Huntington River Study – 2013

Summary of Findings

The Huntington River Conservation Partnership (HRCP) now in its ninth year continued water quality monitoring on the Huntington River in 2013. With laboratory support from a Vermont Dept. of Environmental Conservation Larosa Grant, a large number of volunteers from Huntington and Richmond sampled numerous locations along the length of the Huntington River on a weekly basis for bacterial contamination with *E*. *coli*.

Results from last summer reminded once again of the strong dependence of results on the pattern and timing of precipitation. Though analyses continue, the general pattern of spikes in E. coli contamination at multiple sites along the river is consistent with past results. The finding of high levels of contamination with substantial rain in the period continues to suggest general runoff as an important source. The association between heavy rainfall and contamination is not perfect, however, pointing to additional causes of contamination from sub-surface "point source" waters. This also is supported by finding single-site spikes on a given sample day.

Half hourly measurement of river depth became available for the first time, made possible by a donation of continuous data-logging equipment by the US EPA in late 2012. Taken at the popular Horseshoe Bend swimming hole just below Huntington Lower Village, these measurements permitted a closer look at the relationship between river water level in the days before sampling and the levels of contamination. These measurements permitted examination of the relationship between river depth and change in rive depth in the days before sampling and the levels of contamination. A finding of interest was the greater than 7 foot rise in river depth in the 3 ½ hours following the heavy afternoon rains of July 3. There was a strong correlation between rate of change in river level over the 12 hours prior to sampling, a correlation that became progressively weaker when change was measured over 24 or 48 hours. Interestingly, the correlation between the 12 hr change in depth and contamination was observed whether the river level was rising or falling. One possible interpretation is that significant changes in depth in either direction indicate a recent rainfall causing runoff which in turn leads to contamination. Clearly more work remains to be done on these points.

The HRCP plans to continue monitoring in 2014 and new volunteers are encouraged to participate. Much more information is available at www.huntingtonriver.org, and periodic updates, especially during the sampling season, are tweeted at @huntriver. As the sampling season draws closer, stay tuned for announcements of volunteer sign-ups through Front Porch Forum and other postings.

Those interested in learning more about the Huntington River project should go to: http://www.huntingtonriver.org

Overall Results

What follows is a summary of the results from the 2013 Huntington River *E. coli* study. The reader is encouraged to review the 2006 and 2007 Reports for discussion of definitions, methods, Federal and State Standards and other background material.

E. coli is considered a sentinel for fecal contamination, indicating the possible presence of human pathogens. The presence of pathogenic *E. coli* itself has not been observed.

Figure-1 shows the sampling locations for the main study sites and **Table 1** presents the complete 2013 data set for those sites. Data boxes are color coded indicating values exceeding the Federal standard (pink: 235, measured as *E. coli* / 100 ml). Beginning in 2012, the State standard was adjusted upwards from 77, to the Federal standard of 235. However, values above that level nonetheless were are colored in yellow to allow comparisons with years past when the State Standard was 77.

Table 1 also presents the data from additional sites sampled on a rotating basis. This year, six samples were above State / Federal standard, up from last year. Note that four of these values occurred on 6/25 when values were high uniformly.

As shown in **Table 1**, a wide spectrum of contamination was measured, values for *E. coli* / 100 ml ranging from just short of 2000 (Audubon Hemlock, 6/25) to numbers in the middle teens. There were three days (6/25, 7/2, 8/27) when the majority of samples exceeded Federal Standard (pink). Similarly, abnormal values were clustered on certain days when the cutoff was above the old State Standard (Yellow). Such clustering suggests a principal cause of contamination is runoff, more isolated high values pointing to additional causes of contamination from sub-surface “point sources” waters.

Table 2 shows an annual summary of data gathered since 2004. The number of elevated values for 2013 was higher than in recent years, yielding the highest overall Geomean values since 2005, second highest overall. This was due to some very high values (e.g. 6/25) together with the large number of individual samples over standard. It also should be noted, however, that there were several days characterized by very low values (**Tables 1 and 2**). One possible explanation for the high values may be the pattern of rainfall over the day leading up to sampling, as has been found in the past and will be discussed more fully below.

These comparative findings indicate how variable results can be from season to season even when there has been no widely applied intervention attempted to reduce contamination.

Quality Assurance

During the 2013 sampling season, 215 regular *E.coli* samples were submitted. 9.3 Percent (20 samples) of these were submitted as quality assurance field duplicates. The VTDEC Laboratory quality assurance objectives for *E. coli* on Quanti-tray are the following: <25 colonies, 125% relative percent difference (%RPD); >25 colonies, 50%

RPD. **Table 3** presents all duplicate samples for 2013 with the RPD and absolute difference between duplicates. Overall, the mean %RPD was 27.2% for all samples. This is well within VTDEC objectives for QA duplicates. At the same time, of the 20 duplicate samples submitted, two sets (10%) exceeded the VTDEC QA objectives on 7/2 at Dugway West (58.6% RPD) and on 7/9 at Gorge (83.9% RPD) (in **Bold**). Those duplicate samples were collected under normal flow conditions, with no abnormal comments recorded. There is no clear explanation why the duplicates exceeded quality assurance limits, though on one of the days (7/2) excessive rain and associated runoff with its associated turbidity may have led to the discrepant result.

Date and Site Comparisons

Figures 2-3 look at sample location by date. Perhaps best illustrated by **Figure 3**, a wide variety of patterns was found when different dates are compared. Values for a given date were quite flat in some cases (e.g. 8/6, 8/20, 9/10). In others there were spikes, perhaps indicating a point source of contamination (e.g. 7/9. 8/6, 7/30, 9/10). Other curves were jagged. Missing data, especially downstream, leave open the possibility that other spikes would have been observed.

As observed in past years, spikes on a given date often were followed abruptly by much lower values immediately downstream. This is a pattern seen in previous years and may reflect the known short life-span of viable *E. coli* once it leaves the animal digestive tract (also see 2006 and 2007 Reports). Other factors, such as the sources of the *E. coli* (e.g. wildlife, domestic animals, humans) also could be important (See 2012 Report).

Figure 4 provides a graphic analysis of the data in **Table 1**. When not compromised by missing data, the pattern of peaks and valleys was similar in between site comparisons. This indicates that, generally speaking, some general contributor such as runoff was affecting each site with a similar pattern.

Rainfall, River Depth and Contamination

It has been hypothesized from past studies that high levels of contamination follow heavy rains and represent contamination from land runoff. This was based on significant rain in the 24 hour period before sampling and the co-occurrence of high levels of contamination at multiple sites along the river as was found this year on 6/25, 7/2 and 8/27. As shown in **Figure 5.1**, results for 2013 continue support this hypothesis. The correlation between 24 hour rainfall and overall Geomean for the day was extremely strong (r^2 = 0.8979, indicating 89% of the variability in the Geomean values can be attributed to rainfall occurring the 24 hour before sampling). At the same time, pooled data across all years point to a weaker correlation (r^2 = 0.2322).

The relationship between river depth and Geomean also has been studied in the past and again this year. **Figure 5.2** shows that the correlation between river depth and contamination both measured at the popular Horseshoe Bend swimming hole just below Huntington Lower Village again was not strong.

A new look at this issue was made this past summer. Half hourly measurement of river depth became available for the first time, made possible by a donation of continuous data-logging equipment by the US EPA in late 2012. These measurements permitted examination of the relationship between river depth in the days before sampling and the levels of contamination. As shown in Figure 5.3, there was a strong correlation between rate of change in river level over the 12 hours prior to sampling ($r^2 = 0.8379$). (Red symbols indicate the 12-hour start point; red symbols indicate when water level was rising – see **Figure 5.4.**) That correlation became progressively weaker when change was measured over 24 or 48 hours (**Figure 5.3**. Interestingly, the correlation between 24-hour change in level and 24-hr rain was weak (**Figure 5.4**) though a single point (0 rainfall - 2.15 foot depth change) may be masking a significant relationship. Also interesting was that the correlation between the 12 hr change in depth and contamination was observed whether the river level was rising or falling (**Figure 5.5**). It may be that significant changes in depth in either direction indicate a recent rainfall causing runoff which in turn leads to contamination. Clearly more work remains to be done on these points.

Overall Geomean by Site

Two spikes in overall Geomean were observed (**Figure 6**): Cemetery and Cochran Bridge. A spike at Cochran Bridge was noted last year but has not always been observed (see past Reports). Such spikes more likely would be associated, with a point source(s) of contamination rather than runoff.

Box Plots - variability

Geomeans again were computed for data analysis, because of the wide range of values and the fact the data are not normally distributed (see 2006 Report for further explanation). The spread of values is illustrated by the use of “box plots” (**Figure 7)**. Box plots are often used to assess the variability in the data (see 2007 Report for details). The intent is to compare values for a specific site and not to make comparisons between sites. Hence the vertical axis scale is not the same for each site: using the same scale makes it difficult to see the data distribution in certain cases.

Noteworthy are the many cases of outliers from a statistical perspective (asterisks). Unusually in terms of past results, there were several sites for which there were no outliers as usually are found Yaggy, Gorge, Chalet).

Winooski River

Samples taken from the Winooski River, though with gaps showed a pattern similar to that found in the past (**Table 1**; **Figure 8**). Again, there were no outliers as usually are found. Same date values for Jonesville and Richmond corresponded well as has been found in past years.

Thanks to all the volunteers

Many thanks to all the volunteers whose efforts made the study possible. It was their effort over the years that caused the Huntington River to be chosen as one of only two study sites in the State to be supported through State and Federal funding. All should be proud of the effort and result.

Those interested in learning more about the Huntington River project should go to: http://www.huntingtonriver.org

Huntington River Study – 2013

Tables and Figures

HUNTINGTON RIVER E. COLI STUDY RESULTS 2013

Table 1

	6/25/2013	7/2/2013	7/9/2013	7/16/2013	7/23/2013	7/30/2013	8/6/2013	8/13/2013	8/20/2013	8/27/2013	9/3/2013	9/10/2013	GEOMEAN	Median
Carse Bridge	770.10	435.17	28.13	235.93	325.54	59.4	17.49	20.86	17.12	186.00	77.12	14.80	79	68.3
Shaker Mtn	461.11	161.62	29.92	54.61	488.44	63.14		27.51	53.71	435.17	146.72	36.92	102	63.1
Brace Bridge	410.58	235.93	75.89	33.1	178.21	48.74	26.86	44.12	47.11	123.35	101.44		84	75.9
Spence Bridge	816.41	260.25	36.84	26.86	150.01	69.07	18.69	43.47	58.33	365.40	201.42	18.69	85	63.7
East Street	816.41	517.21	37.44	52.91	155.25	73.28		37.34	47.98	461.11	142.09	22.55	109	73.3
Bridge Street	791.53	272.30	59.4	52.04	146.72	116.19	25.59	51.21	52.08	816.41	129.63	34.98	109	87.8
Cemetery	1553.12	290.93	62.66		190.38	114.46	27.18		52.04	1119.87	151.52		174	151.5
Audubon Horseshoe	1299.65	461.11	75.41	58.78	461.11	95.9	34.98	72.27	25.59	344.80	290.93	32.67	131	85.7
Audubon Hemlock	1986.29	365.40	64.47	61.27	116.02	151.52	34.98	28.47	17.31	307.59			110	90.2
Moultrop Bridge	1553.12	344.80	74.39	54.61	63.67	155.0	18.9		35.92	410.58	55.96	15.79	94	63.7
Dugway West		365.40	86.0	61.98	67.01	155.25		51.22	17.49	344.80	285.10	23.07	92	76.5
Yaggy	980.39	410.58	57.31	48.74	72.15	135.4	43.71	34.54	27.85	435.17	248.90	31.84	104	64.7
Gorge		365.40	48.08									24.33	75	48.1
Triple Buckets	239.23	488.44	56.53						12.11	122.29		17.49	75	89.4
Chalet Trail	1203.33		52.04	52.91	46.38		40.20			115.28	387.32		116	52.9
Cochran Bridge	1413.61	378.40	74.39	45.68	83.29	135.4	34.51			325.54	461.11	54.48	150	109.3
Winooski Jonesville	980.39	228.18	866.44	32.67		344.11	35.45				70.27		177	228.2
Winooski Richmond				31.29	68.88	307.59	50.39	161.62		60.86			83	64.9
GEOMEAN	888.5	342.4	54.6	55.3	140.5	98.2	28.1	38.8	31.6	324.3	173.9	25.4		76.7
Conductivity														
Water temp (°C)														
Water level -feet-new stake	2.15	2.95	2.00	1.56	0.91	1.69	1.39	0.96	1.14	1.15	0.96	1.06		
Values are mpn / 100 ml	888.5	342.4	54.6	55.3	140.5	98.2	28.1	38.8	31.6	324.3	173.9	25.4	105	

Above Federal and State level (235)

Geomean with Winooski	894	334	64	51	134	115	30	44	32	292	163	25

DUPLICATES

	6/25/2013	7/2/2013	7/9/2013	7/16/2013	7/23/2013	7/30/2013	8/6/2013	8/13/2013	8/20/2013	8/27/2013	9/3/2013	9/10/2013
Carse Bridge	387.32									193.49		
Shaker Mtn		214.16									172.33	
Brace Bridge			51.22									
Spence Bridge				24.62								
East Street					102.21							
Bridge Street						144.97						
Cemetery							31.70					
Audubon Horseshoe												
Audubon Hemlock									16.94			
Moultrop Bridge	1413.61											
Dugway West		579.43										
Yaggy				81.62								
Gorge			83.92									18.29
Triple Buckets												
Chalet Trail												
Cochran Bridge							28.20					
Winooski Jonesville												
Winooski Richmond												
Texas Hill Brook	629.40											
Fargo Brook												
Hollow Brook					866.44							
Cobb Brook												
Jones Brook												
7 Falls	307.59											
Rec Field												
Owl's Head Brook												
Brent Field									12.23			
Billy Brook												

Monthly Samples	25-Jun				23-Jul				20-Aug			
Texas Hill Brook	308.82				109.18				35.45			
Fargo Brook	104.97				160.71				13.5			
Hollow Brook	1413.61				920.84				150.01			
Brushy Brook	193.49				133.27				14.64			
Carpenter Brook									13.36			
Cobb Brook	63.82				118.74				23.07			
Jones Brook	65.04				107.12							
7 Falls	613.14				285.10				13.36			
Brent Field												
Rec Field	1119.87								39.31			
Owls Head Brook												

Overall Results Composite - 2005-2013

Table 2

2005

	6/22/2005	6/29/2005	7/6/2005	7/13/2005	7/20/2005	7/27/2005	8/3/2005	8/10/2005	8/17/2005	8/24/2005	8/31/2005	9/7/2005	9/14/2005	9/21/2005	9/28/2005	2005 GeoMean
7 Falls	131	30	117	98	29	95	30	25	9	37	1120	9	9		17	42.1
Carse Bridge	228	38	276	43	95	162	42	888	41	84	2419.6	37	8	18	18	81.8
Shelbrake	201	48	291	45	137	172		19	24	44	980		517	18	20	88.6
Brant Field	272	70	275	210	115	231	50	88	31	40	1750	34	33	9	921	103.9
Shaker Mountain	401	68	276	60	62	167	810	40	90	53	1550	88	53	20	44	113.4
Rec. Field	579	105	649	43	144	291	69	37	21	980	2419.6		46	18	51	128.7
Brace Bridge	613	83	308	24	101	291	66	35	19	572	2419.6		93	28	34	113.6
Spence Bridge	819	99		81	71	411	95	35	18	56	1990	387	141	23	54	134.8
East Street	488	85	1120	45	68	276	63	32	43	71	2419.6	228		34	24	114.8
Bridge Street	770	80	980	38	90	548	79	46	55	206	687	232	83	33	31	128.9
Cemetery	387	101	921	47	198	613	95	52		153	2419.6	166		38	40	167.1
Audubon Horseshoe	147	132	1200	62	137	365	71		37	95	579	192	68	30	37	129.7
Audubon Hemlock	131	68	1730	63	83	401	77	112	37	112	435	192	125	24	29	115.2

2006

	20-Jun-06	27-Jun-06	5-Jul-06	11-Jul-06	18-Jul-06	25-Jul-06	1-Aug-06	8-Aug-06	14-Aug-06	22-Aug-06	29-Aug-06	5-Sep-06	12-Sep-06	18-Sep-06	GEOMEAN
Shadrack	114	116	50	178	48	50	130	32	10	30	22	14	24	18	42.9
Shaker Mountain	152	179	56	79	60	56	64	19	18	71	22			12	48.6
Brace Bridge	86	269	43	79	40	102	156	687	60	158	30	60	21	20	77.8
Spence Bridge	125	185	28	88	125	86	248	61		137		30	32	8	66.0
East Street		172	38	61	178		110	55	22	79	31	37	22	43	55.3
Bridge Street	130	278	57	69	291	57	131	61	18	78	26	26	14	28	57.2
Cemetery	148	214	55	52	172	50	114	63	22	72	28	20	15	22	55.3
Audubon Horseshoe	178	387	49	30	118	82	214	45		81	56	22	18	18	65.2
Audubon Hemlock	112	387	50	56	143	111	148	50	23	96	20	37	17	13	56.7
Moultrop Bridge	186	308	48	28	81	55	172	51	22	187	25	20	13	12	51.7
Dugway West	192	461	55	161	93	63	1410	52	30	107	22	1730	6	44	101.9
Yaggy	173	461	60	140	109	86	172	49	21	102	51	133	12	48	79.9
Gorge	193	326	68	138	88	74	150	51	18	68	31	77	15	34	70.9
Triple Buckets	291	387	86	218	50	72	145	41	11	121	18	61	13	28	64.8
Chalet Trail	365	313	91	108	60	62	96	42	17	102	19	38	11	22	58.8
Cochran Bridge	411	461	72	130	56		218	36	20	95	20	66	24	43	74.0
Winooski Jonesville					105	172	124	63	30	1550	101	63	142	14	98.2
Winooski Bridge St					67	121	114	68	18	888	50	72	105	12	79.3
GEOMEAN	173	290	56	87	81	78	150	50	21	125	31	51	20	21	

2007

	6/18/2007	6/25/2007	7/2/2007	7/9/2007	7/16/2007	7/23/2007	7/30/2007	8/6/2007	8/13/2007	8/20/2007	8/27/2007	9/4/2007	9/10/2007	9/17/2007	GEOMEAN
Carse Bridge	74	52	58	548	81	68	48	68	1050	68	73	38	290	38	87.8
Shaker Mtn	86	58	135	166	86	52	88	51	777	260	79	7	214	30	96.2
Brace Bridge	71	68	58	156	62	79	68	68	1990	27	23		152	30	88.3
Spence Bridge	75	40	26	234	98	93	108	34	1300	18	29		248	33	79.8
East Street	131	41	58	219	326	78	57	20	410	18	816	33		30	78.0
Bridge Street	127	28	67	210	248	64	71	25	387	7	1300		517	41	98.8
Cemetery	70	40	52	201	54	48	62	22	150	13	35	28	579	43	57.9
Audubon Horseshoe	111	46	201	193	84	55	44	22	82	7	13		687	37	61.8
Audubon Hemlock	58	28	41	435	82	81	24	11	38	14	7	21	435	28	41.3
Moultrop Bridge	78	87	46	228	114	58	38	23	613	15	14	17	387	18	56.1
Above Dwg's Head				214	105	208	50	29	2419	128			548	57	148.1
Dugway West	192	193	99	255	118	1730	58	34	1130	131	43	56	649	55	136.2
Yaggy	130	185	89	365	96	54	68	31	143	78	53	28	770	52	86.5
Gorge	133	291	83	435	71	68	50	22	365	86	36	28	727	52	100.5
Triple Buckets	99			428	70	60	32	27	178	68		11	231	33	79.4
Chalet Trail	74	192	61	261	74	78	26	18	365	68	18	5	197	50	62.0
Cochran Bridge	83	291	548	201	82	60	79		461	214	11		209	84	104.4
Winooski Jonesville	36	44	27	238	158	191	173	5	22	18	36	9	579	285	67.7
Winooski Bridge St	81	41	43	218	210	81	238	38	34	20	35	42	548	248	84.7
GEOMEAN	93.5	74.8	68.1	294.0	98.7	87.8	49.5	28.3	430.5	40.7	37.8	18.9	328.3	38.3	82.4

2008

	2/19/1900	6/30/2008	7/7/2008	7/14/2008	7/21/2008	7/28/2008	8/4/2008	8/11/2008	8/18/2008	8/25/2008	9/2/2008	9/8/2008	9/15/2008	9/22/2008	GEOMEAN
Carse Bridge	46	93	128	488	186	43	77	43	56	73	117	35	53	23	74
Shaker Mtn	49	135		488				55	86	91	18	31	105	20	64
Brace Bridge	16	142	91	488	138	167	86	236	45	116	49	55	50	15	81
Spence Bridge	19	152	122	770	147	167	111	61	40	84	26	27	56	35	76
East Street	416	291	96	1300	111	816	111	98	43	91	31	38	579	49	152
Bridge Street	649	166	72	1130	251	141	117	43	46	86	121	25	816	34	147
Cemetery	727		95	427	938	273	121	48	46	88	40	29	66	41	103
Audubon Horseshoe	435	112	121	1130	341	201	88	54	56	123	31	21	56	46	110
Audubon Hemlock	770	132	91	1730	365	191	93	56	30	50	36	32	45	40	106
Moultrop Bridge	1300	123	199	2420	238	236	91	55	30	38	20	22	34	16	103
Dugway West	770	144	179	2420	219	167	82	76	48	48	30	39	30	19	112
Yaggy	727	186	155	1990	687	201	96	74	99	41	29	40	62	11	120
Gorge	770	308	93	2420	411		63	68	41	48	17	24		12	99
Triple Buckets	727	152		2420	411	199	118	77	33	33	16	28	40	8	87
Chalet Trail	387	148	99	2420	272	228	166	52	25	33	9	18	50	9	74
Cochran Bridge	365	142	52	2420	488	411	93	66	33	31		31	55	60	118
Winooski Jonesville	299	132	38		2420	299	210	1550	63	45	19	21	59		122
Winooski Richmond	205	199	54	613	1990	291	345		96	51	15	30	113	66	136
GEOMEAN	282	156	92	1229	362	214	111	75	53	59	29	29	79	22	102

2009

	6/30/2009	7/7/2009	7/14/2009	7/21/2009	7/28/2009	8/4/2009	8/11/2009	8/18/2009	8/25/2009	9/1/2009	9/8/2009	9/15/2009	9/22/2009	9/29/2009	GEOMEAN
Carse Bridge		88.2	78.41		198.9	21.87	218.72	224.68	31		10	68	11	10.81	50
Shaker Mtn	93.99	93.9	64.31	66.35	44.1	34.05	770.1	27.31	35.9	9	12		21.07	33.9	48
Brace Bridge	108.6	178.9	98.81	39.8	44.8	67.66	547.5	78.94	54.6	39	16	727	11		78
Spence Bridge	108.07	84.3	50.41	38.77	66.9	42.57	1203.33	54.48	21.6	75	12	276	10.89		62
East Street	193.49	83	107.28	41.35	71.7	60.86	461.11	51.81	47.9	37		387	11.99	41.91	69
Bridge Street	111.9	111.9	127.4	77.12	81.6	72.27	2419.6	49.54	53.7	67	17	56	30.89	34.05	80
Cemetery	201.42	117.8	81.62	77.28	46.5	63.04	410.38	51.81	52.9	21	30	172	11.1	37.86	66
Audubon Horseshoe	186	111.9	24.62	49.64	51.2	60.53	172.33	51.21	39.9	32	22	84	64.43	26.34	62
Audubon Hemlock	164.9	104.3	52.91	50.41	81.9	54.61	75.99	24.91	69.7	27	19	113	8.6	56.51	56
Moultrop Bridge	172.47	110.6	41.65	43.47		73.28	85.04	58.63	52	35	9		8.6	48.74	45
Dugway West	118.9	118.7	59.81		56.5	53.27	68.28	54.61	31.4	31	29	214	9.79	33.55	56
Yaggy	307.39	142.1	57.86	74.91	67.7	68.88	34.31	49.59	79.4	36	29	112	13.36	73.73	50
Gorge		117.8	44.12	40.86	62.7	57.11	53.21	47.11	55	22	16		4.09	71.15	38
Triple Buckets	22.4	145.5	52.04	38.51	67.7	60.15	29.54	38.99	22.6	12	16	158		32.67	42
Chalet Trail	298.66	77.1	50.39	58.06	56.1	65.04	37.86	24.33	23.1		9	222	1.04	59.8	43
Cochran Bridge	251.25	166.9	57.11	56.33	48.8	90.49	20.13	35.92	36.4	38	16	121	22.53	114.66	58
Winooski Jonesville	960.61	113.7	178.07	37.86	54.6	291.78	40.2	36.41	44.5	76	46	71	5.21	378.33	75
Winooski Richmond		81.6	98.54	48.74	45.7	146.72	46.54	25.59	52.1	76	8		19.05	207.54	52
GEOMEAN	198	111	63	53	63	65	135	50	41	35	18	139	12	60	56

2010

	6/29/2010	7/6/2010	7/13/2010	7/20/2010	7/27/2010	8/3/2010	8/10/2010	8/17/2010	8/24/2010	8/31/2010	9/7/2010	9/14/2010	9/21/2010	GEOMEAN
Carse Bridge	139	70.81	39.36	78.94	78.9	129.53	86.47	11.76	21.87	6.26	11	20.11	2.01	31
Shaker Mtn	43	25.3	63.41	40.44	86.47	201.42	63.14	166.4	49.59	24.52	81.29	20.34	29.75	54
Brace Bridge	39	62.44	47.87		64.37	218.72	104.6	148.32	410.38	21.37	78.94	37.86	14.49	68
Spence Bridge	69	67.66	76.34	66.33	47.21	275.53	120.7	81.29	178.31	30.89	178.9	28.47	20.64	88
East Street	62	32.67	61.98	39.8	54.61	410.38	218.72	69.68	34.05	61.63	63.68	34.98	18.5	61
Bridge Street	102	48.76	83.61	113	166.93	517.21	214.26	79.27	57.91	66.33	64.34	39.31	19.89	82
Cemetery	59	80.88	90.75	129.86	67.66	461.11	144.8	75.41		48.74	25.9	31.84	18.69	73
Audubon Horseshoe	61	50.41	119.83	83.92	83.92	648.82	433.17	53.71	39.31	24.33	35.45	39.31	27.53	72
Audubon Hemlock	67	49.54	108.6	138.63	54.61	579.43	921.54	44.12	48.82	54.91	27.81	31.45	31.45	70
Moultrop Bridge			108.7	107.18	46.38	1119.87	488.44	43.71	29.76		16.11	31.63	24.91	74
Dugway West	107	77.12	153.12	101.68	75.89	1299.65	648.82	29.17	54.63	14.64		29.17	17.33	82
Yaggy	196	58.29	124.37	86.24	68.28	1046.24	686.87	27.85	47.11	20.11	12.23	22.3	15.98	68
Gorge	107	51.22	178.9	90.63	63.14	2419.6	488.44		47.98	21.33	14.64	13.96	13.36	71
Triple Buckets	99		113.28	83.92	34.05	1119.87	189.42	25.3	36.41	36.84	6.2	13.96	13.79	52
Chalet Trail	115	30.11	104.26		31.45	980.39	161.62	29.34	44.79	14.64	7.38			54
Cochran Bridge	91	51.81	114.46	79.36	38.99	1203.33	686.87	24.33	54.48	30.51	40.2	13.21	7.45	63
Winooski Jonesville	1986	39.89	32.25	49.59	61.68	27.85	1046.24	32.25	81.29	19.89	29.21	19.89	21.82	57
Winooski Richmond	2420	33.84	38.39	45	40.2	75.89		47.98	137.95	24.21	41.33	30.51	22.81	68
GEOMEAN	123.3	47.1	83.1	78.7	58.6	451	279	45	58	24	29	28	17	63

2012

	6/25/2012	7/2/2012	7/9/2012	7/16/2012	7/23/2012	7/30/2012	8/6/2012	8/13/2012	8/20/2012	8/27/2012	9/4/2012	9/10/2012	9/17/2012	GEOMEAN
Carse Bridge	209.82	33.1	17.12	307.59	162.42	29.4	290.93	20.11	9.51	113	24.62	19.89	2.02	42
Shaker Mtn	166.4		24.62	98.76	19.89	26.55	410.58	35.46	13.5	20.11	25.3		24.91	41
Brace Bridge	410.58	25.9	36.84	178.9	66.31	133.44	726.99	45.68	8.6	185.01	60.15	39.31	18.90	72
Spence Bridge	517.21	63.14	37.86	151.52	50.39	48.74	579.43	60.53	18.69	139.58	9.69	35.92	22.81	64
East Street		52.08	57.31	160.71	65.04	35.92	579.43	55.39	14.35	101.44		48.08	28.20	64
Bridge Street	435.17	52.04	39.86	165.76	34.51	27.85	726.99	54.61	12.11	143.87	23.78	68.28	15.96	63
Cemetery		75.41	48.82	123.56	33.1		920.84	51.22	17.31	143.87		86.00	24.62	72
Audubon Horseshoe	866.44	47.25	52.84	80.88	30.13	35.92	517.21	52.91	34.05	123.56	60.15	50.41	16.94	71
Audubon Hemlock	488.44	56.33	60.15	67.66		38.77	648.82	50.39	30.13		19.46	39.31	16.77	62
Moultrop Bridge	344.8	52.01	60.86	166.95	193.49	34.05	980.39	50.41	49.59	18.69	34.98	42.23	14.49	71
Dugway West	261.25	63.67	61.98	83.61	387.32	45.19	2419.57	49.54	42.57	42.84	90.63	41.35	12.23	86
Yaggy	224.68	88.59	82.9	78.94	201.42	61.27	770.1	61.55	34.05	24.05	61.27	30.51	18.90	75
Gorge		78.94	88.59		218.72	37.44	579.43	68.28	20.34	21.57	48.82	43.47	14.80	59
Triple Buckets		51.21		93.22	24.33	41.08	209.82	61.98	13.36	25.59	32.67	29.92	0.00	43
Chalet Trail	178.53		68.88	61.98	37.86	37.86	613.14	65.65	27.18	23.78	17.49	25.90	5.21	45
Cochran Bridge	461.11	50.39	100.82	101.22		38.77	648.82	50.39	30.13		19.46	39.31	16.77	62
Winooski Jonesville	29.54	360.87	39.31	6.32	13.23	49.54	209.82		5.16	14.49	6.26	30.89	70.83	29
Winooski Richmond		38.77	24.91	37.34	23.78	95.94	151.52	248.9	33.61	19.89	27.18	44.34	55.73	48
GEOMEAN	338.8	53.9	50.9	116.2	118.2	45.3	619	53	22	58	45	38	6	
Conductivity	136	110	122.5	141.9	143	112.5	112.5	114.6	126.4	157.5	161.9	127.1	149.6	
Water temp (°C)	18.4	17.2	15.1	20.4	21	18.8	18.8	17.9	16.3	19.3	18.4	14.4	11.9	
Water level - Vertical (ft)	0.59	0.71	0.63	0.39	0.39	1.00	1.00	0.82	0.56	0.45	0.41	0.67	0.48	

2013

	6/25/2013	7/2/2013	7/9/2013	7/16/2013	7/23/2013	7/30/2013	8/6/2013	8/13/2013	8/20/2013	8/27/2013	9/3/2013	9/10/2013	GEOMEAN
Carse Bridge	770.10	435.17	28.13	235.93	325.54	59.4	17.49	20.86	17.12	186.00	77.12	14.80	79
Shaker Mtn	461.11	161.62	29.92	54.61	488.44	63.14		27.51	53.71	435.17	146.72	36.92	102
Brace Bridge	410.58	235.93	75.89	33.1	178.21	48.74	26.86	44.12	47.11	123.35	101.44		84
Spence Bridge	816.41	260.25	36.84	26.86	150.01	69.07	18.69	43.47	58.33	365.40	201.42	18.69	85
East Street	816.41	517.21	37.44	52.91	155.25	73.28		37.34	47.98	461.11	142.09	22.55	109
Bridge Street	791.53	272.30	59.4	52.04	146.72	116.19	25.59	51.21	52.08	816.41	129.63	34.98	109
Cemetery	1553.12	290.93	62.66		190.38	114.46	27.18		52.04	1119.87	151.52		174
Audubon Horseshoe	1299.65	461.11	75.41	58.78	461.11	95.9	34.98	72.27	25.59	344.80	290.93	32.67	131
Audubon Hemlock	1986.29	365.40	64.47	61.27	116.02	151.52	34.98	28.47	17.31	307.59			110
Moultrop Bridge	1553.12	344.80	74.39	54.61	63.67	155.0	18.9		35.92	410.58	55.96	15.79	94
Dugway West		365.40	86.0	61.98	67.01	155.25		51.22	17.49	344.80	285.10	23.07	92
Yaggy	980.39	410.58	57.31	48.74	72.15	135.4	43.71	34.54	27.85	435.17	248.90	31.84	104
Gorge		365.40	48.08									24.33	75
Triple Buckets	239.23	488.44	56.53						12.11	122.29		17.49	75
Chalet Trail	1203.33		52.04	52.91	46.38		40.20			115.28	387.32		116
Cochran Bridge	1413.61	378.40	74.39	45.68	83.29	135.4	34.51			325.54	461.11	54.48	150
Winooski Jonesville	980.39	228.18	866.44	32.67		344.11	35.45				70.27		177
Winooski Richmond				31.29	68.88	307.59	50.39	161.62		60.86			83
GEOMEAN	838.5	342.4	54.6	55.3	55.3	98.2	28.1	38.8	31.6	324.28	174	25	
Conductivity													
Water temp (°C)													
Water level -feet-new sta	2.02	2.72	1.70	1.00	0.85	1.28	1.00	0.88	0.72				

2013 Huntington River E. coli Field Duplicates **Table 3**

Date	Location	Results		Relative Percent	Absolute Difference
		A	B		
6/25/2013	Carse	770.10	387.32	49.7	382.8
6/25/2013	Moultrop	1413.61	1553.12	9.9	139.5
7/2/2013	Shaker	161.62	214.16	32.5	52.5
7/2/2013	**Dugway West**	**365.40**	**579.43**	**58.6**	**214.0**
7/9/2013	Brace	75.89	51.22	32.5	24.7
7/9/2013	**Gorge**	**48.08**	**83.92**	**74.5**	**35.8**
7/16/2013	Spence	26.86	24.62	8.34	2.24
7/23/2013	East Street	155.25	102.21	34.16	53.04
7/30/2013	Bridge Street	116.19	144.97	24.77	28.78
8/6/2013	Cemetery	27.18	31.70	16.63	4.52
8/6/2013	Cochran Bridge	34.51	28.20	18.28	6.31
8/20/2013	Audubon Hemlock	17.31	16.94	2.14	0.37
8/27/2013	Carse	186.00	193.49	4.03	7.49
9/3/2013	Shaker	146.72	172.33	17.46	25.61
9/10/2013	Gorge	24.33	18.29	24.83	6.04

Huntington River Study: Year-by-Year Comparisons* **Table 4**

	2004**	2005**	2006	2007	2008	2009	2010	2012	2013
Overall Geomean	58	110	64	88	103	57	65	61	105
Overall Geomean: Huntington	58	110	59	75	99	63	65	60	106
Overall Geomean: Richmond	Not done	Not done	72	102	85	49	66	56	98
Days when overall Geomean for the day > Federal	2	3	1	3	3	0	2	2	3
Days when overall Geomean for the day > State	4	10	6	6	9	4	5	3***	4***
Total samples > Federal	20	48	19	39	61	12	25	27***	48***
Total samples > State	40	98	58	94	137	58	79	37***	75***
Overall Geomean for any site over season > Federal	0	3	0	0	0	0	0	0***	0***
Overall Geomean for a site over season > State	0	12	5	12	14	4	2	2***	14***

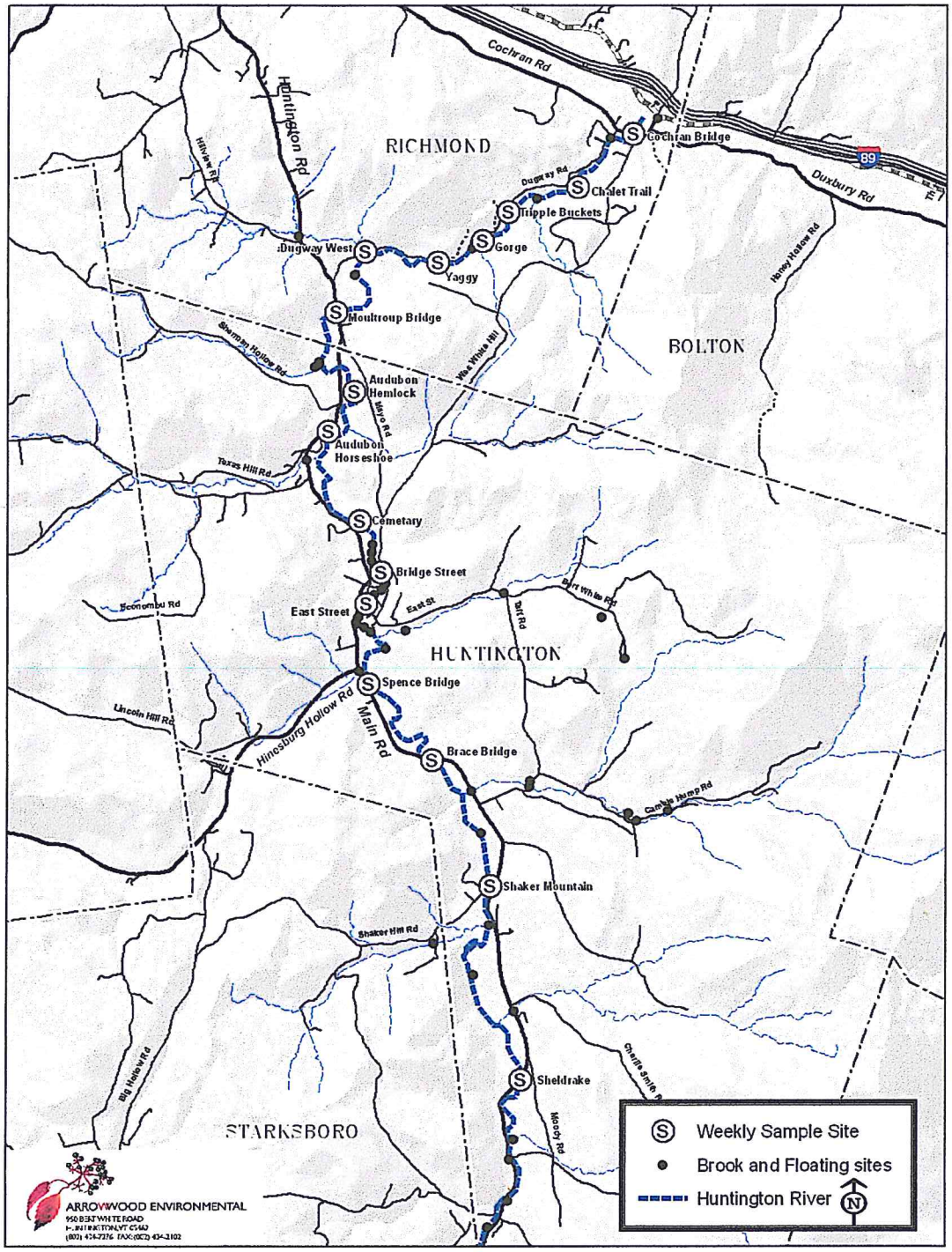
*Winooski River samples not included

**Huntington Segment only was studied

*** State Standard became Federal Standard in 2012. Indicated number based on old State Standard = 77, for purposes of comparison with previous years.

Huntington River Study 2013: Site Map

Figure 1



Huntington River Study - 2013

Figure-2.1

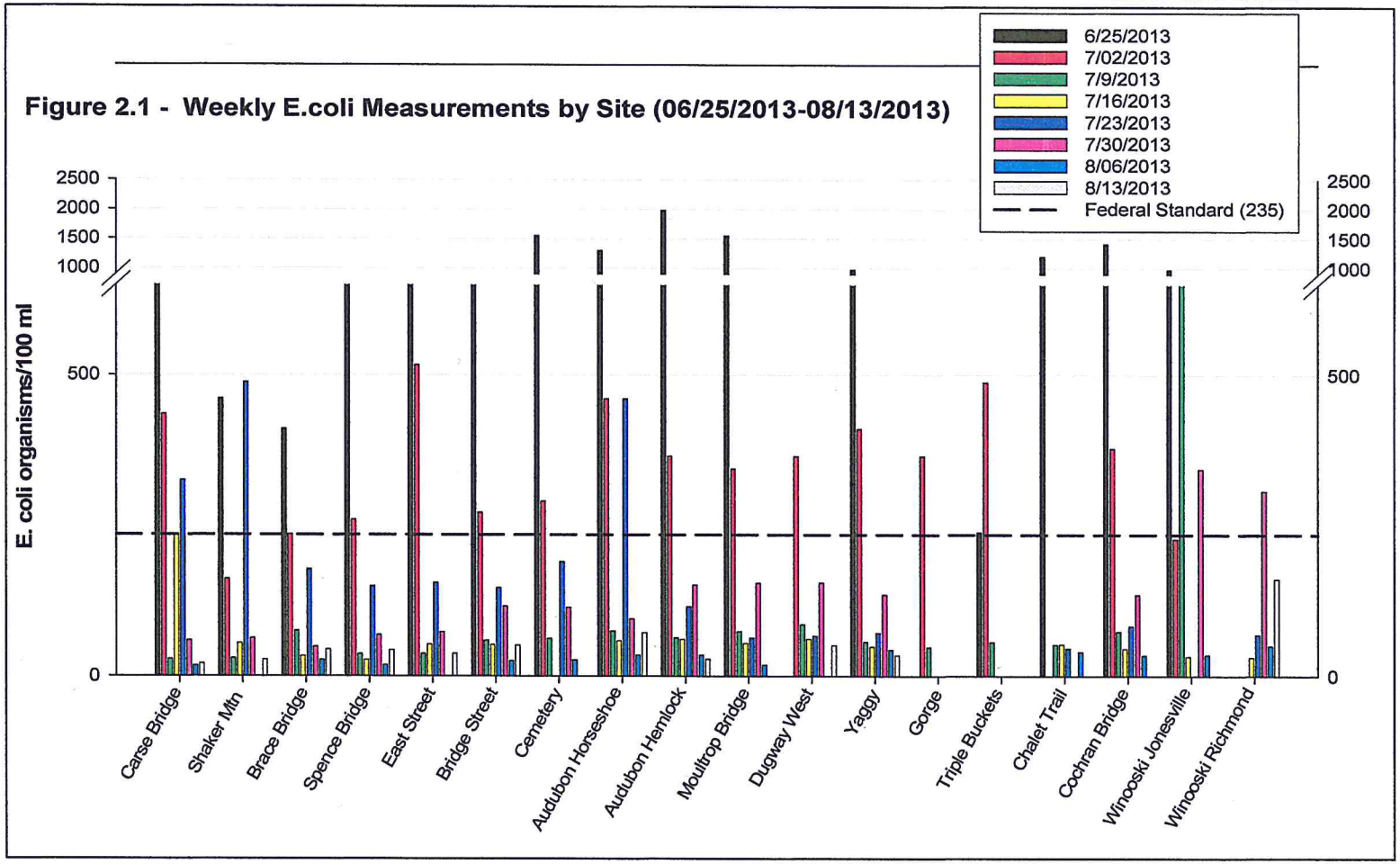


Figure-2.2

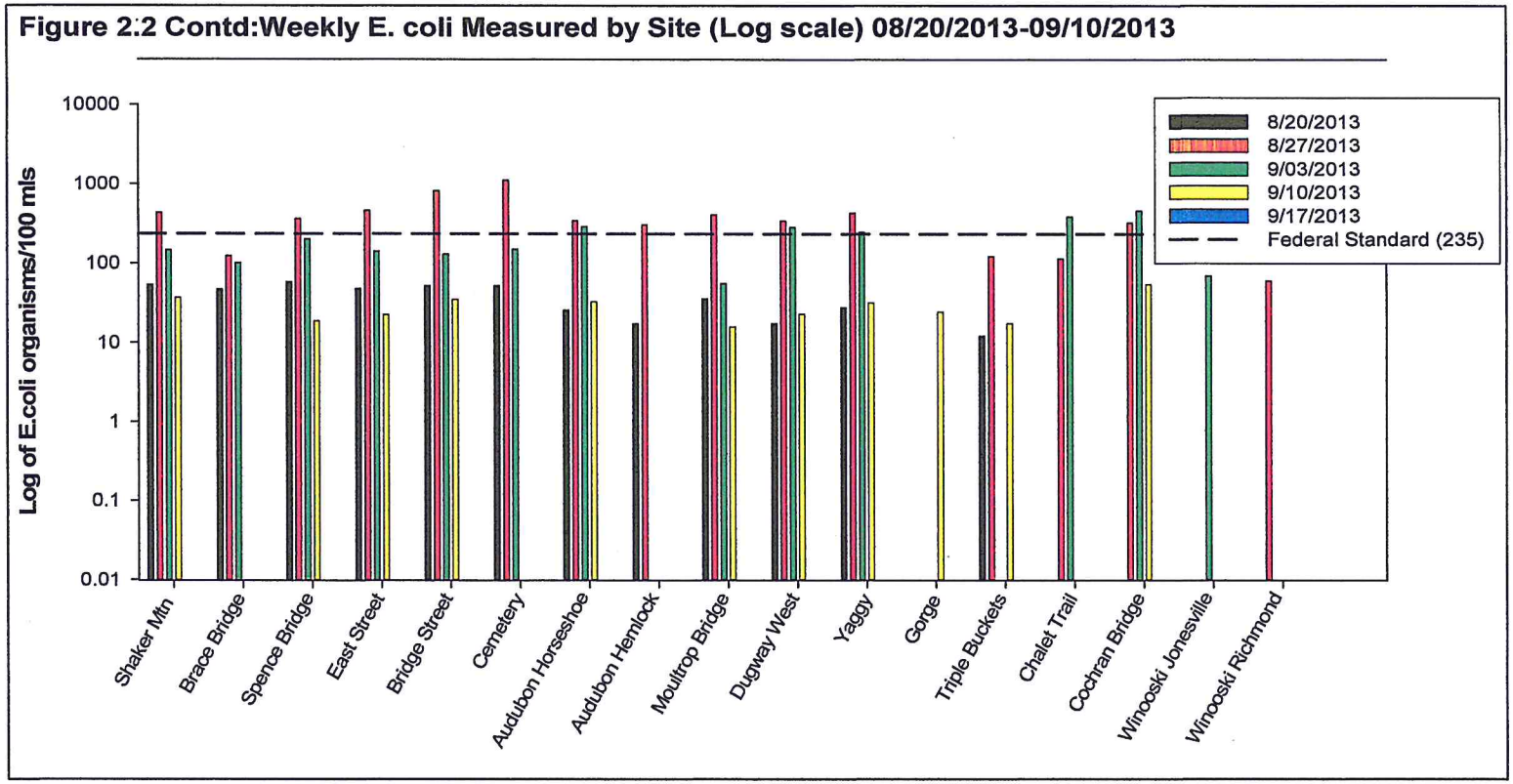
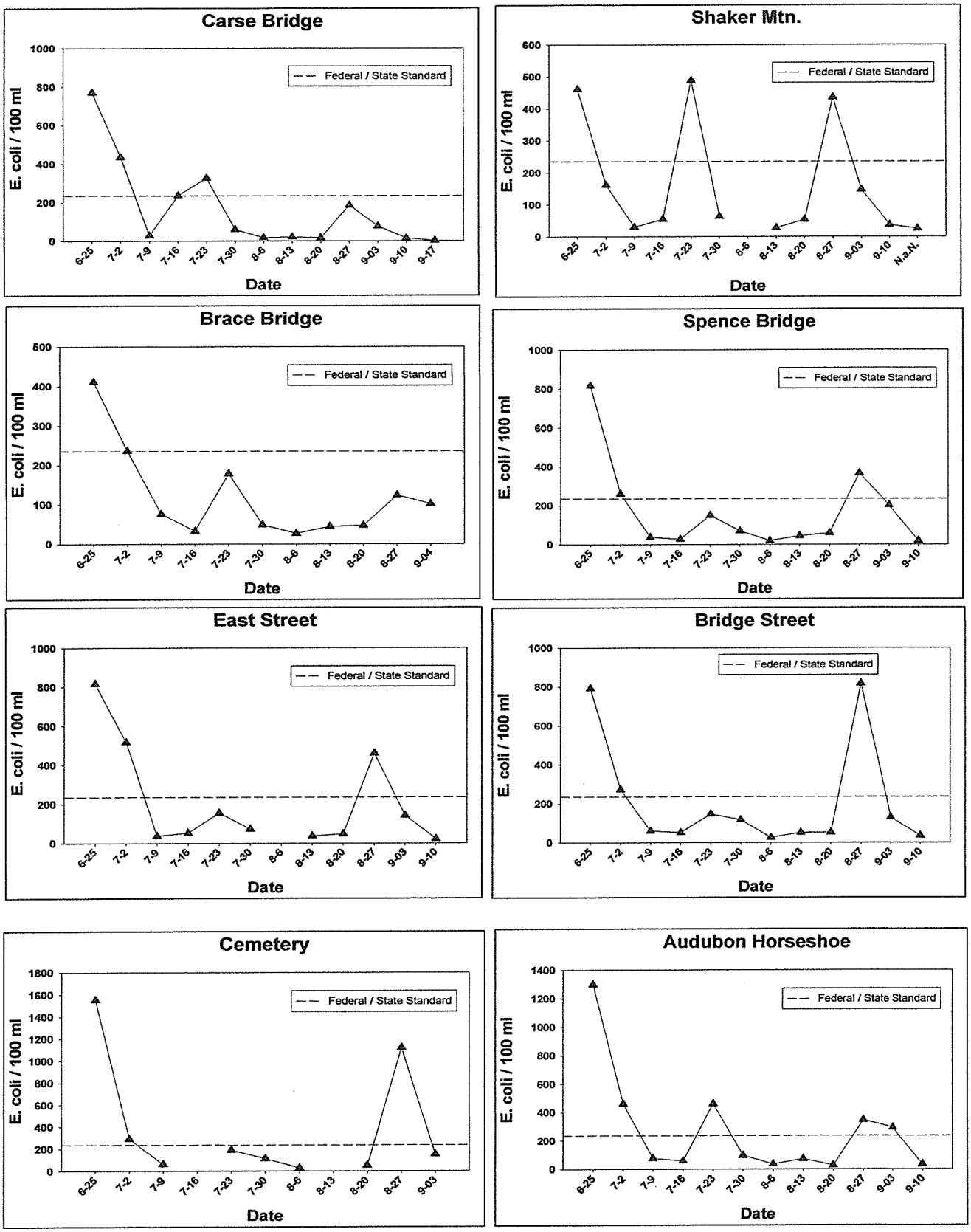


Figure 2:2 Contd:Weekly E. coli Measured by Site (Log scale) 08/20/2013-09/10/2013
Log of E.coli organisms/100 mls
10000
1000
100
10
1
0.1
0.01
8/20/2013
8/27/2013
9/03/2013
9/10/2013
9/17/2013
Federal Standard (235)
Shaker Mtn
Brace Bridge
Spence Bridge
East Street
Bridge Street
Cemetery
Audubon Horseshoe
Audubon Hemlock
Moultrop Bridge
Dugway West
Yaggy
Gorge
Triple Buckets
Chalet Trail
Cochran Bridge
Winooski Jonesville
Winooski Richmond

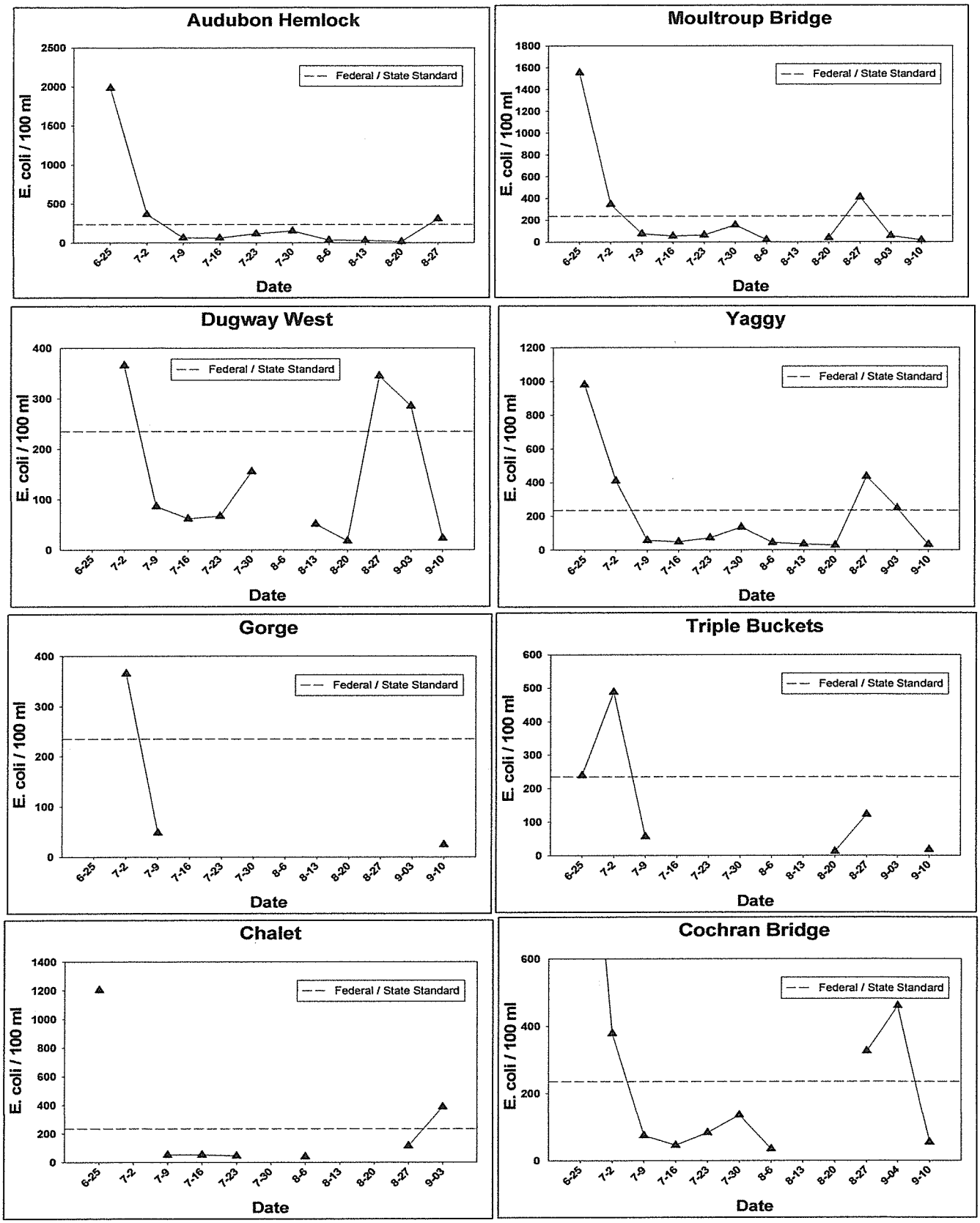
Huntington River Study - 2013

Figure-3.1



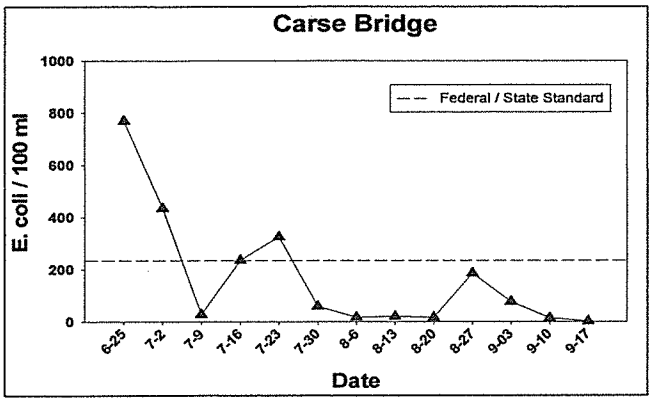
Huntington River Study - 2013

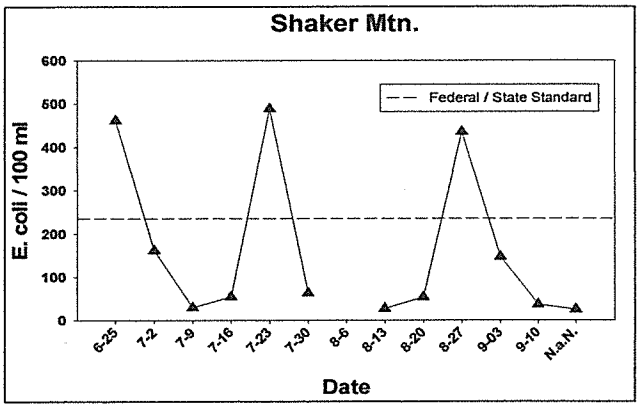
Figure-3.2

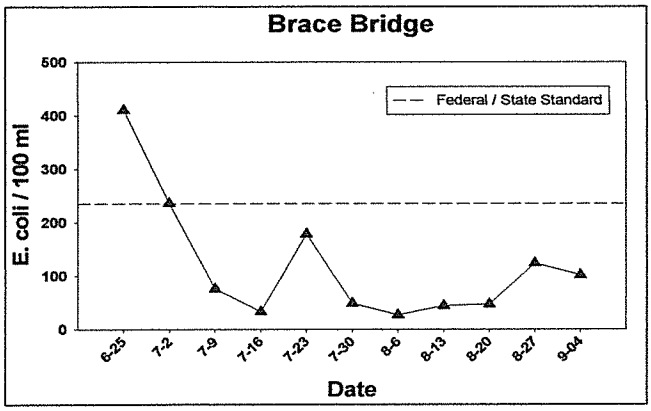


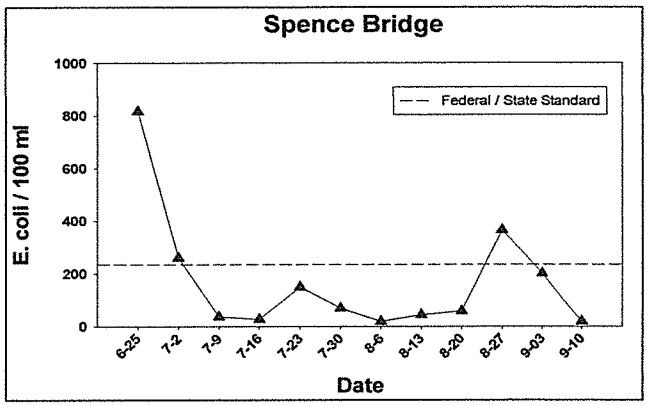
Huntington River Study - 2013

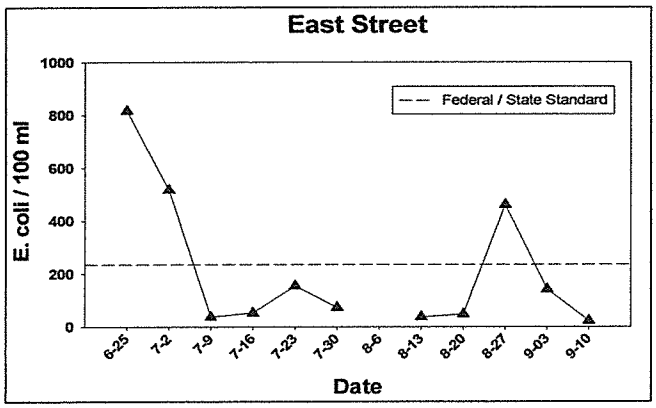
Figure-4.1

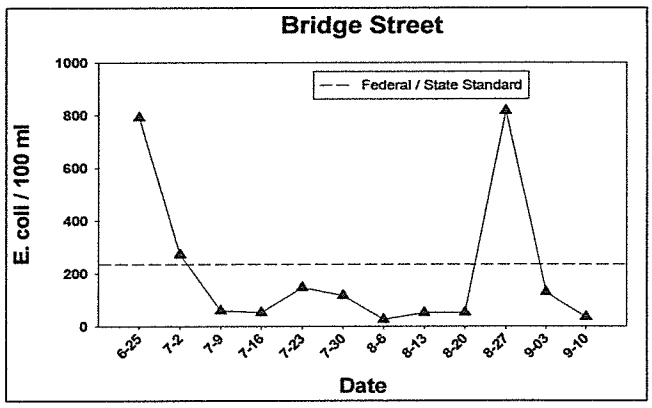


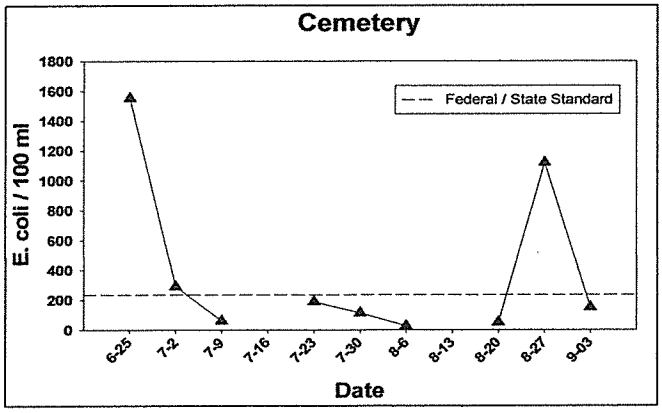


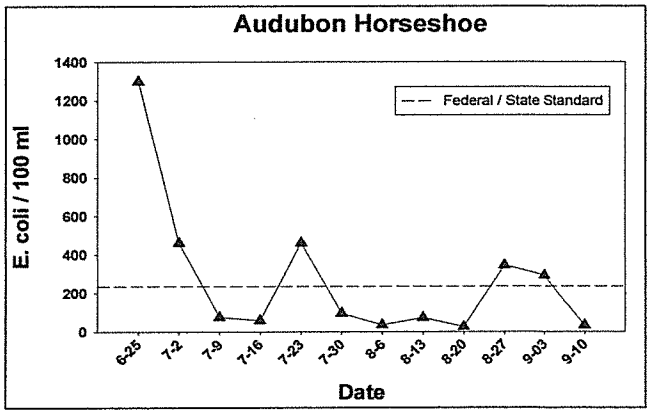












Huntington River Study - 2013

Figure-4.2

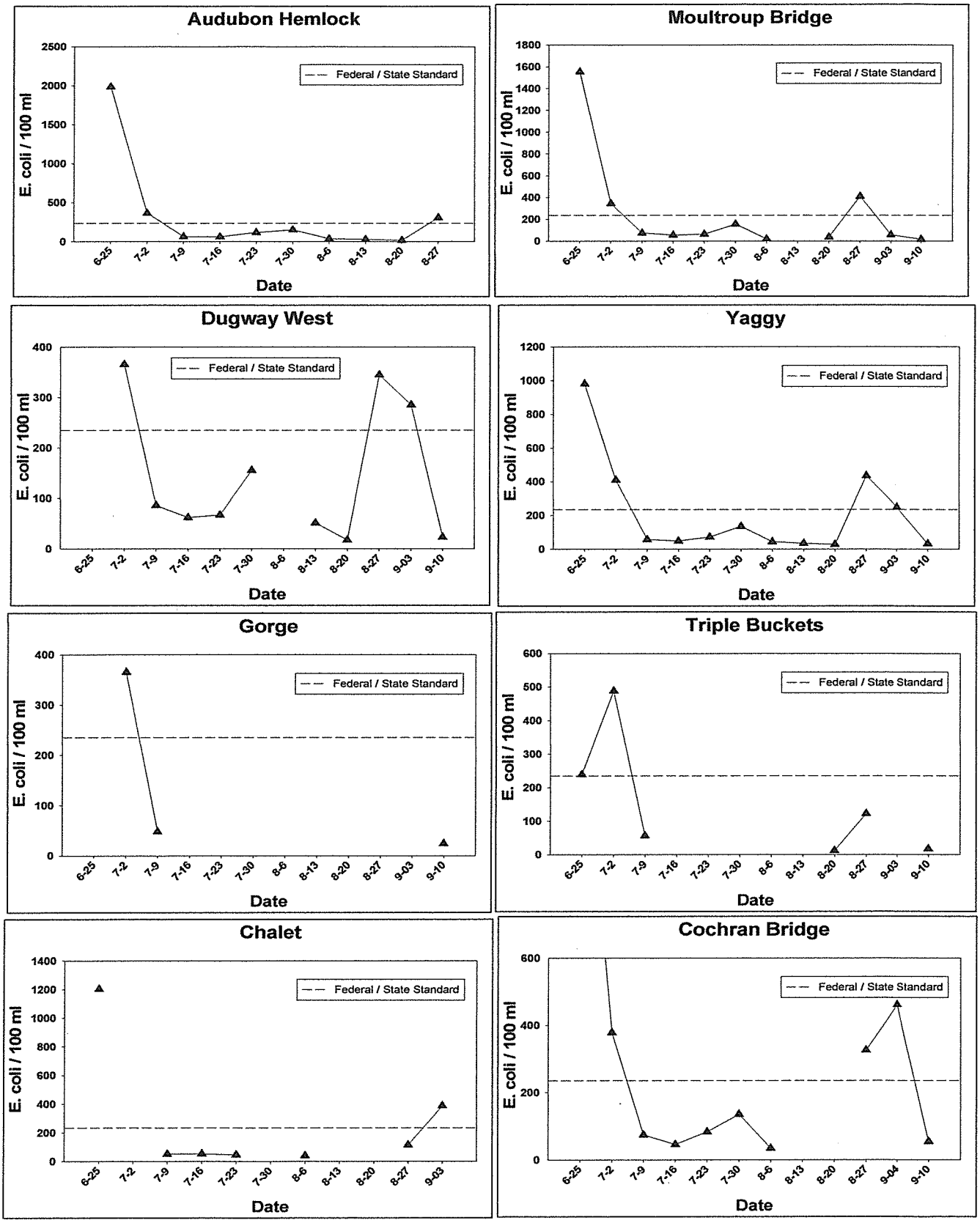
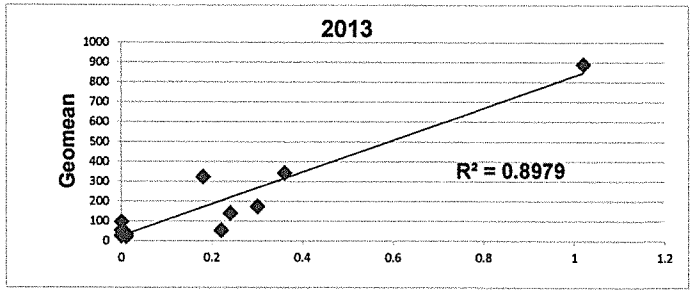
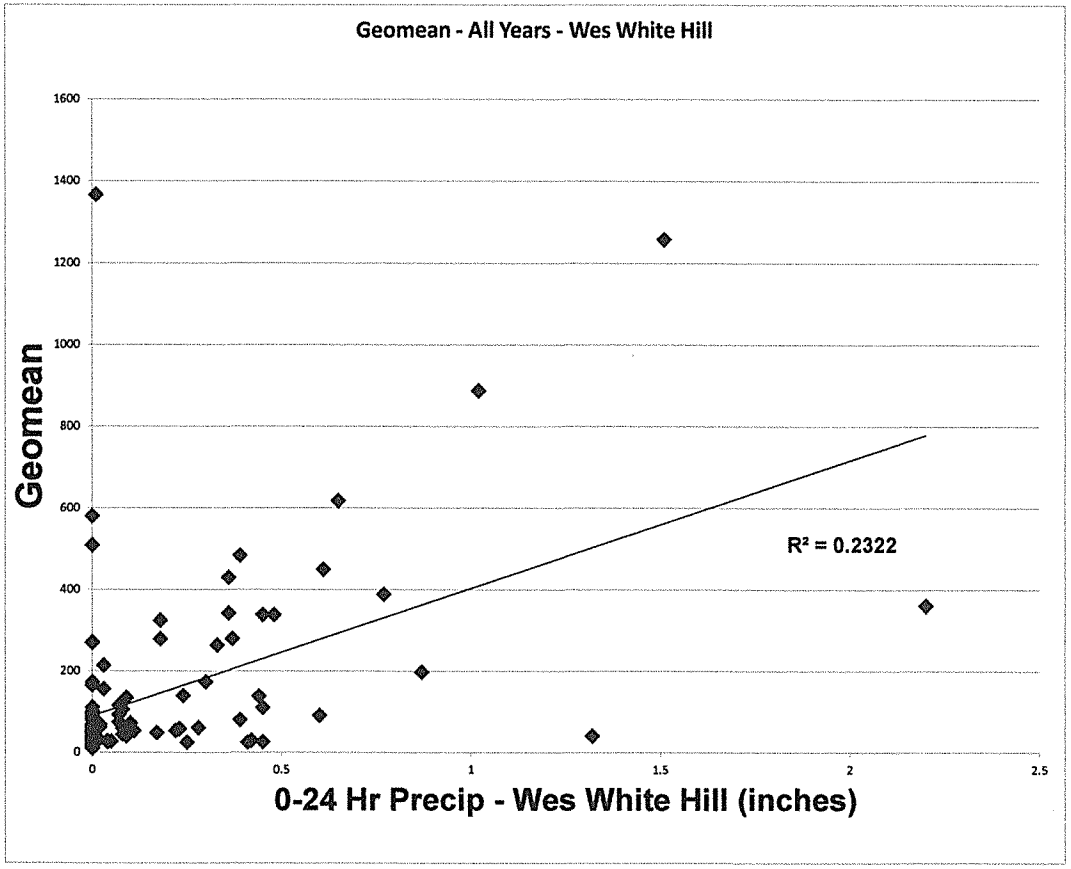


Figure 5.1

2013 Data

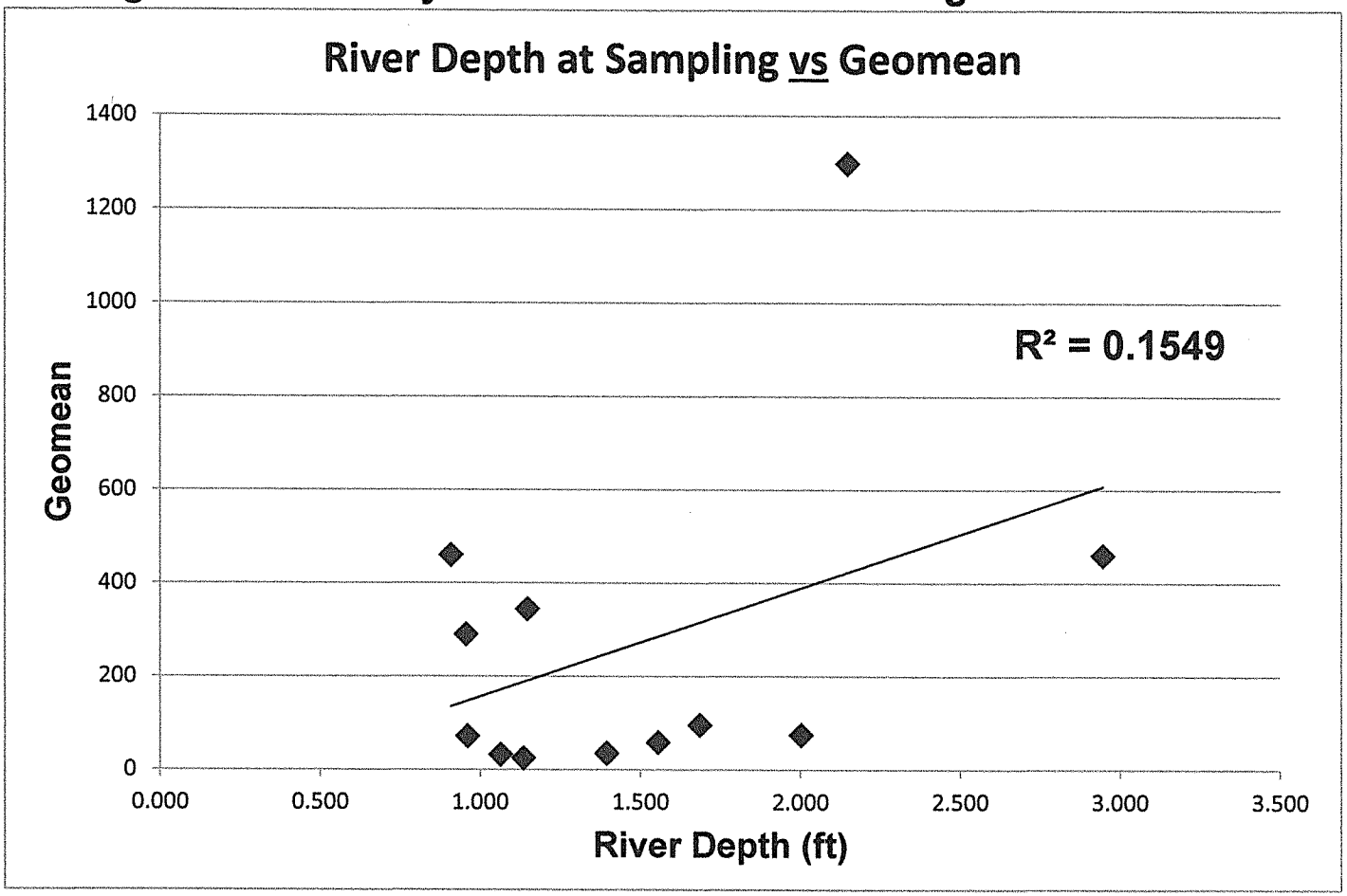
0-48 before	24 before	Geomean
1.99	1.02	889
0.72	0.36	342
0.27	0.22	55
0.01	0.00	55
0.24	0.24	141
2.39	0.00	98
0.48	0.00	28
0.01	0.01	39
0.00	0.00	32
0.31	0.18	324
0.30	0.30	174
0.01	0.01	25





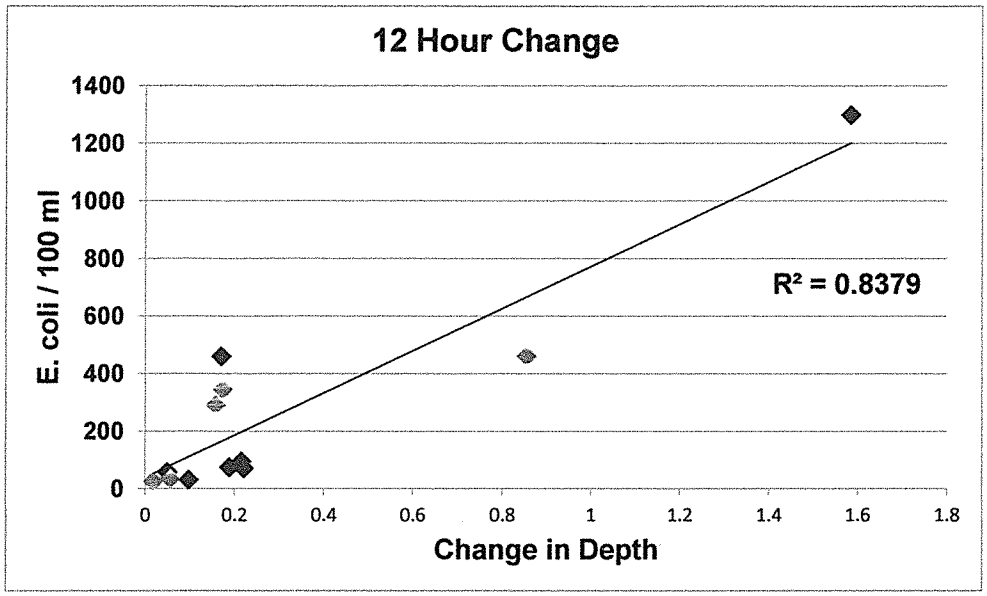
Huntington River Study - 2013

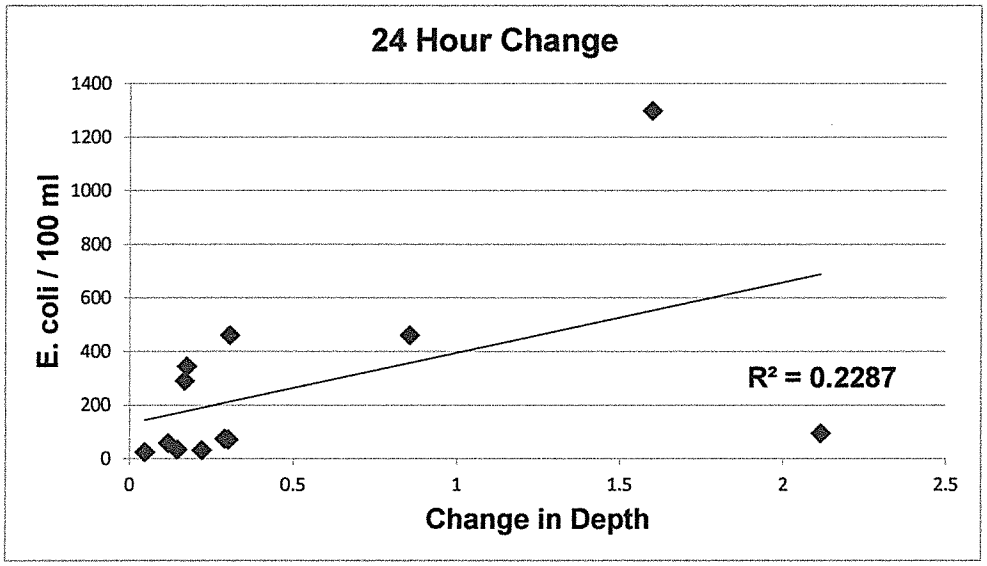
Figure 5.2

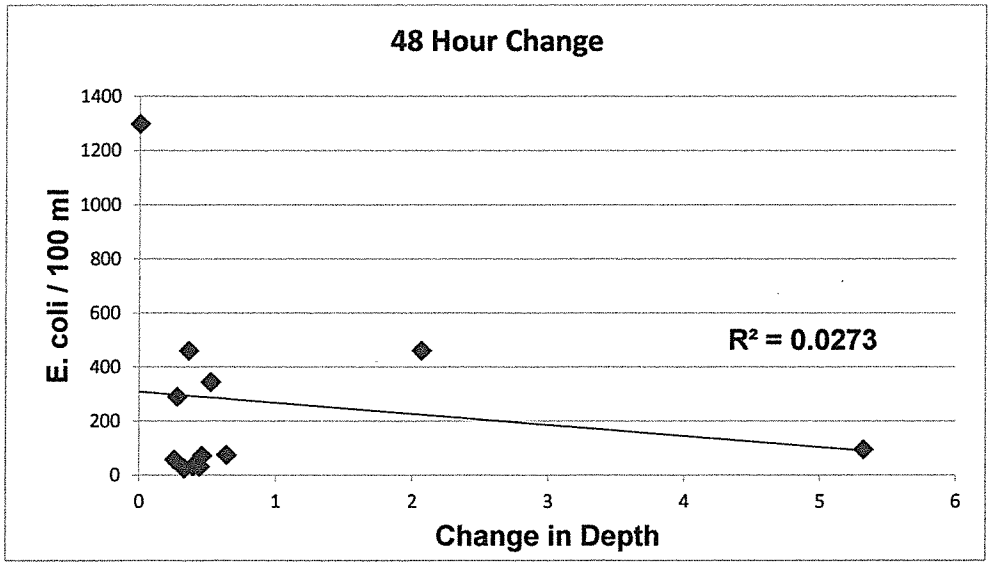


Huntington River Study - 2013

FIGURE 5.3

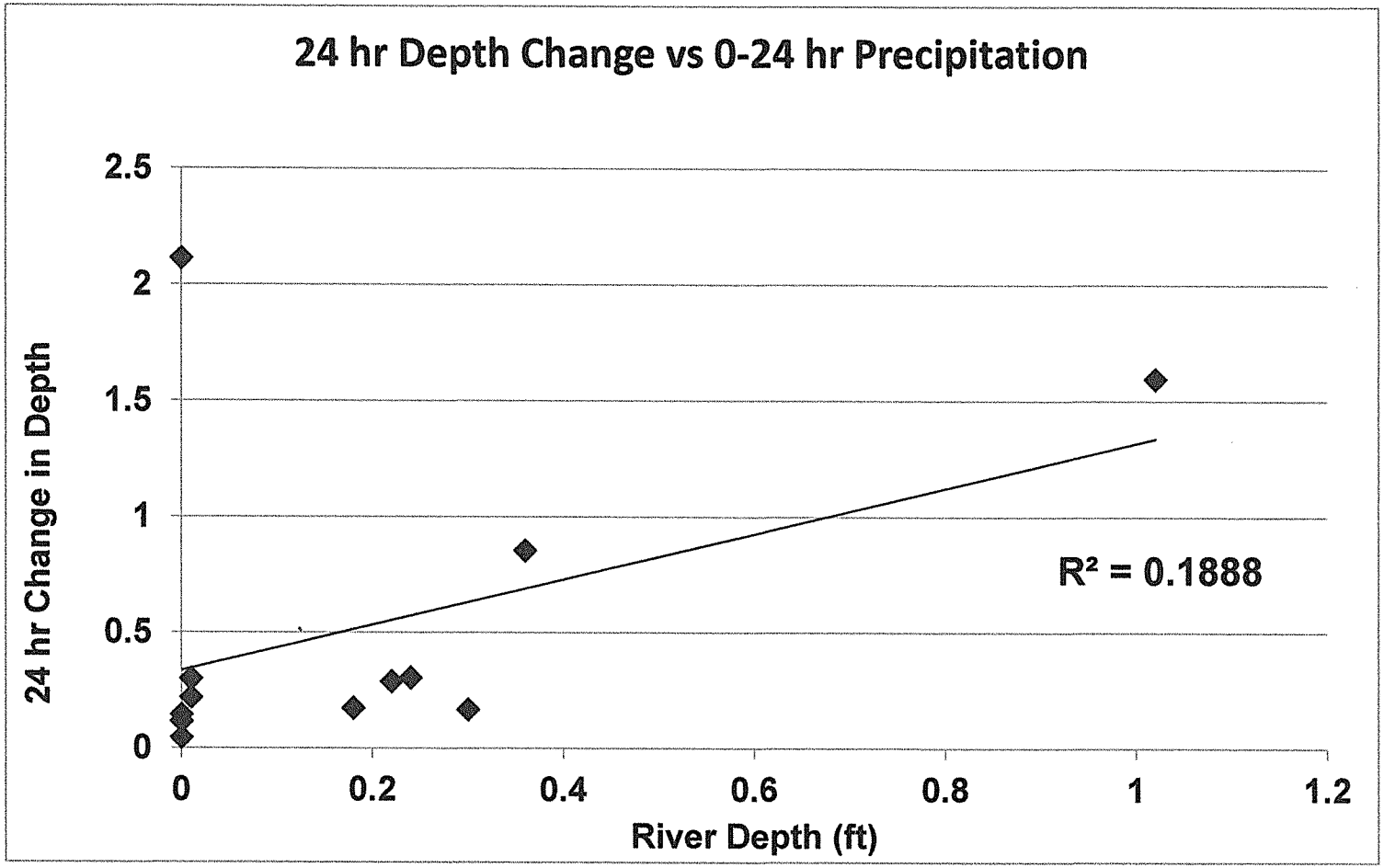






Huntington River Study - 2013

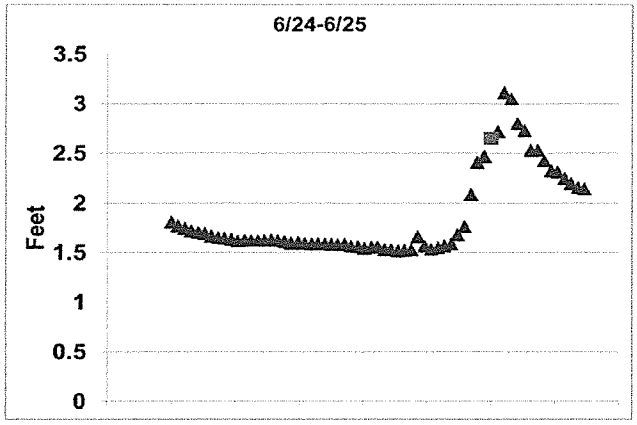
Figure 5.4



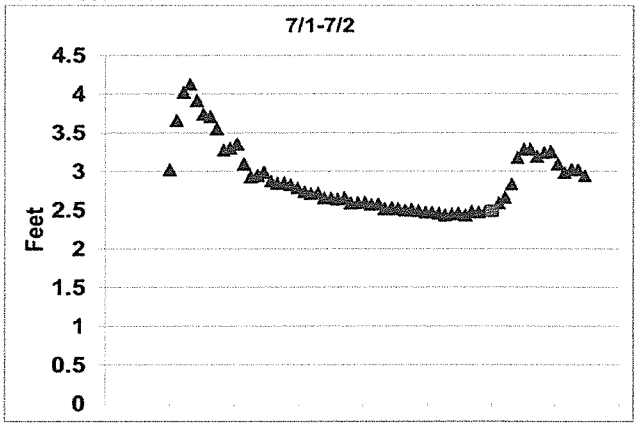
Huntington River Study - 2013 -- Water Level vs Geomean

FIGURE 5.5.1

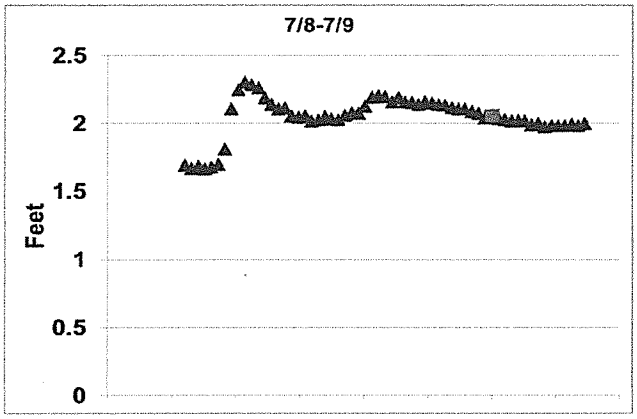
Geomean = 888.5



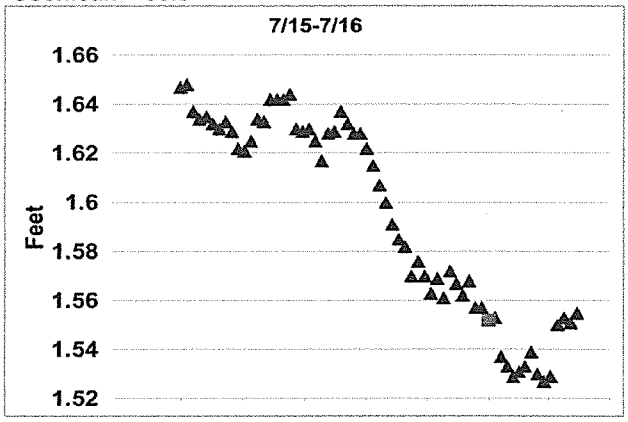
Geomean = 342.4



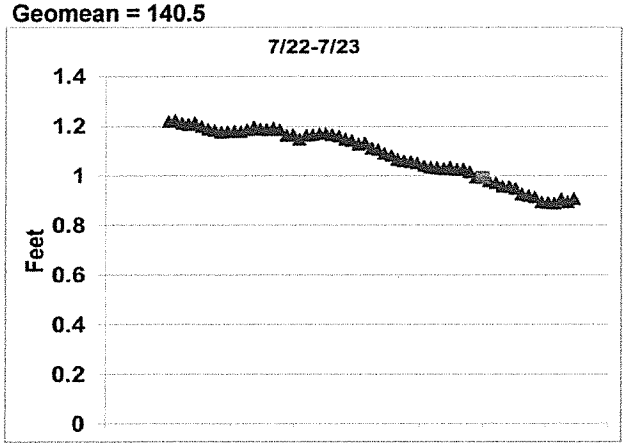
Geomean = 54.6



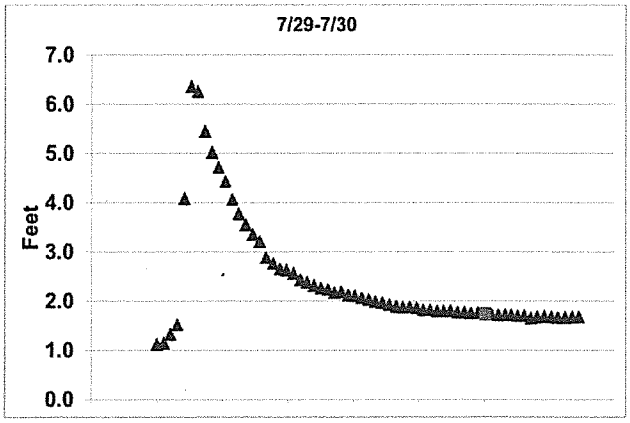
Geomean = 55.3



Geomean = 140.5



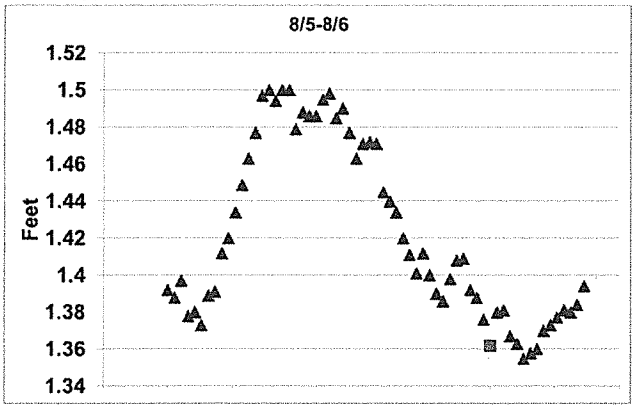
Geomean = 98.2



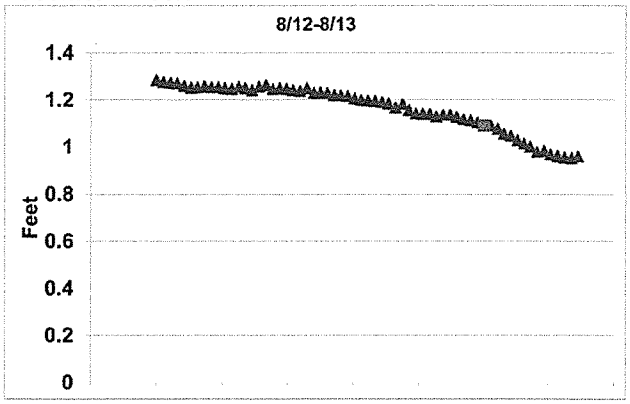
Huntington River Study - 2013 -- Water Level vs Geomean

FIGURE 5.5.2

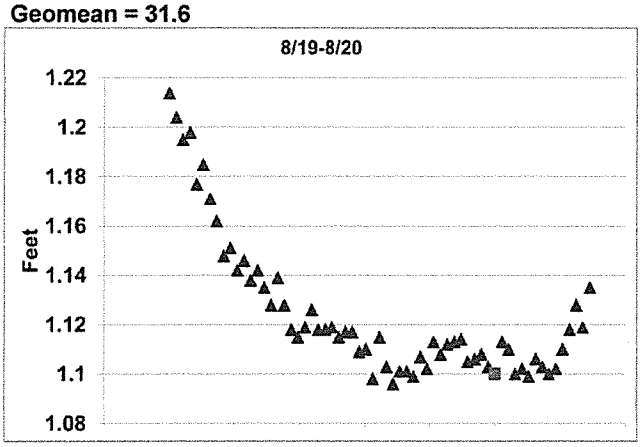
Geomean = 28.1



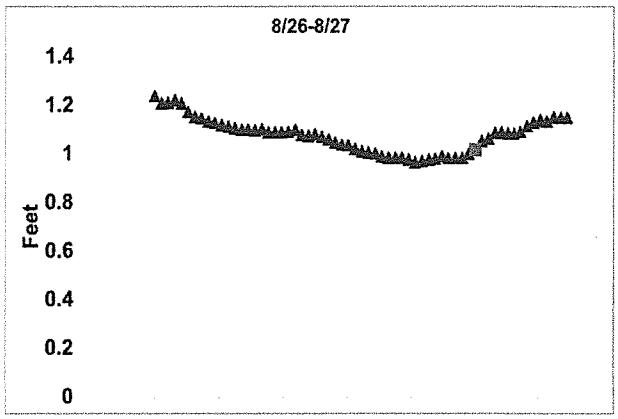
Geomean = 38.8



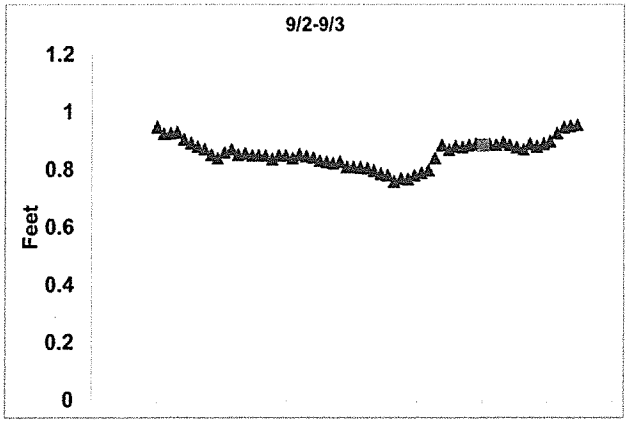
Geomean = 31.6



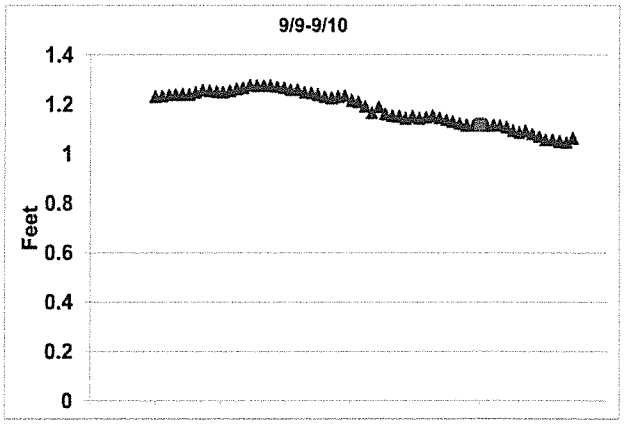
Geomean = 324.3



Geomean = 173.9

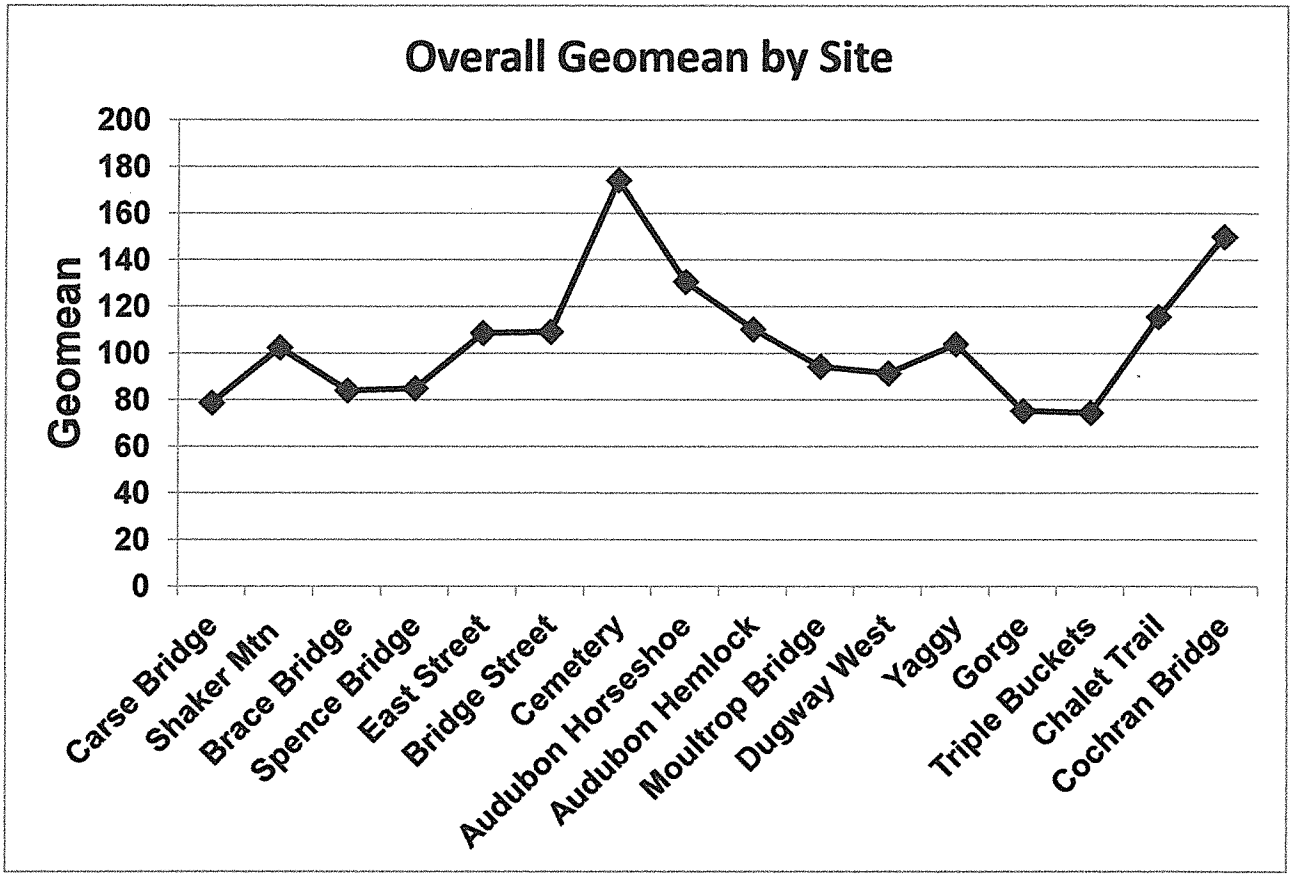


Geomean = 25.4



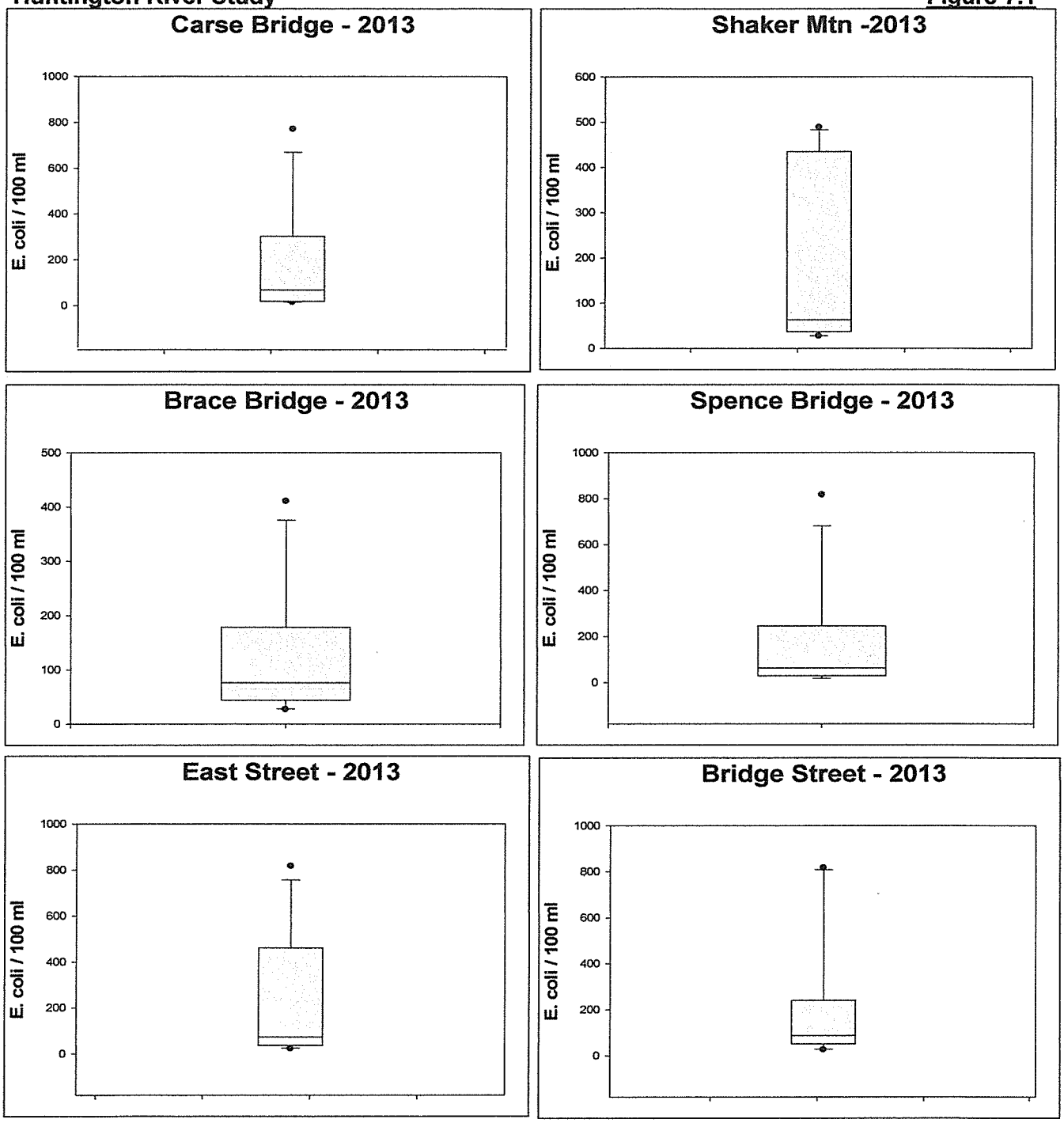
Huntington River Study - 2013

Figure 6



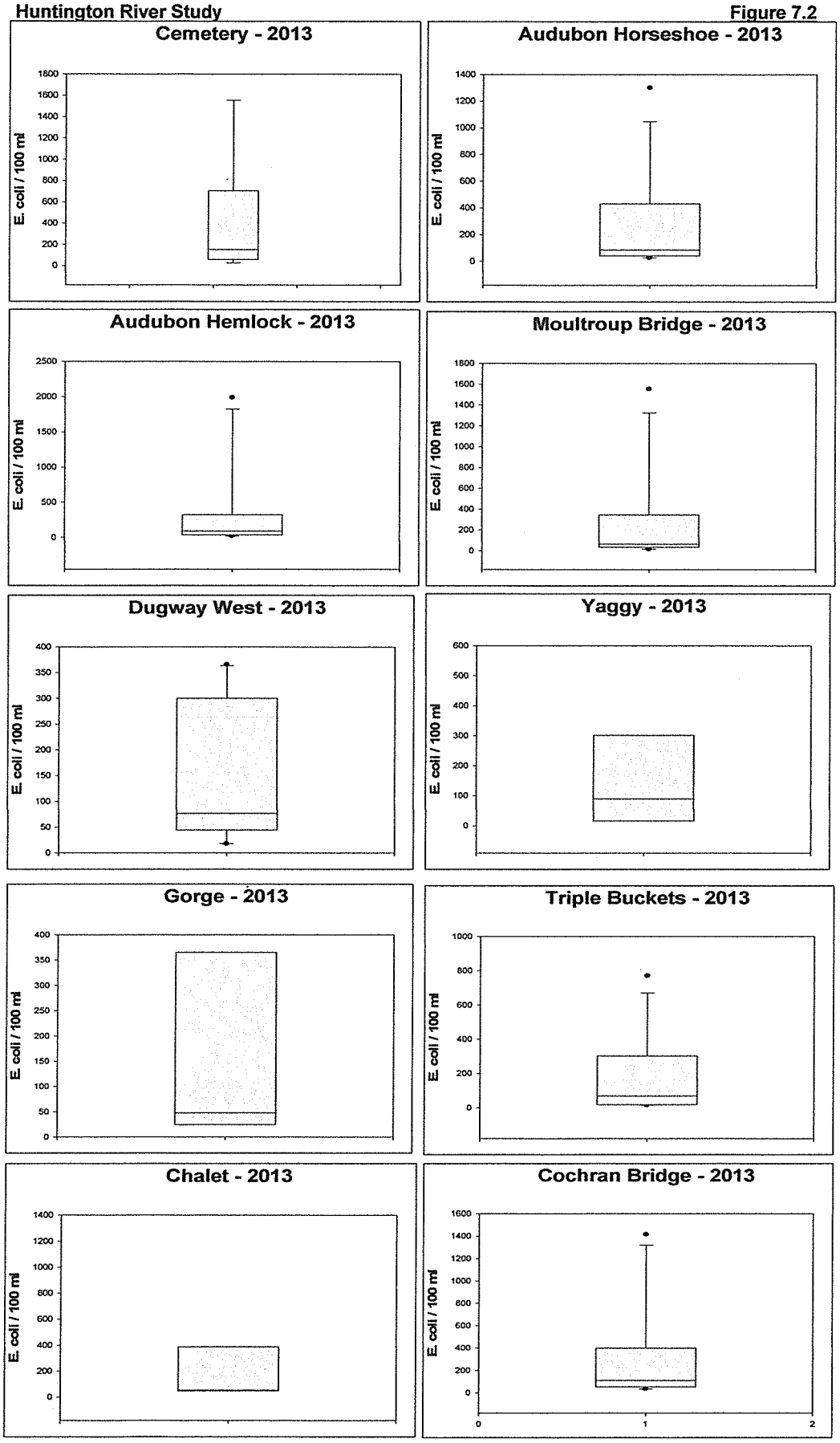
Huntington River Study

Figure 7.1



Huntington River Study

Figure 7.2



Huntington River Study - 2013 - Winooski River

Figure 8