

# Total Dissolved Solids Impact Assessment

April 2017 Exceedance at HCSW-1

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## Document Information

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# 1 Introduction

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This report was prepared as a component of the Horse Creek Stewardship Program (HCSP). The HCSP plan document requires that an “impact assessment” be conducted for any trigger level exceedances or water quality trends found while preparing the annual HCSP report. However, Mosaic has agreed in principle that it is a good idea to provide impact assessments proactively as requested by staff for the Peace River Manasota Regional Water Supply Authority (PRMRWSA) based on monthly monitoring data not yet incorporated into an annual report.

As part of the HCSP, Mosaic monitors four locations monthly on Horse Creek for a number of water quality parameters. Most of the monitored parameters have trigger levels or thresholds that are used by all parties to determine if water quality conditions warrant further investigation as per the HCSP agreement or is acceptable and requiring no further action. The trigger level for total dissolved solids (TDS) is exceeded if concentrations are observed above 500 mg/L; the trigger value for TDS is a conservative threshold that was originally set for the HCSP based on the Florida Class I Potable Water standard for TDS, which does not normally apply in Class III waters like Horse Creek at HCSW-1. This impact assessment is related to the event in April 2017, where TDS at HCSW-1 at State Road 64 exceeded the trigger level with a reported concentration of 524 mg/L. This reported measurement is the only known exceedance of TDS at HCSW-1 since the implementation of the HCSP in 2003.

Mosaic’s NPDES WIN-004 (previously known as FTG-004) and FTG-003 outfalls both discharge to Horse Creek upstream of HCSW-1. The WIN-004 outfall was not discharging to Horse Creek during the April 11, 2017 sampling event (or the previous three months); the last discharge from that outfall was from March 1 to December 8, 2016. There has been no discharge from FTG-003 since July 2009.

The HCSP TDS sampling data are presented below. Additional TDS measurements that were recorded by other agencies during HCSP monthly sampling events through June 2017 are also included.

## 2 Total Dissolved Solids Background

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TDS is a measure of the amount of inorganic and organic matter (in small amounts) dissolved in water. In Florida, inorganic constituents of TDS concentrations typically consist of calcium, magnesium, sodium, as well as bicarbonate alkalinity/calcium, silicon, and sulfate; together, these major constituents occur mainly in ionic form and normally comprise more than 90% of the TDS in groundwater solutions (SWFWMD 1990). TDS is closely related to specific conductivity, which is the ability of a substance to conduct an electrical current (depending on differing ions and levels, hardness, and other parameters found in the water solution); therefore, higher TDS measurements typically coincide with higher specific conductivity readings (WHO 2003). TDS of freshwater ranges from 0 to 1000 mg/L (SWFWMD 1990) and typically originates from natural sources, i.e., geology of the area; concentrations can also be elevated due to anthropogenic impacts (sewage, urban and agriculture run-off, and industrial wastewater) (WHO 2003).

When the HCSP was being developed, there was no applicable Class III surface water standards for TDS, so the HCSP trigger level of 500 mg/L was based on the drinking water standard because of the PRMRWSA Facility located downstream in the Peace River. There still is no Class III Freshwater surface water standard for TDS in Florida; however, the Class I Drinking Water standard for TDS is 500 mg/L as a monthly average, with a daily maximum of 1000 mg/L. While the April 2017 HCSP trigger level of 500 mg/L for TDS was exceeded, it would not violate any Class III Standards as there are currently none in place for this parameter.

## 3 Results and Discussion

### 3.1 History of Total Dissolved Solids at HCSW-1

Water quality data was collected by Mosaic monthly from April 2003 through June 2017 at all four HCSP locations. Horse Creek at State Road 64 was also sampled by the Southwest Florida Water Management District (SWFWMD). Table 1 shows summary statistics for TDS as measured at all four HCSP stations (including SWFWMD data at SR64). TDS has previously never been above the trigger level of 500 mg/L at HCSW-1, although it has previously been measured above 500 mg/L at HCSW-3 and HCSW-4 during dry periods because of higher baseflow contributions and increased agriculture irrigation run off. Table 2 shows all TDS measurements recorded at each of the four HCSP monthly monitoring stations since the implementation of the Stewardship Program.

Figures 1 to 4 show the pattern of TDS at HCSP stations over time. Figures 1 and 2 show the HCSP data time series of TDS concentration at all four stations, with Figure 1 showing the period of record and Figure 2 focusing on 2014 to June 2017. Over the period of record, HCSW-1 generally follows the same peaks and valleys in TDS concentrations as HCSW-3 and HCSW-4, but at a smaller magnitude (Figures 1 and 2). The larger peaks are generally in the later dry season months of February to May, sometimes continuing into June (Figure 1), but do not always occur in the same month, which prevents the box plots<sup>1</sup> from showing a more defined pattern (Figures 3 and 4). However, it is evident that TDS concentrations at HCSW-4 are historically generally higher than those recorded at HCSW-1 (Figure 4); this can be attributed to HCSW-4's location within the Horse Creek basin. HCSW-4 appears to receive more groundwater influence and gets more agriculture run-off than HCSW-1. Some of the elevated TDS concentrations observed during wet season months at HCSW-1 that were not in synch with measurements at HCSW-3 or HCSW-4, occurred during times of NPDES discharge. This was because the majority of the discharge from WIN-004 comes from groundwater (see Appendix I of the HCSP 2014 Annual Report). However, even though HCSW-1 is closer to the WIN-004 outfall, it sees generally lower TDS concentrations than downstream stations HCSW-3 and HCSW-4.

The TDS levels at HCSP monthly sampling station HCSW-1 were also compared to those taken by the SWFWMD station Horse Creek at SR64 as a time series (Figure 5) and monthly box plot (Figure 6). The HCSP and SWFWMD generally agree over the period of record, so it is unlikely that the April 2017 HCSP trigger exceedance is from a laboratory bias.

**Table 1. Summary statistics of TDS levels at HCSP monthly sampling stations and SWFWMD at SR64 from April 2003 to June 2017.**

Summary Statistic	SWFWMD	HCSW-1	HCSW-2	HCSW-3	HCSW-4
	State Road 64	State Road 64	Goose Pond Rd	State Road 70	State Road 72
Minimum	96	93	54	70	44
Median	209	219	205.5	291	372
Mean	226.6	233.2	208.5	324.1	380.9
Maximum	432	524	448	818	1320

<sup>1</sup> The box represents the 25-75% range with the whiskers representing the 5-95% range. The median is represented by a horizontal line within the box.

**Table 2. All recorded TDS levels at HCSP monthly sampling stations from April 2003 to June 2017.**

Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4	Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4
	State Road 64	Goose Pond Rd	State Road 70	State Road 72		State Road 64	Goose Pond Rd	State Road 70	State Road 72
4/30/2003	167	160	219	330	6/22/2005	120	110	110	130
5/27/2003	199	159	185	195	7/27/2005				
6/19/2003	158	168	185	267	8/23/2005	120	82	86	100
7/14/2003	222	156	202	214	9/29/2005	98	110	180	210
8/28/2003	126	90	108	144	10/27/2005	110	110	130	160
9/25/2003	165	116	134	159	11/17/2005	98	96	92	130
10/29/2003	168	164	238	275	12/20/2005	120	150	160	200
11/20/2003	102	86	136	196	1/30/2006	120	54	200	250
12/16/2003	155	133	318	407	2/23/2006	140	130	260	280
1/29/2004	146	138	243	292	3/28/2006	160	150	460	600
2/24/2004	177	146	195	247	4/27/2006	170	150	580	450
3/16/2004	94	107	157	202	5/25/2006		150		560
4/14/2004	93	108	312	447	6/29/2006	180	170	590	1100
5/26/2004	175	145	298	420	7/27/2006	160	380	300	420
6/29/2004	180	153	270	400	8/21/2006	150	200	180	260
7/27/2004	163	154	189	241	9/27/2006	110	110	130	130
8/30/2004	139	118	143	167	10/19/2006	110	110	180	210
9/29/2004	128	107	116	135	11/9/2006	160	130	390	510
10/27/2004	134	107	132	152	12/13/2006	120	140	420	550
11/18/2004	199	173	256	320	1/23/2007	130	170	300	400
12/15/2004	190	150	260	290	2/14/2007	170	180	330	370
1/26/2005	160	62	70	44	3/14/2007	150	180	320	410
2/24/2005	140	110	240	270	4/25/2007	250	140	590	420
3/30/2005	190	110	110	130	5/16/2007	330	150	530	260
4/27/2005	100	130	200	220	6/20/2007	280	170	700	600
5/25/2005	130	92	120	140	7/18/2007	240	210	520	530



Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4	Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4
	State Road 64	Goose Pond Rd	State Road 70	State Road 72		State Road 64	Goose Pond Rd	State Road 70	State Road 72
8/27/2007	390	420	430	450	11/3/2009	212	256	352	372
9/26/2007	280	210	350	380	12/2/2009	216	280	524	604
10/29/2007	230	210	300	400	1/5/2010	384	308	324	380
11/29/2007	300	220	340	410	2/2/2010	380	272	332	388
12/17/2007	230	210	410	470	3/3/2010	388	272	276	332
1/30/2008	220	230	460	550	4/6/2010	356	220	228	244
2/26/2008	180	180	330	420	5/5/2010	444	272	268	316
3/27/2008	170	170	360	660	6/2/2010	172	200	252	276
4/23/2008	200	170	380	420	7/12/2010	240	188	176	192
5/29/2008		180	460	710	8/3/2010	284	219	202	268
6/26/2008	172	316	580	644	9/8/2010	329	229	221	235
7/31/2008	272	292	324	348	10/6/2010	451	329	306	318
8/26/2008	288	232	204	264	11/3/2010	204	363	467	577
9/30/2008	212	168	152	148	12/7/2010	182	302	424	435
10/16/2008	228	184	244	152	1/4/2011	216	292	513	574
11/12/2008	232	228	364	368	2/3/2011	234	246	275	373
12/4/2008	188	240	488	456	3/2/2011	207	249	358	464
1/5/2009	212	220	448	440	4/5/2011	180	226	257	391
2/2/2009	212	216	520	536	5/3/2011	218	212	289	422
3/4/2009	220	268	460	404	6/8/2011				473
4/1/2009	220	264	568	432	7/5/2011	362	369	347	660
5/4/2009				380	8/16/2011	208	242	282	431
6/3/2009	360	388	540	692	9/7/2011	356	221	234	248
7/8/2009	312	264	284	332	10/24/2011	389	270	266	273
8/5/2009	356	224	240	276	11/29/2011	201	288	355	373
9/2/2009	304	156	192	192	12/21/2011	253	309	543	543
10/7/2009	404	180	176	188	1/12/2012	209	294	571	569

Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4	Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4
	State Road 64	Goose Pond Rd	State Road 70	State Road 72		State Road 64	Goose Pond Rd	State Road 70	State Road 72
2/2/2012	216	288	532	512	5/1/2014	223		435	544
3/5/2012	207	287	603	585	6/3/2014	245		548	715
4/2/2012	241	304	714	688	7/1/2014	250		518	580
5/2/2012		325		536	8/6/2014	242	286	350	468
6/5/2012	259		646	1320	9/3/2014	199	216	234	316
7/5/2012	207	197	215	269	10/6/2014	187	165	169	188
8/2/2012	171	183	212	265	11/4/2014	225	206	278	327
9/5/2012	301	171	177	186	12/2/2014	208	205	243	319
10/10/2012	248	164	205	195	1/7/2015	239	209	291	378
11/6/2012	323	269	295	316	2/3/2015	233	202	227	300
12/5/2012	189	273	435	444	3/5/2015	231	207	278	377
1/9/2013	211	255	385	466	4/8/2015	223	202	454	521
2/7/2013	214	262	459	488	5/11/2015		198	400	571
3/6/2013	253	273	643	660	6/3/2015	306		451	504
4/2/2013	233	265	818	595	7/6/2015	381	272	254	275
5/1/2013	187	344	648	614	8/6/2015	335	213	204	230
6/4/2013	219	290	675	687	9/2/2015	283	122	137	153
7/2/2013	296	262	269	278	10/5/2015	272	204	210	238
8/1/2013	295	185	206	212	11/3/2015	357	215	234	257
9/4/2013	230	192	191	236	12/3/2015	274	233	307	311
10/1/2013	319	185	172	183	1/25/2016	203	138	138	162
11/4/2013	194	235	384	478	2/23/2016	234	182	213	238
12/3/2013	219	244	528	617	3/7/2016	306	191	236	319
1/2/2014	196		497	601	4/6/2016	363	270	272	299
2/3/2014	242	247	454	799	5/5/2016	335	272	336	443
3/3/2014	205	256	364	498	6/7/2016	235	208	260	284
4/1/2014	214	220	336	555	7/7/2016	290	200	197	219

Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4	Date	HCSW-1	HCSW-2	HCSW-3	HCSW-4
	State Road 64	Goose Pond Rd	State Road 70	State Road 72		State Road 64	Goose Pond Rd	State Road 70	State Road 72
8/4/2016	241	156	159	182	2/15/2017	438	297	371	464
9/8/2016	238	178	174	203	3/7/2017	467		536	635
10/18/2016	317	214	213	240	4/11/2017	524		527	853
11/7/2016	383	277	311	389	5/10/2017				
12/13/2016	345	334	352	372	6/19/2017	302	448	390	370
1/10/2017	332		482	453					

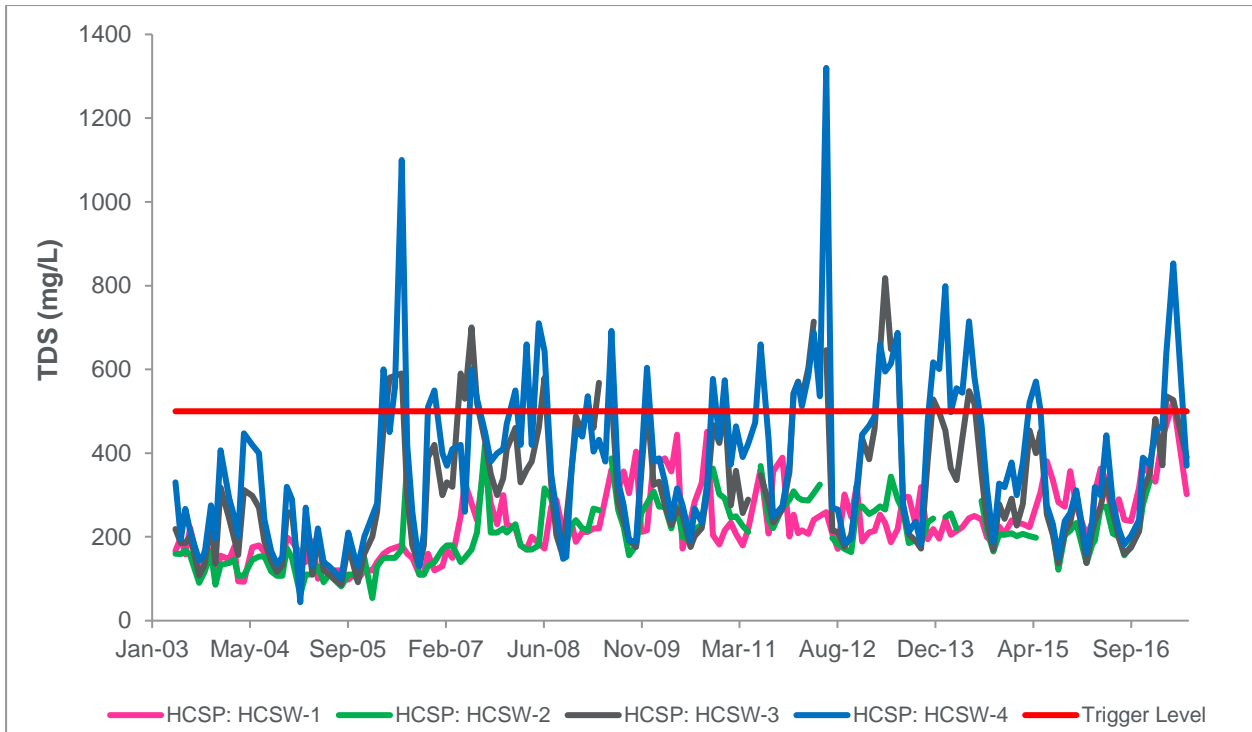


Figure 1. Measured TDS at HCSW monthly sampling stations from April 2003 to June 2017.

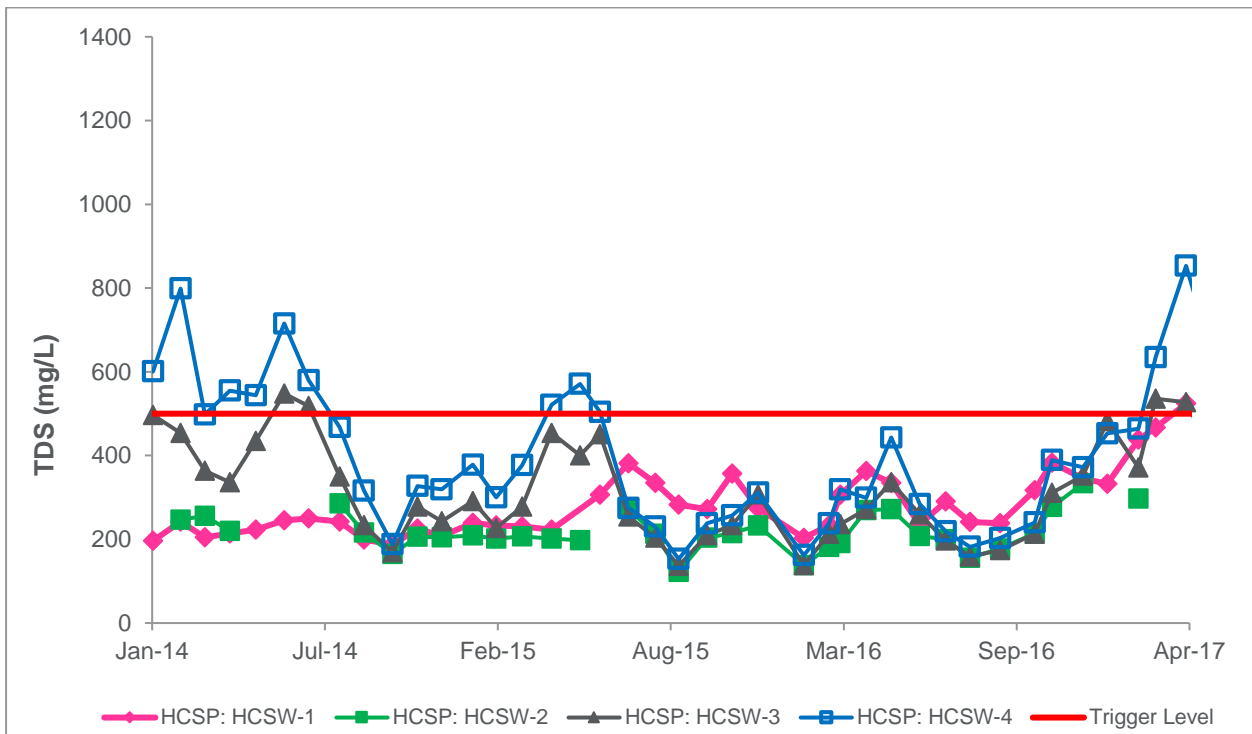
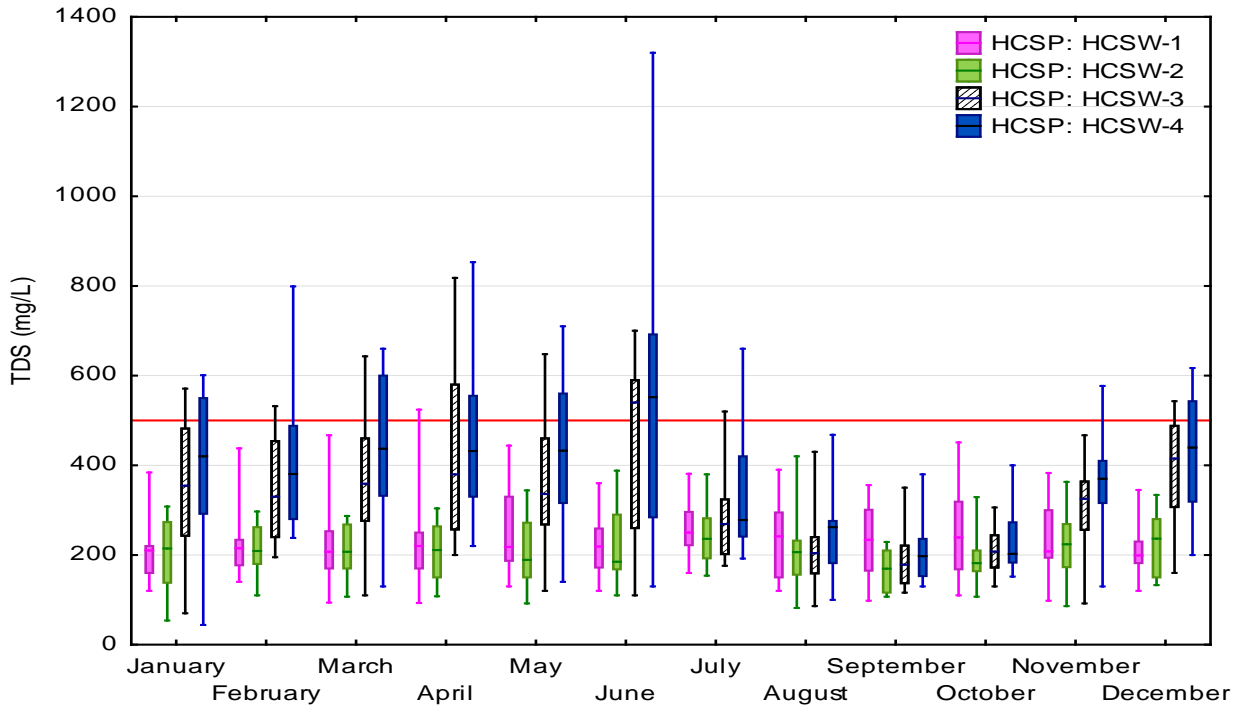
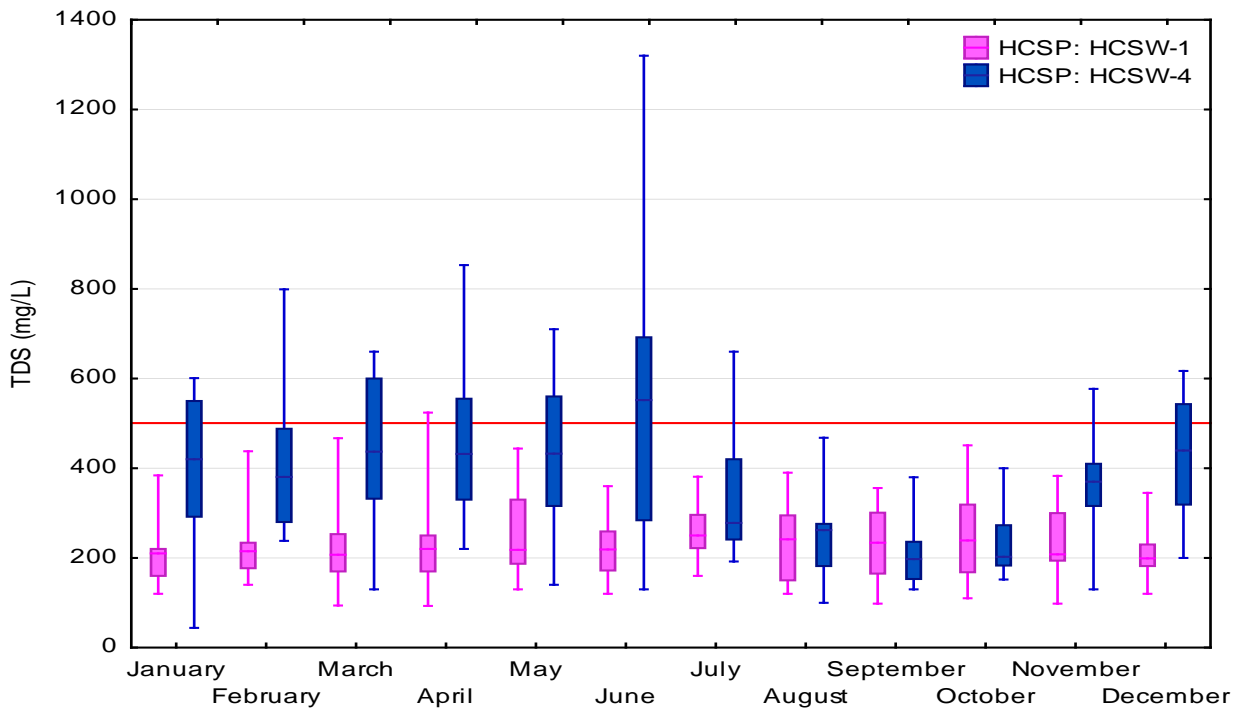


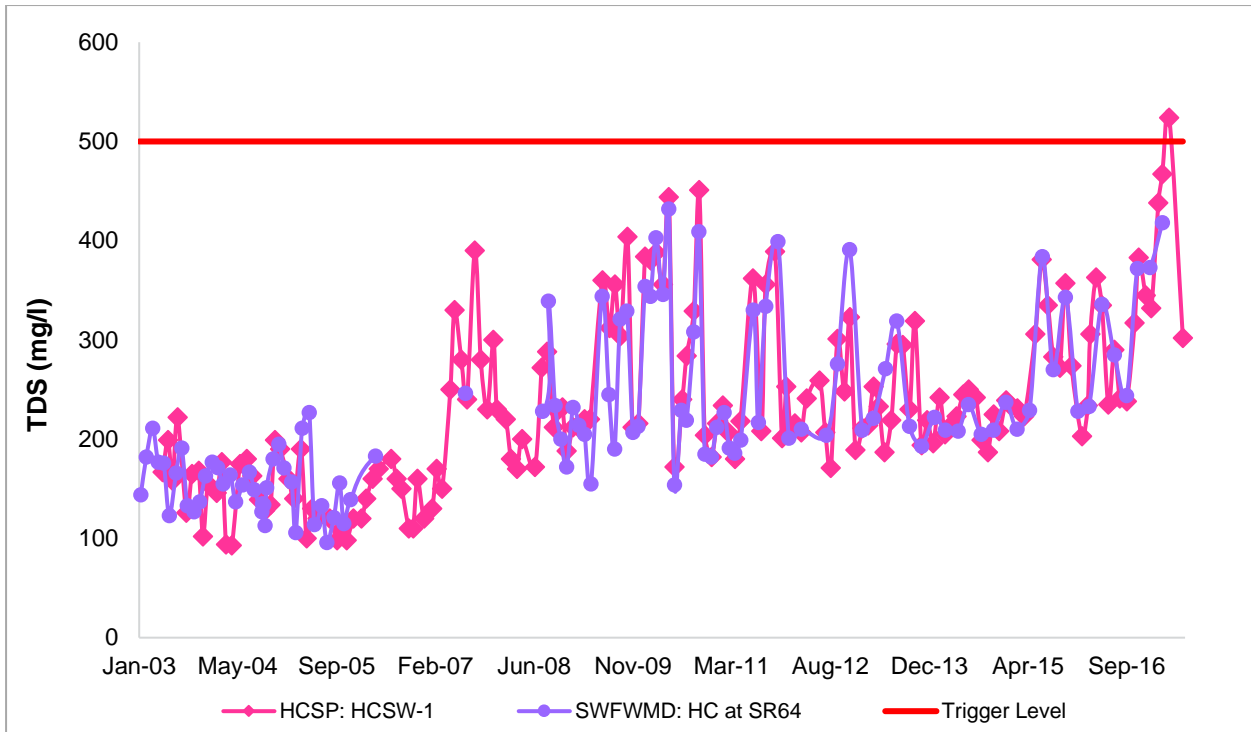
Figure 2. Measured TDS at HCSW monthly sampling stations from January 2014 to June 2017.



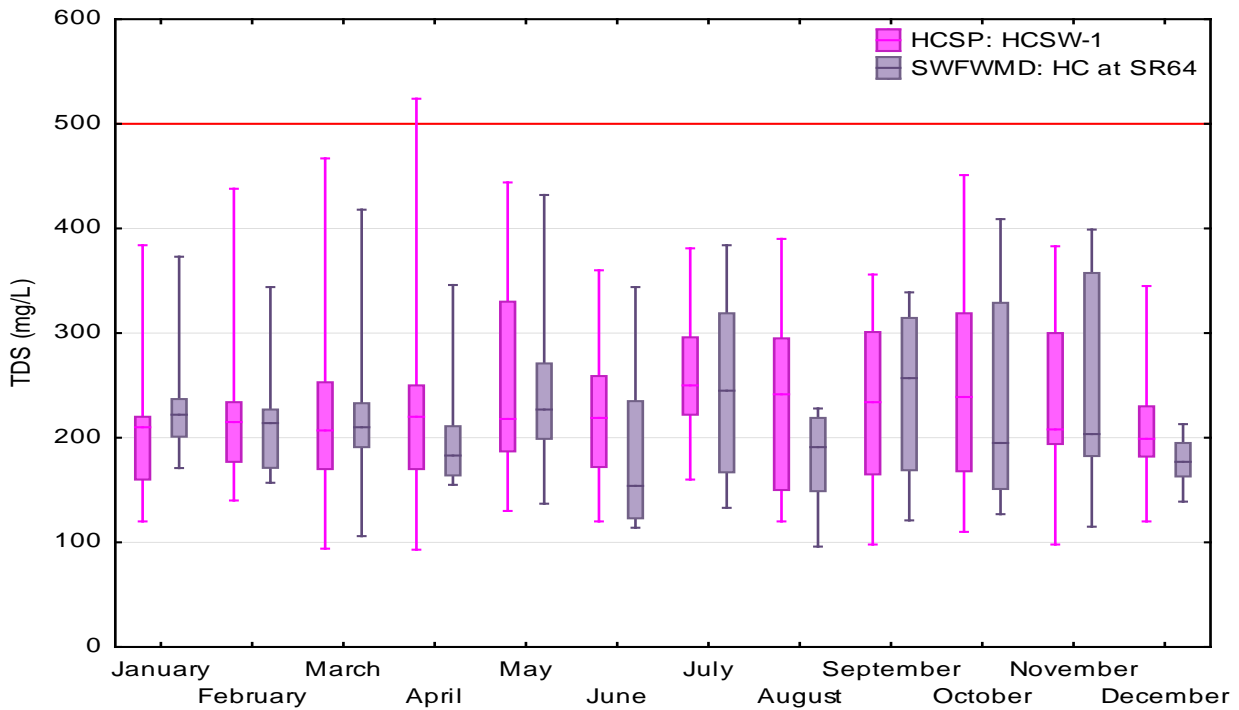
**Figure 3. Box plot of TDS measurements (grouped by month) collected at four HCSW monthly sampling stations from 2003 to 2017.**



**Figure 4. Box plot of TDS measurements (grouped by month) collected at HCSW monthly sampling stations HCSW-1 and HCSW-4 from 2003 to 2017.**



**Figure 5. Measured TDS at HCSW monthly sampling station HCSW-1 and SWFWMD at SR64 from January 2003 to June 2017.**



**Figure 6. Multi-Box plot of TDS measurements (grouped by month) collected at HCSW monthly sampling station HCSW-1 and by SWFWMD at SR64 from 2003 to 2017.**

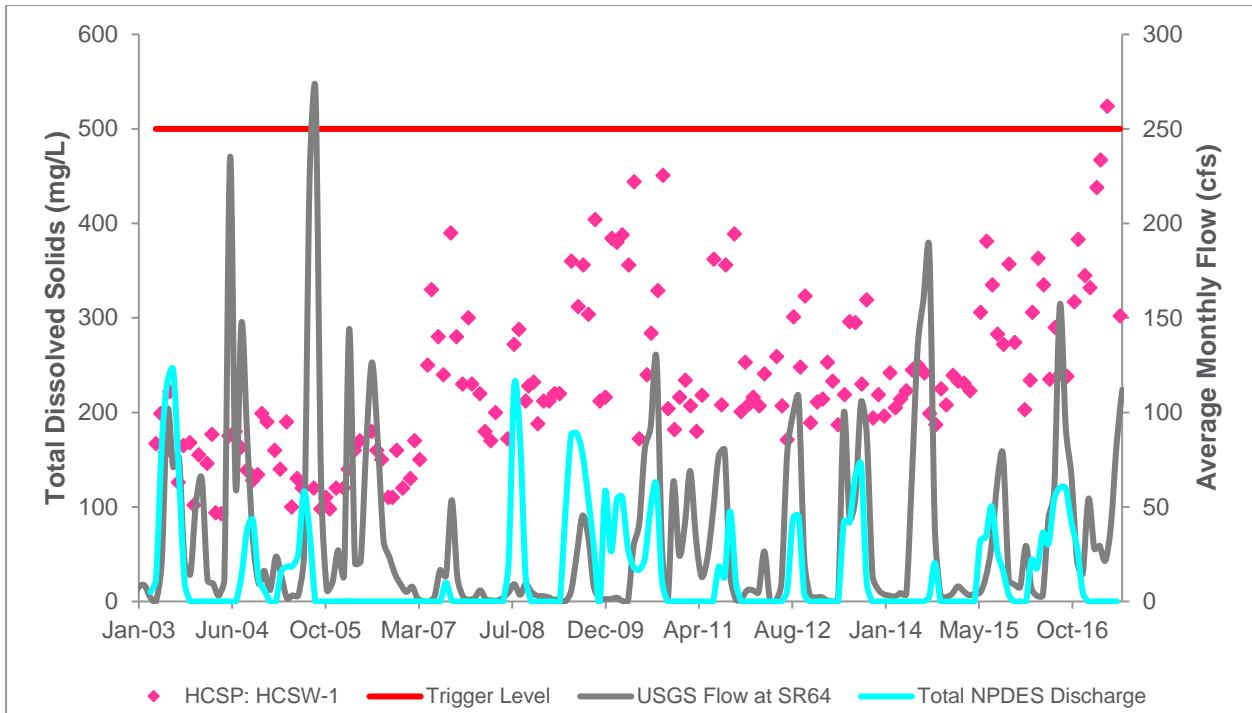
### 3.2 Total Dissolved Solids and Water Quantity

For comparison purposes, all data collected at HCSW-1 and HCSW-4 by Mosaic were graphed alongside streamflow data collected by USGS at SR 64 and NPDES discharge data from Mosaic outfalls on Horse Creek. High TDS values are sometimes associated with periods of low streamflow (April to June 2007), or near the end of the dry season where there may be more groundwater influence through baseflow or irrigation runoff, as in 2006, 2014, and the end of the dry season in 2017 (Figures 7 and 8).

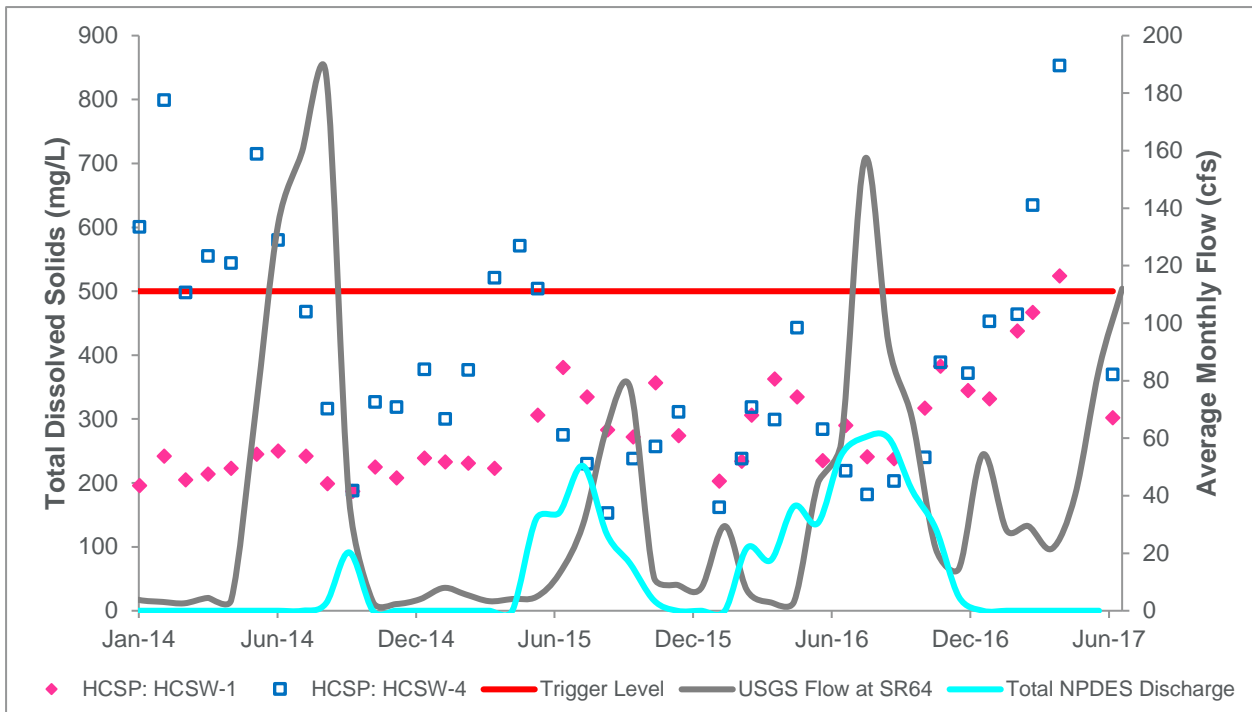
When TDS at HCSW-1 and HCSW-4 was graphed against total monthly rainfall collected both by Mosaic, it appears that periods with higher rainfall totals, i.e., wet seasons, experienced lower TDS levels while periods with drier conditions typically resulted in higher TDS concentrations; this increase was likely caused by an increased proportion of natural baseflow (groundwater influence) with less rain water dilution during those unusually dry time periods (Figures 9 and 10).

In 2017, TDS concentrations began to increase at all four HCSP stations in February and continued to increase through the dry season until the stream was too dry to sample in May (Table 2, Figure 2). In June 2017, there was enough rainfall to start the stream flowing once more (Figure 10), and TDS concentrations decreased to levels seen in December 2016 and January 2017 (Table 2 and Figure 2). During the time period when TDS was increasing (February to April 2017) or the stream was not flowing (May 2017), there was no NPDES discharge into Horse Creek and streamflow was low (Figure 8). The increase in TDS during this time period of low rainfall, low streamflow, and no NPDES discharge is likely caused by an increased proportion of natural baseflow (groundwater influence) with less rain water dilution, as seen previously at this station.

The general increase in TDS over the period of record, and more recently from June 2015 through present which can be visually observed in Figures 7 through 10 will be discussed in more detail in the 2016 and 2017 Annual Reports (trend analysis results or Appendix I). Any trends overall in the TDS data have been discussed in the trend analysis of specific conductivity data in previous reports (see 2010 to 2014 HCSP Annual Reports). Additional discussion on the increases in TDS will be included in the 2016 and 2017 Annual Reports.

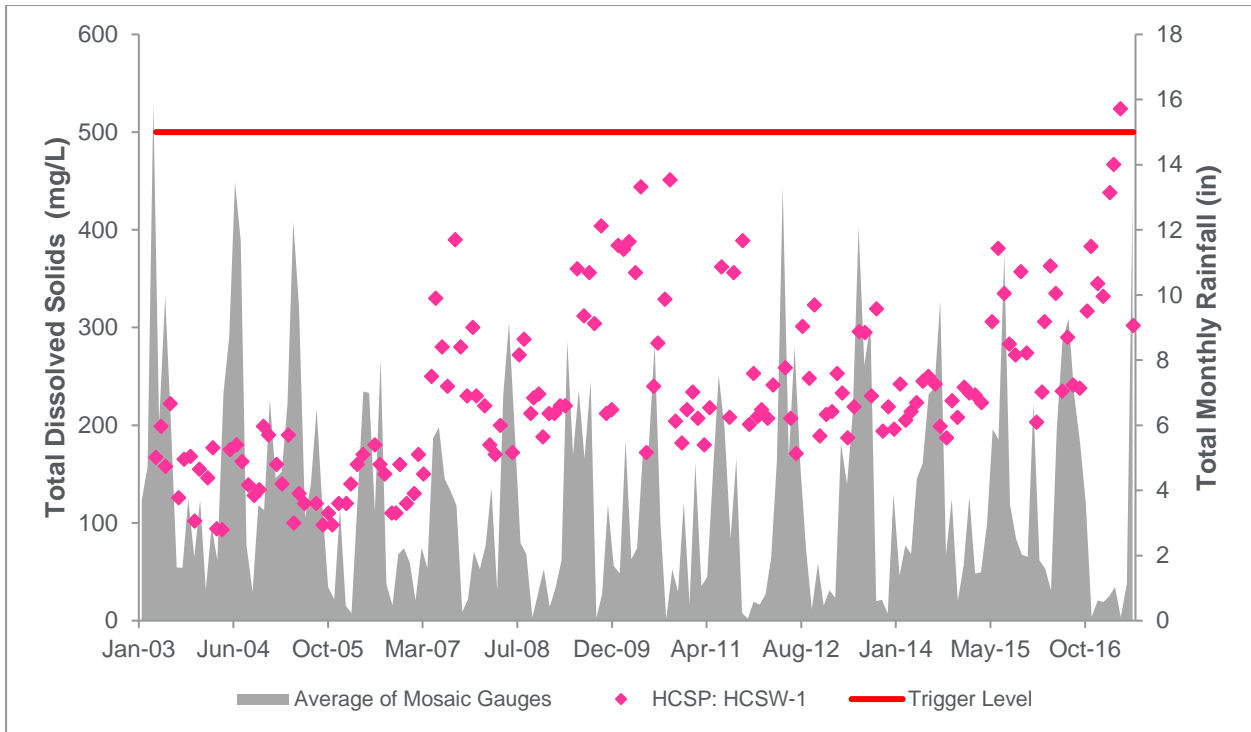


**Figure 7.** TDS measurements at HCSW-1 from April 2003 to June 2017, along with average monthly streamflow at SR64 and total NPDES discharge (Outfalls 003 and 004).

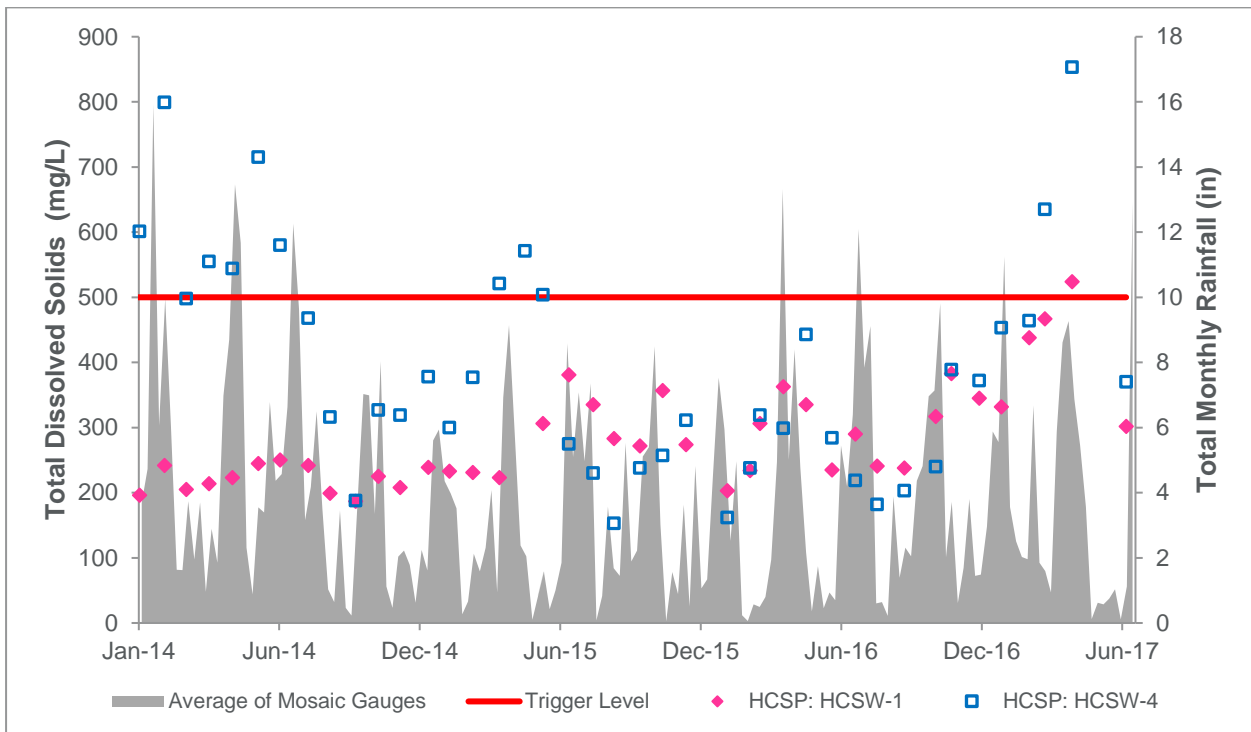


**Figure 8.** TDS measurements at HCSW-1 from January 2014 to June 2017, along with average monthly streamflow at SR64 and total NPDES discharge (Outfalls 003 and 004).





**Figure 9. Measured TDS at HCSP monthly sampling station HCSW-1 compared to average sum of monthly rainfall at all Mosaic rain gauges from April 2003 to June 2017.**



**Figure 10. Measured TDS at HCSP monthly sampling station HCSW-1 compared to average sum of monthly rainfall at all Mosaic rain gauges from January 2014 to June 2017.**

## 4 Conclusions

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In April 2017, the TDS HCSP trigger level was exceeded at HCSP monthly sampling station HCSW-1 (524 mg/L), the first exceedance for this site since the beginning of the Horse Creek Stewardship Program. In 2017, TDS concentrations began to increase at all four HCSP stations in February and continued to increase through the dry season until the stream was too dry to sample in May. In June 2017, there was enough rainfall to start the stream flowing once more, and TDS concentrations decreased to levels seen in December 2016 and January 2017. During the time period when TDS was increasing (February to April 2017) or the stream was not flowing (May 2017), there was no NPDES discharge into Horse Creek and streamflow was low. Therefore, the increase in TDS during this time period of low rainfall, low streamflow, and no NPDES discharge is likely caused by an increased proportion of natural baseflow (groundwater influence) with less rain water dilution, as seen previously at this station.

Because an NPDES discharge did not occur for approximately four months prior to the April 2017 TDS exceedance, it can be concluded that the exceedance in question was almost certainly due to low base flow with groundwater intrusion attributing to the exceeding TDS level near HCSW-1. The April 2017 TDS exceedance raises no concern at this time.

## 5 References

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- Southwest Florida Water Management District (SWFWMD). 1990. Ground Water Quality of the Southwest Florida water Management District: Southern Region, Section 2. pp. 185–186. Prepared by the Ambient Ground-Water Quality Monitoring Program in cooperation with the Florida Department of Environmental Regulation. 185.
- World Health Organization (WHO). 2003. Total dissolved solids in Drinking-water: Background document for development of *WHO Guidelines for Drinking-water Quality*.