

Final Report

Analysis of Historical Groundwater Nitrate Data Using Wakulla County, Florida Water Supply Well Data, With Comparison To Proposed Total Maximum Daily Loads (TMDL) Limits (Addendum to Leon County Analysis)

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Prepared For
City of Tallahassee
Underground Utilities
Water Resources Engineering

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1.0 Scope of Services

NOTE: This report was prepared as an addendum to the report Analysis of Historical Groundwater Nitrate Data in Leon County, Florida With Comparison To Proposed Total Maximum Daily Loads (TMDL) Limits.

The scope of services for this addendum specified that the consultant was to utilize potable water well databases to compile groundwater analysis data for nitrates in Wakulla County, Florida. Compile and tabulate the data, perform statistical evaluation on the data and include the data in a report summarizing the findings. Statistical analysis will be dependent on the quantity and quality of the data for each well site. At a minimum, measurement of central tendency over time (average, median, standard deviation) will be provided.

2.0 Introduction

The Florida Department of Environmental Protection (FDEP) has proposed a nitrate TMDL of 0.35 mg/L for the Upper Wakulla River. Previous groundwater nitrate analysis contained in the Leon County section of this report suggests this concentration may be lower than the long term natural background for groundwater in the Floridan aquifer. To further assess the feasibility of the proposed TMDL, the City of Tallahassee (City) contracted with William Leseman, Water Quality Consulting, to compile a groundwater nitrate database for Wakulla County, Florida and prepare a summary report of the findings. Nitrate data

submitted to FDEP for public water supply wells and private well nitrate data collected by the Northwest Florida Water Management District (NFWWMD) were compiled for this report. The data, originally submitted to those agencies over a 25 year period, were compiled in Excel to be compatible with previously compiled database for Leon County. The database was used to determine the average groundwater nitrate concentration at various locations throughout Wakulla County at various times over the 25-year sample period. Comparisons are made to the proposed nitrate in the Wakulla River Total Maximum Daily Load (TMDL) concentration of 0.35 mg/L. The data compiled for this project along with the data presented in the Leon County section of this report were used to generate a groundwater nitrate contour map encompassing both Leon and Wakulla County. It should be noted, however, that well data are collected at various locations at different points in time. Consequently, these averages do not necessarily portray locational averages that existed at the same point in time.

3.0 Data

Public water systems are required to test for nitrate at least annually. Data used for this project include existing drinking water well nitrate data (FDEP Permitted Public Water Systems and, private potable water well nitrate data collected in 1986, 1997, and 1999 by the NFWWMD.

Data for public water system wells in Wakulla County were obtained from the FDEP. Data were requested for the time period 1986 to the present however very few data points were in the database prior to 1990. An additional request was made to obtain construction and location information for each well. Samples representing the source supply water were identified and included in the raw database. These data were then screened to eliminate samples of unrecorded sources. An example of the data discarded would be where the public water system no longer exists and the system operated a conventional water treatment plant (St. Marks Water

System). It is impossible in that case to know which well was online at the time of the sample collection.

In two cases (Winco Water System and River Sink Water System) it was unclear which well was sampled. In the case of these two systems the wells are located close to one another and are drilled to approximately the same depth. For the purposes of creating a contour point the location was averaged for all samples associated with these two systems.

To eliminate data outliers for the public water systems, the data set (Appendix 1) was evaluated using the Z-test. Seven outliers were removed and the final public water system database created in Excel (Appendix 2).

Two data sets were obtained from the NFWFMD. NFWFMD data sets used for this report were included in the previously published reports:

- *Nitrate Loading as an Indicator of Nonpoint Source Pollution in the Lower St. Marks-Wakulla Rivers Watershed*, April 2002 and
- *Ambient Ground Water Quality In Northwest Florida, Part 1: Ground Water Sampling and Analysis Ambient ground Water Monitoring Program*, October 1989.

4.0 Results

As outlined above three data sets were used to compile the Wakulla nitrate data for inclusion in this addendum report. All results from the three datasets are shown in Appendix 8; FDEP regulated public water system wells after QC outlier removal; multi-year WMD private well samples and single year WMD private well nitrate samples. These three data sets contain a total of 428 nitrate values collected from 75 sites. 105 individual nitrate values exceeded the 0.35 mg/L TMDL (24%). Two private well samples collected by the NFWFMD exceeded the 10 mg/L drinking

water and ground water standard. The average nitrate concentration for all 3 data sets is 0.30 mg/L.

Table 4-1 Data Set Summary

Data Set Type (Source)	Number of Wells	Number of Samples	Average NO3-N mg/L (All Samples)	Number of Wells with Average NO3-N Exceeding 0.35 mg/L
Wakulla Public Water System (FDEP)	21	358	0.17	6
Wakulla Private Well with more than 1 sample event (NFWMD)	14	30	1.62	7
Wakulla Private well with only 1 sample event (NFWMD)	40	40	0.52	13

4.1 Contour Map

Appendix 16 contains the combined Leon and Wakulla County nitrate contour map. The data used to generate the contour map are presented in Table 4-1. Data from 35 well sites in Wakulla County were used to generate the contour map. The nitrate concentration contour map was generated using the average of the FDEP drinking water system well data (after screening for outliers) and the average private well

data obtained from the NFWFMD where there was more than one sample collected. Private well data with only one sample event was not used to generate the contour.

The average nitrate-N concentration for the contour data set exceeded the proposed 0.35 mg/L TMDL for 13 out of the 35 wells (37%) where there was more than one sample event.

The contour data set contains 389 nitrate values from 35 wells. The average nitrate nitrogen concentration using the contour data set was 0.28 mg/L with a data range of 0.0 - 12 mg/L (Table 4-2).

DEP permitted Wastewater Treatment Plants (WWTP) are shown on the map as location points only. No data are associated with those plants except for the Southeast Sprayfield (SEF) as described in the Leon County section of this analysis. The other plants are shown only for consideration as possible sources of nitrate contributors to Wakulla Springs. The extent of impact from those sources has not been determined at this time.

Table 4-2 Wakulla County Contour Data Set - Average Nitrate Concentration From Public and Private Drinking Water Wells, 1986 -2011

Sample Name	Count	Average of Nitrate as N mg/L	Std Dev	Min of Nitrate as N mg/L	Max of Nitrate as N mg/L	Date First Sample	Date Last Sample	Well Depth	Casing Depth	FLUID	Latitude	Longitude
MIRACLE DELIVERANCE CENTER	5	0.28	0.05	0.22	0.33	5/15/06	12/6/10	137	120		30 15 23.470	084 18 58.130
MYSTERIOUS WATERS SUBDIVISION	20	0.01	0.04	0.00	0.17	10/8/90	5/10/11	NA	180	AAA7824	30 11 46.257	084 16 12.705
NEWPORT PARK WELL 1	18	0.02	0.05	0.00	0.16	9/8/93	3/9/10	>105	65	AAA7827	30 11 57.275	084 10 30.077
OUZTS' TOO OYSTER BAR	20	0.06	0.17	0.00	0.73	8/21/89	5/10/11	NA	NA	AAA7829	30 11 58.752	084 10 45.087
PANACEA WELL 3	20	0.38	0.22	0.00	0.75	3/21/89	4/12/11	NA	90	AAA7834	30 01 47.581	084 24 13.652
PANACEA WELL 4	20	0.26	0.19	0.00	0.55	3/21/89	4/12/11	NA	NA	AAA7833	30 01 51.536	084 23 58.573
PANACEA WELL 5	14	0.09	0.18	0.00	0.63	3/21/89	9/14/04	NA	NA		30 01 49.953	084 24 29.114
PANACEA WELL 6	7	0.00	0.00	0.00	0.00	9/13/05	4/12/11	150	60	AAI8480	30 01 50.290	084 24 29.470
SOPCHOPPY WELL 1	21	0.04	0.05	0.00	0.17	4/13/92	4/12/11	260	64	AAA7837	30 03 43.926	084 29 30.436
SOPCHOPPY WELL 2	23	0.01	0.02	0.00	0.08	4/13/92	4/12/11	200	100	AAA0244	30 04 38.011	084 25 10.895
SOPCHOPPY WELL 3	22	0.48	0.32	0.03	1.16	4/13/92	4/12/11			AAA7838	30 07 35.593	084 22 12.525
SOPCHOPPY WELL 4	21	0.44	0.13	0.21	0.73	1/27/92	4/12/11	200	62	AAA7839	30 06 35.831	084 22 50.001
SOPCHOPPY WELL 5	22	0.01	0.02	0.00	0.11	4/13/92	4/12/11	190	160	AAA7840	30 10 31.306	084 22 37.067
SOPCHOPPY WELL 6	21	0.37	0.12	0.18	0.63	12/13/93	4/12/11	180	105	AAA7847	30 12 40.255	084 22 37.067
SOPCHOPPY WELL 7	15	0.53	0.17	0.20	0.90	5/19/99	4/12/11	180	155	AAA7846	30 11 07.263	084 22 18.351
ST MARKS WILDLIFE VISITORS CENTER	18	0.00	0.01	0.00	0.05	6/20/90	12/15/10	NA	NA	AAA7828	30 09 03.287	084 08 51.124
WAKULLA REG. WELL 2 (Gulf Coast)	5	0.00	0.00	0.00	0.00	8/16/05	5/16/11	205	83	AAA7843	30 06 14.368	084 19 37.120
WAKULLA REG. WELL 3 (Shadeville)	22	0.03	0.07	0.00	0.29	4/8/92	5/16/11	322	140	AAA7841	30 11 34.067	084 18 33.519
WAKULLA REG. WELL 4 (Songbird)	8	0.40	0.22	0.15	0.89	7/26/01	5/16/11	251	72	AAI0616	30 11 49.258	084 21 43.495

Sample Name	Count	Average of Nitrate as N mg/L	Std Dev	Min of Nitrate as N mg/L	Max of Nitrate as N mg/L	Date First Sample	Date Last Sample	Well Depth	Casing Depth	FLUID	Latitude	Longitude
WAKULLA WATER SYSTEM (RIVERSINK) Both wells 1 & 2	19	0.10	0.10	0.00	0.28	7/23/98	6/29/11				30 16 37	084 21 15
WINCO WELL 1&2	17	0.06	0.09	0.00	0.24	5/22/96	7/13/10	150	60	AAA7822 & 7823	30 15 48.032	084 13 7.362
CLEMONS/HICKS	2	0.31		0.27	0.34	6/26/97	3/10/99	60	40	AAA6506	30 13 15.717	084 20 27.628
D. BLACKSTAD	2	1.55		1.40	1.70	7/17/97	3/11/99	60	44	AAA6525	30 11 19.719	084 21 5.641
D. SHORES	2	0.28		0.24	0.32	6/5/97	3/8/99	41	32	AAA6536	30 07 40.721	084 23 51.648
DONNIE SPARKMAN WELL	2	0.00		0.00	0.00	7/3/97	3/11/99	105	76	AAA6515	30 11 28.717	084 25 13.639
GODDARD PLANTATION	2	0.84		0.18	1.50	7/29/86	3/17/99	48	21	AAA0245	30 12 01.552	084 18 35.776
J. REEVES	2	0.00		0.00	0.00	7/3/97	3/11/99	118	97	AAA6539	30 09 51.724	084 24 8.624
JOHNSON, THOMAS	2	9.65		7.30	12.00	7/31/97	3/18/99	86	22	AAA6528	30 12 0.725	084 18 35.617
N. GARCIA	2	0.30		0.26	0.34	8/21/97	3/18/99	60	38	AAA6527	30 11 45.722	084 19 21.624
N. WOOTEN	2	0.61		0.52	0.69	8/21/97	3/11/99	98	40	AAA6769	30 10 53.722	084 19 20.635
Ochlockonee River State Park #1	2	0.55		0.00	1.10	7/29/86	5/30/97	74	41		29 59 53	084 29 01
S. B. SMITH	2	0.68		0.38	0.97	7/10/97	3/18/99	50	18	AAA6517	30 13 24.724	084 13 25.628
S. EDWARDS	2	0.02		0.00	0.04	7/3/97	3/11/99	95	55	AAA6498	30 10 18.721	084 24 22.632
USGS ARRAN WORK CTR	3	0.26		0.00	0.78	2/25/86	3/18/99	129	75	AAA0523	30 11 14.08	084 24 12.23
WAKULLA PK REC WELL	3	6.13		3.10	11.00	2/24/86	10/15/97	120	35	AAA0525	30 06 54.83	084 22 36.93

Highlighted averages exceed the 0.35 mg/L nitrate-n TMDL

5.0 DISCUSSION

Elevated nitrate concentrations have been measured in the ground waters of Wakulla County. Two well samples collected as part of NFWFMD studies exceeded the 10 mg/L drinking water and groundwater standard. The Leon/Wakulla groundwater nitrate contour map included with this report, highlights three “pockets” of high nitrate concentration that are greater than the TMDL limit. Based on a complete review of the data and it can be concluded that these areas of high nitrate concentrations are not caused by activities taking place within Leon County.

Nitrate in the public water system wells in Wakulla County exhibit greater concentration variability over time than public water system wells in Leon County. As can be seen in the example presented in Figures 1 and 2 the range of nitrate concentrations fluctuate over a range of 0.03 to 1.16 mg/ L for Sopchoppy public supply well #3, while during the same time period the City of Tallahassee well 17 range was 0.46 to 0.55 mg/L. City well 17 was chosen because it was used as an up-gradient reference well for the USGS model presented in *Nitrate-N Movement in Groundwater, Leon and Wakulla Counties, Florida, 1966-2018* by J. Hal Davis, Brian G. Katz, and Dale W. Griffin

The cause of this variability is unknown. Possible causes include rainfall, pumping rate of the well and aquifer flow reversal influence within the aquifer, or some other factors that affect groundwater nitrate. More detailed sampling would be required to understand the seesaw groundwater nitrate concentrations measured in Wakulla County.

Figure 1

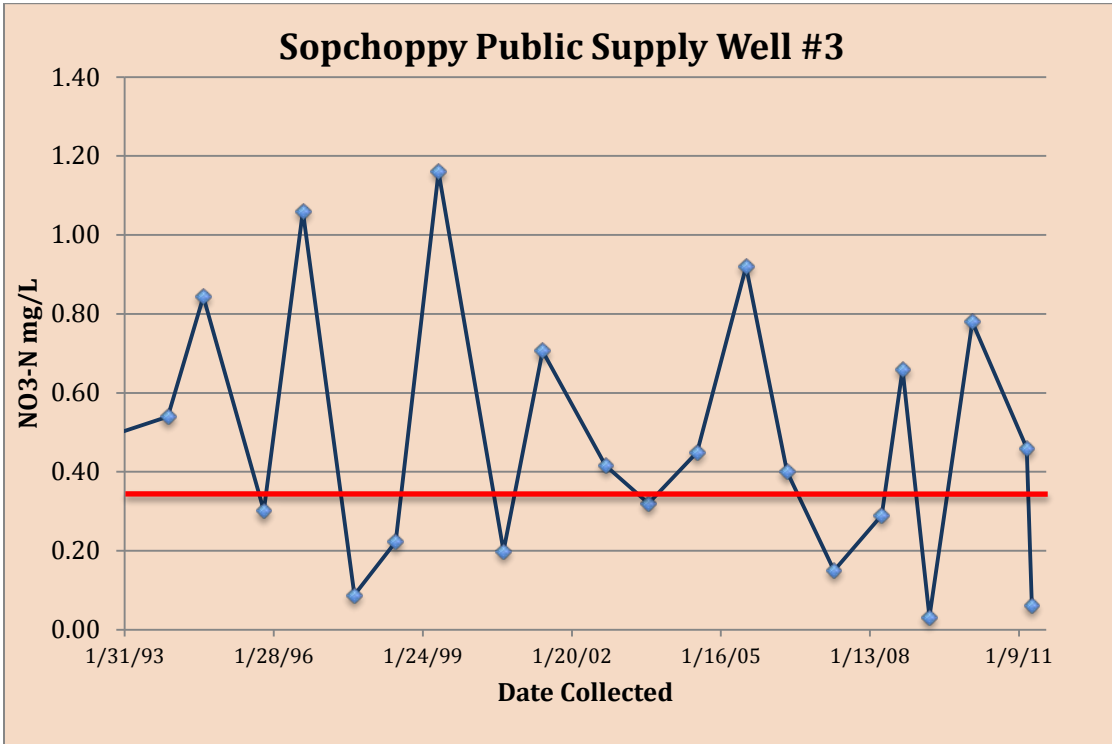
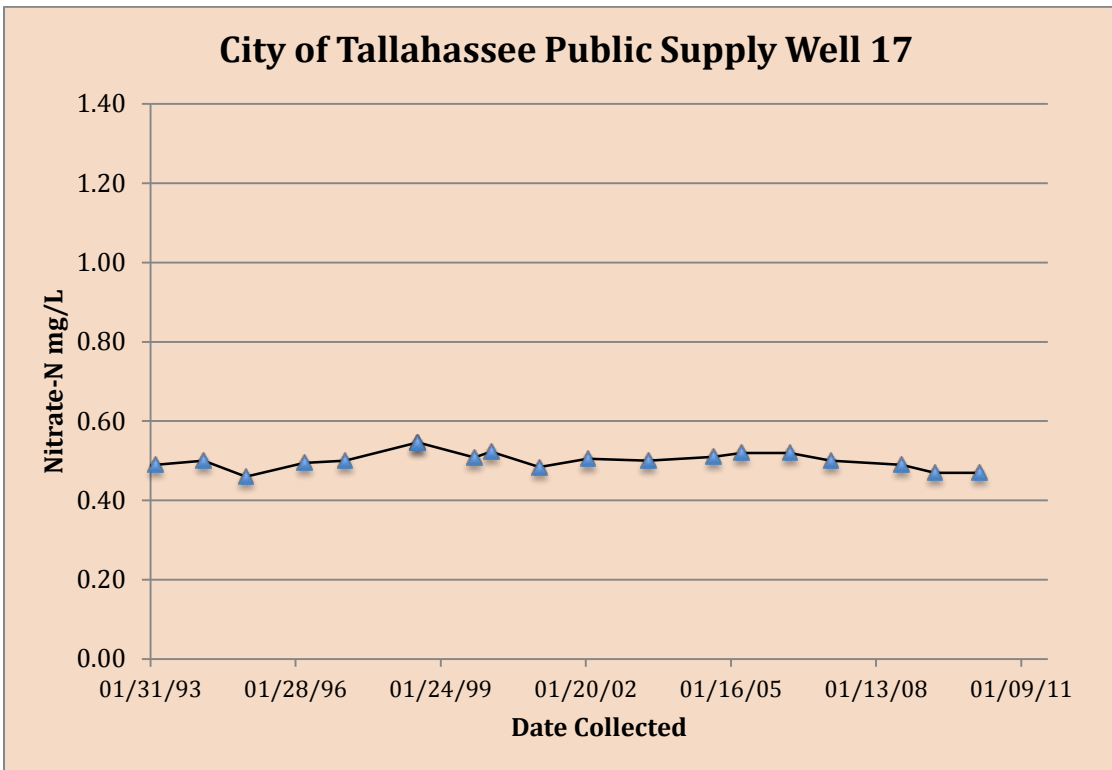


Figure 2



6.0 ADDITIONAL DATA

During 1999 - 2000 the City of Tallahassee collected private well samples from 7 farm wells in Wakulla County. (Appendix 15) A total of 56 samples were collected from 9 different private wells. The average nitrate concentration was 3.08 mg/L with a range of 0.0 - 8.22 mg/L. This data is included on a separate tab in the excel file included with this report. It was not included in the database because of a lack of detailed well location and construction information. The information is important for understanding the impact of agricultural activities practiced in Wakulla County on local groundwater nitrate concentration.

7.0 LIST OF APPENDICES

Data sets used for the Wakulla addendum report are presented in Excel format for ease of use. For completeness and to allow users the ability to evaluate the data based on source, the data sets are compiled individually, and are available in statistical summaries.

APPENDIX NO.	DESCRIPTION	TYPE	EXCEL TAB LABEL
1	Permitted Public Water System (PWS) Nitrate Database From FDEP with QC and Z-Test Information	Spreadsheet w/Subtotals	APPENDIX 1 WAK FDEP PWS RAW+QC
2	Final Permitted PWS Nitrate Database From FDEP After Removal of Outliers	Spreadsheet	APPENDIX 2 WAK FINAL PWS
3	Summary Nitrate Statistics for Final PWS Database (Count, Average, Standard Deviation, Minimum, Maximum, Date Collected Range and Location Data)	Pivot Table	APPENDIX 3 WAK PWS PIVOT TABLE
4	Private Wells That Had Multi Year Sample Collections Nitrate Database From NFWFMD - Values Exceeding 0.35 mg/L Nitrate Highlighted	Spreadsheet	APPENDIX 4 WAK MULTI YEAR PRIV
5	Multi Year Sample Wakulla Private Well Nitrate Statistics (Count, Average, Minimum, Maximum, Date Collected Range and Location Data) Highlighted Averages Exceeding 0.35 mg/L	Pivot Table	APPENDIX 5 WAK PRIV PIVOT TABLE
6	Contour Map Summary Data Table With Average of PWS and Multi Year Private Data Used To Generate Wakulla Contours	Spreadsheet	APPENDIX 6 WAK CONTOUR DATA
7	Private Well With Only Single Sample Event - Data Obtained From NFWFMD	Spreadsheet	APPENDIX 7 WAK PW SINGLE SAMPLE

APPENDIX NO.	DESCRIPTION	TYPE	EXCEL TAB LABEL
8	Data from Appendix 2,4, & 7 Combined In One Spreadsheet. Nitrate Values Exceeding 0.35 mg/L Highlighted	Spreadsheet	APPENDIX 8 ALL WAK PWS & PW DB
9	Sopchoppy Public Supply Well #3 - Nitrate-N vs. Date Collected. 0.35 mg/L Indicated in Red	Chart	APPENDIX 9 CHART SOPCHOPPY 3
10	Sopchoppy Public Supply Well #4 - Nitrate-N vs. Date Collected. 0.35 mg/L Indicated in Red	Chart	APPENDIX 10 CHART SOPCHOPPY 4
11	Sopchoppy Public Supply Well #6 - Nitrate-N vs. Date Collected. 0.35 mg/L Indicated in Red	Chart	APPENDIX 11 CHART SOPCHOPPY 6
12	Sopchoppy Public Supply Well #7 - Nitrate-N vs. Date Collected. 0.35 mg/L Indicated in Red	Chart	APPENDIX 12 CHART SOPCHOPPY 7
13	Panacea Public Supply Well #4 - Nitrate-N vs. Date Collected. 0.35 mg/L Indicated in Red	Chart	APPENDIX 13 CHART PANACEA 4
14	Wakulla Regional Public Water System Supply Well #4 - Nitrate-N vs. Date Collected. 0.35 mg/L Indicated in Red	Chart	APPENDIX 14 CHART WAK REG WELL 4
15	Private Well Nitrate From City of Tallahassee Water Quality Lab - Wakulla Farms	Spreadsheet	APPENDIX 15 WAK PW FROM COT WQL
16	<i>Contour Map 1980 -2010 Average Nitrate Concentrations (mg/L as N) in Leon & Wakulla County Drinking Water Wells and Selected SE Farm Monitoring Wells</i>	Map	NA