Chlorophyll a Impact Assessment

February 2010 Exceedance at HCSW-1

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SECTION 1

Background

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, this assessment is being proactively provided at the request of Sam Stone of 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 that are set to track conditions in the stream. The trigger level for chlorophyll a is exceeded above 15 mg/m^3. In February 2010, chlorophyll a at HCSW-1 at State Road 64 (15.4 mg/ m^3) exceeded the trigger level. Chlorophyll a collected at the other three stations was not above the trigger level. All of the HCSP chlorophyll a sampling data is presented below in Table 1 and Figure 1 (including March 2010 data).

Table 1. All recorded chlorophyll a levels at Horse Creek Stewardship Program monthly sampling stations from April 2003 to March 2010.

Date	HCSW-1 State Road 64	HCSW-2 Goose Pond Rd	HCSW-3 State Road 70	HCSW-4 State Road 72
4/30/2003	1.00	4.00	1.00	1.00
5/27/2003	1.00	5.00	1.00	1.00
6/19/2003	1.00	4.00	1.00	1.00
7/14/2003	1.00	7.00	1.00	1.00
8/28/2003	1.00	1.00	1.00	1.00
9/25/2003	1.00	2.00	1.00	1.00
10/29/2003	2.00	6.00	1.00	1.00
11/20/2003	1.00	1.00	1.00	1.00
12/16/2003	5.00	2.00	1.00	1.00
1/29/2004	1.00	2.00	1.00	3.00
2/24/2004	1.00	4.00	1.00	1.00
3/16/2004	3.00	8.00	1.00	1.00
4/14/2004	1.00	16.00	1.00	1.00
5/26/2004	2.00	21.00	2.00	1.00
6/29/2004	1.00	10.00	1.00	1.00
7/27/2004	1.00	6.00	1.00	1.00
8/30/2004	1.00	35.00	38.00	13.00
9/29/2004	2.00	7.00	3.00	3.00
10/27/2004	1.00	7.00	3.00	4.00
11/18/2004	1.00	6.00	5.00	2.00
12/15/2004	1.00	1.00	2.10	2.10
1/26/2005	1.00	2.00	2.90	1.90
2/24/2005	1.00	4.80	5.30	4.50
3/30/2005	1.00	1.20	1.69	1.20
4/27/2005	1.00	6.10	9.00	7.90
5/25/2005	1.00	17.00	7.50	4.80
6/22/2005	1.00	1.70	1.00	2.40
7/27/2005	1.00	3.40	3.70	3.50
8/23/2005	2.60	3.50	1.00	3.40
9/29/2005	2.10	3.20	1.20	2.50
10/27/2005	1.00	17.00	15.00	7.30

	HCSW-1	HCSW-2	HCSW-3	HCSW-4
11/17/2005	1.00	1.00	1.00	1.00
12/20/2005	1.00	1.00	1.40	1.00
1/30/2006	4.10	4.80	3.70	2.90
2/23/2006	13.00	23.00	2.10	3.20
3/28/2006	2.10	30.00	5.00	1.80
4/27/2006	2.50	9.00	3.00	7.10
5/25/2006		32.00		2.60
6/29/2006	2.10	45.00	2.90	2.90
7/27/2006	3.10	9.20	3.10	2.60
8/21/2006	2.50	20.00	4.00	2.60
9/27/2006	1.30	5.90	4.00	2.60
10/19/2006	1.60	1.40	1.00	1.00
11/9/2006	3.70	1.00	2.20	1.40
12/13/2006	1.00	1.80	1.00	1.00
1/23/2007	2.20	5.80	2.20	1.30
2/14/2007	1.30	3.10	1.40	3.10
3/14/2007	2.40	10.00	2.00	2.40
4/25/2007	2.00	7.30	2.00	3.60
5/16/2007	2.00	25.00	2.00	2.60
6/20/2007	2.00	110.00	2.00	2.00
7/18/2007	2.00	17.00	2.00	2.00
8/27/2007	2.20	14.00	2.00	2.00
9/26/2007	13.00	9.00	2.00	2.00
10/29/2007	2.00	4.50	2.00	2.00
11/29/2007	2.00	3.50	2.00	2.00
12/17/2007	2.00	3.10	2.00	2.00
1/30/2008	2.00	2.00	2.00	2.00
2/26/2008	2.00	2.00	2.00	2.00
3/27/2008	2.00	2.70	2.00	2.00
4/23/2008	2.00	2.00	2.00	2.00
5/29/2008		2.00	2.00	2.00
6/26/2008	1.00	1.00	1.00	1.00
7/31/2008	1.57	22.60	4.36	1.64
8/26/2008	0.73	7.03	5.26	1.84
9/30/2008	0.73	5.78	4.65	2.26
10/16/2008	0.43	6.99	2.28	1.08
11/12/2008	0.77	8.56	1.56	0.53
12/4/2008	1.39	8.68	3.66	2.59
1/5/2009	1.13	24.90	1.89	1.32
2/2/2009	1.48	8.14	1.38	1.31
3/4/2009	0.56	2.11	1.48	0.68
4/1/2009	1.96	21.70	0.95	1.35
5/4/2009				1.81
6/3/2009	3.20	3.53	5.89	1.86
7/8/2009	3.84	6.48	4.06	1.40
8/5/2009	2.71	2.12	1.65	1.58
9/2/2009	0.92	4.80	7.22	1.61
10/7/2009	2.94	2.26	2.26	2.13
11/3/2009	1.08	10.10	2.06	0.80
12/2/2009	0.55	9.18	1.76	2.32
1/5/2010	1.59	1.22	1.22	1.11
2/2/2010	15.40	1.81	1.30	1.80
3/5/2010	0.79	0.74	0.89	0.75

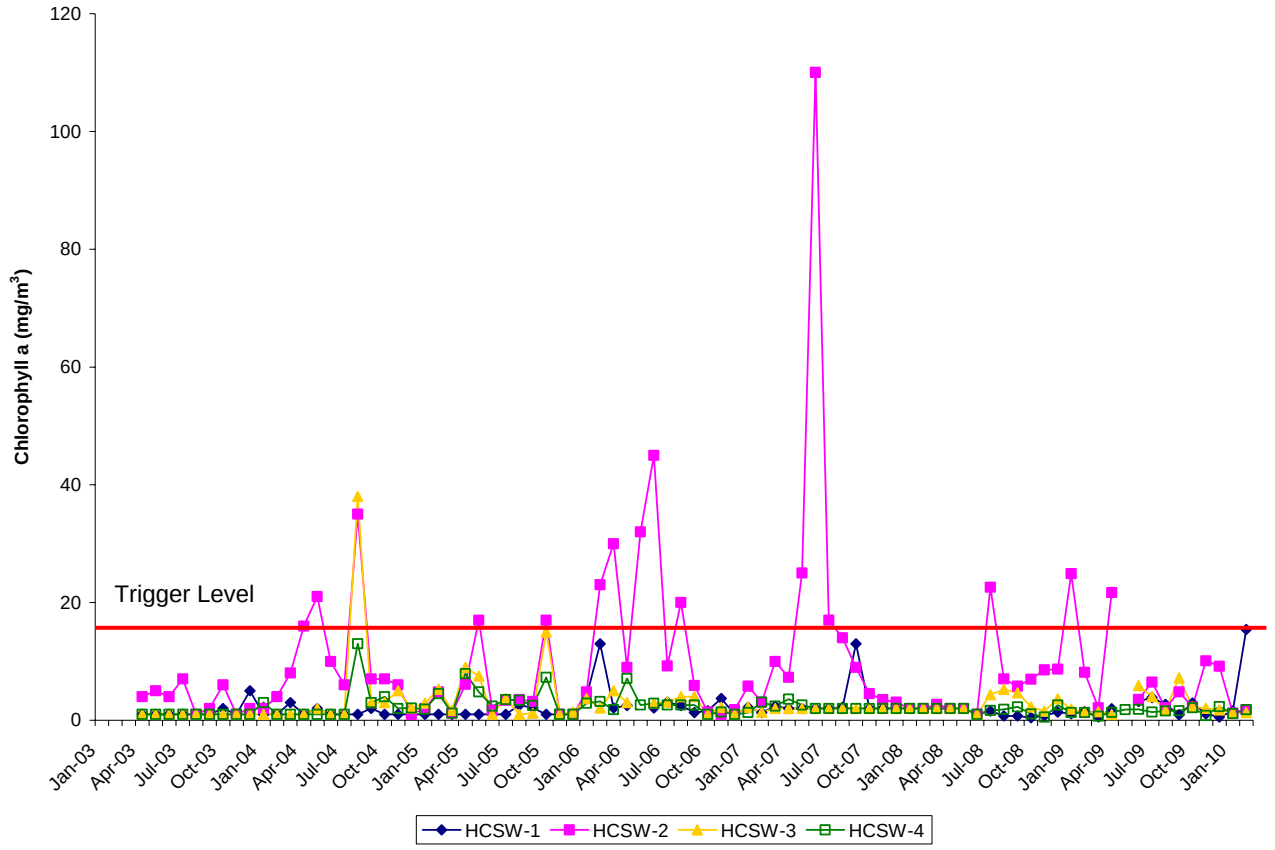

Figure 1. Measured chlorophyll a at Horse Creek Stewardship Program monthly sampling stations from April 2003 to March 2010.

The trigger level for chlorophyll a has been exceeded eighteen (18) times during the HCSP: February 2010 at HCSW-1, various months from 2004-2009 at HCSW-2, and August 2004 at HCSW-3 (Table 1, Figure 1). For three of the four HCSP stations, chlorophyll tends to remain close to the detection limit (1-2 mg/m^3) with occasional isolated peaks that usually last for only one monthly sample. Chlorophyll was also measured at 13 mg/m^3 (below the trigger level) on two occasions at HCSW-1: February 23, 2006, and September 26, 2007. There was no NPDES discharge occurring during or for three or more weeks prior to the events, indicating that NPDES discharge was not the source of chlorophyll during those events.

Chlorophyll a concentrations at HSCW-1 do not correlate with rainfall, streamflow, or gage height, but are weakly negatively correlated with NPDES average monthly discharge (Table 2, Figures 2 - 5). This means that chlorophyll levels at HCSW-1 are likely to be lower during times of NPDES discharge (Figure 5), probably because of the increased rainfall and streamflow that coincide with NPDES discharge events, as indicated by the near significant correlations with those other variables shown in Table 2. Thus, there is no indication that the volume or presence of NPDES discharge increases chlorophyll concentrations in Horse Creek. When the correlation analysis from Table 2 is run only during months with NPDES discharge, there was no significant correlation between chlorophyll a at HCSW-1 and any water quantity variables.

Chlorophyll a is only sampled at each NPDES outfall quarterly during times of discharge, as required under Mosaic's NPDES permit. Chlorophyll a concentrations at NPDES outfalls are not correlated with concentrations at HCSW-1, during months when both are sampled (Table 3). The outfall measurement for January 2010 (closest to HCSW-1 February exceedance) was 10.1 mg/m^3, below the HCSP trigger level. The

data available show no relationship between chlorophyll a concentrations in the discharge and those at HCSW-1 in Horse Creek.

Because the winter of 2009-2010 was an El Nino year, the NPDES discharge during January and February 2010 was higher than that of other years of the program (2004-2009). The most recent year that had NPDES discharge during these two months was 2003, and the SWFWMD-collected chlorophyll a concentrations were undetected (<1 mg/m^3).

Table 2. Spearman's correlation between chlorophyll a levels measured during Horse Creek Stewardship Program monthly sampling at HCSW-1 from April 2003 to March 2010 and SWFWMD rainfall, Mosaic NPDES discharge, and USGS monthly average streamflow and gauge height (provisional data from USGS website).

	Average Monthly USGS Streamflow	Average Monthly USGS Gauge Height	Total Monthly SWFWMD Rainfall	Average Monthly NPDES Discharge
	(cfs)	(ft)	(in)	(ft)
r^2	-0.22	-0.20	-0.21	-0.23
p	0.052	0.081	0.054	0.041
N	81	80	81	81

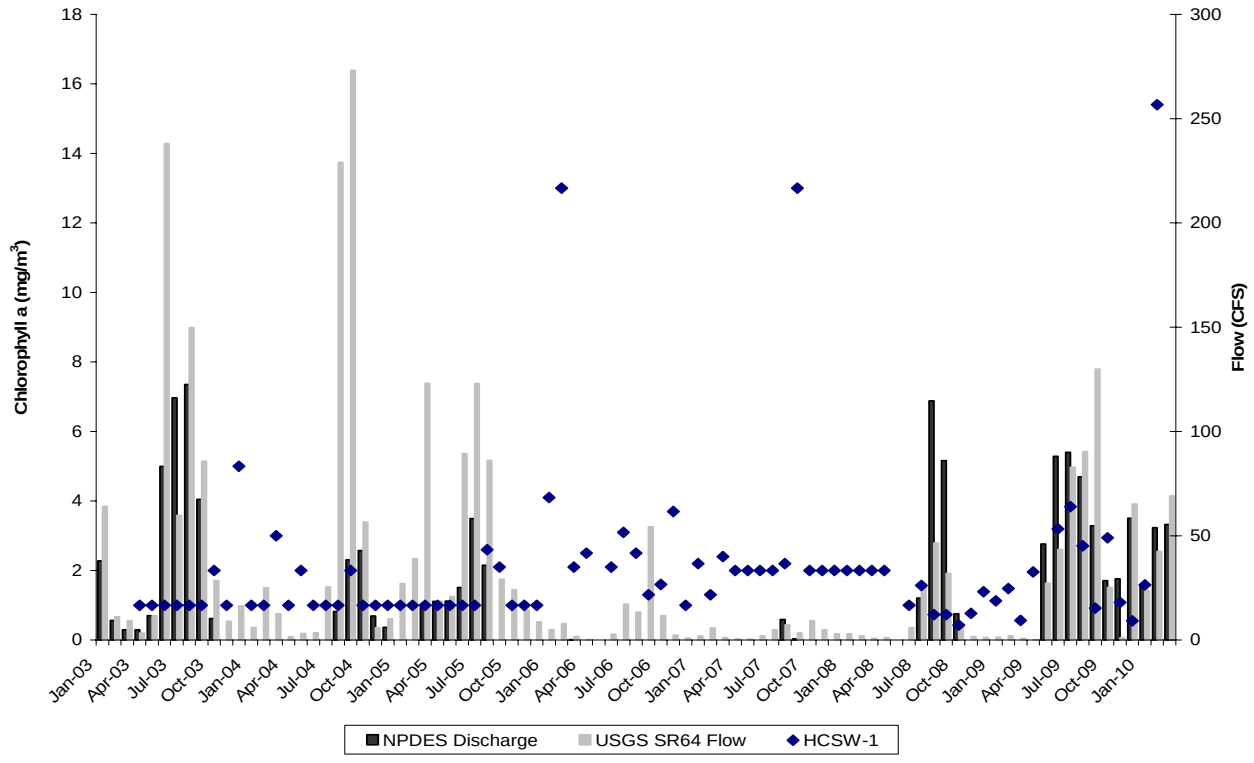

Figure 2. Measured chlorophyll a at Horse Creek Stewardship Program HCSW-1 from April 2003 to March 2010, along with monthly average NPDES discharge and USGS streamflow.

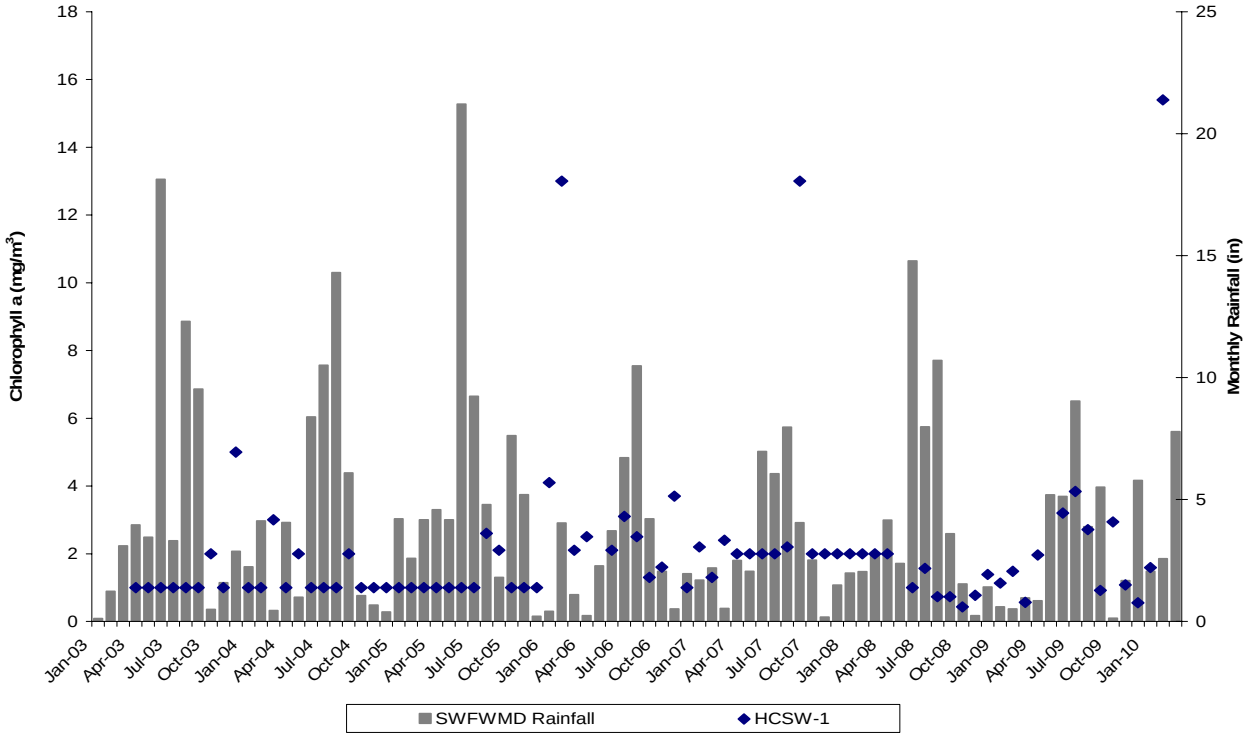

Figure 3. Measured chlorophyll a at Horse Creek Stewardship Program HCSW-1 from April 2003 to March 2010, along with SWFWMD total monthly rainfall measurements.

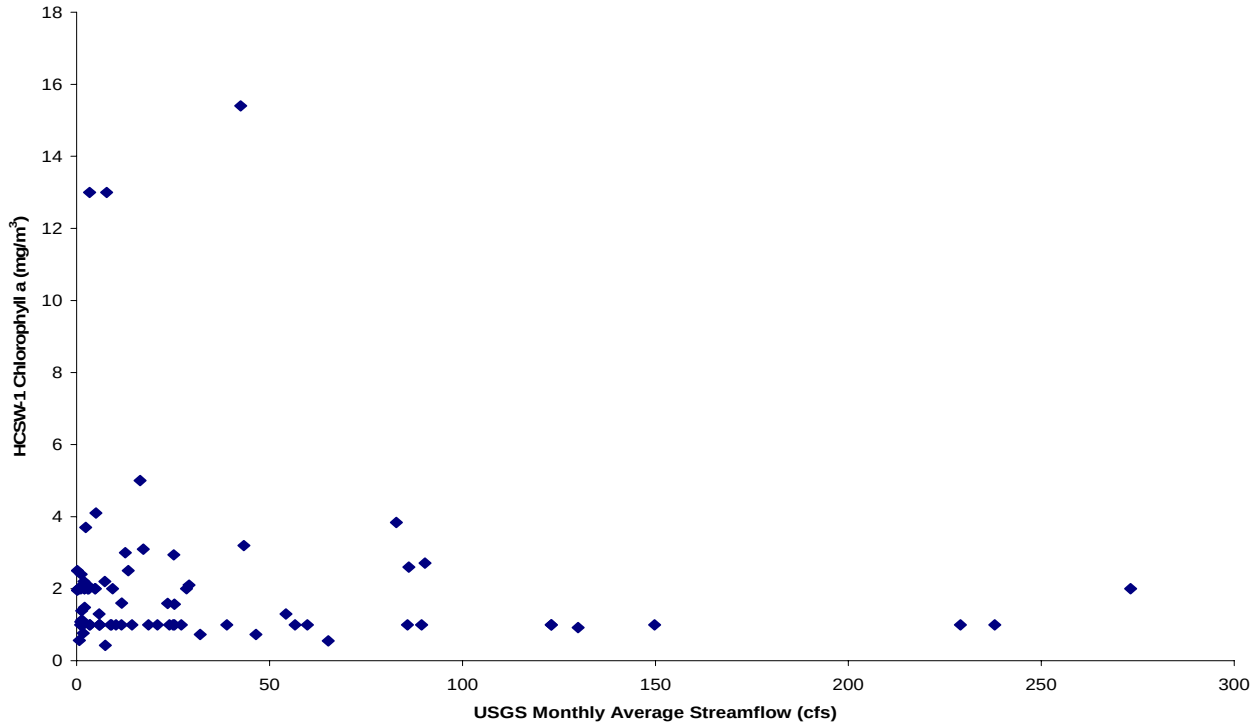

Figure 4. Measured chlorophyll a at HCSW-1 monthly sampling from April 2003 to March 2010, along with monthly average USGS average streamflow at Horse Creek Near SR 64.

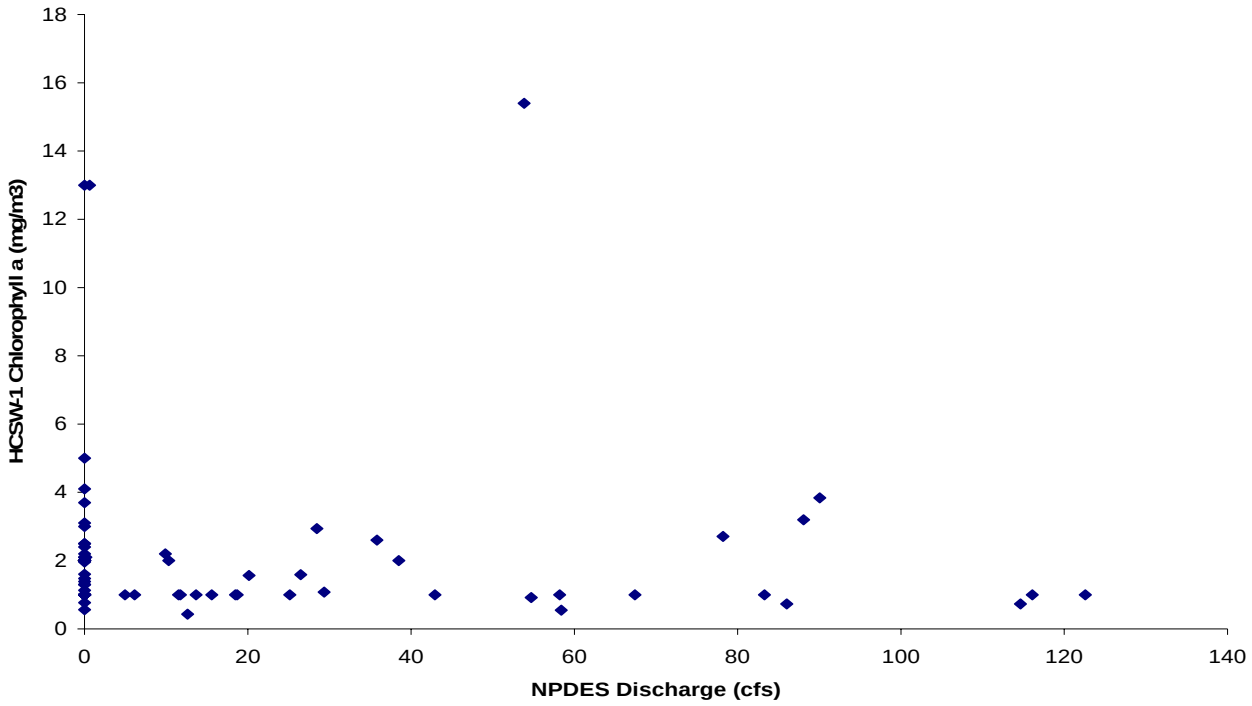

Figure 5. Measured chlorophyll a at HCSW-1 monthly sampling from April 2003 to March 2010, along with monthly average NPDES discharge (Outfalls (D-003 and D-004).

Table 3. Chlorophyll a levels measured during Horse Creek Stewardship Program monthly sampling at HCSW-1 and during quarterly sampling at NPDES Outfalls D-003 and D-004 from April 2003 to March 2010.

	Outfall D-003	Outfall D-004	HCSW-1 (Value and Remark)	
April-03		1.0	1.0	U
June-03	114.0		1.0	U
July-03	25.0	5.0	1.0	U
October-03		1.0	2.0	U
August-04	16.0	29.0		
October-04		5.0	4.1	
March-05		5.0	1.0	U
April-05		1.0	1.0	U
July-05	57.0	18.0	1.0	U
March-06		34.0	1.0	U
August-07		44.0	2.2	
July-08		3.0	1.6	
August-08	44.6		0.7	
October-08		39.5	0.4	
May-09	18.0	46.5	3.2	
July-09		20.4	3.8	
January-10		10.1	1.6	

Other measurements taken concurrently with HCSW-1 chlorophyll concentrations show that there was no elevation in bioavailable nutrient forms (nitrate+nitrite, ammonia, orthophosphate) during February 2010 that would indicate an increase in nutrient inputs to the system (Figure 6). Therefore, it is unlikely that mining discharges or other activities caused an increase in algal growth at HCSW-1 by increasing nutrients.

In addition, pH and dissolved oxygen concentrations were normal during the February 2010 event (Figure 7), indicating that it is unlikely that HCSW-1 experienced a biologically significant algal bloom. If an algae bloom was occurring, then pH should have been substantially elevated, and dissolved oxygen either substantially lower or higher than normal (depending on the time of collection). Algal blooms can have biological consequences related to the water chemistry changes they produce, such as depressed dissolved oxygen concentrations when photosynthesis is not occurring. In addition, some algal species are toxic to other organisms, especially in great numbers. At the level of chlorophyll measured at HCSW-1, the presence of an algal bloom that would have adverse effects on stream organisms is unlikely.

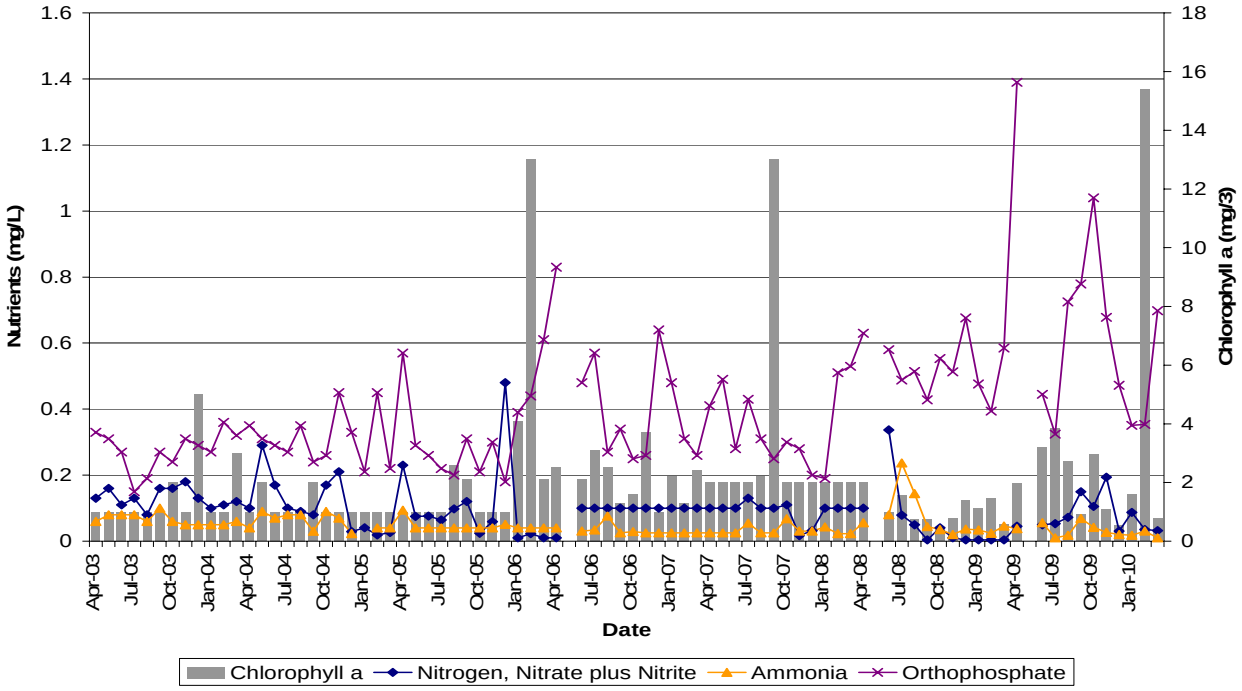

Figure 6. Measured chlorophyll a and nutrients at Horse Creek Stewardship Program HCSW-1 from April 2003 to March 2010.

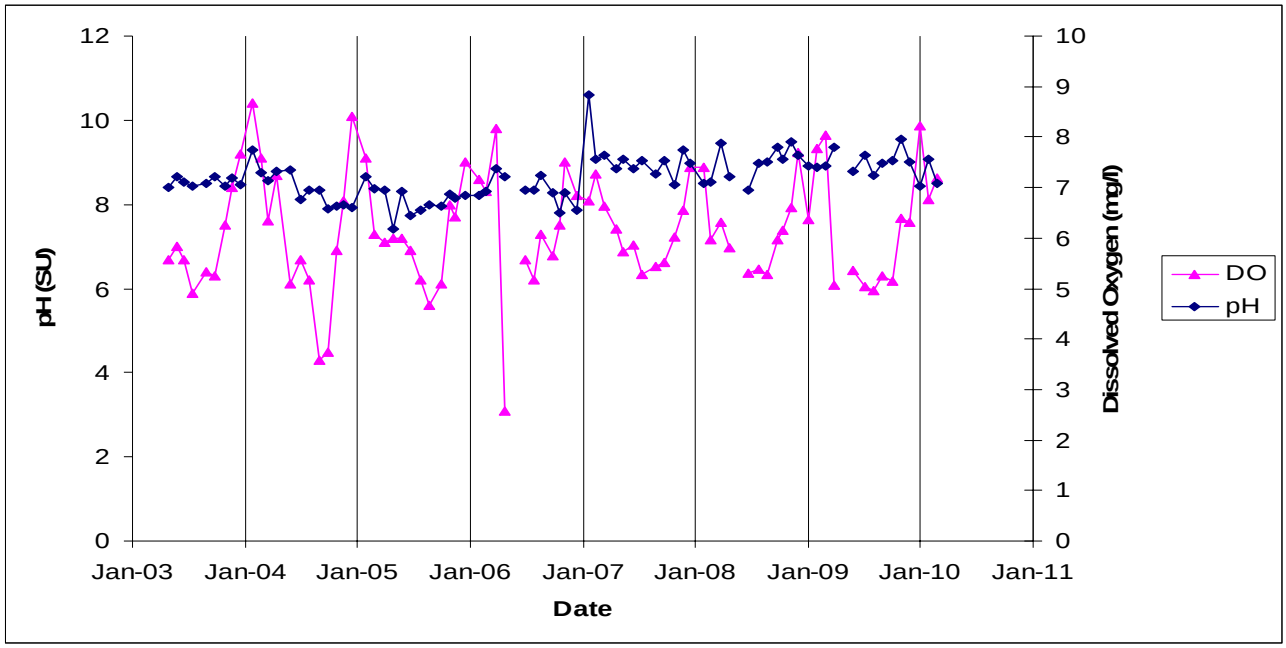

Figure 7. Measured pH and dissolved oxygen at Horse Creek Stewardship Program HCSW-1 from April 2003 to March 2010.

The history of chlorophyll a measurements recorded throughout the HCSP indicate that the February 2010 HCSW-1 chlorophyll a measurement is within the range of measurements collected by other entities in Horse Creek since 1997, although it is slightly higher than the majority of measurements (Figure 8). Isolated peaks in chlorophyll a every few years are not unusual for small, freshwater streams in the Bone Valley.

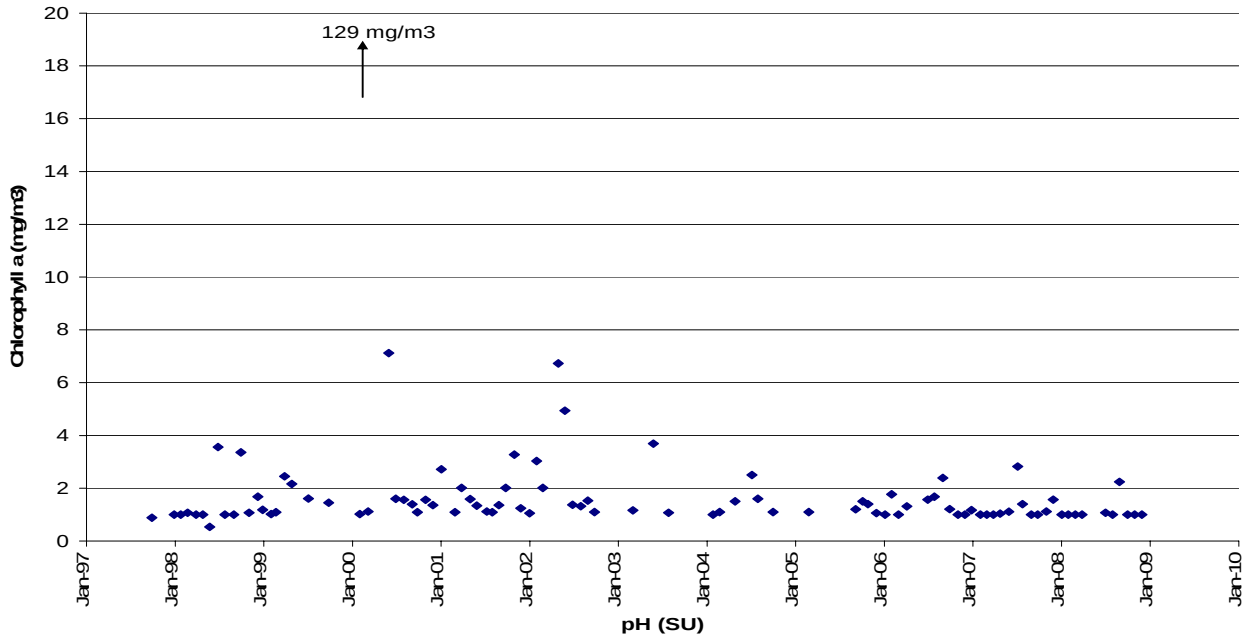

Figure 8. Historical chlorophyll a at Horse Creek Stewardship Program HCSW-1 (from USGS, FDEP, and SWFWMD) from October 1997 to December 2008.

In conclusion, it is unlikely that the elevated chlorophyll a levels recorded by Mosaic staff in Horse Creek were caused by mining operations. We believe that no further corrective action is needed at this time for the following reasons:

1. The chlorophyll exceedance at HCSW-1 was isolated, with concentrations returning to low levels (< 1 mg/m^3) in the next month, which had a similar volume of NPDES discharge.

2. Chlorophyll concentrations at HCSW-1 are negatively related to the volume of NPDES discharge, indicating no adverse effect of NPDES discharge over the course of the HCSP.

3. Chlorophyll concentrations at HCSW-1 are not related to the chlorophyll concentration of NPDES discharge.

4. Nutrient levels in HCSW-1 were not elevated, indicating no increased nutrient concentrations from NPDES discharge.

5. Dissolved oxygen and pH concentrations were not abnormal, indicating no evidence of substantial algal blooms. In the absence of algal blooms, this concentration of chlorophyll is unlikely to have any significant adverse affect on ecological communities.

6. The chlorophyll a concentration measured (15.4 mg/m^3) is low enough to be barely discernable by visual inspection, thus having no affect on human perception of recreational value.

7. The elevated chlorophyll concentration recorded during February 2010 may be an anomaly caused by sampling error. If small pieces of leaf matter were collected along with the water sample, then the chlorophyll a concentrations may have been biased high. Extra care will be taken in the future to eliminate this potential source of error.

8. Mosaic staff will now be taking pictures at each location during each sampling event to give a better indication of field conditions at the time of sampling, including documenting the presence or absence of algae.