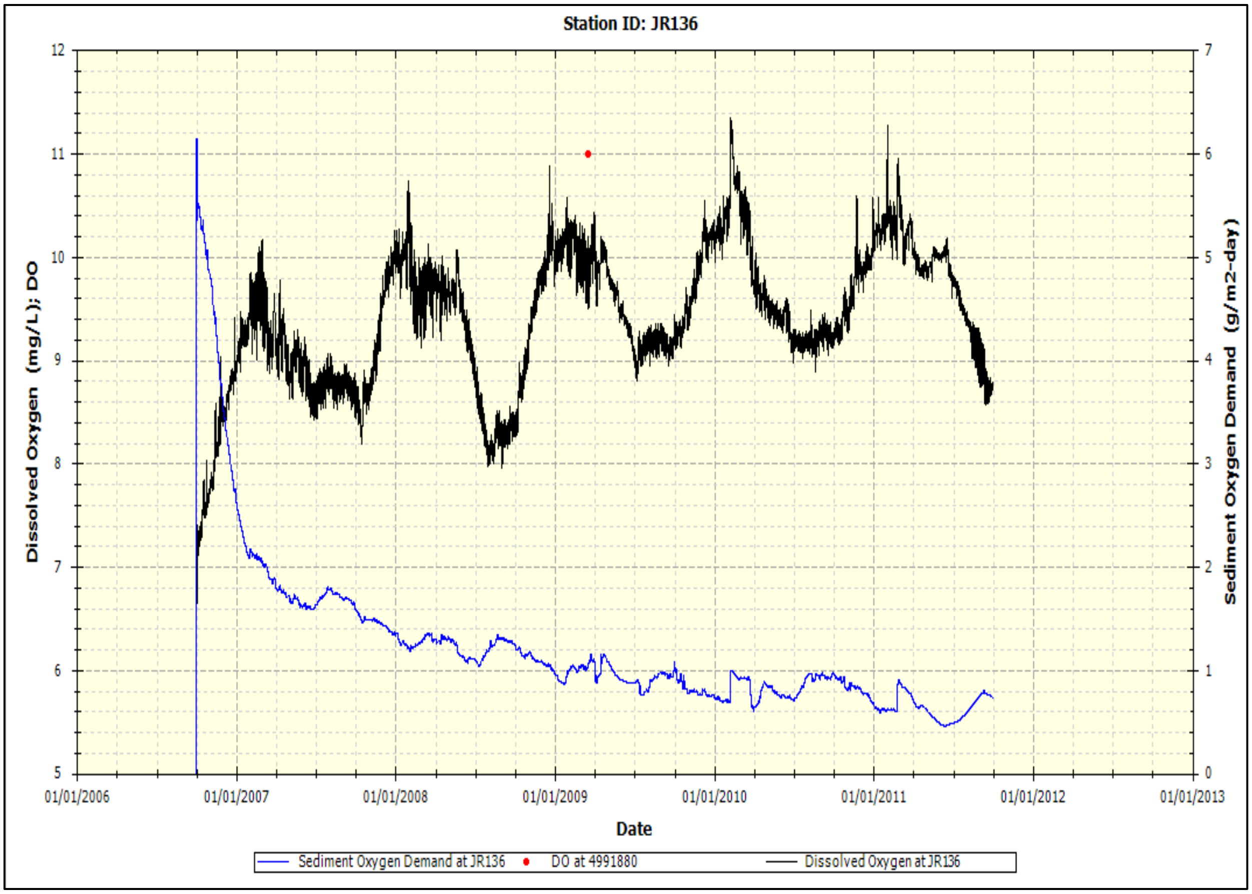
Station ID: JR118
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR118
DO at 4992290
Dissolved Oxygen at JR118

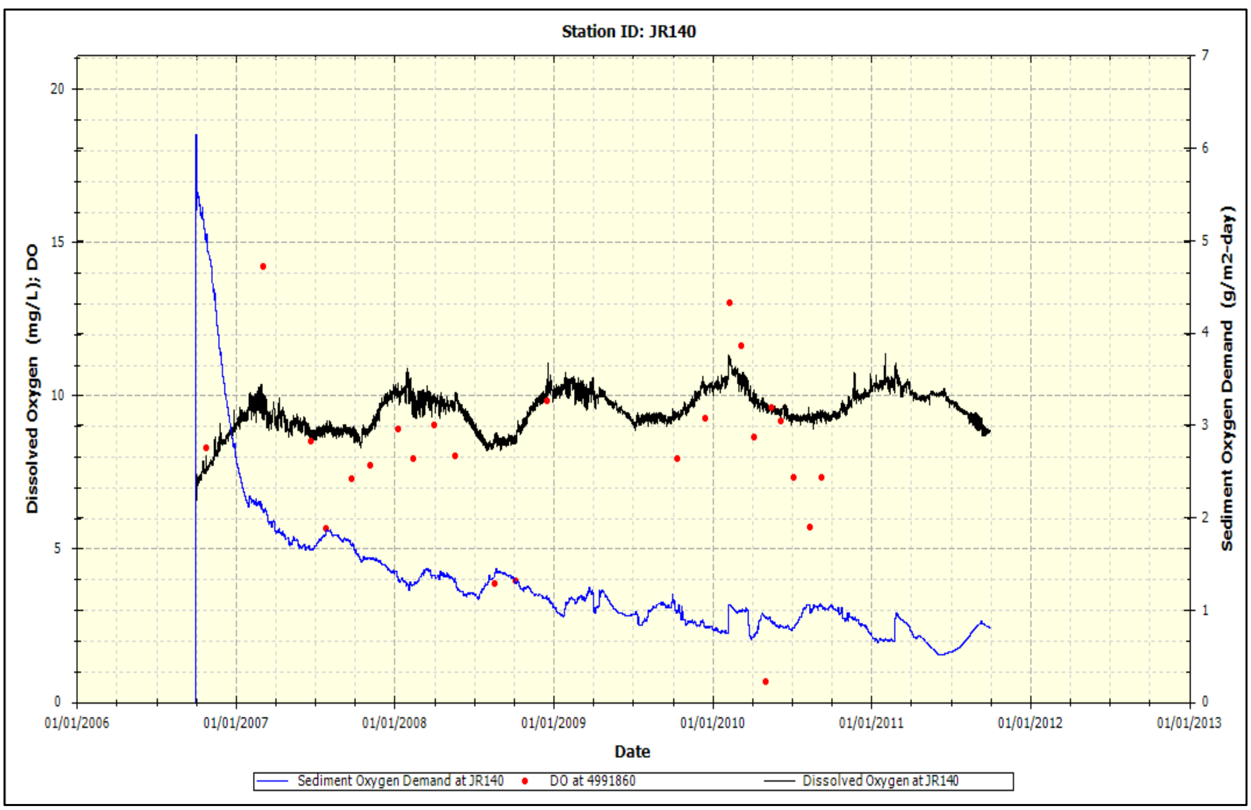

Station ID: JR124
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
15
14
13
12
11
10
9
8
7
6
5
10
9
8
7
6
5
4
3
2
1
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR124
DO at 4992055
Dissolved Oxygen at JR124

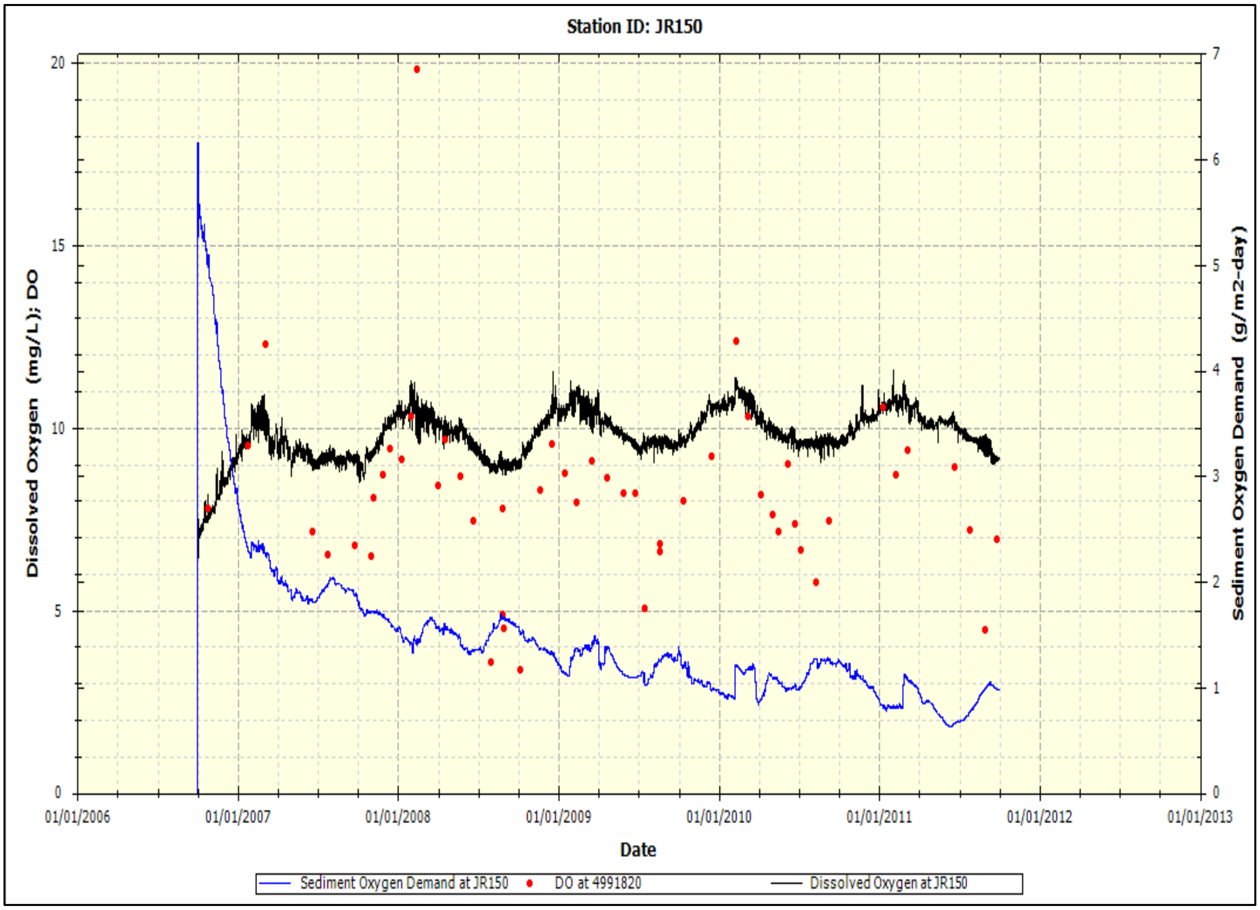

Station ID: JR127
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
15
14
13
12
11
10
9
8
7
6
5
10
9
8
7
6
5
4
3
2
1
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR127
DO at 4991940
Dissolved Oxygen at JR127


Station ID: JR132
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR132
DO at 4991900
Dissolved Oxygen at JR132

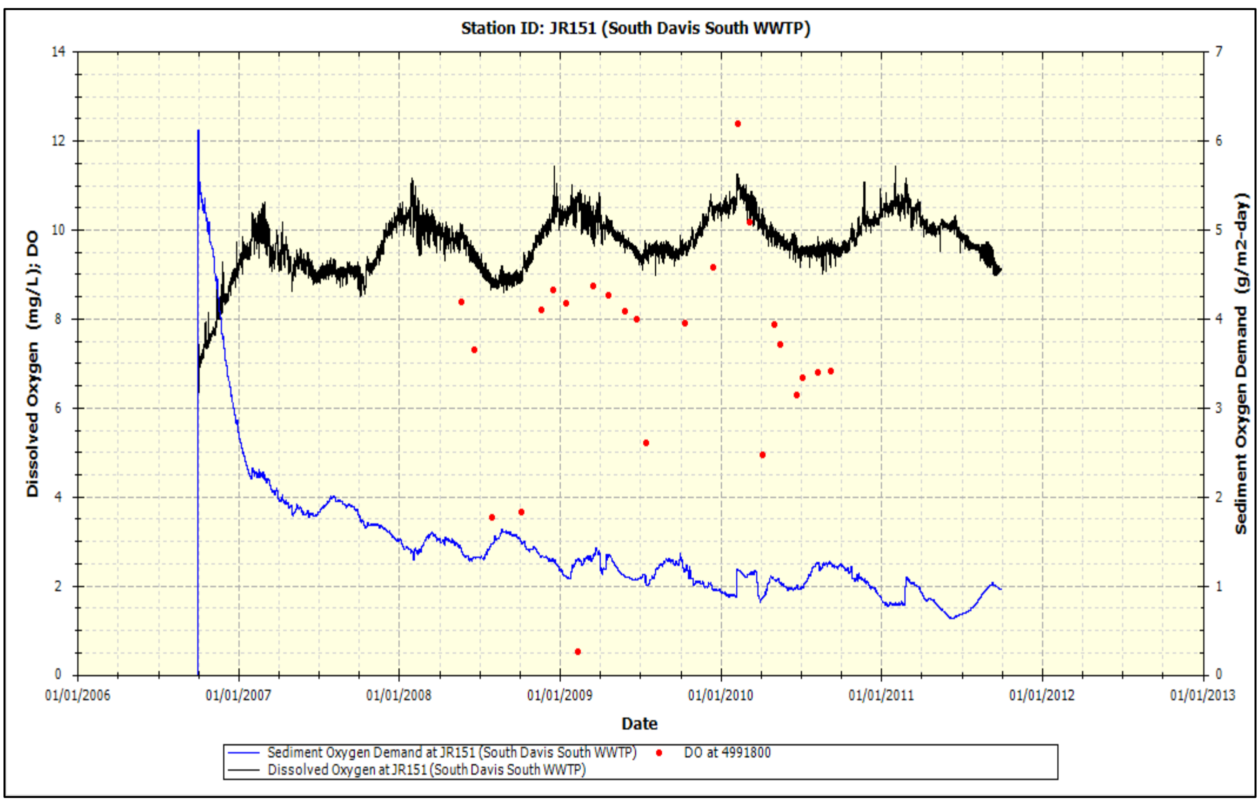

Station ID: JR133
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR133
DO at 4991890
Dissolved Oxygen at JR133


Station ID: JR136
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
12
11
10
9
8
7
6
5
7
6
5
4
3
2
1
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Sediment Oxygen Demand at JR136
DO at 4991880
Dissolved Oxygen at JR136

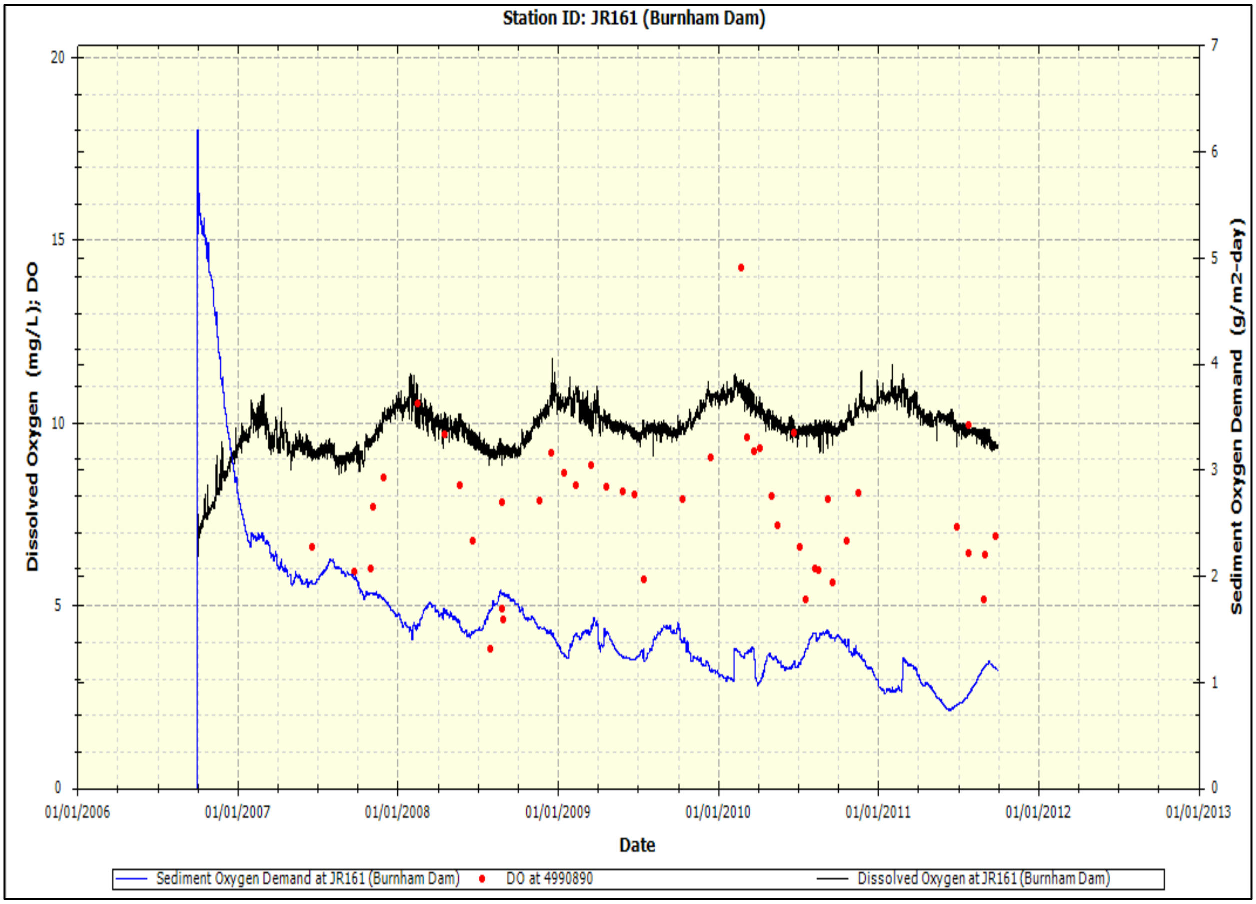

Station ID: JR140
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
20
15
10
5
0
7
6
5
4
3
2
1
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Sediment Oxygen Demand at JR140
DO at 4991860
Dissolved Oxygen at JR140



Station ID: JR150
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
0
5
10
15
20
0
1
2
3
4
5
6
7
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR150
DO at 4991820
Dissolved Oxygen at JR150

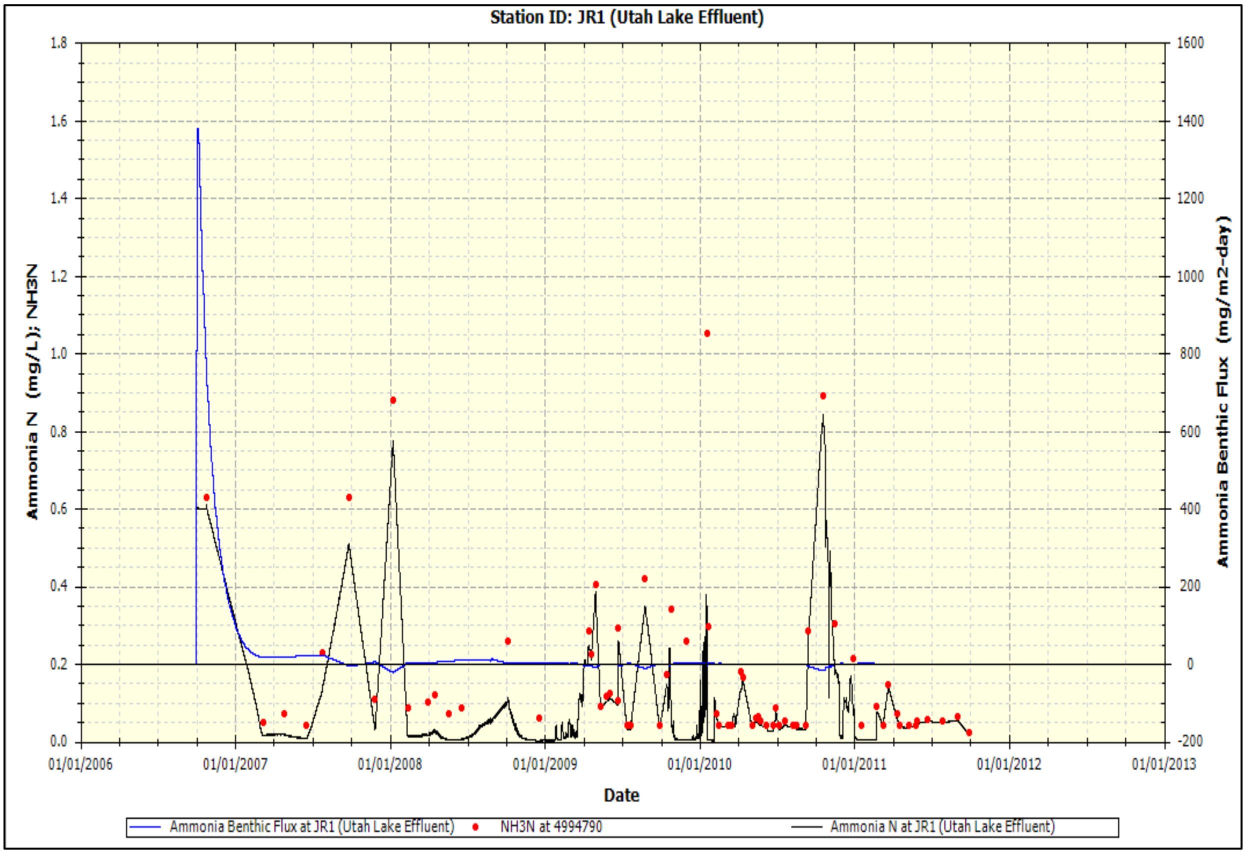


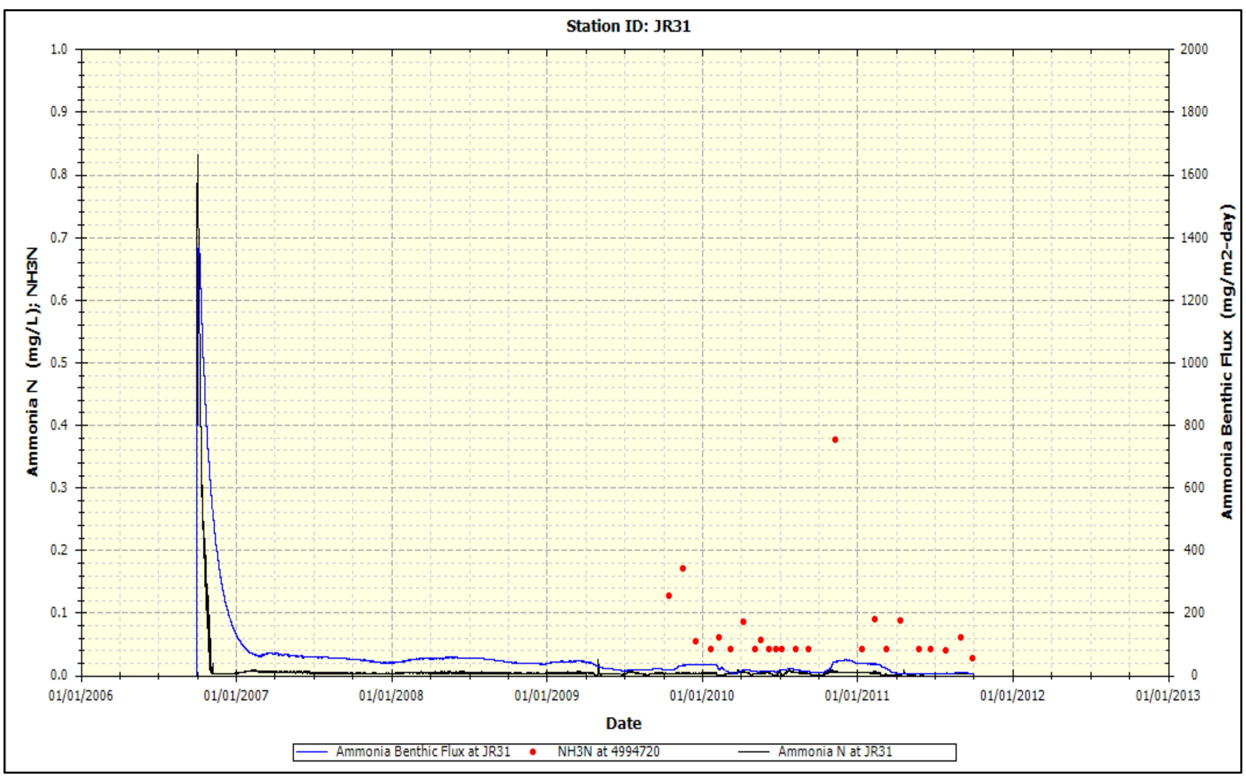
Station ID: JR151 (South Davis South WWTP)
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
Date
0
2
4
6
8
10
12
14
0
1
2
3
4
5
6
7
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Sediment Oxygen Demand at JR151 (South Davis South WWTP)
DO at 4991800
Dissolved Oxygen at JR151 (South Davis South WWTP)

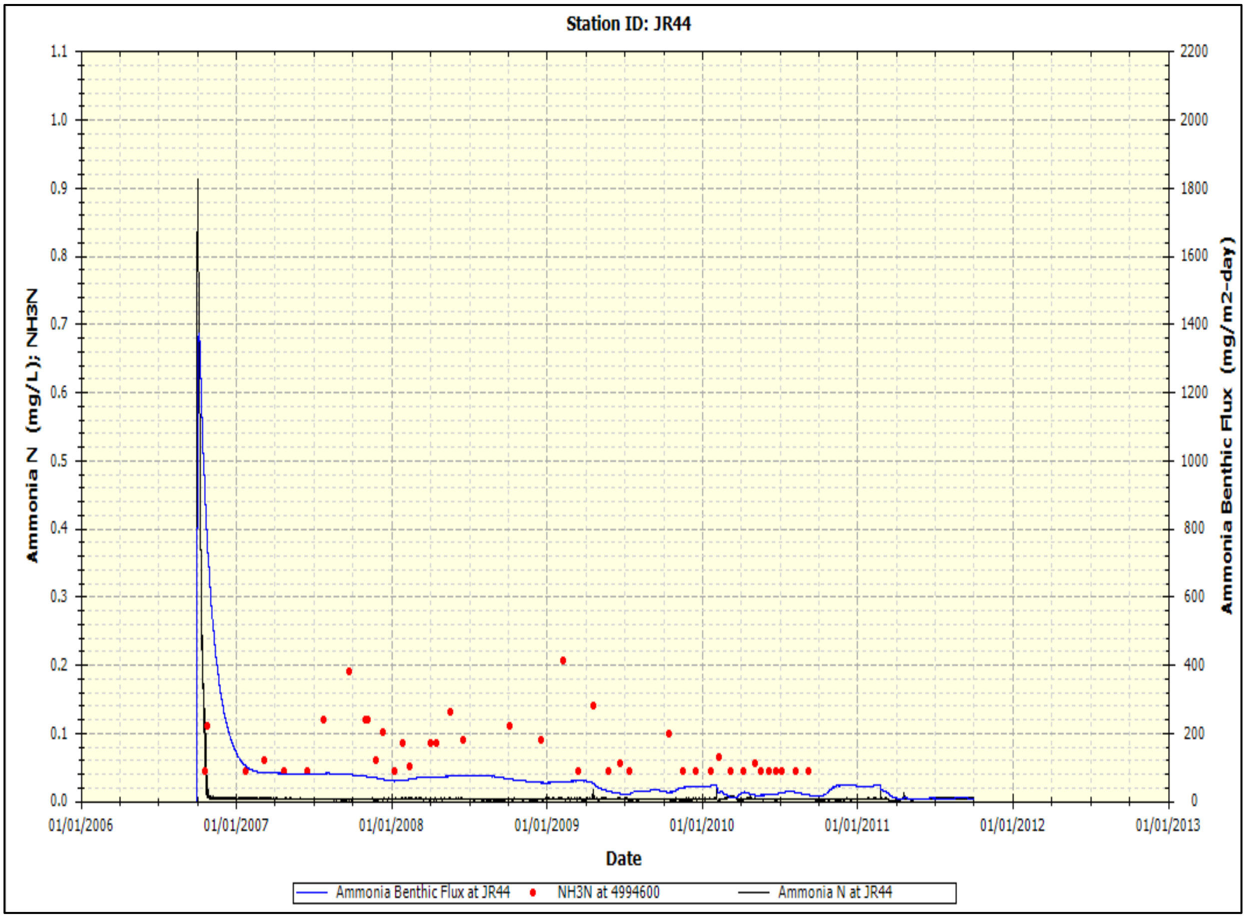


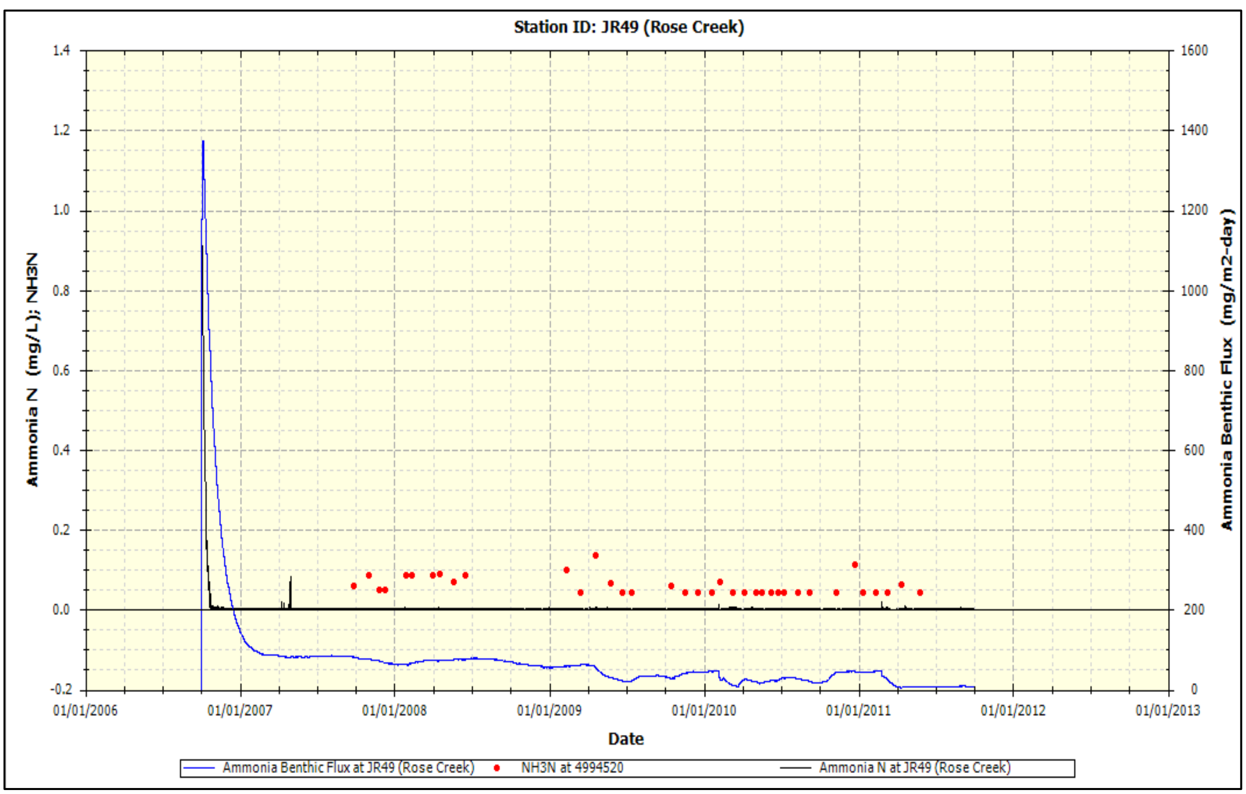
Station ID: JR161 (Burnham Dam)
Dissolved Oxygen (mg/L); DO
Sediment Oxygen Demand (g/m2-day)
20
15
10
5
0
7
6
5
4
3
2
1
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Sediment Oxygen Demand at JR161 (Burnham Dam)
DO at 4990890
Dissolved Oxygen at JR161 (Burnham Dam)

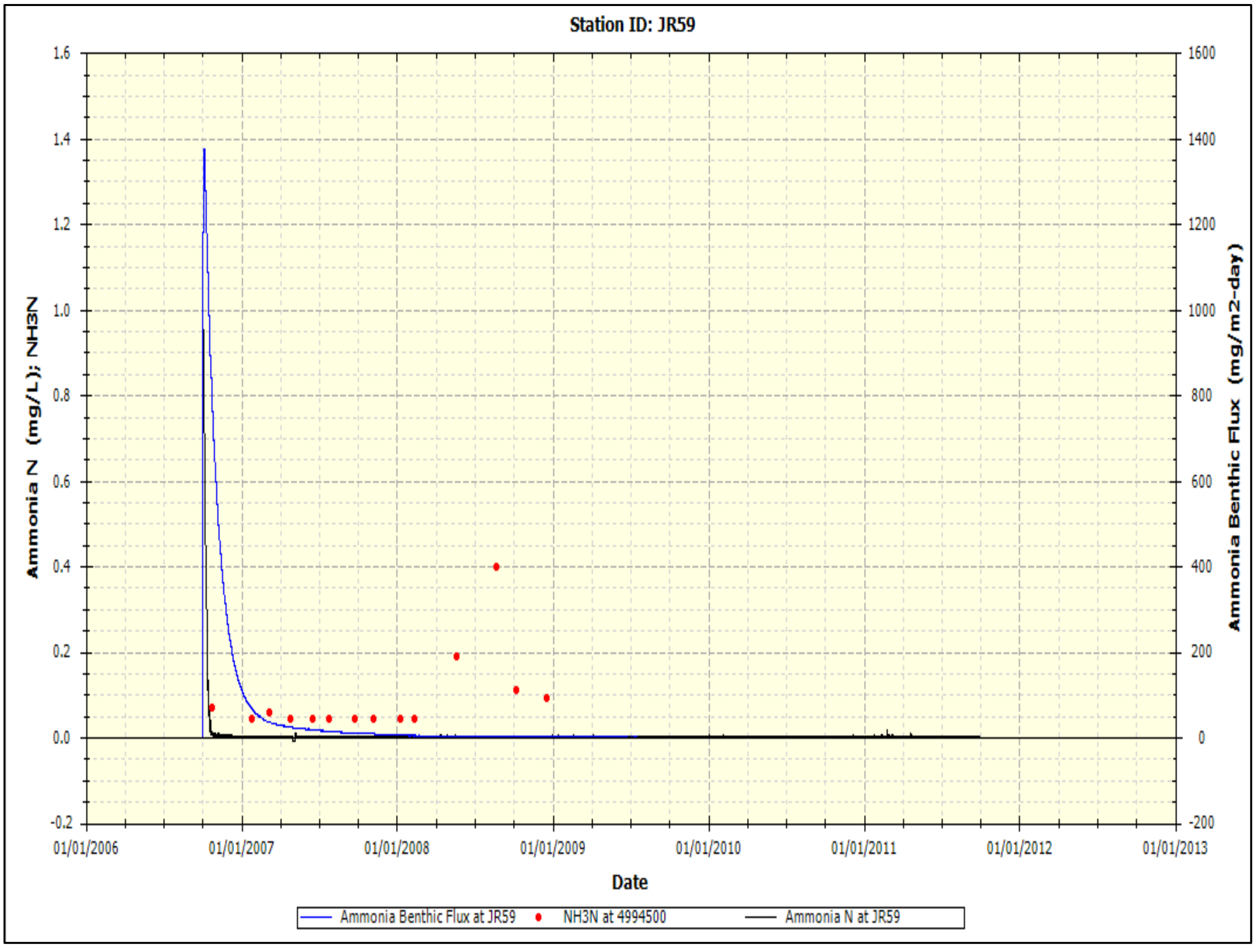
B.1.6: AMMONIA-NITROGEN

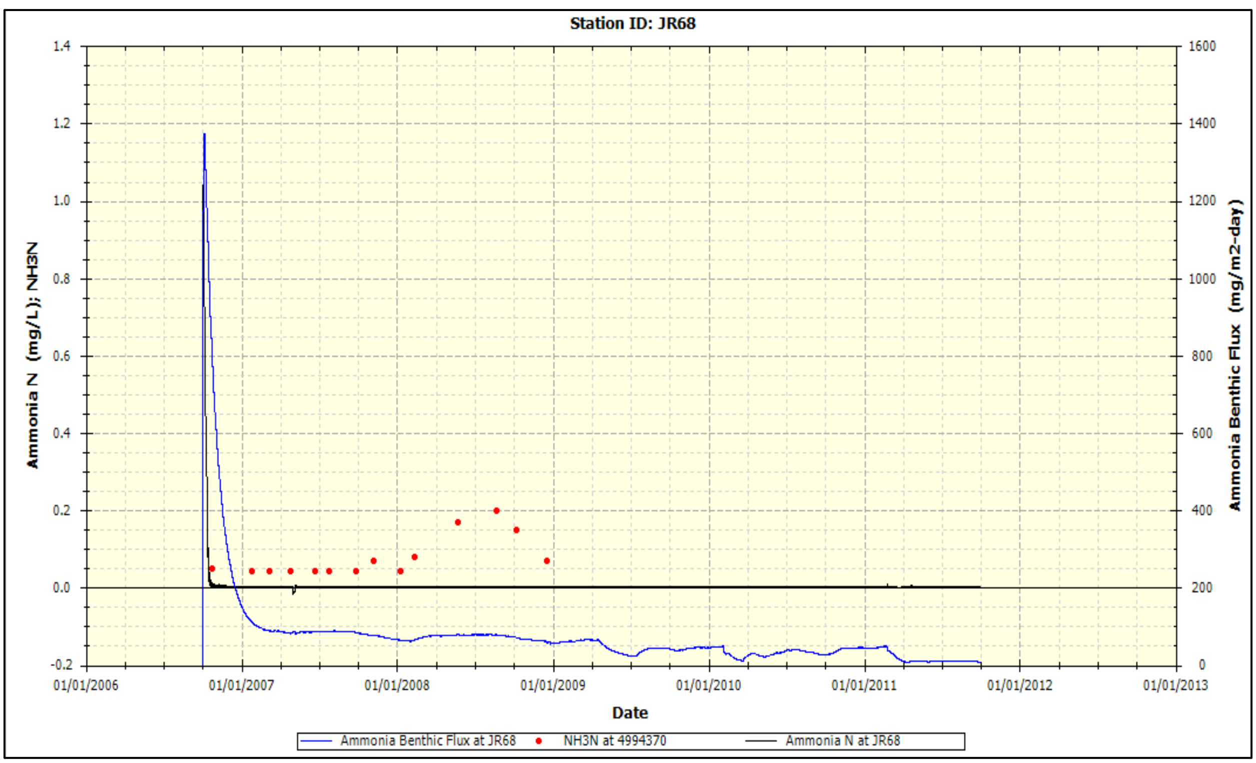


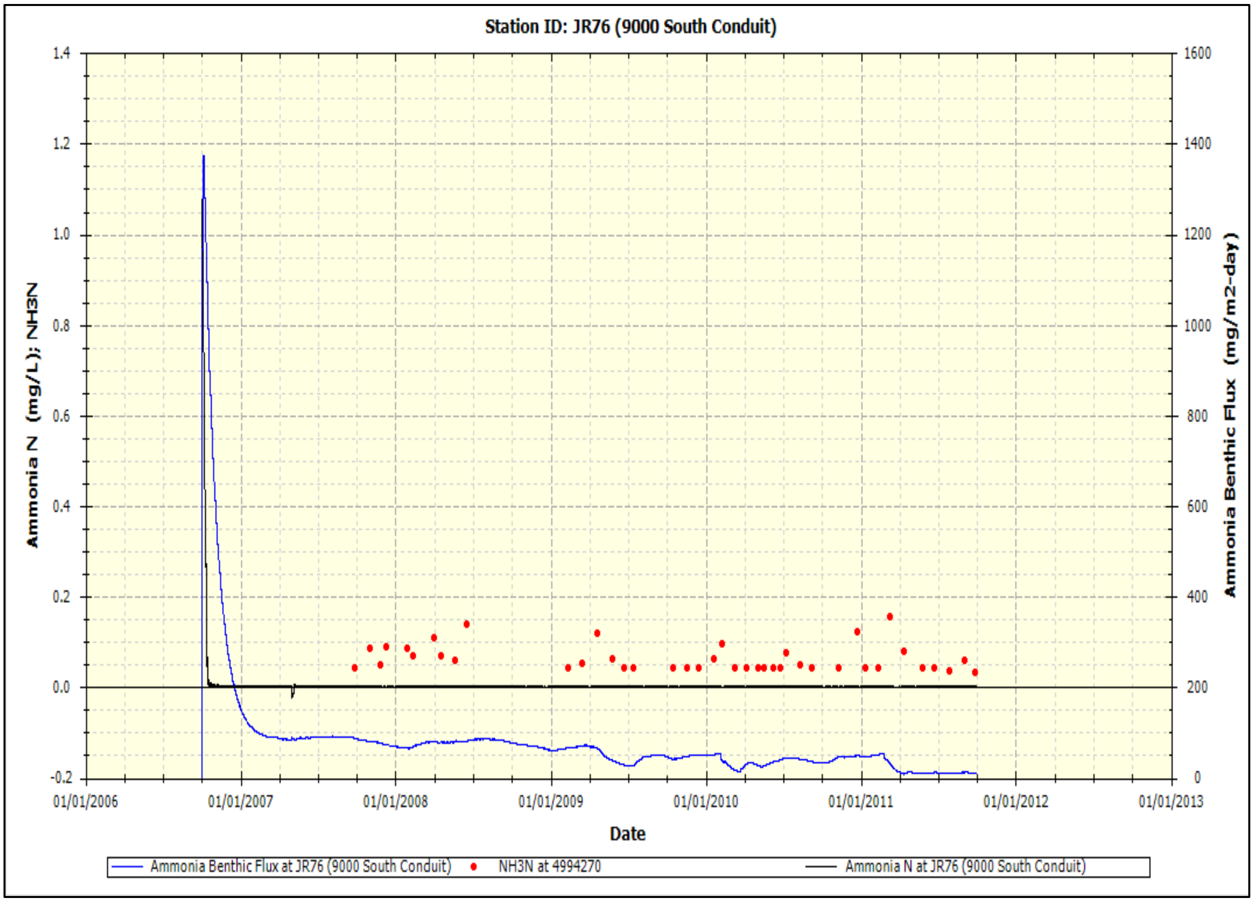


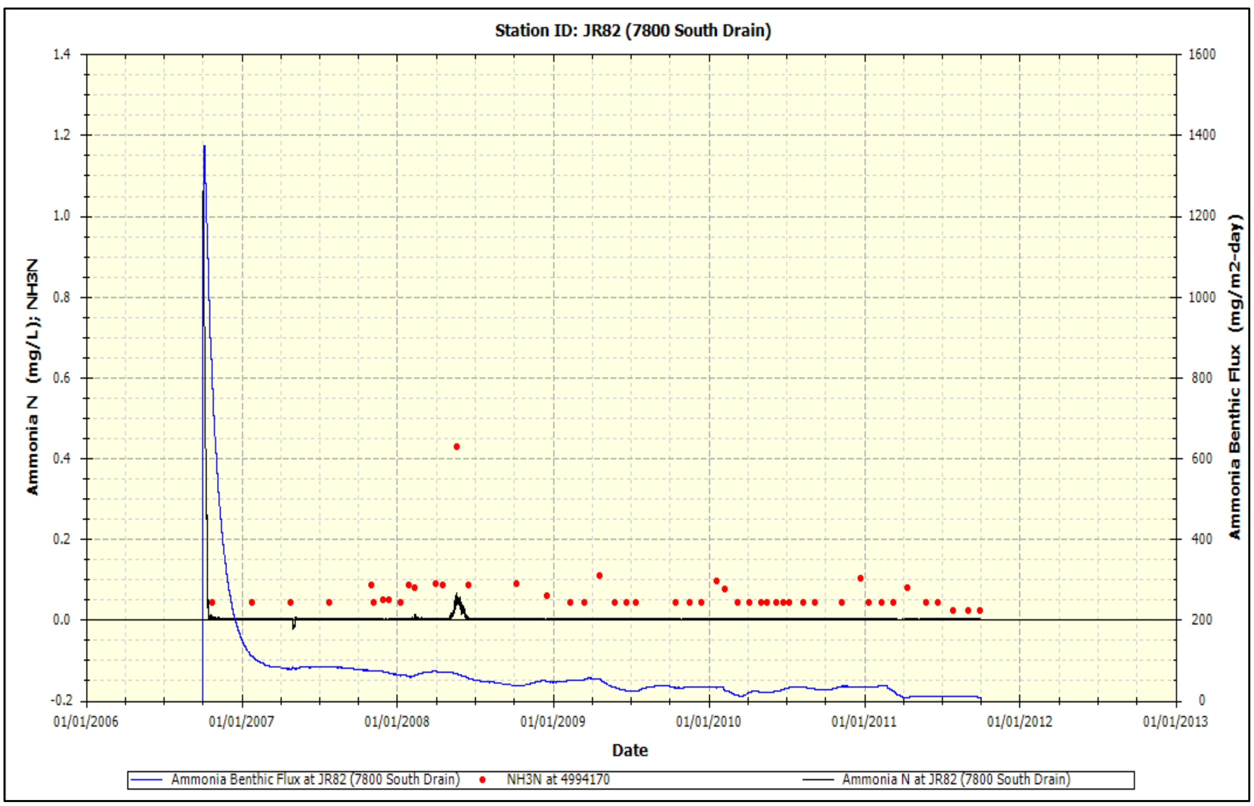

Station ID: JR44
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR44
NH3N at 4994600
Ammonia N at JR44

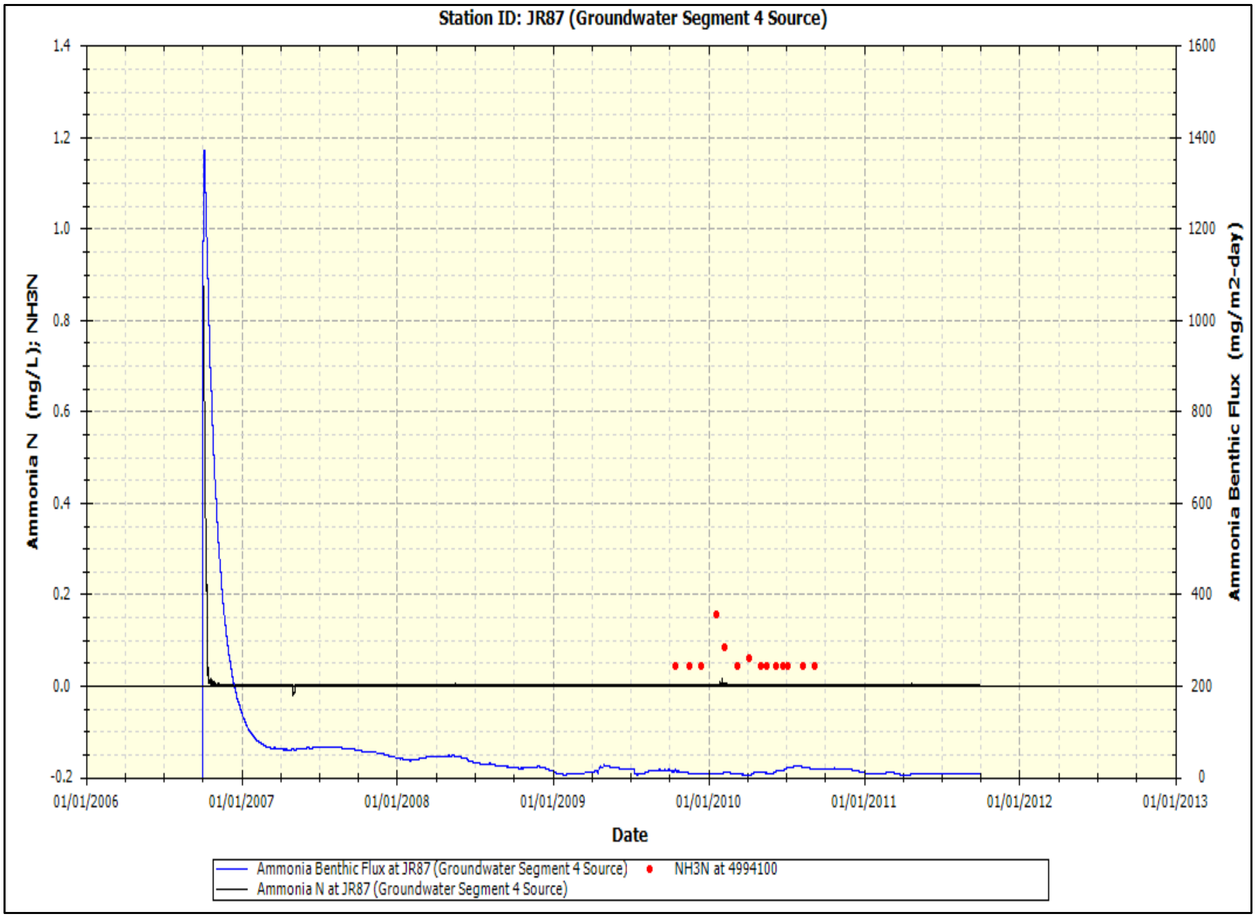

Station ID: JR49 (Rose Creek)
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR49 (Rose Creek)
NH3N at 4994520
Ammonia N at JR49 (Rose Creek)

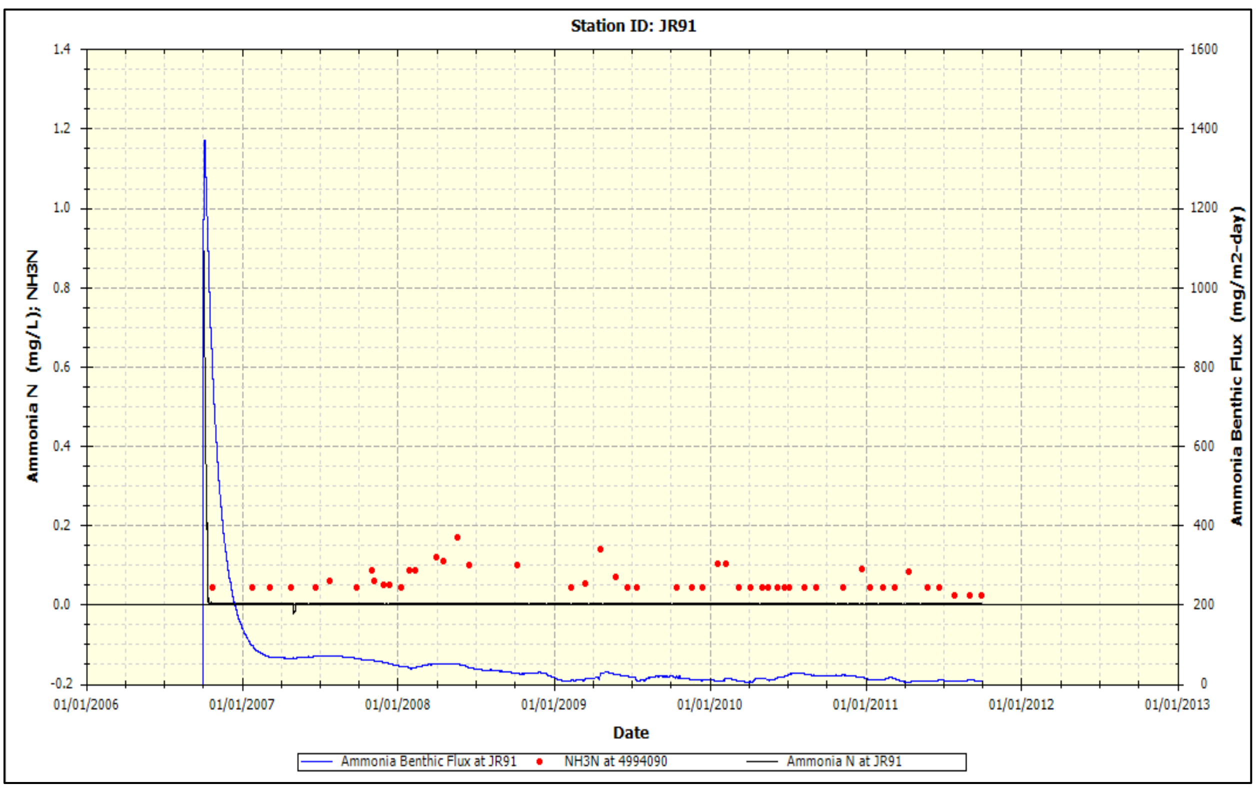

Station ID: JR59
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR59
NH3N at 4994500
Ammonia N at JR59

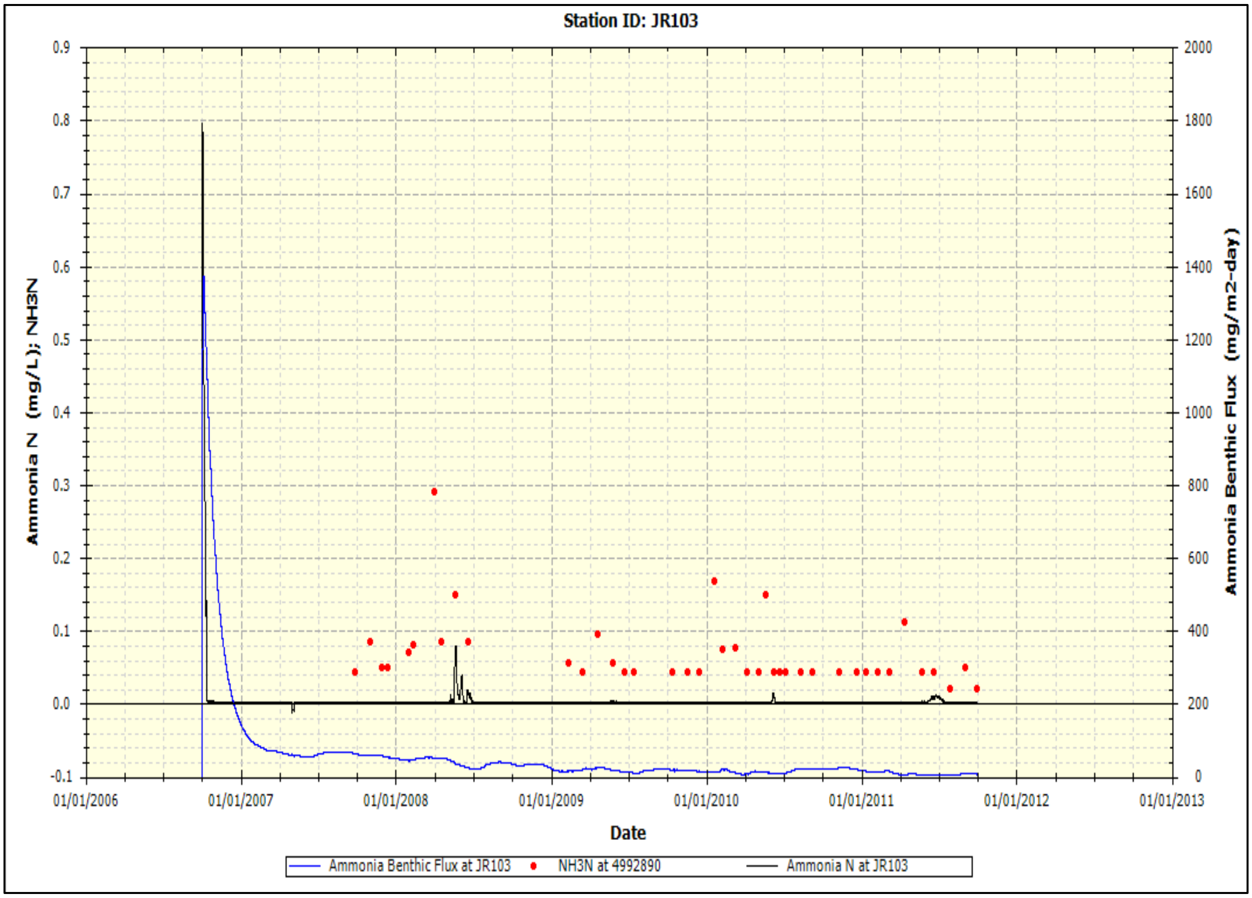

Station ID: JR68
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR68
NH3N at 4994370
Ammonia N at JR68

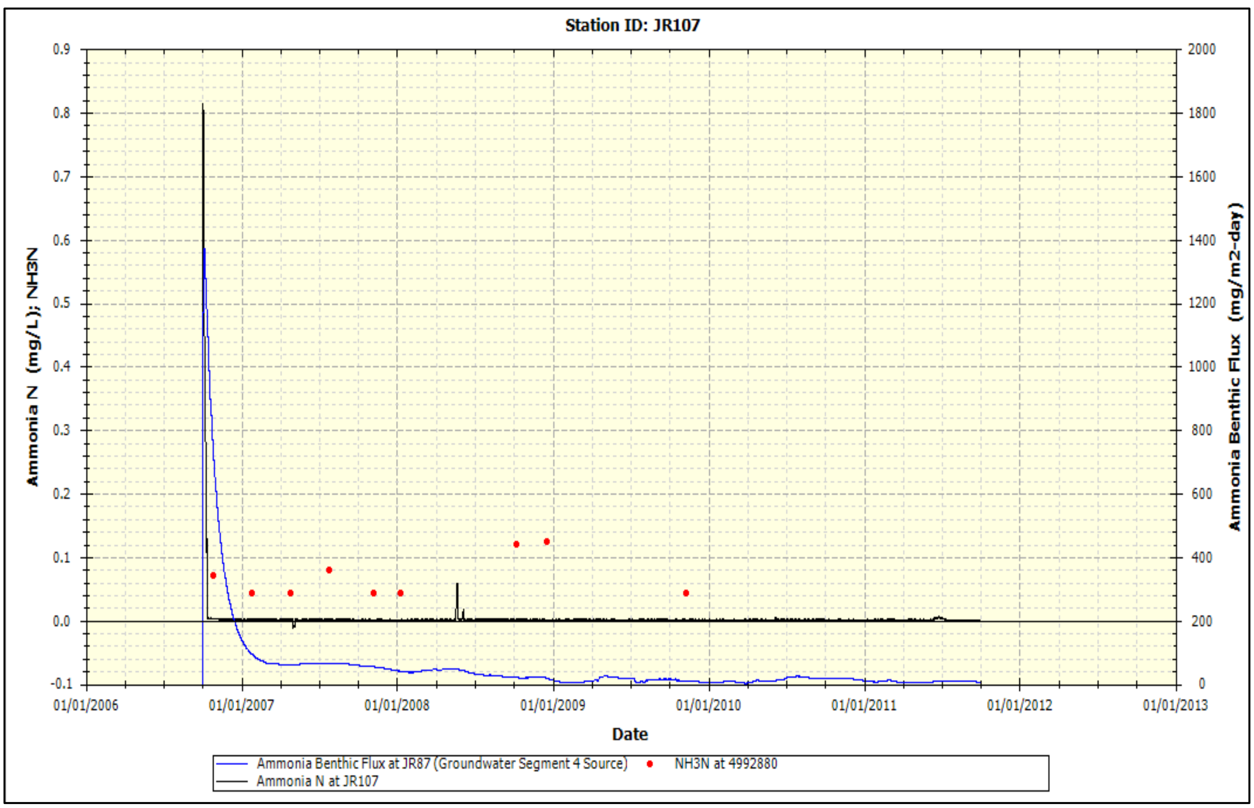

Station ID: JR76 (9000 South Conduit)
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1600
1400
1200
1000
800
600
400
200
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Ammonia Benthic Flux at JR76 (9000 South Conduit)
NH3N at 4994270
Ammonia N at JR76 (9000 South Conduit)

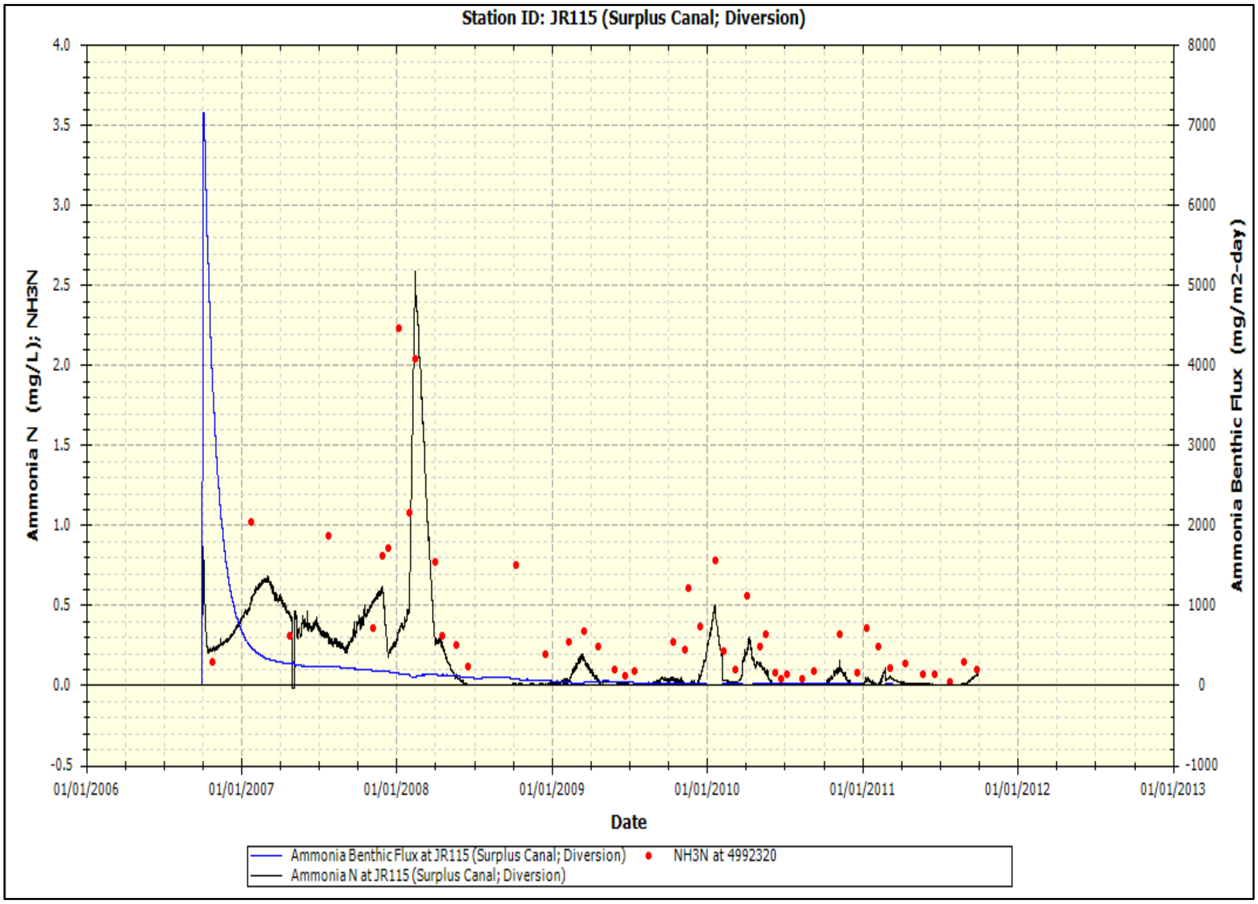

Station ID: JR82 (7800 South Drain)
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1600
1400
1200
1000
800
600
400
200
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Ammonia Benthic Flux at JR82 (7800 South Drain)
NH3N at 4994170
Ammonia N at JR82 (7800 South Drain)

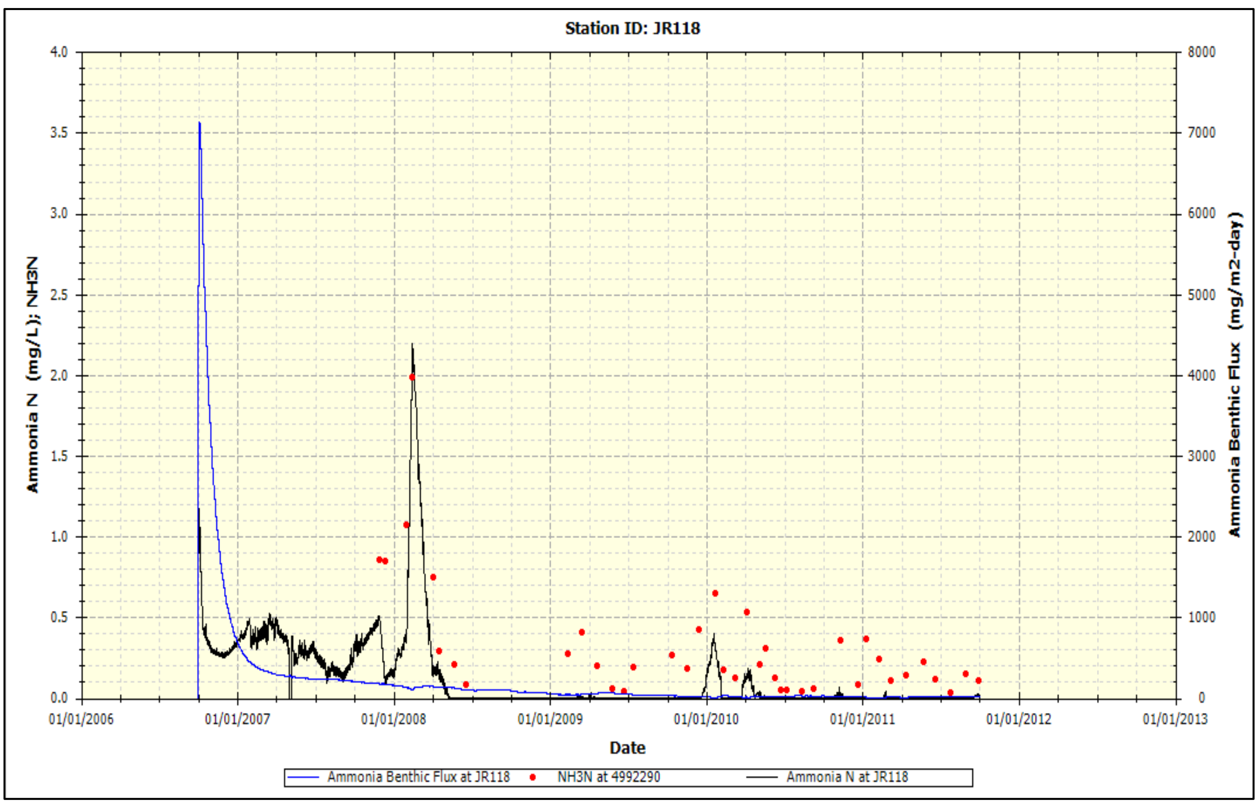

Station ID: JR87 (Groundwater Segment 4 Source)
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR87 (Groundwater Segment 4 Source)
NH3N at 4994100
Ammonia N at JR87 (Groundwater Segment 4 Source)

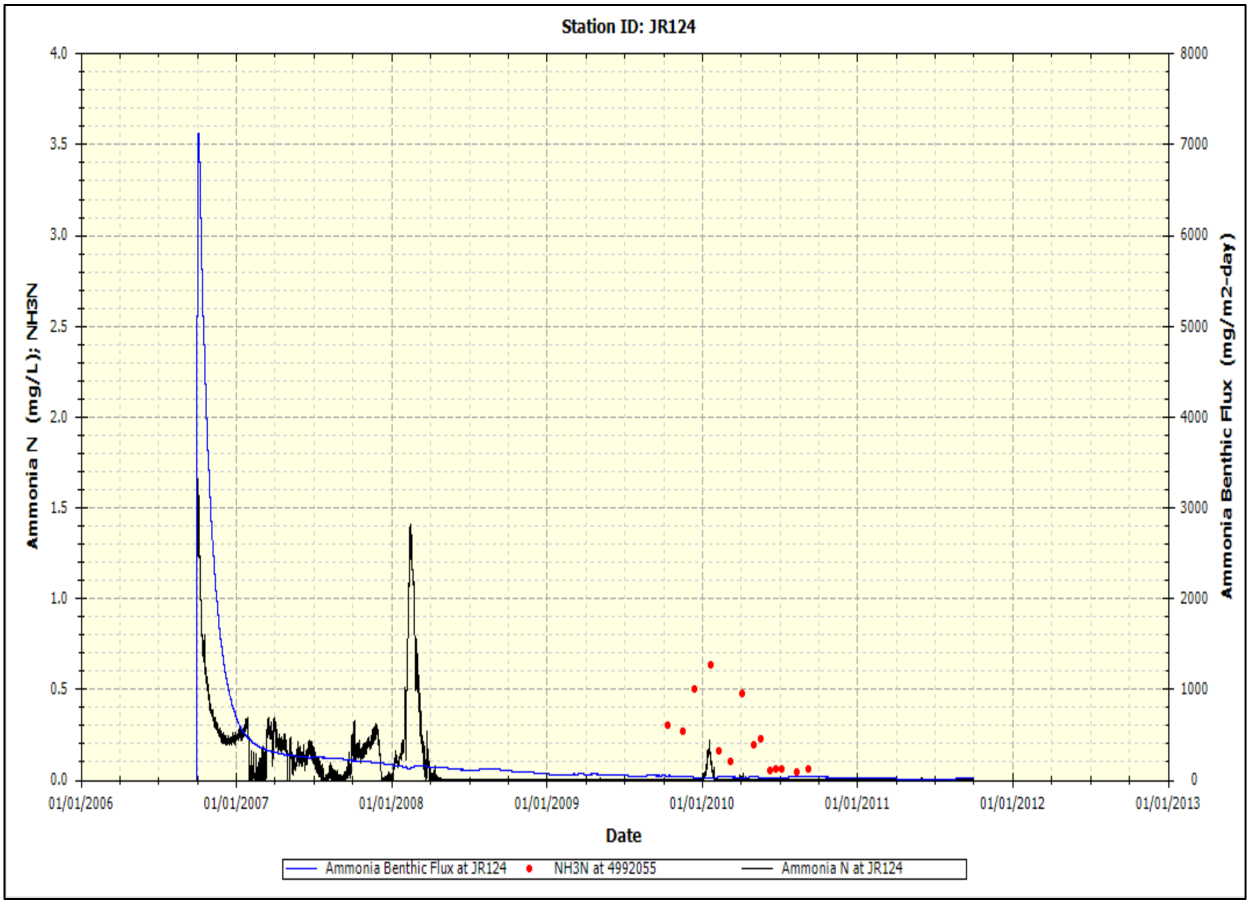

Station ID: JR91
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR91
NH3N at 4994090
Ammonia N at JR91

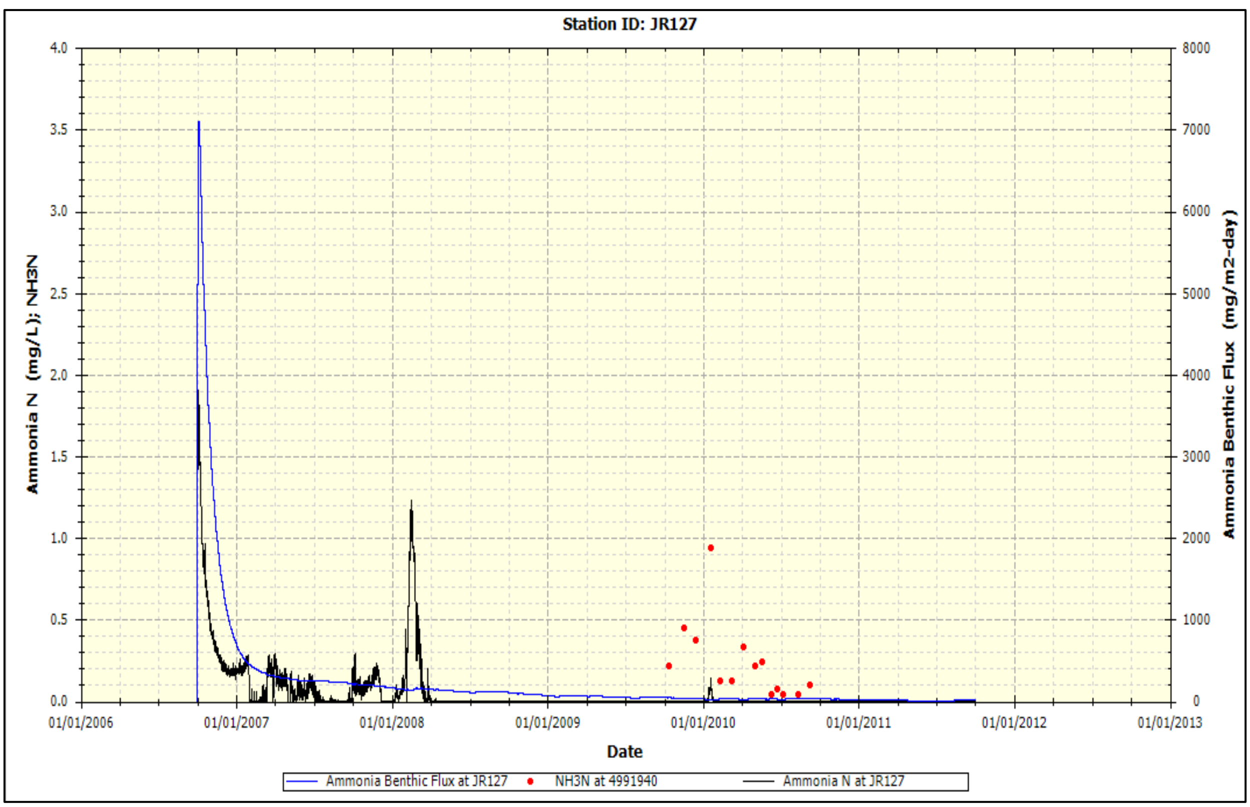

Station ID: JR103
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR103
NH3N at 4992890
Ammonia N at JR103

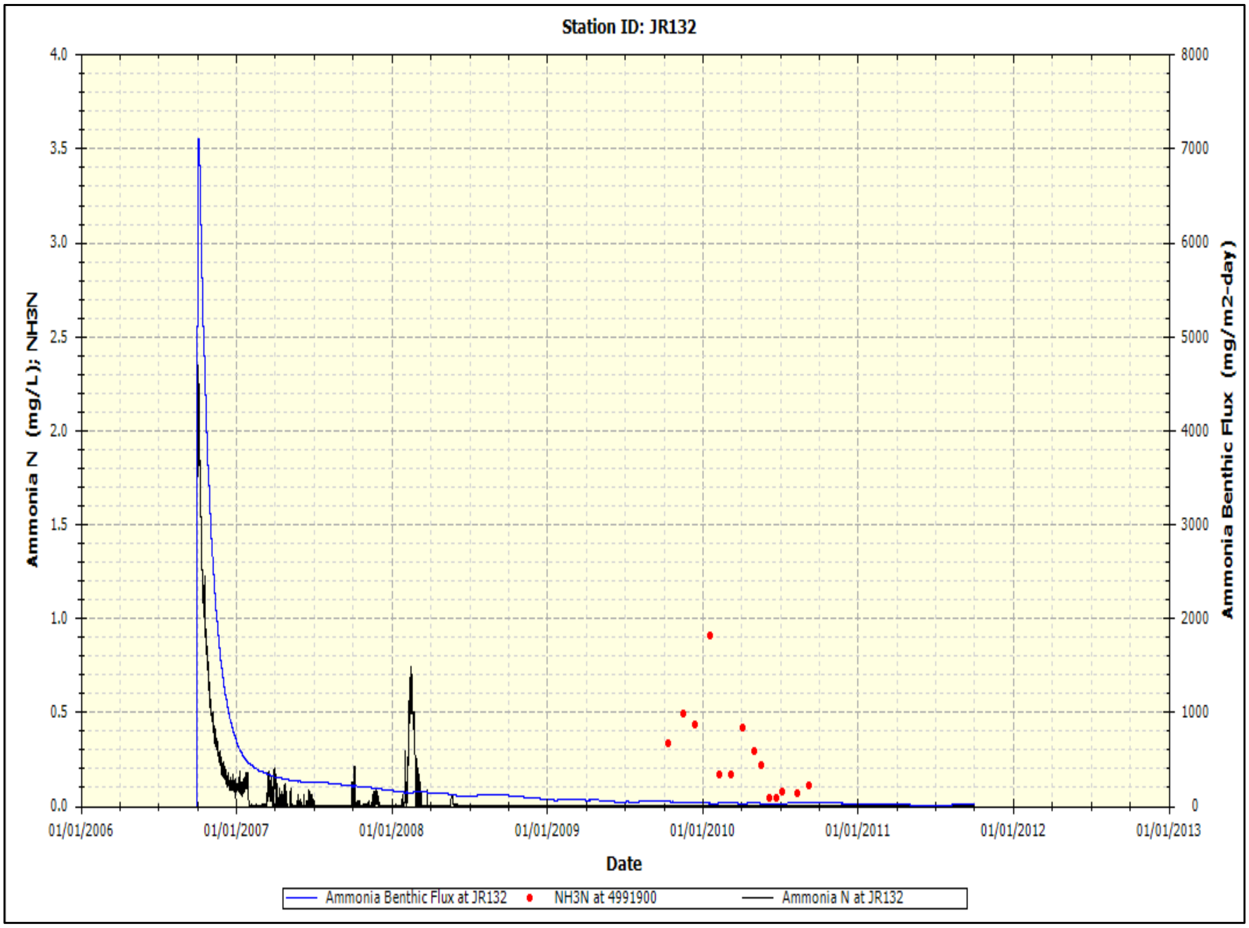

Station ID: JR107
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR87 (Groundwater Segment 4 Source)
NH3N at 4992880
Ammonia N at JR107

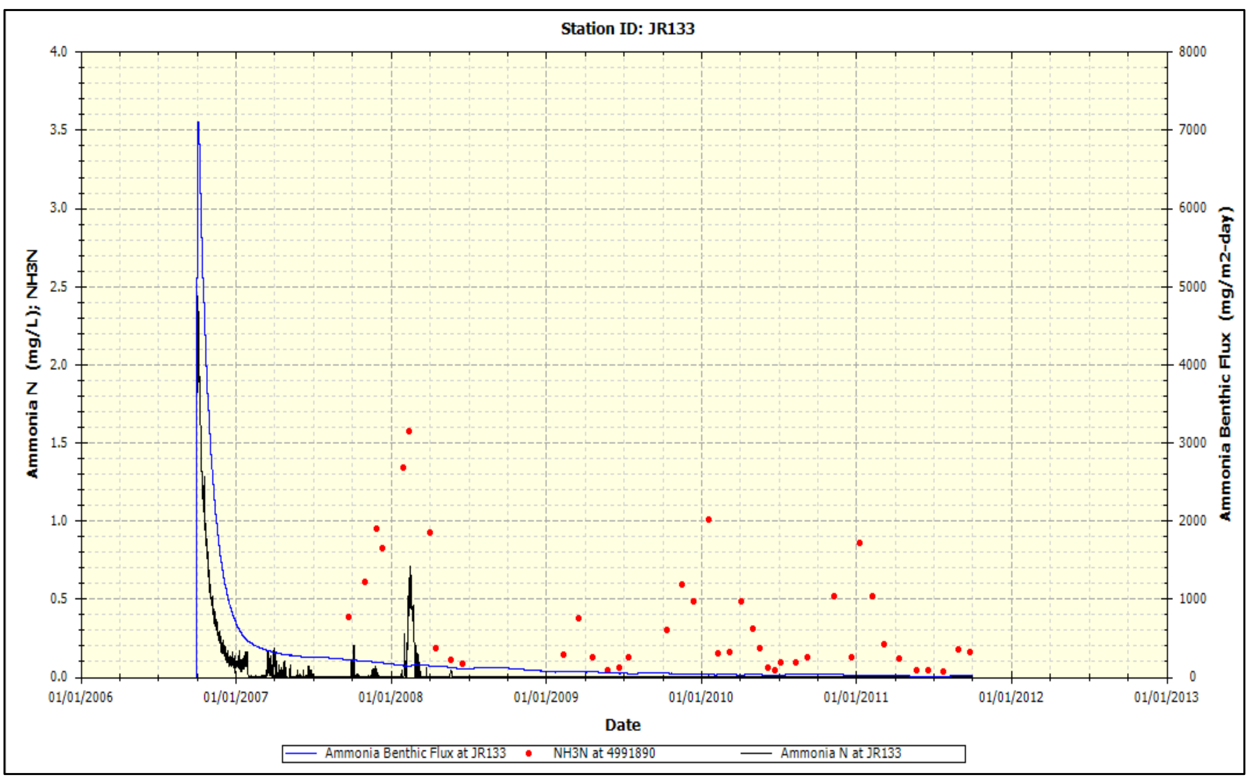

Station ID: JR115 (Surplus Canal; Diversion)
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR115 (Surplus Canal; Diversion)
NH3N at 4992320
Ammonia N at JR115 (Surplus Canal; Diversion)

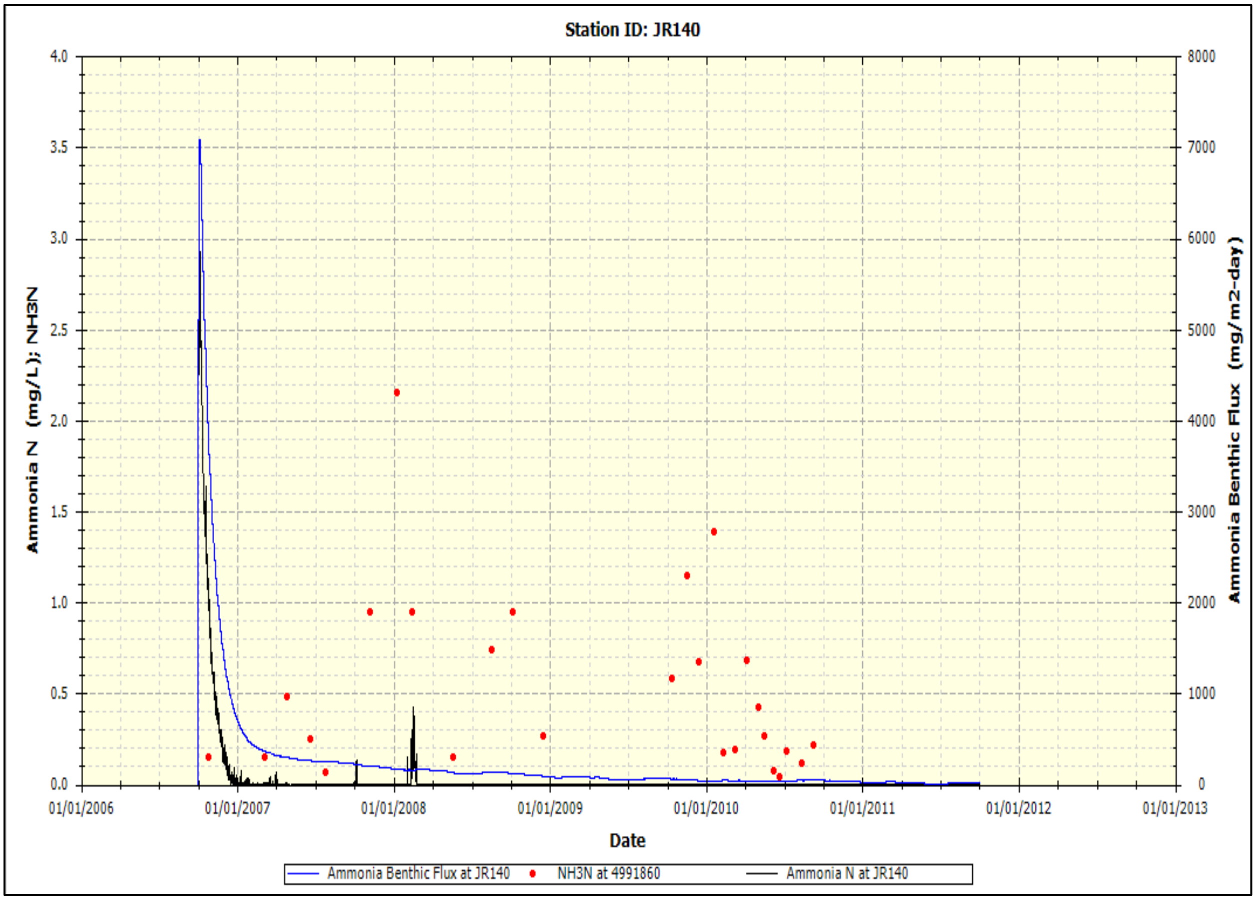

Station ID: JR118
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR118
NH3N at 4992290
Ammonia N at JR118

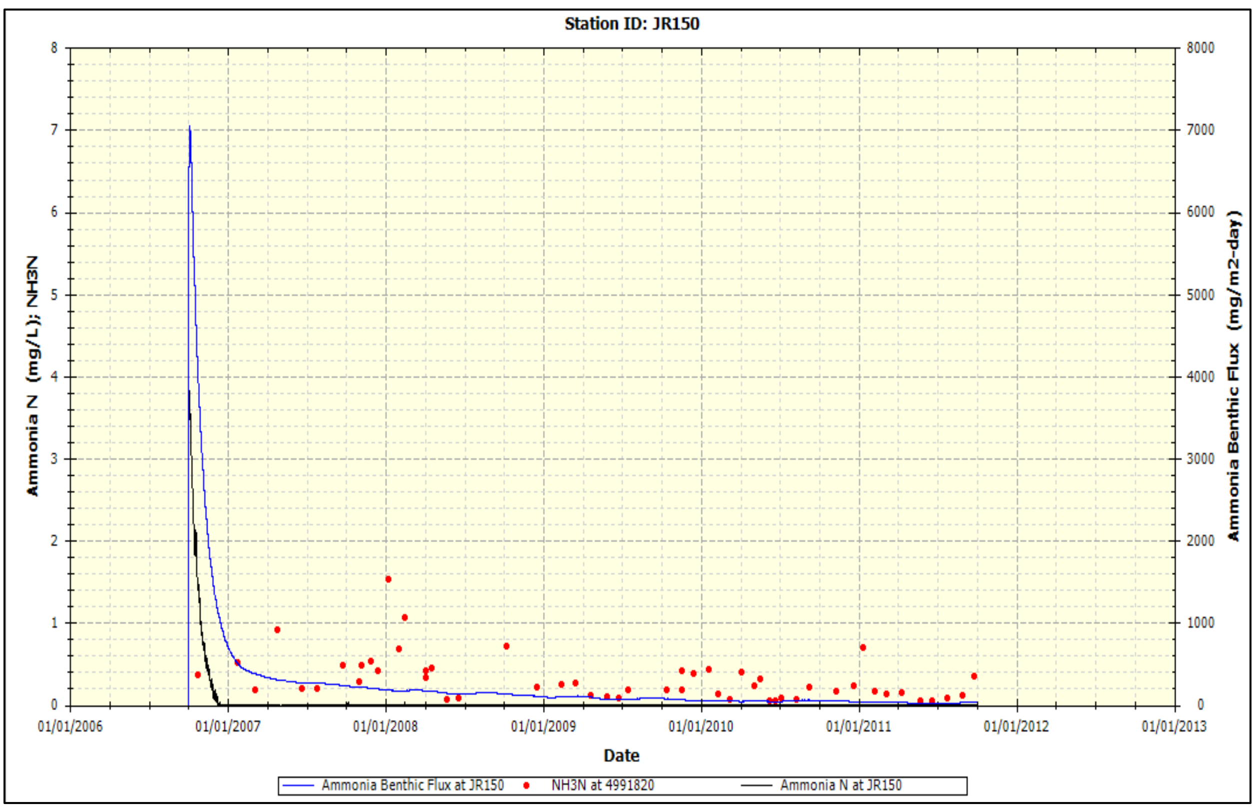

Station ID: JR124
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR124
NH3N at 4992055
Ammonia N at JR124

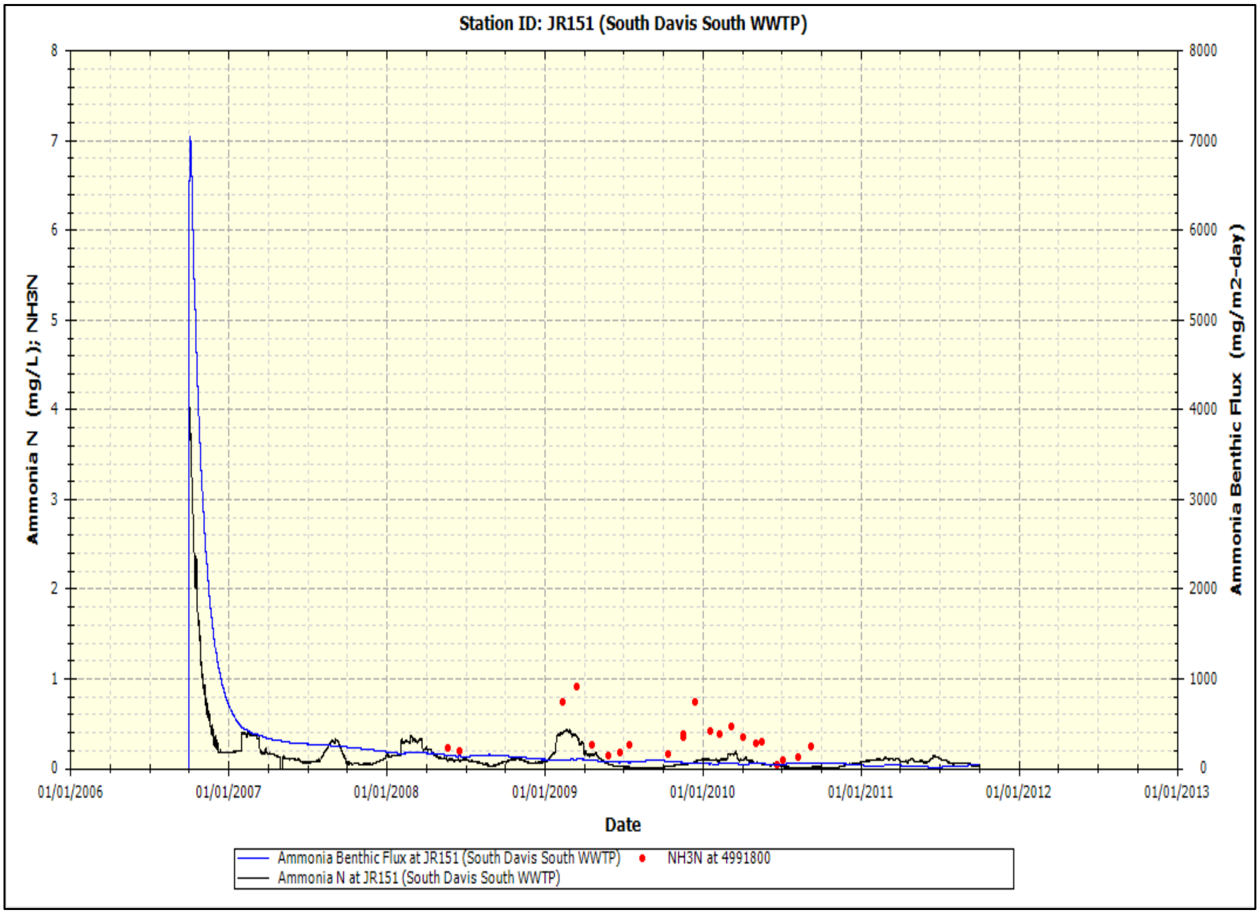

Station ID: JR127
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR127
NH3N at 4991940
Ammonia N at JR127


Station ID: JR132
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
8000
7000
6000
5000
4000
3000
2000
1000
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Ammonia Benthic Flux at JR132
NH3N at 4991900
Ammonia N at JR132

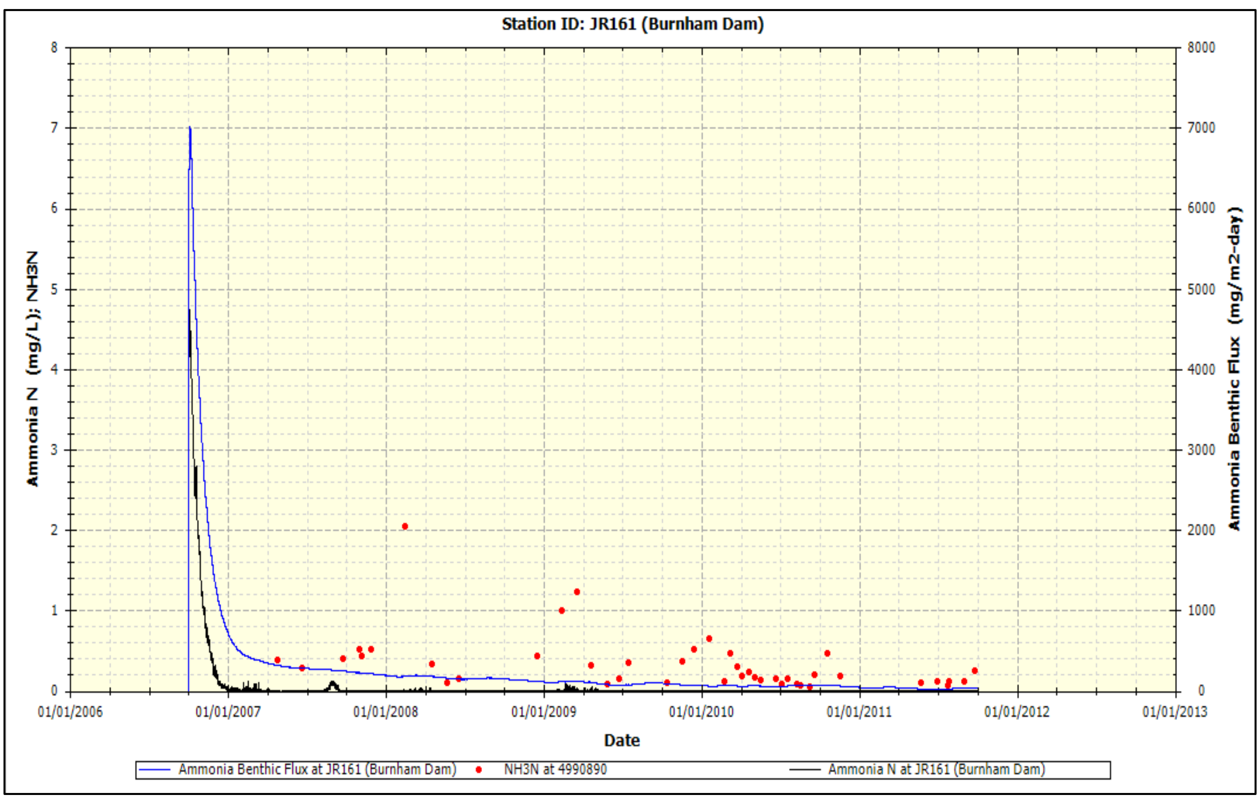

Station ID: JR133
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
8000
7000
6000
5000
4000
3000
2000
1000
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
Ammonia Benthic Flux at JR133
NH3N at 4991890
Ammonia N at JR133


Station ID: JR140
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR140
NH3N at 4991860
Ammonia N at JR140


Station ID: JR150
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
Ammonia Benthic Flux at JR150
NH3N at 4991820
Ammonia N at JR150

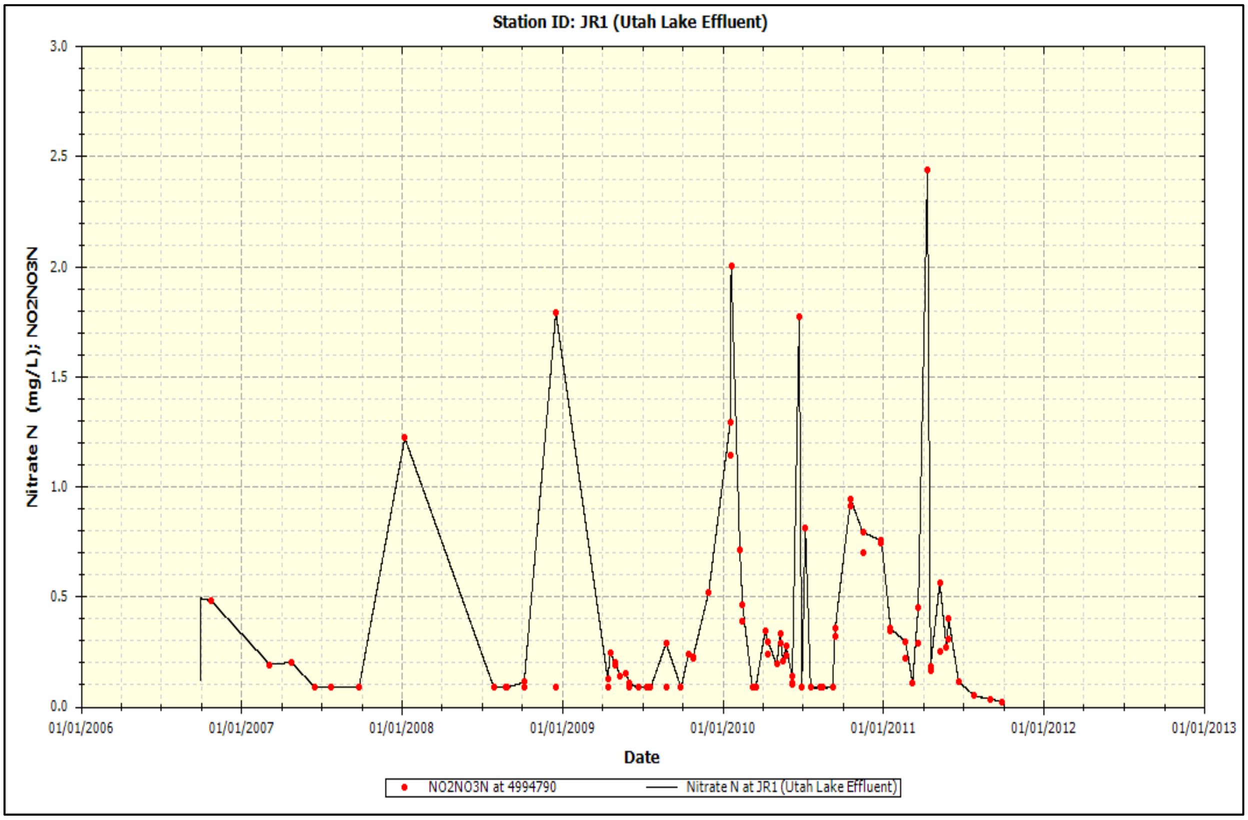


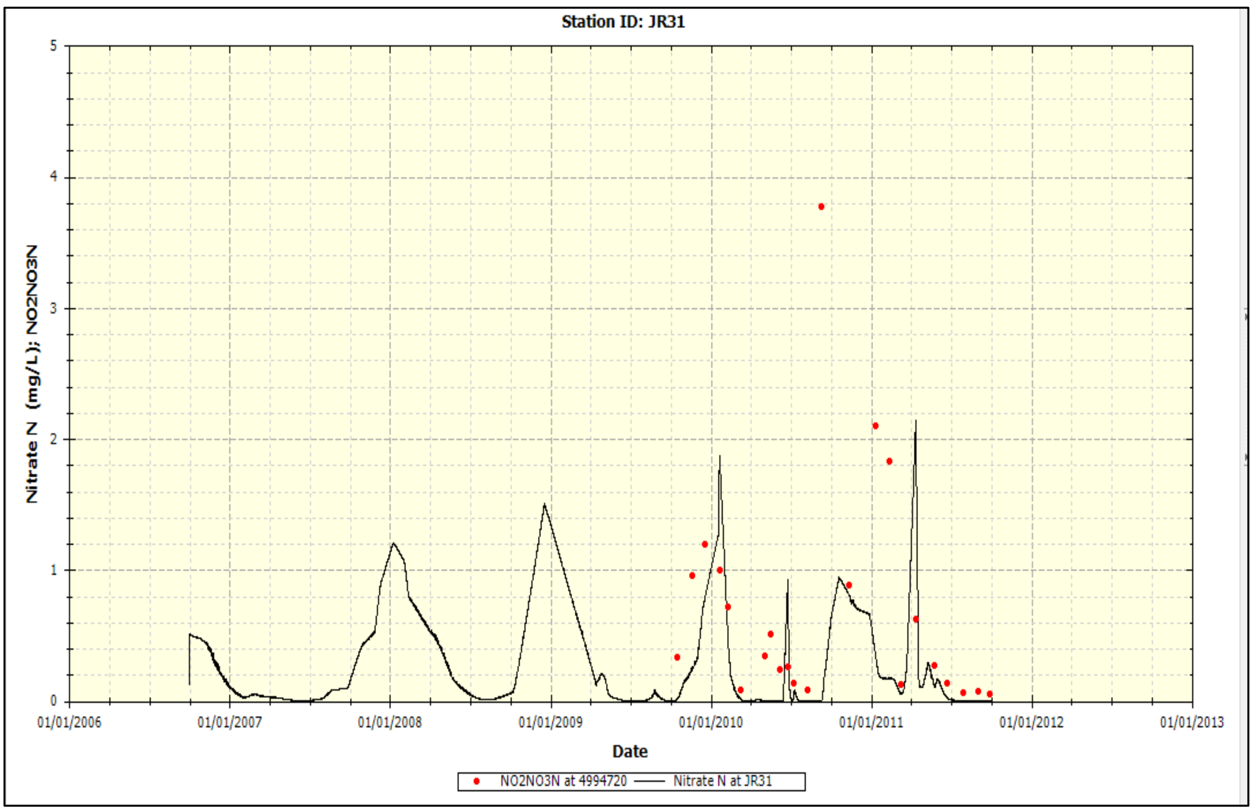
Station ID: JR151 (South Davis South WWTP)
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR151 (South Davis South WWTP)
NH3N at 4991800
Ammonia N at JR151 (South Davis South WWTP)

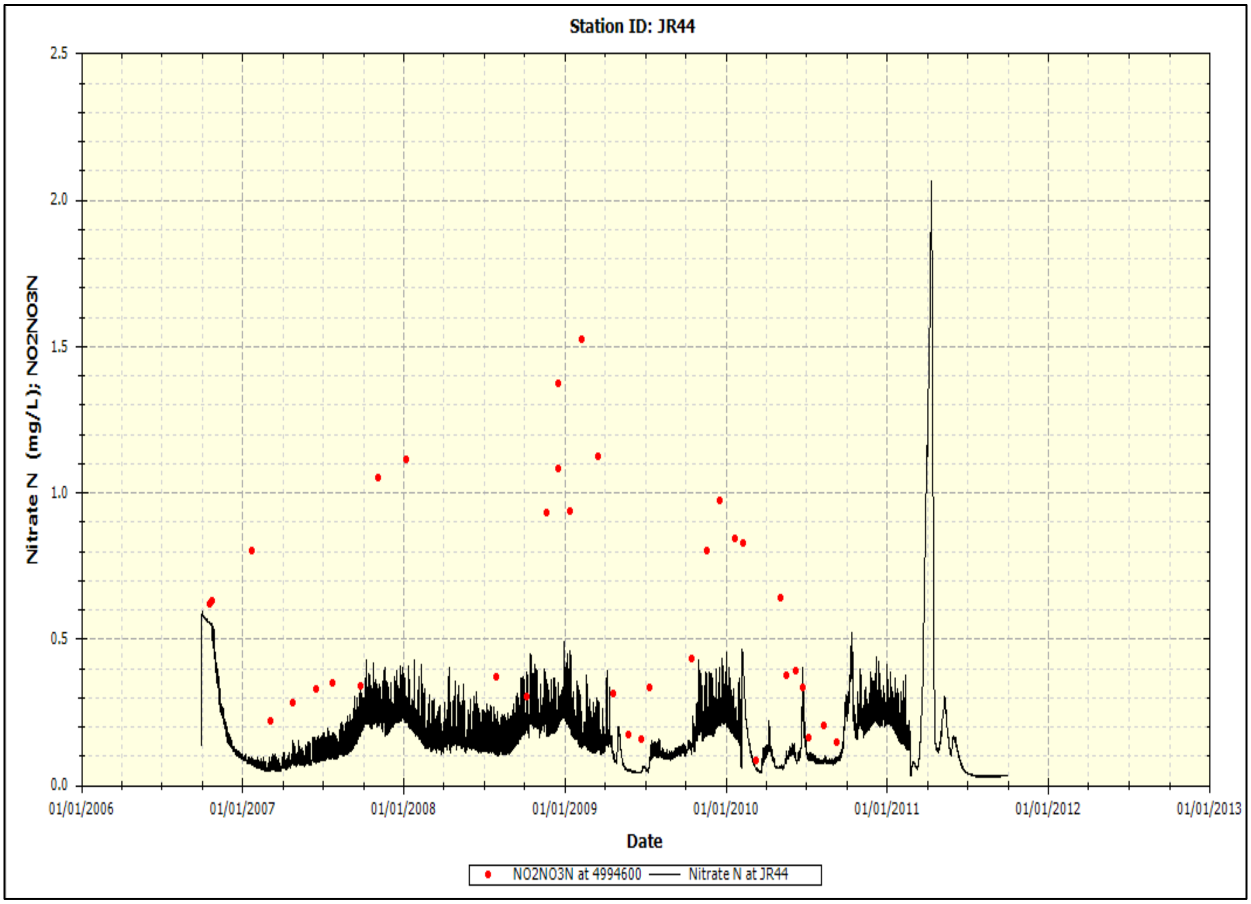


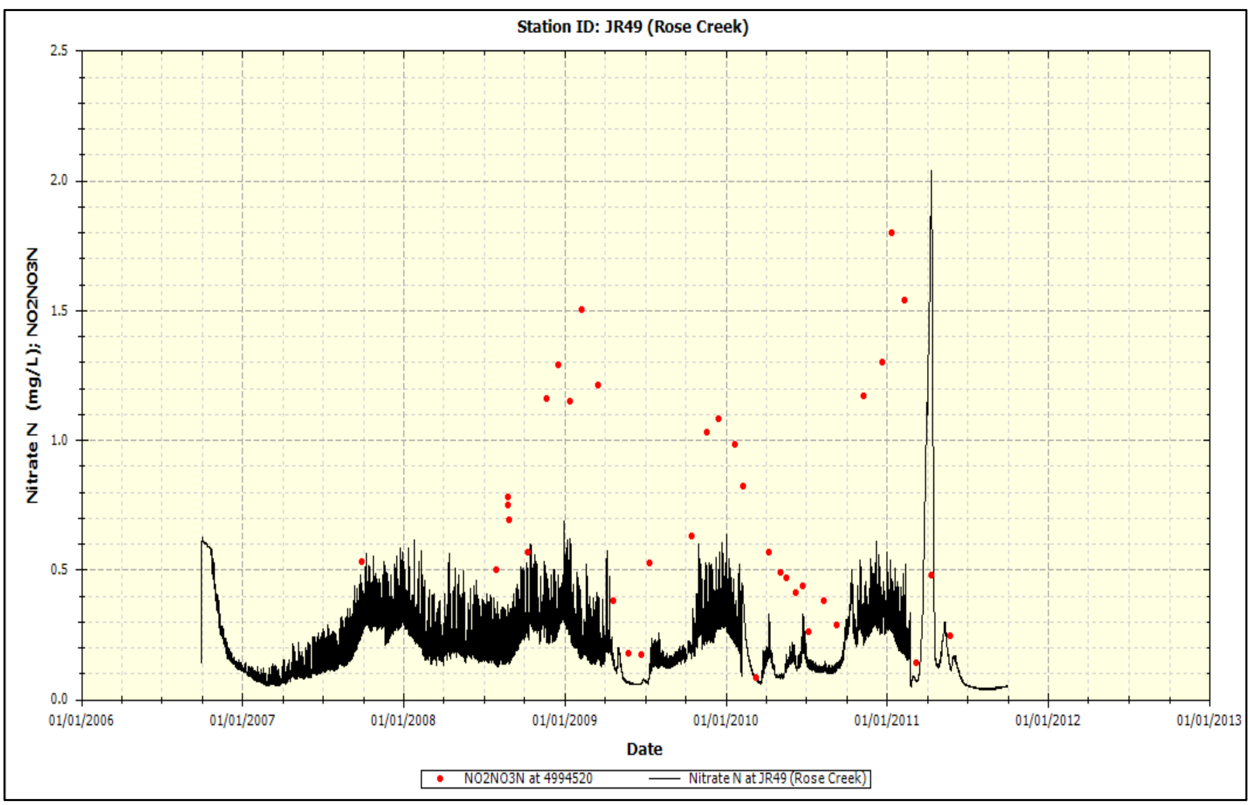
Station ID: JR161 (Burnham Dam)
Ammonia N (mg/L); NH3N
Ammonia Benthic Flux (mg/m2-day)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Ammonia Benthic Flux at JR161 (Burnham Dam)
NH3N at 4990890
Ammonia N at JR161 (Burnham Dam)

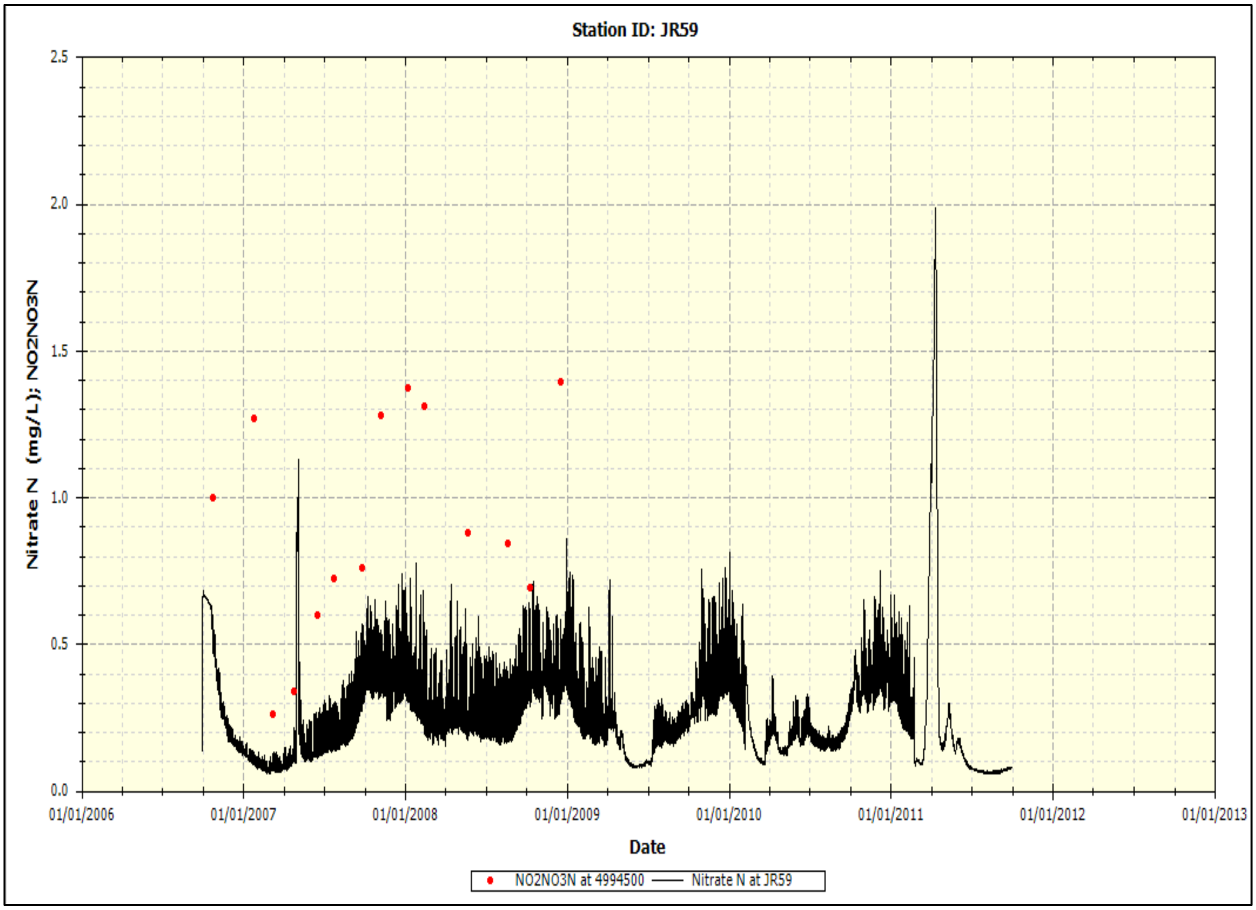
B.1.7: INORGANIC NITROGEN (NITRATE AND NITRITE)

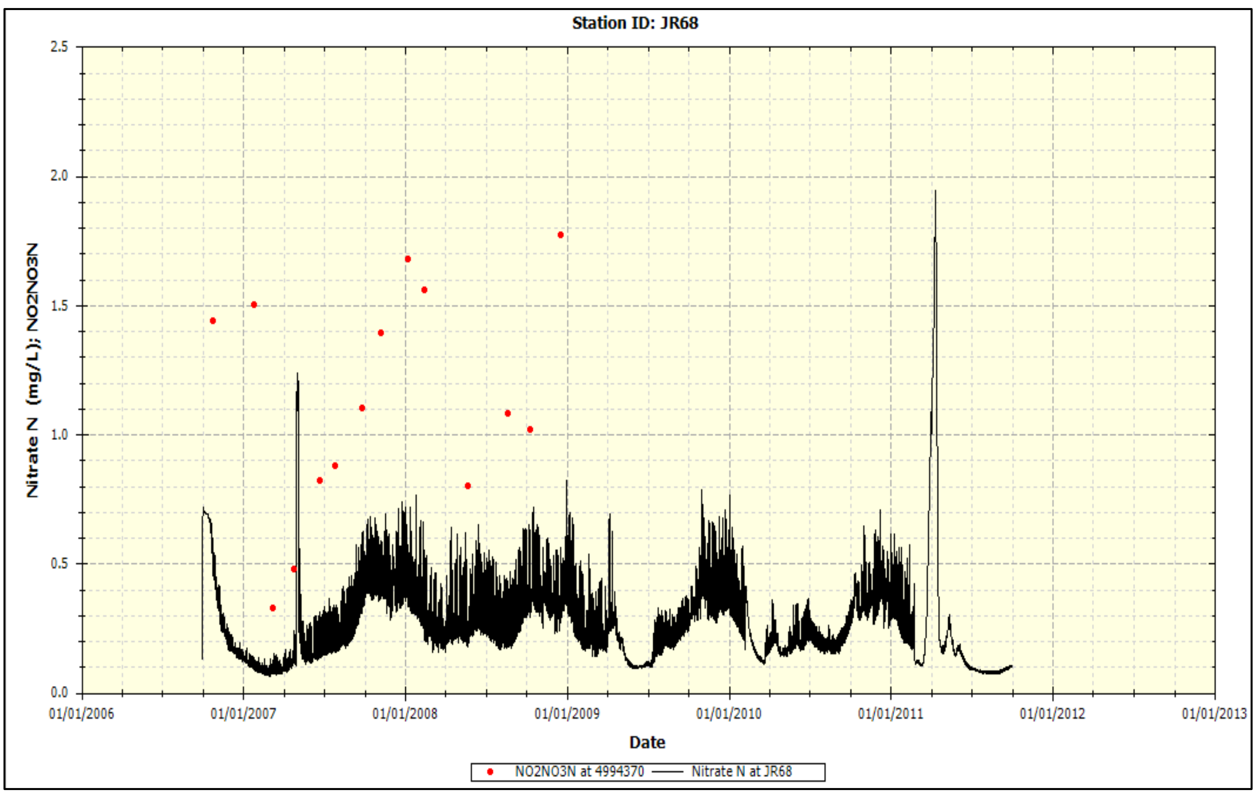


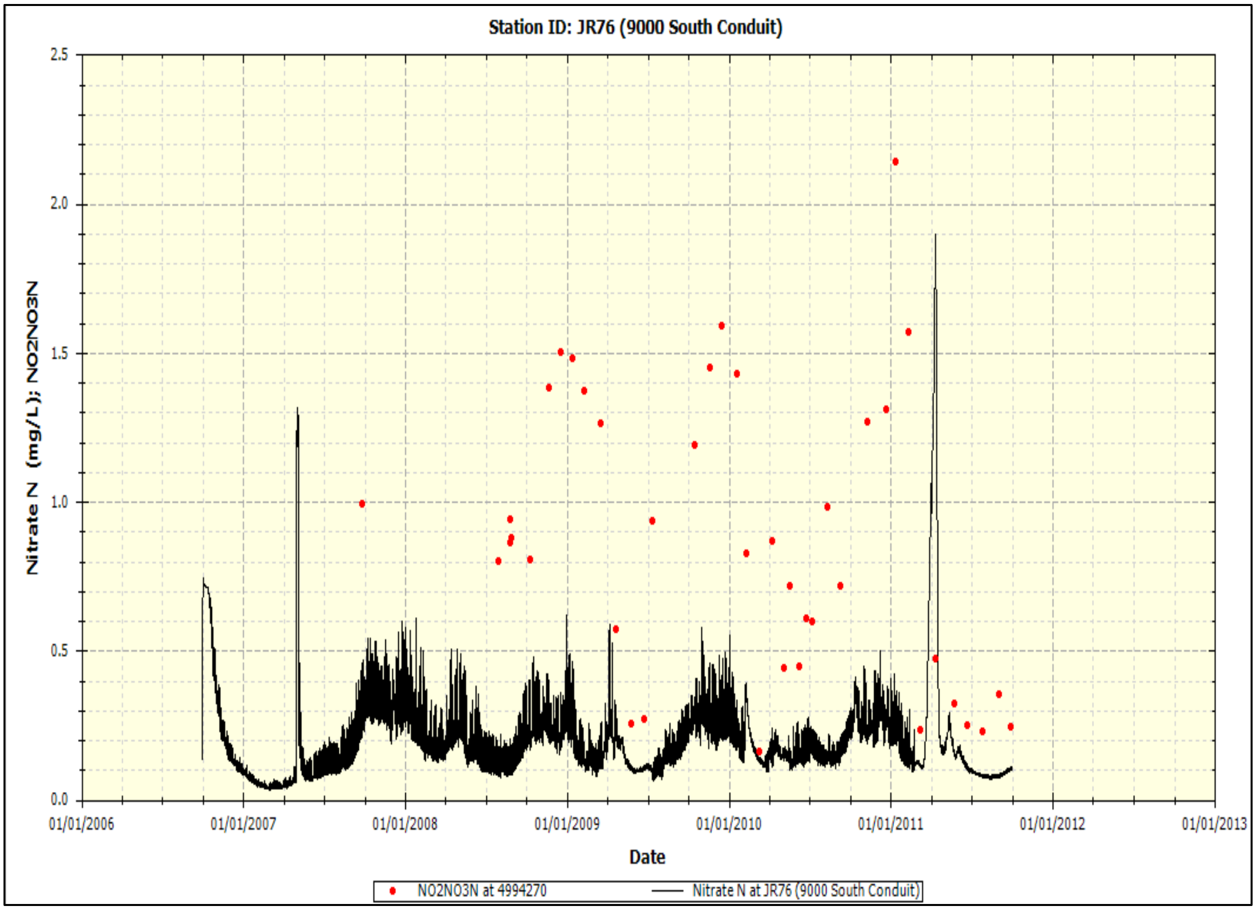


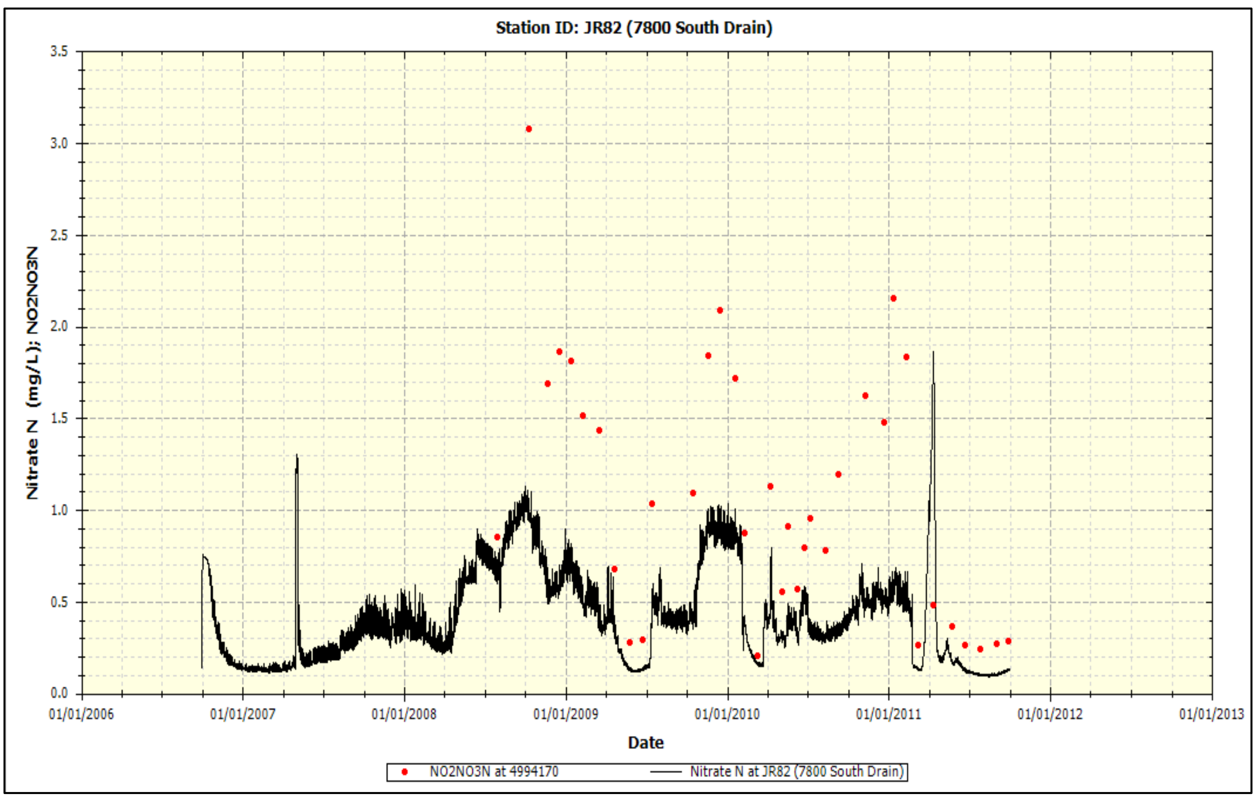

Station ID: JR44
Nitrate N (mg/L); NO2NO3N
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4994600
Nitrate N at JR44

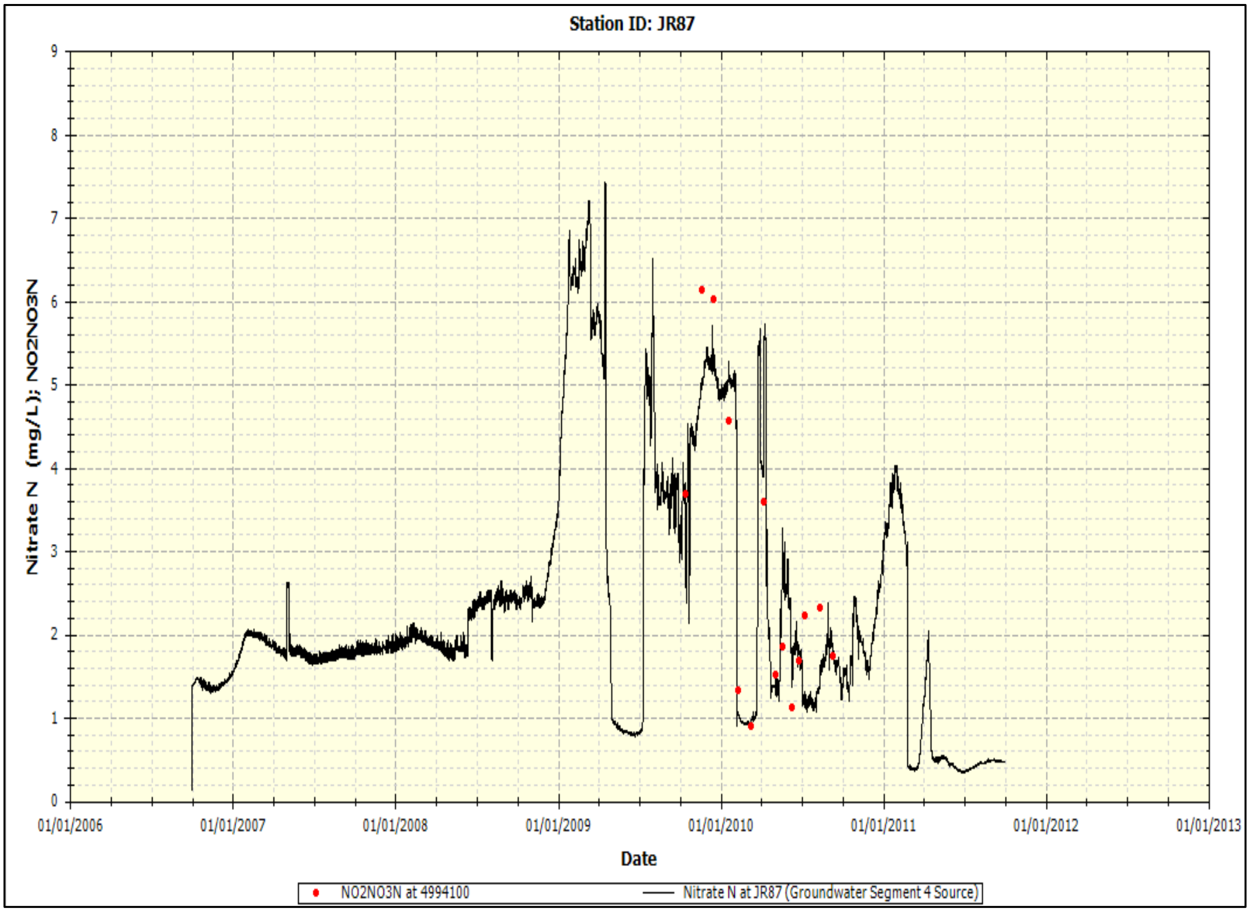

Station ID: JR49 (Rose Creek)
Nitrate N (mg/L); NO2NO3N
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4994520
Nitrate N at JR49 (Rose Creek)

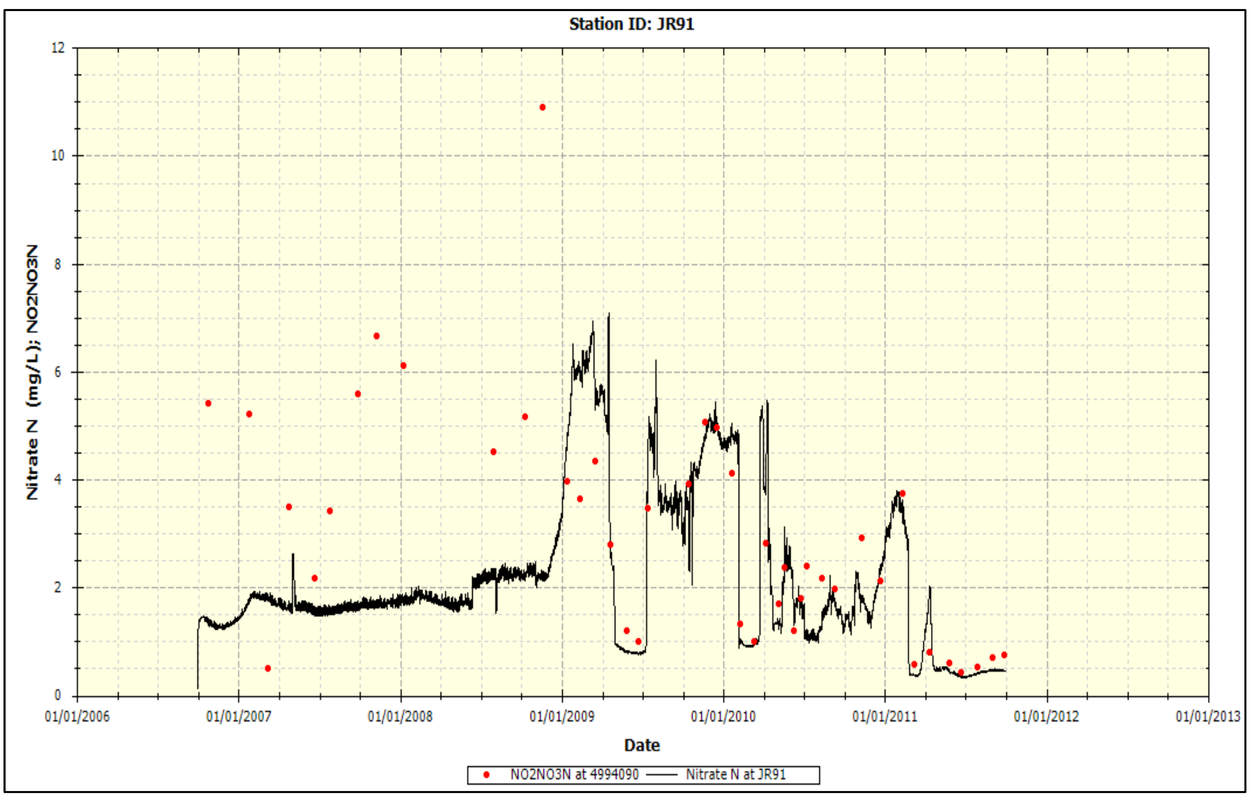

Station ID: JR59
Nitrate N (mg/L); NO2NO3N
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4994500
Nitrate N at JR59

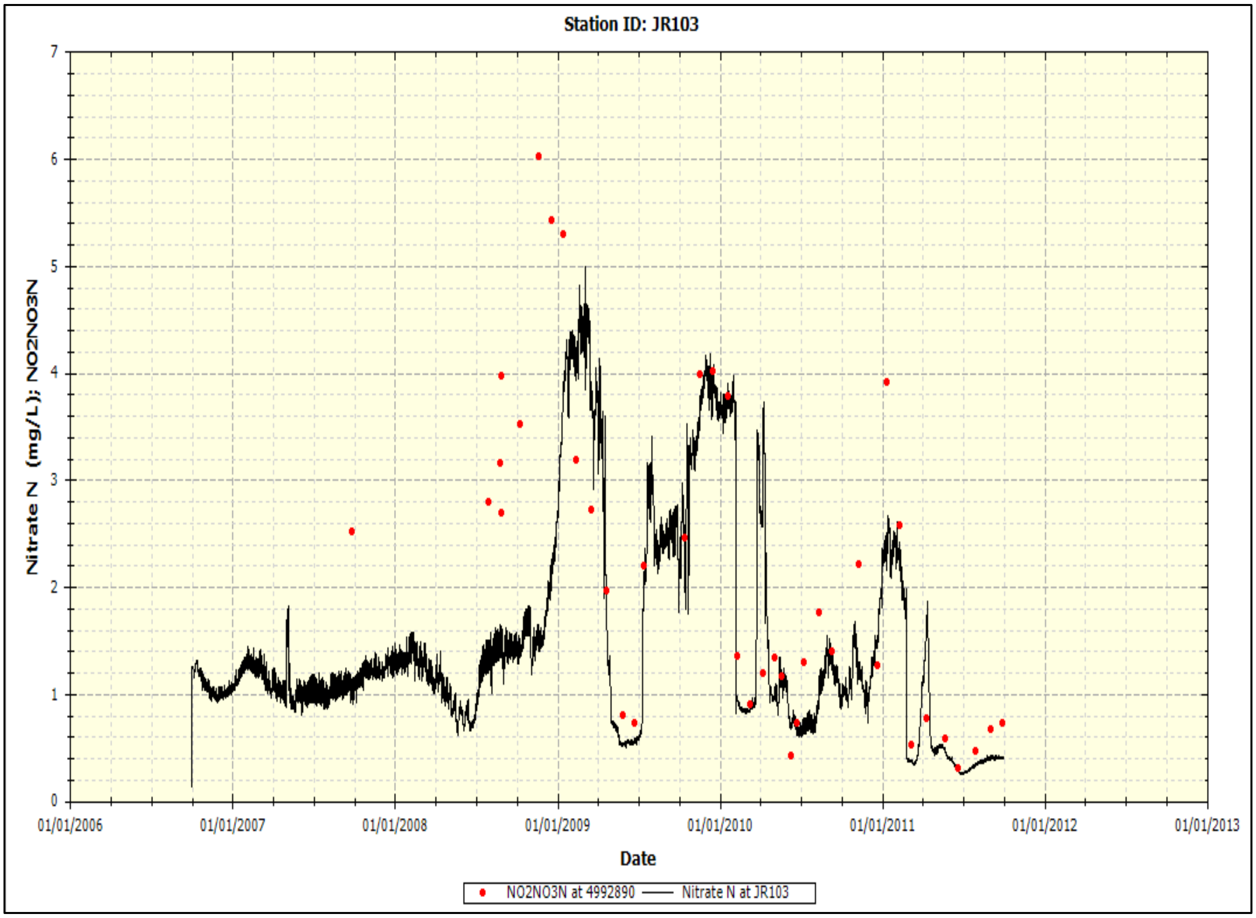

Station ID: JR68
Nitrate N (mg/L); NO2NO3N
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4994370
Nitrate N at JR68


Station ID: JR76 (9000 South Conduit)
Nitrate N (mg/L); NO2NO3N
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4994270
Nitrate N at JR76 (9000 South Conduit)

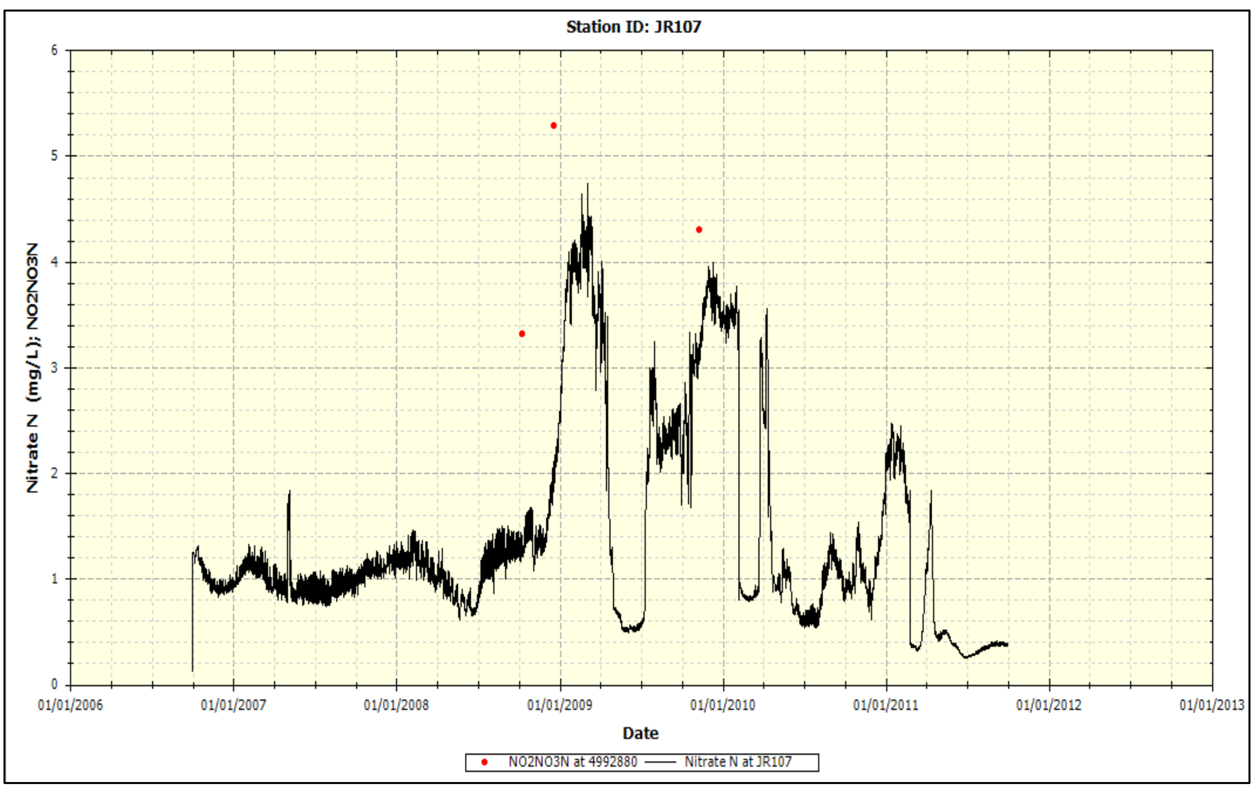

Station ID: JR82 (7800 South Drain)
Nitrate N (mg/L); NO2NO3N
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4994170
Nitrate N at JR82 (7800 South Drain)


Station ID: JR87
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4994100
Nitrate N at JR87 (Groundwater Segment 4 Source)

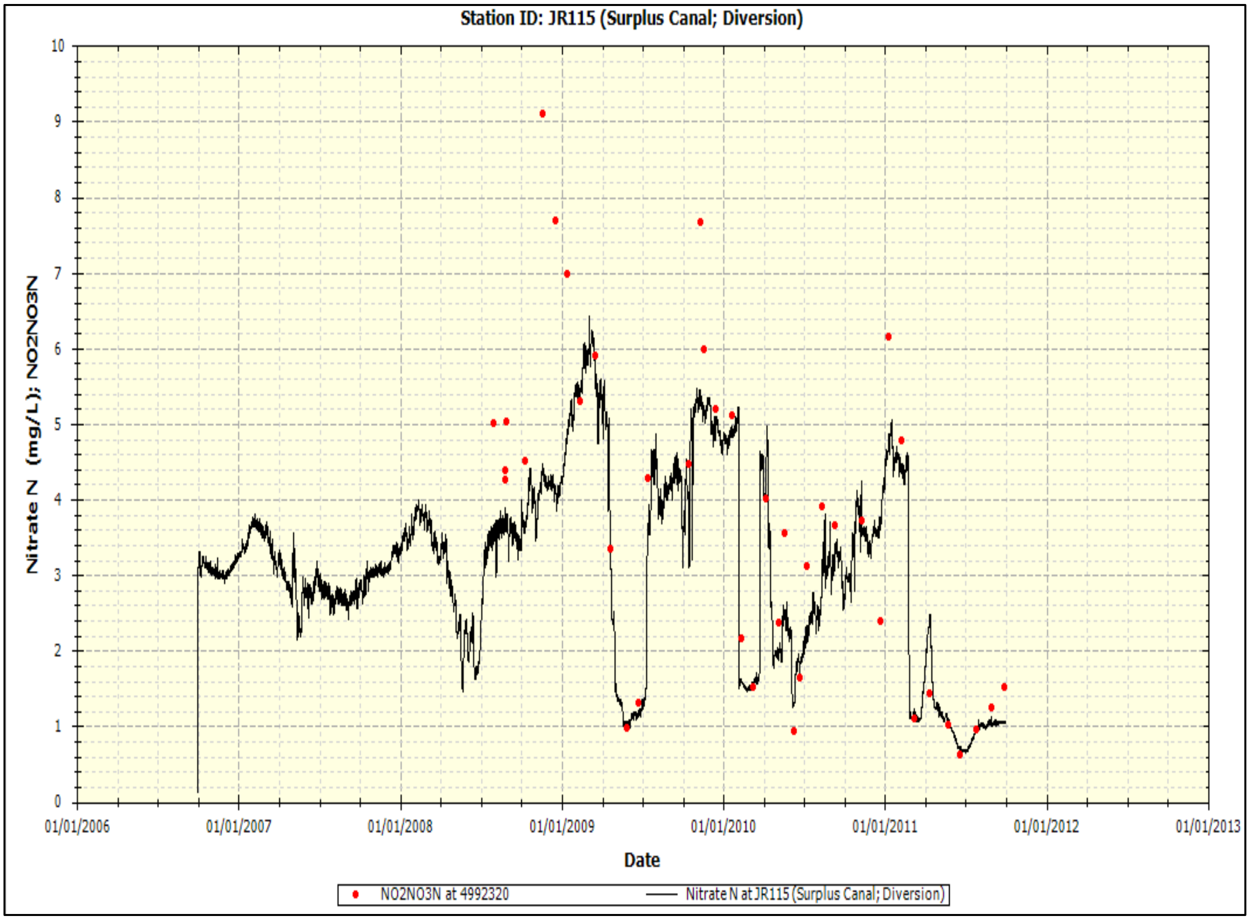

Station ID: JR91
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4994090
Nitrate N at JR91



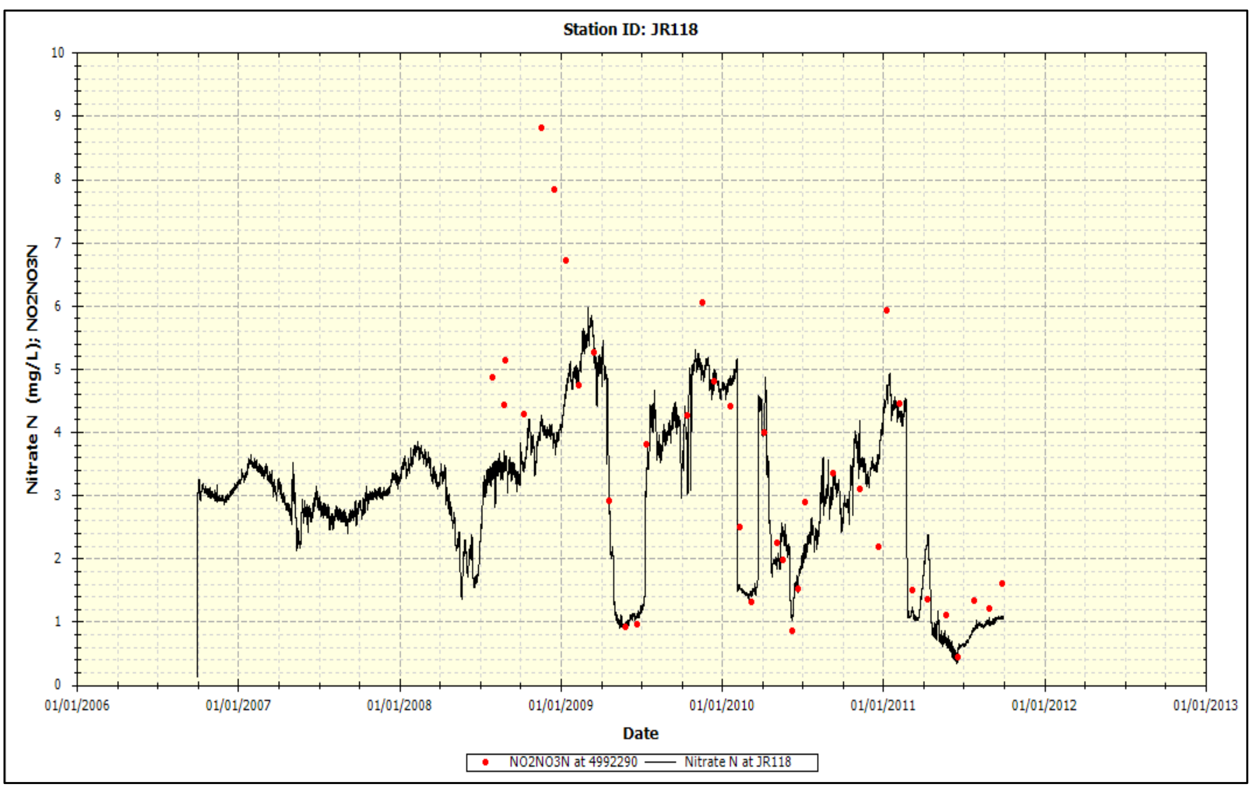
Station ID: JR103
Nitrate N (mg/L); NO2NO3N
0
1
2
3
4
5
6
7
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4992890
Nitrate N at JR103



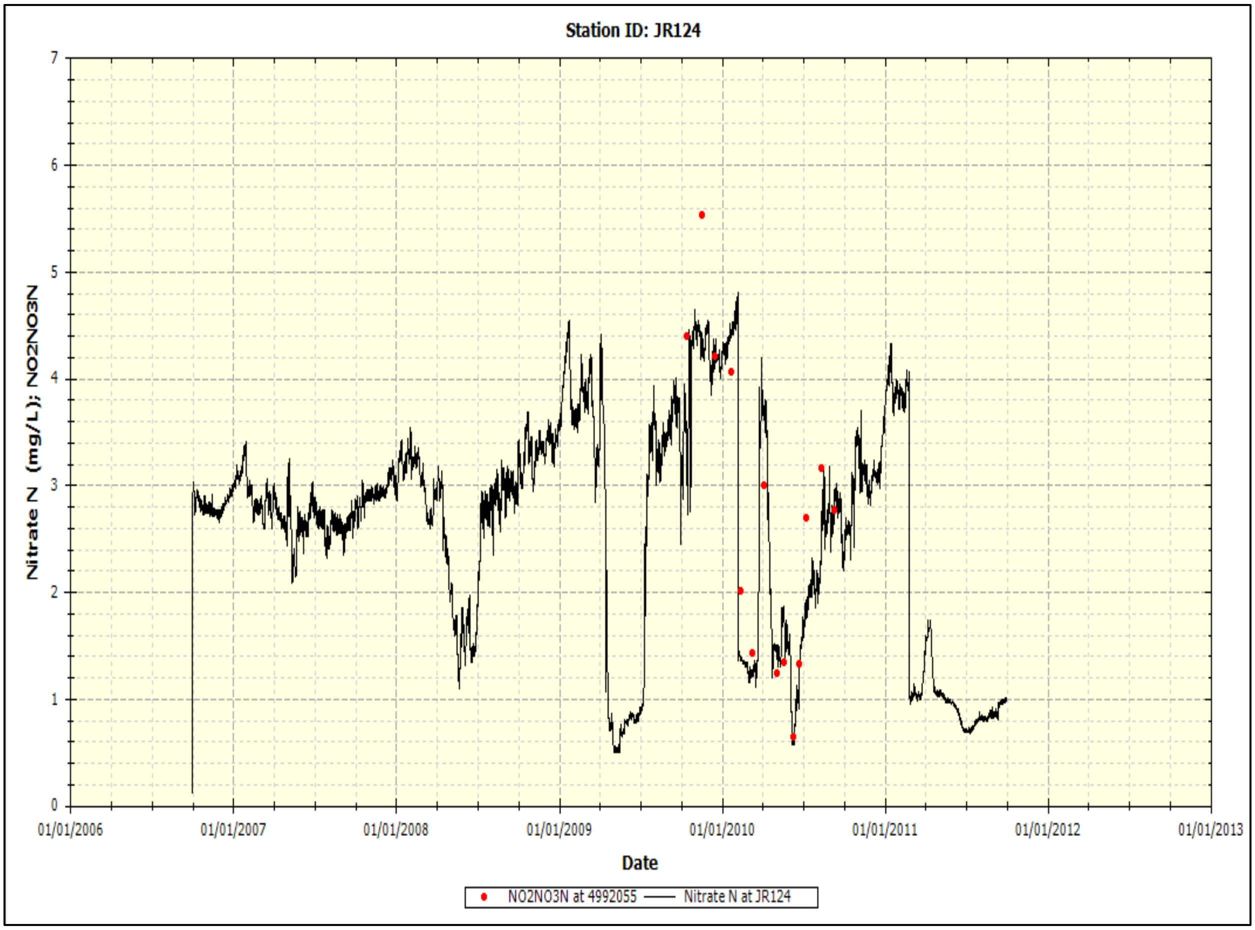
Station ID: JR107
Nitrate N (mg/L); NO2NO3N
0
1
2
3
4
5
6
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4992880
Nitrate N at JR107



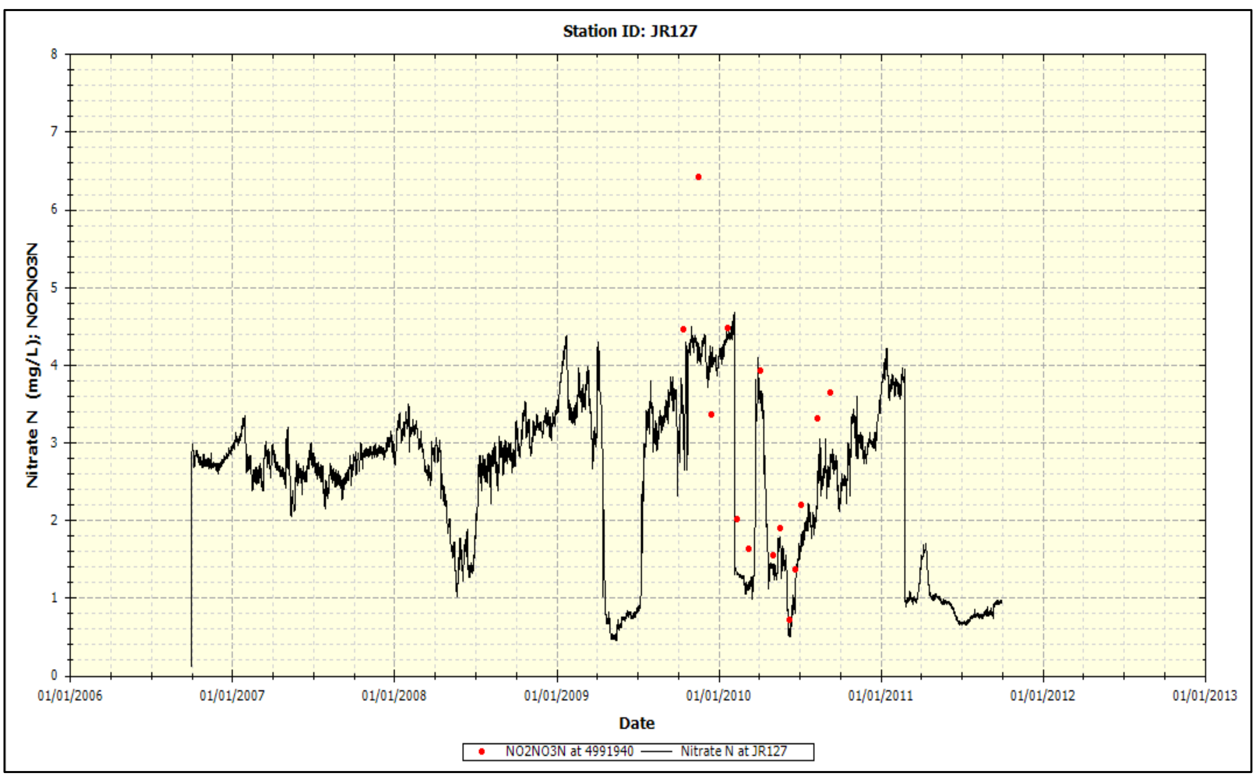
Station ID: JR115 (Surplus Canal; Diversion)
Nitrate N (mg/L); NO2NO3N
0
1
2
3
4
5
6
7
8
9
10
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4992320
Nitrate N at JR115 (Surplus Canal; Diversion)



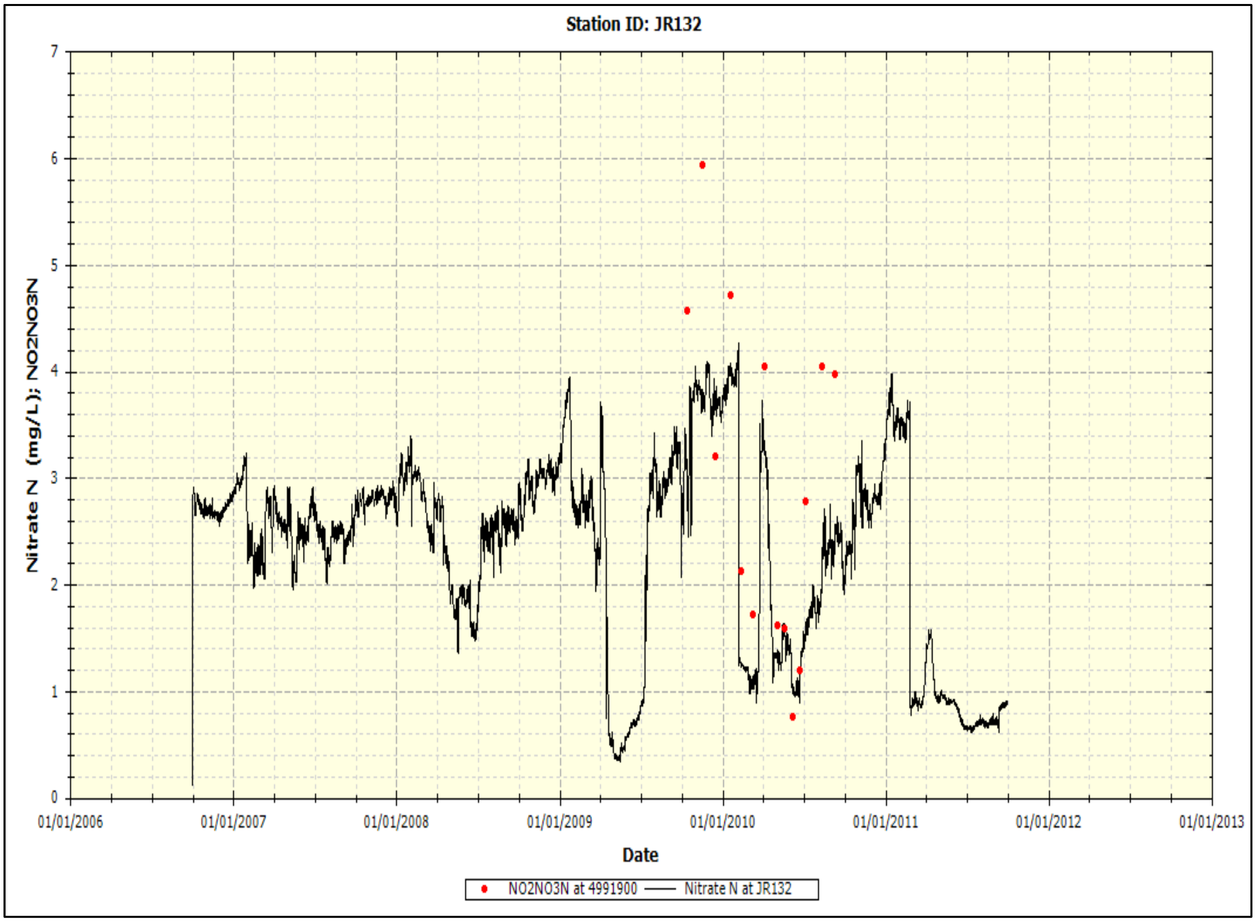
Station ID: JR118
Nitrate N (mg/L); NO2NO3N
0
1
2
3
4
5
6
7
8
9
10
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4992290
Nitrate N at JR118

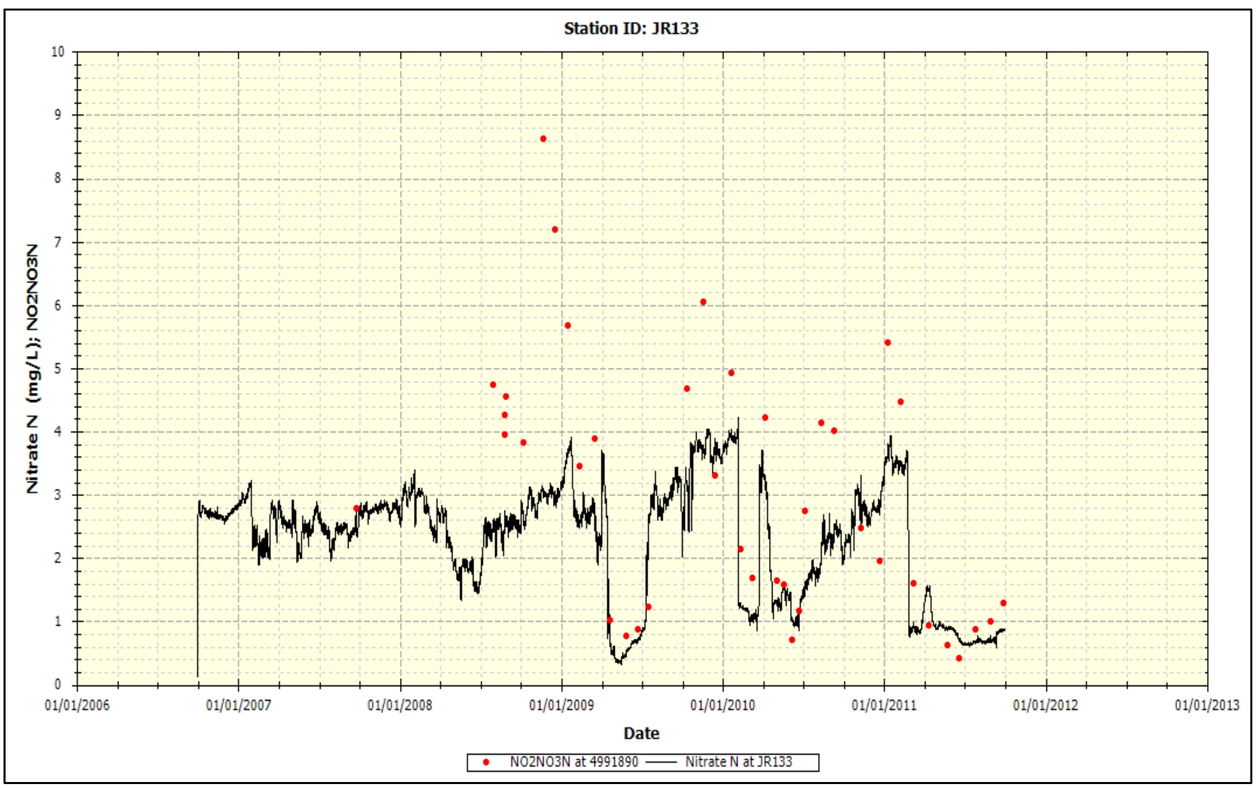


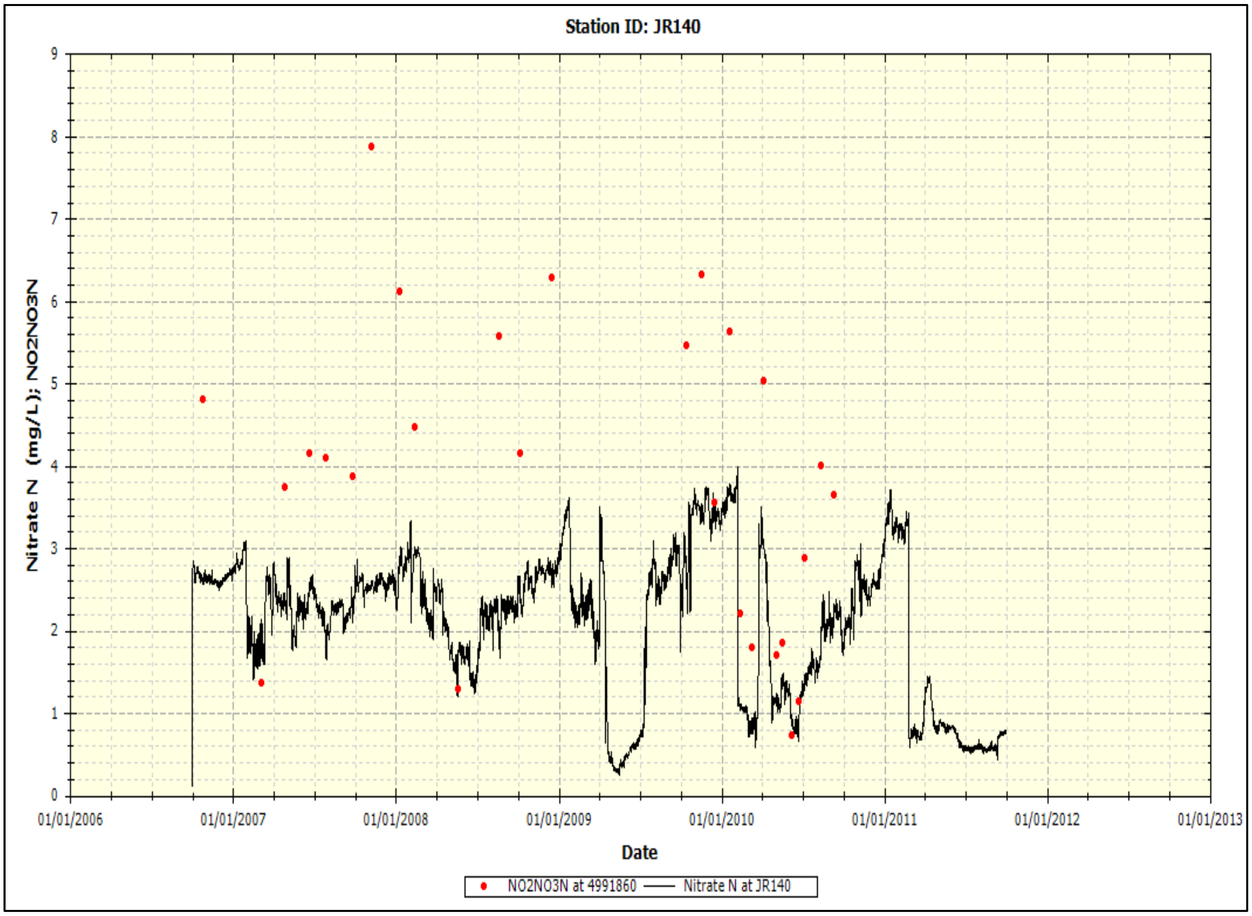
Station ID: JR124
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4992055
Nitrate N at JR124



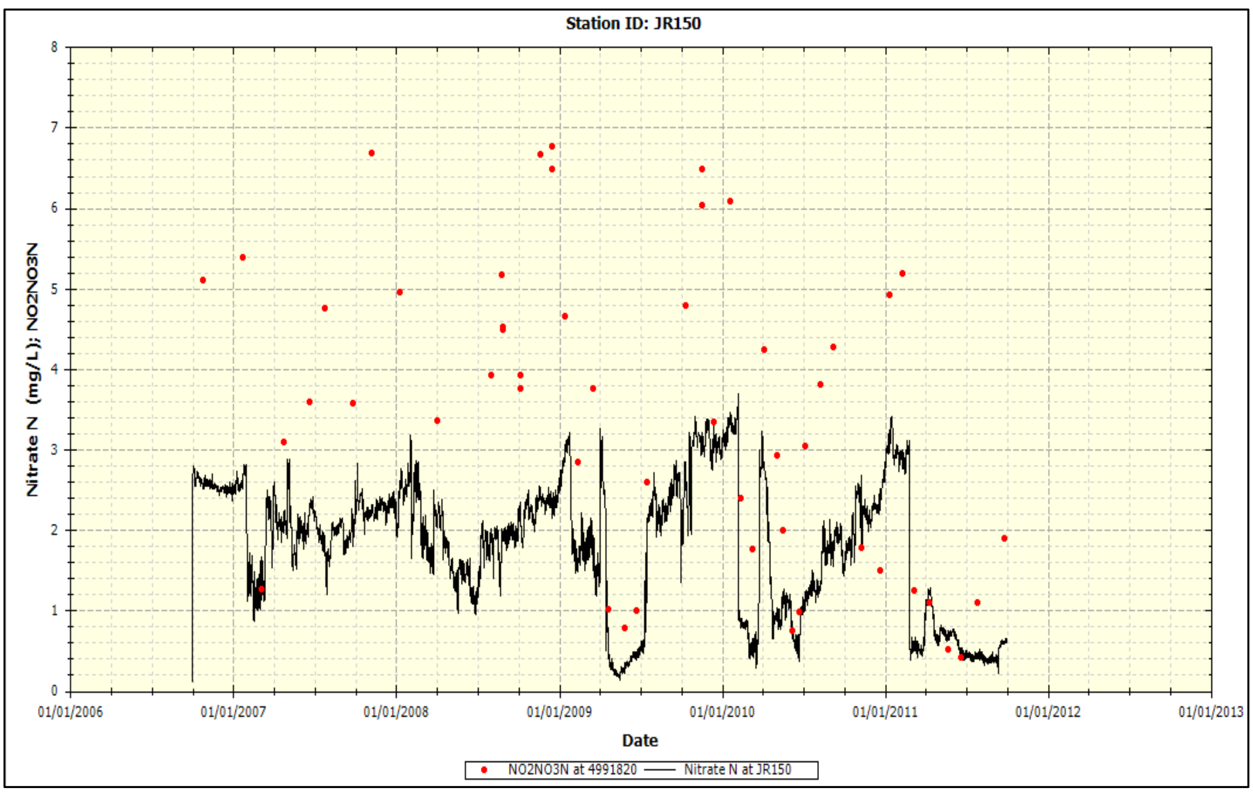
Station ID: JR127
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4991940
Nitrate N at JR127


Station ID: JR132
Nitrate N (mg/L); NO2NO3N
0
1
2
3
4
5
6
7
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4991900
Nitrate N at JR132

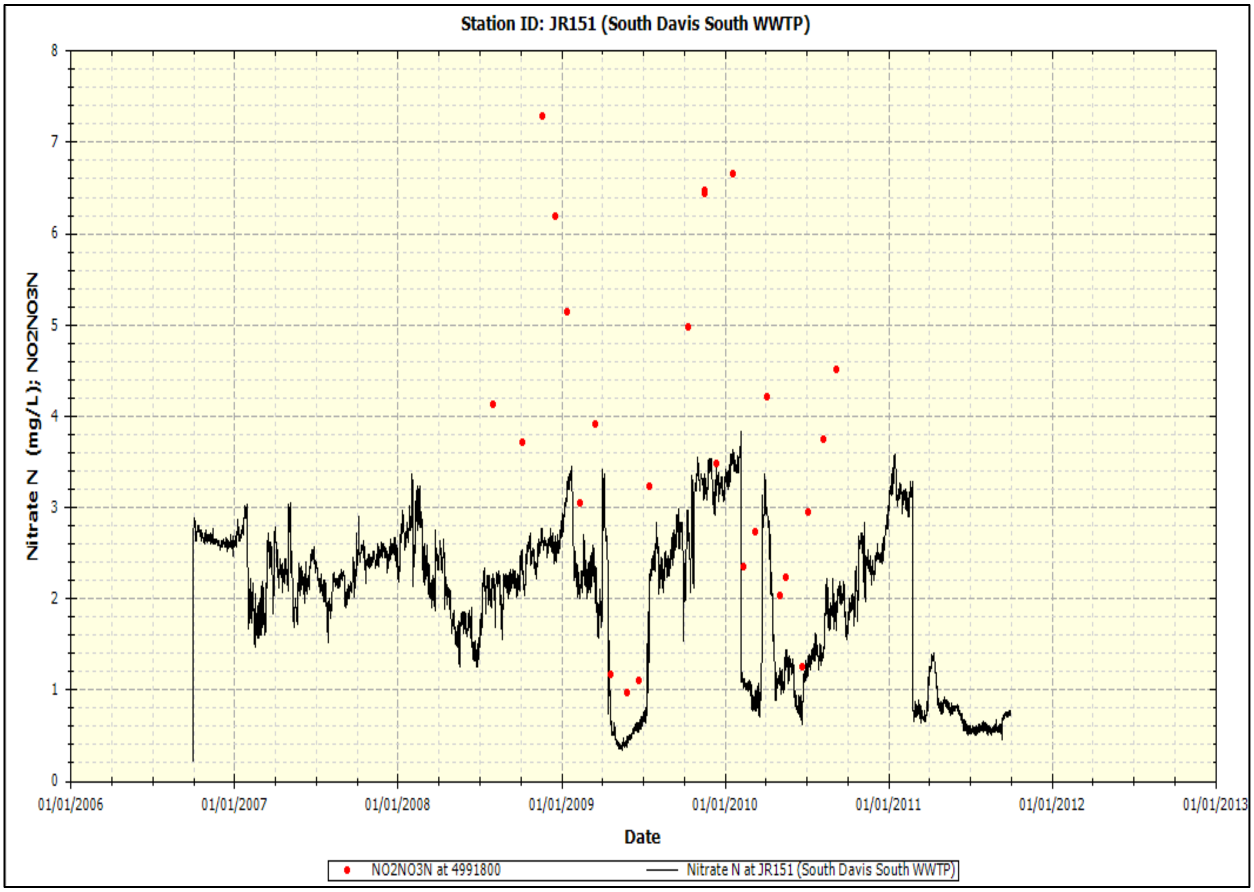

Station ID: JR133
Nitrate N (mg/L); NO2NO3N
0
1
2
3
4
5
6
7
8
9
10
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
NO2NO3N at 4991890
Nitrate N at JR133

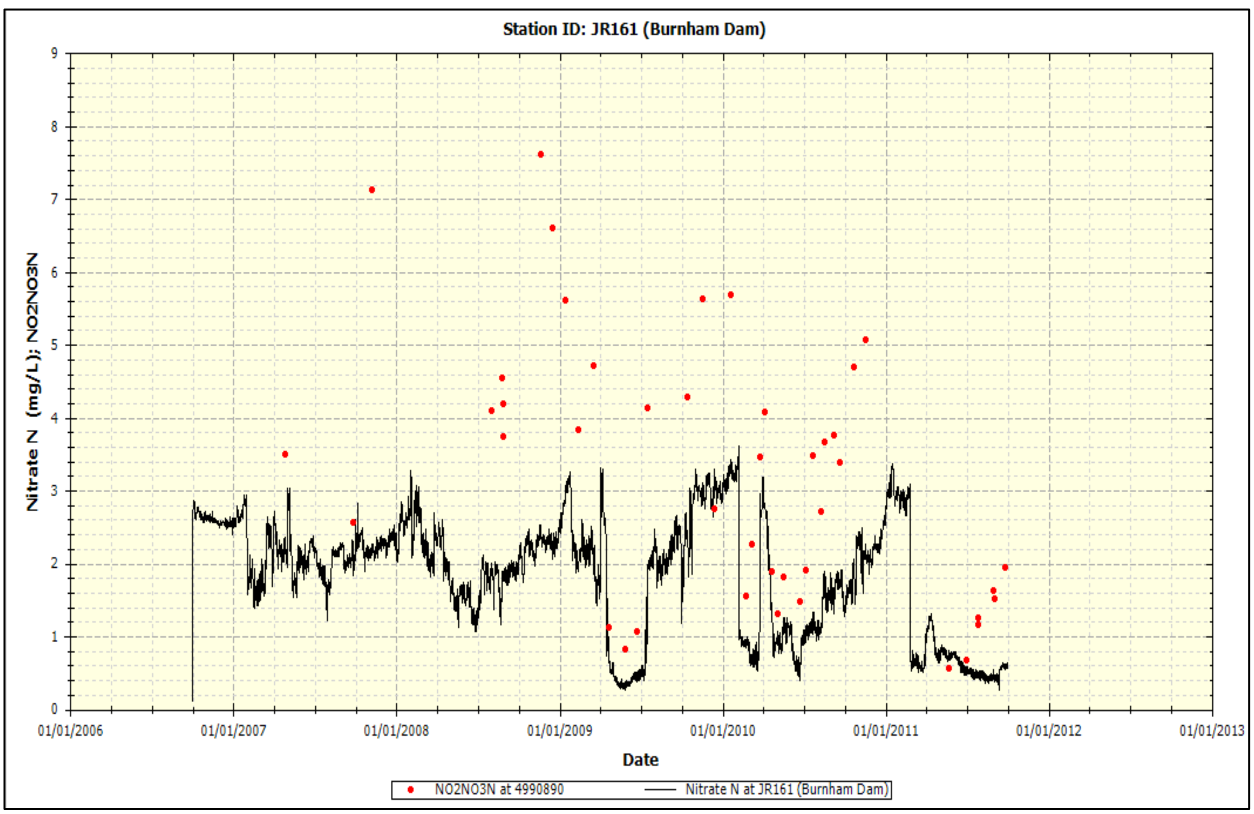


Station ID: JR140
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4991860
Nitrate N at JR140

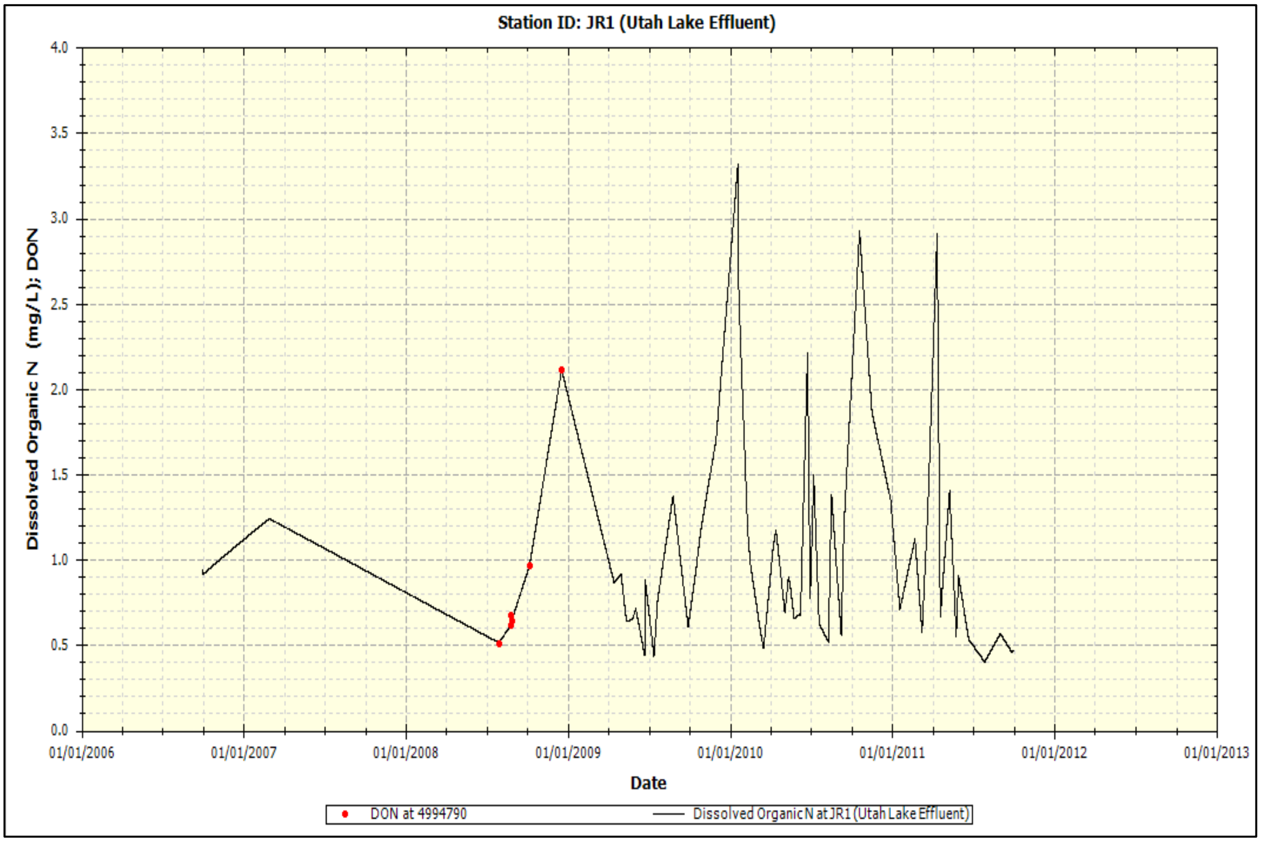


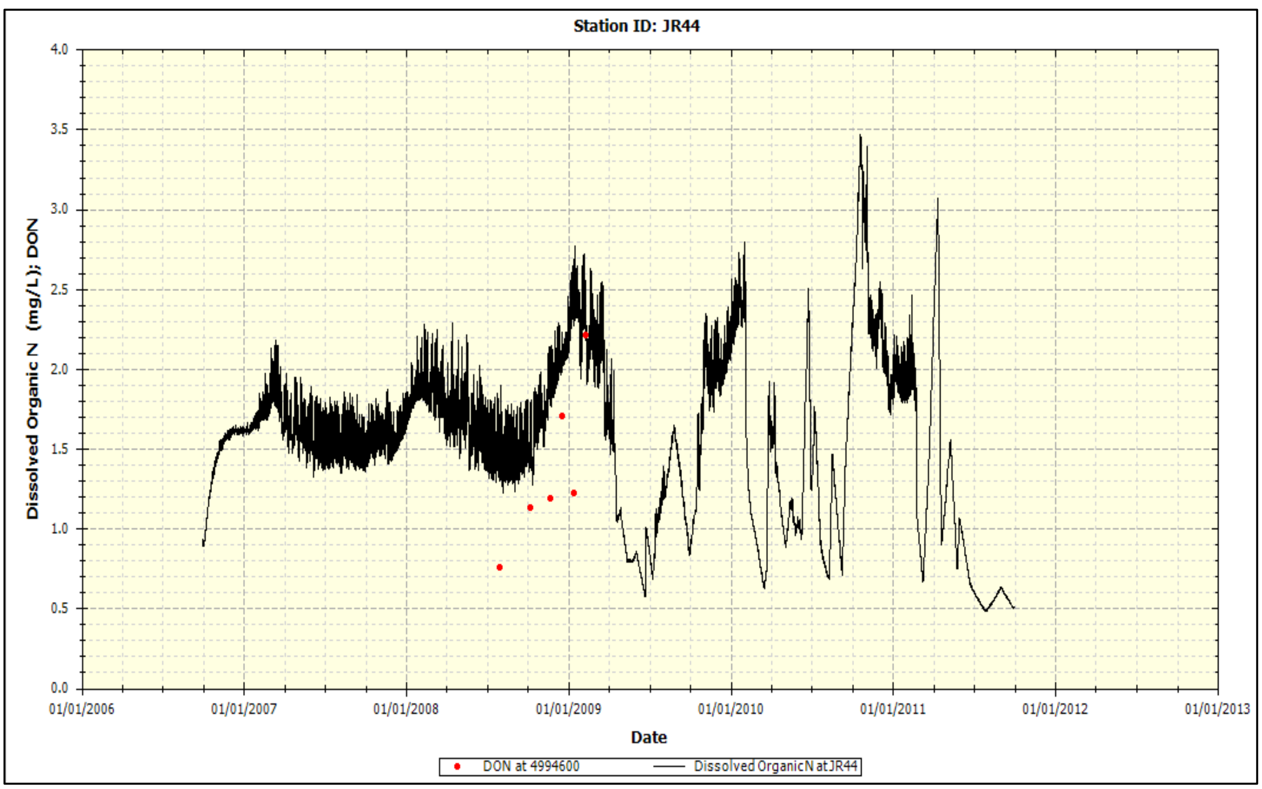
Station ID: JR150
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4991820
Nitrate N at JR150

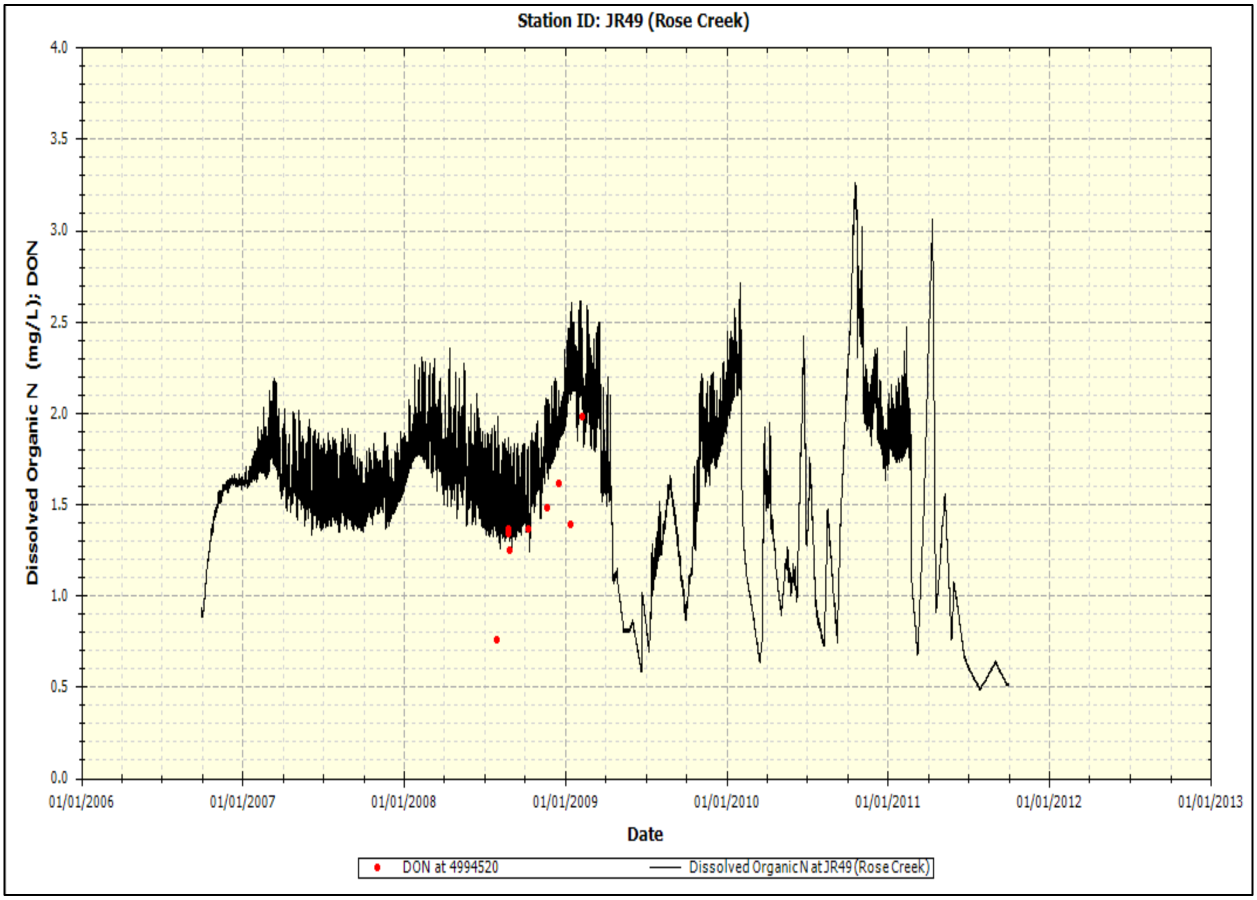

Station ID: JR151 (South Davis South WWTP)
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4991800
Nitrate N at JR151 (South Davis South WWTP)

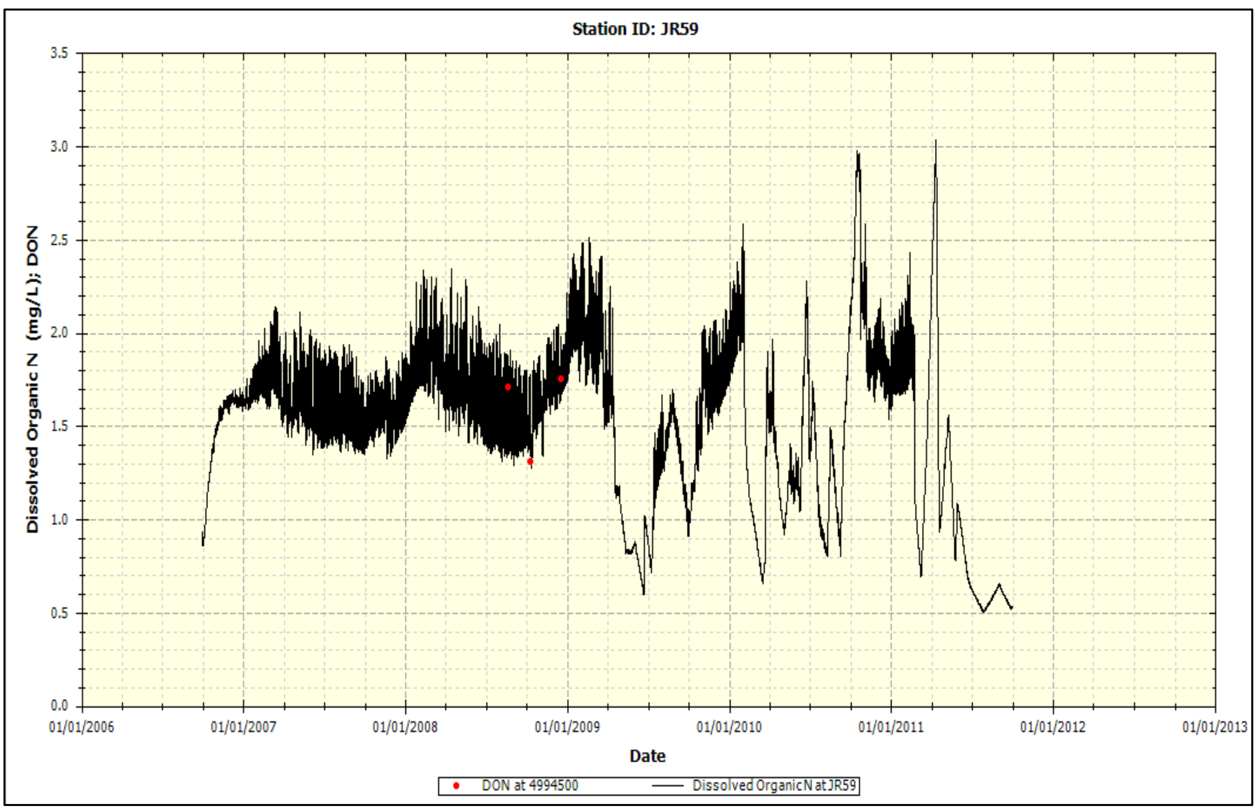

Station ID: JR161 (Burnham Dam)
Nitrate N (mg/L); NO2NO3N
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
NO2NO3N at 4990890
Nitrate N at JR161 (Burnham Dam)

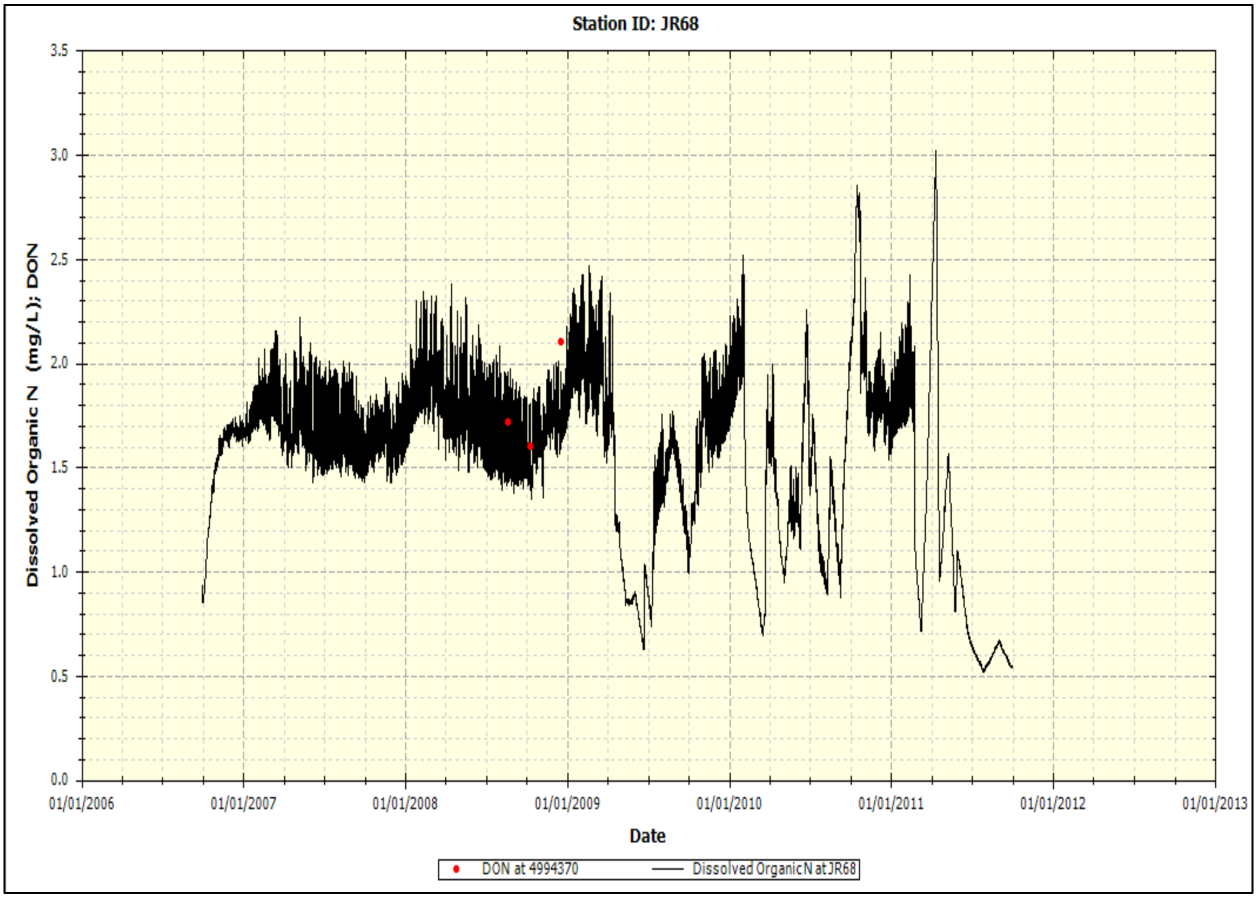
B.1.8: DISSOLVED ORGANIC NITROGEN (DON)

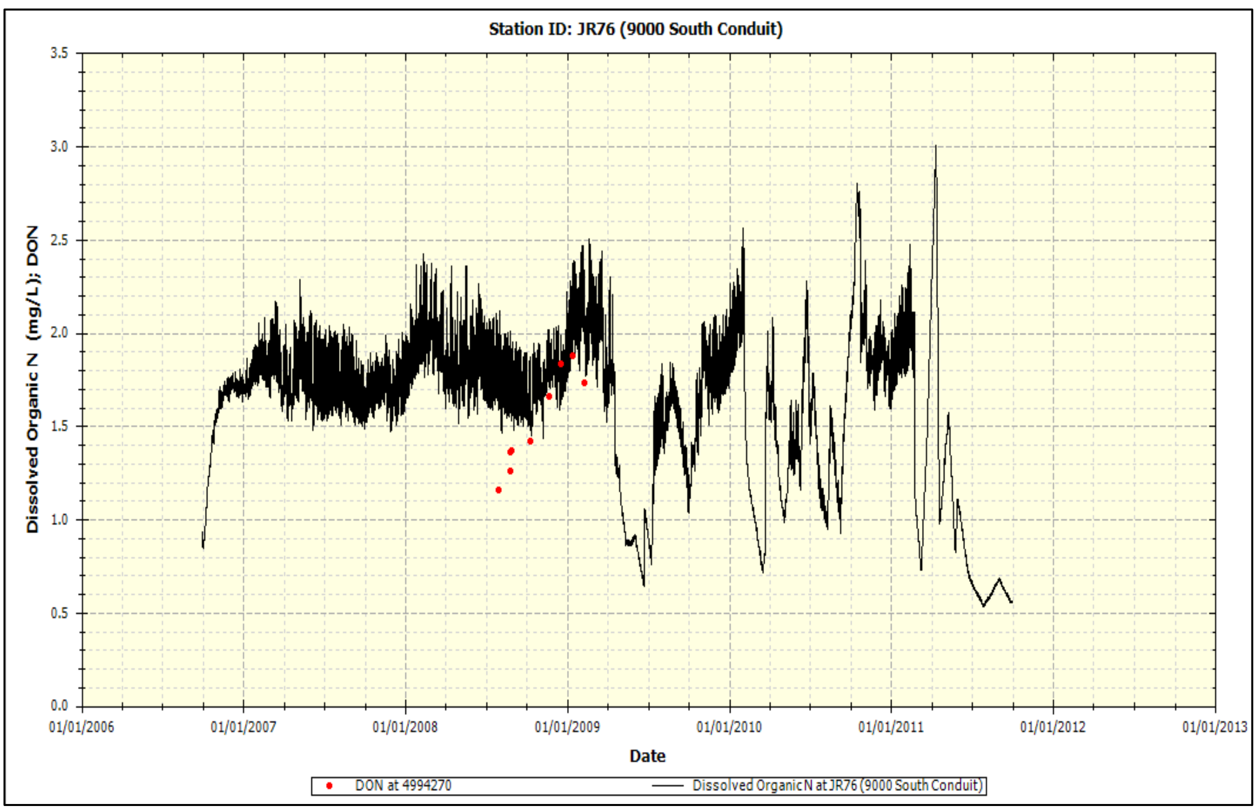


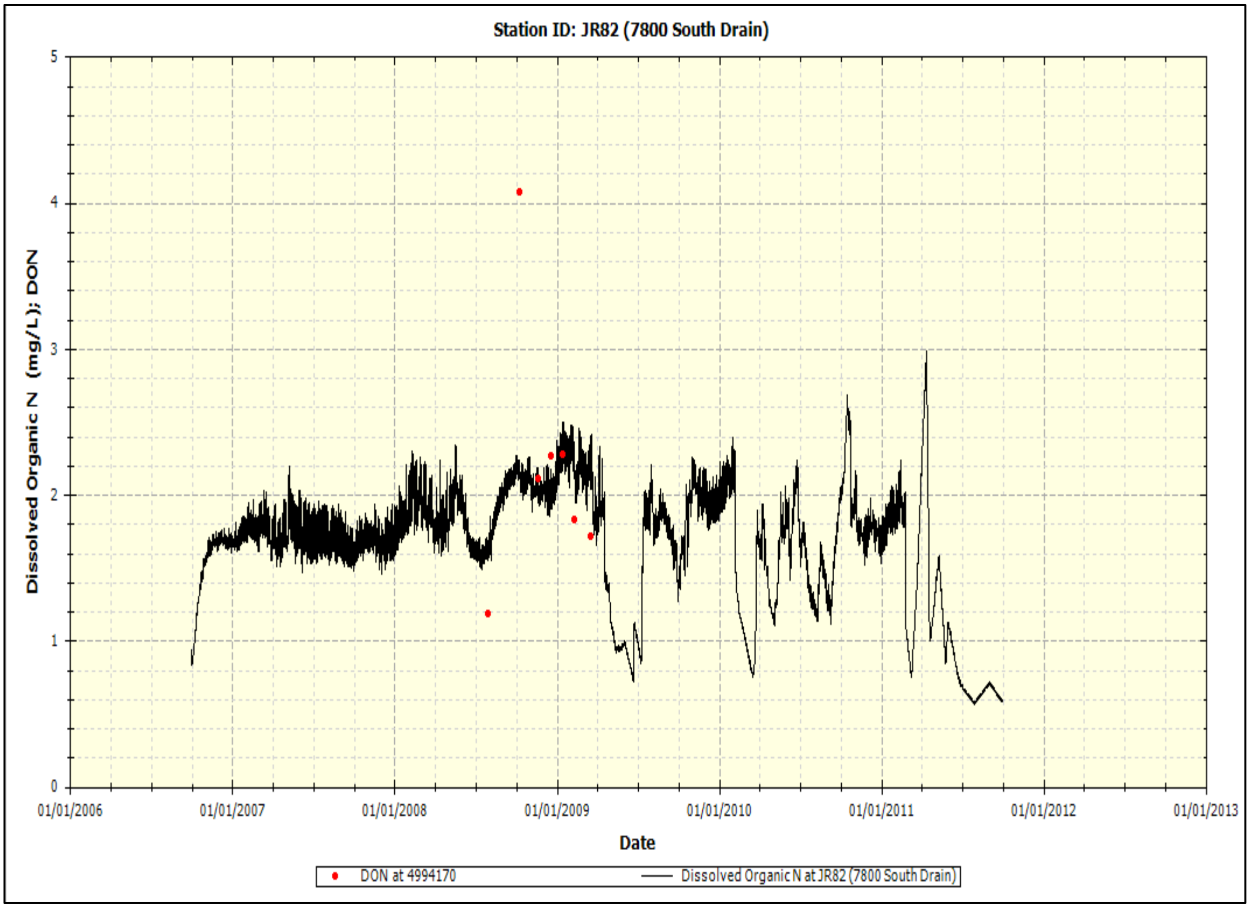


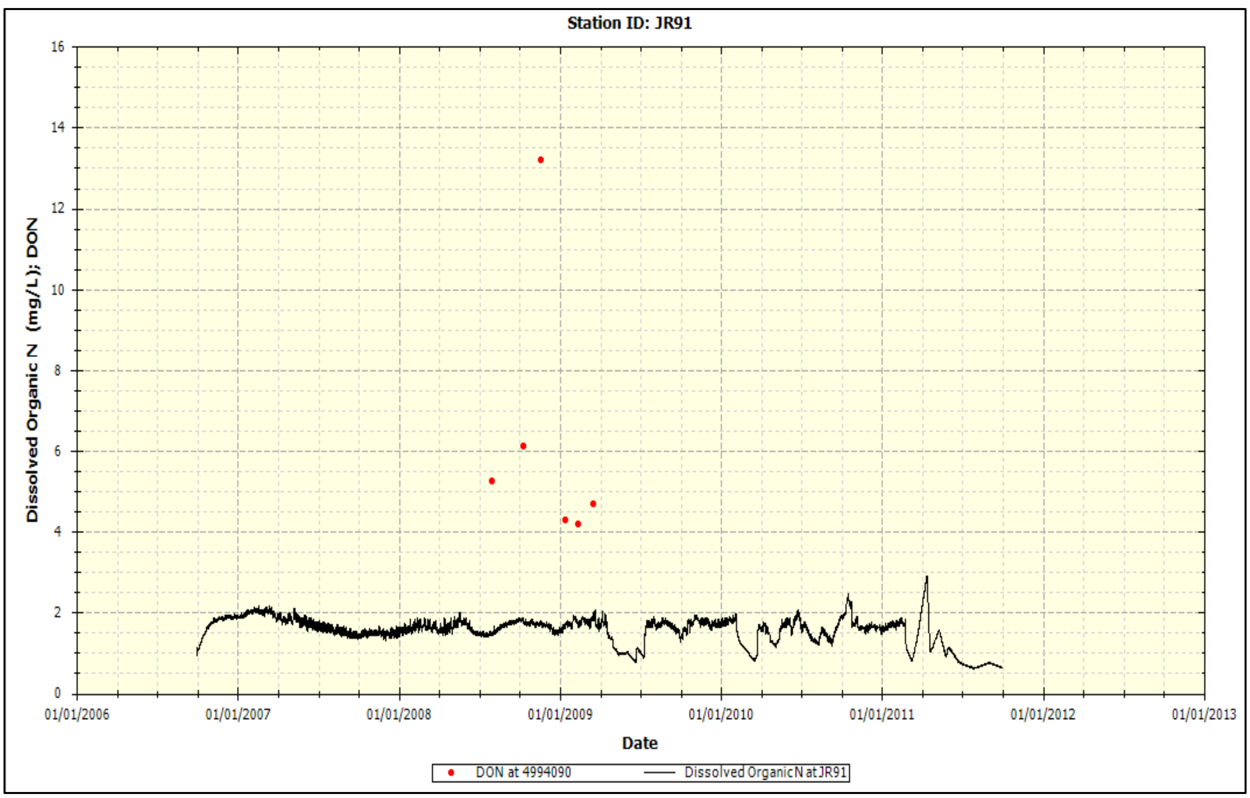

Station ID: JR49 (Rose Creek)
Dissolved Organic N (mg/L); DON
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
DON at 4994520
Dissolved Organic N at JR49 (Rose Creek)

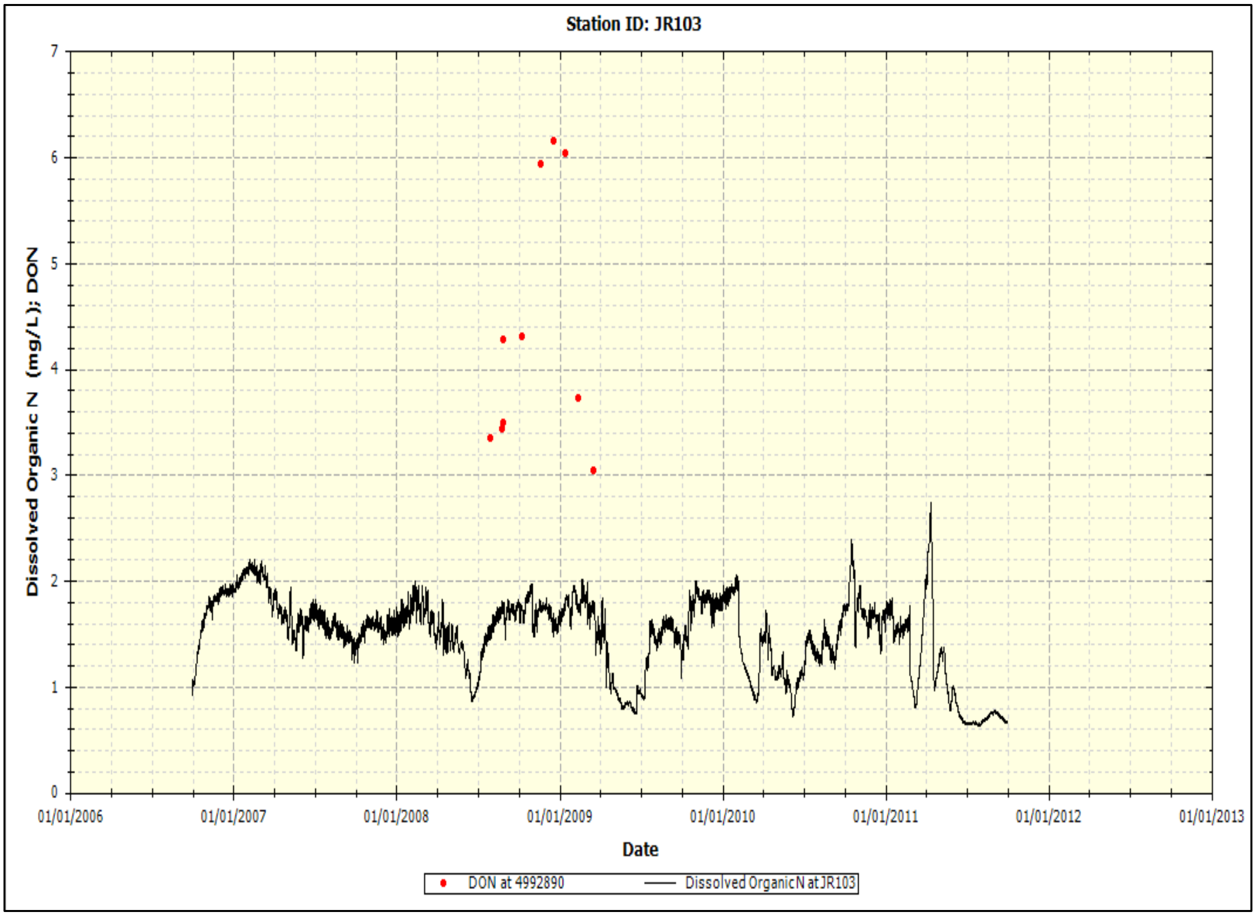

Station ID: JR59
Dissolved Organic N (mg/L); DON
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
DON at 4994500
Dissolved Organic N at JR59

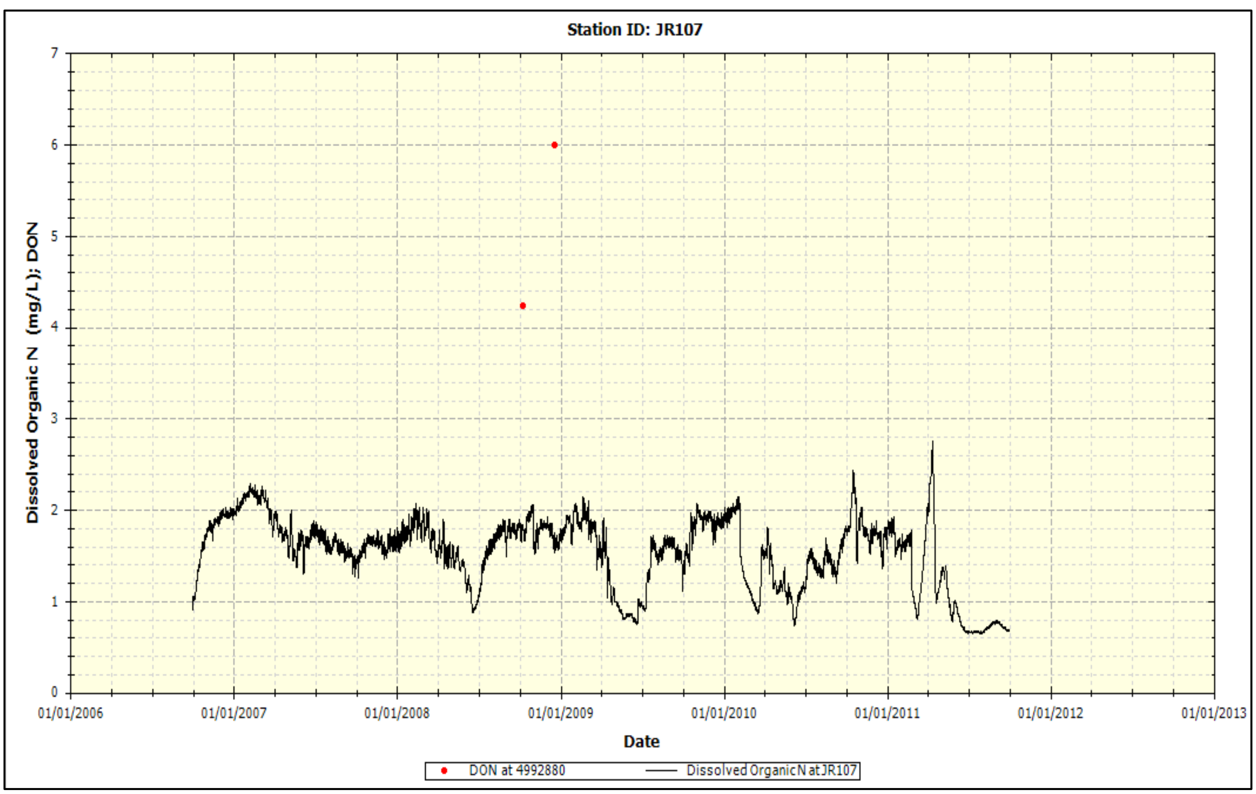

Station ID: JR68
Dissolved Organic N (mg/L); DON
Date
DON at 4994370
Dissolved Organic N at JR68
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013

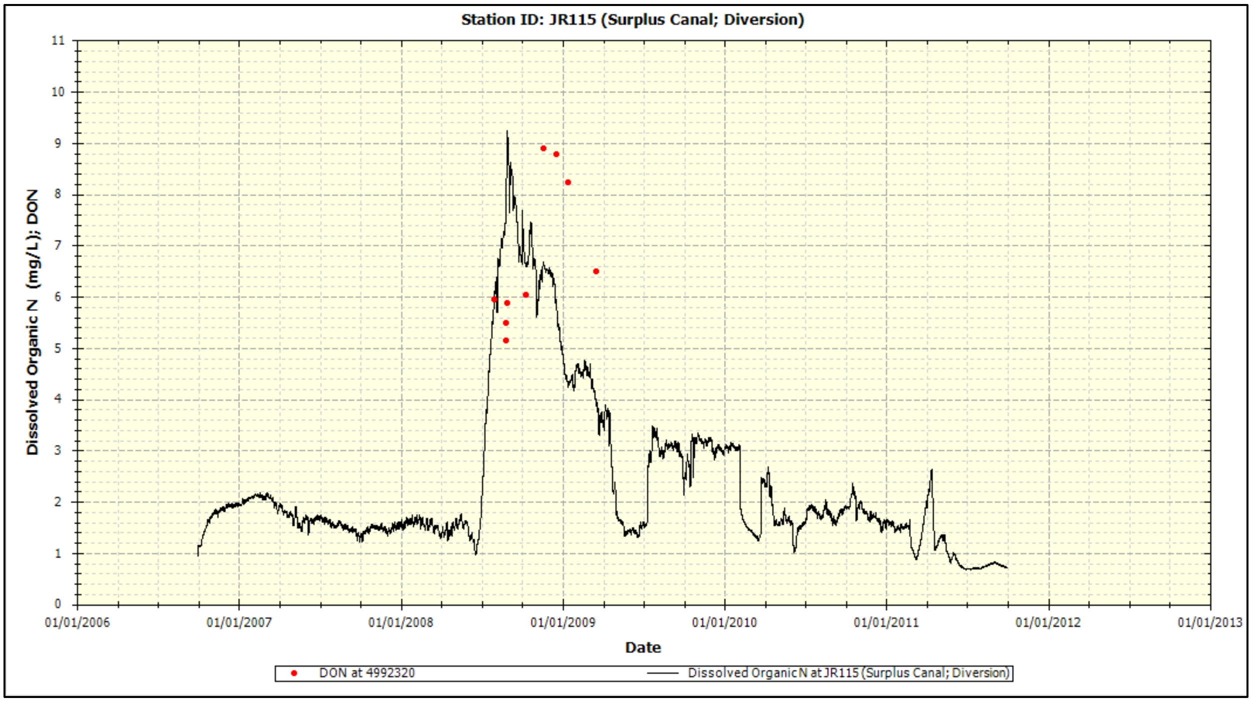

Station ID: JR76 (9000 South Conduit)
Dissolved Organic N (mg/L); DON
Date
DON at 4994270
Dissolved Organic N at JR76 (9000 South Conduit)
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013

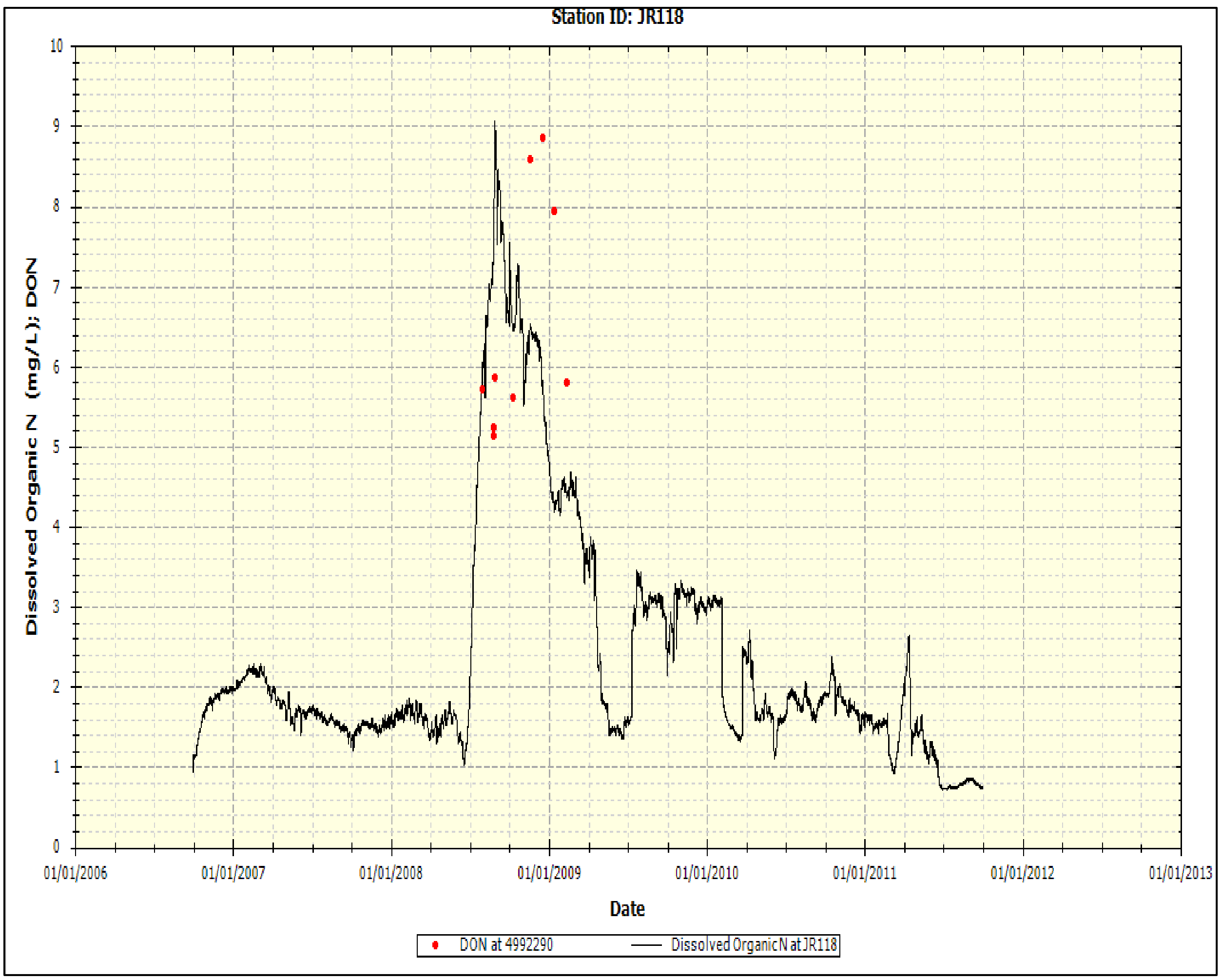

Station ID: JR82 (7800 South Drain)
Dissolved Organic N (mg/L); DON
0
1
2
3
4
5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
DON at 4994170
Dissolved Organic N at JR82 (7800 South Drain)

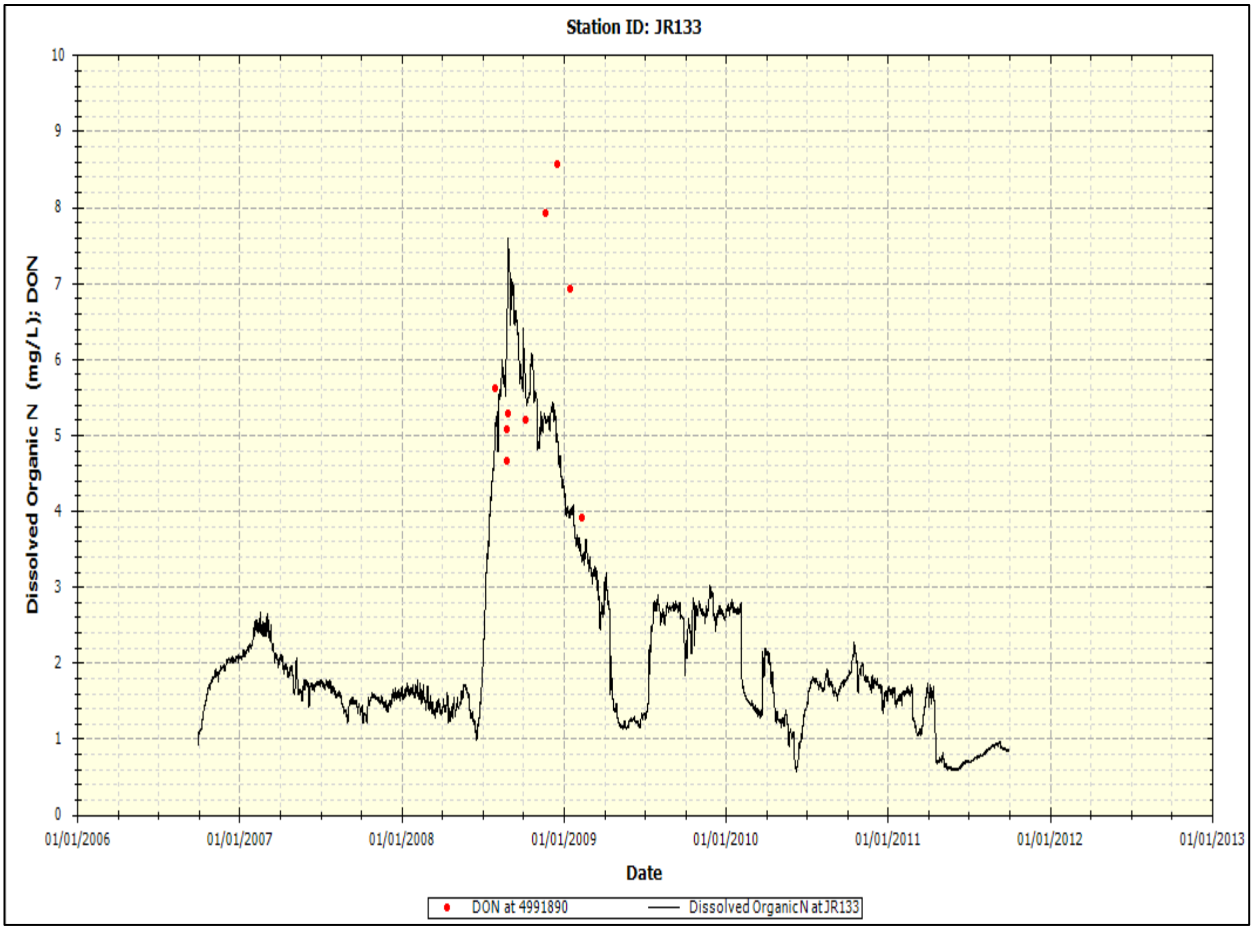

Station ID: JR91
Dissolved Organic N (mg/L); DON
0
2
4
6
8
10
12
14
16
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
DON at 4994090
Dissolved Organic N at JR91

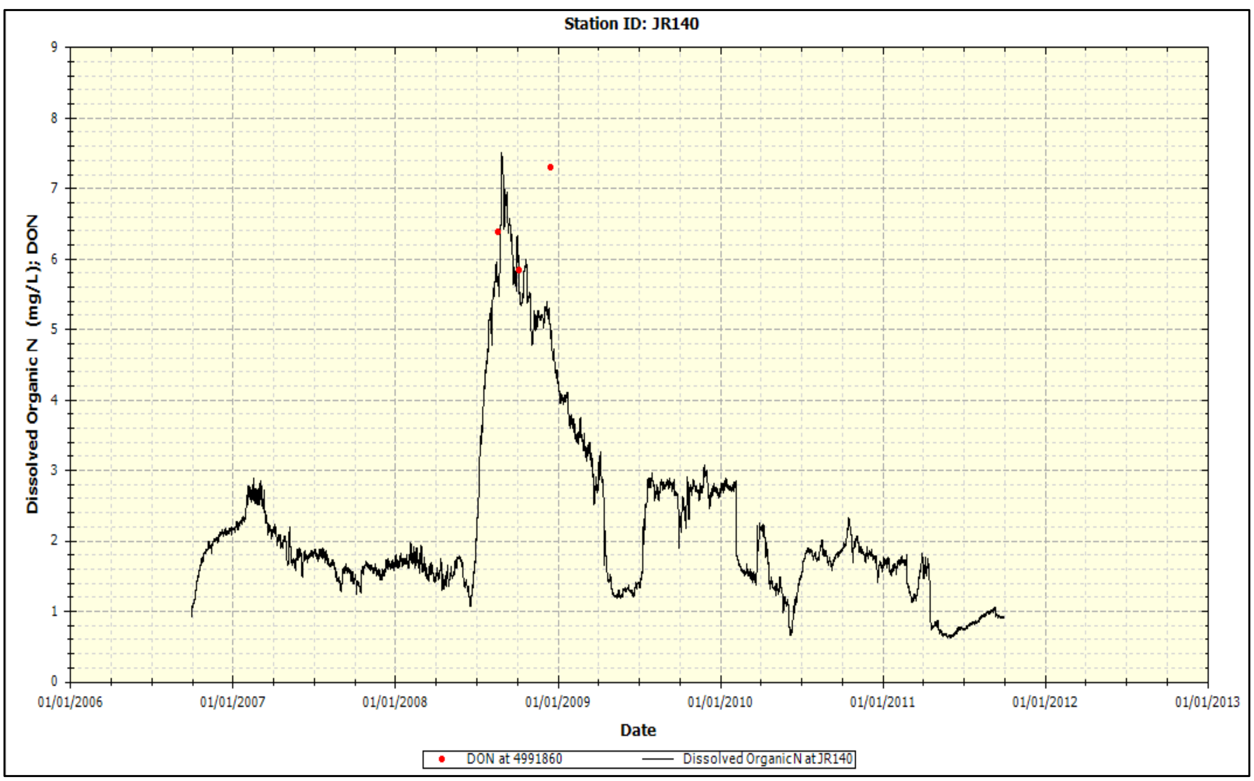

Station ID: JR103
Dissolved Organic N (mg/L); DON
Date
0
1
2
3
4
5
6
7
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
DON at 4992890
Dissolved Organic N at JR103

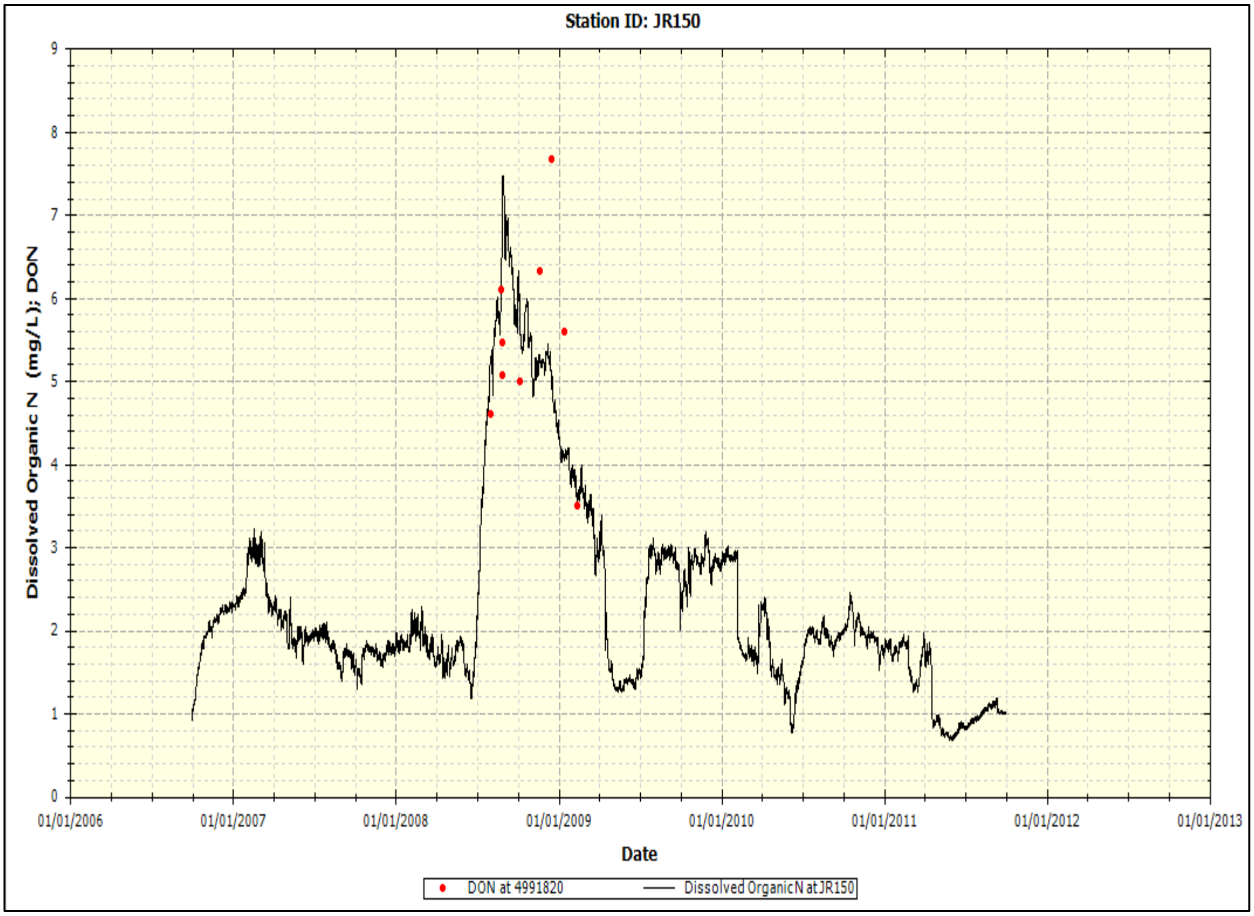

Station ID: JR107
Dissolved Organic N (mg/L); DON
Date
0
1
2
3
4
5
6
7
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
DON at 4992880
Dissolved Organic N at JR107

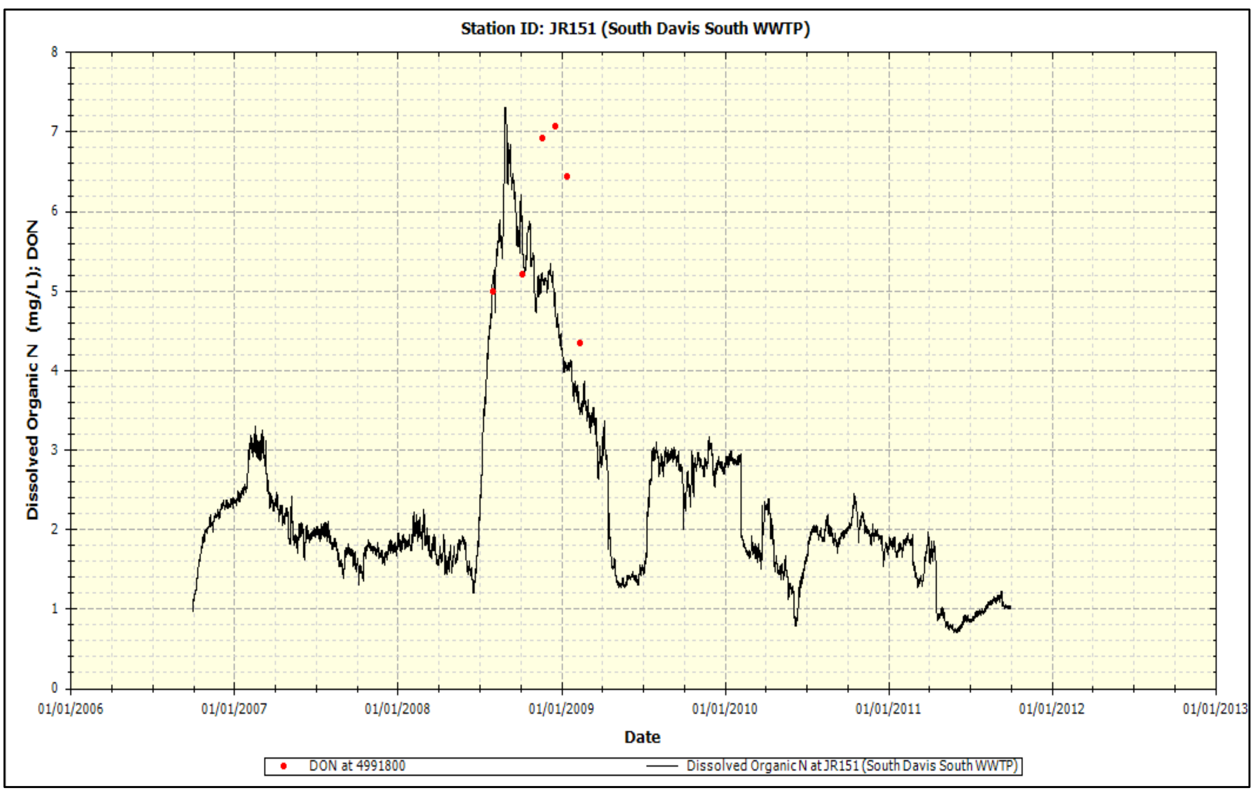

Station ID: JR115 (Surplus Canal; Diversion)
Dissolved Organic N (mg/L); DON
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
DON at 4992320
Dissolved Organic N at JR115 (Surplus Canal; Diversion)

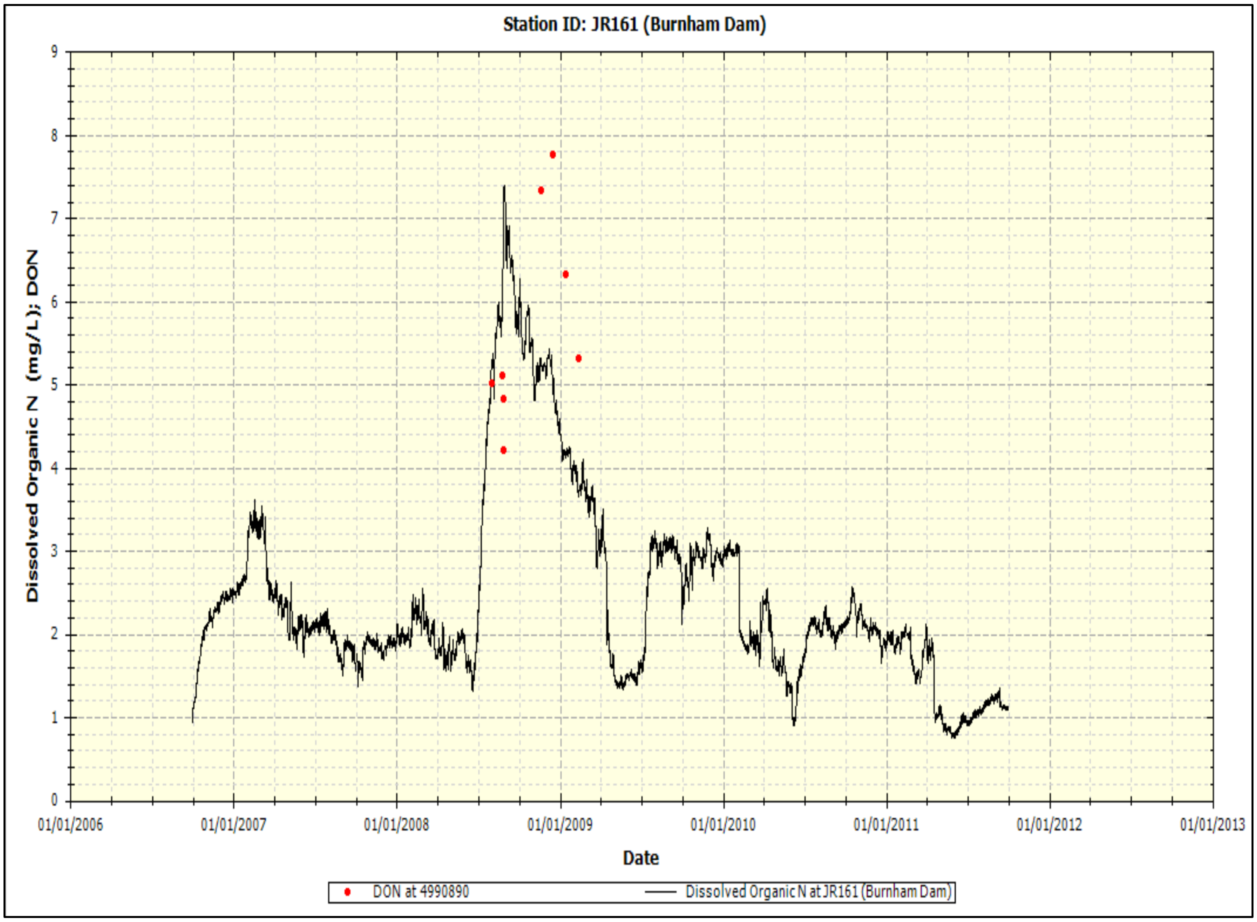

Station ID: JR118
Dissolved Organic N (mg/L); DON
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
DON at 4992290
Dissolved Organic N at JR118


Station ID: JR133
Dissolved Organic N (mg/L); DON
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
DON at 4991890
Dissolved Organic N at JR133


Station ID: JR140
Dissolved Organic N (mg/L); DON
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
DON at 4991860
Dissolved Organic N at JR140

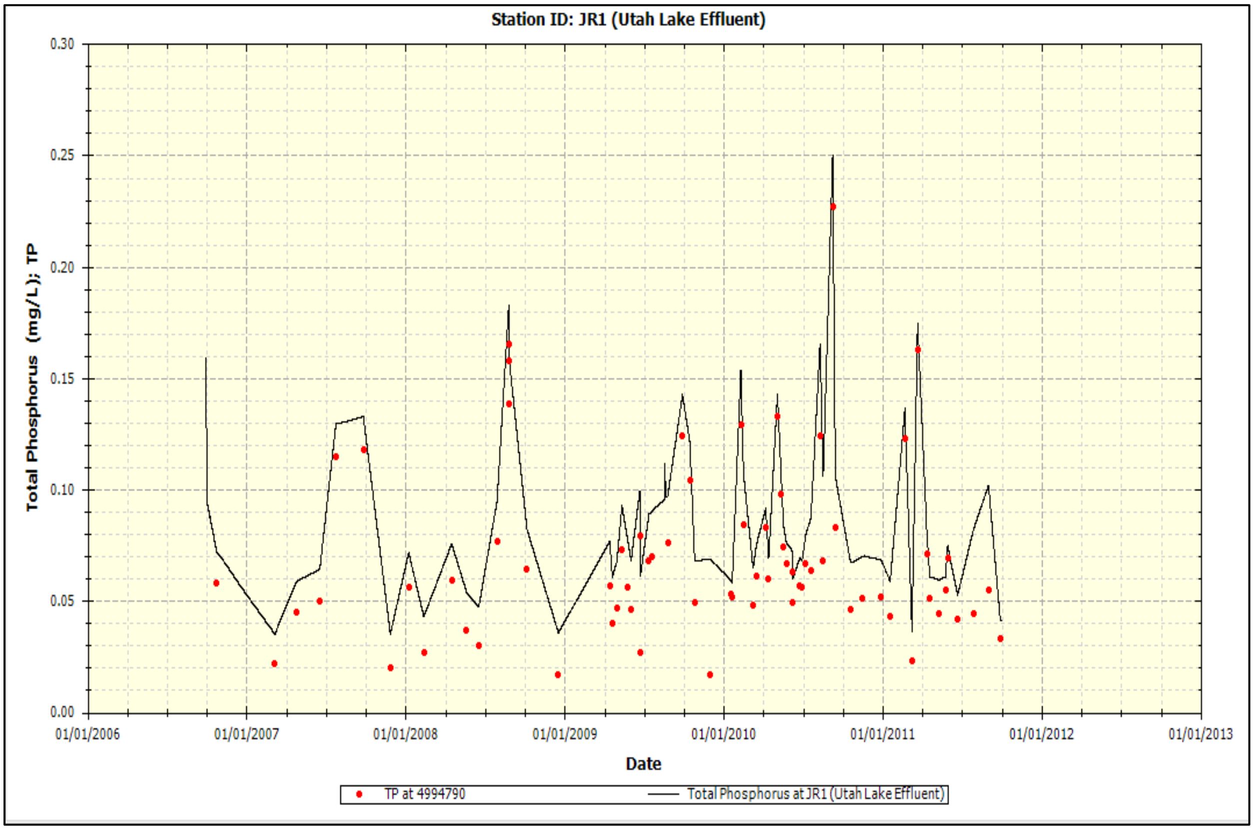

Station ID: JR150
Dissolved Organic N (mg/L); DON
Date
DON at 4991820
Dissolved Organic N at JR150

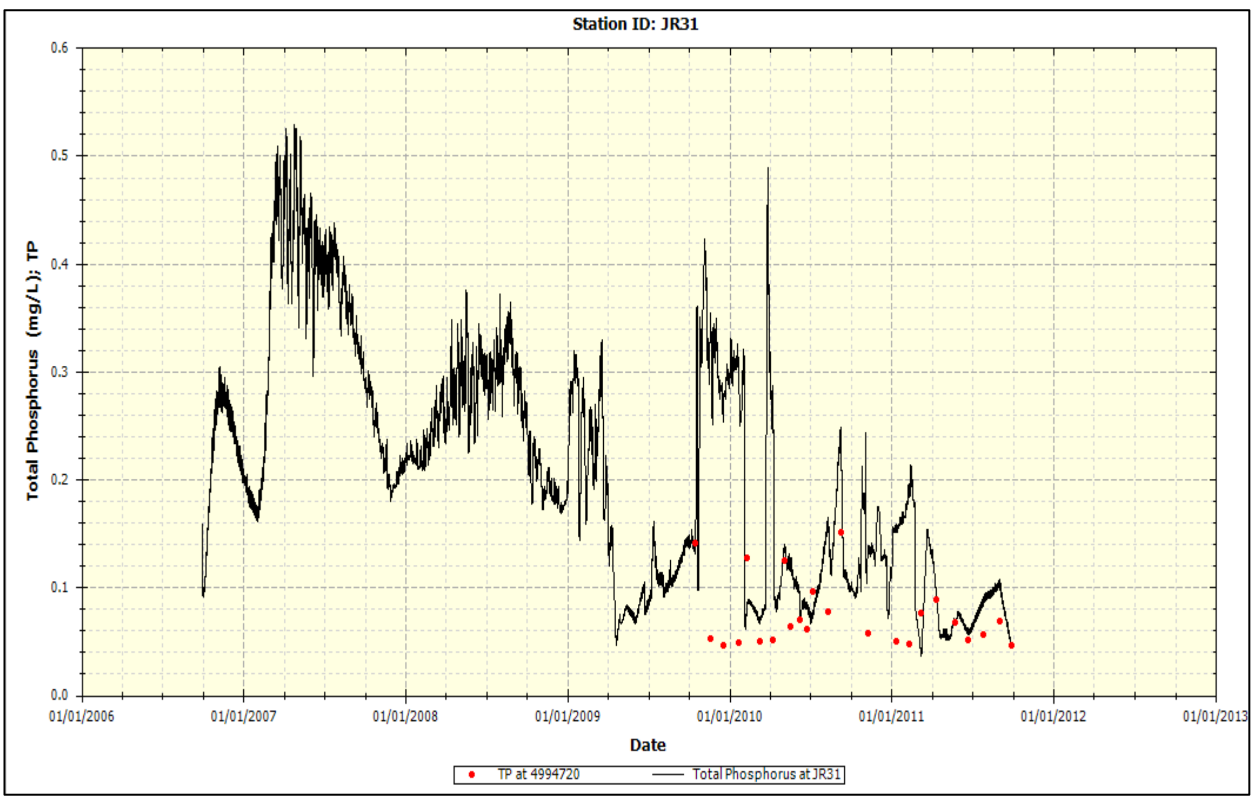

Station ID: JR151 (South Davis South WWTP)
Dissolved Organic N (mg/L); DON
Date
DON at 4991800
Dissolved Organic N at JR151 (South Davis South WWTP)

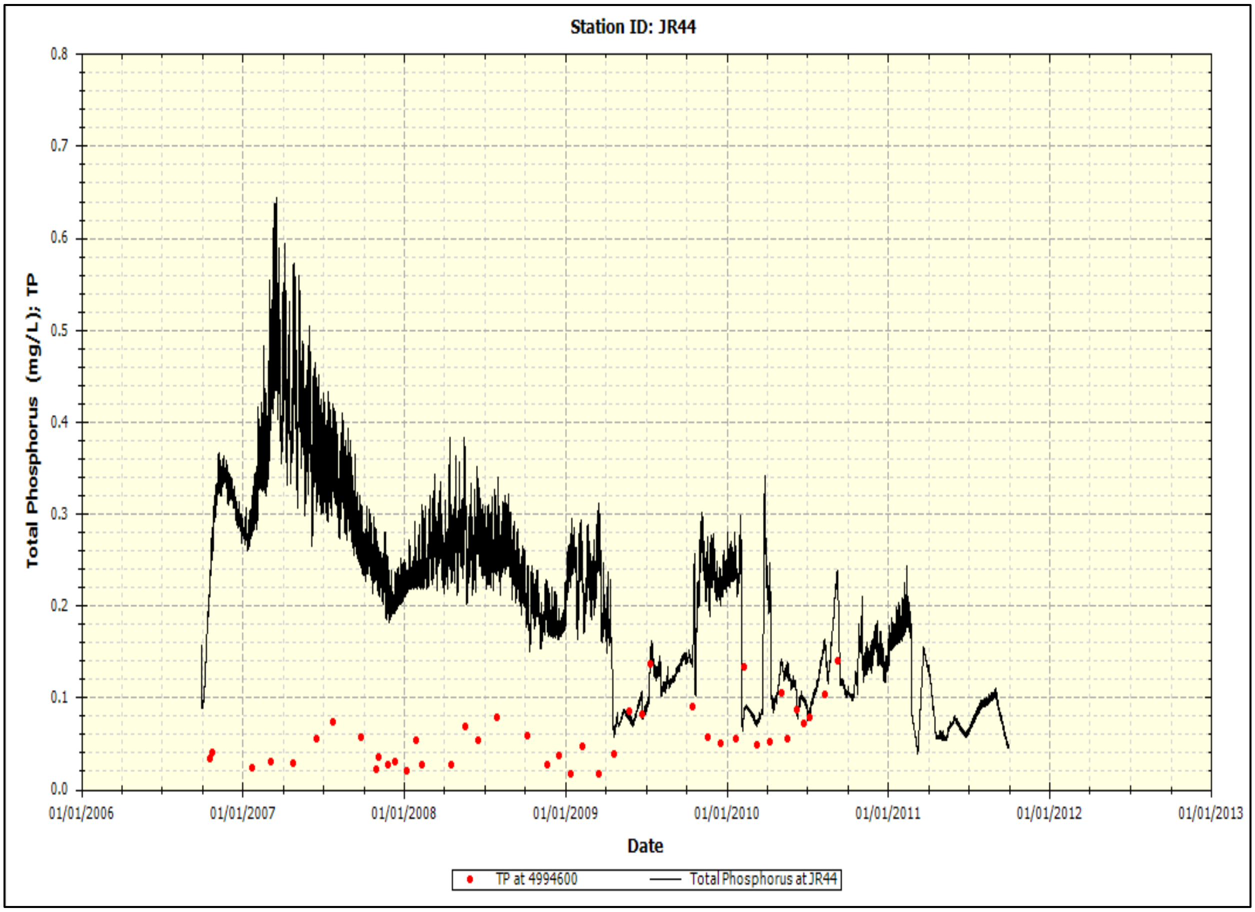


Station ID: JR161 (Burnham Dam)
Dissolved Organic N (mg/L); DON
0
1
2
3
4
5
6
7
8
9
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
DON at 4990890
Dissolved Organic N at JR161 (Burnham Dam)

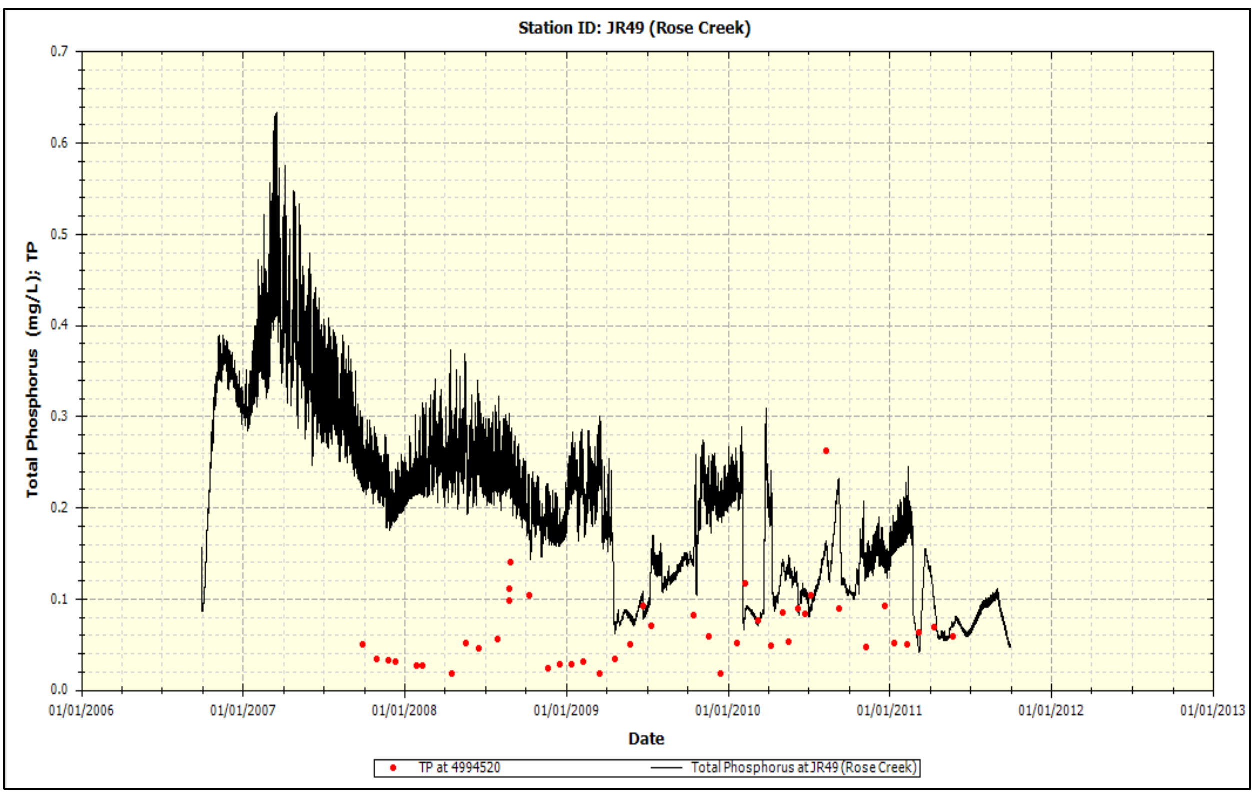
B.1.9: TOTAL PHOSPHATE-PHOSPHORUS (TP)



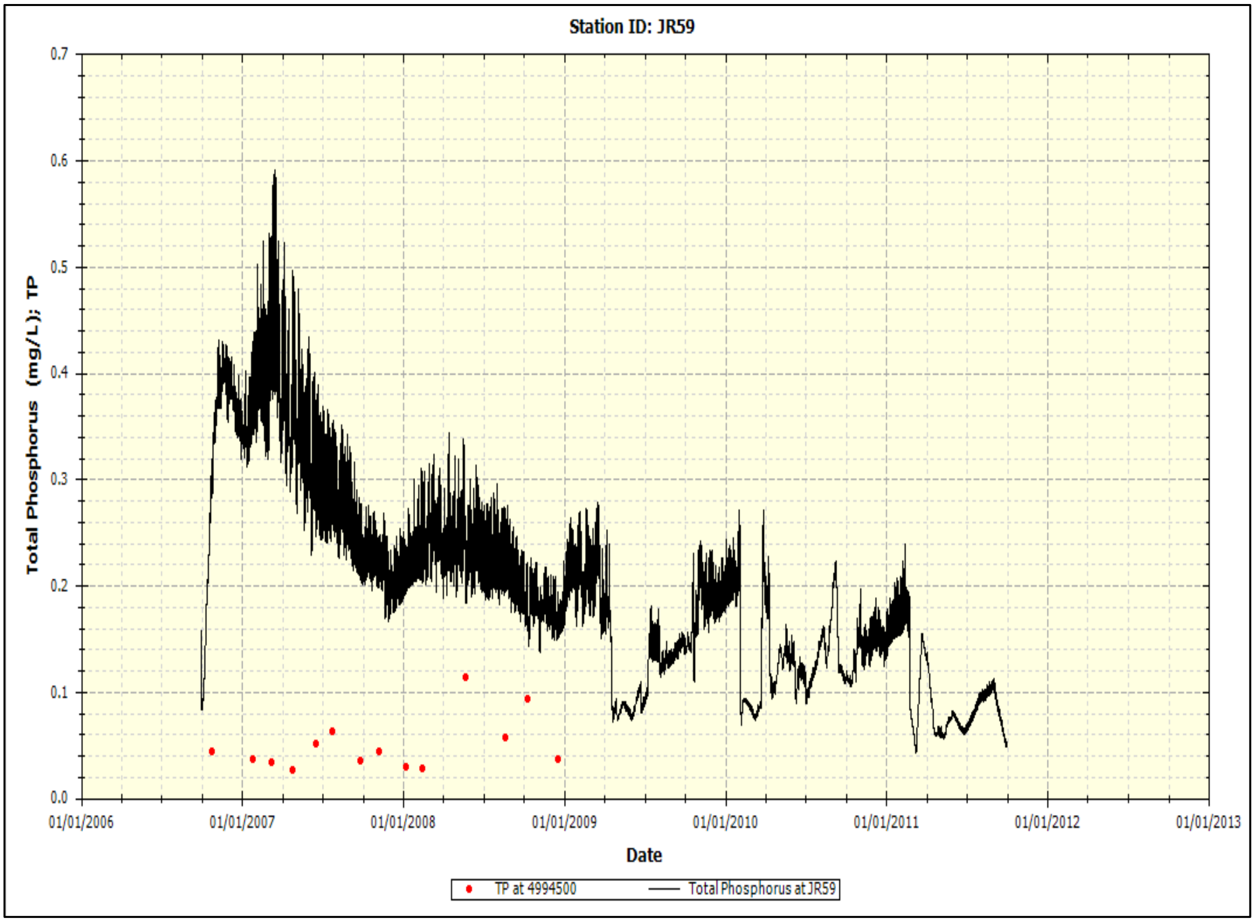


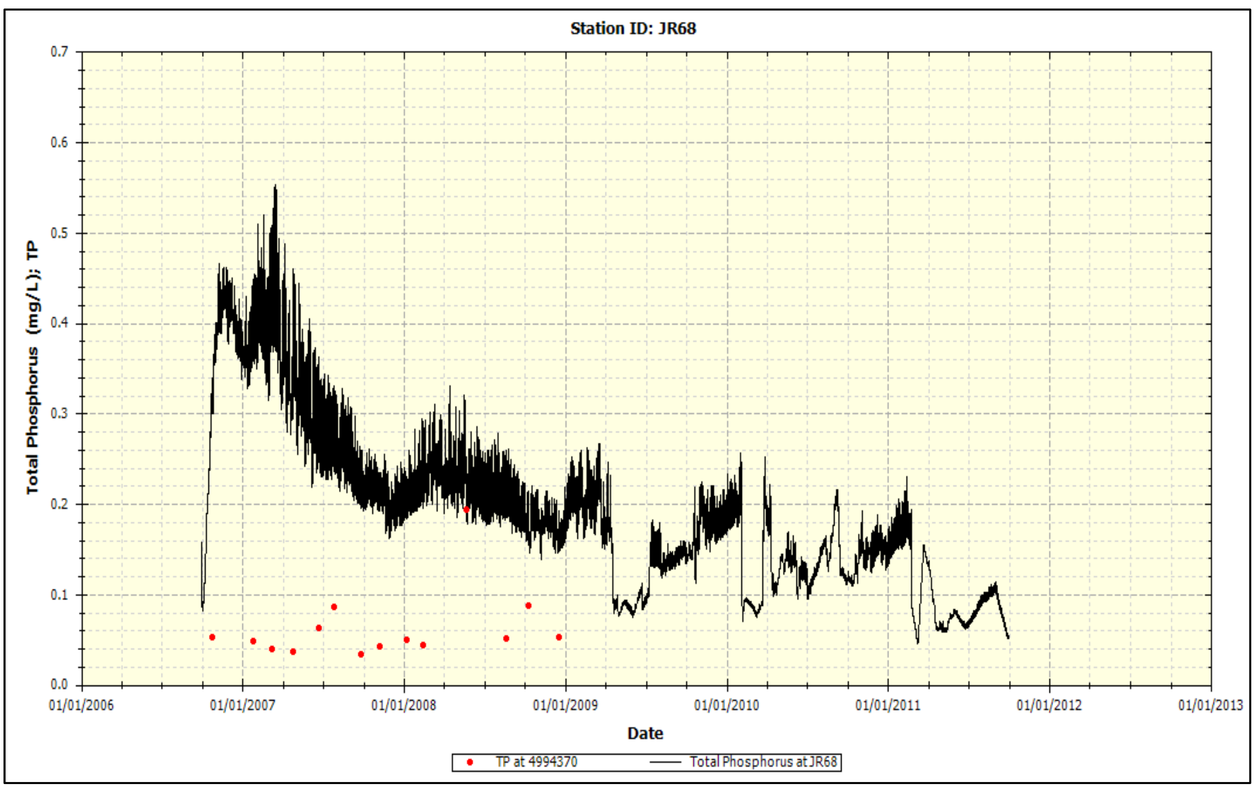


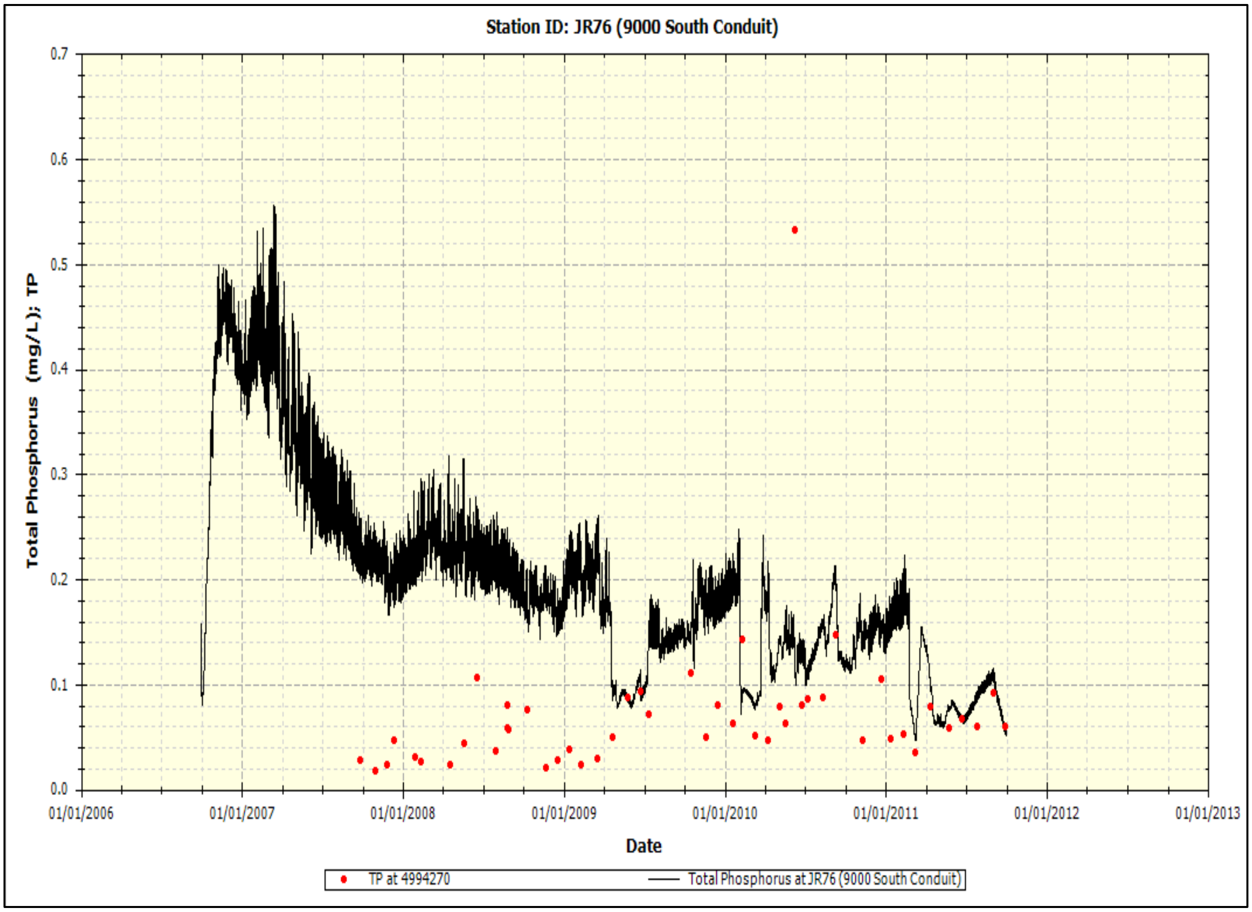
Station ID: JR44
Total Phosphorus (mg/L); TP
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994600
Total Phosphorus at JR44



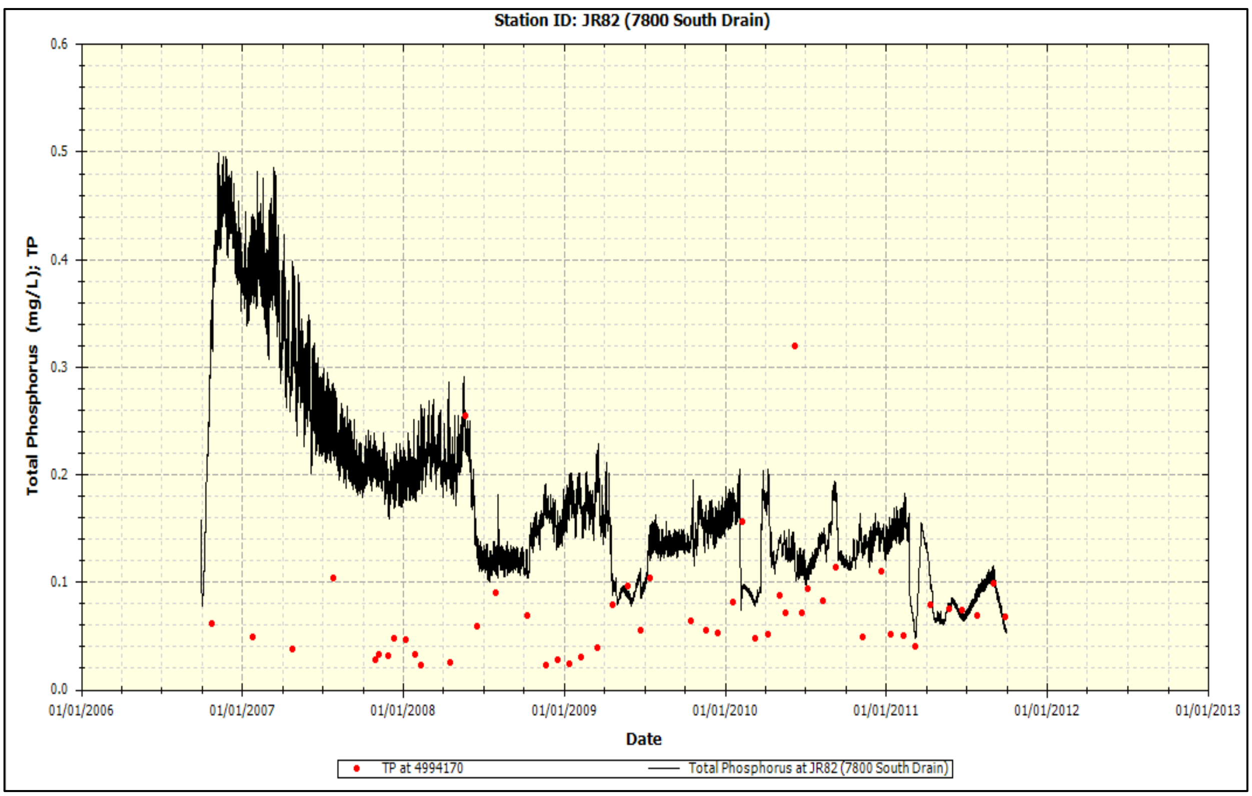
Station ID: JR49 (Rose Creek)
Total Phosphorus (mg/L); TP
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994520
Total Phosphorus at JR49 (Rose Creek)


Station ID: JR59
Total Phosphorus (mg/L); TP
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994500
Total Phosphorus at JR59

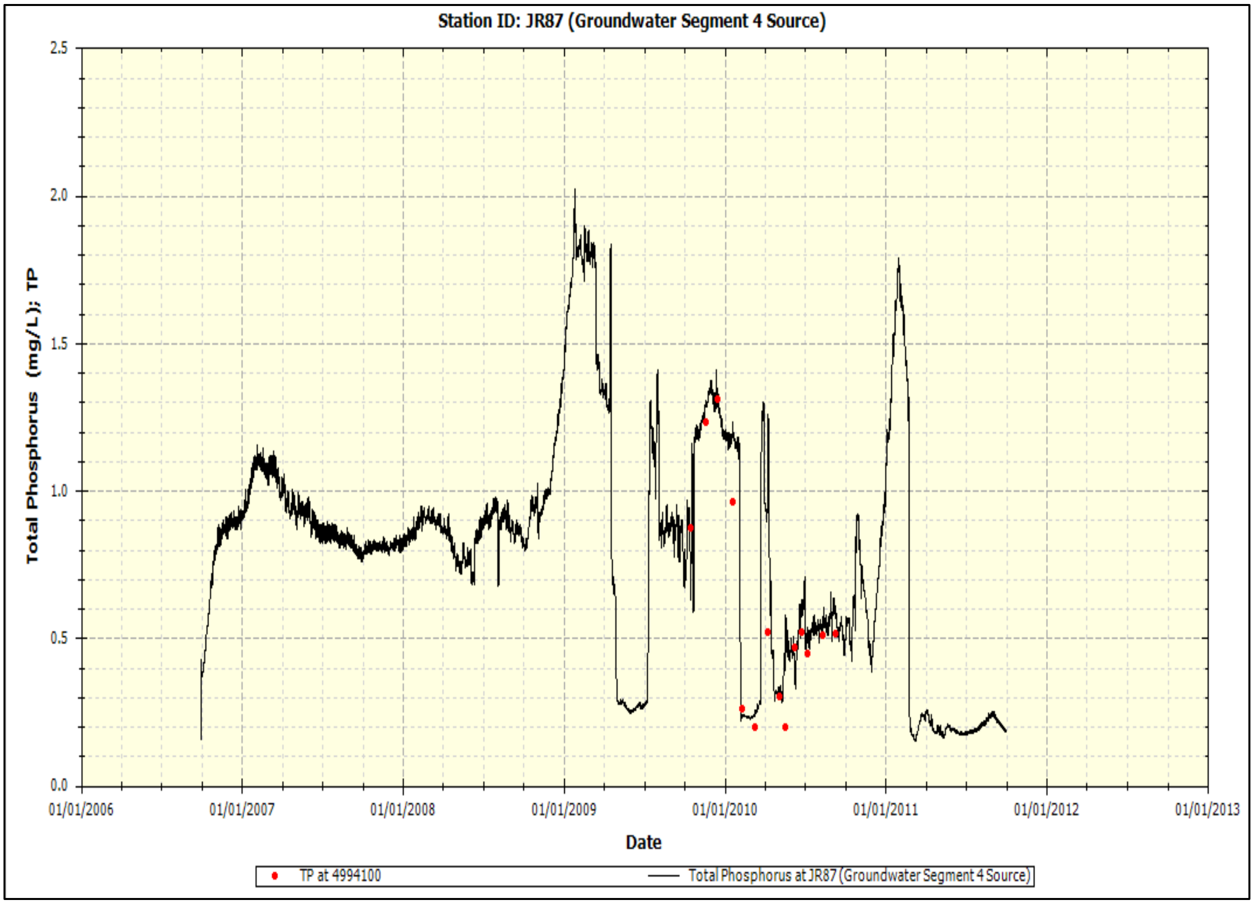

Station ID: JR68
Total Phosphorus (mg/L); TP
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994370
Total Phosphorus at JR68



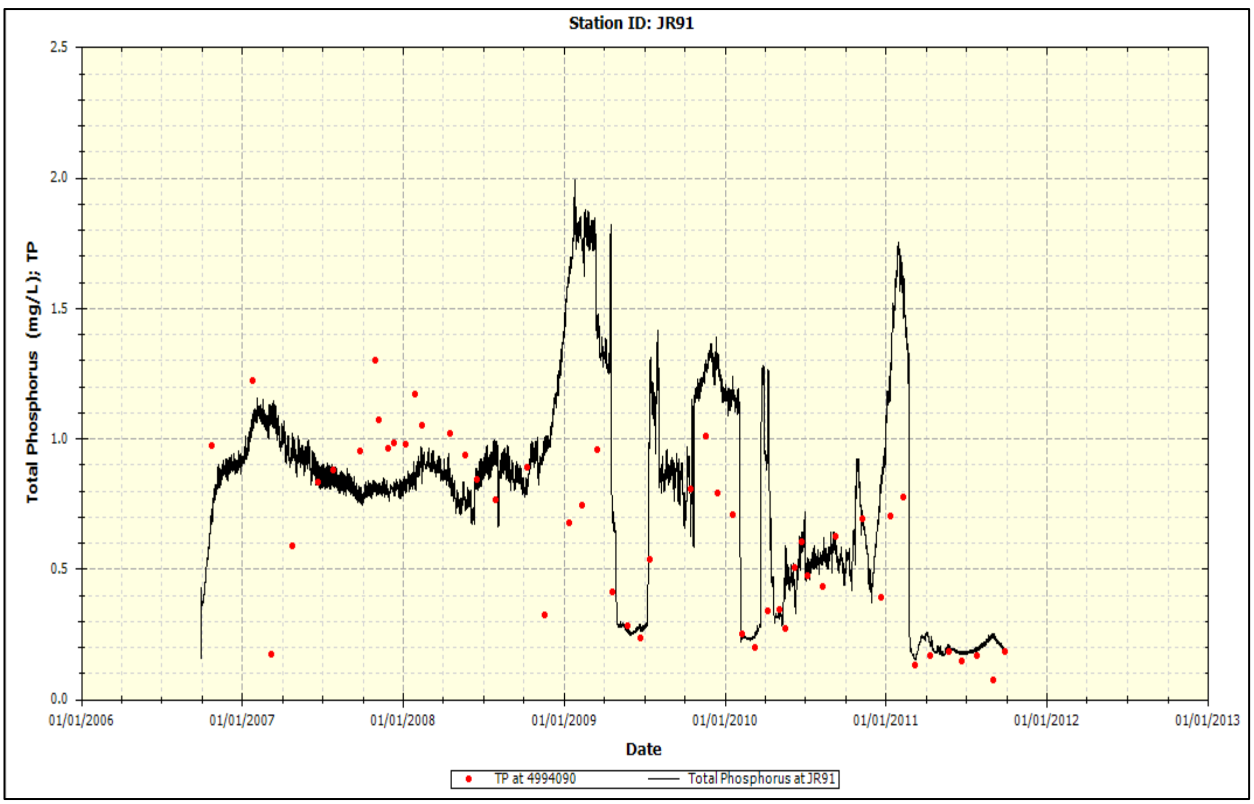
Station ID: JR76 (9000 South Conduit)
Total Phosphorus (mg/L); TP
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994270
Total Phosphorus at JR76 (9000 South Conduit)



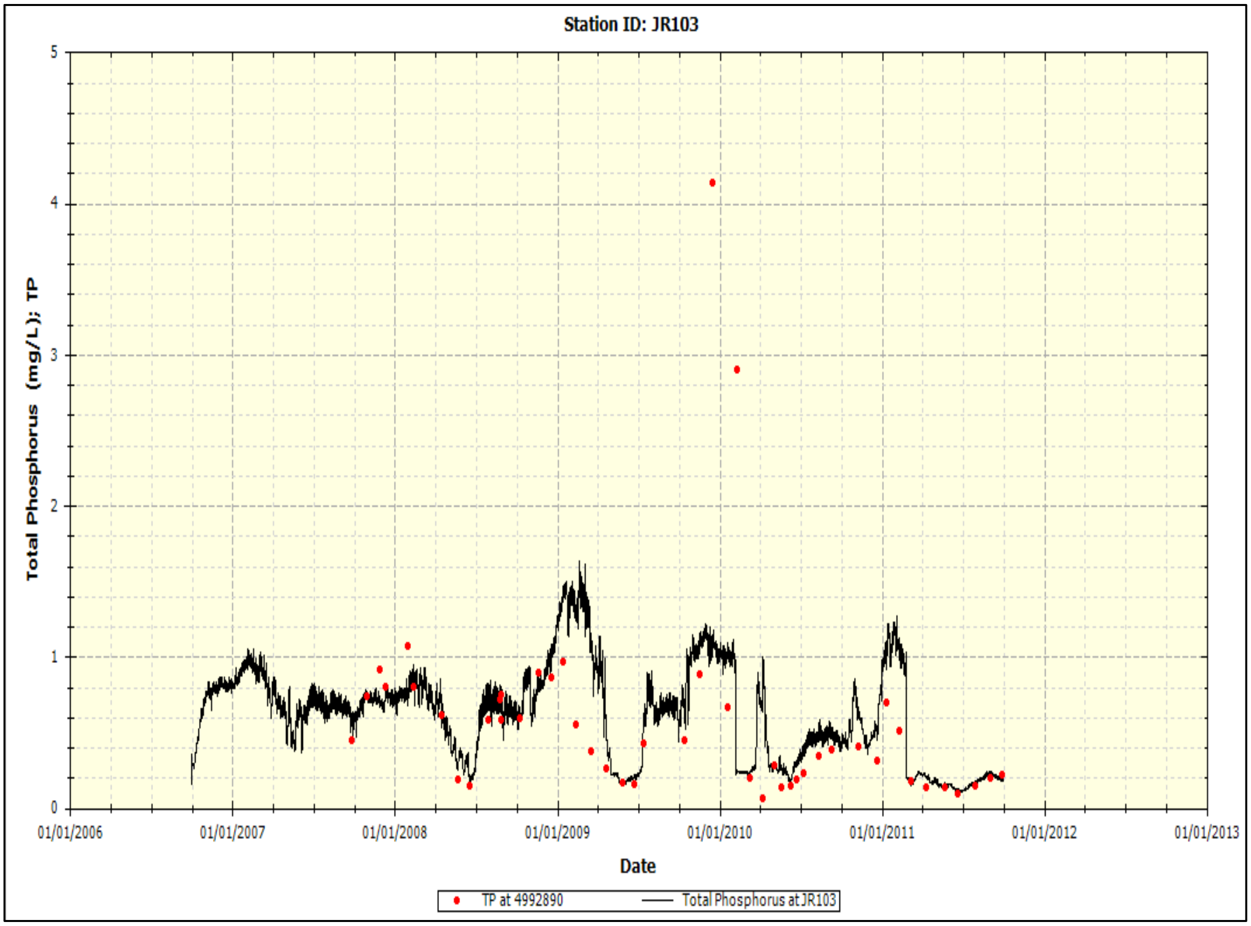
Station ID: JR82 (7800 South Drain)
Total Phosphorus (mg/L); TP
0.0
0.1
0.2
0.3
0.4
0.5
0.6
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994170
Total Phosphorus at JR82 (7800 South Drain)

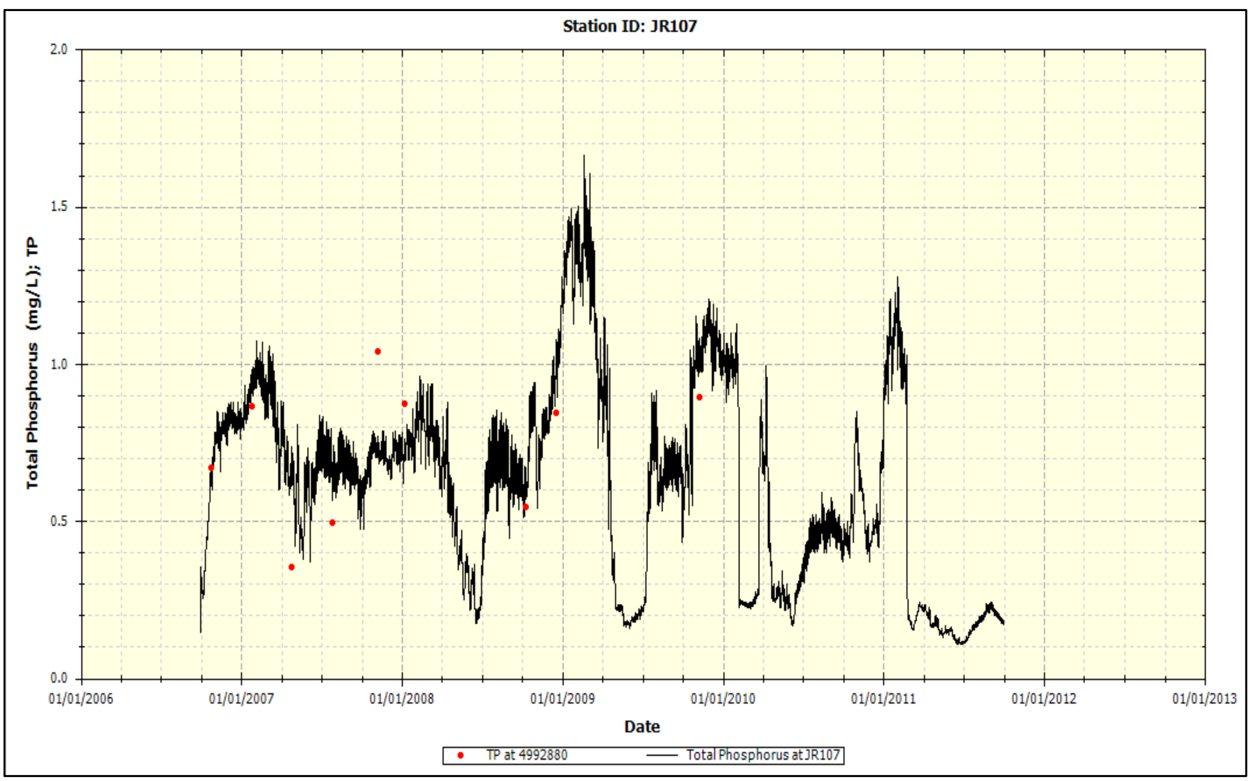


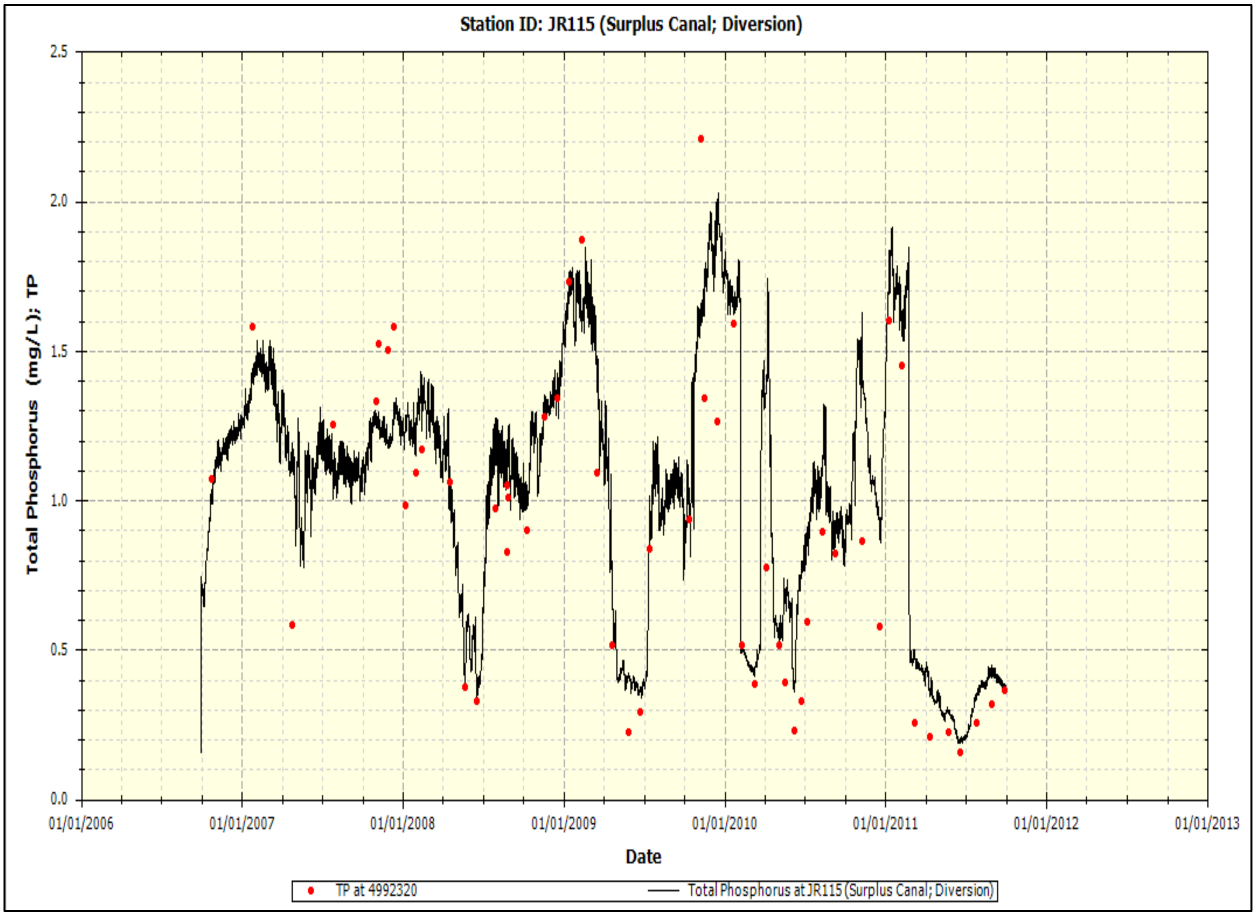
Station ID: JR87 (Groundwater Segment 4 Source)
Total Phosphorus (mg/L); TP
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994100
Total Phosphorus at JR87 (Groundwater Segment 4 Source)



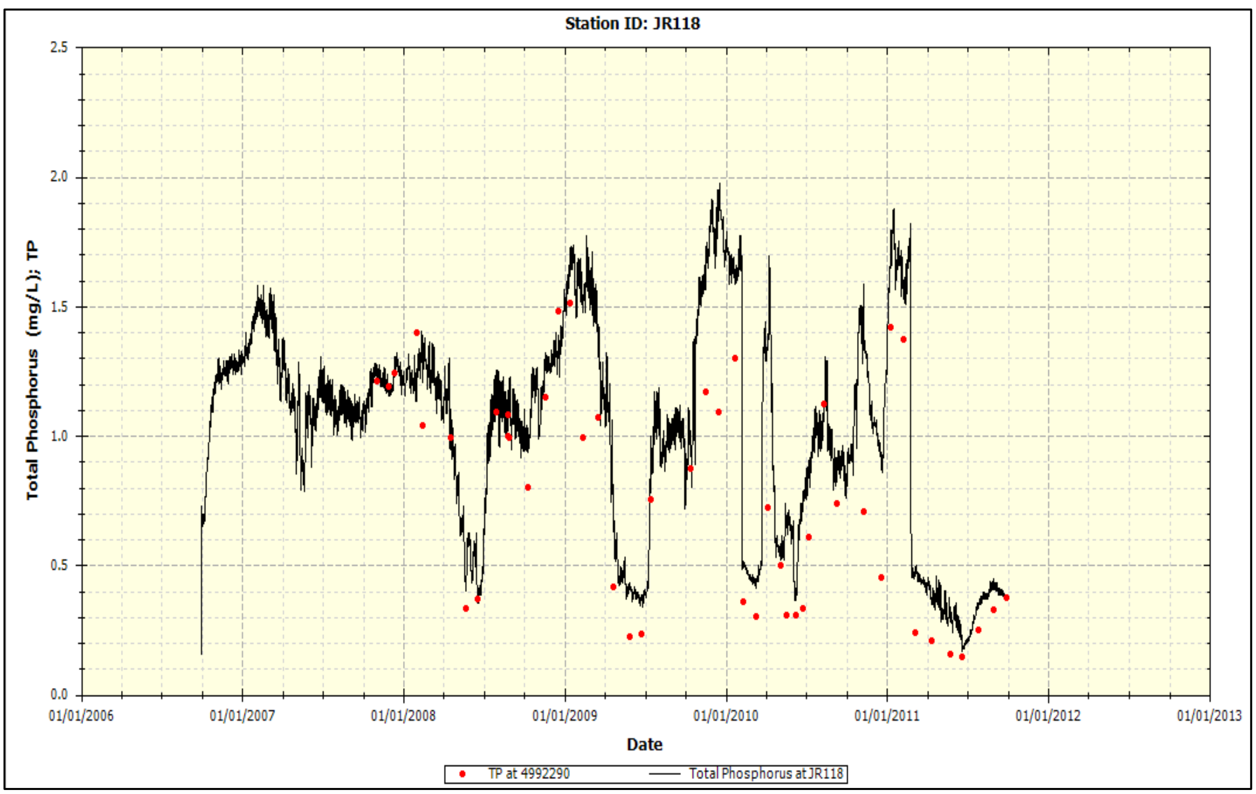
Station ID: JR91
Total Phosphorus (mg/L); TP
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4994090
Total Phosphorus at JR91


Station ID: JR103
Total Phosphorus (mg/L); TP
0
1
2
3
4
5
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4992890
Total Phosphorus at JR103

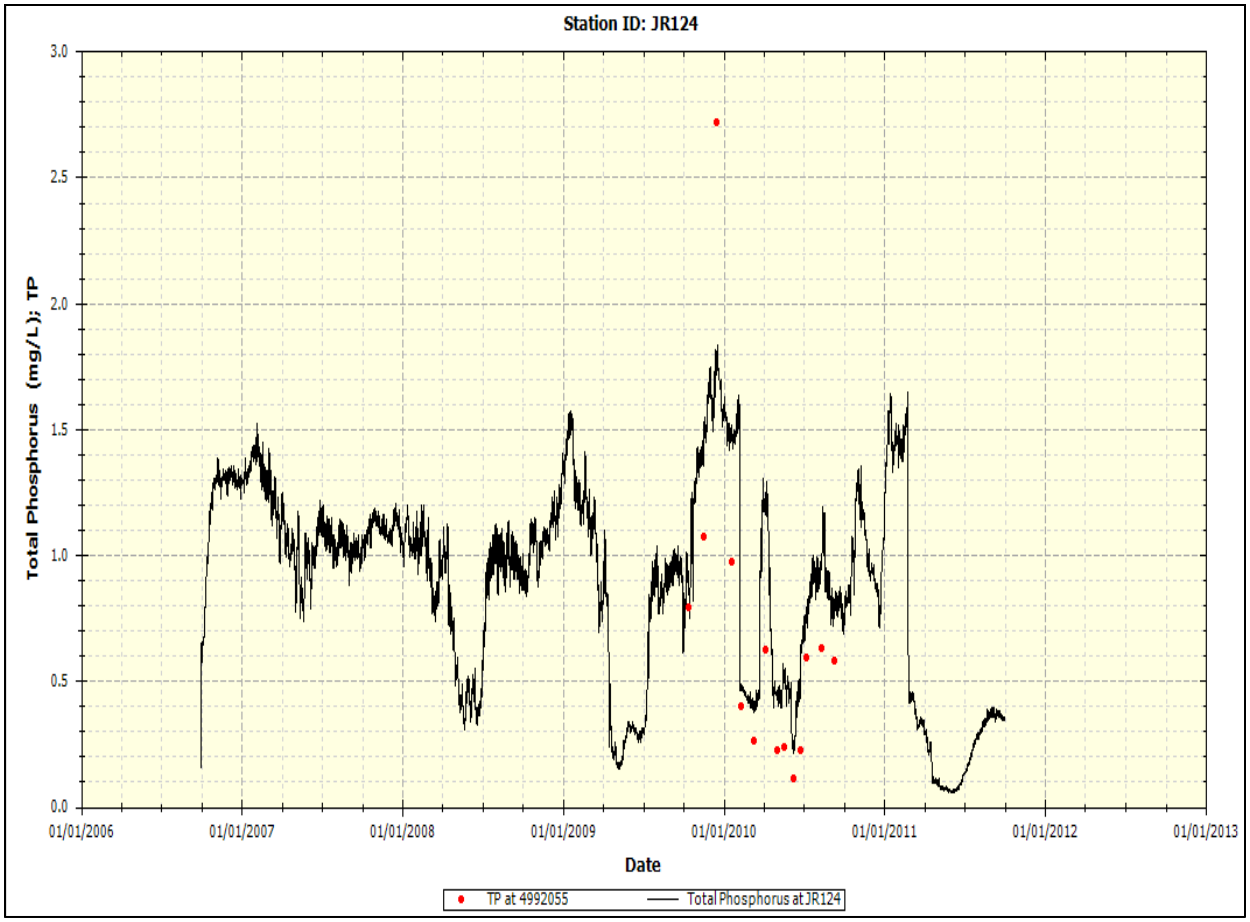

Station ID: JR107
Total Phosphorus (mg/L); TP
0.0
0.5
1.0
1.5
2.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4992880
Total Phosphorus at JR107

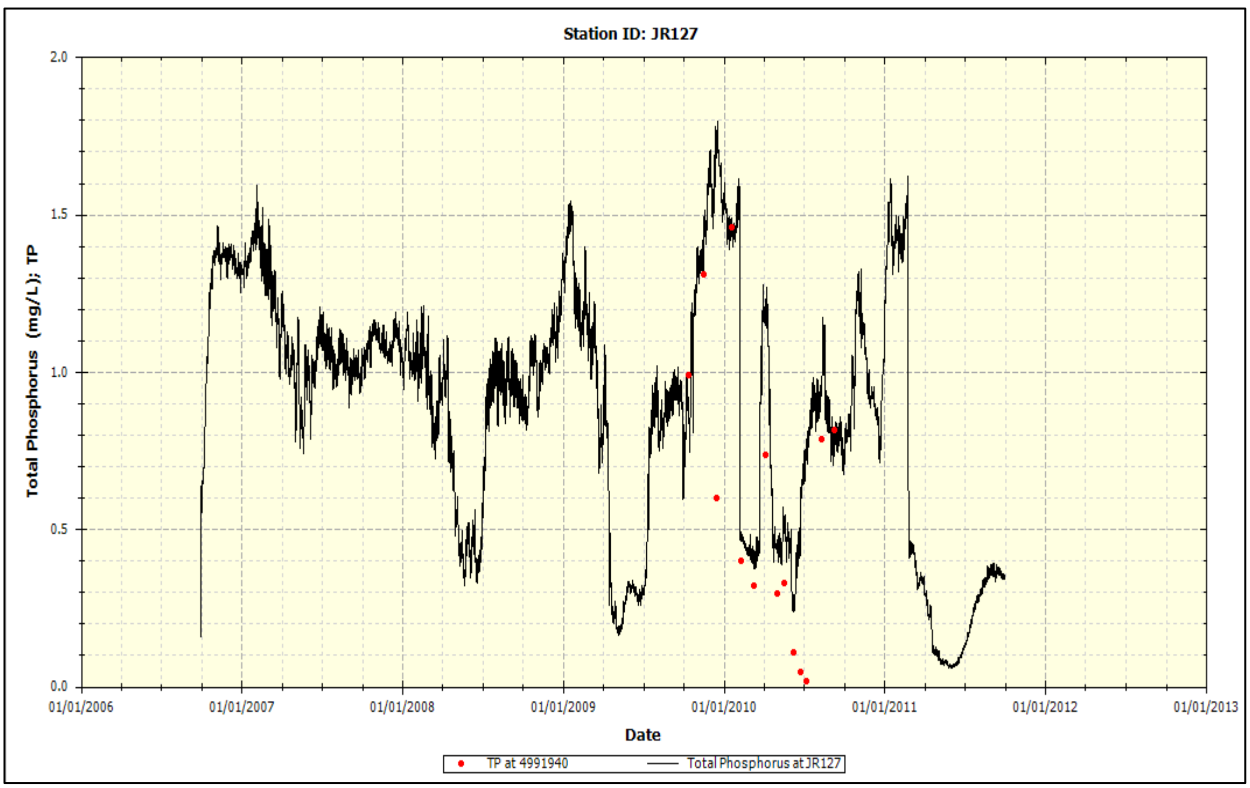


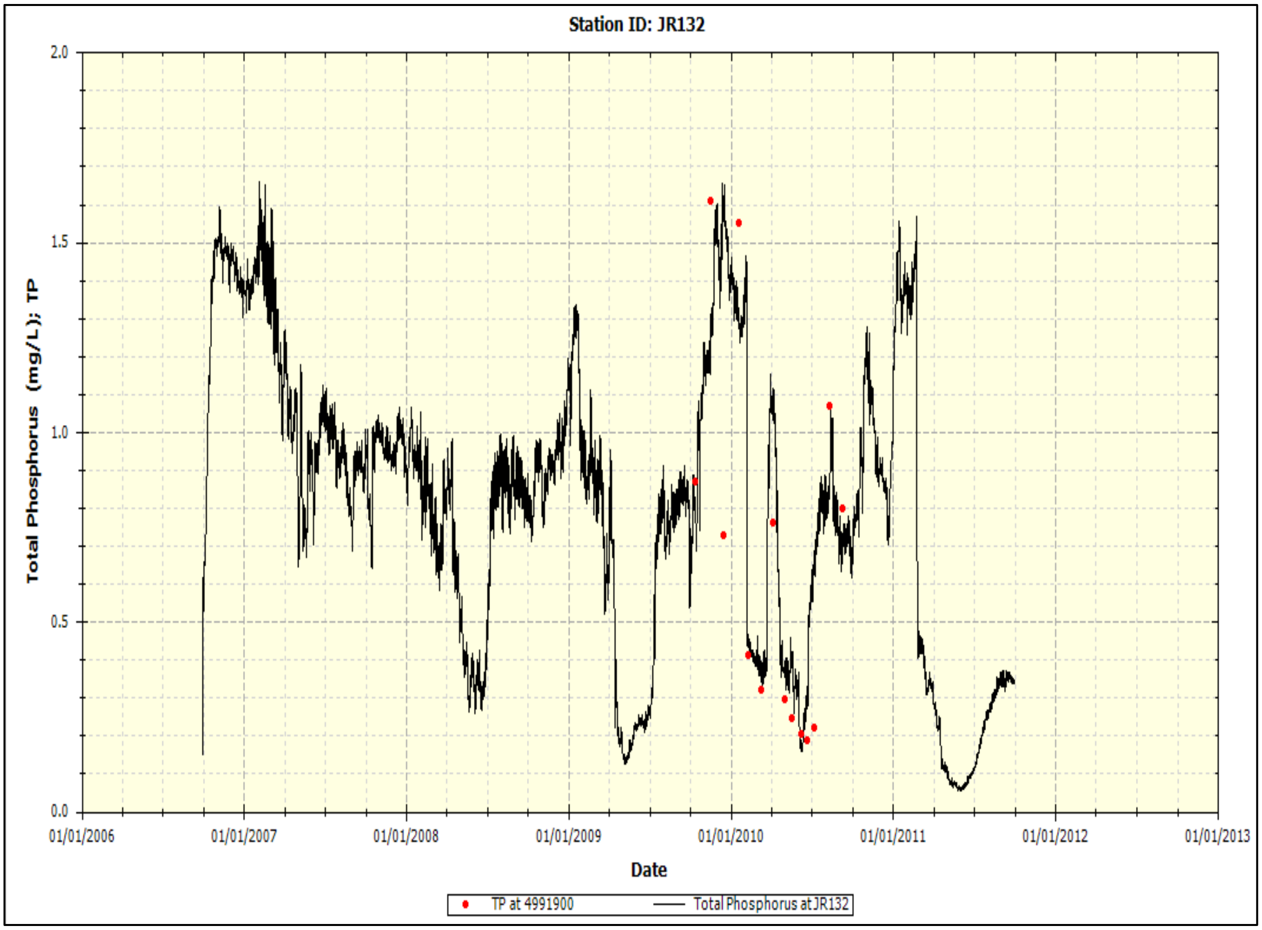
Station ID: JR115 (Surplus Canal; Diversion)
Total Phosphorus (mg/L); TP
Date
TP at 4992320
Total Phosphorus at JR115 (Surplus Canal; Diversion)

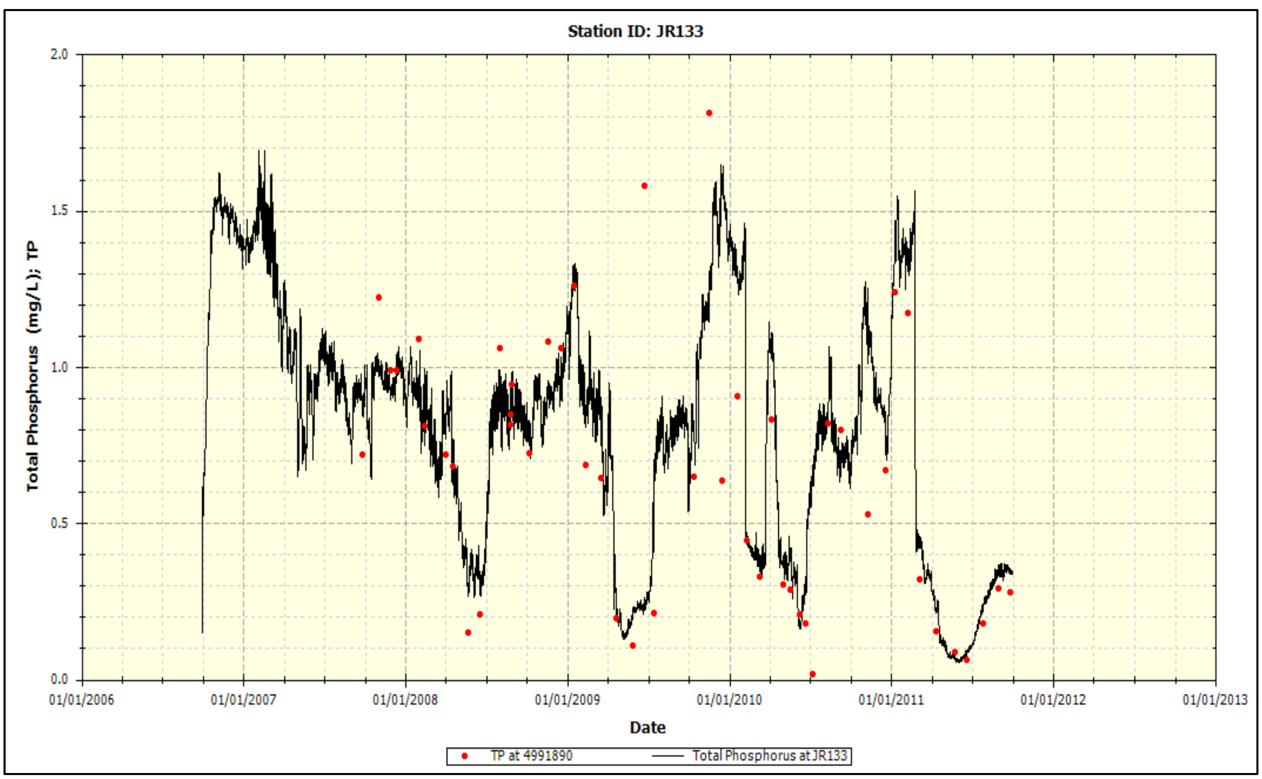


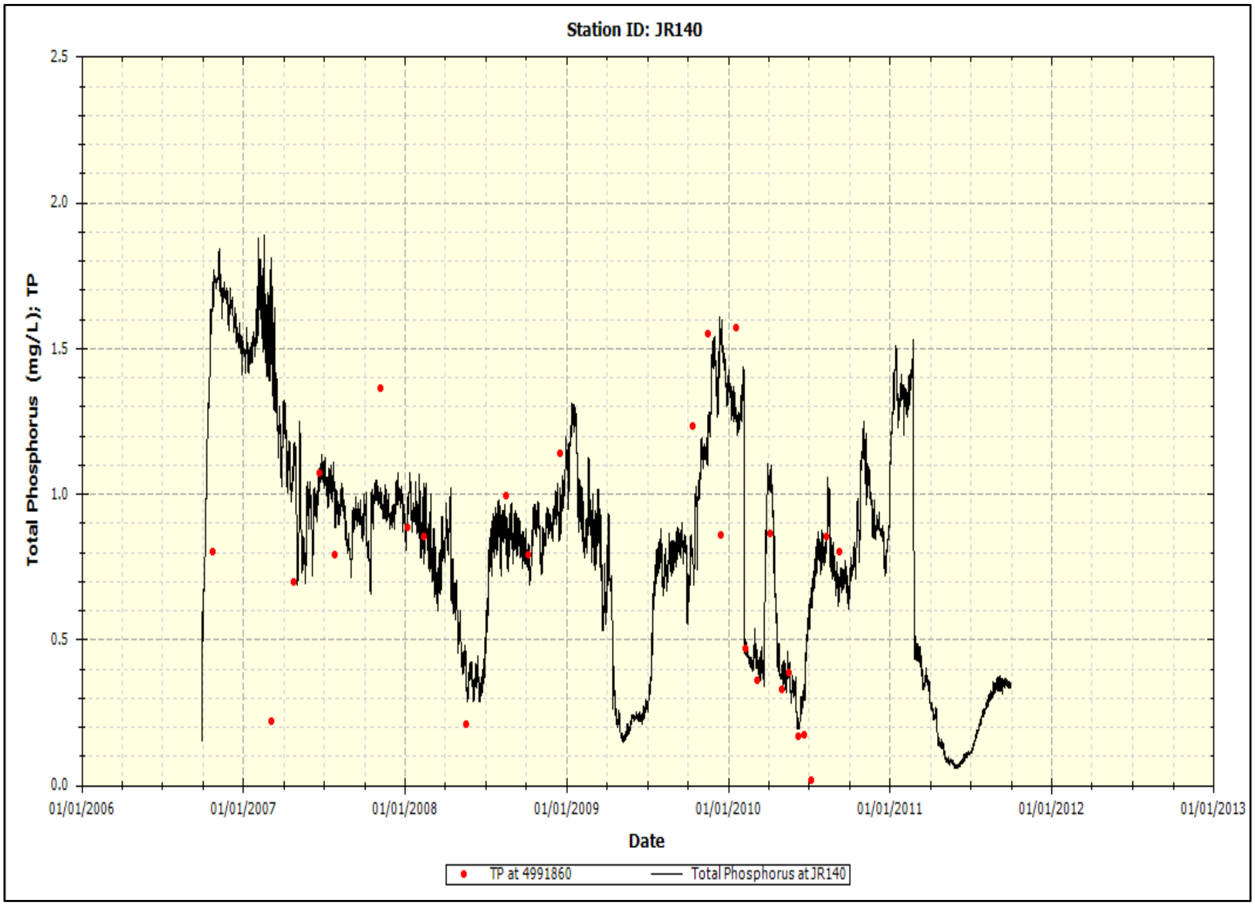
Station ID: JR118
Total Phosphorus (mg/L); TP
Date
TP at 4992290
Total Phosphorus at JR118

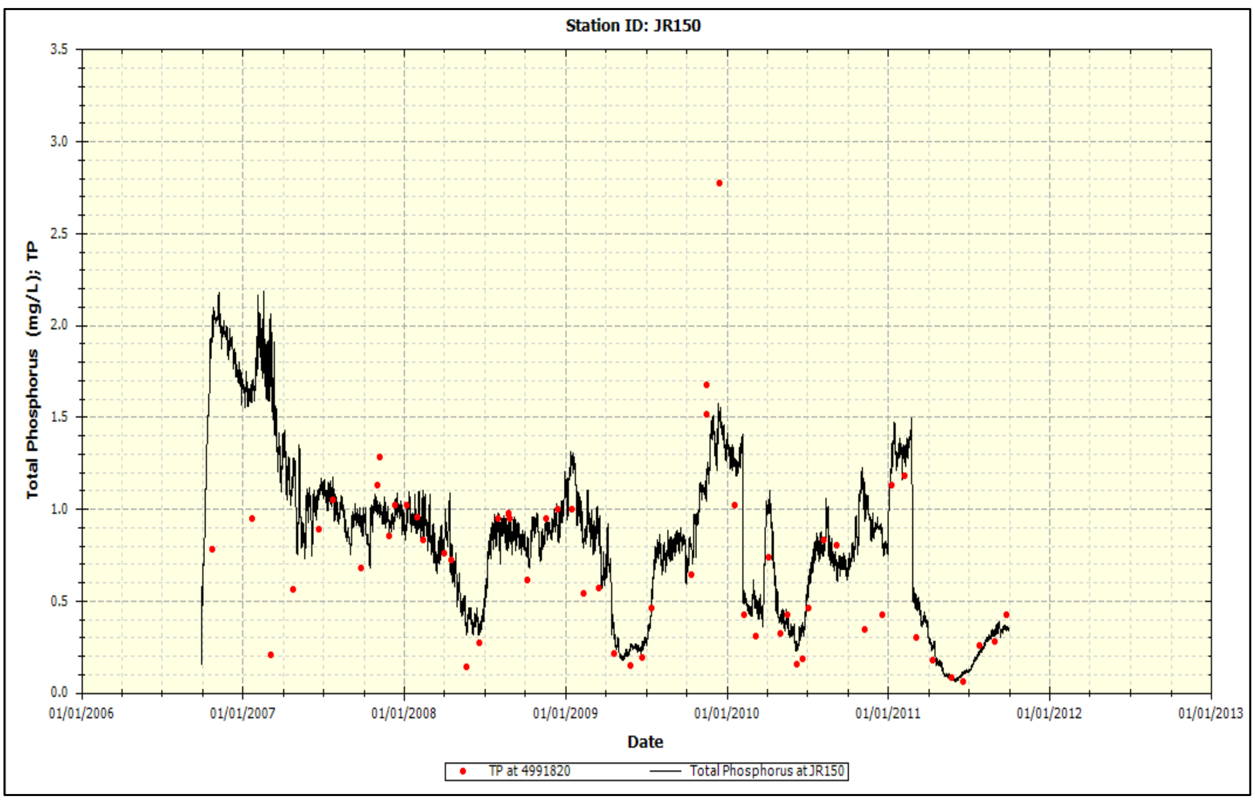

Station ID: JR124
Total Phosphorus (mg/L); TP
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4992055
Total Phosphorus at JR124

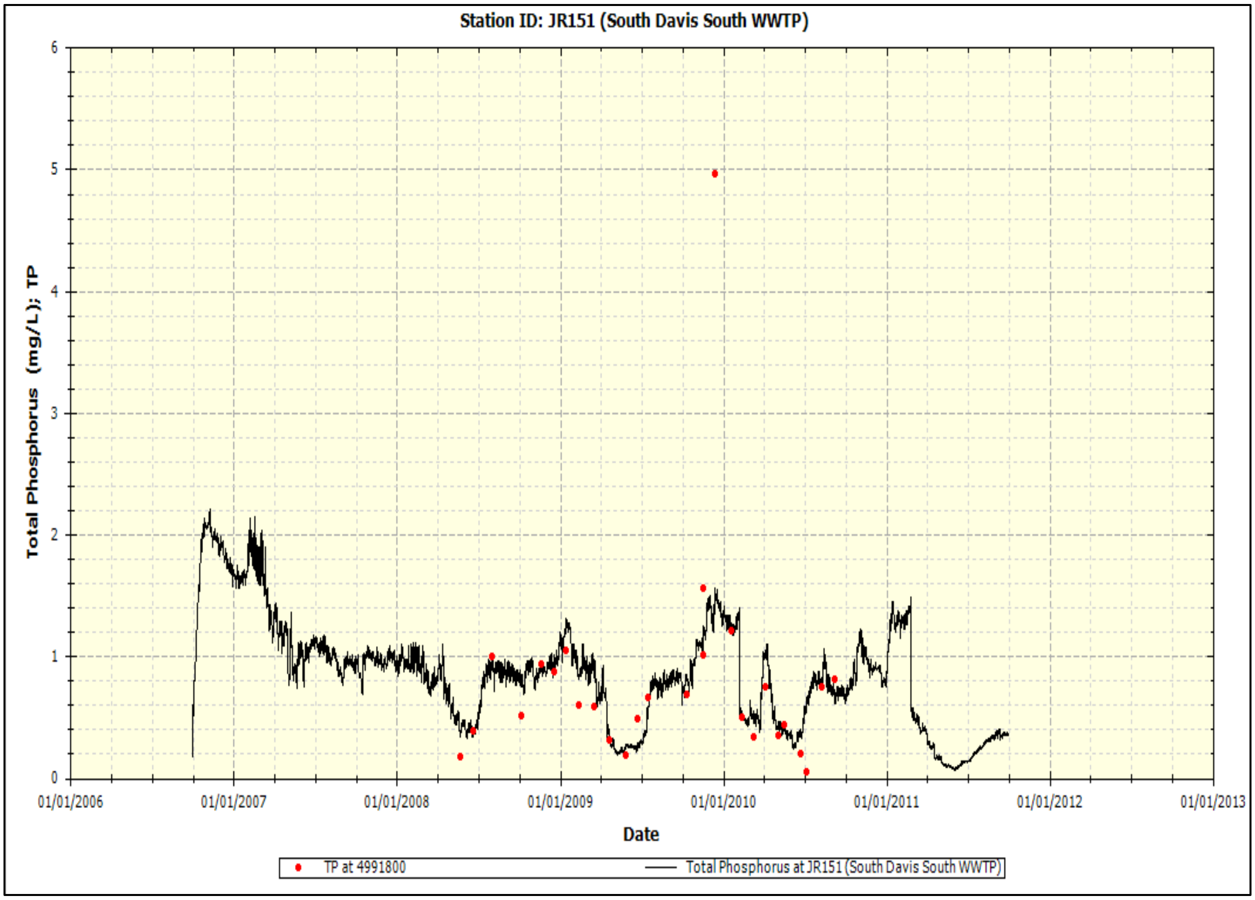

Station ID: JR127
Total Phosphorus (mg/L); TP
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4991940
Total Phosphorus at JR127

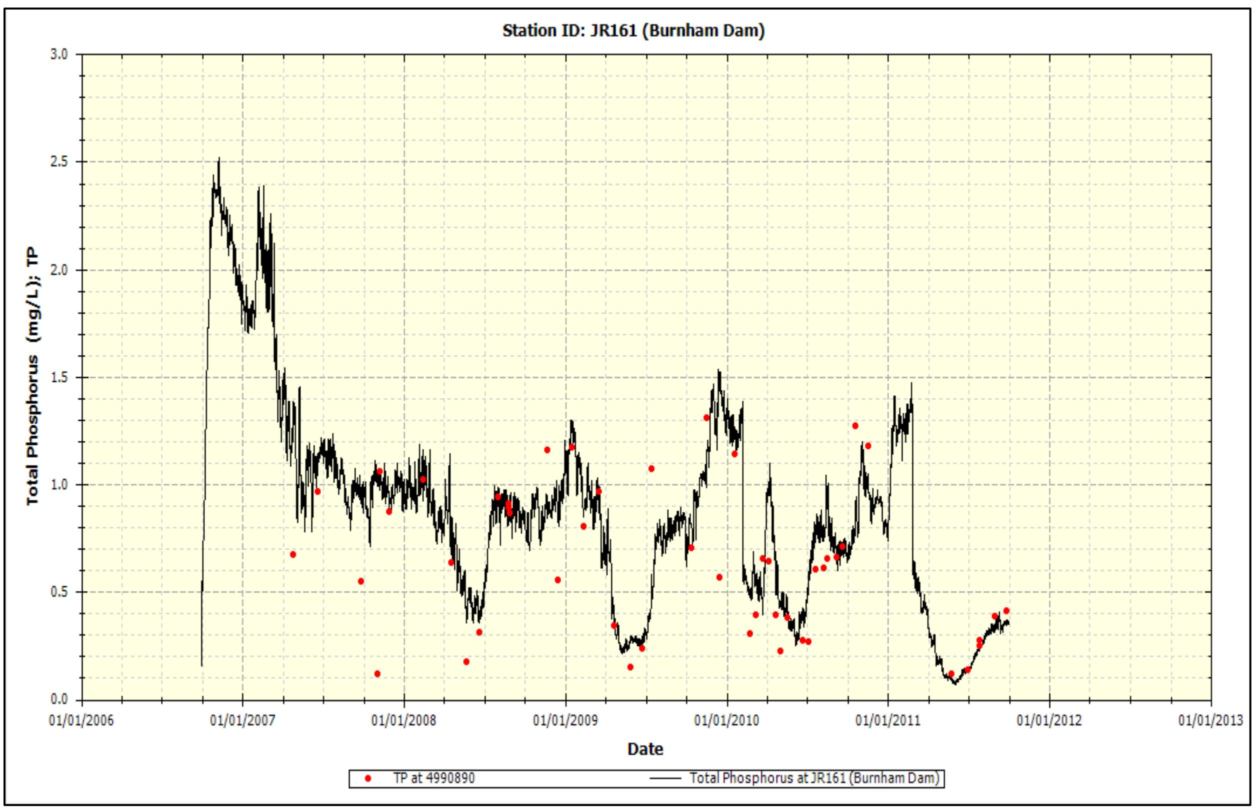

Station ID: JR132
2.0
1.5
1.0
0.5
0.0
Total Phosphorus (mg/L); TP
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4991900
Total Phosphorus at JR132


Station ID: JR133
2.0
1.5
1.0
0.5
0.0
Total Phosphorus (mg/L); TP
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4991890
Total Phosphorus at JR133

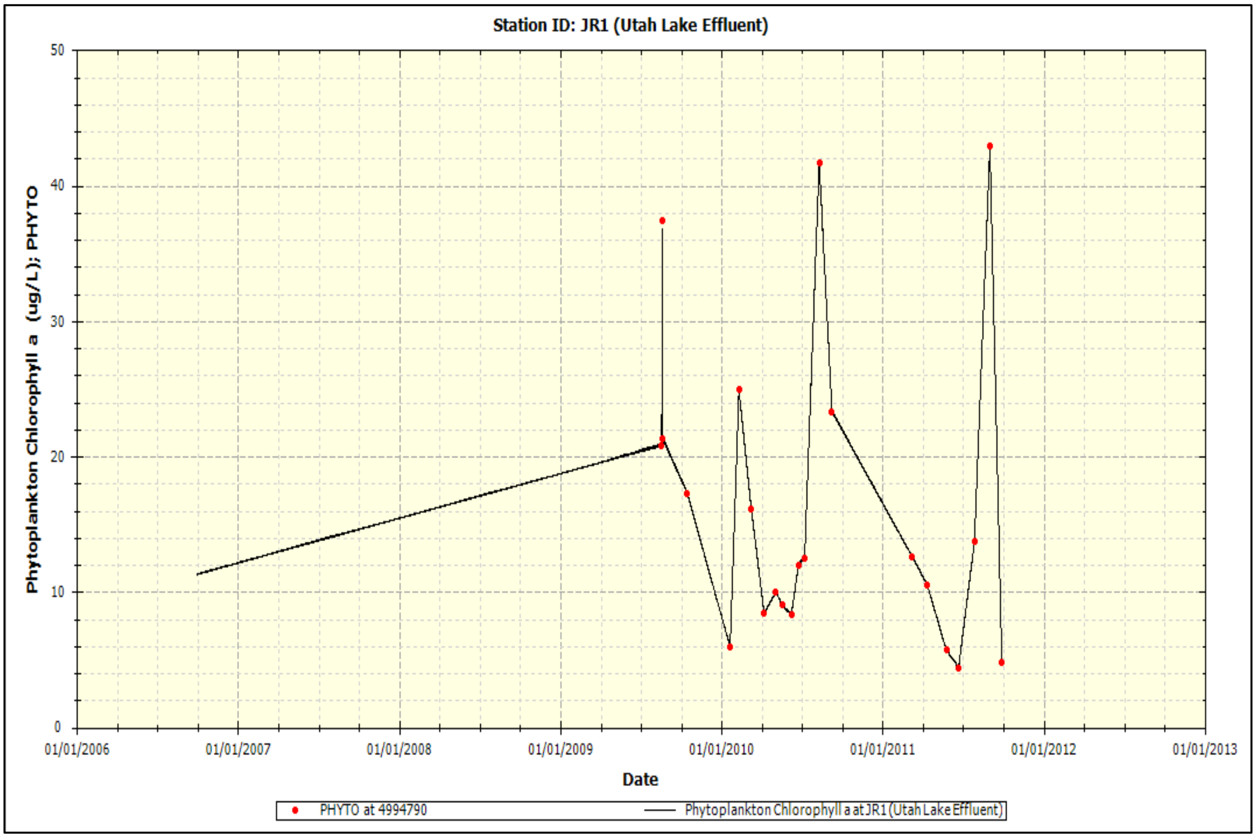

Station ID: JR140
Total Phosphorus (mg/L); TP
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4991860
Total Phosphorus at JR140

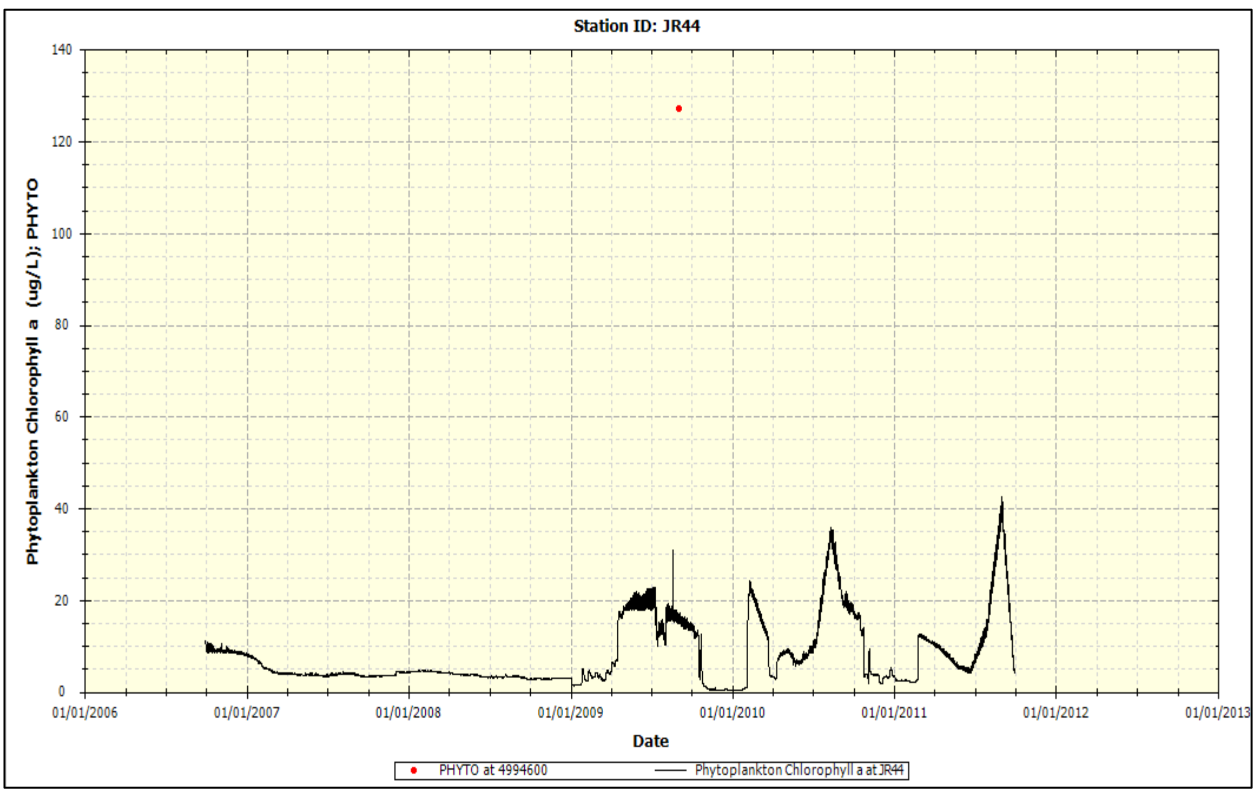

Station ID: JR150
Total Phosphorus (mg/L); TP
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
TP at 4991820
Total Phosphorus at JR150

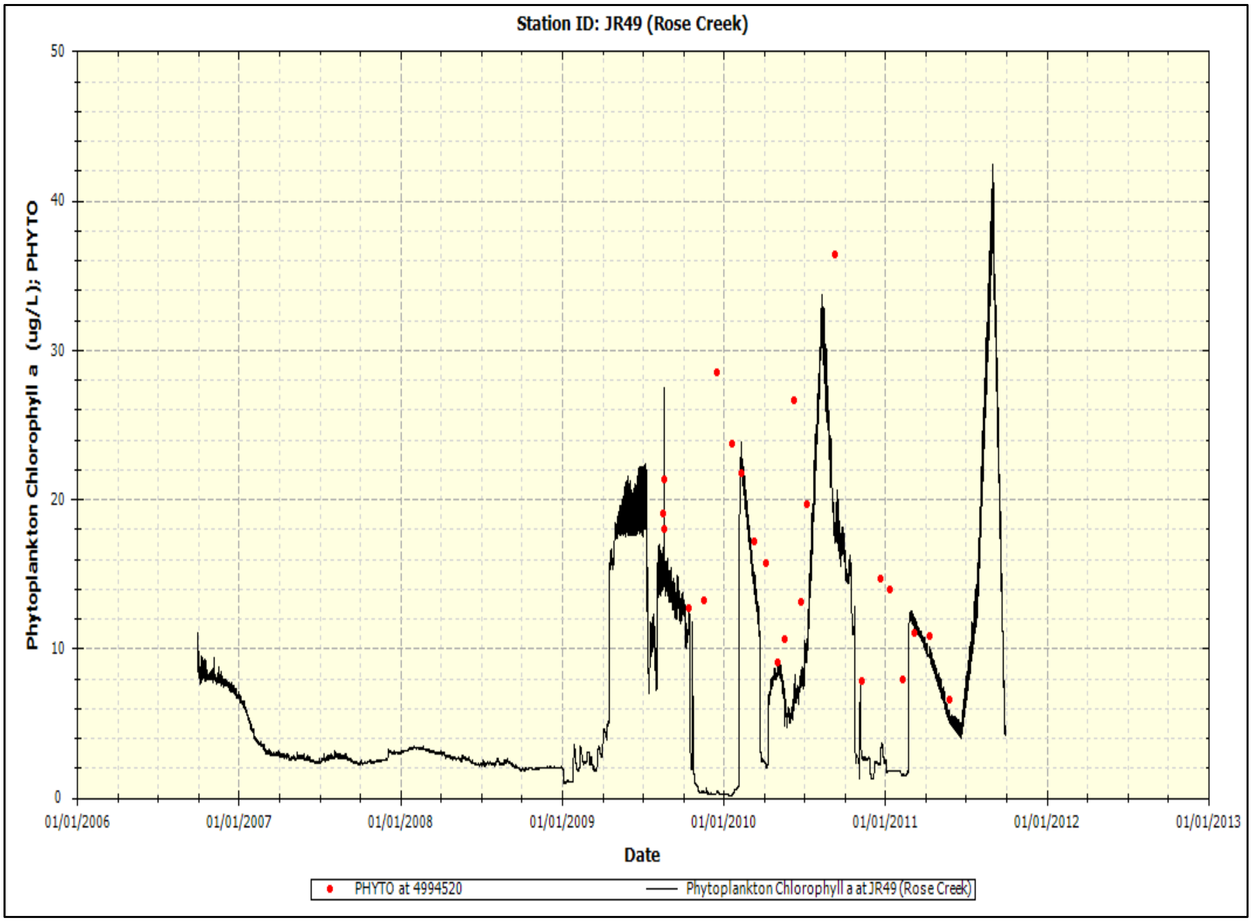

Station ID: JR151 (South Davis South WWTP)
Total Phosphorus (mg/L); TP
Date
TP at 4991800
Total Phosphorus at JR151 (South Davis South WWTP)

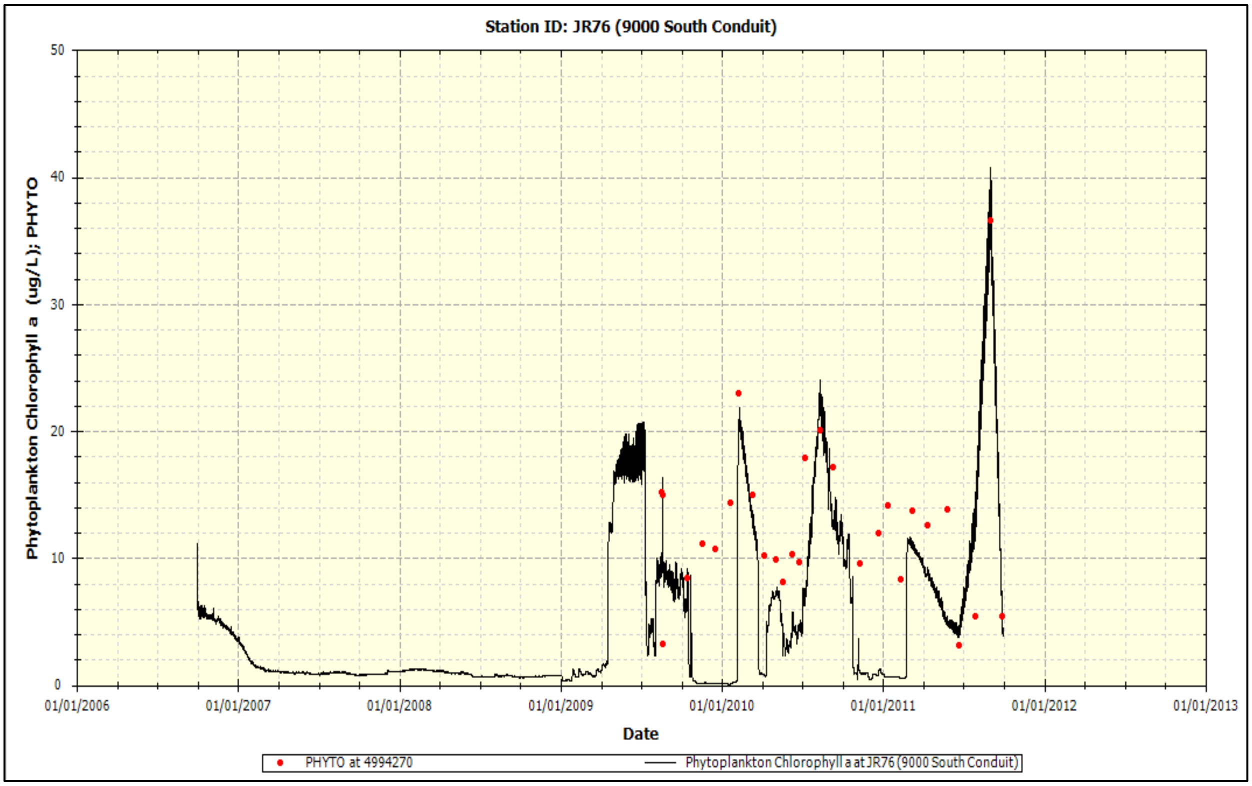

Station ID: JR161 (Burnham Dam)
Total Phosphorus (mg/L); TP
Date
TP at 4990890
Total Phosphorus at JR161 (Burnham Dam)

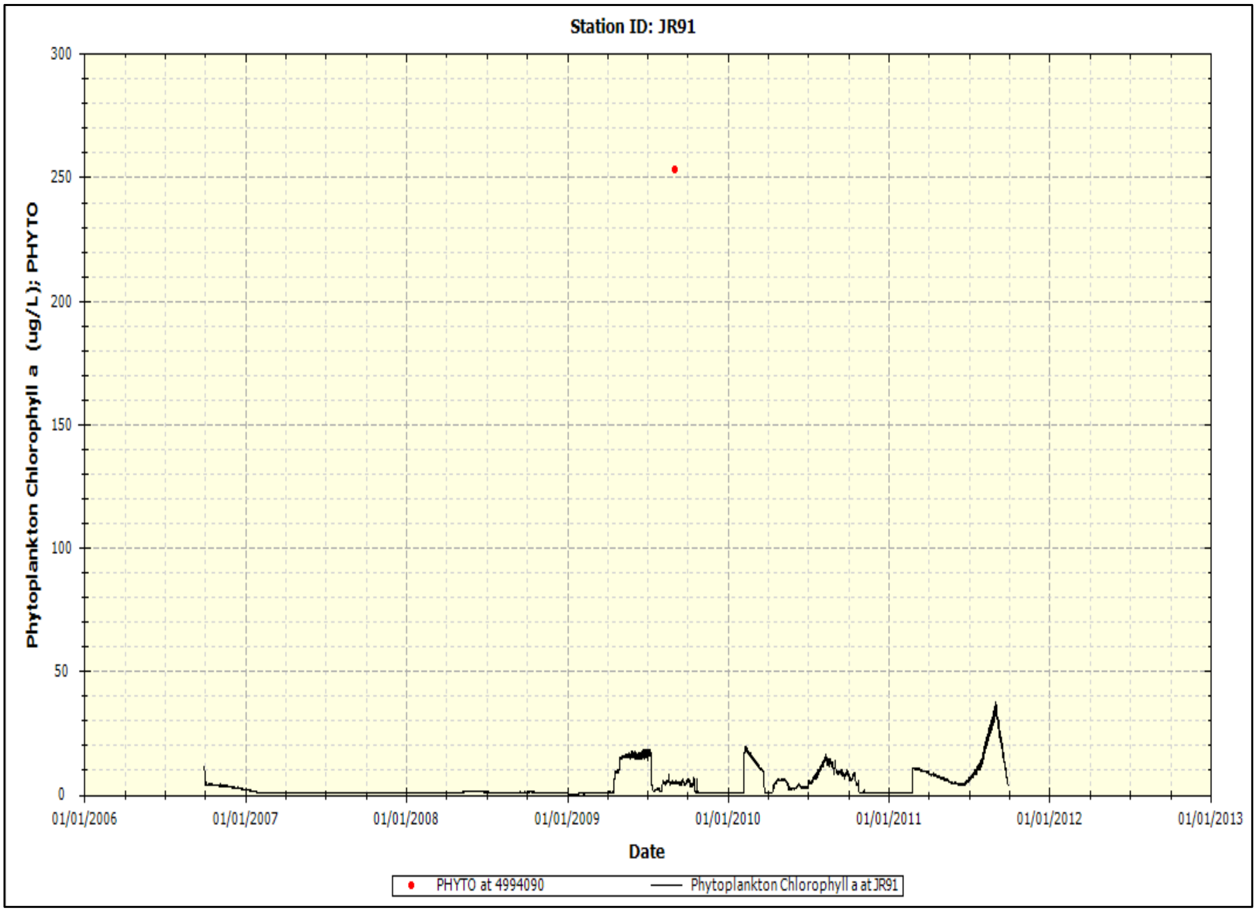
B.1.10: PHYTOPLANKTON CHLOROPHYLL-A

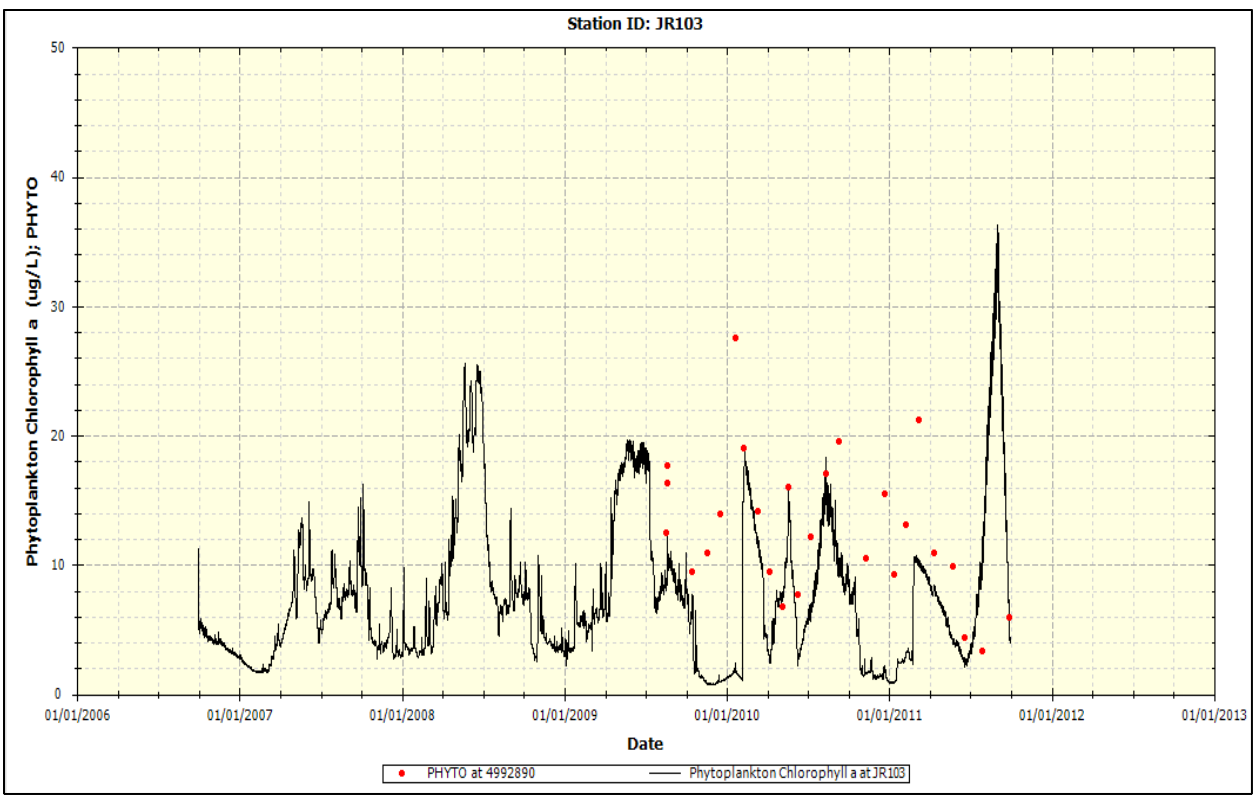


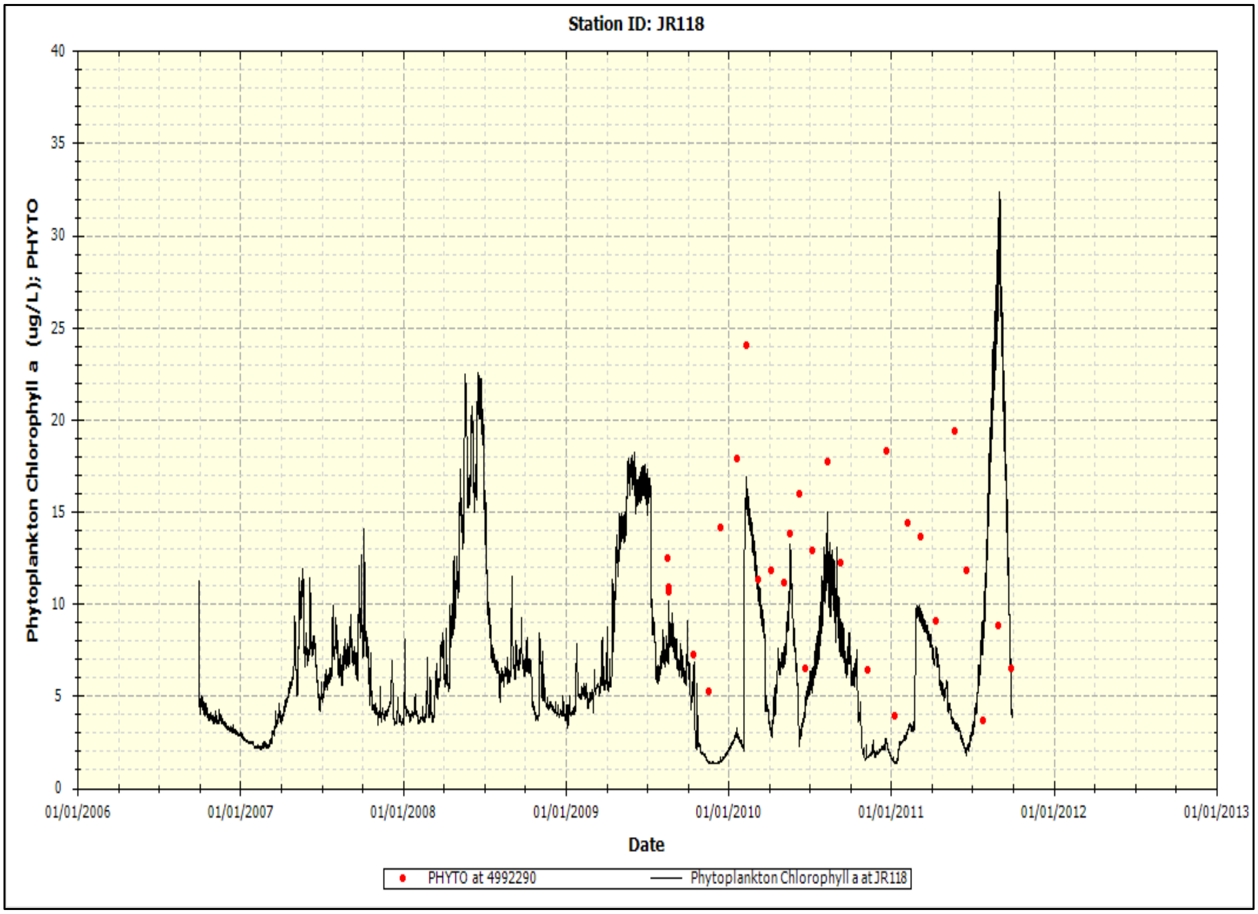



Station ID: JR49 (Rose Creek)
Phytoplankton Chlorophyll a (ug/L); PHYTO
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
PHYTO at 4994520
Phytoplankton Chlorophyll a at JR49 (Rose Creek)

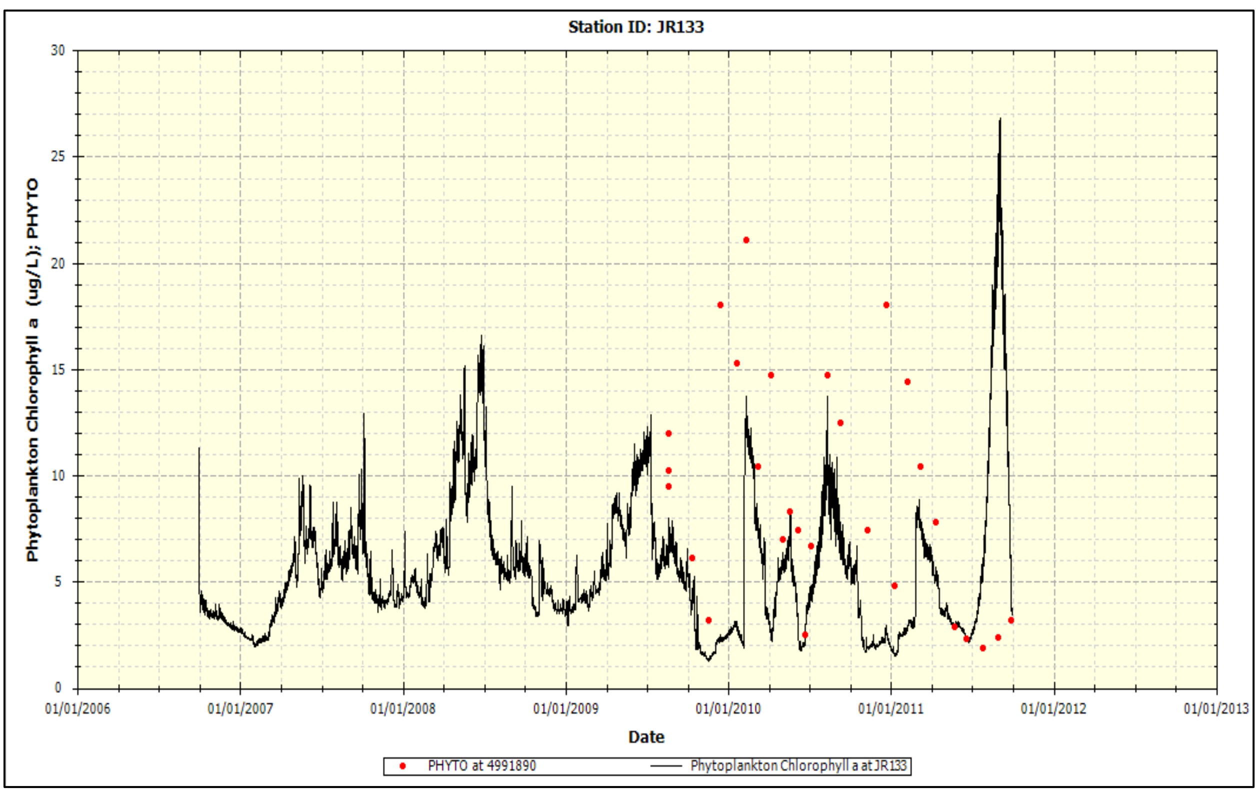

Station ID: JR76 (9000 South Conduit)
Phytoplankton Chlorophyll a (ug/L); PHYTO
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
PHYTO at 4994270
Phytoplankton Chlorophyll a at JR76 (9000 South Conduit)


Station ID: JR91
300
250
200
150
100
50
0
Phytoplankton Chlorophyll a (ug/L); PHYTO
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PHYTO at 4994090
Phytoplankton Chlorophyll a at JR91

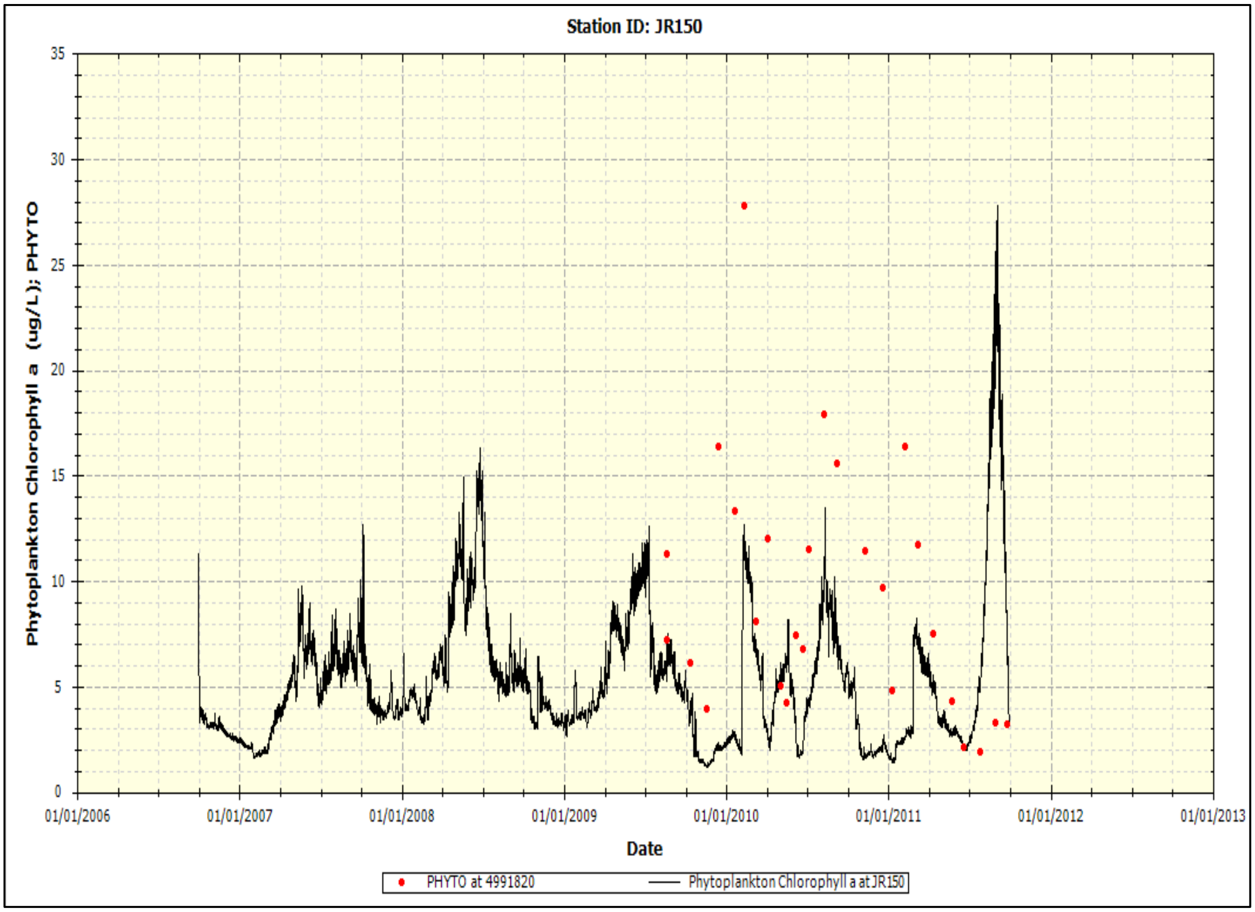

Station ID: JR103
50
40
30
20
10
0
Phytoplankton Chlorophyll a (ug/L); PHYTO
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PHYTO at 4992890
Phytoplankton Chlorophyll a at JR103

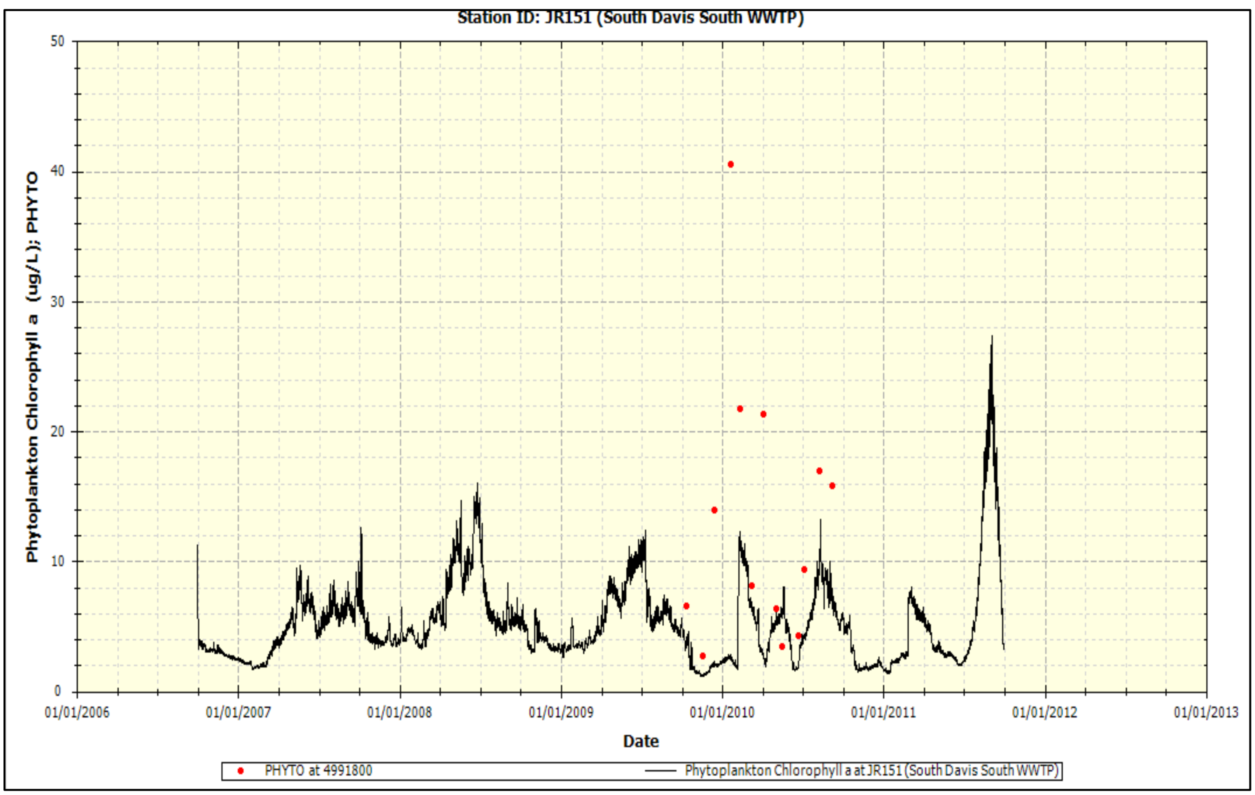


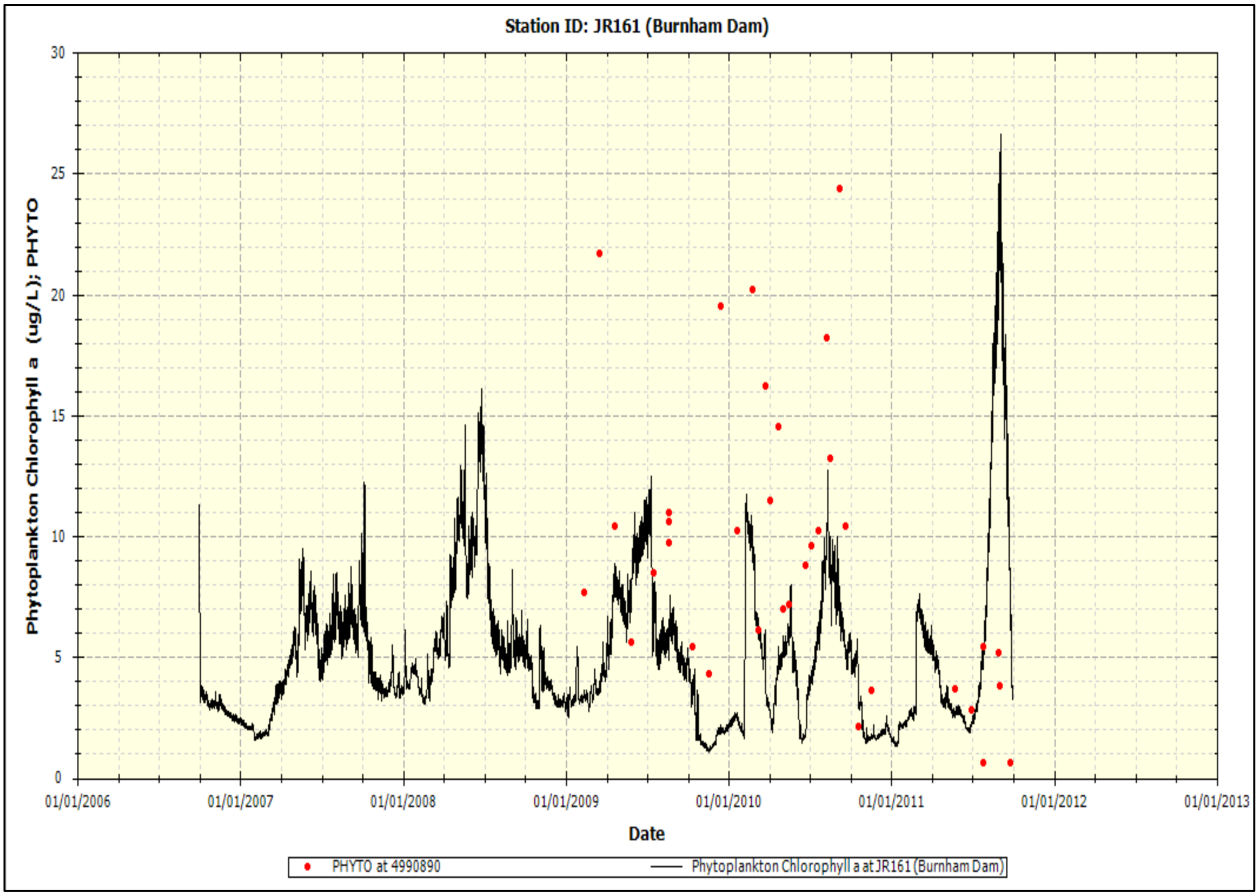
Station ID: JR118
Phytoplankton Chlorophyll a (ug/L); PHYTO
0
5
10
15
20
25
30
35
40
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PHYTO at 4992290
Phytoplankton Chlorophyll a at JR118



Station ID: JR133
Phytoplankton Chlorophyll a (ug/L); PHYTO
0
5
10
15
20
25
30
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PHYTO at 4991890
Phytoplankton Chlorophyll a at JR133

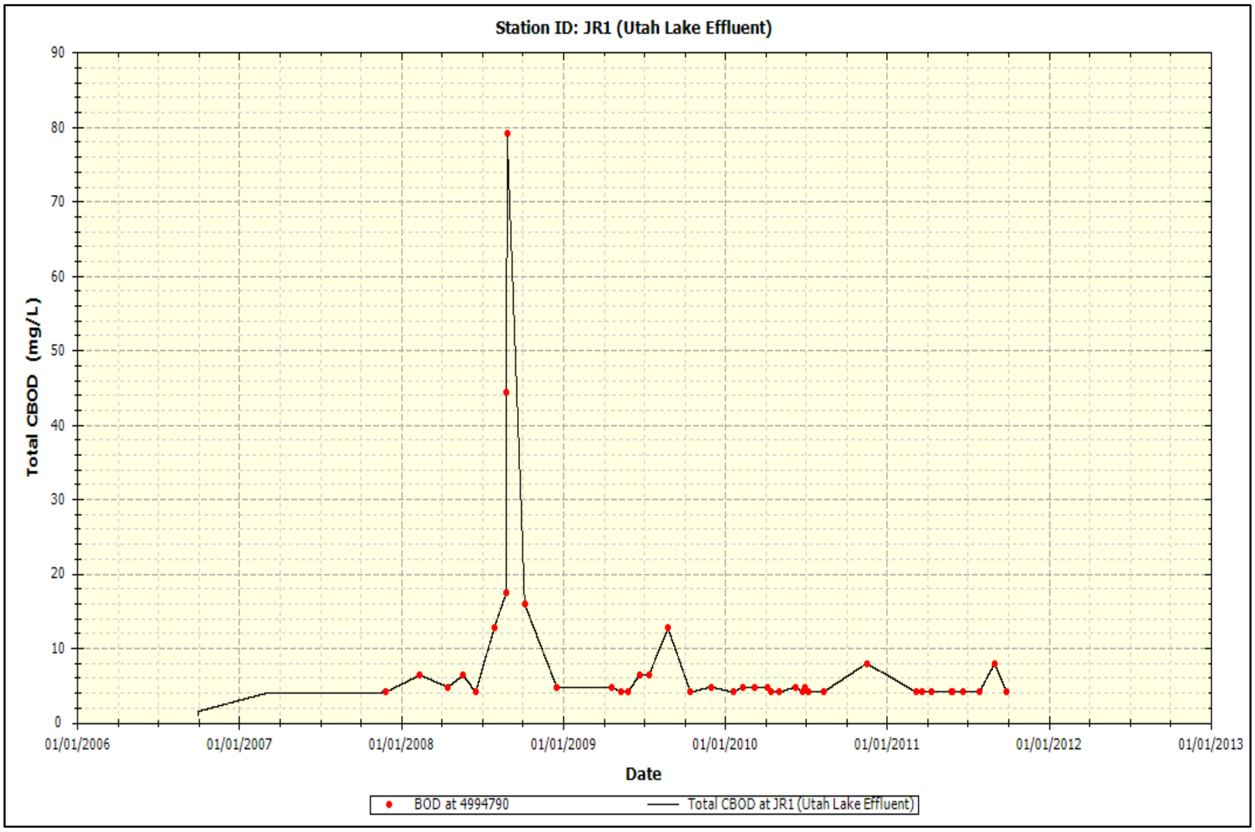

Station ID: JR150
Phytoplankton Chlorophyll a (ug/L); PHYTO
0
5
10
15
20
25
30
35
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PHYTO at 4991820
Phytoplankton Chlorophyll a at JR150

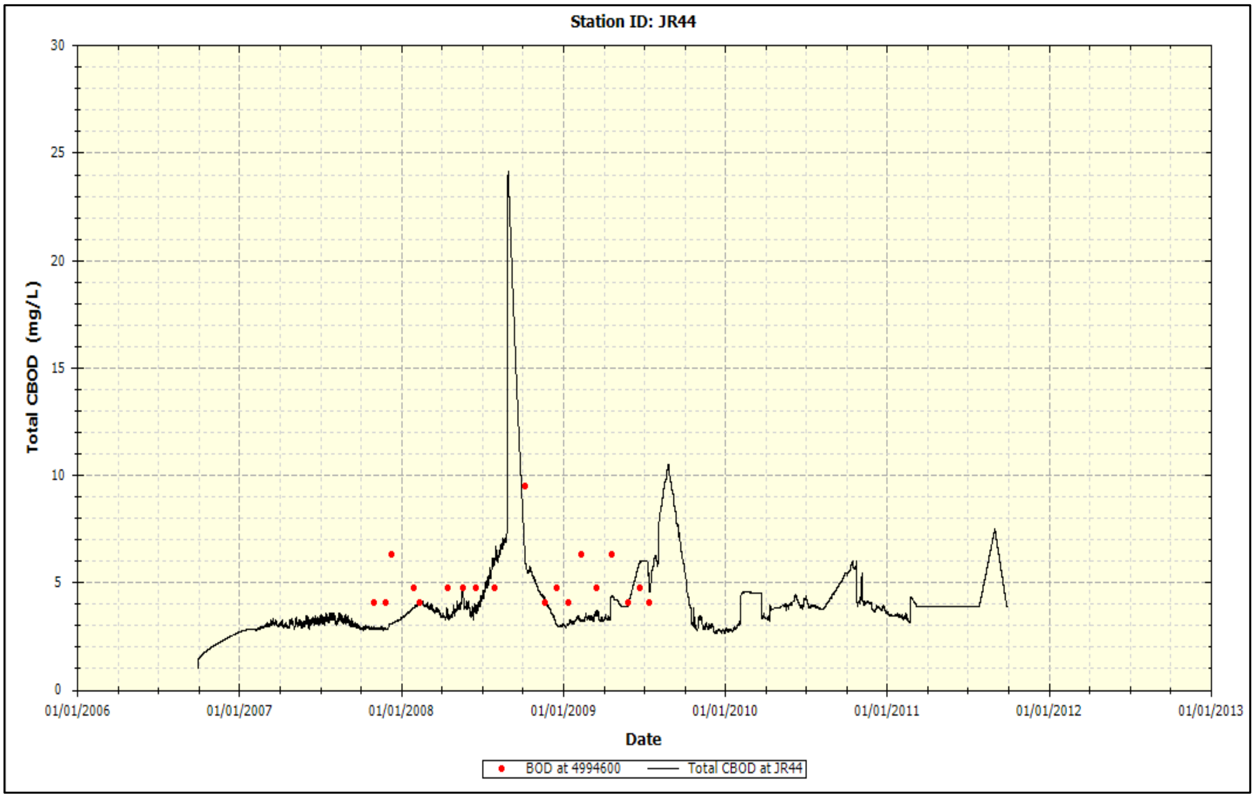

Station ID: JR151 (South Davis South WWTP)
Phytoplankton Chlorophyll a (ug/L); PHYTO
0
10
20
30
40
50
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PHYTO at 4991800
Phytoplankton Chlorophyll a at JR151 (South Davis South WWTP)

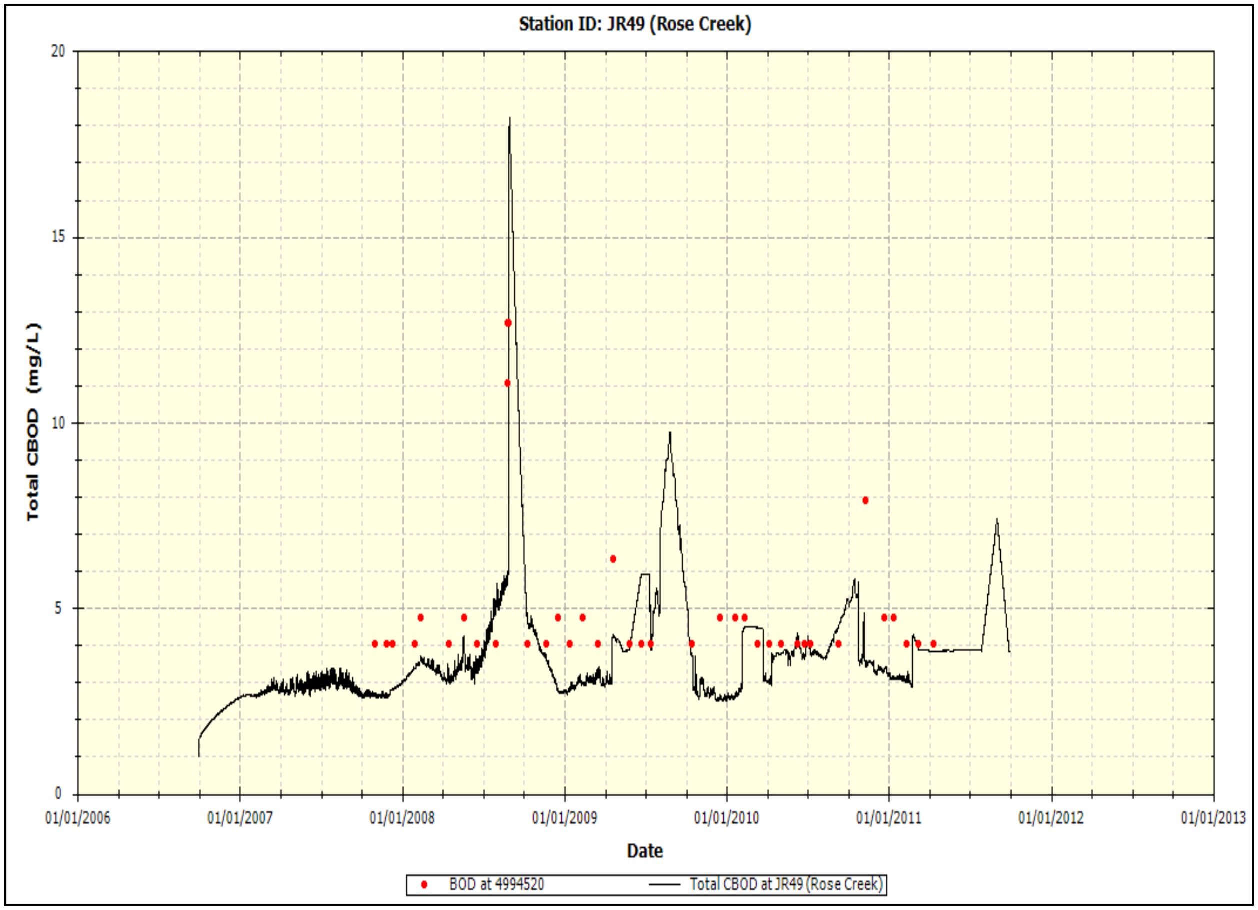


Station ID: JR161 (Burnham Dam)
Phytoplankton Chlorophyll a (ug/L); PHYTO
30
25
20
15
10
5
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
PHYTO at 4990890
Phytoplankton Chlorophyll a at JR161 (Burnham Dam)

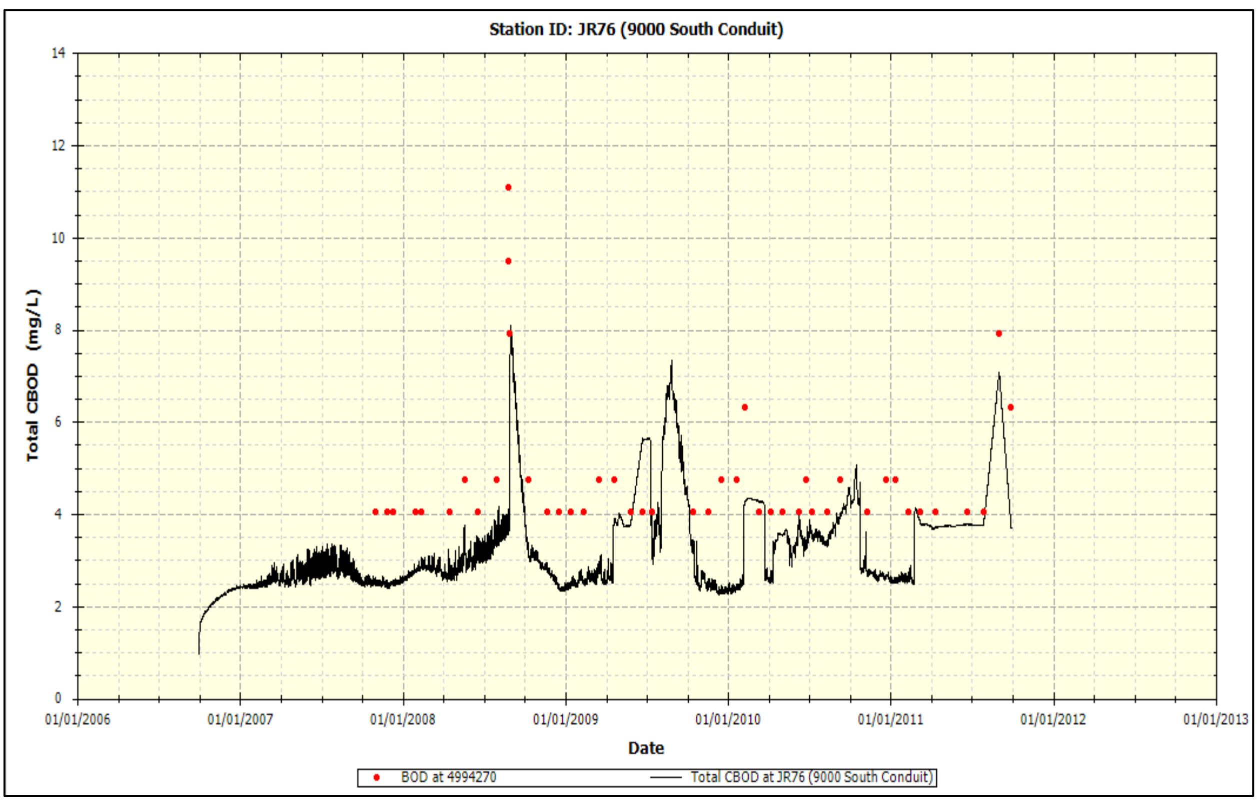
B.1.11: CBOD


Station ID: JR1 (Utah Lake Effluent)
Total CBOD (mg/L)
90
80
70
60
50
40
30
20
10
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4994790
Total CBOD at JR1 (Utah Lake Effluent)

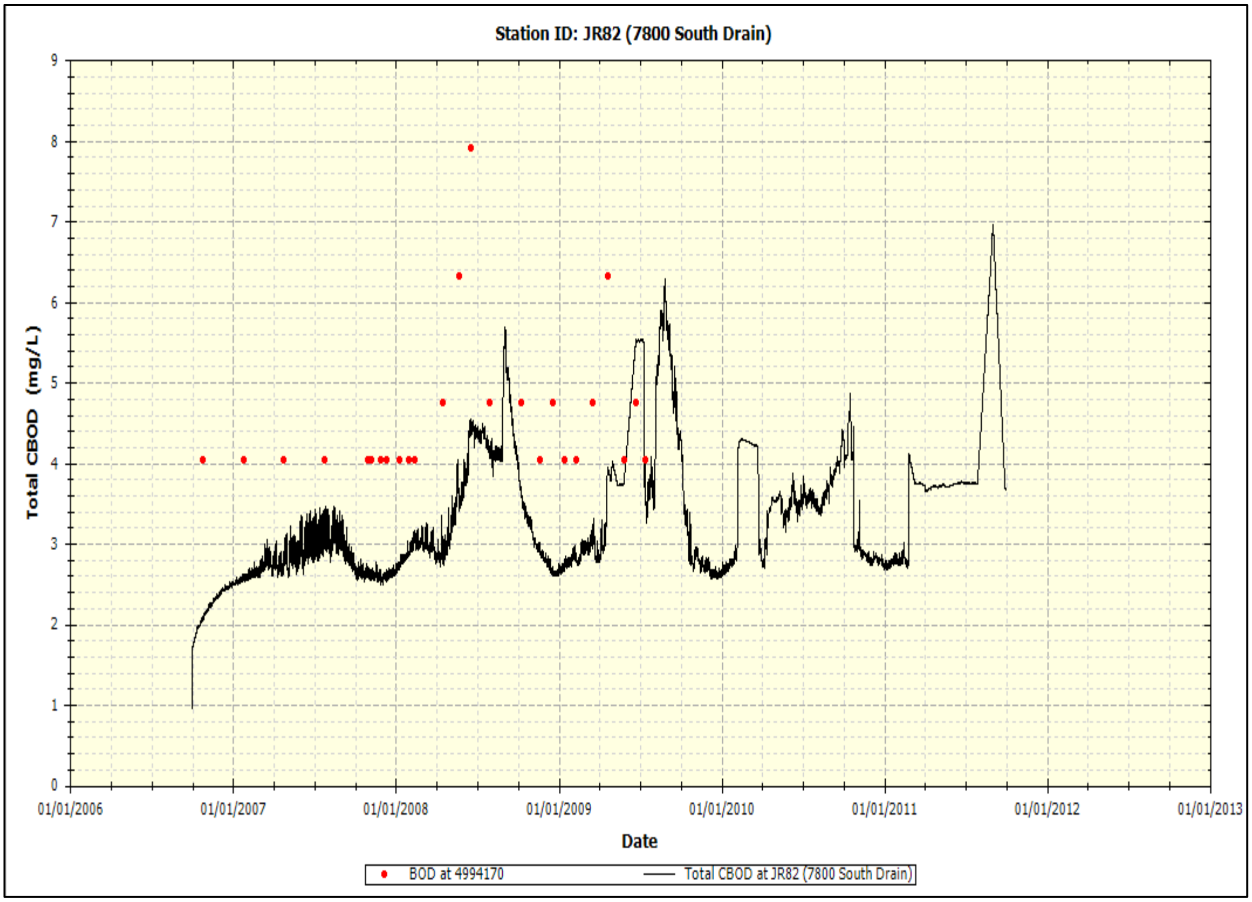

Station ID: JR44
Total CBOD (mg/L)
30
25
20
15
10
5
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4994600
Total CBOD at JR44

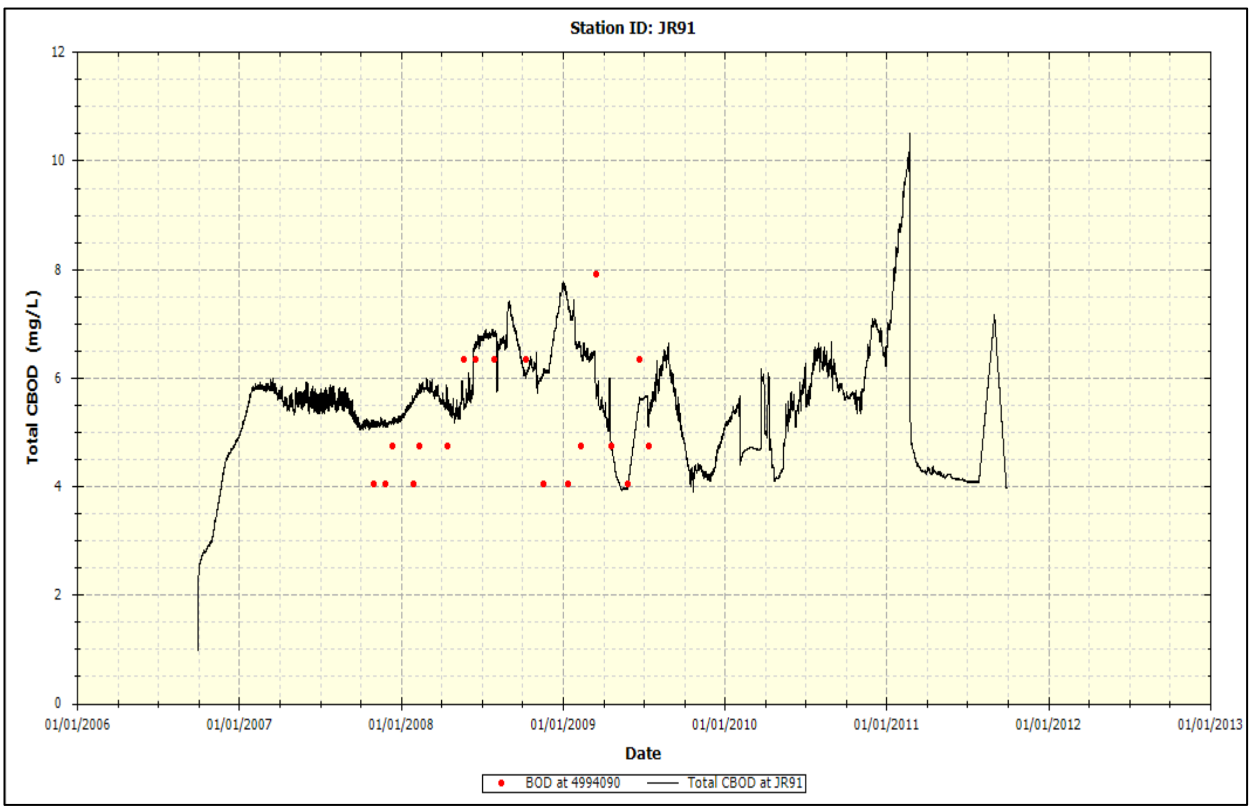


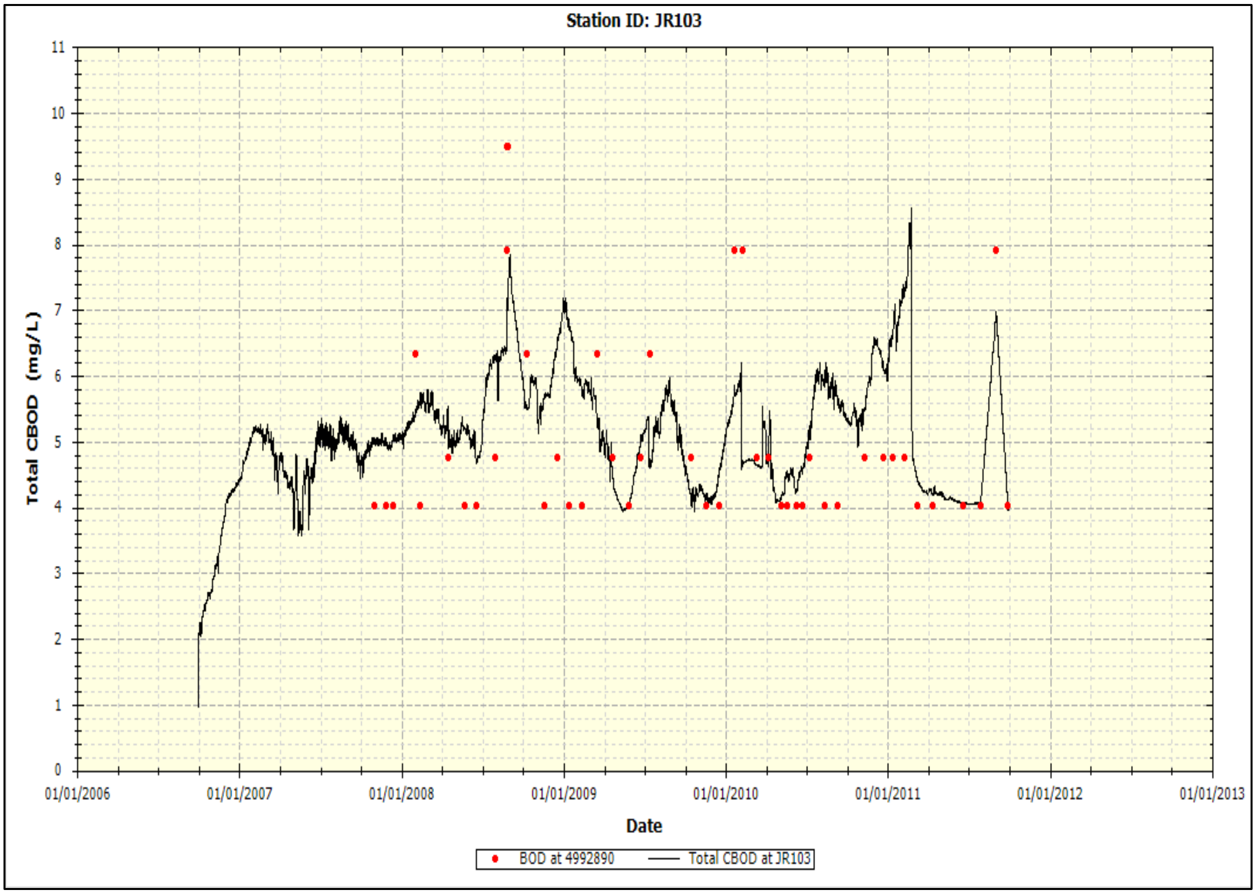
Station ID: JR49 (Rose Creek)
20
15
10
5
0
Total CBOD (mg/L)
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4994520
Total CBOD at JR49 (Rose Creek)



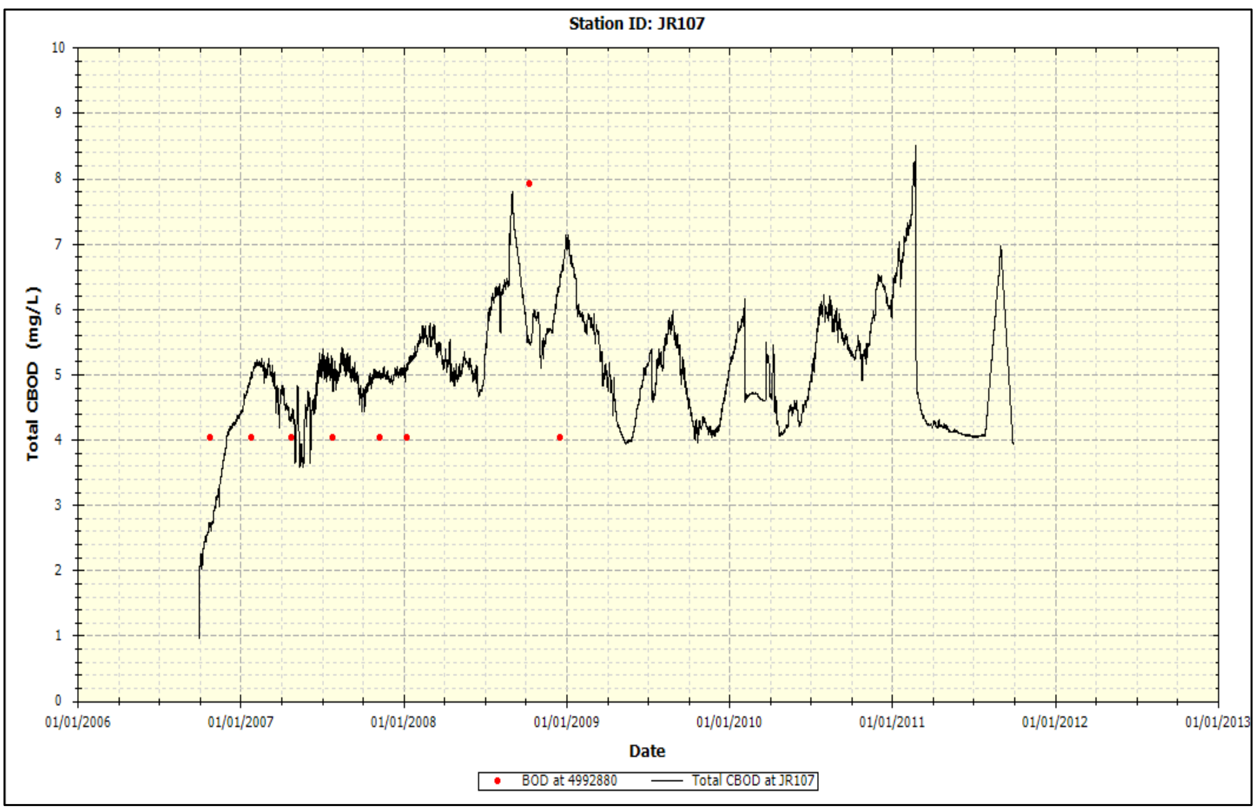
Station ID: JR76 (9000 South Conduit)
14
12
10
8
6
4
2
0
Total CBOD (mg/L)
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4994270
Total CBOD at JR76 (9000 South Conduit)


Station ID: JR82 (7800 South Drain)
Total CBOD (mg/L)
0
1
2
3
4
5
6
7
8
9
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4994170
Total CBOD at JR82 (7800 South Drain)

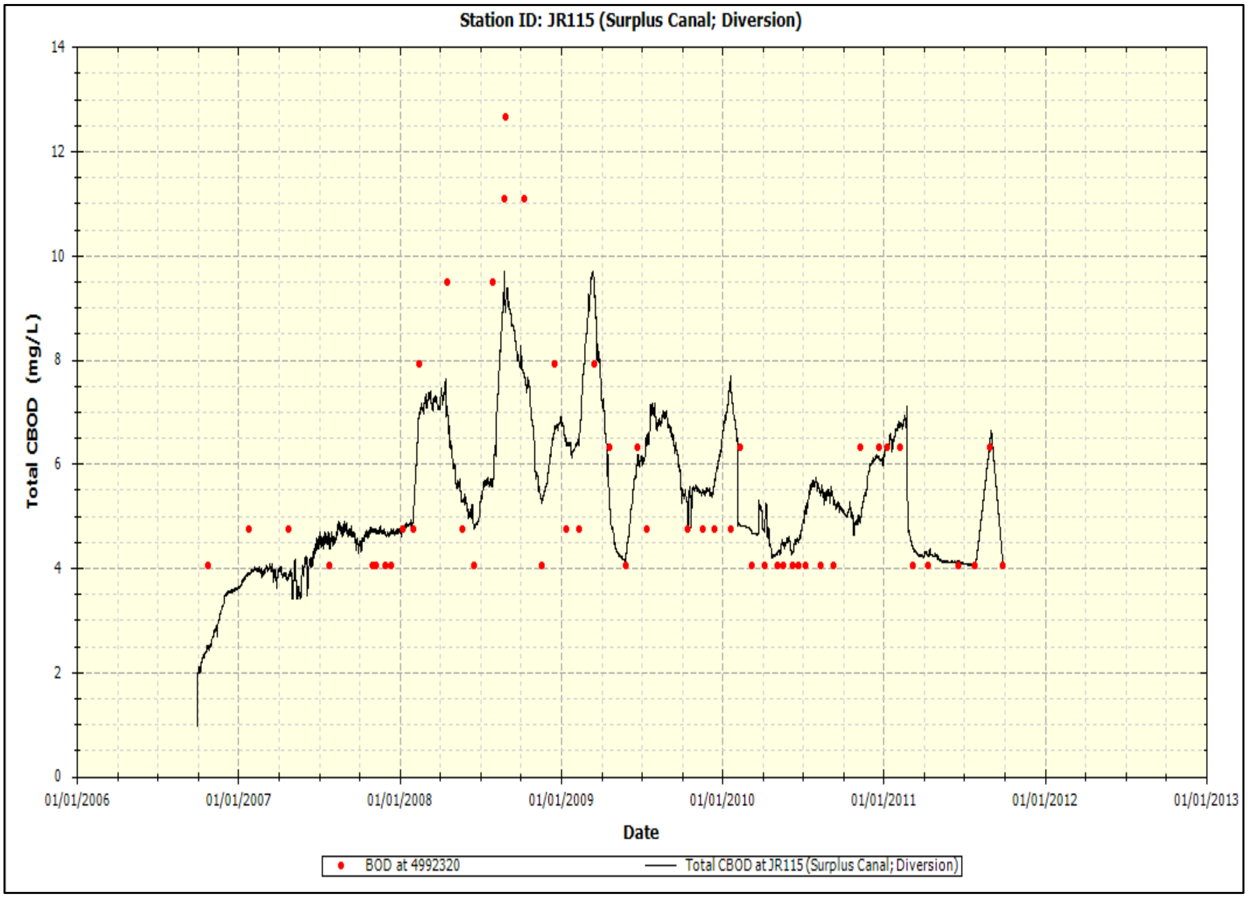

Station ID: JR91
Total CBOD (mg/L)
0
2
4
6
8
10
12
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4994090
Total CBOD at JR91



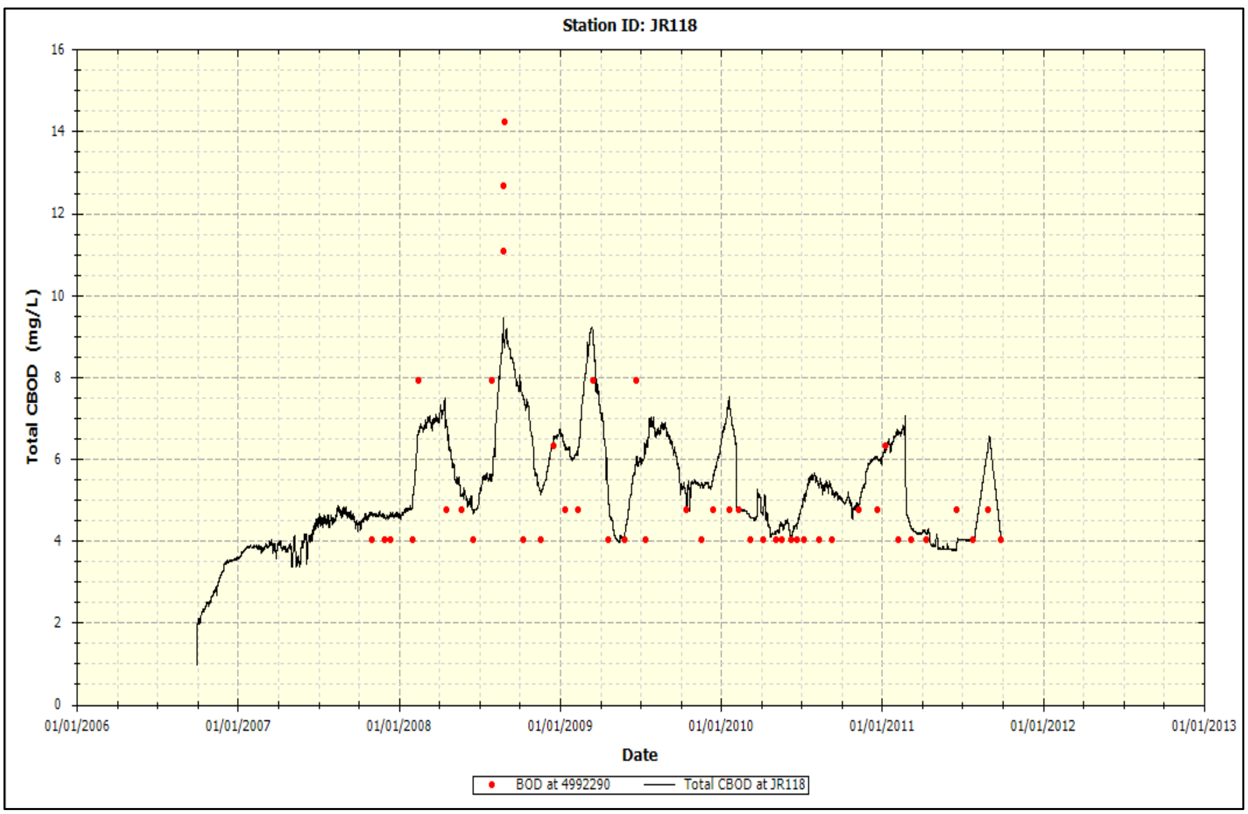
Station ID: JR103
Total CBOD (mg/L)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
BOD at 4992890
Total CBOD at JR103



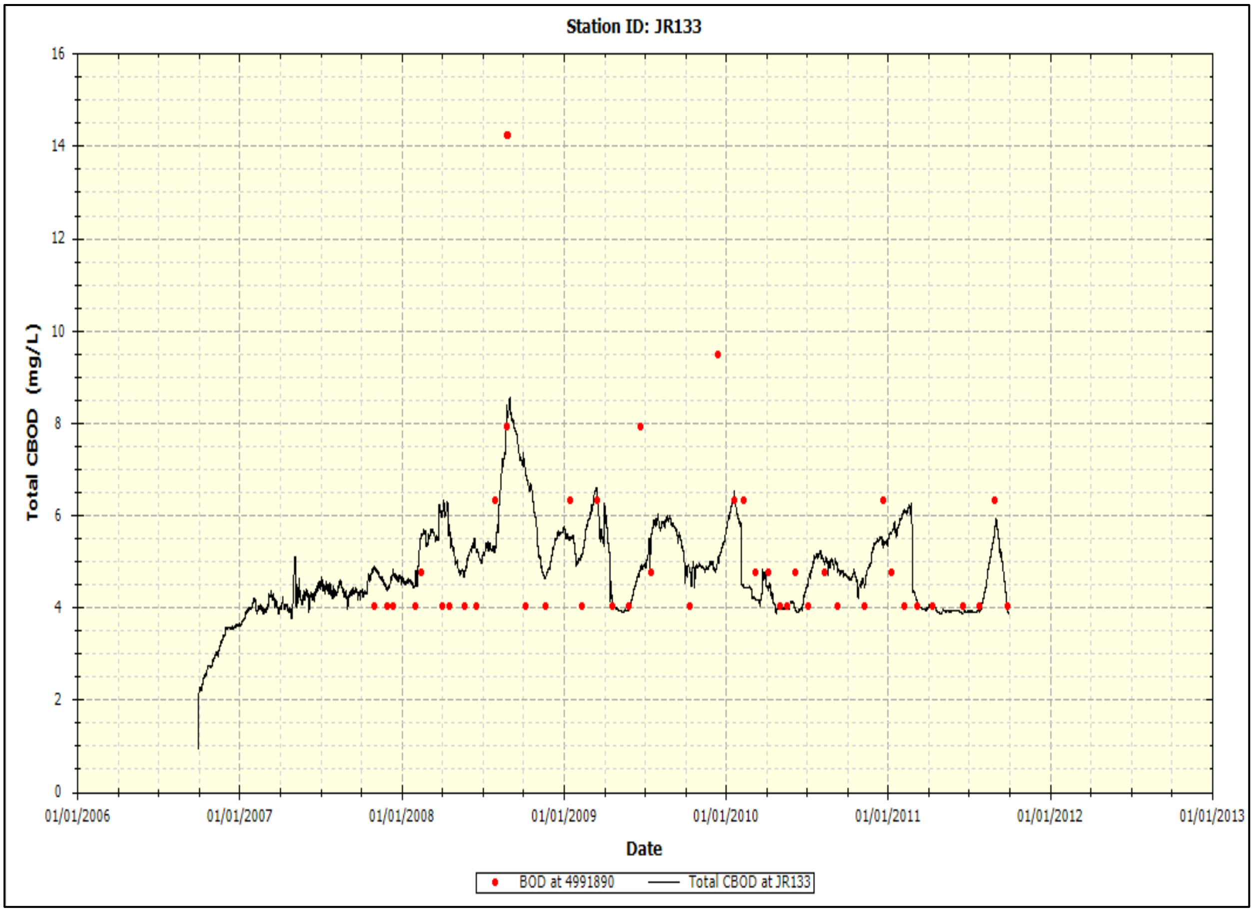
Station ID: JR107
Total CBOD (mg/L)
Date
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
BOD at 4992880
Total CBOD at JR107

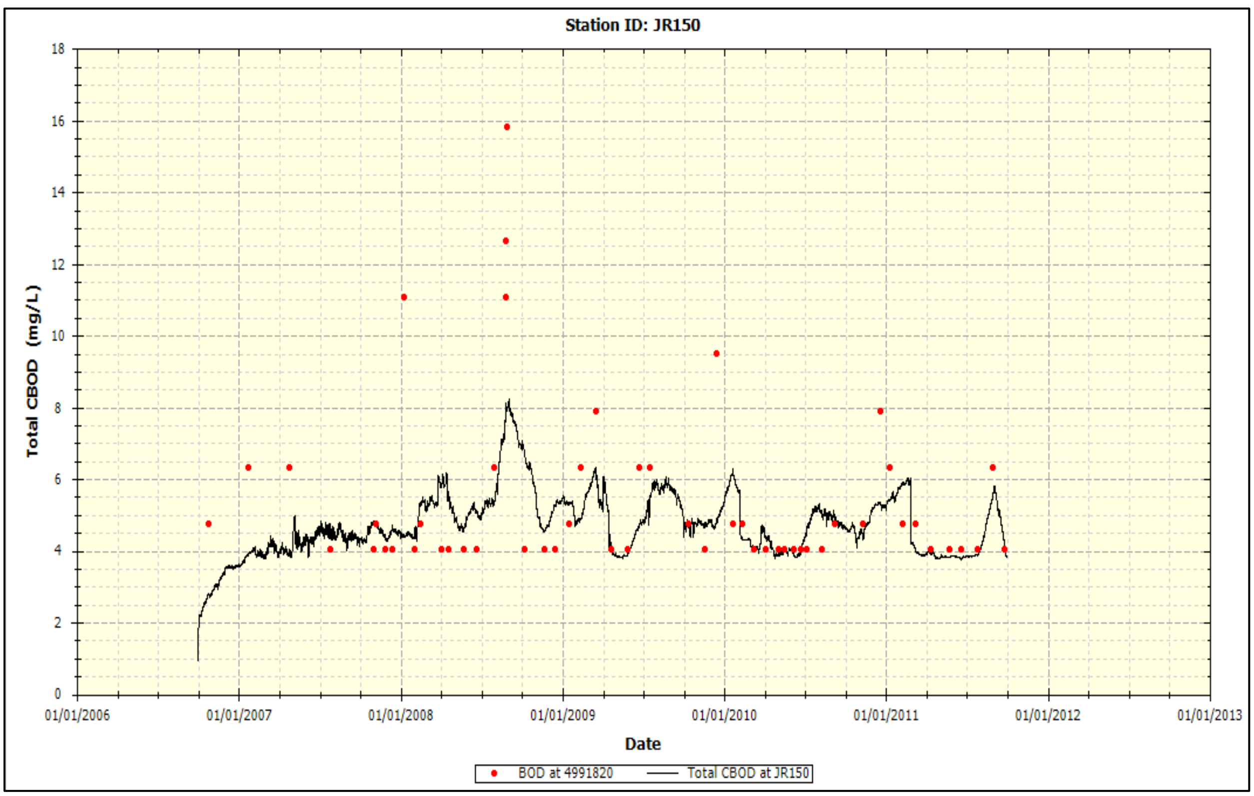


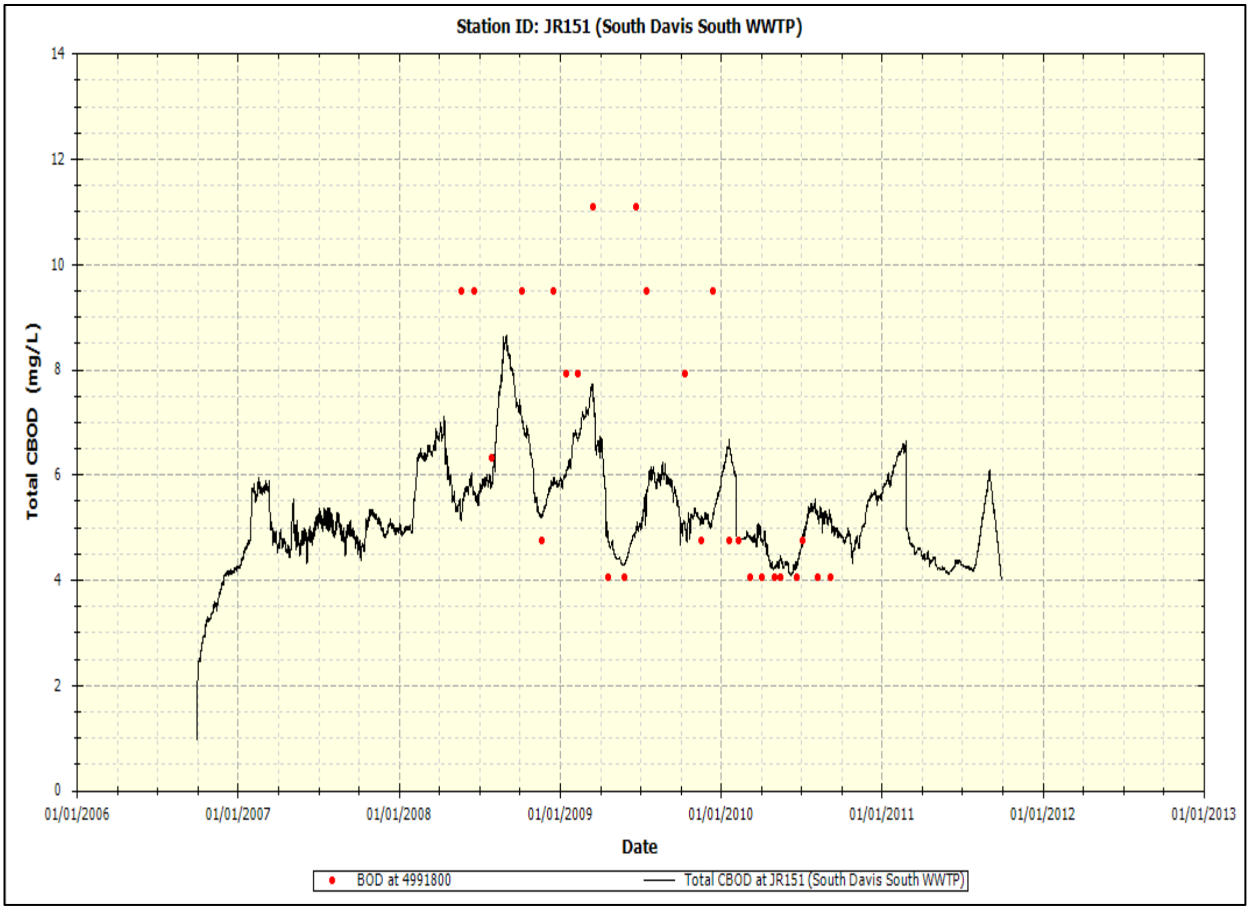
Station ID: JR115 (Surplus Canal; Diversion)
Total CBOD (mg/L)
0
2
4
6
8
10
12
14
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4992320
Total CBOD at JR115 (Surplus Canal; Diversion)

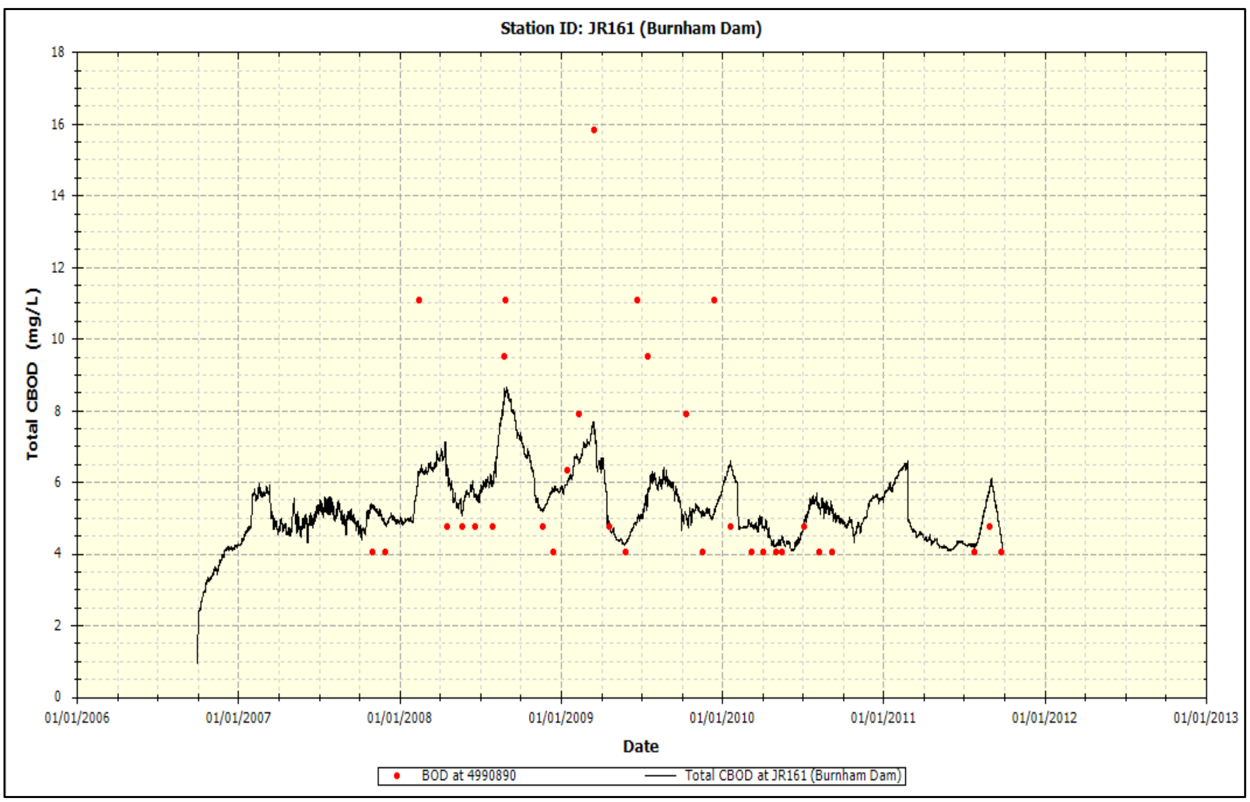


Station ID: JR118
Total CBOD (mg/L)
0
2
4
6
8
10
12
14
16
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4992290
Total CBOD at JR118

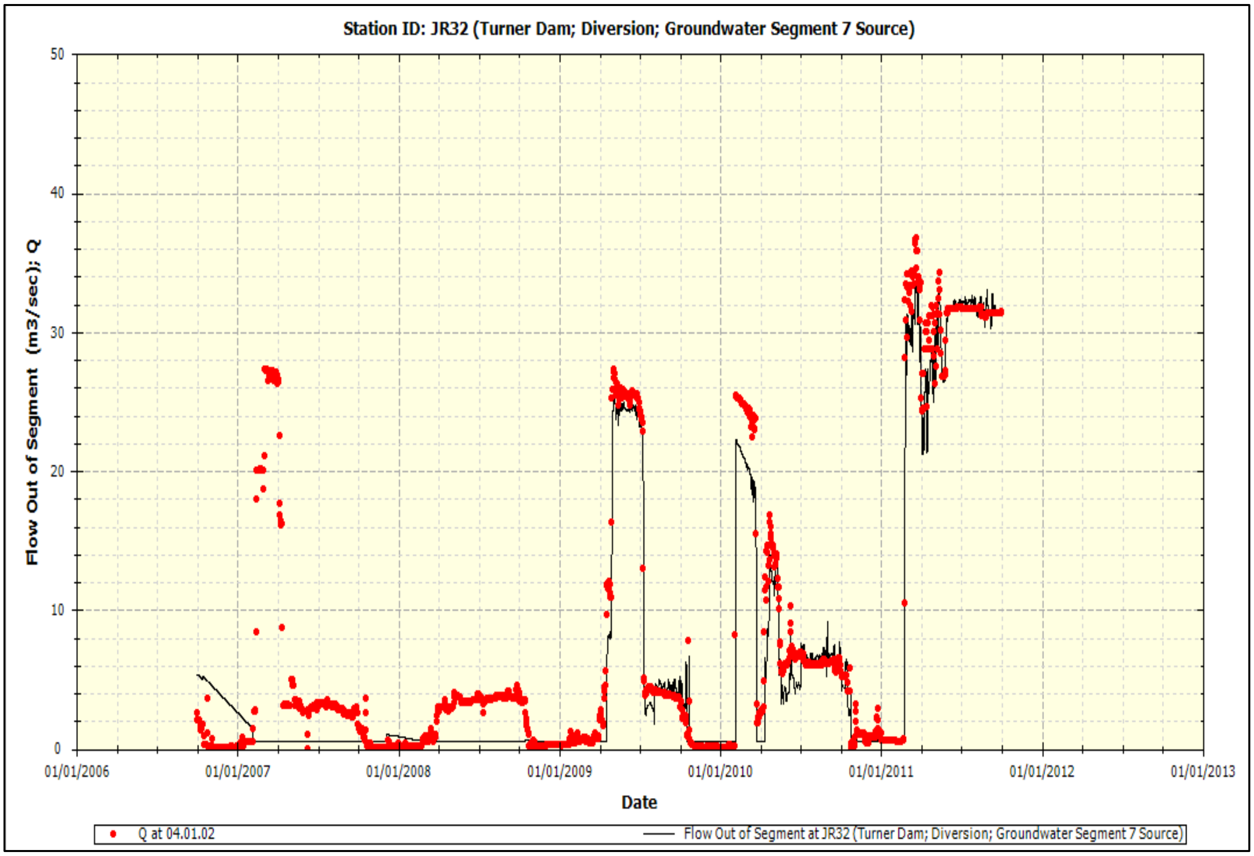

Station ID: JR133
Total CBOD (mg/L)
16
14
12
10
8
6
4
2
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4991890
Total CBOD at JR133

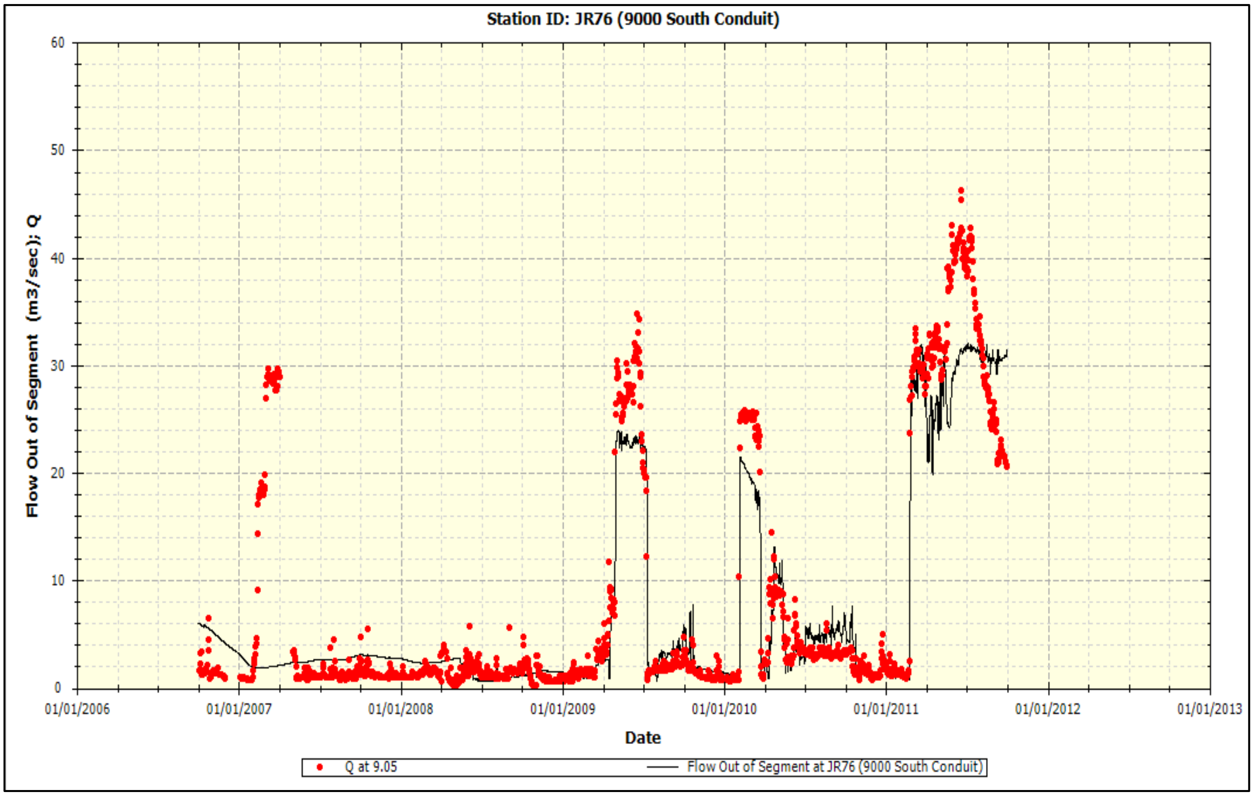

Station ID: JR150
Total CBOD (mg/L)
18
16
14
12
10
8
6
4
2
0
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013
Date
BOD at 4991820
Total CBOD at JR150

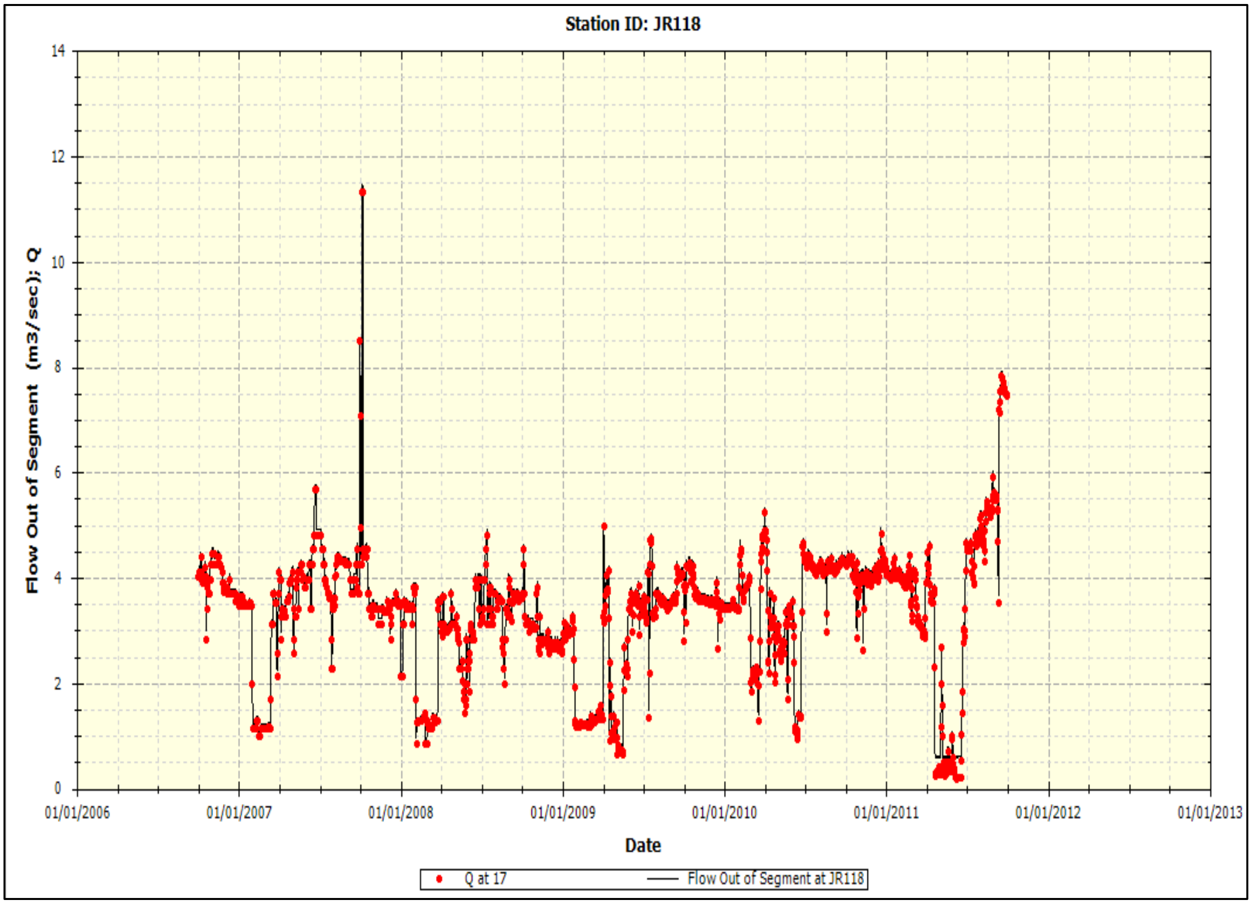

Station ID: JR151 (South Davis South WWTP)
Total CBOD (mg/L)
Date
BOD at 4991800
Total CBOD at JR151 (South Davis South WWTP)
0
2
4
6
8
10
12
14
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013


Station ID: JR161 (Burnham Dam)
Total CBOD (mg/L)
Date
BOD at 4990890
Total CBOD at JR161 (Burnham Dam)
0
2
4
6
8
10
12
14
16
18
01/01/2006
01/01/2007
01/01/2008
01/01/2009
01/01/2010
01/01/2011
01/01/2012
01/01/2013

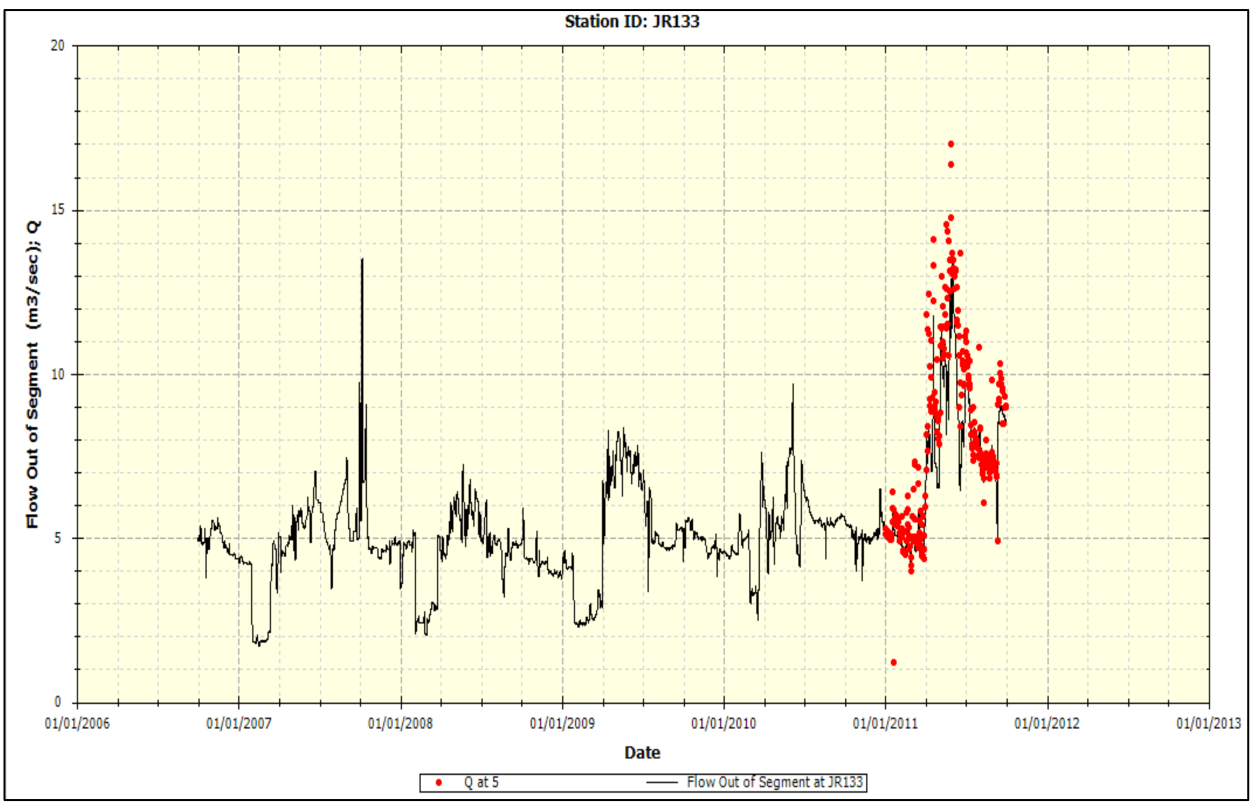
B.1.12: FLOW QUANTITY







Station ID: JR118
Flow Out of Segment (m3/sec); Q
Date
Q at 17
Flow Out of Segment at JR118



Station ID: JR133
Flow Out of Segment (m3/sec); Q
Date
Q at 5
Flow Out of Segment at JR133

B.2: STATISTICAL RESULTS

The following table provides the model calibration results among the Jordan River WASP (e.g., simulated results) against the measured data employed for the exercise, with sub-sections organized based on water quality constituent. Please note the following notations displayed under each table per constituent.

- 25%tile = 25th Percentile
- 75%tile = 75th Percentile
- R^2 = Coefficient of Determination
- Mean Abs Err = Mean Absolute Error
- RMS Err = Root-Mean Square Error
- Norm RMS Err = Normalized Root-Mean Square Error
- Index of Agrmt = Index of Argument

B.2.1: WATER TEMPERATURE

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Water Temperature	13.725	15.143	2.52	24.615	13.697	15.284	2.017	24.402	1	0.129	0.239	0.015	1
JR31	Water Temperature	12.572	16.575	0.807	22.929	10.742	13.762	-0.021	21.684	0.97	1.859	2.284	0.165	0.98
JR44	Water Temperature	10.912	11.161	1.167	21.839	9.955	9.335	1.474	21.566	0.91	1.844	2.284	0.185	0.97
JR49 (Rose Creek)	Water Temperature	11.695	12.616	2.478	21.287	10.689	11.274	2.667	20.659	0.93	1.511	1.996	0.158	0.97
JR59	Water Temperature	11.382	11.305	0	0	11.619	10.851	0	0	0.69	2.886	3.529	0.279	0.9
JR68	Water Temperature	11.023	11.685	0	0	10.138	10.404	0	0	0.66	2.69	3.338	0.293	0.87
JR76 (9000	Water Temperature	12.638	13.488	3.67	21.515	11.291	11.87	1.833	20.441	0.93	1.702	2.07	0.157	0.97

South Conduit)														
JR82 (7800 South Drain)	Water Temperature	12.532	13.176	4.77	22.641	11.036	11.279	1.997	20.388	0.94	1.732	2.061	0.158	0.97
JR87	Water Temperature	14.452	16.605	0	0	12.954	14.292	0	0	0.96	1.53	1.822	0.126	0.96
JR91	Water Temperature	13.824	15.046	5.848	23.052	12.531	13.155	4.306	20.28	0.89	1.695	2.133	0.152	0.96
JR103	Water Temperature	12.501	12.63	5.425	21.455	11.358	12.244	3.548	19.89	0.93	1.44	1.736	0.134	0.97
JR107	Water Temperature	11.918	11.74	0	0	10.596	9.601	0	0	0.9	1.815	2.502	0.205	0.94
JR115 (Surplus Canal; Diversion)	Water Temperature	12.86	12.99	5.516	23.007	11.832	12.316	5.254	20.1	0.96	1.268	1.66	0.125	0.97
JR118	Water Temperature	13.195	13.565	5.513	22.882	11.947	12.474	5.094	20.241	0.96	1.377	1.756	0.13	0.97
JR124	Water Temperature	12.217	13.414	0	0	10.916	12.444	0	0	0.91	1.614	2.096	0.171	0.94
JR127	Water Temperature	12.718	14.314	0	0	11.779	12.85	0	0	0.77	1.998	2.519	0.195	0.91
JR132	Water Temperature	12.673	13.607	0	0	11.815	12.853	0	0	0.83	1.767	2.28	0.178	0.92
JR133	Water Temperature	12.665	13.33	5.114	22.188	11.657	12.429	4.586	19.905	0.9	1.569	2.054	0.157	0.96
JR136	Water Temperature	12.25	0	0	0	11.419	0	0	0	0	0	0	0	0
JR140	Water Temperature	13.293	13.795	4.785	23.963	11.761	12.342	5.02	20.009	0.86	2.07	2.683	0.2	0.93

JR150	Water Temperature	13.061	13.699	4.777	23.454	10.806	12.272	3.016	18.83	0.95	2.348	2.874	0.22	0.93
JR151 (South Davis South WWTP)	Water Temperature	13.063	14.34	4.738	21.935	10.955	11.906	3.722	16.969	0.94	2.39	2.787	0.218	0.91
JR161 (Burnham Dam)	Water Temperature	14.813	16.55	4.194	23.303	11.533	13.075	2.531	18.113	0.95	3.331	3.808	0.271	0.88

B.2.2: PH

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	pH	8.335	8.323	7.608	8.881	8.309	8.362	7.592	8.794	0.17	0.191	0.683	0.082	0.51
JR31	pH	8.455	8.25	7.388	13.246	8.655	8.602	8.069	9.268	0.03	0.721	1.364	0.16	0.12
JR44	pH	8.25	8.357	7.558	8.885	8.284	8.403	7.736	8.78	0	0.436	0.522	0.063	0.42
JR49 (Rose Creek)	pH	8.371	8.211	7.484	9.154	8.166	8.295	7.556	8.702	0.02	0.665	1.236	0.149	0.26
JR59	pH	7.981	8.105	0	0	7.875	7.916	0	0	0.06	0.393	0.485	0.061	0.53
JR68	pH	7.927	8.098	0	0	7.783	7.884	0	0	0.01	0.337	0.397	0.05	0.46
JR76 (9000 South Conduit)	pH	8.107	8.07	7.392	8.966	8.081	8.176	7.575	8.621	0	0.487	0.617	0.076	0.35
JR82 (7800 South Drain)	pH	8.149	8.072	7.454	8.938	8.06	8.085	7.678	8.538	0.14	0.432	0.825	0.102	0.45
JR87	pH	7.956	7.945	0	0	8.163	8.313	0	0	0.41	0.217	0.294	0.036	0.72
JR91	pH	8.194	8.108	7.645	8.925	8.061	8.057	7.744	8.479	0.12	0.417	0.834	0.103	0.39
JR103	pH	8.275	8.2	7.678	8.961	8.298	8.324	8.047	8.561	0.06	0.377	0.681	0.082	0.3
JR107	pH	8.188	8.128	0	0	8.269	8.283	0	0	0.12	0.259	0.326	0.04	0.27

JR115 (Surplus Canal; Diversion)	pH	8.053	7.97	7.526	8.812	8.234	8.248	7.975	8.549	0.08	0.437	0.7	0.086	0.31
JR118	pH	8.134	7.982	7.495	8.862	8.289	8.33	8.048	8.548	0.09	0.52	0.977	0.119	0.24
JR124	pH	7.851	7.898	0	0	8.354	8.417	0	0	0.33	0.503	0.521	0.064	0.38
JR127	pH	8.013	7.982	0	0	8.382	8.426	0	0	0.4	0.374	0.423	0.052	0.5
JR132	pH	7.933	7.912	0	0	8.383	8.415	0	0	0.18	0.462	0.514	0.063	0.38
JR133	pH	8.111	8.06	7.57	8.788	8.415	8.42	8.164	8.654	0.03	0.434	0.519	0.063	0.34
JR136	pH	8.2	0	0	0	8.414	0	0	0	0	0	0	0	0
JR140	pH	7.906	7.953	7.412	8.366	8.452	8.451	8.208	8.699	0.05	0.554	0.599	0.073	0.27
JR150	pH	8.121	8.097	7.511	8.866	8.565	8.549	8.364	8.825	0	0.544	0.661	0.079	0.22
JR151 (South Davis South WWTP)	pH	8.036	8.102	7.415	8.728	8.573	8.614	8.371	8.815	0.01	0.555	0.65	0.078	0.23
JR161 (Burnham Dam)	pH	8.119	8.041	7.592	8.786	8.69	8.694	8.475	8.919	0.01	0.668	0.78	0.093	0.17

B.2.3: ALKALINITY

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Alkalinity	201.283	200	172.5	243.4	201.402	199.993	172.534	244.439	1	0.228	0.579	0.003	1
JR31	Alkalinity	216.292	206	157.75	302.75	216.686	206.287	175.69	284.695	0.74	11.397	19.265	0.088	0.91
JR44	Alkalinity	225.091	218.9	174.45	269	238.771	225.58	192.897	295.728	0.81	15.292	20.466	0.088	0.9
JR49 (Rose Creek)	Alkalinity	236.207	232.5	184	294.5	244.891	240.425	194.989	296.744	0.76	14.192	19.943	0.082	0.92
JR76	Alkalinity	238.939	246	171	300.7	251.562	248.802	186.317	301.784	0.61	17.336	30.149	0.122	0.86

(9000 South Conduit)														
JR82 (7800 South Drain)	Alkalinity	243.364	238	172.4	313.5	253.615	250.434	188.064	310.267	0.8	13.761	22.242	0.088	0.93
JR87	Alkalinity	235.429	241.5	0	0	240.36	240.243	0	0	0.38	11.036	17.189	0.072	0.74
JR91	Alkalinity	230.121	240.4	175.4	277	233.484	240.164	189.148	263.952	0.61	12.577	19.031	0.082	0.85
JR103	Alkalinity	205.152	218.5	120.5	272.6	209.446	226.365	120.059	264.262	0.93	7.999	11.798	0.056	0.98
JR107	Alkalinity	239	0	0	0	267.527	0	0	0	0	0	0	0	0
JR115 (Surplus Canal; Diversion)	Alkalinity	199.088	212.75	127.25	247.25	205.572	221.561	133.714	242.802	0.85	10.691	15.336	0.075	0.95
JR118	Alkalinity	199.03	211.4	122.1	243.7	209.013	222.368	142.121	244.502	0.79	13.582	19.458	0.094	0.91
JR124	Alkalinity	209.643	218	0	0	220.219	227.154	0	0	0.8	11.237	15.334	0.071	0.9
JR127	Alkalinity	209	220	0	0	223.032	229.802	0	0	0.46	14.032	22.748	0.105	0.77
JR132	Alkalinity	206.571	216.5	0	0	228.674	232.324	0	0	0.32	22.102	29.478	0.135	0.6
JR133	Alkalinity	204.303	219.4	141.6	246.1	225.72	230.288	195.151	250.999	0.33	22.053	31.408	0.146	0.6
JR140	Alkalinity	204.429	209	0	0	231.991	235.311	0	0	0.26	27.562	34.066	0.156	0.52
JR150	Alkalinity	204.794	215.25	129	249.75	231.58	237.515	197.839	255.782	0.28	27.592	38.277	0.175	0.52
JR151 (South Davis South WWTP)	Alkalinity	215.682	220.65	167.45	249	237.06	240.885	195.945	256.633	0.28	21.447	28.086	0.124	0.59
JR161 (Burnham Dam)	Alkalinity	215.882	225.25	170.75	244	233.302	239.019	199.799	258.185	0.12	20.073	28.035	0.125	0.54

B.2.4: TSS

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25	75	Mean	Median	25	75					

				%tile	**%tile**			**%tile**	**%tile**					
JR1 (Utah Lake Effluent)	Solids	55.817	51.12	7.44	165.6	55.799	51.11	7.46	165.279	1	0.177	0.549	0.007	1
JR31	Solids	53.596	52.9	7.7	114.175	52.122	40.483	2.008	256.638	0.51	26.194	44.412	0.677	0.76
JR44	Solids	43.496	43.6	8.8	82.17	31.437	25.693	1.59	142.118	0.14	27.543	42.994	1.019	0.53
JR49 (Rose Creek)	Solids	44.998	36.78	9.22	147.45	30.028	21.929	1.113	134.762	0.09	31.18	51.312	1.189	0.49
JR59	Solids	41.836	29.1	0	0	10.408	10.668	0	0	0.01	33.887	45.011	2.236	0.16
JR68	Solids	45.521	41	0	0	10.106	9.771	0	0	0	35.416	41.888	1.966	0.19
JR76 (9000 South Conduit)	Solids	50.89	31.28	11.04	158.8	22.794	14.963	0.92	99.926	0.02	37.673	77.652	2.036	0.24
JR82 (7800 South Drain)	Solids	48.867	40	8.5	156.55	25.555	16.978	3.701	90.044	0.2	31.278	48.45	1.129	0.53
JR87	Solids	44.664	31	0	0	33.906	25.201	0	0	0.04	33.508	48.495	1.153	0.42
JR91	Solids	40.859	33.36	10.56	95.96	22.438	15.112	5.598	81.281	0.3	23.594	32.08	0.892	0.62
JR103	Solids	38.677	35.96	10.8	93.12	24.88	19.184	6.466	89.543	0.33	19.627	26.437	0.732	0.68
JR107	Solids	22.778	15.9	0	0	13.459	13.695	0	0	0.61	12.065	16.82	0.877	0.48
JR115 (Surplus Canal; Diversion)	Solids	37.158	27.52	11.56	88.96	22.953	19.065	8.811	67.371	0.37	17.41	24.866	0.737	0.67
JR118	Solids	36.332	32.2	10.8	95.36	26.758	21.93	11.511	73.495	0.49	13.981	19.678	0.548	0.78
JR124	Solids	37.8	39.8	0	0	37.022	29.621	0	0	0.21	14.652	18.582	0.475	0.66
JR127	Solids	42.414	33.25	0	0	38.57	32.062	0	0	0.15	27.727	52.532	1.154	0.42
JR132	Solids	43.479	34	0	0	34.338	29.063	0	0	0.09	22.802	36.234	0.885	0.39
JR133	Solids	44.66	32.8	9.46	141.15	28.046	26.591	17.251	62.99	0.07	24.449	53.011	1.404	0.23
JR140	Solids	32.63	30.24	8.72	82.6	33.661	30.616	21.672	69.202	0.16	15.285	19.766	0.57	0.6
JR150	Solids	40.407	38.56	15.64	105.62	32.021	31.523	21.497	62.226	0.08	17.348	25.361	0.684	0.43

JR151 (South Davis South WWTP)	Solids	41.027	31.6	8.66	154.775	32.781	30.056	22.154	66.875	0.03	19.458	40.074	1.058	0.26
JR161 (Burnham Dam)	Solids	52.654	50.86	14.5	123.1	34.332	32.337	22.55	62.855	0.17	24.492	34.083	0.769	0.41

B.2.5: DISSOLVED OXYGEN (DO)

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Dissolved Oxygen	8.737	8.41	4.84	17.59	8.85	8.424	5.002	17.497	0.99	0.157	0.27	0.029	1
JR31	Dissolved Oxygen	9.312	7.728	5.105	15.909	9.558	9.088	5.794	17.225	0.56	1.768	2.238	0.229	0.84
JR44	Dissolved Oxygen	10.141	10.595	6.702	14.43	8.418	8.235	7.145	14.126	0.1	2.468	3.084	0.331	0.47
JR49 (Rose Creek)	Dissolved Oxygen	9.708	10.257	3.039	15.584	8.092	7.788	6.89	14.037	0.08	2.663	3.502	0.391	0.44
JR59	Dissolved Oxygen	10.697	11.325	0	0	7.337	7.331	0	0	0.1	4.11	4.794	0.54	0.13
JR68	Dissolved Oxygen	9.838	10.18	0	0	7.583	7.575	0	0	0.18	3.17	3.982	0.46	0.11
JR76 (9000 South Conduit)	Dissolved Oxygen	8.898	9.635	3.59	12.805	8.483	8.306	7.566	11.875	0.2	1.767	2.285	0.261	0.53
JR82 (7800 South Drain)	Dissolved Oxygen	9.647	10.05	6.292	13.125	8.584	8.445	7.127	11.527	0.29	1.53	1.972	0.215	0.59
JR87	Dissolved Oxygen	9.119	9.204	0	0	9.063	8.549	0	0	0.19	1.149	1.498	0.164	0.65
JR91	Dissolved Oxygen	9.544	9.928	5.59	12.44	8.801	8.77	7.737	10.987	0.08	1.624	2.243	0.244	0.4
JR103	Dissolved Oxygen	9.456	9.905	4.053	12.975	9.65	9.642	8.163	11.605	0.52	1.086	1.621	0.168	0.7
JR107	Dissolved	10.266	9.768	0	0	9.619	10.007	0	0	0.14	1.388	1.628	0.163	0.38

	Oxygen													
JR115 (Surplus Canal; Diversion)	Dissolved Oxygen	8.398	8.662	4.106	10.952	9.312	9.43	7.453	10.897	0.65	1.181	1.482	0.166	0.73
JR118	Dissolved Oxygen	8.244	8.459	3.5	10.745	9.317	9.358	7.691	10.952	0.64	1.302	1.823	0.206	0.65
JR124	Dissolved Oxygen	8.593	8.429	0	0	9.504	9.142	0	0	0.86	1.262	1.413	0.155	0.75
JR127	Dissolved Oxygen	8.737	8.584	0	0	9.479	9.213	0	0	0.8	1.035	1.213	0.132	0.75
JR132	Dissolved Oxygen	8.635	8.76	0	0	9.612	9.417	0	0	0.58	1.355	1.537	0.168	0.57
JR133	Dissolved Oxygen	8.326	8.92	3.638	11.414	9.46	9.514	8.048	10.429	0.66	1.452	1.896	0.212	0.59
JR136	Dissolved Oxygen	10.99	0	0	0	9.867	0	0	0	0	0	0	0	0
JR140	Dissolved Oxygen	8.055	8.45	1.448	13.913	9.508	9.632	7.765	10.976	0.25	2.14	2.898	0.329	0.37
JR150	Dissolved Oxygen	8.123	8.231	4.142	12.315	9.912	10.017	8.952	10.975	0.4	2.253	2.767	0.306	0.4
JR151 (South Davis South WWTP)	Dissolved Oxygen	7.228	7.948	1.275	11.825	9.954	9.955	8.879	11.04	0.19	2.83	3.486	0.409	0.25
JR161 (Burnham Dam)	Dissolved Oxygen	7.6	7.931	4.69	10.347	9.996	9.98	9.19	11.031	0.57	2.538	2.83	0.323	0.31

B.2.6: AMMONIA-NITROGEN

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Ammonia N	0.167	0.086	0.043	0.767	0.112	0.05	0.003	0.558	0.75	0.056	0.121	0.546	0.9

JR31	Ammonia N	0.073	0.043	0.031	0.325	0.002	0.002	0	0.005	0.13	0.07	0.1	7.026	0.02
JR44	Ammonia N	0.077	0.06	0.043	0.204	0.004	0.002	0.001	0.008	0.01	0.075	0.088	5.469	0.04
JR49 (Rose Creek)	Ammonia N	0.061	0.05	0.043	0.112	0.002	0.001	0.001	0.004	0	0.059	0.064	6.699	0.01
JR59	Ammonia N	0.09	0.047	0	0	0.002	0.002	0	0	0.16	0.088	0.13	9.977	0.01
JR68	Ammonia N	0.078	0.055	0	0	0.002	0.002	0	0	0.12	0.075	0.092	7.279	0.01
JR76 (9000 South Conduit)	Ammonia N	0.062	0.05	0.037	0.137	0.001	0.001	0.001	0.002	0.02	0.061	0.068	7.306	0.01
JR82 (7800 South Drain)	Ammonia N	0.061	0.043	0.021	0.105	0.002	0.002	0.001	0.004	0.87	0.058	0.077	3.597	0.19
JR87	Ammonia N	0.055	0.043	0	0	0.001	0.001	0	0	0.16	0.053	0.061	6.88	0.01
JR91	Ammonia N	0.059	0.043	0.021	0.127	0.001	0.001	0.001	0.002	0	0.058	0.065	7.557	0.01
JR103	Ammonia N	0.065	0.044	0.026	0.165	0.004	0.001	0.001	0.015	0.07	0.062	0.077	3.847	0.17
JR107	Ammonia N	0.067	0.056	0	0	0.001	0.001	0	0	0.01	0.066	0.073	7.55	0.01
JR115 (Surplus Canal; Diversion)	Ammonia N	0.392	0.269	0.043	1.56	0.171	0.048	0.001	0.57	0.49	0.257	0.397	0.913	0.77
JR118	Ammonia N	0.317	0.217	0.043	1.06	0.098	0.001	0.001	0.484	0.76	0.226	0.284	0.761	0.85
JR124	Ammonia N	0.222	0.201	0	0	0.012	0.001	0	0	0.39	0.211	0.267	3.254	0.25
JR127	Ammonia N	0.238	0.218	0	0	0.006	0.001	0	0	0.71	0.232	0.318	4.462	0.15
JR132	Ammonia N	0.268	0.235	0	0	0.001	0.001	0	0	0.51	0.267	0.351	16.476	0
JR133	Ammonia N	0.353	0.181	0.043	1.291	0.013	0.001	0.001	0.037	0.26	0.34	0.483	3.754	0.21
JR140	Ammonia	0.515	0.401	0.052	1.884	0.047	0.002	0.001	0.742	0.02	0.542	0.732	7.384	0.04

	N													
JR150	Ammonia N	0.313	0.249	0.043	0.955	0.027	0.001	0.001	0.002	0	0.324	0.438	4.429	0.15
JR151 (South Davis South WWTP)	Ammonia N	0.342	0.295	0.051	0.872	0.096	0.067	0.004	0.384	0.65	0.246	0.288	1.243	0.56
JR161 (Burnham Dam)	Ammonia N	0.343	0.273	0.069	1.171	0.001	0.001	0.001	0.002	0	0.342	0.502	23.596	0

B.2.7: INORGANIC NITROGEN (NITRATE AND NITRITE)

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Nitrate N	0.343	0.219	0.085	1.314	0.357	0.216	0.077	1.64	0.84	0.048	0.177	0.324	0.96
JR31	Nitrate N	0.687	0.373	0.052	3.436	0.155	0.007	0.002	1.814	0	0.696	1.124	3.885	0.14
JR44	Nitrate N	0.621	0.63	0.147	1.52	0.177	0.199	0.05	0.532	0.1	0.444	0.584	1.656	0.22
JR49 (Rose Creek)	Nitrate N	0.763	0.75	0.141	1.54	0.257	0.232	0.063	0.433	0.01	0.584	0.72	1.568	0.19
JR59	Nitrate N	0.908	0.91	0	0	0.284	0.324	0	0	0.3	0.624	0.698	1.317	0.27
JR68	Nitrate N	1.132	1.173	0	0	0.274	0.33	0	0	0.42	0.858	0.93	1.582	0.24
JR76 (9000 South Conduit)	Nitrate N	0.908	0.938	0.229	1.586	0.207	0.156	0.081	0.353	0	0.765	0.896	2.075	0.1
JR82 (7800 South Drain)	Nitrate N	1.125	1.163	0.243	2.147	0.462	0.446	0.098	0.976	0.28	0.729	0.88	1.104	0.41
JR87	Nitrate N	2.766	2.245	0	0	2.624	2.055	0	0	0.86	0.557	0.655	0.21	0.96
JR91	Nitrate N	3.093	3.482	0.507	6.438	2.395	1.874	0.381	5.629	0.19	1.311	2.114	0.71	0.62
JR103	Nitrate N	2.347	2.505	0.436	5.398	1.769	1.5	0.332	3.926	0.49	0.857	1.269	0.541	0.78
JR107	Nitrate N	4.303	4.498	0	0	2.102	2.184	0	0	0.14	2.201	2.364	0.776	0.34

JR115 (Surplus Canal; Diversion)	Nitrate N	3.912	4.31	0.946	7.684	3.219	3.673	0.967	5.44	0.8	0.835	1.291	0.327	0.88
JR118	Nitrate N	3.598	4.253	0.859	7.727	3.007	3.519	0.691	4.945	0.73	0.81	1.28	0.349	0.87
JR124	Nitrate N	2.698	2.818	0	0	2.467	2.418	0	0	0.85	0.469	0.592	0.205	0.95
JR127	Nitrate N	2.923	3.32	0	0	2.373	2.308	0	0	0.83	0.638	0.833	0.282	0.91
JR132	Nitrate N	3.017	3.393	0	0	2.22	2.158	0	0	0.75	0.904	1.114	0.391	0.83
JR133	Nitrate N	3.154	3.516	0.641	6.968	2.167	2.471	0.612	3.746	0.7	1.168	1.586	0.54	0.74
JR140	Nitrate N	3.845	4.114	0.898	7.26	2.153	2.387	0.748	3.615	0.61	1.753	2.135	0.694	0.53
JR150	Nitrate N	3.497	3.838	0.694	6.668	1.796	2.038	0.401	3.189	0.61	1.775	2.114	0.768	0.56
JR151 (South Davis South WWTP)	Nitrate N	3.824	3.892	1.022	6.997	2.016	2.167	0.467	3.461	0.74	1.808	2.089	0.689	0.6
JR161 (Burnham Dam)	Nitrate N	3.347	3.728	0.719	6.948	1.561	1.82	0.411	3.137	0.64	1.811	2.163	0.848	0.54

B.2.8: DISSOLVED ORGANIC NITROGEN (DON)

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Dissolved Organic N	0.92	0.67	0	0	0.992	0.729	0	0	1	0.073	0.074	0.067	1
JR44	Dissolved Organic N	1.368	1.216	0	0	1.865	2.005	0	0	0.43	0.5	0.61	0.374	0.64
JR49 (Rose Creek)	Dissolved Organic N	1.392	1.375	0	0	1.681	1.639	0	0	0.45	0.289	0.376	0.243	0.69
JR59	Dissolved Organic N	1.59	1.718	0	0	1.506	1.49	0	0	0.17	0.164	0.215	0.139	0.67

JR68	Dissolved Organic N	1.807	1.796	0	0	1.533	1.523	0	0	0.84	0.274	0.304	0.182	0.52
JR76 (9000 South Conduit)	Dissolved Organic N	1.519	1.54	0	0	1.726	1.728	0	0	0.44	0.229	0.279	0.172	0.53
JR82 (7800 South Drain)	Dissolved Organic N	2.207	2.174	0	0	2.005	2.089	0	0	0.26	0.515	0.791	0.373	0.35
JR91	Dissolved Organic N	6.292	5.173	0	0	1.707	1.743	0	0	0	4.584	5.568	1.7	0.02
JR103	Dissolved Organic N	4.376	4.282	0	0	1.701	1.737	0	0	0.03	2.675	2.908	1.065	0.04
JR107	Dissolved Organic N	5.12	5.384	0	0	1.741	1.755	0	0	1	3.379	3.503	1.176	0.02
JR115 (Surplus Canal; Diversion)	Dissolved Organic N	6.764	6.27	0	0	6.448	6.627	0	0	0.22	2.283	2.565	0.393	0.05
JR118	Dissolved Organic N	6.529	5.83	0	0	6.393	6.497	0	0	0.17	2.154	2.406	0.376	0.12
JR133	Dissolved Organic N	5.902	5.445	0	0	5.384	5.39	0	0	0.02	1.784	2.1	0.374	0.23
JR140	Dissolved Organic N	6.503	6.564	0	0	5.37	5.554	0	0	0.72	1.133	1.445	0.245	0.19
JR150	Dissolved Organic N	5.477	5.53	0	0	5.397	5.412	0	0	0.05	1.098	1.361	0.249	0.51
JR151 (South Davis South WWTP)	Dissolved Organic N	5.82	6.246	0	0	4.687	5.072	0	0	0.1	1.265	1.547	0.295	0.42
JR161 (Burnham Dam)	Dissolved Organic N	5.738	5.31	0	0	5.358	5.253	0	0	0.22	1.795	1.958	0.357	0.01

B.2.9: TOTAL PHOSPHATE-PHOSPHORUS (TP)

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Total Phosphorus	0.07	0.062	0.021	0.16	0.089	0.081	0.039	0.176	0.92	0.019	0.022	0.251	0.93
JR31	Total Phosphorus	0.074	0.066	0.046	0.149	0.137	0.13	0.039	0.324	0.01	0.073	0.11	1.106	0.43
JR44	Total Phosphorus	0.055	0.054	0.017	0.135	0.21	0.223	0.071	0.419	0.13	0.158	0.188	1.838	0.33
JR49 (Rose Creek)	Total Phosphorus	0.062	0.054	0.017	0.13	0.171	0.197	0.066	0.25	0.06	0.117	0.136	1.364	0.36
JR59	Total Phosphorus	0.049	0.043	0	0	0.271	0.272	0	0	0.11	0.222	0.242	2.156	0.37
JR68	Total Phosphorus	0.063	0.051	0	0	0.248	0.256	0	0	0.07	0.185	0.207	1.699	0.35
JR76 (9000 South Conduit)	Total Phosphorus	0.069	0.059	0.022	0.145	0.155	0.171	0.06	0.217	0.04	0.105	0.129	1.295	0.29
JR82 (7800 South Drain)	Total Phosphorus	0.068	0.062	0.024	0.181	0.153	0.151	0.063	0.315	0.02	0.096	0.121	1.207	0.35
JR87	Total Phosphorus	0.594	0.517	0	0	0.676	0.601	0	0	0.86	0.111	0.161	0.223	0.95
JR91	Total Phosphorus	0.638	0.72	0.143	1.178	0.81	0.832	0.183	1.631	0.3	0.284	0.41	0.532	0.7
JR103	Total Phosphorus	0.586	0.517	0.117	1.711	0.616	0.643	0.153	1.366	0.15	0.284	0.621	0.918	0.55
JR107	Total Phosphorus	0.73	0.853	0	0	0.765	0.727	0	0	0.34	0.146	0.178	0.235	0.73
JR115 (Surplus Canal; Diversion)	Total Phosphorus	0.812	0.91	0.132	1.708	1.009	1.138	0.321	1.755	0.6	0.285	0.432	0.422	0.84
JR118	Total Phosphorus	0.799	0.991	0.185	1.51	0.98	1.111	0.324	1.716	0.82	0.198	0.271	0.275	0.91
JR124	Total Phosphorus	0.674	0.599	0	0	0.84	0.788	0	0	0.73	0.303	0.381	0.423	0.87

JR127	Total Phosphorus	0.587	0.632	0	0	0.83	0.777	0	0	0.55	0.269	0.398	0.501	0.8
JR132	Total Phosphorus	0.662	0.735	0	0	0.727	0.697	0	0	0.61	0.219	0.304	0.383	0.87
JR133	Total Phosphorus	0.677	0.721	0.079	1.372	0.723	0.817	0.143	1.354	0.56	0.167	0.294	0.376	0.86
JR140	Total Phosphorus	0.747	0.842	0.07	1.563	0.846	0.896	0.235	1.645	0.29	0.267	0.403	0.475	0.73
JR150	Total Phosphorus	0.705	0.78	0.142	1.487	0.8	0.844	0.205	1.631	0.44	0.22	0.371	0.447	0.8
JR151 (South Davis South WWTP)	Total Phosphorus	0.801	0.683	0.116	3.09	0.758	0.81	0.254	1.364	0.47	0.265	0.661	0.735	0.65
JR161 (Burnham Dam)	Total Phosphorus	0.656	0.665	0.131	1.212	0.732	0.847	0.192	1.276	0.53	0.173	0.264	0.351	0.85

B.2.10: PHYTOPLANKTON CHLOROPHYLL-A

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Phytoplankton Chlorophyll a	16.523	13.315	4.46	42.72	16.53	13.334	4.473	42.687	1	0.098	0.218	0.011	1
JR44	Phytoplankton Chlorophyll a	127.2	0	0	0	14.995	0	0	0	0	0	0	0	0
JR49 (Rose Creek)	Phytoplankton Chlorophyll a	24.408	16.75	6.9	164.275	8.714	9.063	0.211	22.141	0.04	16.084	41.001	2.509	0.15
JR76 (9000 South Conduit)	Phytoplankton Chlorophyll a	23.01	13.15	3.15	175.05	8.037	7.509	0.082	29.689	0.01	16.596	57.146	3.826	0.06

JR91	Phytoplankton Chlorophyll a	253.2	0	0	0	5.05	0	0	0	0	0	0	0	0
JR103	Phytoplankton Chlorophyll a	25.964	13.86	3.795	210.41	7.886	8.306	0.853	25.813	0.03	18.579	62.353	3.79	0.07
JR115 (Surplus Canal; Diversion)	Phytoplankton Chlorophyll-a	15.924	11.3	3.3	91.45	7.054	7.415	1.4	22.277	0	10.787	29.265	2.652	0.07
JR118	Phytoplankton Chlorophyll a	11.843	12.18	3.79	21.93	6.77	7.001	1.356	22.339	0.02	6.674	8.462	0.921	0.45
JR133	Phytoplankton Chlorophyll a	9.111	9.44	2.08	19.705	5.406	5.259	1.414	17.777	0	5.553	7.552	1.064	0.37
JR150	Phytoplankton Chlorophyll a	9.289	8.74	1.98	23.84	5.064	4.908	1.289	17.116	0.02	6.196	7.887	1.115	0.38
JR151 (South Davis South WWTP)	Phytoplankton Chlorophyll a	13.146	12.55	0	0	4.896	5.072	0	0	0.01	8.686	13.098	1.592	0.26
JR161 (Burnham Dam)	Phytoplankton Chlorophyll a	9.425	9.68	0.595	22.24	5.91	5.553	1.575	20.143	0	6.113	8.16	1.091	0.27

B.2.11: CBOD

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR1 (Utah Lake Effluent)	Total CBOD	8.56	4.746	4.034	42.951	8.511	4.74	4.03	42.263	1	0.078	0.293	0.019	1
JR44	Total	4.958	4.746	4.034	9.017	3.903	3.726	2.81	6.316	0.14	1.403	1.692	0.38	0.55

	CBOD													
JR49 (Rose Creek)	Total CBOD	4.929	4.034	4.034	12.419	3.744	3.699	2.608	5.871	0.38	1.436	2.073	0.466	0.59
JR76 (9000 South Conduit)	Total CBOD	4.715	4.034	4.034	8.78	3.233	3.309	2.382	5.004	0.13	1.557	2.044	0.516	0.43
JR82 (7800 South Drain)	Total CBOD	4.498	4.034	4.034	7.119	3.088	2.864	2.306	4.946	0.31	1.462	1.607	0.426	0.5
JR91	Total CBOD	5.134	4.746	4.034	7.91	5.845	5.769	4.057	7.292	0	1.301	1.647	0.301	0.42
JR103	Total CBOD	4.977	4.746	4.034	8.622	5.311	5.277	4.034	7.046	0.19	1.105	1.404	0.27	0.64
JR107	Total CBOD	4.519	4.034	0	0	4.851	4.987	0	0	0.05	1.283	1.473	0.312	0.49
JR115 (Surplus Canal; Diversion)	Total CBOD	5.57	4.746	4.034	11.074	5.608	5.268	3.883	9.322	0.62	1.022	1.362	0.234	0.86
JR118	Total CBOD	5.19	4.746	4.034	11.865	5.61	5.433	4.013	8.841	0.55	1.135	1.569	0.28	0.8
JR133	Total CBOD	5.295	4.319	4.034	12.339	5.119	5.017	3.919	8.17	0.47	1.071	1.737	0.324	0.71
JR150	Total CBOD	5.395	4.746	4.034	11.232	4.851	4.74	3.81	7.945	0.41	1.21	1.966	0.373	0.64
JR151 (South Davis South WWTP)	Total CBOD	6.652	7.91	4.034	11.074	5.395	5.217	4.226	7.202	0.35	1.809	2.435	0.4	0.5
JR161 (Burnham Dam)	Total CBOD	6.291	4.746	4.034	11.786	5.615	5.406	4.203	8.526	0.37	1.602	2.501	0.409	0.6

B.2.12: FLOW QUANTITY

Station	Parameter	Measured				Simulated				R^2	Mean Abs Err	RMS Err	Norm RMS Err	Index of Agrmt
		Mean	Median	25 %tile	75 %tile	Mean	Median	25 %tile	75 %tile					
JR32 (Turner Dam; Diversion)	FLOW OUT OF SEGMENT	8.204	3.566	0.523	7.724	6.663	0.825	0.5	6.368	0.83	2.332	4.834	0.383	0.95
JR76 (9000 South Conduit)	FLOW OUT OF SEGMENT	8.123	2.115	1.104	7.499	7.253	2.724	1.622	5.473	0.81	2.808	5.262	0.412	0.94
JR118	FLOW OUT OF SEGMENT	3.312	3.596	2.888	4.021	3.414	3.672	3.01	4.133	0.98	0.136	0.218	0.061	0.99
JR133	FLOW OUT OF SEGMENT	8.155	8.202	5.482	10.221	7.306	7.562	5.081	8.673	0.84	0.952	1.49	0.185	0.91

APPENDIX C: SUPPLEMENTAL R SCRIPTS

This appendix provides the programming scripts that have been developed for retrieving, processing, and inputting some of the data needed for the Jordan River WASP.

C.1: R SCRIPT FOR SOLAR RADIATION DATA

The solar radiation data obtained for the Jordan River WASP are retrieved from the FTP website ftp://aftp.cmdl.noaa.gov/data/radiation/solrad/, which provides 3-minute observed solar radiation for selected sites across the U.S. The FTP weblink places observed solar radiation data as individual DAT files based on Julian Day, serving as text files that provide the coordinates of the site followed by time-series data, with values exhibiting "-9999.9" indicated as missing data. On the other hand, since the Jordan River WASP requires approximately 5 full years of solar radiation data, retrieving the DAT files manually from the FTP website seems time-consuming and hence inefficient. Therefore, the following R script has been developed for retrieving observed solar radiation data from the FTP website (through the "RCurl" library that can be obtained from the CranR website), indicated as the variable "direct" in the DAT files, processing the data into an output CSV file, re-reading in the output CSV file, and yielding an updated CSV file that exhibits all missing data removed.

```
#Retrieving 3-Minute Observed Solar Radiation from SLC FTP website
#By: Juhn-Yuan Su, M.S., E.I.T.
#Updated June 7, 2019
#Since the FTP website yields individual DAT files per day and then organized
per year per city, this code is developed.
#This code downloads the observed 3-minute solar radiation data from the FTP
website for a time period specified by the user.
#This code implements solar radiation data as the variable "Direct", which is
defined as the observed solar radiation WITHOUT any light blockage and
directly from the sun.
#The code then combines the output into a single CSV file based on the time
period specified by the user.
#The code then removes any missing radiation data that have been indicated as
-9999.9 and then creates a new CSV accordingly.

#The below library is REQUIRED for running this code and can be installed
through the "Install Packages" through CranR.
library(RCurl)

#Please specify the starting year and ending year. This code will download
all data per year, starting from day 1 (01/01).
startyear<-2006
endyear<-2011

#Output CSV file will exhibit the following filename; this is the initial CSV
(uncleaned) file.
outputcsv<-sprintf("%s_%s_%s.csv","SLCAirport",startyear,endyear)

#Output CSV file that exhibits data that does NOT have "-9999.9" as the
Direct Solar Radiation Data
outputrevisedcsv<-
sprintf("%s_%s_%s_Cleaned.csv","SLCAirport",startyear,endyear)

#This line is simply for providing headers to the very first row of the
output CSV file.
```

```
startyearcharacter<-paste(substr(toString(startyear),3,4),"001",sep = "")

#The code will now download all data based on the time period specified by
the user and place the data into a single CSV.
#Please be careful when including multiple years (e.g., large gaps among
startyear vs. endyear); Excel has a row limit.
for(i in startyear:endyear){
  #Developing a URL
  urlcharacter<-
sprintf("ftp://aftp.cmdl.noaa.gov/data/radiation/solrad/slc/%s/",i)
  url<-urlcharacter
  #Identifying all files within the URL
  filenames = getURL(url, ftp.use.epsv = FALSE, dirlistonly = TRUE)
    filenames <- strsplit(filenames, "\r\n")
  filenames = unlist(filenames)
  #Downloading all files and writing relevant results to an output CSV
  for(filename in filenames){
    download.file(paste(url, filename, sep = ""), paste(getwd(), "/",
filename,sep = ""))
    mydayofyear<-substr(filename,4,8)
    daytable<-read.table(file=filename,skip=2,sep="")
    year<-daytable$V1
    month<-daytable$V3
    day<-daytable$V4
    hour<-daytable$V5
    minute<-daytable$V6
    radiation<-daytable$V11
    finaldatatable<-data.frame(year,month,day,hour,minute,radiation)
    if(mydayofyear==startyearcharacter){
      write.table(finaldatatable,file=outputcsv,append=FALSE,row.names =
FALSE,col.names = TRUE,sep = ",")
    }else{
      write.table(finaldatatable,file=outputcsv,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
    }
  }
}

#Now removing any bad data
uncleandatatable<-read.csv(file=outputcsv,header = TRUE,sep = ",")

#Separating into arrays
reviseddatatable<-
subset.data.frame(uncleandatatable,uncleandatatable$radiation!=-9999.9)

#Writing into output CSV file for "cleaned" data; note that this code does
NOT alter any negative radiation.
write.table(reviseddatatable,file=outputrevisedcsv,append=FALSE,row.names=FAL
SE,col.names=TRUE,sep=",")
```

The above R Script yields the solar radiation data into a single CSV file that covers the entire model calibration period (e.g., October 1, 2006 to September 30, 2011), with all the missing data removed. On the other hand, such implementation yields significant missing data observed along Water Year 2007 (June to November 2007). Hence, the solar radiation data for June to November 2007 have been re-approximated as the average of the solar radiation values for the remaining water years that exhibit non-missing data per time step. For instance, the solar radiation at 07/15/2007 at 3:00 PM is re-approximated as the average of solar radiation values at 07/15/2008 at 3

PM, 07/15/2009 at 3 PM, 07/15/2010 at 3 PM, and 07/15/2011 at 3 PM. Such approaches have been implemented for substituting any missing data observed over a significant time frame (e.g., at least 1 week).

C.2: R SCRIPT FOR OBTAINING INFLOW DATA FROM SALT LAKE COUNTY

The following R Script reads the outflow data that are retrieved as TXT files per site and per water year from the Salt Lake County (SLC) Tributary Historical Data and places the outflow data into a single CSV file. The user may need to modify portions of the R Script based on the site of interest for ensuring that the data have been retrieved, read, and processed correctly.

```
outputsitename<-"SLC490"
startwateryear<-2006
endwateryear<-2012
outputcsvname<-sprintf("%s_B%s-
E%s.csv",outputsitename,startwateryear,endwateryear)

for(i in startwateryear:endwateryear){
  outputwateryear<-i
  inputdatafilename<-
sprintf("%s_WaterYear%s.txt",outputsitename,outputwateryear)
  datatable<-read.fwf(file=inputdatafilename,widths =
c(9,10,10,10,10,10,10,10,10,10,10,10,10),skip=10,header=FALSE,n=36)
  BeginYear<-i-1
  EndYear<-i

  Day<-datatable$V1
  Oct<-datatable$V2
  Nov<-datatable$V3
  Dec<-datatable$V4
  Jan<-datatable$V5
  Feb<-datatable$V6
  Mar<-datatable$V7
  Apr<-datatable$V8
  May<-datatable$V9
  Jun<-datatable$V10
  Jul<-datatable$V11
  Aug<-datatable$V12
  Sep<-datatable$V13

  Oct[Oct=="   ------ "]<-NA
  Nov[Nov=="   ------ "]<-NA
  Dec[Dec=="   ------ "]<-NA
  Jan[Jan=="   ------ "]<-NA
  Feb[Feb=="   ------ "]<-NA
  Mar[Mar=="   ------ "]<-NA
  Apr[Apr=="   ------ "]<-NA
  May[May=="   ------ "]<-NA
  Jun[Jun=="   ------ "]<-NA
  Jul[Jul=="   ------ "]<-NA
  Aug[Aug=="   ------ "]<-NA
  Sep[Sep=="   ------ "]<-NA

  Oct[Oct=="          "]<-NA
  Nov[Nov=="          "]<-NA
  Dec[Dec=="          "]<-NA
```

```
Jan[Jan=="          "]<-NA
Feb[Feb=="          "]<-NA
Mar[Mar=="          "]<-NA
Apr[Apr=="          "]<-NA
May[May=="          "]<-NA
Jun[Jun=="          "]<-NA
Jul[Jul=="          "]<-NA
Aug[Aug=="          "]<-NA
Sep[Sep=="          "]<-NA

Oct[Oct=="       *  "]<-NA
Nov[Nov=="       *  "]<-NA
Dec[Dec=="       *  "]<-NA
Jan[Jan=="       *  "]<-NA
Feb[Feb=="       *  "]<-NA
Mar[Mar=="       *  "]<-NA
Apr[Apr=="       *  "]<-NA
May[May=="       *  "]<-NA
Jun[Jun=="       *  "]<-NA
Jul[Jul=="       *  "]<-NA
Aug[Aug=="       *  "]<-NA
Sep[Sep=="       *  "]<-NA

Oct[Oct=="      5.0>" ]<-NA
Nov[Nov=="      5.0>" ]<-NA
Dec[Dec=="      5.0>" ]<-NA
Jan[Jan=="      5.0>" ]<-NA
Feb[Feb=="      5.0>" ]<-NA
Mar[Mar=="      5.0>" ]<-NA
Apr[Apr=="      5.0>" ]<-NA
May[May=="      5.0>" ]<-NA
Jun[Jun=="      5.0>" ]<-NA
Jul[Jul=="      5.0>" ]<-NA
Aug[Aug=="      5.0>" ]<-NA
Sep[Sep=="      5.0>" ]<-NA

OctUn<-data.frame(10,Day,BeginYear,Oct)
NovUn<-data.frame(11,Day,BeginYear,Nov)
DecUn<-data.frame(12,Day,BeginYear,Dec)
JanUn<-data.frame(1,Day,EndYear,Jan)
FebUn<-data.frame(2,Day,EndYear,Feb)
MarUn<-data.frame(3,Day,EndYear,Mar)
AprUn<-data.frame(4,Day,EndYear,Apr)
MayUn<-data.frame(5,Day,EndYear,May)
JunUn<-data.frame(6,Day,EndYear,Jun)
JulUn<-data.frame(7,Day,EndYear,Jul)
AugUn<-data.frame(8,Day,EndYear,Aug)
SepUn<-data.frame(9,Day,EndYear,Sep)

OctRev<-subset.data.frame(OctUn,OctUn$Oct!="NA")
NovRev<-subset.data.frame(NovUn,NovUn$Nov!="NA")
DecRev<-subset.data.frame(DecUn,DecUn$Dec!="NA")
JanRev<-subset.data.frame(JanUn,JanUn$Jan!="NA")
FebRev<-subset.data.frame(FebUn,FebUn$Feb!="NA")
MarRev<-subset.data.frame(MarUn,MarUn$Mar!="NA")
AprRev<-subset.data.frame(AprUn,AprUn$Apr!="NA")
MayRev<-subset.data.frame(MayUn,MayUn$May!="NA")
```

```
  JunRev<-subset.data.frame(JunUn,JunUn$Jun!="NA")
  JulRev<-subset.data.frame(JulUn,JulUn$Jul!="NA")
  AugRev<-subset.data.frame(AugUn,AugUn$Aug!="NA")
  SepRev<-subset.data.frame(SepUn,SepUn$Sep!="NA")

  if(i==startwateryear){
    write.table(OctRev,file=outputcsvname,append=FALSE,row.names =
FALSE,col.names = TRUE,sep = ",")
  }else{
    write.table(OctRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  }
  write.table(NovRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(DecRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(JanRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(FebRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(MarRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(AprRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(MayRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(JunRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(JulRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(AugRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
  write.table(SepRev,file=outputcsvname,append=TRUE,row.names =
FALSE,col.names = FALSE,sep = ",")
}
```