2010

Clackamas Water Quality Monitoring

Clackamas County Soil and Water
CONSERVATION DISTRICT
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PROJECT OVERVIEW

The Clackamas Water Quality Monitoring Program is an initiative undertaken through a partnership between the Clackamas County Soil and Water Conservation District and the Oregon Department of Agriculture. These agencies have a long standing commitment to promoting the economic viability of our rural and agricultural communities while preserving the integrity of our natural resources. This water quality monitoring program was established to examine the effects that our land use practices have on water quality and ecological health.

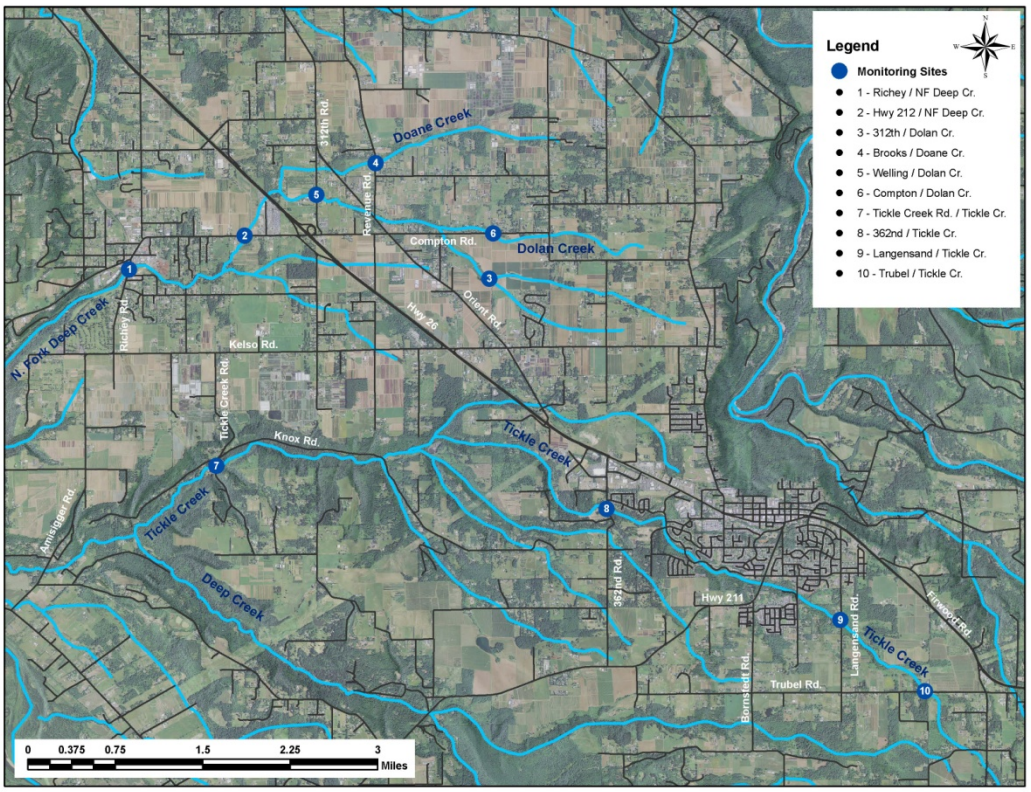


Figure 1. Clackamas Water Quality Monitoring Site Locations

Initiated in 2009, the Clackamas Water Quality Monitoring Program seeks to assess the relative impacts of urban and agricultural land use practices on water quality. Ten sites within the Deep Creek sub-basin of the Clackamas River were identified and define the overall study area (*Figure 1*). These sites were selected based on their accessibility, and relative distribution throughout the Deep Creek sub-basin.

The desired result of the Clackamas Water Quality Monitoring Program is increased insight into the effects of various land use practices on water quality. These findings will allow us to make more informed management decisions to protect our natural resources while preserving the economic viability of our urban and rural communities.

STREAM SAMPLING

Stream Sampling Overview

Stream sampling was initiated in September, 2009 at ten sampling sites in the Deep Creek sub-basin (Figure 1). Sampling was carried out on a monthly basis for eight water quality metrics. Each of the ten sites were sampled for total phosphorus (mg/L), conductivity (µS), pH (std units), dissolved oxygen (mg/L), turbidity (NTU), *E. coli* (MPN/100), nitrate-nitrite (mg/L), and total suspended solids (mg/L). Water samples were collected through a cooperative agreement with the Clackamas County Water and Environment Services (WES) laboratory.

Monthly sampling dates, specifically included September 28, 2009, October 23, 2009, October 26, 2009, November 23, 2009, December 15, 2009, January 25, 2010, February 11, 2010, March 22, 2010, April 2, 2010, May 24, 2010, and June 21, 2010 (Appendix I). June samples were still being processed at the time of this report and are therefore unavailable for inclusion.

The Clackamas Water Quality Monitoring Program has also recorded stream temperature data continually since September 28, 2009. HOBO™ water temperature data loggers were deployed at each of the ten study sites. The data loggers were attached to a cinderblock and secured to a post or tree to allow for later retrieval. Temperature data was collected at one hour intervals since deployment.

An inspection of the data loggers was carried out on February 26, 2010 to ensure that no data loggers were lost following winter storm activity and high stream flows. At that time all data loggers were located and identified, but were not removed from the water column. On July 7, 2010, the data loggers were recovered, and data was downloaded for inclusion in this report..

Stream Sampling Results

Analysis of the water quality data was carried out for water samples collected between September, 2009 and May 2010. The summary data presented is cumulative and incorporates all data collected to date (Table 1). Each of the water quality metrics were analyzed and compared to published freshwater aquatic life standards or benchmarks whenever available using the chronic criteria.

A summary graph for each metric is provided for all observation times at each of the sites. Averages across all samples periods were also calculated for each metric. 95% confidence intervals (± SE ×1.96) were calculated for each of the summary graphs. Sampling sites are depicted upstream to downstream moving from left to right. The North Fork Deep Creek and Tickle Creek stream systems are separated for each graph. Site specific results and graphs were also prepared for each metrics at each site, but were excluded from analysis and interpretation. These are available for consideration (Appendix III).

Table 1. Stream sampling summary for September 2009 through May 2010

Location	Total Phosphorous		Dissolved Oxygen		Conductivity		Turbidity		pH		*E. Coli*		Nitrate-Nitrite		Total Suspended Solids	
	Ave	StDev	Ave	StDev	Ave	StDev	Ave	StDev	Ave	StDev	Ave	StDev	Ave	StDev	Ave	StDev
Welling/Dolan Cr.	0.07	0.14	8.87	1.97	85.01	68.29	78.48	134.95	6.08	0.29	204.30	253.62	2.72	0.98	56.98	97.58
Compton/Dolan	0.46	1.19	9.81	0.94	59.21	49.32	185.87	344.08	5.86	0.23	1616.56	3837.17	2.29	0.44	90.82	180.06
Brooks/Doane Cr.	0.19	0.15	10.30	0.88	103.75	79.22	89.96	68.97	6.28	0.36	404.00	544.83	2.25	0.88	45.56	40.25
312th/Dolan Cr.	0.11	0.09	9.81	1.21	133.41	152.58	63.08	49.44	6.33	0.42	387.90	595.76	1.97	0.98	40.43	37.28
Hwy 212/ NF Deep Cr.	0.08	0.11	9.47	1.32	97.86	72.23	47.26	57.70	6.18	0.51	425.20	383.54	1.69	0.85	24.04	27.65
Richey/NF Deep Cr.	0.13	0.15	10.09	0.95	118.87	106.99	36.31	32.01	6.41	0.41	706.90	819.44	2.00	0.83	31.88	48.26
Trubel/Tickle Cr.	0.02	0.05	10.46	0.91	51.87	41.69	14.57	22.33	6.29	0.35	698.10	1699.17	1.13	0.56	20.70	41.91
Langensand/Tickle Cr.	0.00	0.00	10.85	1.77	53.69	40.80	7.84	6.54	6.19	0.44	355.90	574.47	0.99	0.45	10.88	12.60
362/Tickle Cr.	0.01	0.03	10.53	0.79	58.18	48.69	13.48	9.43	6.25	0.36	350.70	607.39	0.96	0.45	15.41	14.84
Tickle Cr Rd/Tickle Cr.	0.27	0.27	10.77	0.89	91.66	86.75	20.59	19.99	6.35	0.34	448.30	528.40	1.58	0.66	23.60	27.81

Stream temperature data was analyzed for diurnal fluctuations for each site and across all sites (Appendix III). Monthly average stream temperature was also analyzed for each site and across all sites. Upon retrieval an error was identified with the Site 3 (312 & Dolan) data logger. The Site 3 data logger only collected temperature data for September 2009. As a result, the temperature data from this site was omitted for the majority of this analysis. Site 3 (312th & Dolan) analysis was limited to averages obtained from September 2009 totals only. Stream temperature was summarized for hourly and monthly variation between sites

pH

Standard: 6.5 to 8.5 for all basin waters [2]
Figures: 2 & 3
Results: pH values varied across sites (Figure 2). Values for pH varied from 5.3 to 7.1 with a mean of 6.22 (S_n=0.39). Values were notably acidic. In general the pH was relatively consistent between sampling points (Figure 3), with only a slight increase in pH moving downstream. Site 6 (Compton & Dolan) was on average the most acidic with an average pH of 5.86 (S_n=0.23). Site 1 (Richey & Dolan) had the highest average pH with 6.41 (S_n=0.41). Concern was raised by early reviewers regarding potential systematic errors as a result of low conductivity. A review of the QA/QC protocols provided by WES revealed no apparent anomalies. The observed pH was typically lower than the state water quality standard. Average pH values exceeded DEQ standards and were acidic at all 10 of the sample sites.

Dissolved Oxygen

Standard: For Steelhead and Salmon spawning (Oct 15-June 15), the DO level should be 11mg/L. For other cold water aquatic life, it should be 9 mg/L.[2]
Figure: 4 & 5
Results: Dissolved oxygen was generally lower in the early fall measurements. Observed values have ranged from 4.54 mg/L

and 15.20 mg/L with a mean of 10.10 mg/L (S_n=1.31). Values generally increased following the onset of seasonal rains in October. Average dissolved oxygen was relatively unchanged across the sampling area. Dissolved oxygen content was consistent from upstream to downstream locations and across drainages. Samples taken in the early fall had observed dissolved oxygen levels below the state standards. Winter sampling dates were within or near the acceptable range for spawning salmonids.

E. coli

Standard: The average of five samples shall not exceed 126 MPN/100 and no single sample may exceed 406 MPN/100.[3]
TMDL: mandates a 78% reduction from current conditions to attain standard.
Figure: 6 & 7
Results: *E. coli* values have ranged from 1 MPN/100 to 11636 MPN/100. Mean *E. coli* values were 549 MPN/100 (S_n=1345.5). *E. coli* values peaked in October shortly following the onset of seasonal rains. Average *E. coli* values were consistent across sites. Values were typically below 2500 MPN/100, but two anomalous peaks were observed during the October 26, 2009 sampling period. The majority of the observed *E. coli* values in fall and early winter exceeded the state criteria. Samples taken in late winter and spring exhibited a significant reduction in *E. coli* abundance and were within the state recommendation standards.

Total Phosphorus:

Standard: No accepted standard
Benchmark: < 0.08 mg/L[1]
Figure: 8 & 9
Results: Total phosphorus values ranged from 0 mg/L to 3.62 mg/L. Average phosphorus values were 0.13 mg/L (S_n=0.39). Values typically were less than 0.5 mg/L, with the exception of a large anomalous peak at Site 6 (Compton/Dolan Cr.) on Oct 26, 2009. Two small peaks were also noted at Site 7 (Tickle Cr Rd./Tickle Cr.) on Sept 28, 2009, and Oct 26, 2009. Average phosphorus levels were relatively consistent across the drainage. Total phosphorus values typically exceeded the ODA recommended benchmarks.

Nitrate-Nitrite

Standard: No accepted standard
Benchmark: < 0.5 mg/L [1]
Figure: 10 & 11
Results: The nitrate-nitrite values ranged from 0.1 mg/L and 3.91 mg/L. The mean nitrate-nitrite value was 1.75 mg/L (S_n=0.91). Nitrate-nitrite values were generally higher in North Fork Deep Creek than in Tickle Creek. No apparent trends were observed upstream to downstream or with time. The observed nitrate-nitrite levels generally exceeded the ODA recommended benchmarks at all the sites. When looking at average nitrate-nitrite values every site exceeded the ODA recommended benchmark range.

Total Suspended Solids

Standard: No accepted standard
Benchmark: < 25 mg/L [1]
Figure: 12 & 13
Results: The total suspended solids ranged from 1.4 mg/L to 545 mg/L. The mean was 35.5 mg/L (S_n=69.6). Samples generally were less than 200 mg/L with the exception of two noteworthy peaks. The first peak occurred at Site 6 (Compton/Dolan Cr.) with 545 mg/L on Oct 26, 2009. The second smaller peak occurred at Site 5 (Welling/Dolan Cr.) with 281 mg/L. Observed samples regularly exceeded the ODA recommended benchmarks for total suspended solids, particularly in the North Fork Deep Creek locations. Total suspended solids were typically reduced in late winter and spring.

Conductivity

Standard: No accepted standard
Benchmark: None accepted
Figure: 14 & 15
Results: Conductivity values ranged from 12.5 µS to 554.0 µS, with a mean of 85.61 µS (S_n=82.8). Conductivity values were relatively unchanged over time. Observations in the North Fork Deep Creek and Tickle Creek trended upwards as you moved downstream. An anomalous series of conductivity measurements were recorded for the March 22, 2010 observation date. The reason for this rapid increase is not apparent but may indicate a systematic error for that observation period date.

Turbidity

Standard: No more than a ten percent cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity.[2]
Figure: 16 & 17
Results: Turbidity values ranged from 2.98 NTU to 1000 NTU. The mean turbidity across all sites was 54.4 NTU (S_n=122.4). Turbidity was typically less than 200 at all sites, with the exception of three peaks observed. Two strong peaks (496 NTU and 1000 NTU) were observed at Site 6 (Compton/ Dolan) on Oct 23, 2009 and Oct 26, 2009 respectively. The third peak of 452 NTU was observed at Site 5 (Wellington/Dolan Cr.) on Nov, 23, 2009. Generally the North Fork Deep Creek locations had higher turbidity than those observed in the Tickle Creek area. Turbidity in general decreased moving upstream to downstream.

Temperature

Standard: Target temperature criteria is 55.4 °F during time and locations of salmon and steelhead, 60.8 °F during times of core cold water habitat identification, and 64.4 °F during times and locations of salmon & trout rearing and migration.[3]
Figure: 18, 19, & 20
Results: Average stream temperature values ranged from 47.3 °F to 50.6 °F. The mean temperature across all sites was 50.5 °F (S_n=3.9) (Figure 20). Water temperature was lowest in December and highest in July (Figure 19). Temperature tended to increase in summer months and decreased in winter months in the North Fork Deep Creek locations moving upstream to downstream. Temperatures in the Tickle Creek area show no obvious trend moving upstream to downstream (Figure 18). Diurnal fluctuations for each site exhibited a normal sinusoidal pattern (Appendix III).

Stream Sampling Figures

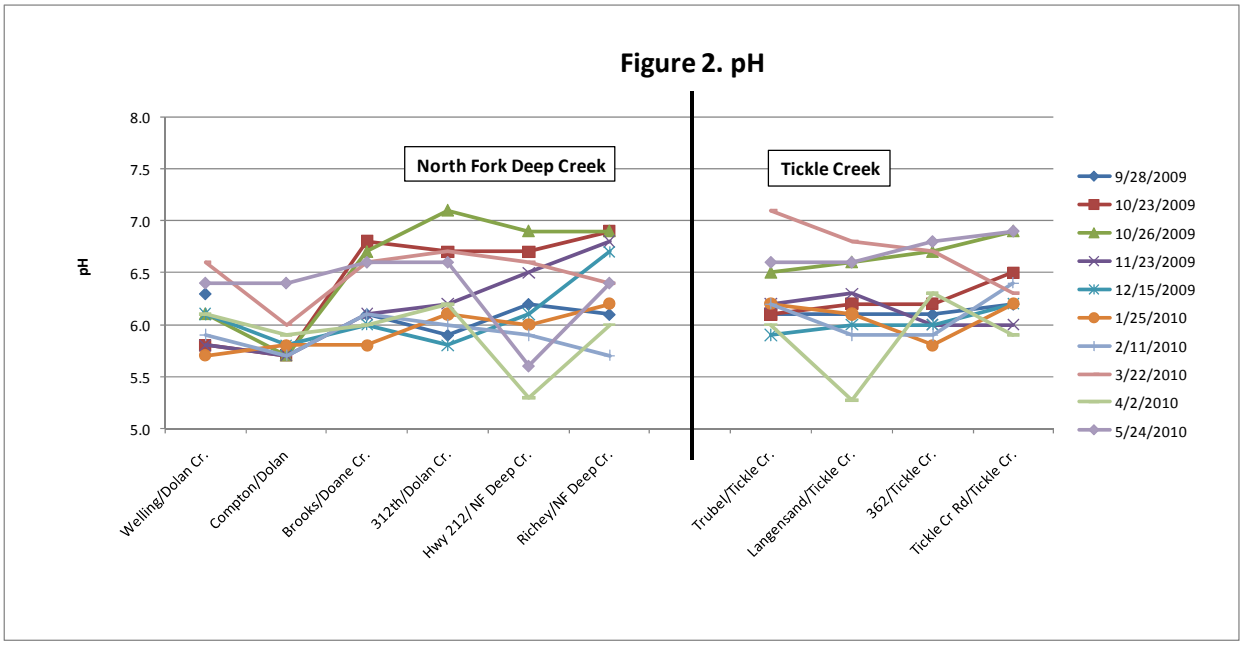
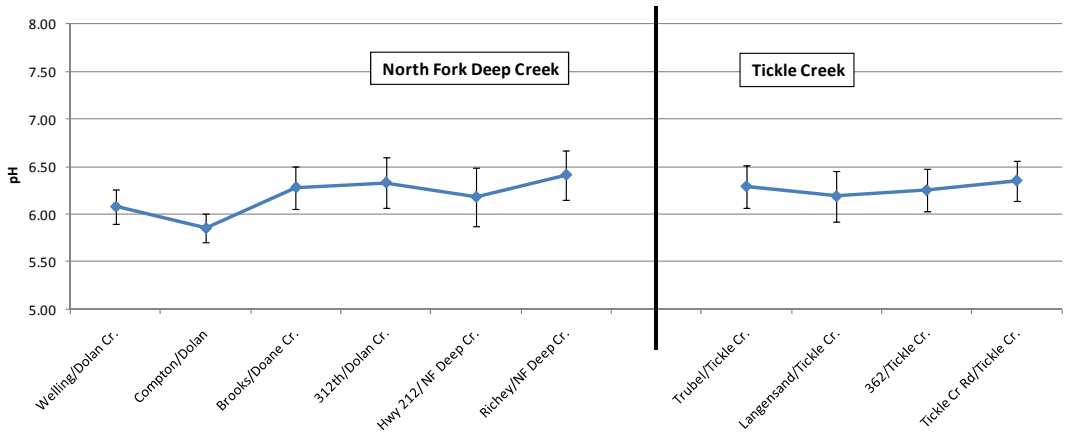


Figure 3. Average pH (95% CI)



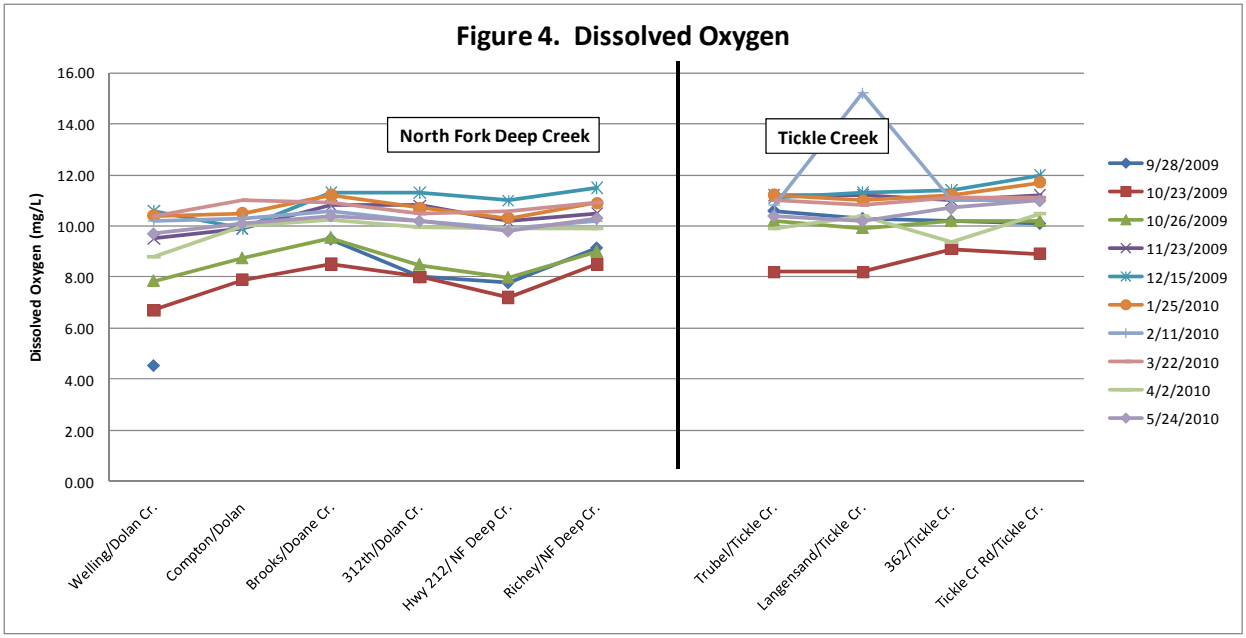


Figure 4. Dissolved Oxygen
Dissolved Oxygen (mg/L)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
North Fork Deep Creek
Tickle Creek
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.
9/28/2009
10/23/2009
10/26/2009
11/23/2009
12/15/2009
1/25/2010
2/11/2010
3/22/2010
4/2/2010
5/24/2010

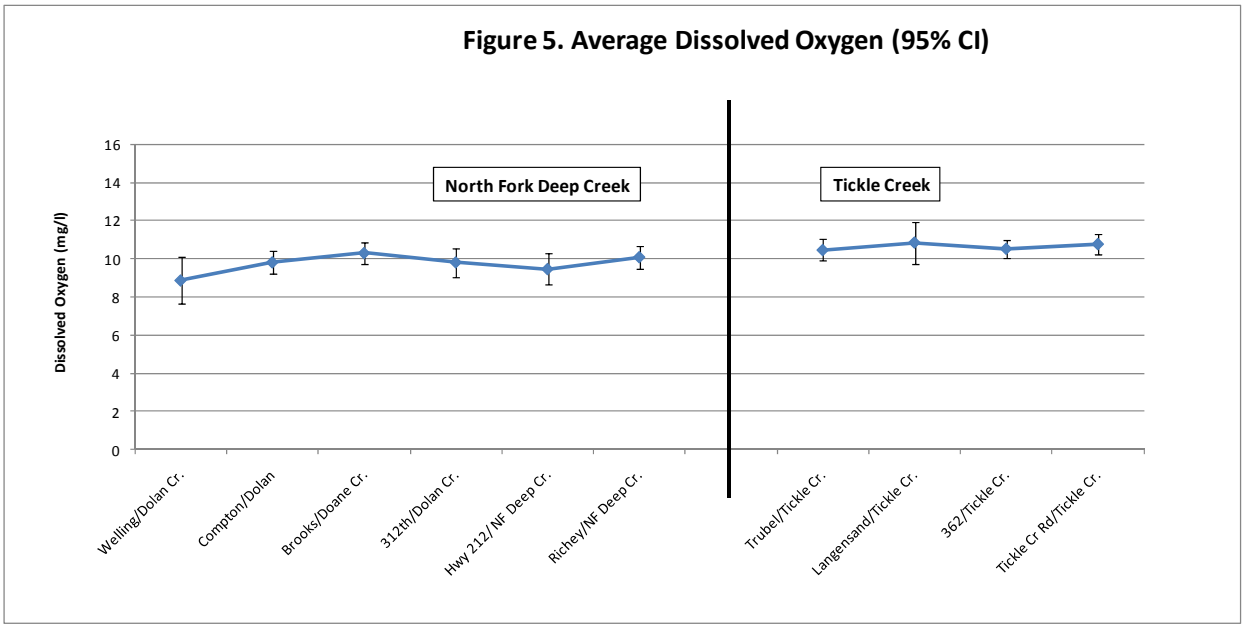


Figure 5. Average Dissolved Oxygen (95% CI)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
North Fork Deep Creek
Tickle Creek
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.

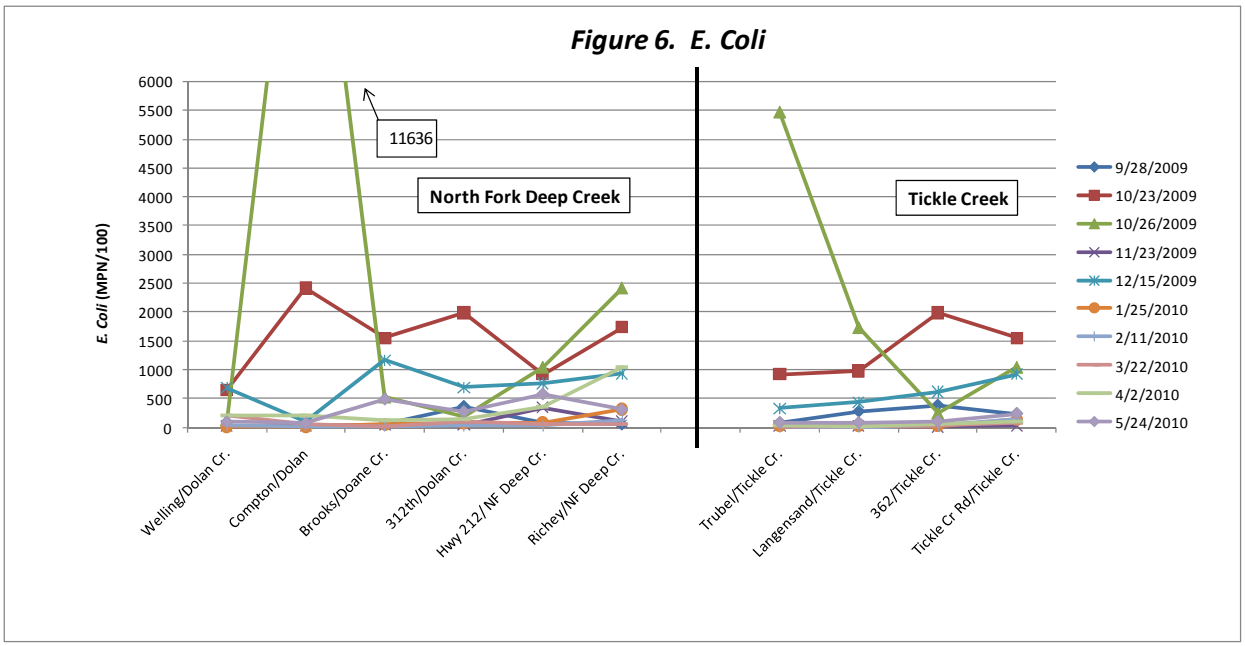


Figure 6. E. Coli
E. Coli (MPN/100)
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
11636
North Fork Deep Creek
Tickle Creek
9/28/2009
10/23/2009
10/26/2009
11/23/2009
12/15/2009
1/25/2010
2/11/2010
3/22/2010
4/2/2010
5/24/2010
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.

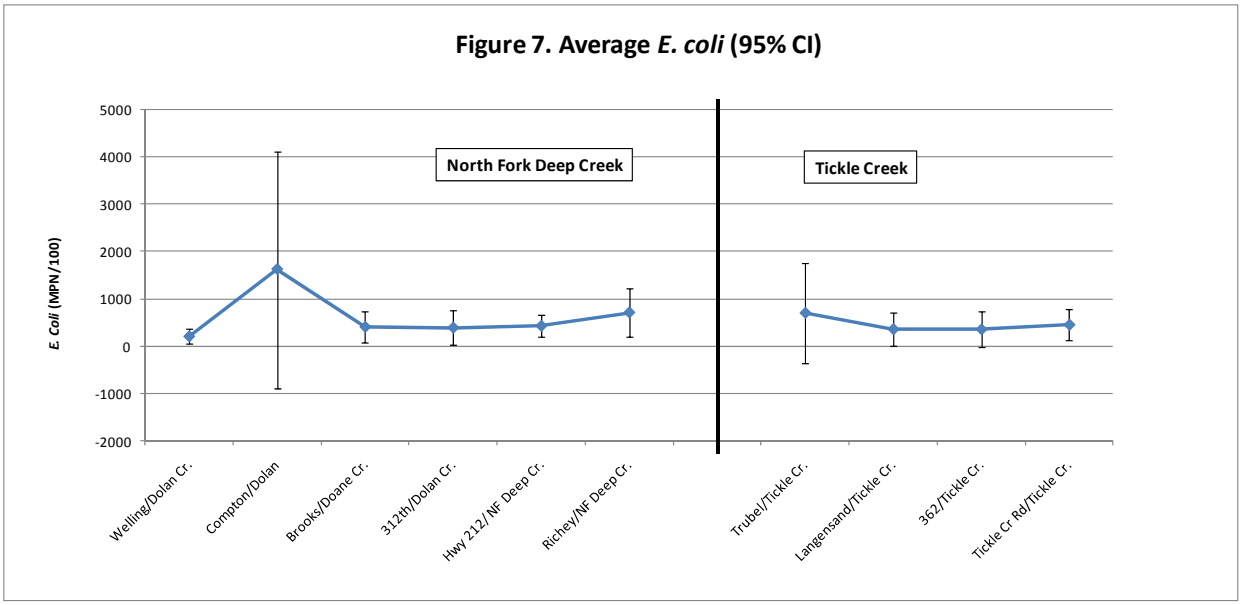


Figure 7. Average E. coli (95% CI)
E. Coli (MPN/100)
5000
4000
3000
2000
1000
0
-1000
-2000
North Fork Deep Creek
Tickle Creek
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.

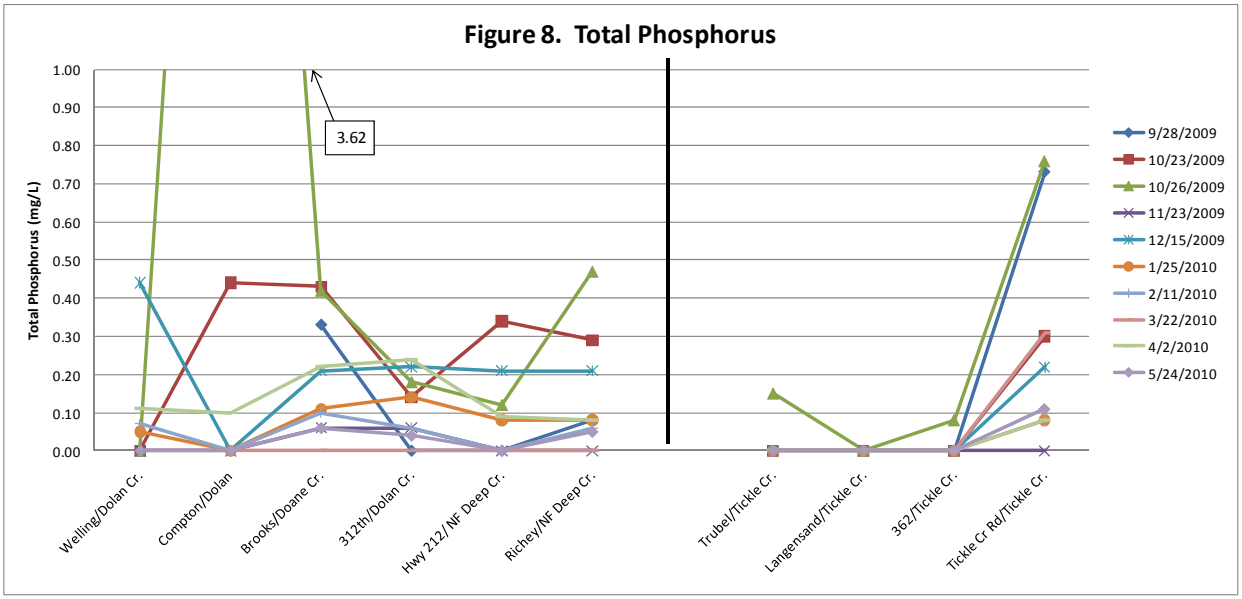


Figure 8. Total Phosphorus
Total Phosphorus (mg/L)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
3.62
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.
9/28/2009
10/23/2009
10/26/2009
11/23/2009
12/15/2009
1/25/2010
2/11/2010
3/22/2010
4/2/2010
5/24/2010

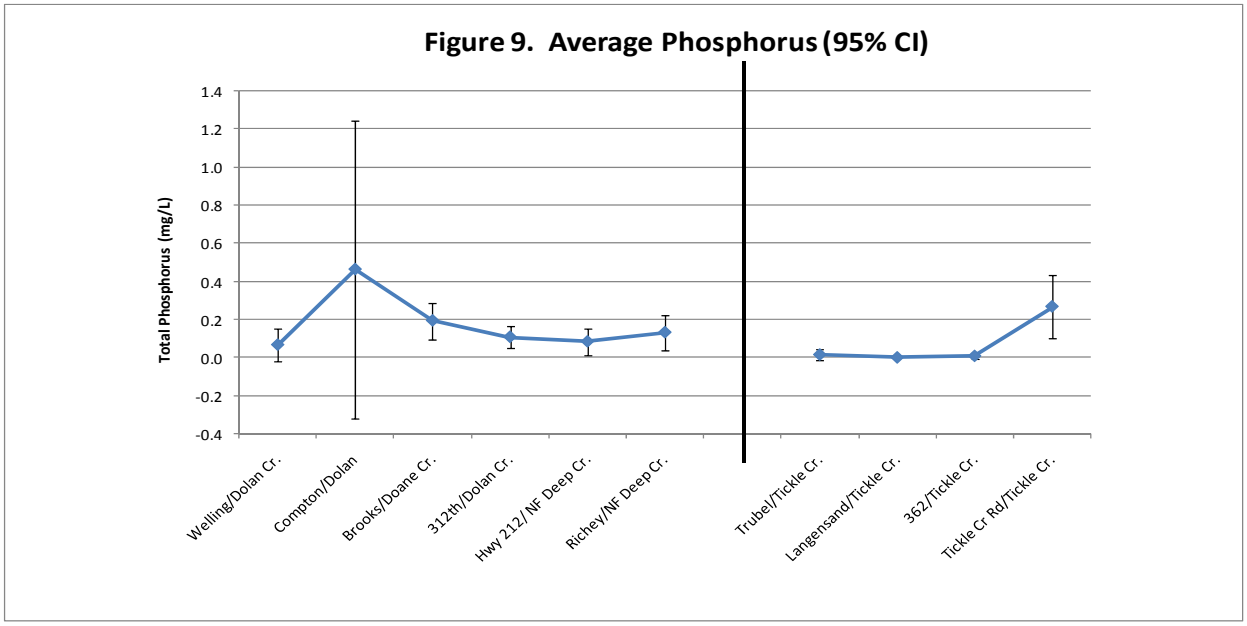


Figure 9. Average Phosphorus (95% CI)
Total Phosphorus (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.

Figure 10. Nitrate-Nitrite

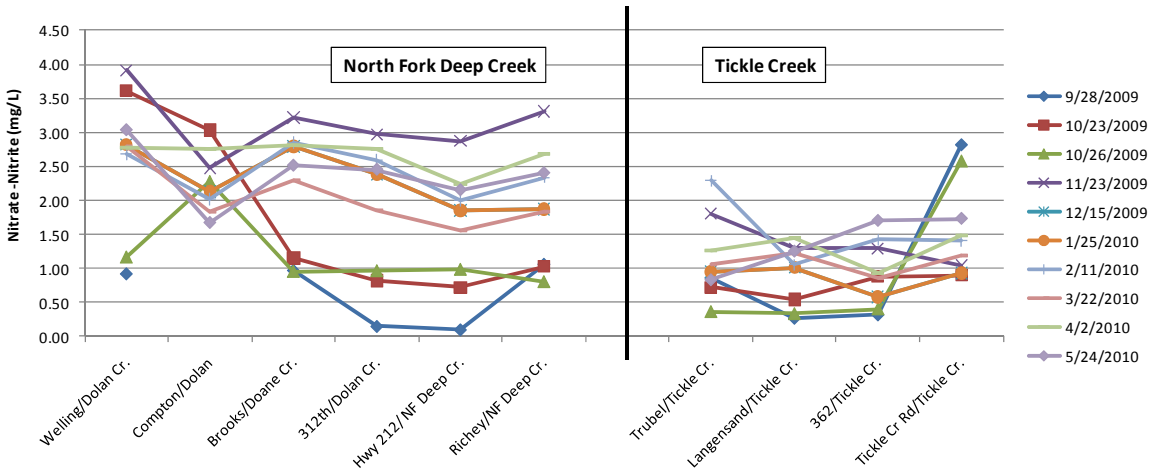


Figure 11. Average Nitrate-Nitrite (95% CI)

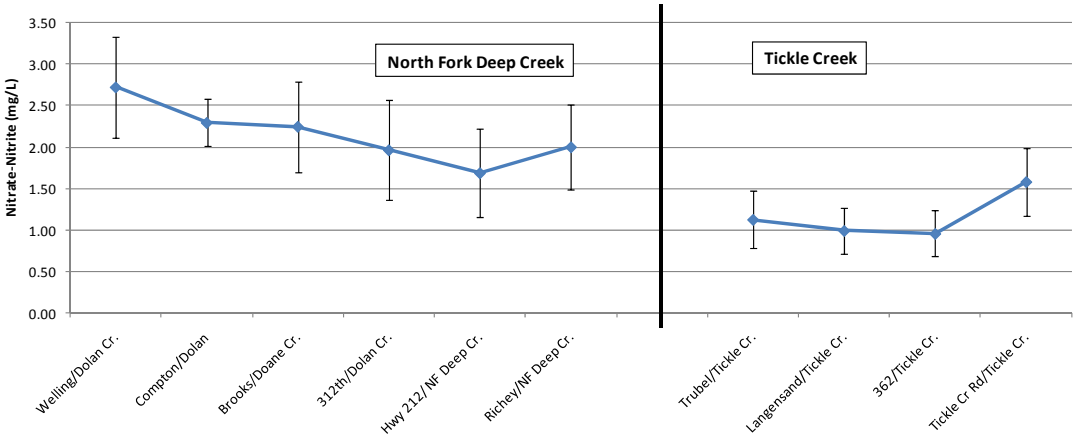


Figure 12. Total Suspended Solids

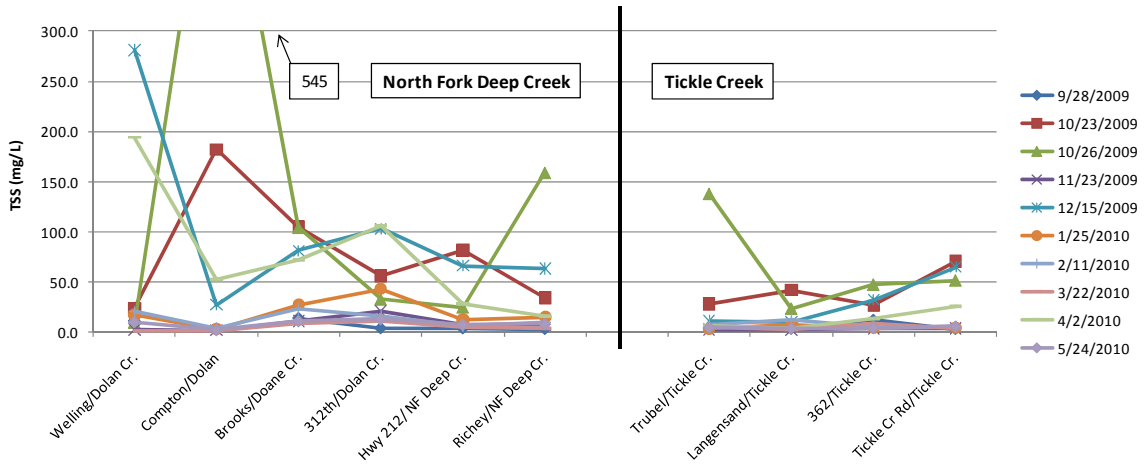
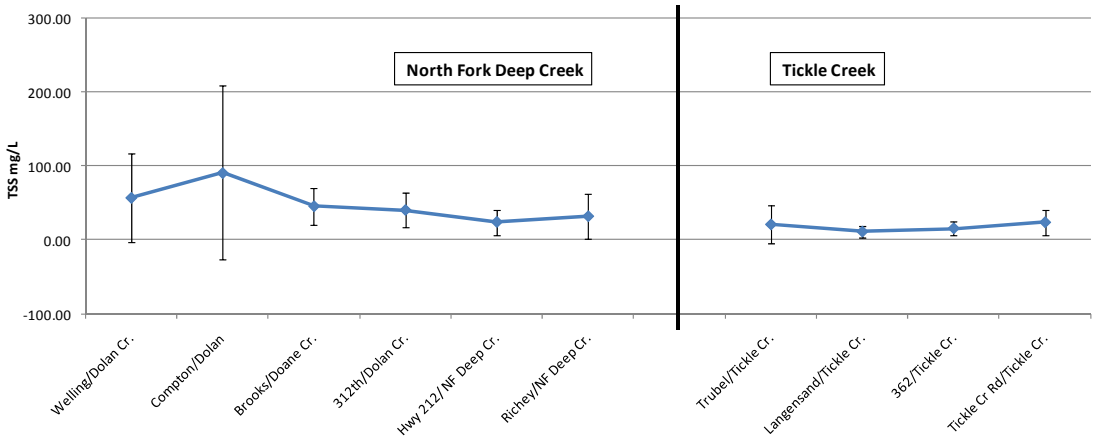


Figure 13. Average Total Suspended Solids (95% CI)



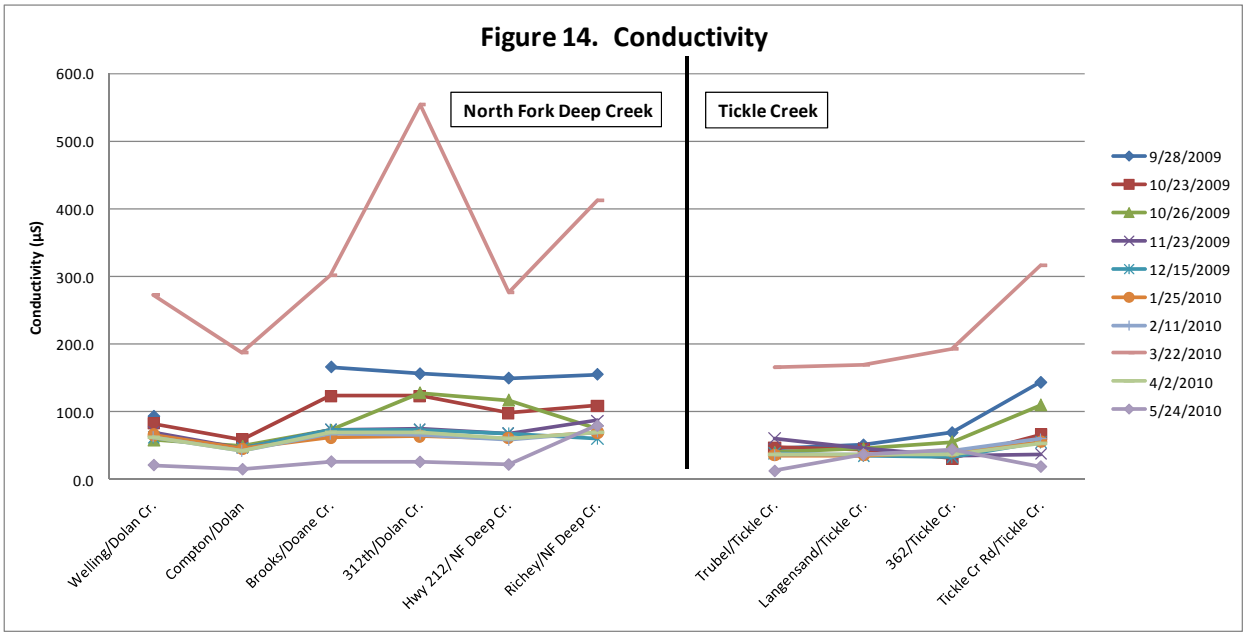


Figure 14. Conductivity
Conductivity (µS)
600.0
500.0
400.0
300.0
200.0
100.0
0.0
North Fork Deep Creek
Tickle Creek
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.
9/28/2009
10/23/2009
10/26/2009
11/23/2009
12/15/2009
1/25/2010
2/11/2010
3/22/2010
4/2/2010
5/24/2010

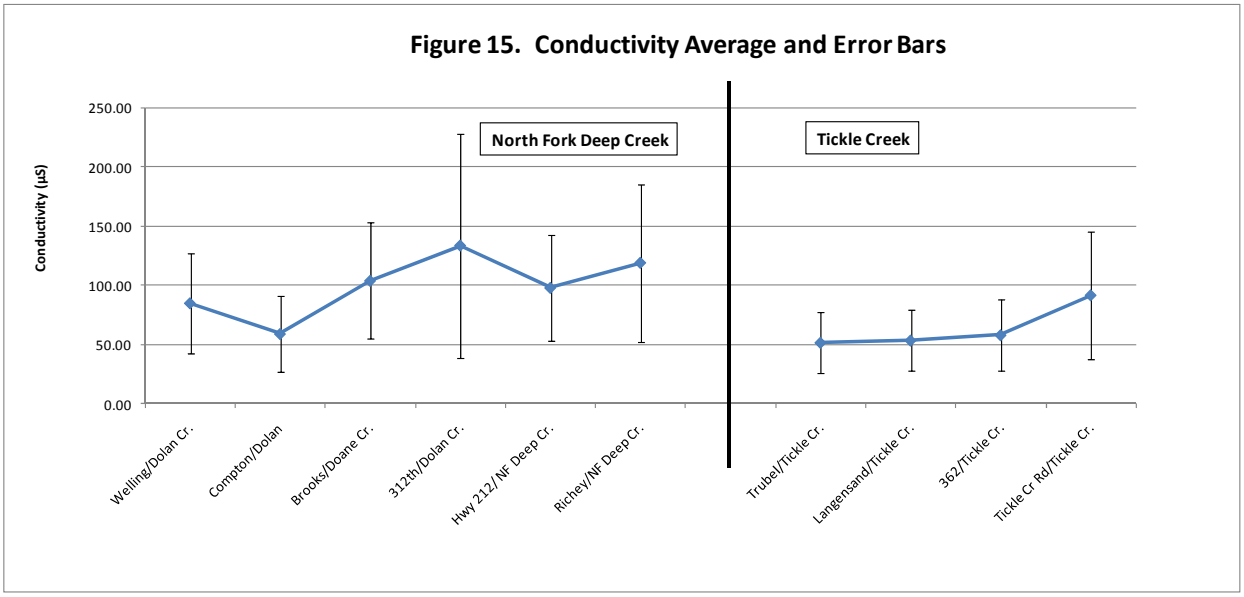


Figure 15. Conductivity Average and Error Bars
Conductivity (µS)
250.00
200.00
150.00
100.00
50.00
0.00
North Fork Deep Creek
Tickle Creek
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.

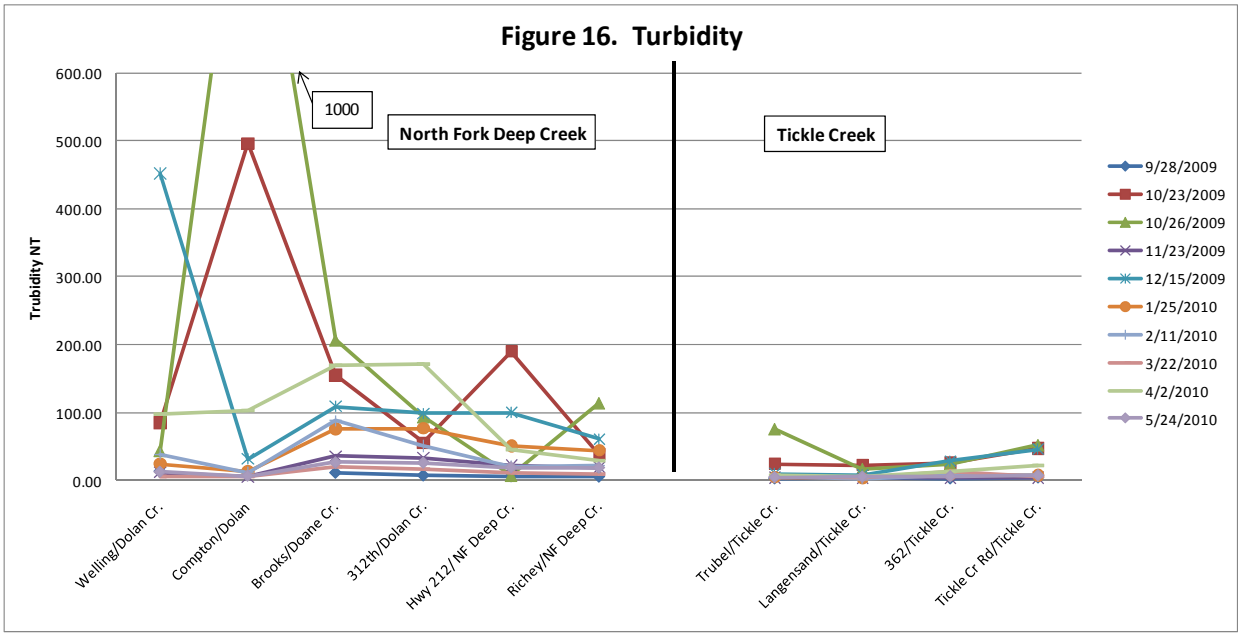


Figure 16. Turbidity
Trubidity NT
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1000
North Fork Deep Creek
Tickle Creek
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/ NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.
9/28/2009
10/23/2009
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4/2/2010
5/24/2010

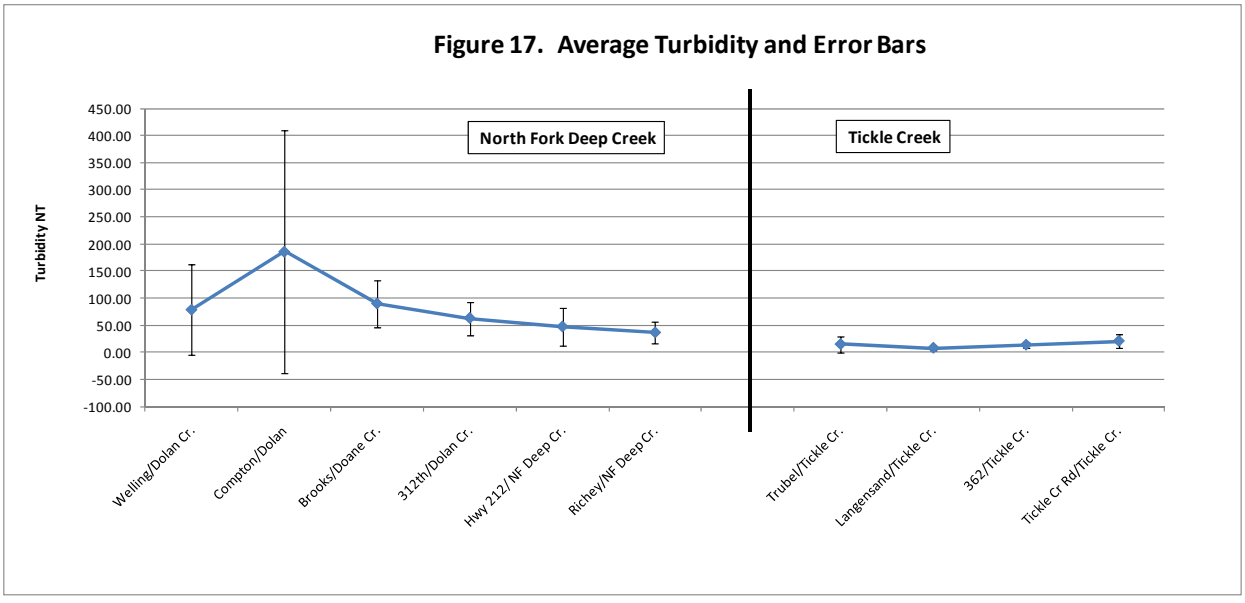


Figure 17. Average Turbidity and Error Bars
Turbidity NT
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
-50.00
-100.00
North Fork Deep Creek
Tickle Creek
Welling/Dolan Cr.
Compton/Dolan
Brooks/Doane Cr.
312th/Dolan Cr.
Hwy 212/ NF Deep Cr.
Richey/NF Deep Cr.
Trubel/Tickle Cr.
Langensand/Tickle Cr.
362/Tickle Cr.
Tickle Cr Rd/Tickle Cr.

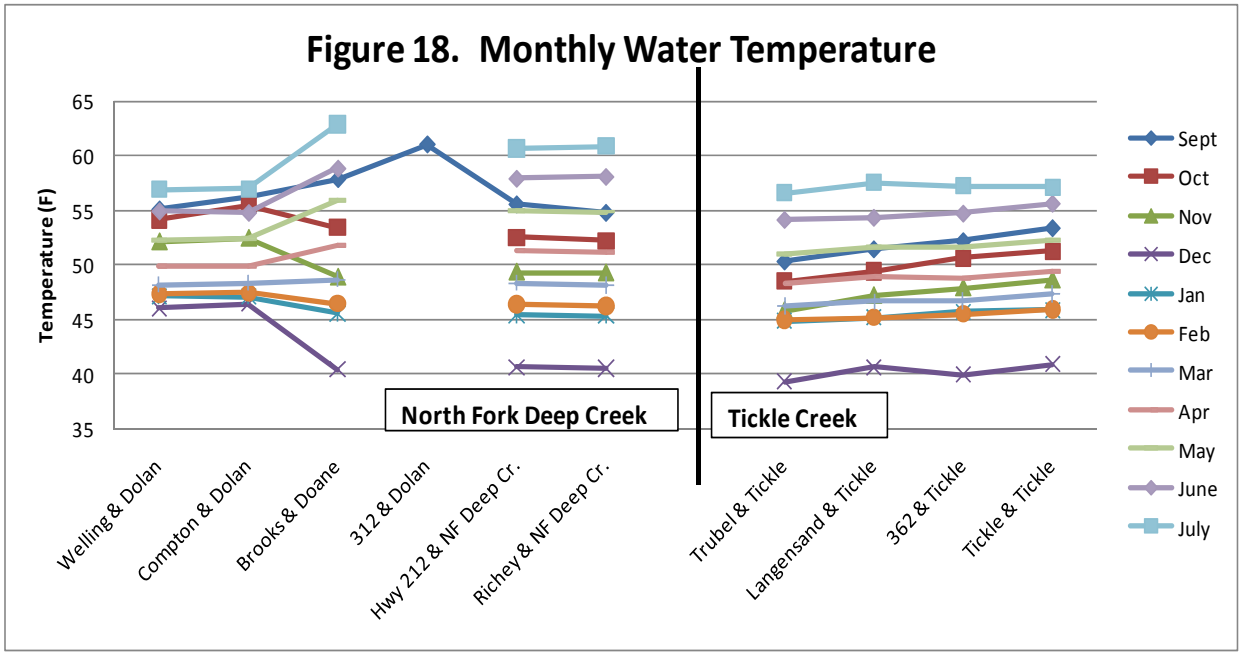


Figure 18. Monthly Water Temperature
Temperature (F)
65
60
55
50
45
40
35
North Fork Deep Creek
Tickle Creek
Welling & Dolan
Compton & Dolan
Brooks & Doane
312 & Dolan
Hwy 212 & NF Deep Cr.
Richey & NF Deep Cr.
Trubel & Tickle
Langensand & Tickle
362 & Tickle
Tickle & Tickle
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
July

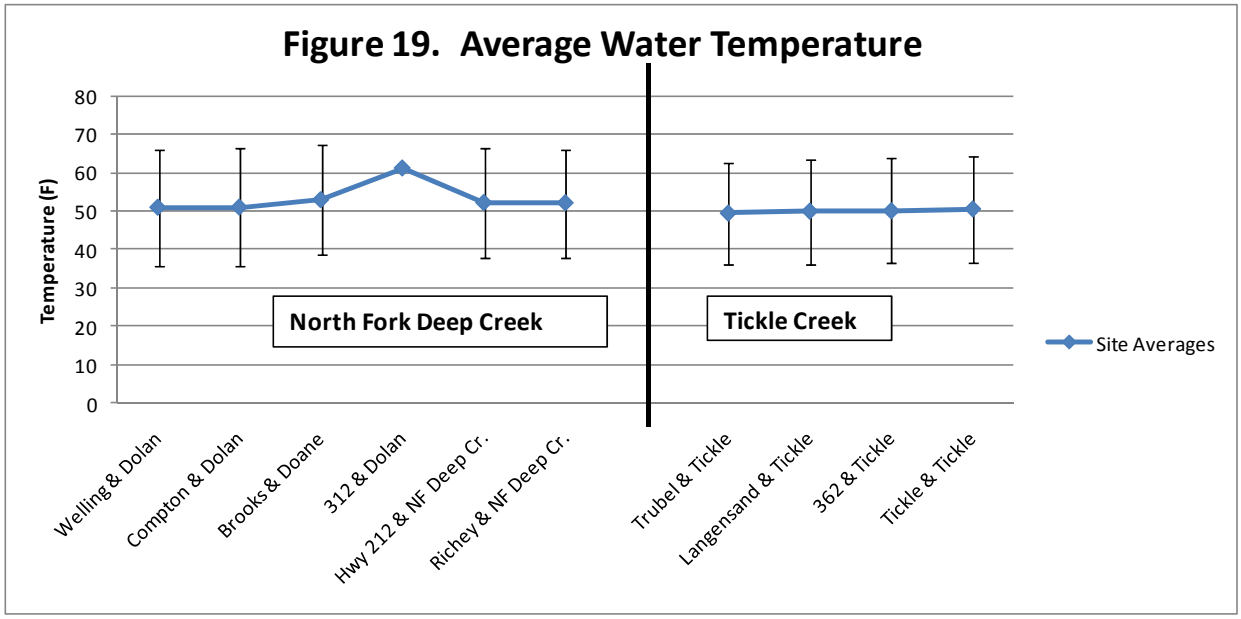
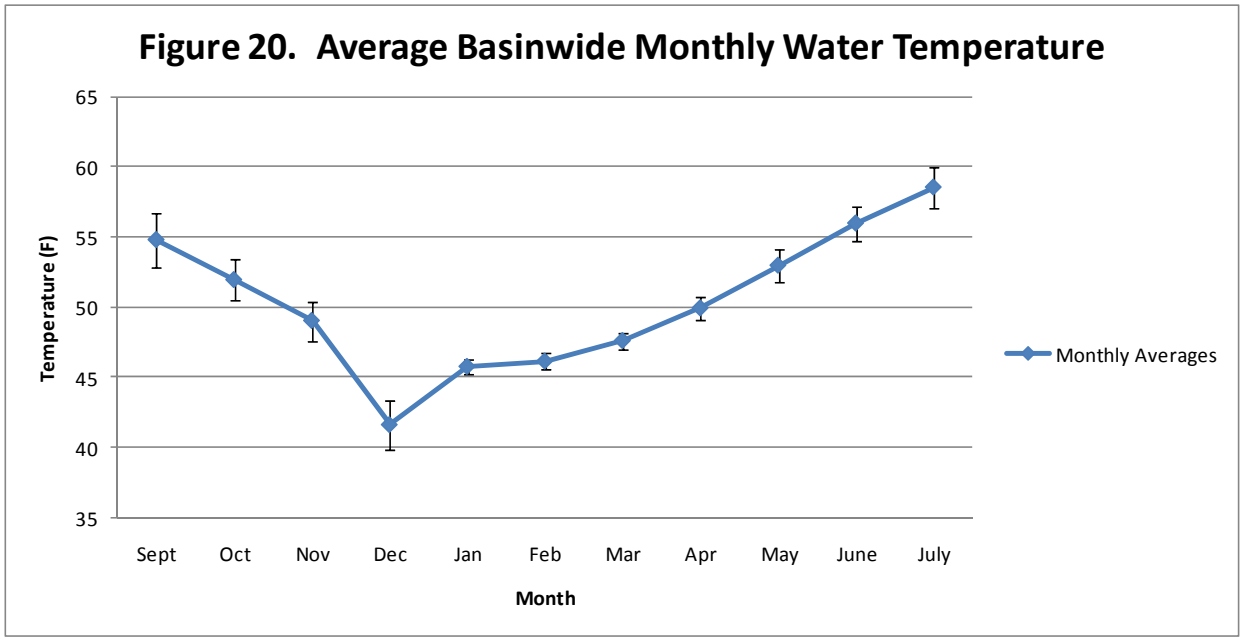


Figure 19. Average Water Temperature
Temperature (F)
80
70
60
50
40
30
20
10
0
North Fork Deep Creek
Tickle Creek
Welling & Dolan
Compton & Dolan
Brooks & Doane
312 & Dolan
Hwy 212 & NF Deep Cr.
Richey & NF Deep Cr.
Trubel & Tickle
Langensand & Tickle
362 & Tickle
Tickle & Tickle
Site Averages



LAND USE ASSESSMENT

Land Use Overview

The Clackamas Conservation District has been working with the US Geological Survey to evaluate land use practices within each of the drainages at each sampling point. Preliminary land use was assessed by USGS using existing land use cover data. Two maps were developed by USGS for preliminary planning and site selection (Figure 21 & Figure 22). Once sampling sites were selected USGS provided land use percentages to the Conservation District for evaluation (Table 2). Land uses were categorized into 13 separate categories including: Open water, Developed open space, Developed low Intensity, Developed medium intensity, Developed high intensity, Deciduous forest, Evergreen forest, Mixed forest, Scrub/shrub, Grassland/herbaceous, Pasture/hay, Cultivated crops, and Woody wetlands (Appendix III).

Relevant land use categories were grouped into Urban and Agricultural classes. The Urban class consisted of the sum of Developed open space, Developed low Intensity, Developed medium intensity, and Developed high intensity land categories. Percent Urban land use ranged from 5.4% to 27.5%. The Agricultural class consisted of the sum of Pasture/Hay and Cultivated Crops. The percent agriculture ranged from 20.0% to 77.7%.

In addition, the Conservation District contracted for a series of aerial photo flyovers of the project area. These photos are available for review and allow for a refinement of land use types for both the Urban and Agricultural land use classes.

Correlation analysis was carried out for the urban and agricultural land use percentages. Urban and agricultural land uses were used as predictive variable for each of the metrics recorded from the stream sampling. Each assessment was evaluated based on the relative slope (positive or negative) and the coefficient of determination (R^2).

TABLE 2. Summary table of urban and agricultural land uses.

Site	Latitude	Longitude	Location	Urban	Agricultural
1	45.428550	-122.375083	Richey / NF Deep Cr.	15.58%	64.00%
2	45.432650	-122.354600	Hwy 212 / NF Deep Cr.	13.84%	65.51%
3	45.427030	-122.311526	312th / Dolan Cr.	13.78%	77.66%
4	45.441568	-122.331395	Brooks / Doane Cr.	7.72%	65.49%
5	45.437664	-122.341886	Welling / Dolan Cr.	13.83%	67.38%
6	45.432667	-122.310750	Compton / Dolan Cr.	14.08%	69.90%
7	45.403980	-122.359951	Tickle Creek Rd. / Tickle Cr.	15.92%	37.08%
8	45.398209	-122.291191	362nd / Tickle Cr.	27.45%	31.28%
9	45.384083	-122.250100	Langensand / Tickle Cr.	5.40%	47.14%
10	45.375117	-122.235317	Trubel / Tickle Cr.	8.09%	20.01%

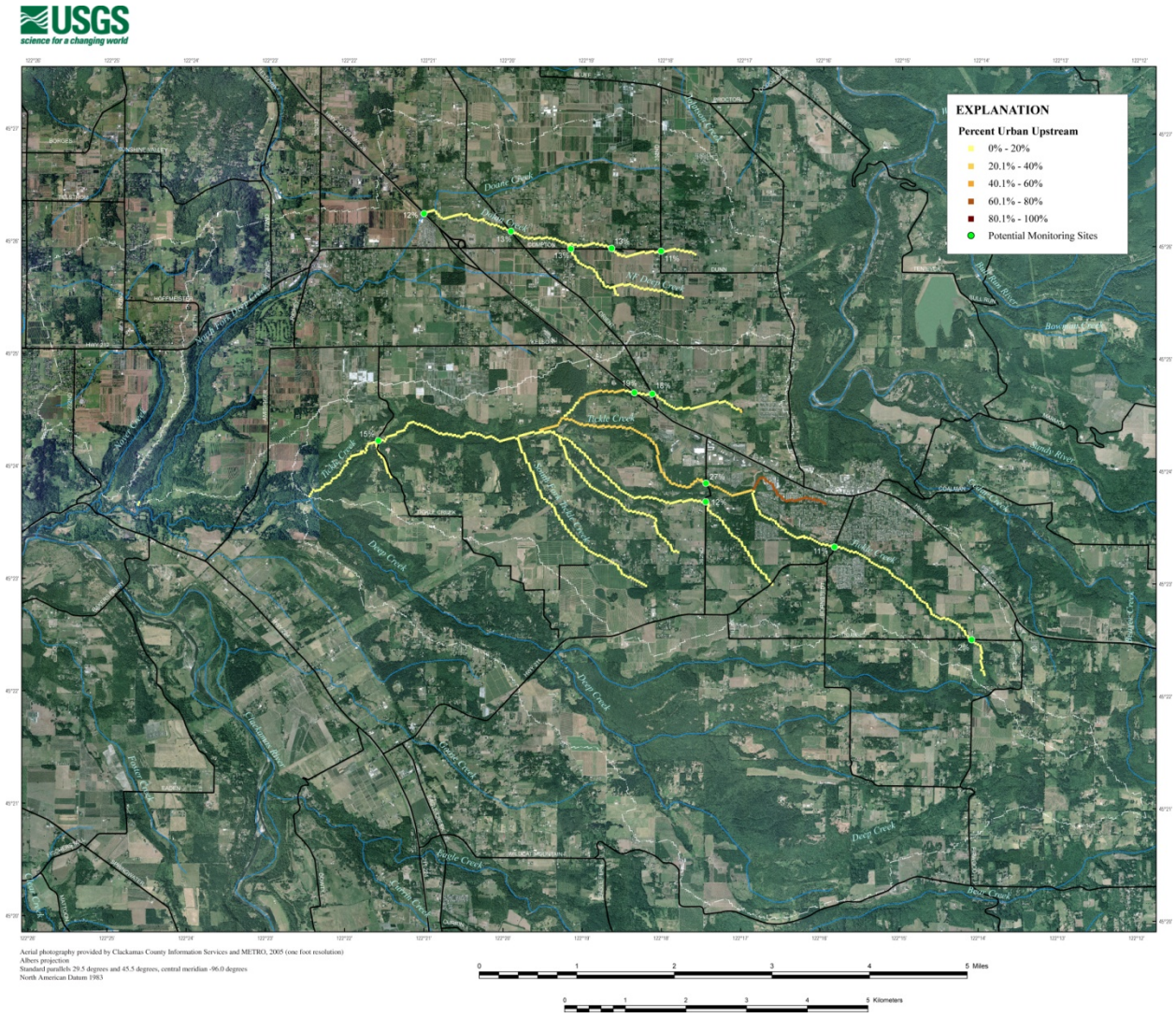


Figure 21. Preliminary Land Use planning map, depicting percent urban land use. (Source USGS 2009)

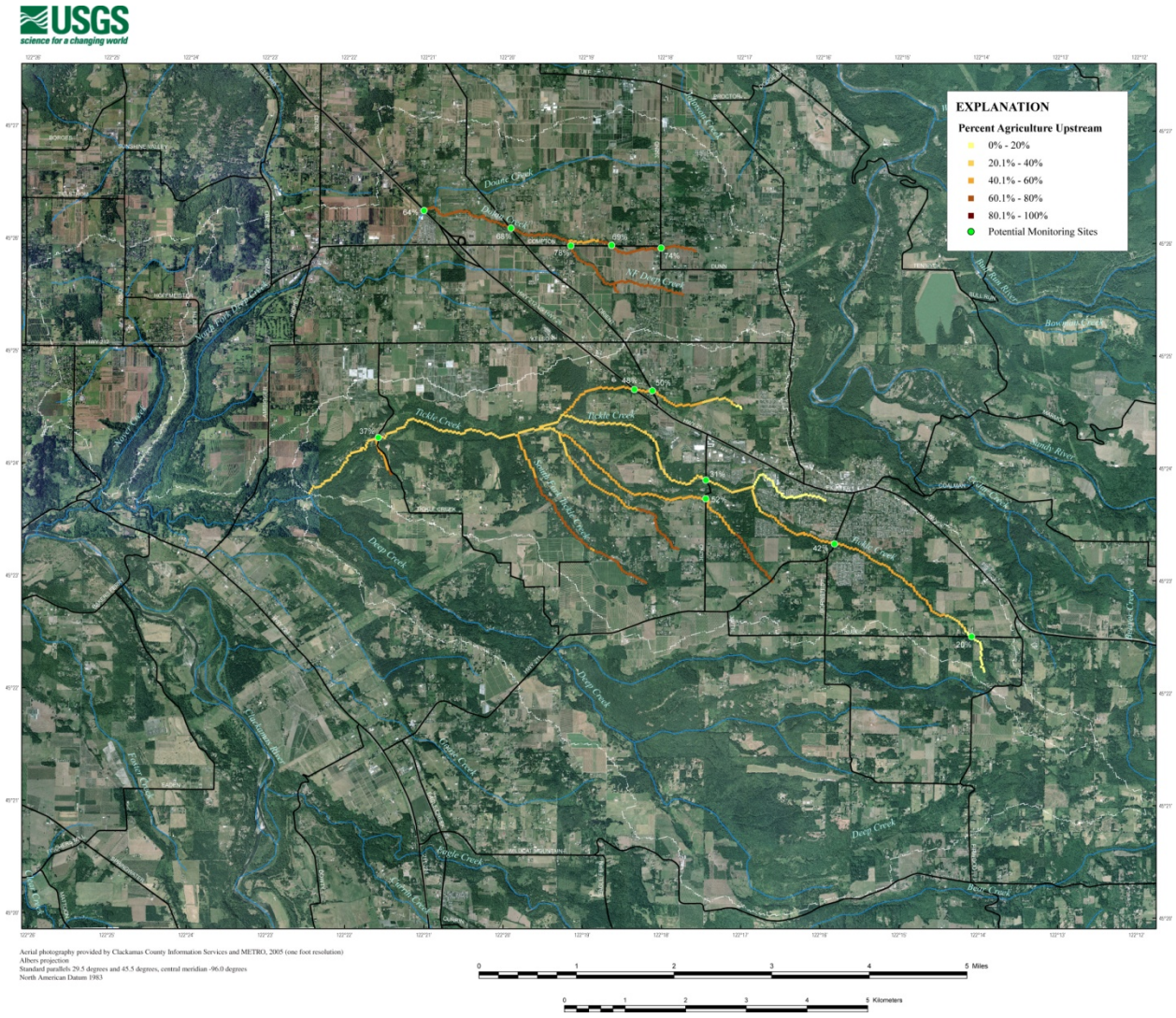


Figure 22. Preliminary Land Use planning map, depicting percent agricultural land use. (Source USGS 2009)

Land Use Results

Urban Land Use

When urban land use was compared to the various stream sampling metrics, it was clear that urban land use exhibited a weak coefficient of determination (R^2) when compared to the stream sampling metrics. The strongest coefficient of determination observed was R^2=0.0056. In addition the slopes of each

correlation were typically flat. As a result urban land use practices appear to be poorly predictor of the water quality metrics assessed. The observed range of urban land use was also fairly narrow (5%-30%),

When urban land use was compared to pH, the slope was weakly positive suggesting that as urban land use increased pH would trend more neutral (Figure 23). The slope noted within the observed range and the weak coefficient of determination suggests a little to know correlation between urban land use and pH.

Dissolved oxygen also showed little to no correlation with the percentage of urban land use (Figure 24). While the slope suggests a negative correlation between the increasing urban land use and the amount of dissolved oxygen, this relationship was very weak and the coefficient of determination was low (R^2=0.0056).

When *E. coli* levels were compared to urban land use, a slight negative slope was observed. Suggesting that as urban land use increases the levels of *E. coli* would decrease (Figure 25). The slope was relatively minor and the coefficient of determination was low at R^2=0.0009.

Total phosphorus and urban land use had exhibited almost no correlation (Figure 26). The slope was nearly flat and the coefficient of determination was R^2=0.0001.

Urban land use and nitrite-nitrate levels were negatively correlated (Figure 27). While the slope was prominent, the relative coefficient of determination was low, R^2=0.0124 suggesting that urban land use is a poor predictor for nitrate-nitrite levels.

The total suspended solids levels were also negatively correlated with urban land use (Figure 28). The coefficient of determination was low at R^2=0.002.

Conductivity was relatively flat with increasing levels of urban land use (Figure 29). The coefficient of determination was low at R^2=0.0006.

Urban land use and turbidity were negatively correlated. As urban land use increased turbidity was predicted to decrease (Figure 30). Again this relationship exhibited a low coefficient of determination R^2=0.0055.

Water temperature exhibited almost no change with increasing levels of urban land use (Figure 31). This relationship had a low coefficient of determination R^2=0.0004 suggesting that urban land use is a poor predictor of water temperature.

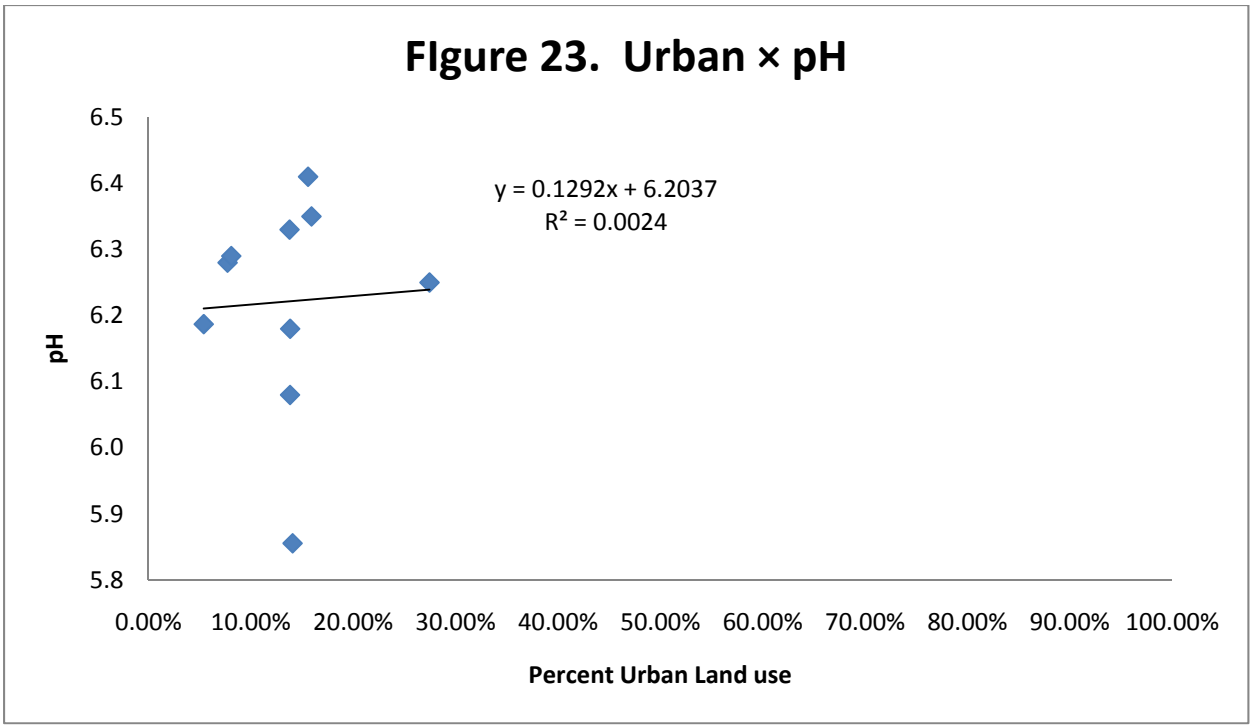


FIgure 23. Urban × pH
6.5
6.4
6.3
6.2
6.1
6.0
5.9
5.8
pH
y = 0.1292x + 6.2037
R² = 0.0024
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%
Percent Urban Land use

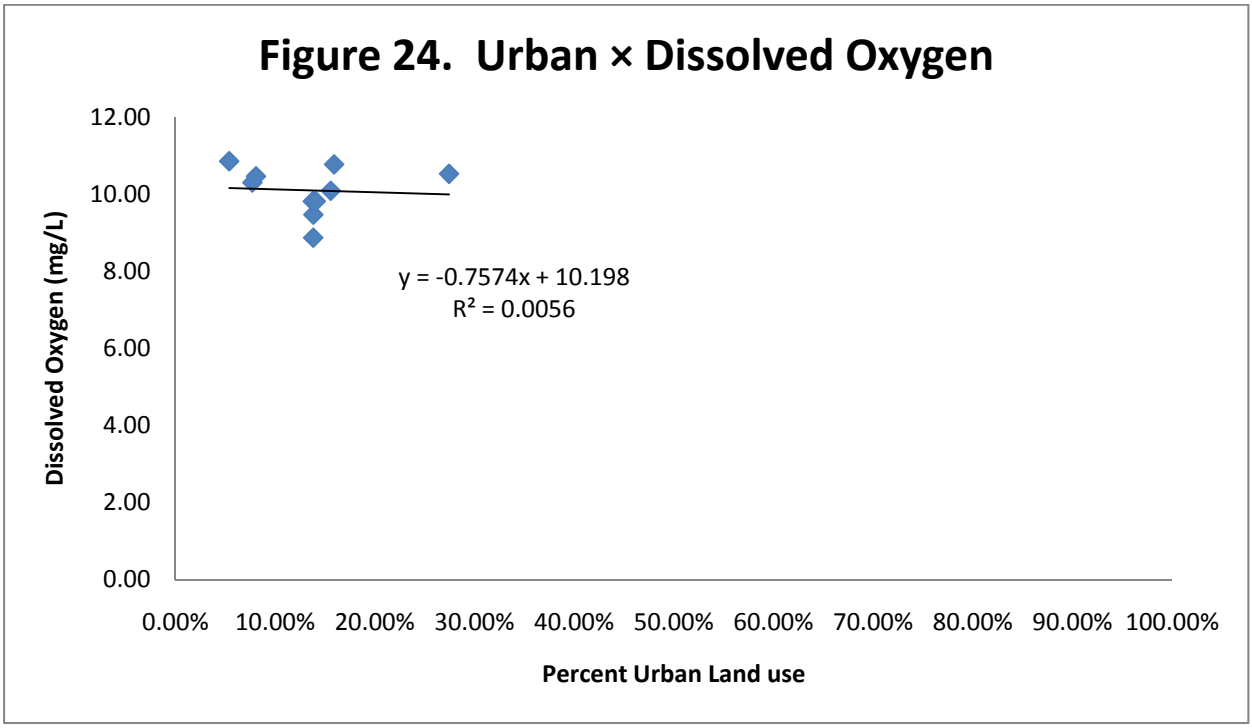


Figure 24. Urban × Dissolved Oxygen
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Dissolved Oxygen (mg/L)
y = -0.7574x + 10.198
R² = 0.0056
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%
Percent Urban Land use

Figure 25. Urban × *E. Coli*

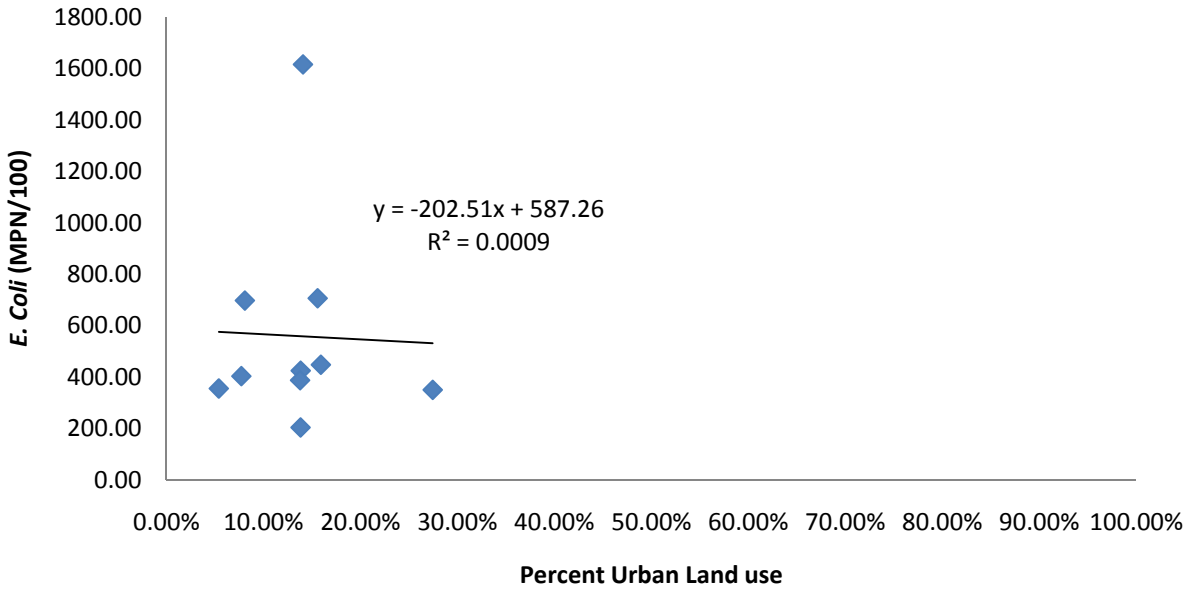
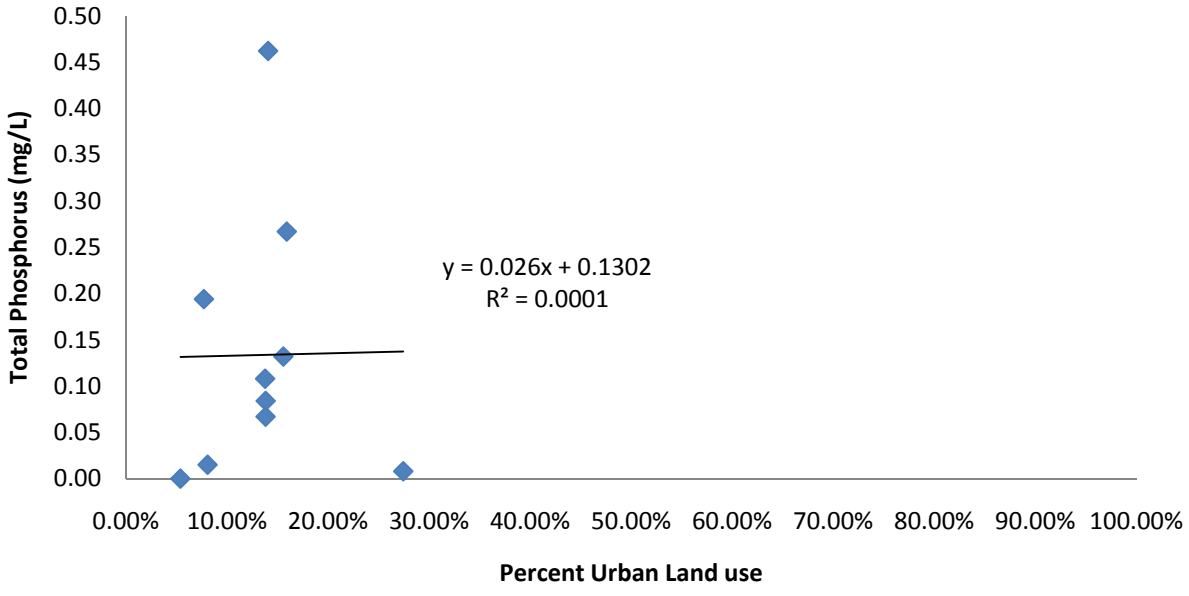


Figure 26. Urban × Total Phosphorus



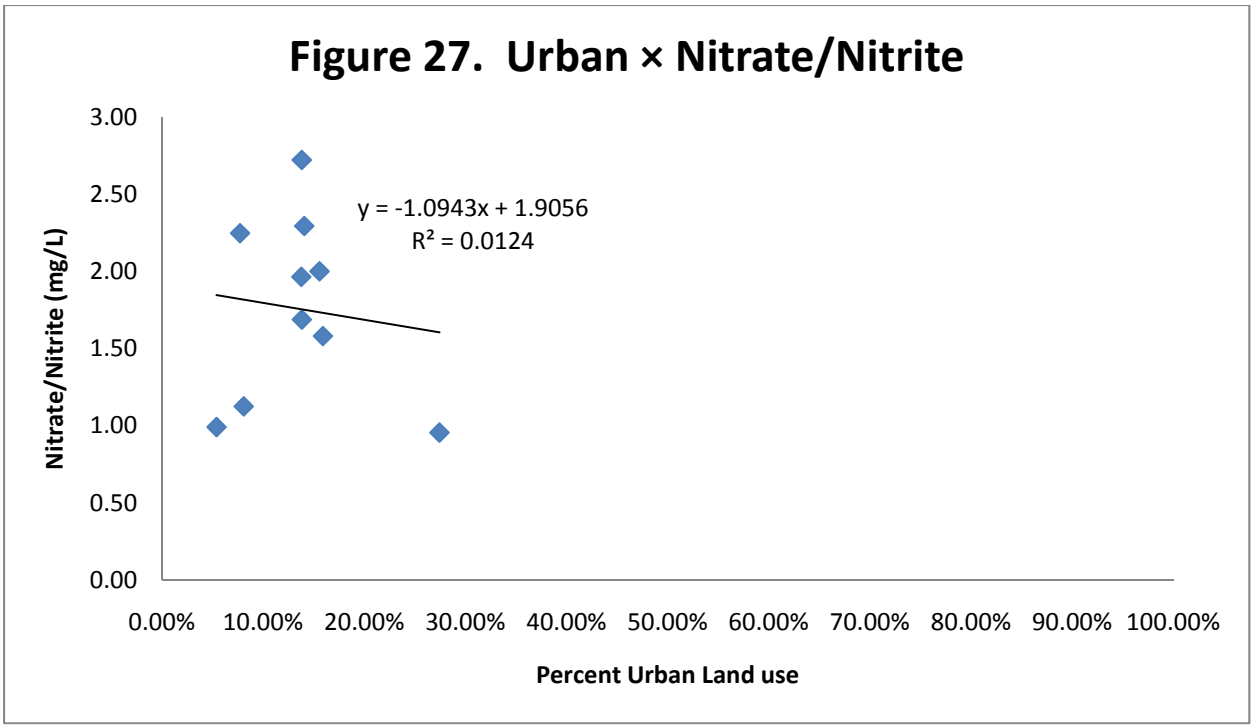


Figure 27. Urban × Nitrate/Nitrite
Nitrate/Nitrite (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
y = -1.0943x + 1.9056
R² = 0.0124
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
Percent Urban Land use

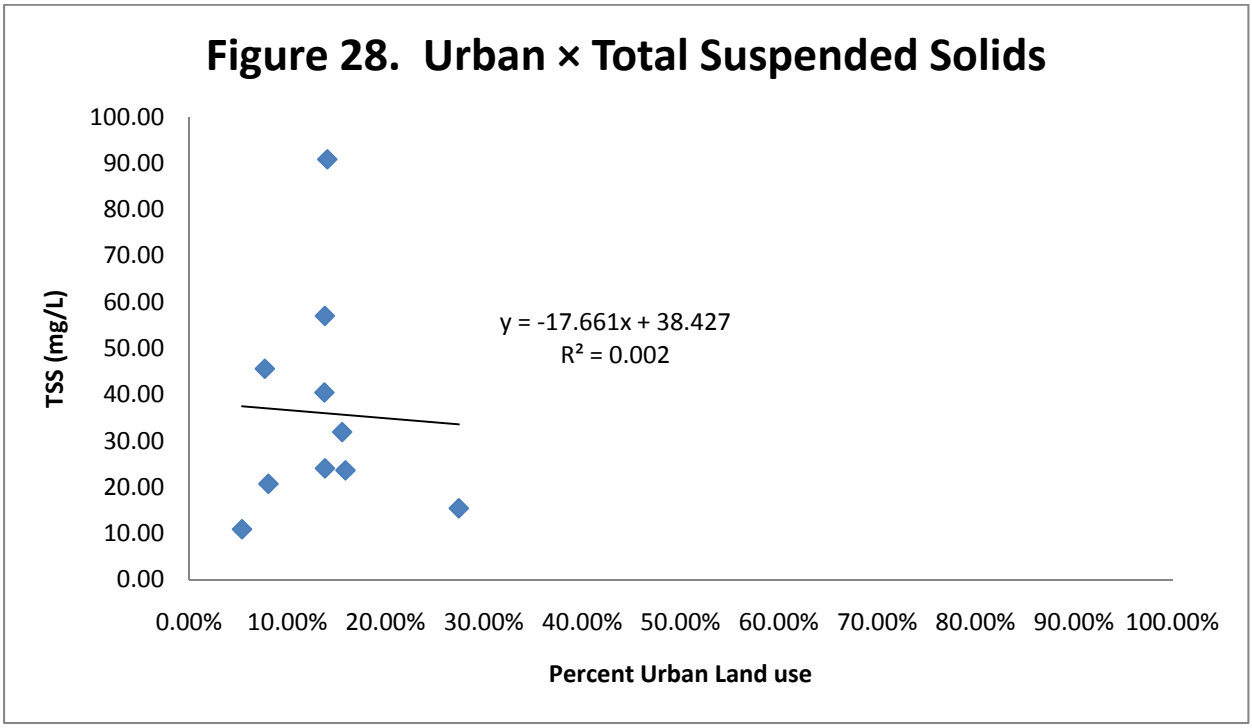


Figure 28. Urban × Total Suspended Solids
TSS (mg/L)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
y = -17.661x + 38.427
R² = 0.002
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
Percent Urban Land use

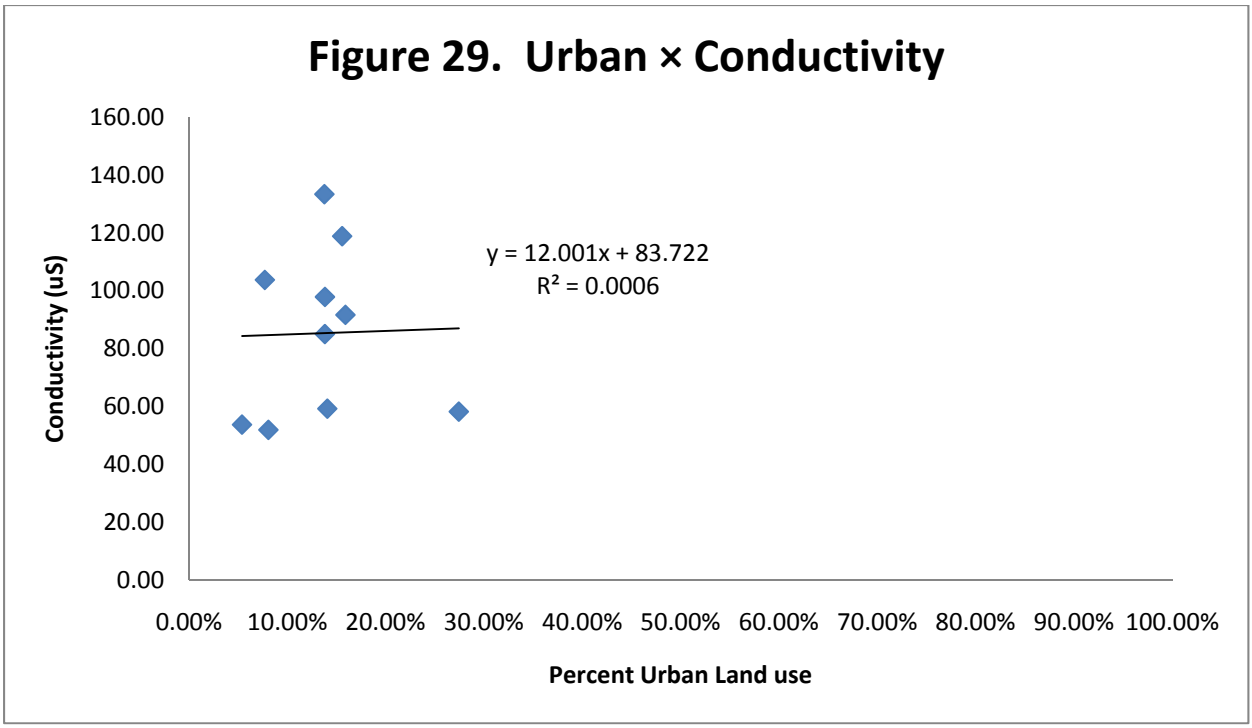


Figure 29. Urban × Conductivity
Conductivity (uS)
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
y = 12.001x + 83.722
R² = 0.0006
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
Percent Urban Land use

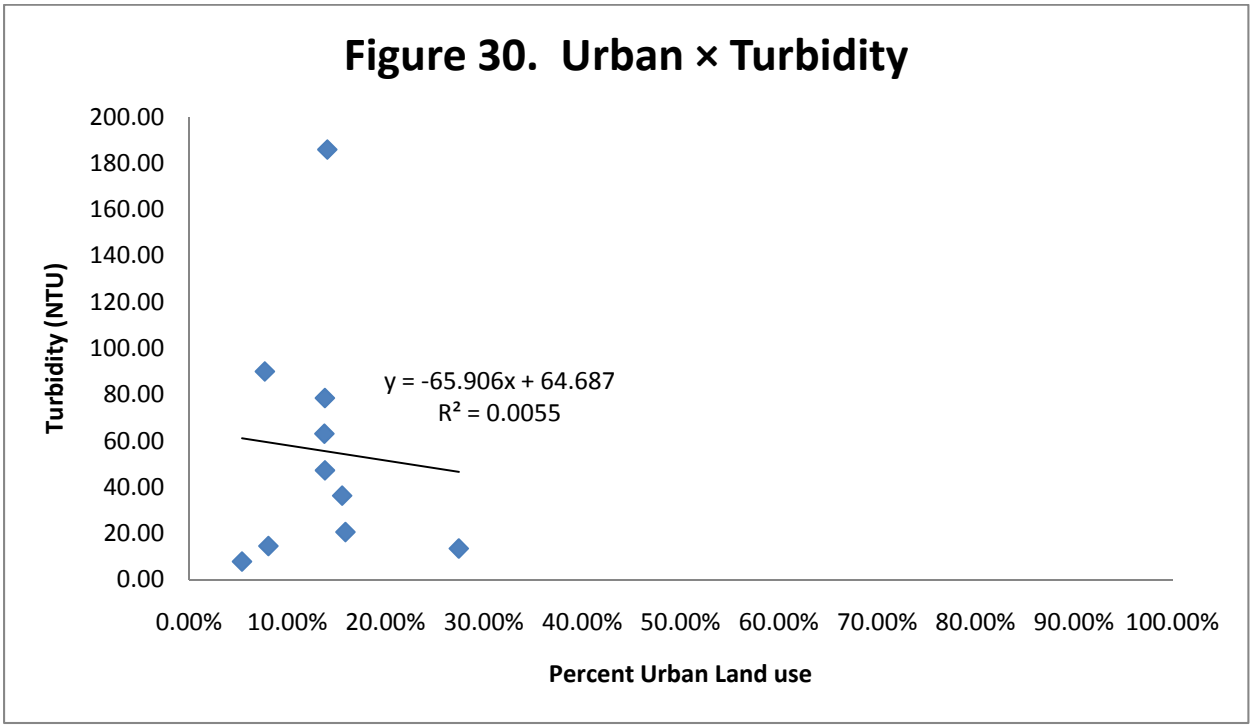
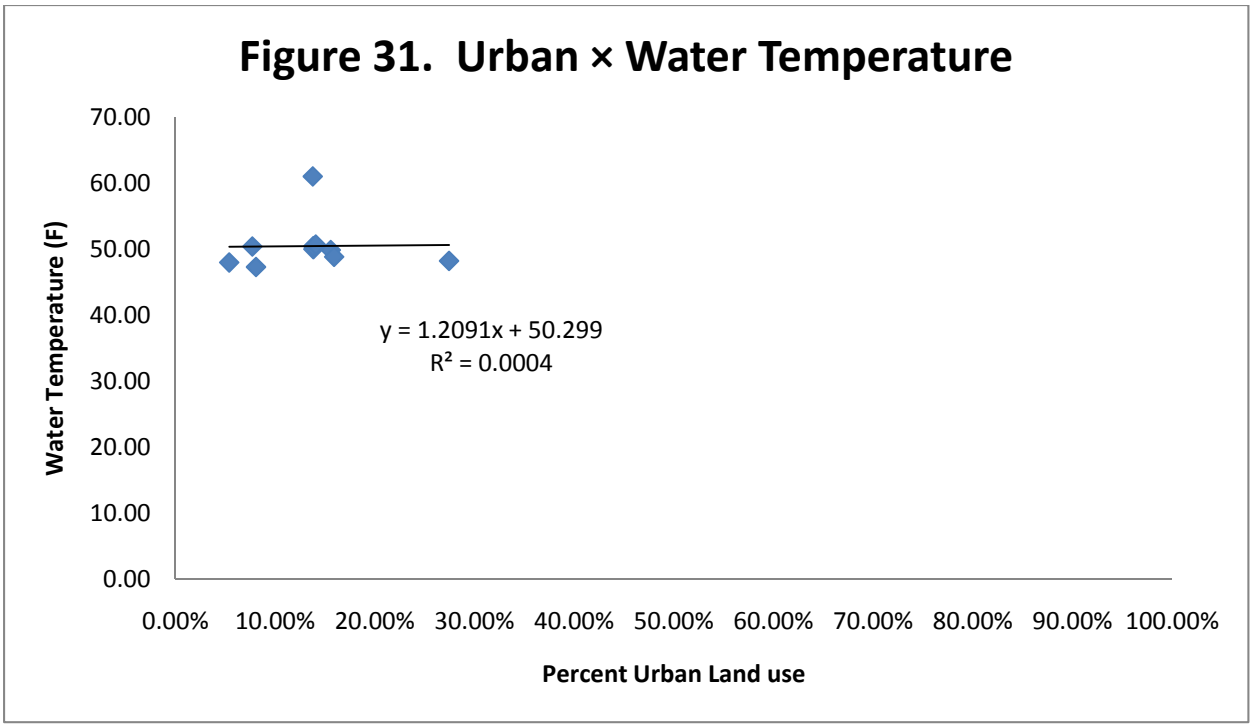


Figure 30. Urban × Turbidity
Turbidity (NTU)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
y = -65.906x + 64.687
R² = 0.0055
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
Percent Urban Land use



Agricultural Land Use

Assessment of agricultural land use exhibited a range of land use levels. The relative range of agricultural land use was much broader than those observed in the urban land use assessment. Agricultural land use ranged from 20% to 80% which provided a wide range of observations for the correlation analysis.

When agricultural land use was compared to pH, a negative correlation was observed. As the percentage of agriculture increased the pH level became more acidic (Figure 32). The coefficient of determination was relatively weak at R^2=0.0825. The slope was steep by comparison suggesting a strong relationship between agricultural land practices and pH.

Dissolved oxygen tended to decrease with increasing levels of agricultural land use (Figure 33). The coefficient of determination was moderately strong (R^2 =0.4397) when compared to other land uses correlations. The predicted DO levels within the observed range varied from 11 to 9 mg/L., suggesting that the relationship is relatively minor.

Agricultural land use was positively correlated with increasing levels of *E. coli* abundance (Figure 34). The coefficient of determination was weak (R^2 =0.0183) suggesting that percent agriculture may be a poor predictor of *E. coli* abundance. The observed slope was also relatively minor and demonstrated a predicted change of 200 mg/L across the observed range.

Total phosphorus exhibited a strong positive relationship with agricultural land use. The slope was rather strong, and phosphorus levels were predicted to increase from 0.05 and .20 mg/L with increases in agricultural land use within the observed range (Figure 35). The coefficient of determination was relatively weak at R^2=0.1418, which suggested that agricultural land use is a poor predictor of total phosphorus levels.

Agricultural land use also had a strong positive relationship with nitrate-nitrite levels (Figure 36). The slope was relatively steep with predicted ranges between 1.0 and 2.5 mg/L in the observable range. The coefficient of determination was the highest observed in the correlation analysis at R^2=0.614. This suggests that the percent of agriculture may be a good predictor of nitrate-nitrite levels within the observed range.

Total suspended solids were positively correlated with increases in agricultural land uses. The slope of the relationship was rather steep and TSS levels were predicted to increase from 10 to 55 mg/L within the observed range (Figure 37). The coefficient of determination was moderate at R^2=0.3776.

When conductivity was compared with agricultural land use, a strong positive relationship was observed. The relative slope of the regression predicted increases in conductivity from 50 to 110 µS across the observed range (Figure 38). The coefficient of determination was moderately high at R^2=0.4247.

Turbidity was also positively correlated with increasing agricultural land use percentages (Figure 39). . Turbidity was predicted to increase from 0 to nearly 1000 NTU within the observed range. The coefficient of determination was also moderately high (R2=0.4008) suggesting that agricultural land use may be a good predictor of turbidity levels.

Water temperature and agricultural land use was also positively correlated (Figure 40). The slope of this correlation was relatively flat, and only a five degree increase in water temperature was predicted across the observed range of agricultural land use. The coefficient of determination was moderately high at R^2=0.4325.

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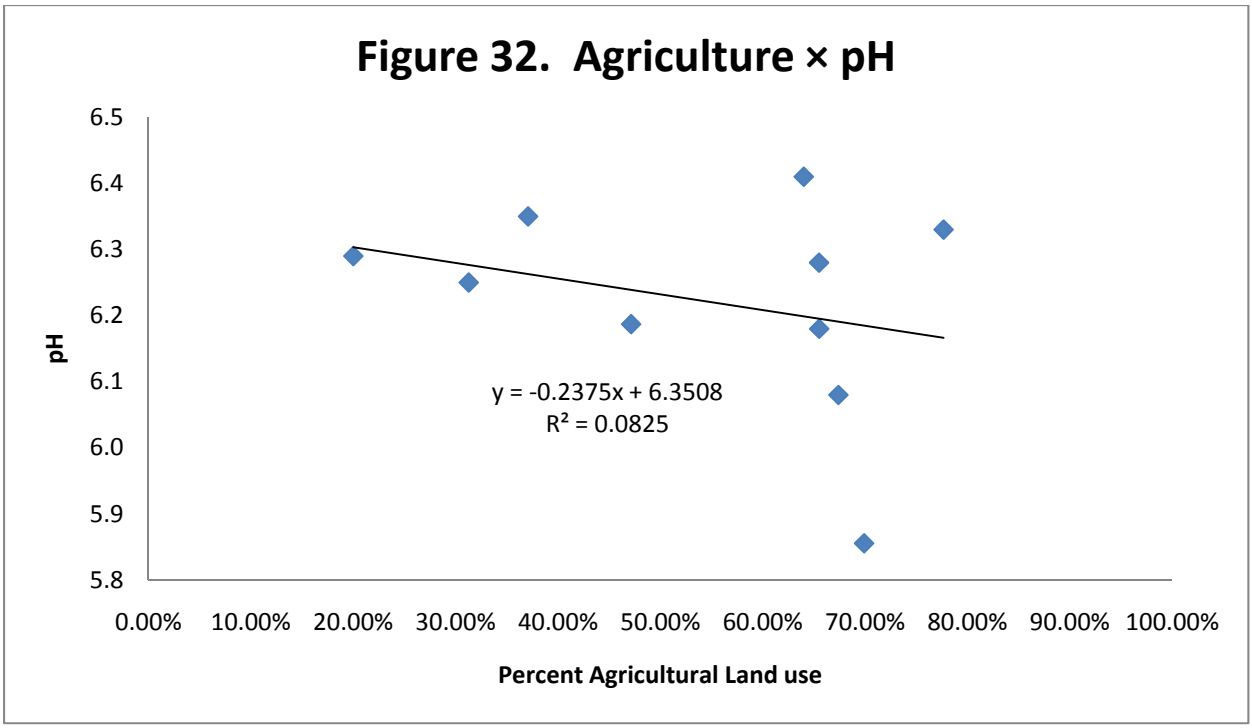


Figure 32. Agriculture × pH
pH
6.5
6.4
6.3
6.2
6.1
6.0
5.9
5.8
y = -0.2375x + 6.3508
R² = 0.0825
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%
Percent Agricultural Land use

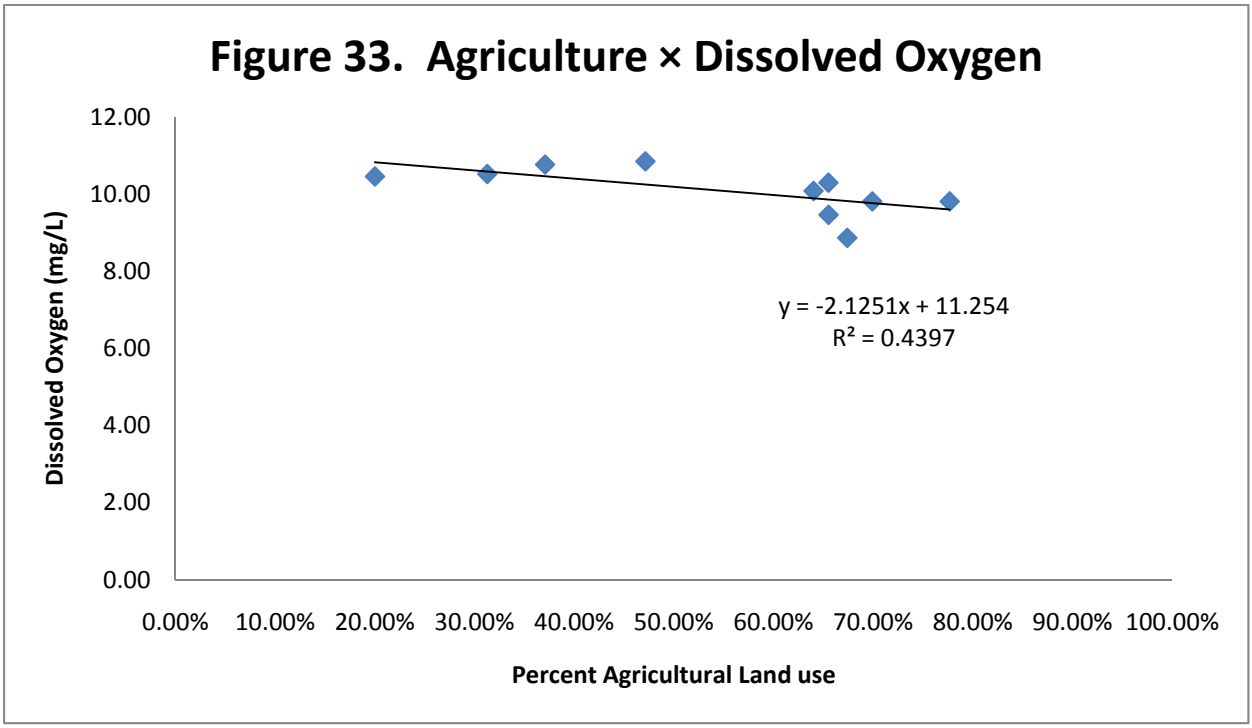


Figure 33. Agriculture × Dissolved Oxygen
Dissolved Oxygen (mg/L)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
y = -2.1251x + 11.254
R² = 0.4397
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%
Percent Agricultural Land use

Figure 34. Agriculture × *E. Coli*

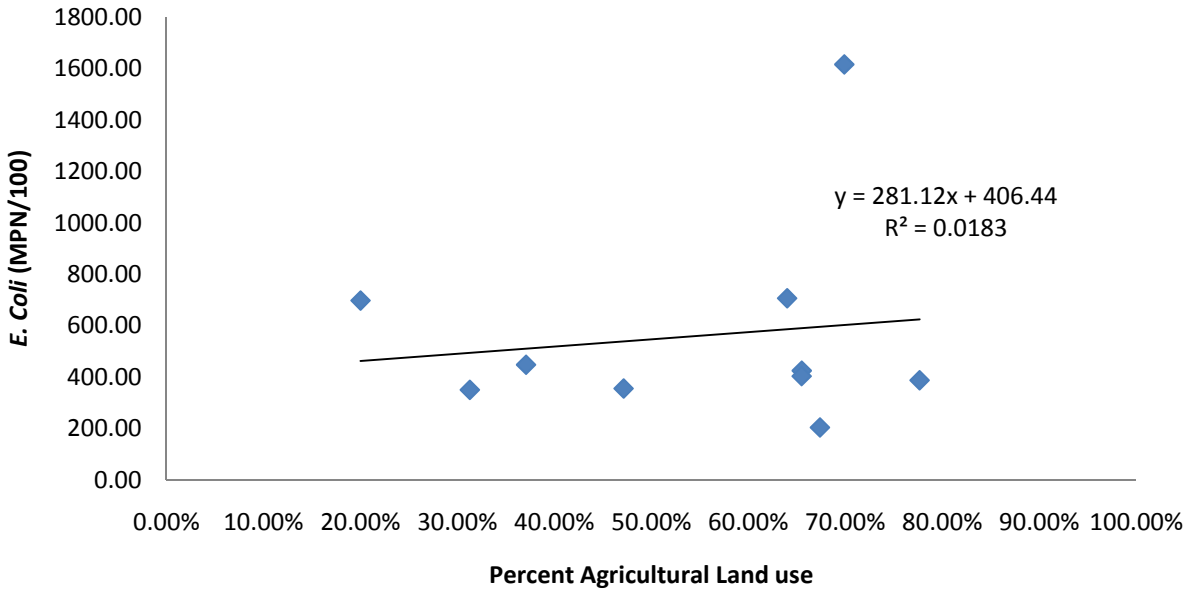


Figure 35. Agriculture × Total Phosphorus

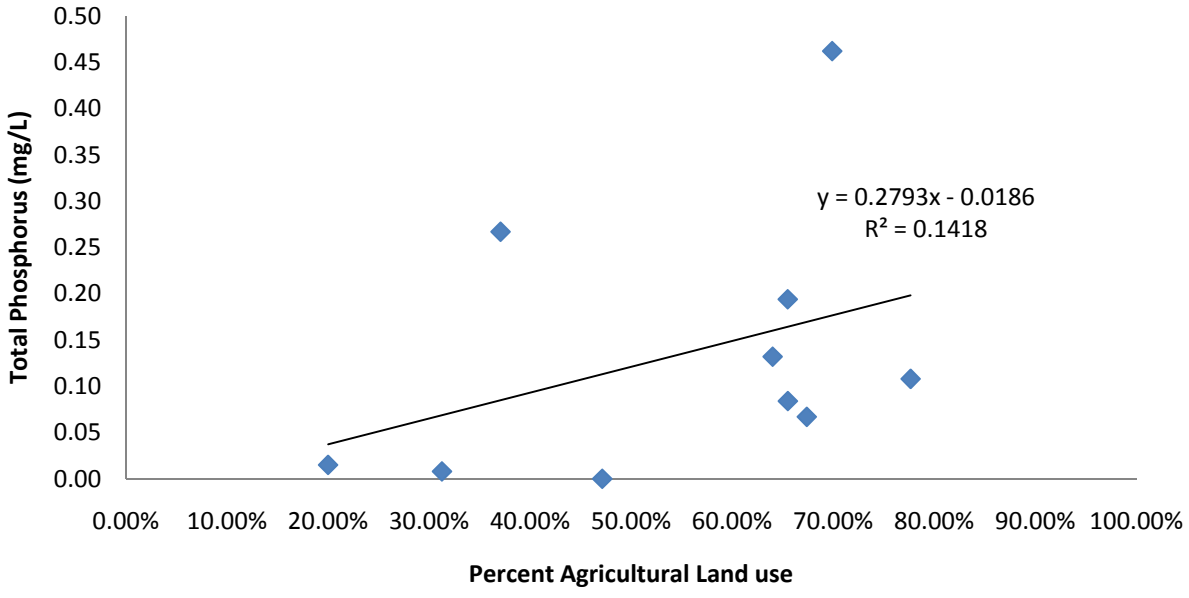


Figure 36. Agriculture × Nitrate/Nitrite

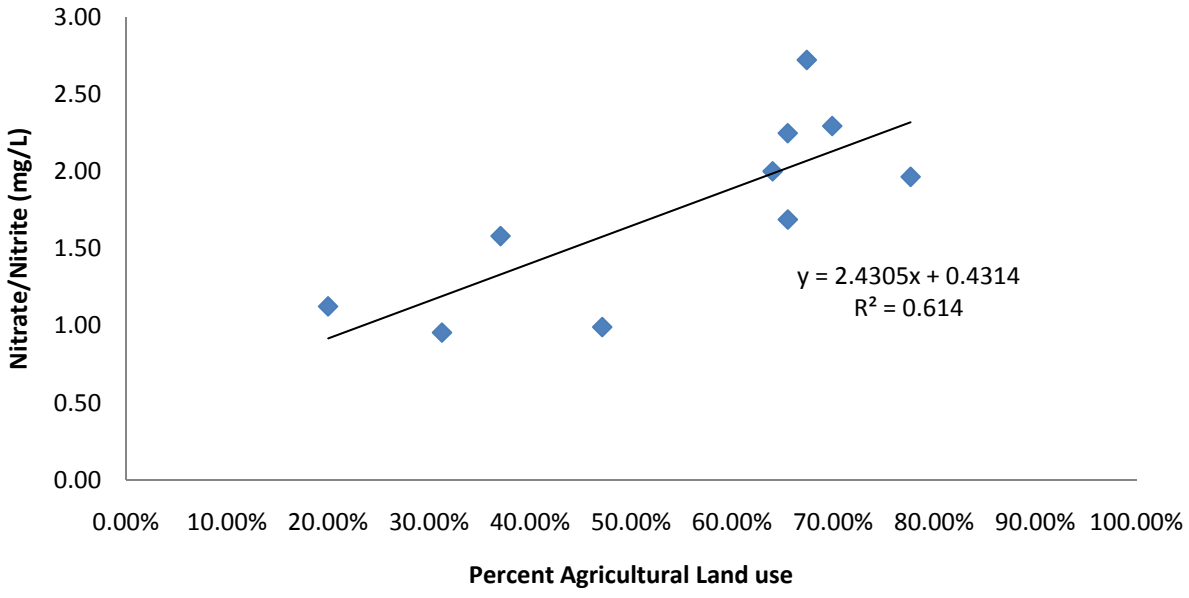
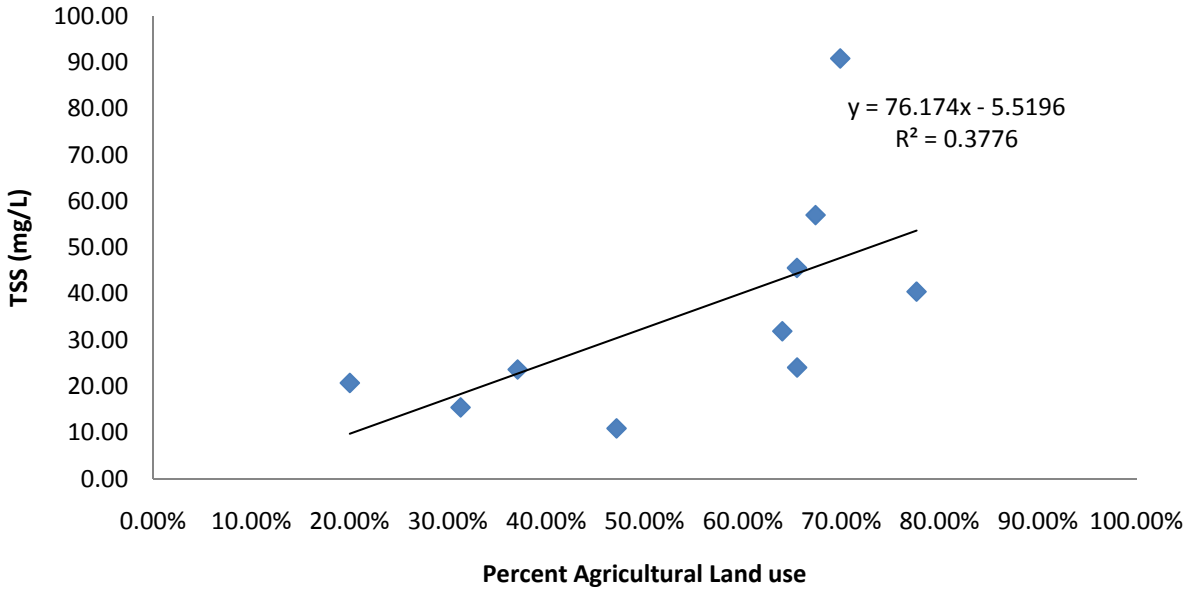


Figure 37. Agriculture × Total Suspended Solids



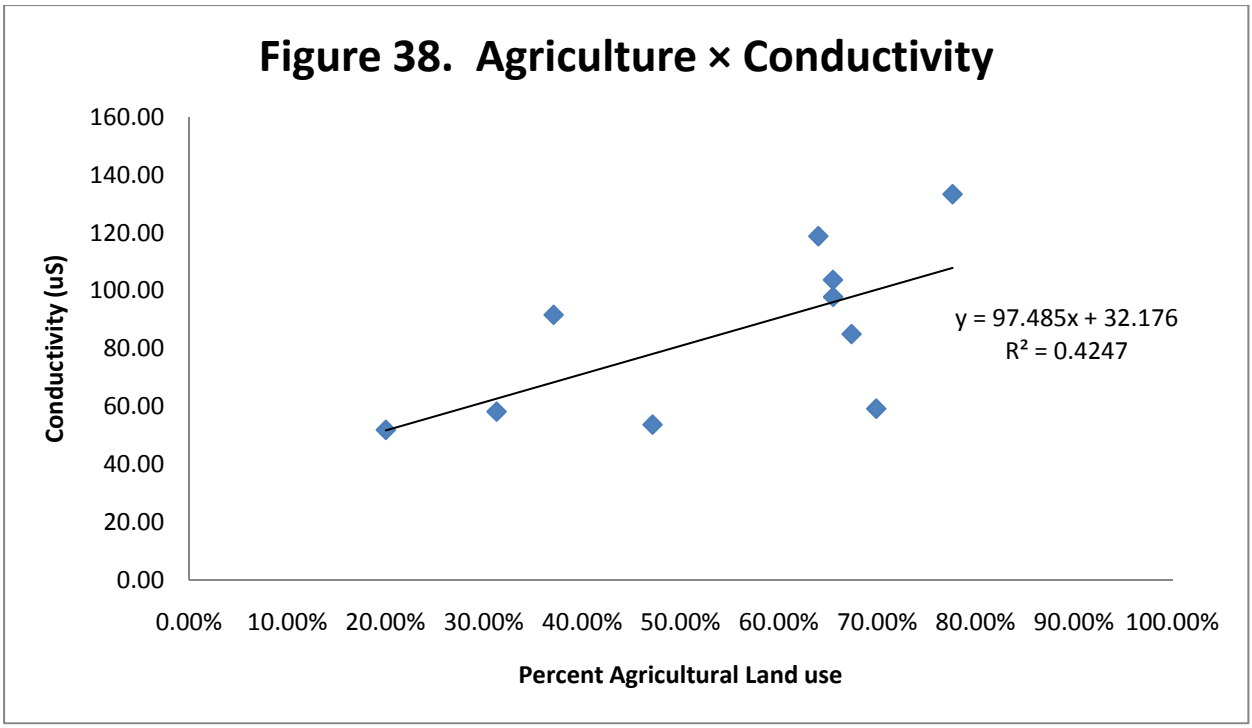


Figure 38. Agriculture × Conductivity
Conductivity (uS)
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%
Percent Agricultural Land use
y = 97.485x + 32.176
R² = 0.4247

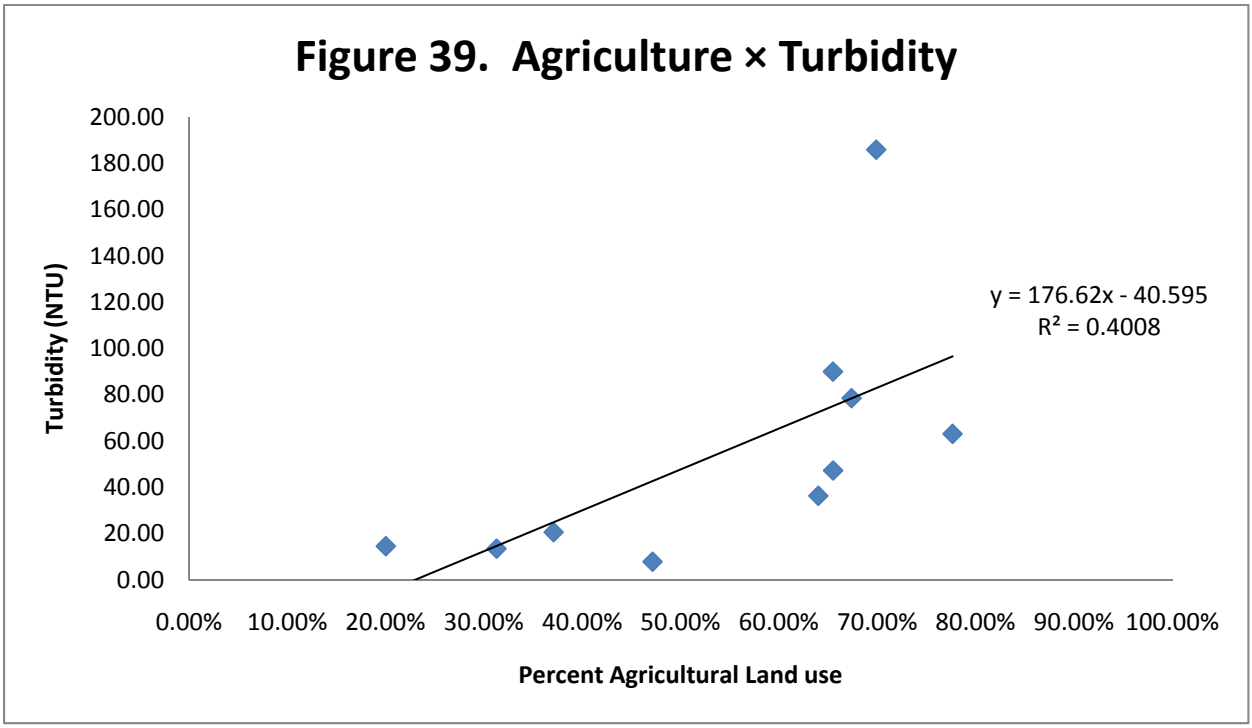


Figure 39. Agriculture × Turbidity
Turbidity (NTU)
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%
Percent Agricultural Land use
y = 176.62x - 40.595
R² = 0.4008

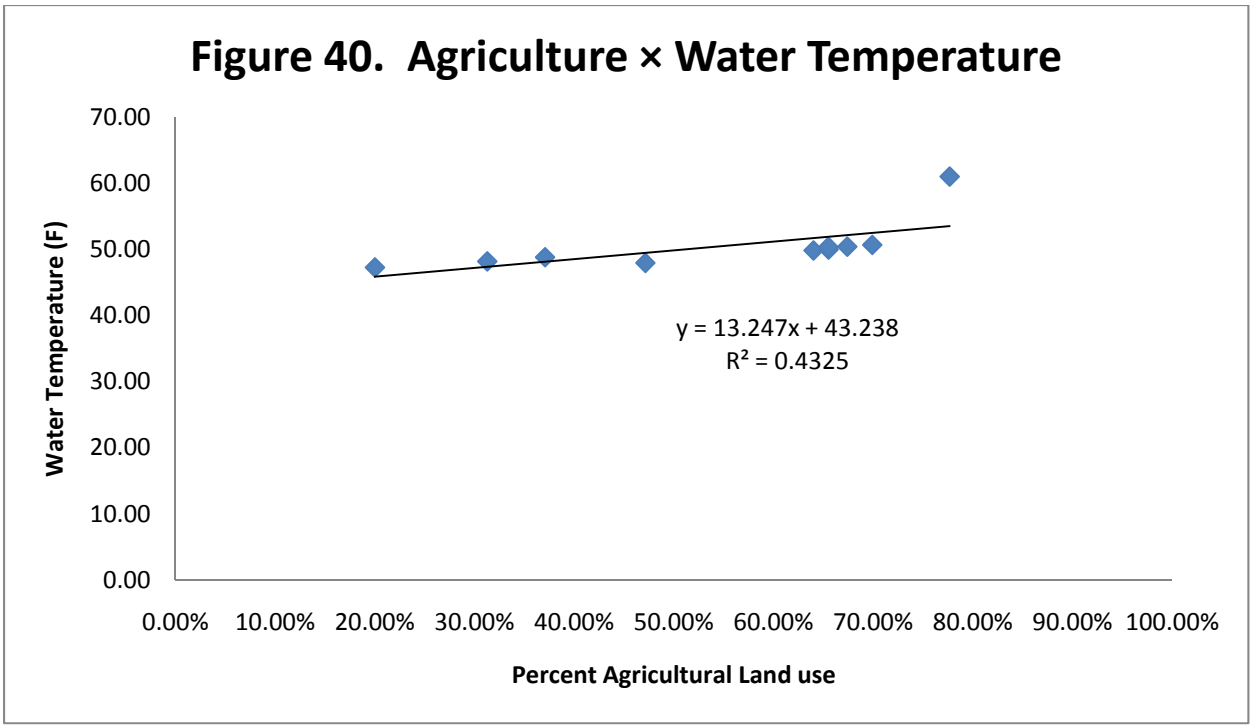


Figure 40. Agriculture × Water Temperature
Water Temperature (F)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
y = 13.247x + 43.238
R² = 0.4325
0.00% 10.00% 20.00% 30.00% 40.00% 50.00% 60.00% 70.00% 80.00% 90.00% 100.00%
Percent Agricultural Land use

PESTICIDE SAMPLING

Pesticide Sampling Overview

The Clackamas Water Quality Monitoring Program also included a test for pesticides following a fall and spring storm event. Pesticides were evaluated at each of the study site locations and were analyzed for pesticides and polychlorinated biphenyls (EPA method 508.1), semi-volatile organics (EPA method 525.2), oraganochlorine pesticides (EPA method 8081A), and organophosphorus pesticides (EPA method 8141). Water samples were tested for pesticides by Clackamas County Water and Environment Services lab through a subcontract with Columbia Analytical Services. Duplicate samples and blanks were processed along with samples from each location.

Water samples were first collected following the first seasonal onset of heavy rains on October 23, 2009. Unfortunately, when results were supplied to the Conservation District, it became clear that these samples were only analyzed for oraganochlorine pesticides (EPA method 8081A), and omitted the other three testing methods. As a result, a second sampling period was undertaken following a strong winter storm event on February 11, 2010. This winter round of pesticide monitoring was carried out to compensate for the improperly tested samples in October, 2009.

A round of spring pesticide sampling was carried out on April 5, 2010. This spring sampling was carried out following a strong storm system and all samples were again processed by Columbia Analytical Services.

The Clackamas County Soil and Water Conservation District met with Oregon Department of Agriculture personnel to review sampling techniques and data analysis. A thorough review of data collection and data analysis processes was carried out prior to completion of the 3rd quarter report. The Clackamas Conservation District has implemented a number of changes recommended by ODA and has been working with field personnel at Clackamas County Water and Environment Services to enhance data collection techniques and to ensure the integrity of data collected.

The quality control measures implemented exhibited three detects in field blanks collected by Clackamas Water and Environment Services. Although the pesticides detected where small abundance is these indicate a potential for error within the pesticide samples.

Although a full suite of pesticides were tested for each sample only the those chemicals that were detected are represented in the analysis. For a complete list of pesticides test please review Appendix II.

Pesticide Results

Site 1 (Richey/NF Deep Cr.):

Oct 23, 2009

Pesticide detected: Endosulfane sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane sulfate was detected at 0.018 µg/L

Feb 11, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0012 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Chlorpyrifos
Criteria: < 0.041 [2]
Discussion: Chlorpyrifos was detected at 0.076 µg/L which exceeds the recommended DEQ level.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0022 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at 0.0024 µg/L.

Pesticide detected: Endrin Aldehyde
Criteria: No accepted standard for aquatic life
Discussion: Endrin Aldehyde was detected at 0.0029 µg/L

Pesticide detected: Simazine
Criteria: "Slightly to practically nontoxic to aquatic organisms"[5]
Discussion: Simazine was detected at 0.0690 µg/L.

Apr 2, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]

Discussion: 4,4 DDE was detected at 0.0012 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0045 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at 0.0037 µg/L.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0011 µg/L is below the recommended DEQ level.

Pesticide detected: Metolachlor
Criteria: No accepted standard for aquatic life
Discussion: Metolachlor was detected at 0.0900 µg/L

Site 2: (Hwy 212/ NF Deep Cr.)

Oct 23, 2009

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.013 µg/L The detected value is 13 times the recommended freshwater criteria.

Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.018 µg/L. The detected value is 18 times the recommended freshwater criteria.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.015 µg/L, which is below the recommended DEQ level.

Feb 11, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.001 µg/L The detected value is equal to the recommended freshwater criteria.

Pesticide detected: Chlorpyrifos
Criteria: < 0.041 [2]
Discussion: Chlorpyrifos was detected at 0.0079 µg/L is below the recommended DEQ level.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0043 µg/L, which is below the recommended DEQ level.

Apr 2, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0028 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0057 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0068 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at 0.0031 µg/L.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0010 µg/L is below the recommended DEQ level.

Pesticide detected: Hexachlorobenzene
Criteria: No accepted standard for aquatic life
Discussion: Hexachlorobenzene was detected at 0.0005 µg/L.

Pesticide detected: Metolachlor
Criteria: No accepted standard for aquatic life
Discussion: Metolachlor was detected at 0.1400 µg/L

Pesticide detected: Simazine
Criteria: "Slightly to practically nontoxic to aquatic organisms"[5]
Discussion: Simazine was detected at 0.0530 µg/L.

Site 3: (312th/Dolan Cr.)

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0006 µg/L. The detected value did not exceed the recommended freshwater criteria.

Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0019 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Chlorpyrifos
Criteria: < 0.041 [2]
Discussion: Chlorpyrifos was detected at 0.0200 µg/L is below the recommended DEQ level.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0033 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0012 µg/L is below the recommended DEQ level.

Pesticide detected: gamma-BHC (Lindane)
Criteria: < 0.95[4]
Discussion: gamma-BHC (Lindane) was detected at 0.0005 µg/L is below the recommended DEQ level.

Pesticide detected: Simazine
Criteria: "Slightly to practically nontoxic to aquatic organisms"[5]
Discussion: Simazine was detected at 0.3800 µg/L.

Apr 2, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0046 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0084 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0088 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at 0.0033 µg/L.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0015 µg/L is below the recommended DEQ level.

Pesticide detected: Hexachlorobenzene
Criteria: No accepted standard for aquatic life
Discussion: Hexachlorobenzene was detected at 0.0018 µg/L.

Pesticide detected: Simazine
Criteria: "Slightly to practically nontoxic to aquatic organisms"[5]
Discussion: Simazine was detected at 0.2100 µg/L.

Site 4: (Brooks/Doane Cr.)

Oct 23, 2009

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at .013 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at .013 µg/L.

Pesticide detected: Chlorpyrifos
Criteria: < 0.041 [2]

Discussion: Chlorpyrifos was detected at 0.034 µg/L is below the recommended DEQ level.

Feb 11, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0016 µg/L. The detected exceeds the recommended freshwater criterion.

Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0035 µg/L. The detected exceeds the recommended freshwater criterion.

Pesticide detected: Chlorpyrifos
Criteria: < 0.041 [2]
Discussion: Chlorpyrifos was detected at 0.037 µg/L is below the recommended DEQ level.

Pesticide detected: Diazinon
Criteria: < 0.17[2]
Discussion: Diazinon was detected at 0.2500 µg/L which exceeds the recommended DEQ level.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0043 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0014 µg/L which is below the recommended DEQ level.

Pesticide detected: Simazine
Criteria: Slightly to practically nontoxic to aquatic organisms[5]
Discussion: Simazine was detected at 0.5200 µg/L is below the recommended DEQ level.

Apr 2, 2010

Pesticide detected: 2,4 DDT
Criteria: No accepted standard for aquatic life
Discussion: 2,4 DDT was detected at 0.0008 µg/L.

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]

Discussion: 4,4 DDE was detected at 0.0037 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0077 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0098 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at 0.0019 µg/L.

Pesticide detected: Hexachlorobenzene
Criteria: No accepted standard for aquatic life
Discussion: Hexachlorobenzene was detected at 0.0011 µg/L.

Pesticide detected: Simazine
Criteria: "Slightly to practically nontoxic to aquatic organisms"[5]
Discussion: Simazine was detected at 0.1200 µg/L.

Site 5: (Welling/Dolan Cr.)

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0022 µg/L. The detected value exceeds the recommended freshwater criterion.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at .0027 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfan I
Criteria: < 0.056 [2]
Discussion: Endosulfan I was detected at 0.0012 µg/L which is below the recommended DEQ level.

Pesticide detected: Endosulfan II
Criteria: < 0.056 [2]
Discussion: Endosulfan II was detected at 0.0014 µg/L which is below the recommended DEQ level.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0006 µg/L which is below the recommended DEQ level.

Pesticide detected: Endrin Aldehyde
Criteria: No accepted standard for aquatic life
Discussion: Endrin Aldehyde was detected at 0.0008 µg/L.

Pesticide detected: trans-Nonachlor
Criteria: No accepted standard for aquatic life
Discussion: trans-Nonachlor was detected at 0.0012 µg/.

Apr 2, 2010

Pesticide detected: 2,4 DDT
Criteria: No accepted standard for aquatic life
Discussion: 2,4 DDT was detected at 0.0007 µg/L.

Pesticide detected: 4,4 DDD
Criteria: < 0.001 [4]
Discussion: 4,4 DDD was detected at 0.0006 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0070 µg/L. The detected value exceeds the recommended freshwater criteria.

Date: Apr 2, 2010
Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0055 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Chlordane
Criteria: < 0.0043[6]
Discussion: Chlordane was reported at 0.0390 µg/L. The detected value is more than nine times the recommended criteria.

Pesticide detected: Dieldrin

Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0064 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at 0.0013 µg/L.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0016 µg/L which is below the recommended DEQ level.

Pesticide detected: Endrin Aldehyde
Criteria: No accepted standard for aquatic life
Discussion: Endrin Aldehyde was detected at 0.0020 µg/L.

Pesticide detected: gamma-Chlordane
Criteria: No accepted standard for aquatic life
Discussion: gamma-Chlordane was detected at 0.0015 µg/L.

Pesticide detected: Metolachlor
Criteria: No accepted standard for aquatic life
Discussion: Metolachlor was detected at 0.2600 µg/L

Pesticide detected: Pyrene
Criteria: No accepted standard for aquatic life
Discussion: Pyrene was detected at 0.0540 µg/L

Pesticide detected: trans-Nonachlor
Criteria: No accepted standard for aquatic life
Discussion: trans-Nonachlor was detected at 0.0023 µg/.

Site 6: (Compton/Dolan)

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0010 µg/L which is below the recommended DEQ level.

Apr 2, 2010

Pesticide detected: 4,4 DDE
Criteria: < 0.001 [4]
Discussion: 4,4 DDE was detected at 0.0020 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: 4,4 DDT.
Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0028 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at 0.0021 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0013 µg/L which is below the recommended DEQ level.

Pesticide detected: Simazine
Criteria: "Slightly to practically nontoxic to aquatic organisms"[5]
Discussion: Simazine was detected at 1.400 µg/L.

Site 7: (Tickle Cr Rd/Tickle Cr.)

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: Chlorpyrifos
Criteria: < 0.041 [2]
Discussion: Chlorpyrifos was detected at 0.0075 µg/L is below the recommended DEQ level.

Pesticide detected: Oxychlordane
Criteria: No accepted standard for aquatic life
Discussion: Oxychlordane was detected at 0.0006 µg/L.

Apr 2, 2010

Pesticide detected: 4,4 DDT.

Criteria: < 0.001 [4]
Discussion: 4,4 DDT was detected at 0.0018 µg/L. The detected value exceeds the recommended freshwater criteria.

Pesticide detected: Endosulfane Sulfate
Criteria: No accepted standard for aquatic life
Discussion: Endosulfane Sulfate was detected at 0.0030 µg/L.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0011 µg/L which is below the recommended DEQ level.

Pesticide detected: Hexptachlor Epoxide
Criteria: No accepted standard for aquatic life
Discussion: Hexptachlor Epoxide was detected at 0.0013 µg/L.

Site 8: (362/Tickle Cr.)

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0009 µg/L which is below the recommended DEQ level.

Apr 2, 2010

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0006 µg/L which is below the recommended DEQ level.

Pesticide detected: Pyrene
Criteria: No accepted standard for aquatic life
Discussion: Pyrene was detected at 0.0570 µg/L

Site 9: (Langensand/Tickle Cr.)

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0010 µg/L which is below the recommended DEQ level.

Apr 2, 2010

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at .0012 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0012 µg/L which is below the recommended DEQ level.

Site 10: (Trubel/Tickle Cr.)

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at .0007 µg/L, which is below the recommended DEQ level.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0008 µg/L which is below the recommended DEQ level.

Apr 2, 2010

Pesticide detected: Dieldrin
Criteria: < 0.056 [2]
Discussion: Dieldrin was reported at .0013 µg/L, which is below the recommended DEQ level.

Field Blanks

Oct 23, 2009

Discussion: None detected

Feb 11, 2010

Pesticide detected: Endosulfan II
Criteria: < 0.056 [2]
Discussion: Endosulfan II was detected at 0.0022 µg/L which is below the recommended DEQ level.

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0006 µg/L which is below the recommended DEQ level.

Apr 2, 2010

Pesticide detected: Endrin
Criteria: < 0.036 [2]
Discussion: Endrin was detected at 0.0006 µg/L which is below the recommended DEQ level.

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5. Extoxnet. 2010. *Extoxnet:Pesticide information Project.* http://extoxnet.orst.edu/pips/simazine.htm
6. EPA. Office of Pesticide Program, Office of Water. 2009. Aquatic Life Criteria Benchmarks. http://www.epa.gov/waterscience/criteria/wqctable/index.htm

PROGRAM SUMMARY

Overall the Clackamas Water Quality Monitoring Program has provided a broad overview of water quality within the Deep Creek Sub-basin. This information serves as a baseline for evaluating how our land management practices influence ecosystem health. These findings allow us to implement conservation practices to enhance our ecological resources while preserving the viability of our local economy.

Although the finds of the Clackamas Water Quality monitoring report indicate a need for improving water quality to meet established standards. This study serves as a call to action. The ongoing work of the Conservation District and the Oregon Department of Agriculture is committed to improving water quality within Clackamas County.

The land use assessment within the study area demonstrated a correlation between land use practices and several water quality metrics. Although this analysis serves to define the relative role of different land use practices, it should be noted that these land uses are inherently confounded. Rural and urban landscapes are linked through complex social and economic relationships, not excluding the need for, efficient agricultural practices to make urban living possible.

Clackamas County has a distinct rural and urban component and each has their role to play in improving water quality. The Conservation District is committed to promoting land management practices that promote ecosystem health and economic viability.

APPENDIX I

Laboratory Analysis Reports,

Laboratory Analytical QC Reports,

Field Analytical QC Reports,

Routine Surface Water Monitoring Field Sheets

APPENDIX II

Pesticide Sampling Analytical Reports

APPENDIX III

Digital Program Files