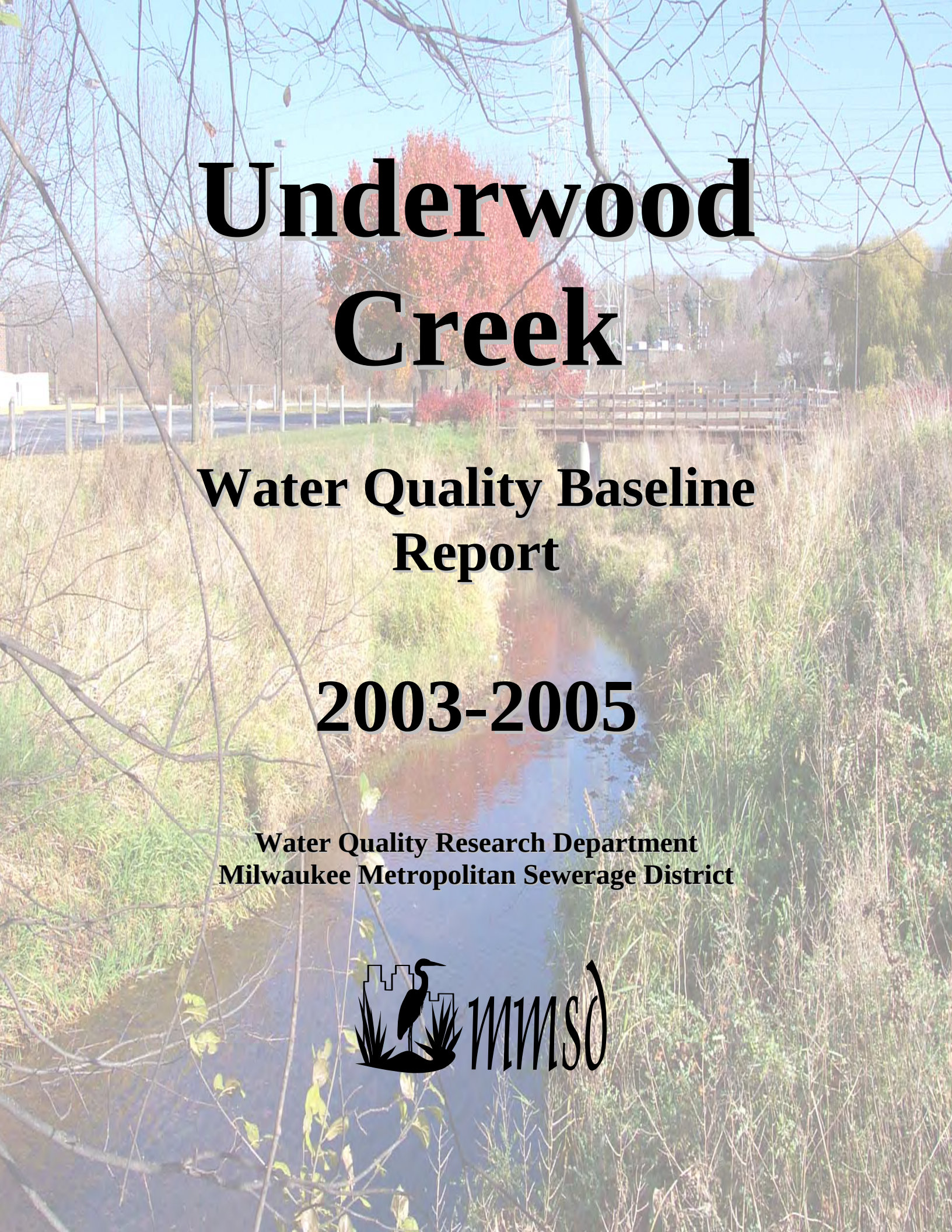


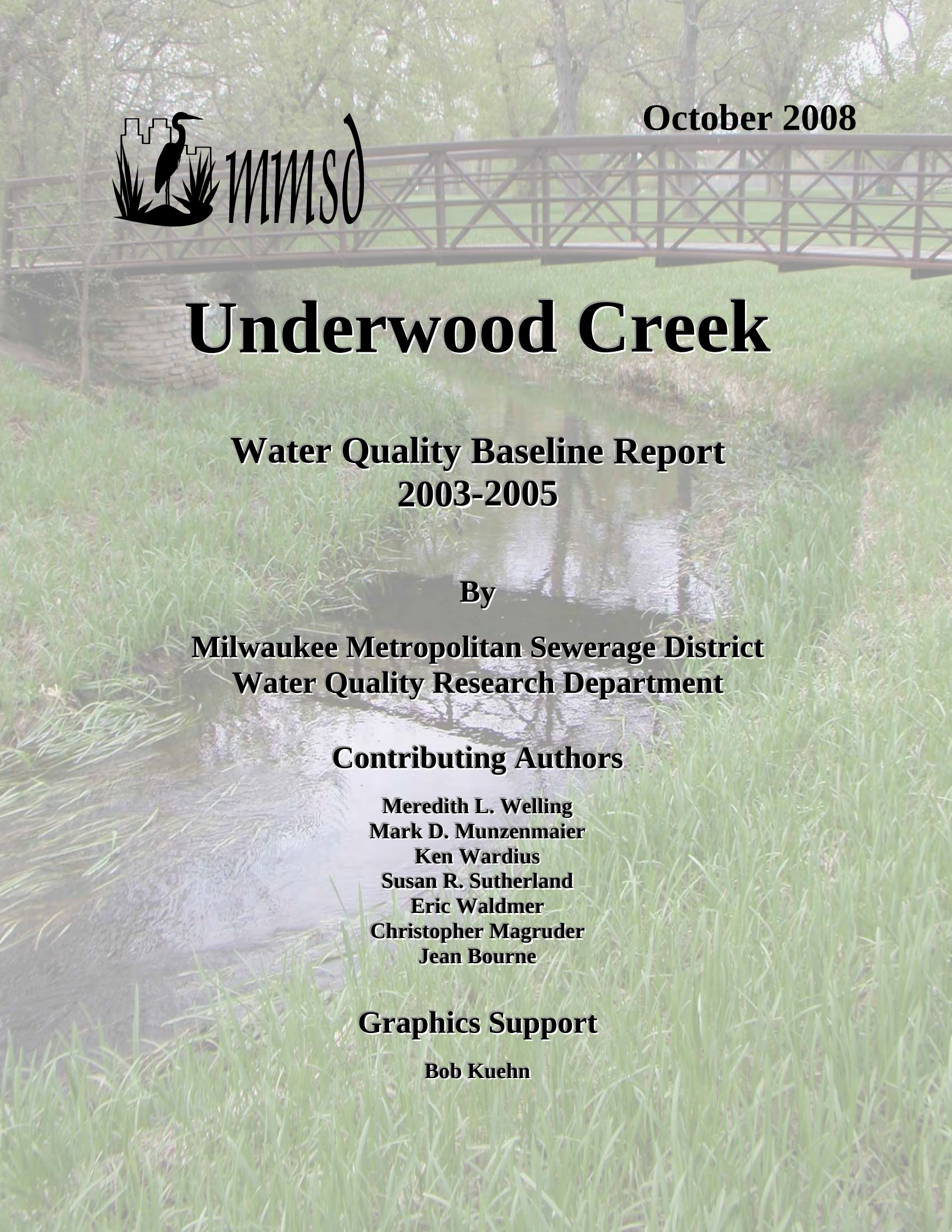
Underwood Creek

Water Quality Baseline Report

2003-2005

Water Quality Research Department
Milwaukee Metropolitan Sewerage District

MMSD



October 2008

Underwood Creek

Water Quality Baseline Report
2003-2005

By

Milwaukee Metropolitan Sewerage District
Water Quality Research Department

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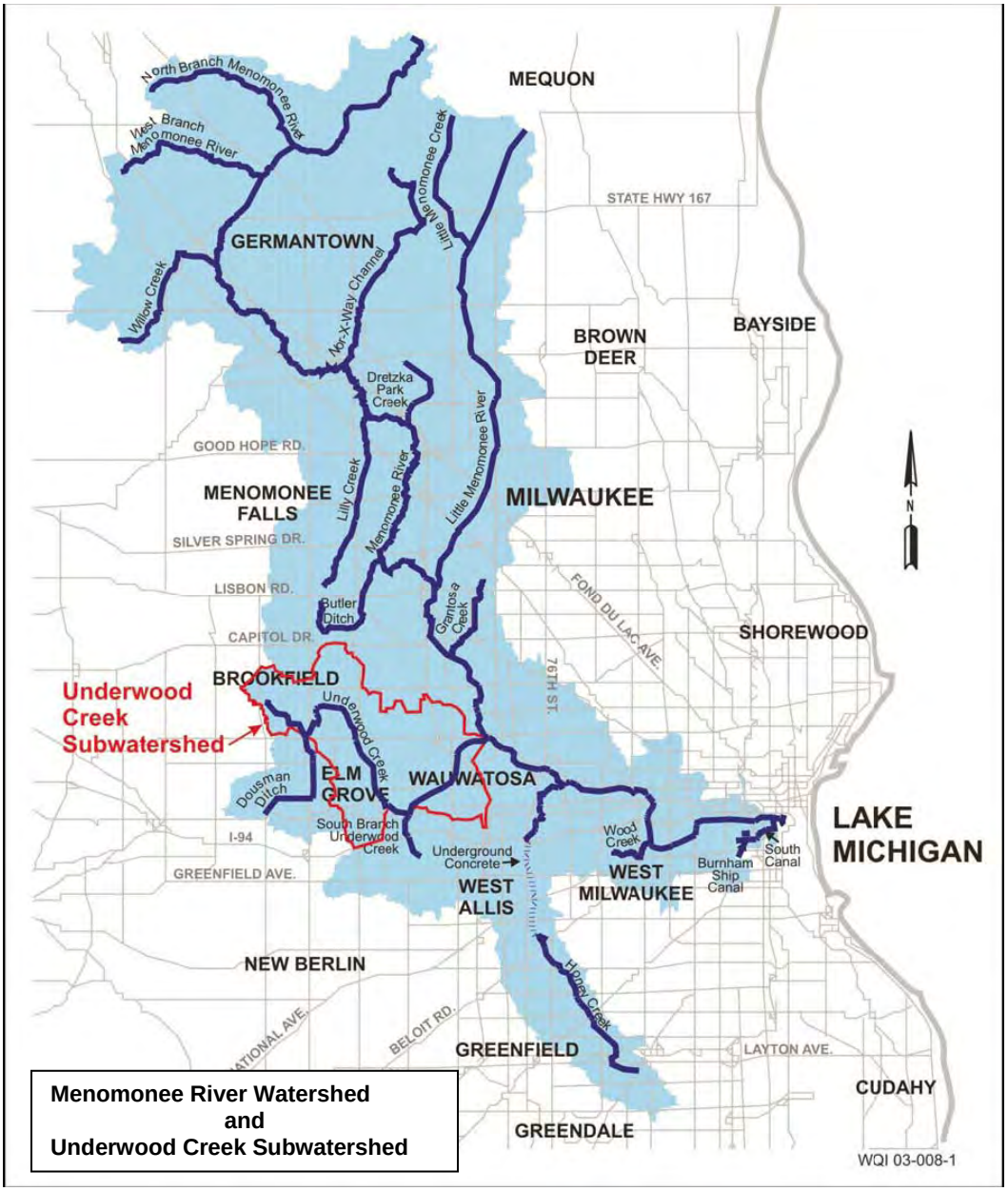
Executive Summary

Underwood Creek (UC) is an 8.0 mile perennial stream that is tributary to the Menomonee River; the Menomonee River is tributary to Lake Michigan. The creek's major tributaries are Dousman Ditch (2.6 mile length) and the South Branch of Underwood Creek (1.1 mile length) (SEWRPC 2008). The Underwood Creek subwatershed comprises about 15% of the Menomonee River watershed (HNTB 2006).



The Underwood Creek sub-watershed is an urban watershed that drains approximately 19.9 square miles (SEWRPC, Nov. 2000), and includes portions of the Cities of Brookfield,

Milwaukee, New Berlin, Wauwatosa, and West Allis, the Town of Brookfield and the Village of Elm Grove.

The annual peak streamflow in Underwood Creek (USGS gaging station data at Wauwatosa) ranges from 320 to 7500 cubic feet per second based on flows for the years 1975 to 2006. Future flow increases from 0 to 5 % are expected along Underwood Creek (based on 2020 land use conditions, 100 year flows) (MMSD 2000).

Much of Underwood Creek is channelized with concrete lining and has been diverted from its original course. The drainage area is relatively small and is influenced by poorly to very poorly drained soils (SEWRPC, Feb. 2000). These types of soils affect not only the amount of runoff but also the rate. The perennial and intermittent streams in the watershed receive runoff from storm sewers, culverts, roadside swales, drainage ditches and drainageways (SEWRPC, Feb. 2000).

Underwood Creek, concrete lined and straightened channel

The mission of the Milwaukee Metropolitan Sewerage District (MMSD) is to cost effectively protect the water resources within its jurisdiction. The MMSD and other governmental entities are working to reduce the risk of serious damage caused by flooding to homes, businesses, and people while incorporating environmentally sound best management practices for stormwater and flood management.

Among natural disasters, flooding is the leading cause of fatalities and property damage in the United States (MMSD 2000). Bridges and culverts in the Underwood Creek watershed can cause constrictions resulting in backwater effects and creating an upstream floodland area (SEWRPC Feb. 2000). The MMSD estimated the number of flooded structures projected from 2020 land use development conditions based on a one percent probability storm (100 year flood) at 58 flooded structures. Street and yard flooding have also occurred in the watershed (SEWRPC Feb. 2000). Using the same criteria, MMSD estimated the total damages at $2,075,000 (MMSD 2000).

The MMSD and other governmental entities are working to reduce the risk of serious damage caused by flooding to homes, businesses, and people. The Underwood Creek Rehabilitation Project comprises a portion of a comprehensive approach for flood management by the MMSD. The MMSD seeks to provide a permanent, reliable, and cost-effective solution to reducing the risk of flooding problems within its jurisdiction (Lau 2005) and to improve the habitat and ecological value of its water resources (HNTB 2006).

The entire watershed must be examined when looking for solutions to reduce the risk of flooding, and excessive stormwater runoff must be limited as much as possible. Channel alterations to Underwood Creek have resulted in increased peak discharges and channel velocities during periods of intense rainfall in the watershed (MMSD 2005). The design and installation of a floodwater storage facility on the Milwaukee County Grounds by MMSD will help to moderate flooding conditions in the Menomonee River (MMSD 2005). The project also provided an opportunity to rehabilitate a portion of Underwood Creek through removal of concrete channel lining, and development of a replacement bioengineered channel that provides desirable aesthetic habitat, environmentally friendly stream restoration, and public safety improvements (MMSD 2005). The principal goals of the Underwood Creek Rehabilitation and Flood Management Project are to meet the following criteria:

- Develop stable channel sections using an environmentally sensitive and aesthetically acceptable channel design and lining materials that are acceptable to the WDNR.
- Provide aquatic habitat appropriate for the flow regime that contains suitable meanders, pools and riffles, and provide appropriate vegetation along the channel banks using native plant materials.
- Provide assurance that flood damages will not occur along Underwood Creek during the one-percent probability flood (100 year) event, and that appropriate peak discharges will be diverted to the Milwaukee County Grounds flood management facility.
- Develop a channel design with acceptable short and long-term maintenance requirements and costs; and acceptable public safety measures (MMSD 2005).

This project will lessen the impact of Underwood Creek on the Menomonee River both from an environmental and a flood management perspective.

Water quality monitoring in Underwood Creek began in May of 2003, the survey encompasses 2 sites on the south branch and 5 sites on the mainstem (MMSD 2003). Surface water quality monitoring was proposed on Underwood Creek to gather data before, during, and after flood and stormwater management projects. The data gathered will also be utilized to evaluate the impact that Underwood Creek has on the Menomonee River. One of the main concerns is high historic and current fecal coliform bacteria numbers at a Menomonee River water quality site located downstream of the Underwood Creek confluence (N. 70th Street just south of State Street, RI-09). Data collected before construction and remediation projects occur will provide valuable baseline data that will characterize water quality in Underwood Creek. Data collected during construction and remediation projects will allow the MMSD to assess any changes in water quality due to these activities. Data collected after project completion will facilitate the assessment of any water

MMSD Water Quality Research Sampling Van

quality improvements as a result of flood and stormwater management projects and will help to ascertain the effectiveness of these efforts.

The MMSD Underwood Creek survey consists of 7 single depth sampling locations with each site being designated by UC and a number. The MMSD Technical Services Division and the Water Quality Research (WQR) Department determined site position. These sites were chosen based on accessibility and location within the watershed. Samples for several dozen variables are collected and analyzed.

Underwood Creek (UC) Sampling Locations

Site Number	Location	Other
UC-01	Pilgrim Road in Wirth Park	mainstem
UC-02	Lilly Road & Marcella Street	mainstem
UC-03	124th Street & Bluemound Road by UPS	mainstem
UC-04	116th Street & Greenfield Avenue	south branch
UC-05	~121st Street & Underwood Creek Parkway Krueger Park	south branch
UC-06	115th Street and Underwood Creek Parkway	mainstem
UC-07	107th Street & Fisher Parkway	mainstem

Some parameters, including dissolved oxygen, suspended solids, un-ionized ammonia, nitrate, nitrite, chloride, mercury, copper, lead, zinc, cadmium, chromium, and nickel were at levels conducive to good water quality with values below recommended maxima or state criteria. At

other times, conventional pollutants, including fecal coliform bacteria, total phosphorus, soluble phosphorus, TKN, and to a lesser extent, dissolved oxygen exceeded State of Wisconsin Criteria or recommended maximums. Toxic pollutants (PAH's, mercury) were present in Underwood Creek. PAH's were present at all sites in all years. Mercury was also present at all sites in all years; however, at no time did the levels exceed State of Wisconsin chronic criteria.
MMSD's Water Quality Research Department has developed a Water Quality Index (WQI) that is used as an assessment tool for evaluating river and creek water quality. Based on nationally recognized indices and established water quality criteria, eleven variables are mathematically calculated into subindex and final index values and translated into descriptive categories, i.e., excellent, good, fair, bad, very bad, and worst water quality. The raw data for each variable are transformed to comparable scales so that no one variable is more important than another, yielding a subindex value. The subindex value is then ranked: good, fair, bad, etc. The final index value is a combination (geometric mean) of all subindices. Note that as the index values increase, water quality improves. The variables used to calculate the WQI are: dissolved oxygen, total phosphorus, soluble phosphorus, ammonia, un-ionized ammonia, fecal coliform bacteria, suspended solids, total organic carbon, chloride, copper, and zinc. These variables are known to cause stress to aquatic life, are by-products of human activity, and can be measured against known criteria. A more detailed explanation of the MMSD WQI can be found in: MMSD Development of a Water Quality Index for the Milwaukee Metropolitan Sewerage District, 1994.

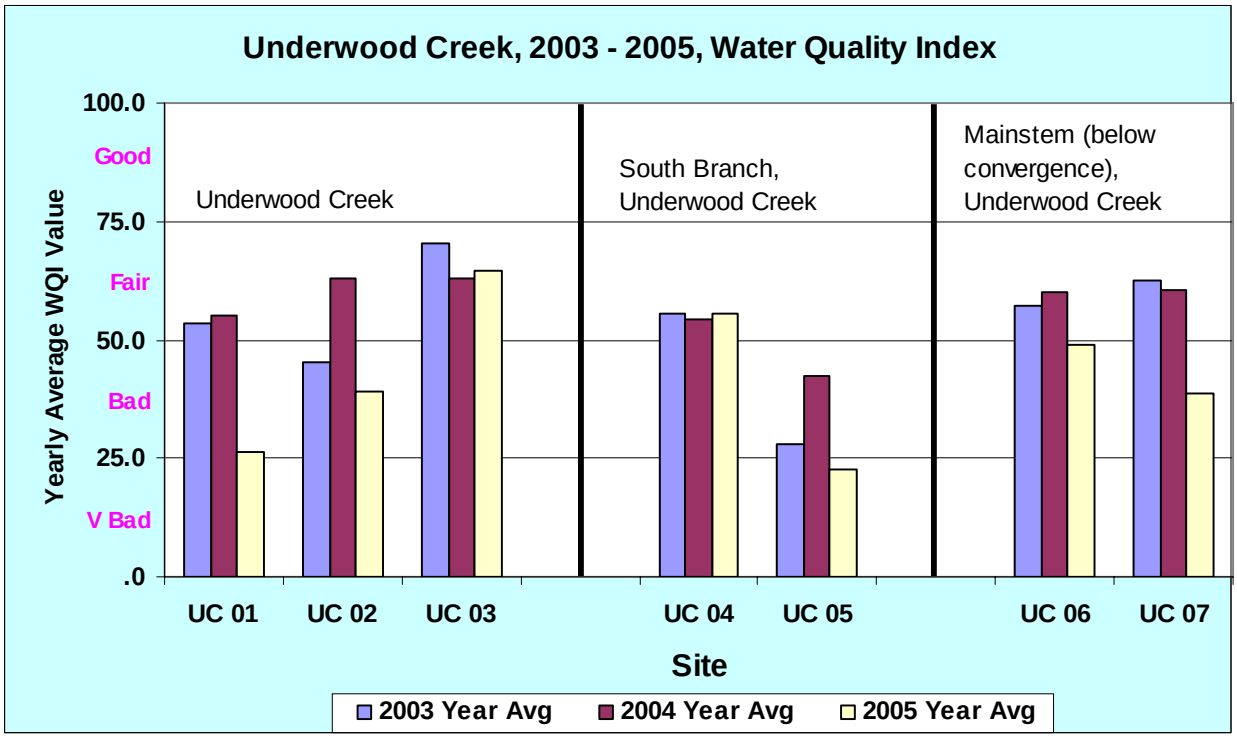
The WQI was used to evaluate the Underwood Creek water quality database. The annual average WQI values are presented below. The MMSD WQI regularly classified Underwood Creek as either "fair" or "bad" water quality.

2003-2005 Underwood Creek Annual Average WQI Values.

	Underwood Creek			UC South Branch		UC Mainstem – Below convergence	
Year	**UC-01**	**UC-02**	**UC-03**	**UC-04**	**UC-05**	**UC-06**	**UC-07**
2003	53.32	**45.07**	70.23	55.46	**27.86**	57.04	62.57
2004	55.29	63.15	62.96	54.41	**42.42**	60.10	60.61
2005	**26.45**	**39.20**	64.62	55.70	**22.60**	**49.12**	**38.75**
3 yr avg	**45.02**	**49.14**	**65.94**	**55.19**	**30.96**	**55.42**	**53.98**
	Bad	**Bad**	**Fair**	**Fair**	**Bad**	**Fair**	**Fair**
			Best Site		**Worst Site**		
Index Key: Excellent = 100, Good = 75-99, Fair = 50-74, Bad = 25-49, Very Bad = 1-24, Worst = <1							

Of the 21 annual WQI averages produced, 62% were ranked as "fair", 33% were ranked as "bad" and 5% were ranked as "very bad". No annual final WQI numbers resided in the "excellent" or "worst" categories. UC-03 was the best ranked site for the three year period (3 year average = 65.94) and the WQI consistently fell into the "fair" water quality category; while UC-05 was the worst ranked site (3 year average = 30.96) and habitually displayed WQI values in the "bad" and "very bad" categories. The year 2004 was the best year on average with 6 of the 7 sites exhibiting WQI values in the "fair" category. Additionally, the WQI for 5 of the 7 Underwood Creek sites worsened in 2005; with 4 of these falling from the "fair" to "bad" category and 1 site falling from the "bad" to the "very bad" category. Consequently, the year 2005 was the worst year on average.

A graphical representation of the annual average (2003 – 2005) WQI values for all sites on Underwood Creek can be found below. Again, the best year across all sites was 2004, followed by 2003. Generally, the year 2005 experienced degradation in the WQI at all sites when

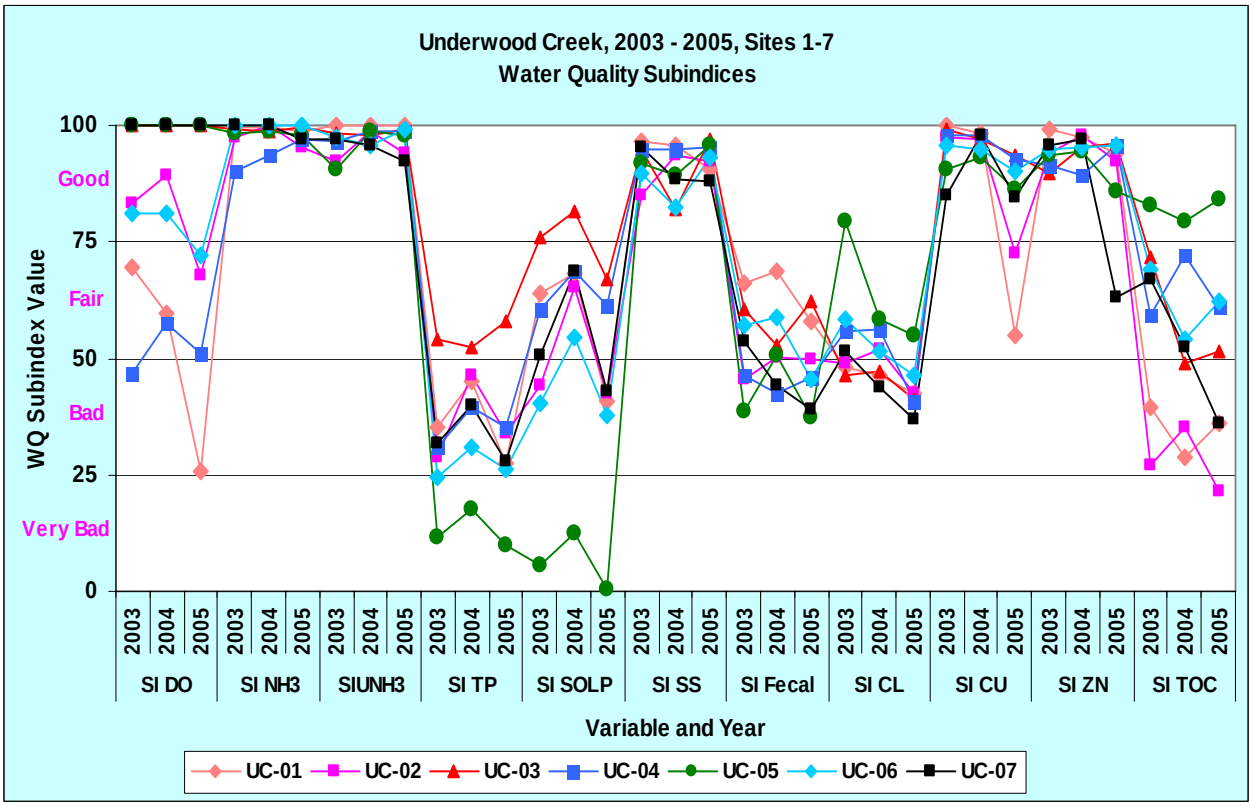


Water Quality Index, Underwood Creek, Sites 1 – 7, 2003 – 2005

compared to the previous 2 years except UC-04. This site remained very consistent, exhibiting a slight improvement in the WQI in 2005. Based on the annual averages, water quality improves in the upper reaches of Underwood Creek as it heads downstream; water quality becomes worse when moving downstream in the south branch of Underwood Creek; and with the exception of the year 2005, improves slightly in the lower reaches (mainstem) when moving downstream.

The figure below illustrates the predominant individual subindex variables contributing to lower WQI values. This figure should only be utilized for examining how the subindex variables reacted as a group and not for the determination of specific data points. For all sites, generally, total phosphorus (TP), soluble phosphorus (SOLP), fecal coliform bacteria (fecal), chlorides (CL), and to a lesser extent total organic carbon (TOC) drag the final WQI value downward toward poorer water quality. Conversely, the subindices for ammonia (NH3), un-ionized ammonia (UNH3), suspended solids (SS), copper (CU) and zinc (ZN) were consistently ranked as “good” with copper and zinc dropping to “fair” on a few occasions. Dissolved oxygen (DO) generally displayed subindex values in the “good” and “fair” ranges and on the two occasions that it did receive a “bad” ranking, it almost certainly had a negative effect on the final WQI value. Total organic carbon (TOC) ranged from “good” to “bad” water quality with one “very bad” subindex value. On a site to site basis, ammonia, un-ionized ammonia, suspended solids, copper, and zinc remained generally steady. Dissolved oxygen, total phosphorus, soluble phosphorus, fecal coliforms, and total organic carbon displayed more variability in the subindex

values. On a site by site basis, all subindices remained fairly consistent, never fluctuating out of its yearly ranking more than once.



Water Quality Subindices, Underwood Creek, Sites 1 – 7, 2003 – 2005

Underwood Creek sites were also compared statistically using the software package - *Statistica*®. WQI data were utilized for this comparison. Statistically, water quality at UC-05 was significantly different from all other Underwood Creek sites, verifying the WQI's analysis and finding of the worst water quality of all sites examined. Water quality at UC-03 (best site by WQI analysis) was found to be significantly different from UC-01 and UC-02 but not significantly different from water quality at UC-04, UC-06, and UC-07. This is not surprising given the WQI results at these locations; UC-03, UC-04, UC-06, and UC-07 were the only sites ranking as "fair" water quality while the other Underwood Creek sites (UC-01, UC-02, and UC-05) were ranked as "bad" water quality.

The impact of rainfall was analyzed for the three year sampling period utilizing a linear correlation yielding the following results:

Suspended solids, log fecal coliform, copper, and zinc were all negatively impacted by rainfall (as rainfall increases, the WQI value for these variables deteriorates) and most likely the subsequent associated stormwater runoff. The concentrations of these variables in Underwood Creek increased with rainfall; this was a statistically valid correlation. The Wisconsin Department of Natural Resources estimates that within the State, approximately 40% of our streams and 90% of our inland lakes are degraded or threatened due to nonpoint source pollution or polluted stormwater runoff (WDNR 2001). Chlorides exhibited a positive correlation

(as rainfall increases, the WQI value for this variable improves). It is possible that precipitation is exhibiting a dilutional effect on chloride concentrations.

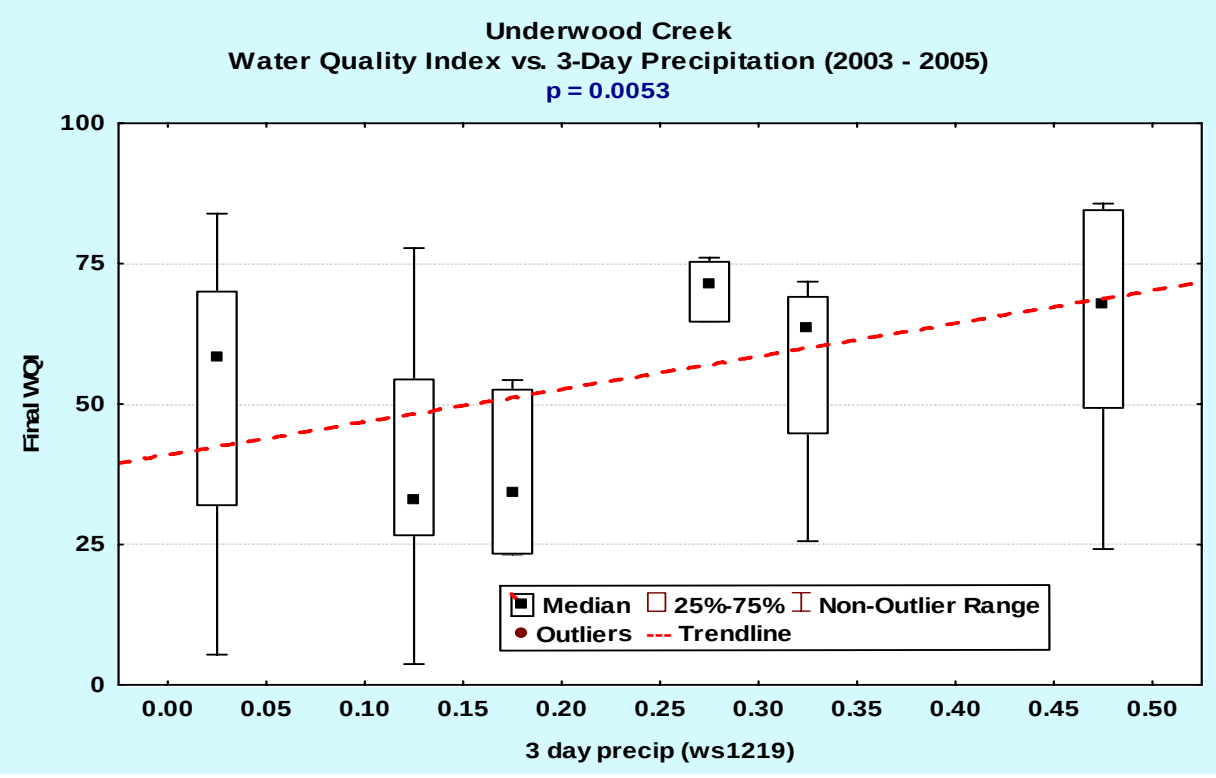
2003-2005 Underwood Creek Water Quality Index vs. 3-Day Precipitation.

Pair of Variables	Valid N	Spearman R	t(N-2)	p-level
	Spearman Rank Order Correlations MD pairwise deleted **Marked correlations are significant at p <.05000**			
SIDO & 3 day precip (ws1219)	168	-0.026203	-0.33772	0.736002
SITNH3 & 3 day precip (ws1219)	168	-0.027904	-0.35965	0.719564
SIUNNH3 & 3 day precip (ws1219)	168	0.005095	0.06565	0.947736
SITP & 3 day precip (ws1219)	168	-0.110387	-1.43098	0.154317
SISOLP & 3 day precip (ws1219)	168	-0.075164	-0.97117	0.332876
SISS & 3 day precip (ws1219)	**168**	**-0.156139**	**-2.03669**	**0.043270**
SILGFEC & 3 day precip (ws1219)	**168**	**-0.481508**	**-7.07840**	**0.000000**
SICHLOR & 3 day precip (ws1219)	**168**	**0.305971**	**4.14075**	**0.000055**
SICU & 3 day precip (ws1219)	**168**	**-0.331177**	**-4.52210**	**0.000012**
SIZN & 3 day precip (ws1219)	**168**	**-0.344994**	**-4.73568**	**0.000005**
SITOC & 3 day precip (ws1219)	168	0.044917	0.57930	0.563174
FNLNDX & 3 day precip (ws1219)	166	-0.081049	-1.04136	0.299239

WS = rain gauge station
SI = Subindex

Appendix D contains a variable abbreviations list

A statistically significant correlation was not found between the final WQI and 3-day precipitation and this is illustrated in the graph below. Again, the trendline illustrated in the Figure below was not significant and is the exact opposite of what one would expect to see with increasing rainfall amounts. This is most likely due to the limited amount of precipitation greater than 0.25 inches received during the study period (on or preceding sampling dates). These were marginal events, not typical of a more significant rainfall that would generate a greater load of stormwater to the creek. Of the 24 sampling dates, only 3 had a 3-day average precipitation of 0.25 or greater.



Water Quality Index vs. 3-Day Precipitation

Tremendous changes have begun within the Underwood Creek subwatershed to curb the impact of flooding and pollution on the Menomonee River. The design and installation of a floodwater storage facility on the Milwaukee County Grounds by MMSD will help to reduce the risk of flooding conditions in the Menomonee River (MMSD 2005).

Milwaukee County Grounds: habitat restoration emphasizes replanting trees, shrubs and plants with native species

More specifically, this project will help to reduce the risk of current flooding in downtown Wauwatosa, western portions of Milwaukee, and the Menomonee Valley by diverting floodwater from Underwood Creek during major rain events.

The project also provided an opportunity to rehabilitate a portion of Underwood Creek through removal of concrete channel lining, and development of a replacement bioengineered channel that provides desirable esthetic habitat, environmentally friendly stream restoration, and public safety improvements (MMSD 2005). Additionally, a partnership between MMSD and the City of Brookfield allowed the purchase of conservation easements that will result in floodwater being naturally stored, protecting property near the river, reducing future flood risk, and protecting water quality. Water quality monitoring will continue for an additional 3 to 5 years as this project attains full completion to substantiate improvements to the water quality of Underwood Creek as a result of MMSD's efforts.

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INTRODUCTION

Background

Underwood Creek (UC) is an 8.0 mile perennial stream that is tributary the Menomonee River which discharges to Lake Michigan. The Underwood Creek sub-watershed comprises about 15% of the Menomonee River watershed (HNTB 2006). It is an urban watershed that drains approximately 19.9 square miles (SEWRPC, Nov. 2000). The Underwood Creek subwatershed includes portions of the Cities of Brookfield, Milwaukee, New Berlin, Wauwatosa, and West Allis, the Town of Brookfield and the Village of Elm Grove. Perennial streams that are tributary to Underwood Creek include Dousman Ditch, the North branch of Underwood Creek, the South Branch of Underwood Creek, and several unnamed tributaries to Dousman Ditch (SEWRPC, Feb. 2000). Dousman Ditch joins Underwood Creek in Franklin Wirth Park (City of Brookfield); the creek then flows through Brookfield and into Elm Grove. The South Branch of Underwood Creek joins the mainstem just east of Elm Grove; the mainstem then flows through the City of Wauwatosa to its confluence with the Menomonee River southwest of the intersection of North Avenue and the Menomonee River Parkway (USGS 2000). Lake Evinrude, located in the Milwaukee County Zoo drains into the South Branch of Underwood Creek (MMSD WQI-03-009-1). The source of Underwood Creek is a large wetland located in the northwestern part of the subwatershed in the City of Brookfield (SEWRPC, Nov. 2000).

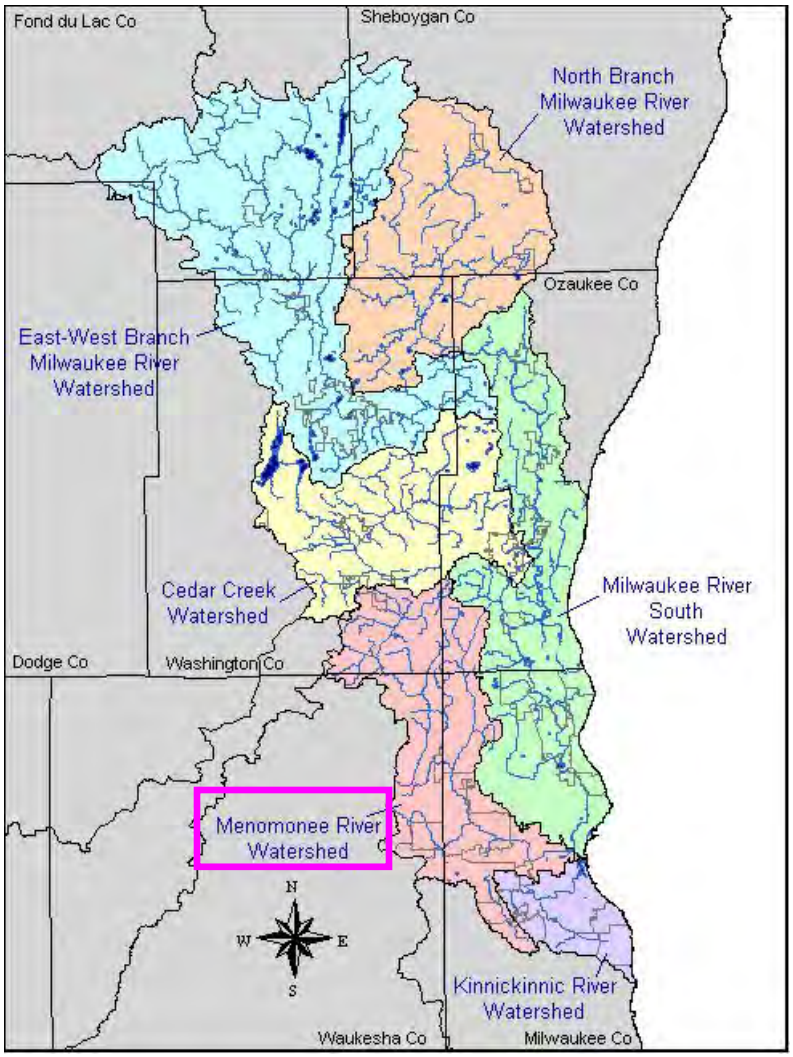


Figure 1: Menomonee River Watershed
Map courtesy: http://basineducation.uwex.edu/milwaukee/map.html

The Underwood Creek subwatershed is situated approximately 720 feet to 940 feet above sea level. (SEWRPC Feb. 2000). Some wetlands do exist in the watershed. In 1990, there were approximately 271 acres of wetlands in the Dousman Ditch subwatershed, and 439 acres in the Underwood Creek subwatershed comprising about 12 percent and 9 percent of the area, respectively (SEWRPC Feb. 2000). Natural storage areas do exist along most of Underwood

Creek (MMSD 2000) and would be considered primary or secondary environmental corridors. The annual peak streamflow in Underwood Creek (USGS gaging station data at Wauwatosa) ranges from 320 to 7500 cubic feet per second based on flows for the years 1975 to 2006. Future flow increases from 0 to 5 % are expected along Underwood Creek (based on 2020 land use conditions, 100 year flows) (MMSD 2000).

Land use is one factor that can greatly affect the quality of a creek or river by means of stormwater runoff. Land use also is a major contributor to the quantity of stormwater runoff. The Underwood Creek subwatershed is approximately 84% developed (HNTB 2005). Land use is primarily single density residential (SEWRPC 1995). Urban land uses are expected to cover about 81 and 86 percent of the Dousman Ditch and Underwood Creek subwatersheds (SEWRPC Feb. 2000). Stormwater runoff from lawns, rooftops, streets and driveways, parking lots, and storage areas contribute sediment, nutrients, organic matter, oil and grease, bacteria, metals, and toxic organic substances to streams (SEWRPC Feb. 2000). Documented toxic spills in Underwood Creek include oil, concrete, wash water, gasoline, and an unknown substance (SEWRPC 1995). Urban development generally increases stormwater flow rates and runoff volumes and the loadings of some pollutants (SEWRPC Feb. 2000). Much of Underwood Creek is channelized with concrete and has been diverted from its original course. The drainage area is relatively small and is influenced by poorly to very poorly drained soils (SEWRPC, Feb. 2000). These soil types affect not only the amount of runoff but also the rate. One would anticipate that a significant

Sections of Underwood Creek in Milwaukee County were lined with concrete in the 1960s and 1970s for flood management. Because of concrete lining, the aquatic habitat is lacking and the water warms more easily, making it harder for fish and aquatic organisms to survive. However, concrete lining can help protect local area homes and businesses from flooding. Water resource tradeoffs like this are common in highly urbanized environments.
(MMSD Water Quality Initiative, Menomonee River Watershed: http://www.mmsd.com/wqi/menomonee_river_watershed.cfm)

amount of runoff would be generated. The perennial and intermittent streams in the watershed receive runoff from storm sewers, culverts, roadside swales, drainage ditches and drainageways (SEWRPC, Feb. 2000). In 1975 there were 15 sewer flow relief devices that discharged into Underwood Creek, two from the City of Brookfield, five from the City of West Allis, and eight from the City of Wauwatosa (SEWRPC 1995). There are a number of point sources located on Underwood Creek via storm sewers or unnamed tributaries (1990 data); these include various school districts, industries, swimming pools, business other than industrial, a hospital, and a private household (SEWRPC 1995). There are sixteen permitted

industrial discharge points in Underwood Creek and three in Dousman Ditch (SEWRPC 1995). There is one abandoned landfill that was identified in 1990 by SEWRPC to be a potential pollution source located in the City of Brookfield (SEWRPC 1995). There were also several LUST (Leaking Underground Storage Tank) sites identified by SEWRPC to be potential sources of pollution located in the Cities of Wauwatosa, Brookfield, and West Allis (SEWRPC 1995). These sites may be permitted under the WPDES (Wisconsin Pollutant Discharge Elimination System). These factors contribute greatly to stormwater runoff quality and quantity and flooding problems in the watershed.

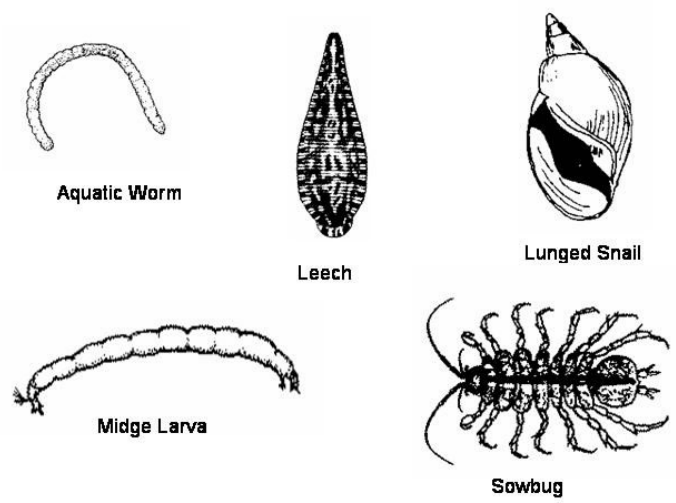
Flooding

Among natural disasters, flooding is the leading cause of fatalities and property damage in the United States (MMSD 2000). Bridges and culverts in the Underwood Creek watershed can cause constrictions resulting in backwater effects and creating an upstream floodland area (SEWRPC Feb. 2000). The Milwaukee Metropolitan Sewerage District (MMSD) estimated the number of flooded structures projected from 2020 land use development conditions based on a one percent probability storm (100 year flood) at 58 flooded structures. Street and yard flooding have also occurred in the watershed (SEWRPC Feb. 2000). Using the same criteria, MMSD estimated the total damages at $2,075,000 (MMSD 2000). Flooding of Underwood Creek in 1997 and 1998 left all of downtown Elm Grove underwater and resulted in sewage backups, devastating businesses and causing some to leave entirely (Business Journal 2002), The City of Brookfield and the Village of Elm Grove are in the process of adopting stormwater management ordinances that regulate stormwater runoff from new urban development and redevelopment (SEWRPC Feb. 2000).

Stormwater Debris

Potential sources of water pollutants in the Underwood Creek watershed include stormwater runoff, sanitary sewer overflows, construction site erosion, streambank erosion, atmospheric contributions, and industrial material leaks and spills (SEWRPC Feb. 2000).

Underwood Creek is generally recommended for the following water and biological use objectives: upstream of Watertown Plank Road and the South Branch are recommended for warmwater forage fish and limited recreational use; downstream of Watertown Plank Road, it is recommended for limited aquatic life and limited recreational use; and Dousman Ditch is recommended for limited forage fish and limited recreational use (SEWRPC 1995). According to SEWRPC (1995), fish population and diversity are poor, there have been recorded fish kills, there are water quality problems with fecal coliforms and toxics, the Hilsenhoff biotic index resulted in a fair to poor rating and physical modifications to Underwood Creek were major. This was also the case for Dousman Ditch (note that no fish kills were reported and the biotic index was absent from the data). Portions of these streams were contaminated with bacteria from both human and animal waste sources. The bottom dwelling organisms were comprised of pollution tolerant species and were representative of poor water quality conditions (SEWRPC Feb. 2000). In general, SEWRPC (Feb. 2000) found that the aquatic habitat was rated as fair to poor for most of the reaches of Dousman Ditch and Underwood Creek.



Pollution Tolerant Macroinvertebrates. Image courtesy of Michigan Environmental Education Curriculum Stream Monitoring. http://techalive.mtu.edu/meec/module05/images/Tolerant.jpg

MMSD's Interest and Involvement

The MMSD and other governmental entities are working to reduce the risk of serious damage caused by flooding to homes, businesses, and people. The Milwaukee area experienced significant storms (up to 8 inches of rainfall) in 1997 and 1998, resulting in very serious flooding. Millions of dollars in damage was rendered and two young boys drowned in the Village of Elm Grove. The floods on Underwood Creek were the largest recorded in the 23 years that streamflow gages had been involved in data gathering (SEWRPC 2004). The City of Brookfield received a reported 11.75 inches of rain in a 24 hour period in August of 1998. The storms causing these rains resulted in considerable flooding in northeastern Waukesha County (SEWRPC 2004). The Underwood Creek Rehabilitation Project comprises a portion of a comprehensive approach for flood risk reduction by the MMSD. The MMSD seeks to provide a reliable and cost-effective solution to reducing the risk of flooding problems within its jurisdiction (Lau 2005) and to improve the habitat and ecological value of its water resources (HNTB 2006).

The entire watershed must be examined when looking for solutions to reduce the risk of flooding and excessive stormwater runoff must be limited as much as possible. Channel alterations to

Underwood Creek have resulted in increased peak discharges and channel velocities during periods of intense rainfall in the Menomonee River (MMSD 2005). The design and installation of a floodwater storage facility on the Milwaukee County Grounds by MMSD will help to reduce the risk of flooding conditions in the Menomonee River (MMSD 2005). More specifically, this project will help to reduce current flooding risk in downtown Wauwatosa, western portions of

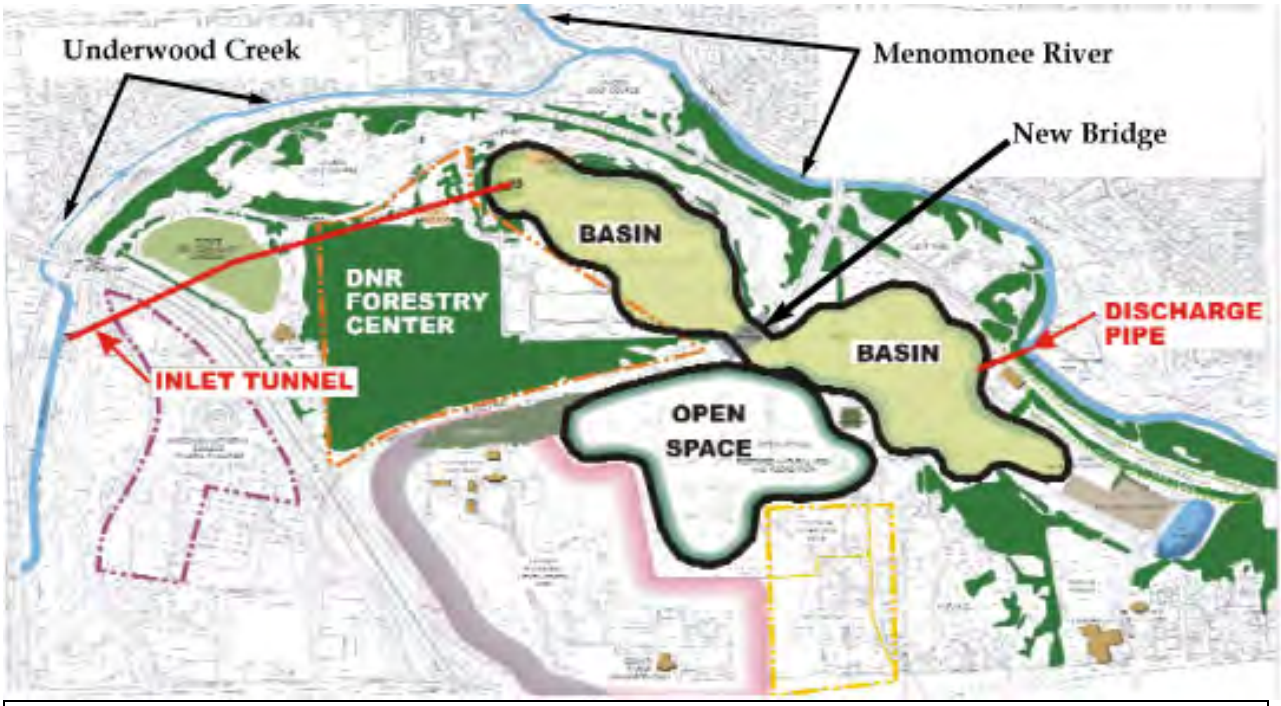


Figure 2: Milwaukee County Grounds, Flood Management Basin

Milwaukee, and the Menomonee Valley by diverting floodwater from Underwood Creek during major rain events and conveying it through a tunnel to a approximately 65 acre basin. Floodwater will be held in this basin until flooding conditions in the Menomonee River have lowered. The diverted Underwood Creek water will then be slowly released to the Menomonee River over a period of 3 to 4 days (MMSD 2006). The basin facility will store approximately 330 millions gallons of diverted flow from Underwood Creek. The project also provided an opportunity to rehabilitate a portion of Underwood Creek through removal of concrete channel lining, and development of a replacement bioengineered channel that provides desirable esthetic habitat, environmentally friendly stream restoration, and public safety improvements (MMSD 2005). The principal goals of the Underwood Creek Rehabilitation and Flood Management Project are to meet the following criteria:

- Develop stable channel sections using an environmentally sensitive and aesthetically acceptable channel design and lining materials that are acceptable to the WDNR.
- Provide aquatic habitat appropriate for the flow regime that contains suitable meanders, pools and riffles, and provide appropriate vegetation along the channel banks using native plant materials.
- Provide assurance that flood damages will not occur along Underwood Creek during the one-percent probability flood (100 year) event, and that appropriate peak discharges will be diverted to the Milwaukee County Grounds flood management facility.

- Develop a channel design with acceptable short and long-term maintenance requirements and costs; and acceptable public safety measures (MMSD 2005).

This project will lessen the impact of Underwood Creek on the Menomonee River both from an environmental and flood management perspective.

Table 1: Construction Schedule (MMSD. June, 2006)

2006	2009
• Begin bridge construction on Swan Boulevard • Excavate east basin, move soil to open space area • Revegetate east basin	• Begin tunnel construction • Build outlet structure and emergency overflow • Rehabilitate Underwood Creek
2007	**2010**
• Finish Swan Boulevard bridge • Excavate west basin, move soil to open space area • Revegetate west basin	• Tunnel construction • Build inlet to tunnel from Underwood Creek • Rehabilitate Underwood Creek
2008	**2011**
• Complete revegetation of basin and open space area	• Rehabilitate Underwood Creek

Specifically, the Underwood Creek restoration component will provide public safety and improved aquatic habitat aspects. The project will create a more natural flow and provide pools that are cooler and deeper for aquatic life. The more natural flow will help to slow the moving water down; this will help with flooding and ultimately, public safety.

The construction phase of the Underwood Creek Floodwater Management Project will alter habitat for the Butler's garter snake, *Thamnophis butleri,* which is officially listed as a threatened species by the Wisconsin Department of Natural Resources. The MMSD will remove the snakes in portions of the project where habitat will be altered. These snakes will be sustained until the areas have been restored. The WDNR has approved a conservation plan for the Butler's garter snake that contains a vegetation restoration plan, a snake monitoring and viability assurance plan, and a long-term habitat management plan. The WDNR has determined that the project is not likely to jeopardize the continued existence or recovery of the state population of these snakes or the whole plant-animal community of which they are a part. Additionally, the WDNR believes that the conservation measures being implemented will likely increase the Butler's garter snake population by increasing the acreage of suitable snake habitat and by improving habitat quality (MMSD. January 2006).

Wisconsin Distribution of the Butler's Garter Snake, Graphic Courtesy – http://www.dnr.state.wi.us/org/land/er/herps /snakes/butlersgrt.htm

Other potential biological impacts include; Orchard oriole, Forked aster, and Wafer ash, all of which have been observed on the County grounds. The oriole and aster are legally protected and the project would not impact the aster but would potentially impact nesting orioles if trees are removed in early summer (HNTB 2006). All disturbed areas would receive naturalized plantings.

The primary physical impacts from the project involve; grade changes, fill placement, concrete lining removal, and flood management berm construction along Underwood Creek (HNTB 2006).

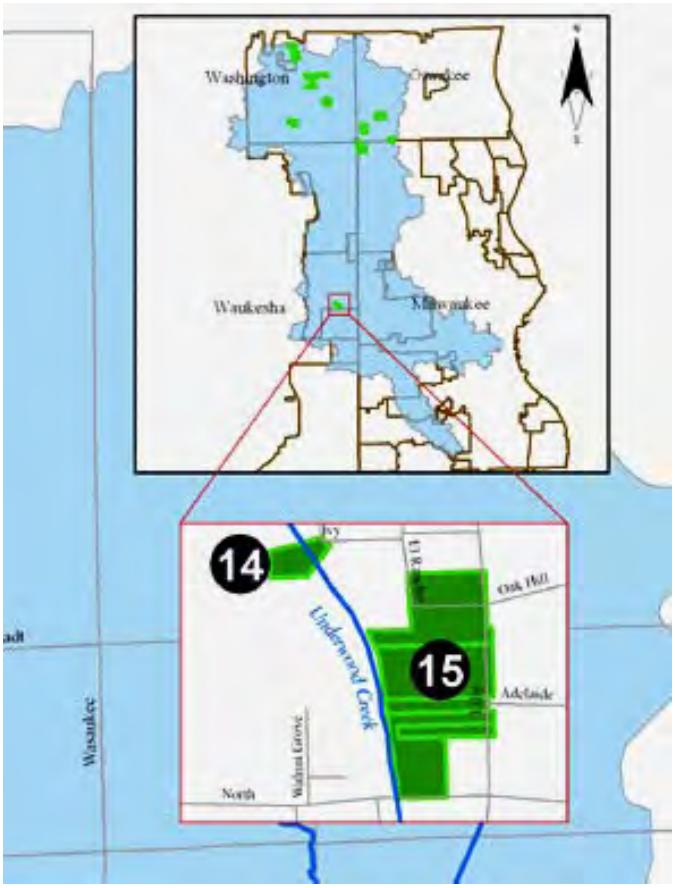
Butler's Garter Snake, Photo Courtesy – http://www.dnr.state.wi.us/org/land/er/factsheets/ herps/btgrsn.htm

Wetlands are an important economic and environmental feature to the landscape. Not only do they act as natural filters for pollutants but they are also biologically productive habitats, supporting many wildlife species. Economically, wetlands facilitate flood management and enhance property values by serving as an aesthetically pleasing open space, providing visual and sound barriers, and offering recreational opportunities (GLU 2007). Unavoidable impacts to approximately 4.67 acres of wetland habitat would occur as a result of the Underwood Creek Rehabilitation, requiring mitigation. Additionally, some wetlands along Underwood Creek would be temporarily impacted, but would be restored following rehabilitation. Mitigation for all impacted wetlands is proposed with the Underwood Creek Corridor (HNTB 2006). Monitoring and management of the wetland mitigation area would be carried out in accordance to United States Army Corps of Engineers (USACE) guidelines (HNTB 2006). Mitigation for 2 of the impacted wetlands will include restoration at a ratio of 1.5 acres of restored wetland for every impacted acre. Other wetlands impacted by the Underwood Creek Rehabilitation would be restored at a ratio of 1.0 acre of restored wetland for every 1.0 acre of impacted wetland (HNTB 2006).

Wetland. Photo Credit:
http://vathena.arc.nasa.gov/curric/land/wetland/cattail.gif

Wetland featuring a Great Blue Heron. Photo Credit:
http://www.cooperativeconservationamerica.org/images/web%20heron%20wetland.JPG

Additional Projects and Studies



Greenseams Project: Conservation Easements on Underwood Creek.

#14 – Brookfield Knull Easement equaling 1.25 acres,

 # 15 – Brookfield Underwood Creek Easement equaling 14.91 acres.

The MMSD has partnered with the City of Brookfield to purchase two conservation easements that include extensive floodplain portions of Underwood Creek, totaling 16.16 acres. These purchases will naturally store floodwater and help protect homes built near the river (www.mmsd.com, flood management, greenseams). These purchases are a component of the Greenseams Project which strives to preserve key lands containing water absorbing soils and preserve land along stream corridors. The program reduces future flood risk and protects water quality through nonstructural flood mitigation—a mechanism in which properties with hydric soils near major waterways are purchased and left undeveloped to maximize their water-absorbing capacities (Conservation Fund. October 2006) (see www.mmsd.com for more information).

Additional projects or studies that have been completed; are currently in place; or have been proposed are as follows:

- Brookfield Flood Management Project
- Village of Elm Grove Preliminary Engineering of Flood Control Alternatives
- MMSD Underwood Creek Restoration Project at Bluemound Road
- Friends of Milwaukee's Rivers – Channel and Floodplain Restoration Study
- U.S. Army Corps of Engineers Section 206 Study
- SEWRPC's Analysis of Alternative Plans for Removal of the Concrete Lining in Underwood Creek in the City of Wauwatosa. (HNTB 2006).

Water Quality Monitoring

MMSD Water Quality Research Sampling Van

Surface water quality (WQ) monitoring was proposed for Underwood Creek to gather important data that will facilitate the assessment of water quality. This data will be invaluable when determining the effectiveness of local stormwater management efforts and the documentation of surface water improvements due to these flood and stormwater management efforts.

Water quality monitoring in Underwood Creek began in May of 2003. The survey encompasses 2 sites on the south branch and 5 sites on the mainstem (MMSD 2003). Surface water quality monitoring was proposed on Underwood Creek to gather data before, during, and after flood and stormwater management projects. The data gathered will also be utilized to evaluate the impact that Underwood Creek has on the Menomonee River. One of the main concerns is high historic and current fecal coliform bacteria numbers at a Menomonee River water quality site located downstream of the Underwood Creek confluence (near 70th and State Streets). Data collected before construction and remediation projects occur will provide valuable baseline data that will characterize water quality in Underwood Creek. Data collected during construction and remediation projects will allow the MMSD to assess any changes in water quality due to these activities. Data collected after project completion will facilitate the assessment of any water quality improvements as a result of flood and stormwater management projects and will help to ascertain the effectiveness of these efforts.

Collected samples on ice

METHODS

Sampling Locations

The MMSD Underwood Creek survey consists of 7 single depth sampling locations (Figure 3, Table 2). The MMSD Technical Services Division and the Water Quality Research (WQR) Department determined site position. These sites were chosen based on accessibility and location within the watershed.

Table 2: Underwood Creek Survey: Site Designations and Locations

Site Number	Location	Other
UC-01	Pilgrim Road in Wirth Park	mainstem
UC-02	Lilly Road & Marcella Street	mainstem
UC-03	124th Street & Bluemound Road by UPS	mainstem
UC-04	116th Street & Greenfield Avenue	south branch
UC-05	~121st Street & Underwood Creek Parkway Krueger Park	south branch
UC-06	115th Street and Underwood Creek Parkway	mainstem
UC-07	107th Street & Fisher Parkway	mainstem

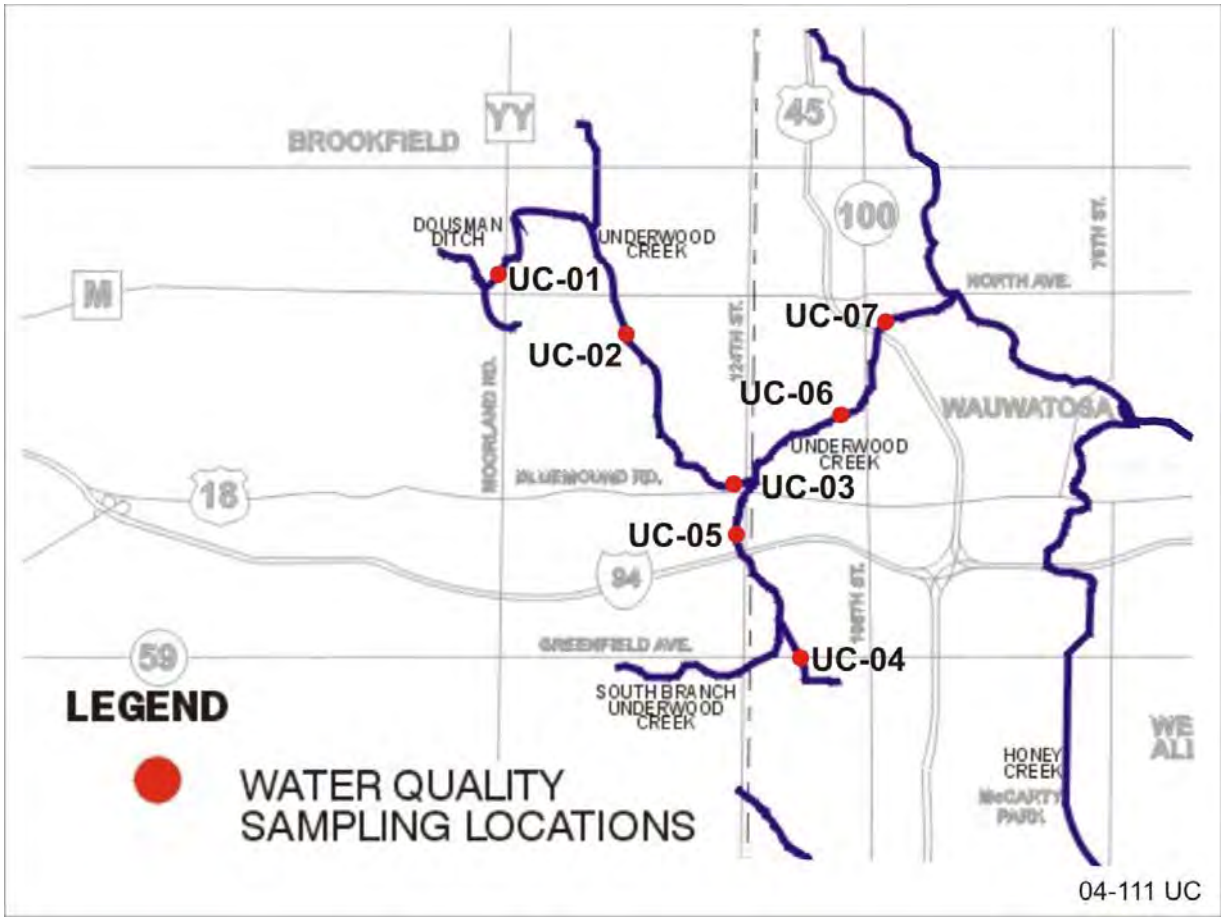


Figure 3: Underwood Creek (UC) Surface Water Quality Sampling Locations

UC - 01

Site UC-01 is located on the eastern edge of Wirth Park in Brookfield just west of Pilgrim Road, and below the confluence with Dousman Ditch. The samples are obtained from a pedestrian bridge adjacent to a parking lot and tot lot.

The water depth is typically less than 1 foot under normal baseline flows. The creek is typically choked with aquatic vascular plants in the summer. The creek is not channelized and the streambanks are vegetated at this site. The riparian area surrounding UC-01 is mainly grass buffered space with a few trees; therefore the tree canopy is minimal. There is a parking lot immediately adjacent to the creek and Pilgrim Road is immediately east of the sampling location. The site is located within Wirth Park, in a low density residential neighborhood. The creek's substrate consists mostly of rocks, sediment, and attached algae. As previously noted, aquatic vascular plants are a large component of the substrate during the summer months.

UC - 02

Site UC-02 is located in Brookfield near the intersection of Lilly Road and Marcella Street.

The water depth is typically less than 1 foot under normal baseline flow conditions. The waterway is not channelized with concrete at this location and the streambanks are vegetated. The riparian area surrounding UC-02 consists mostly of trees with some shrubs and grassy areas. The existing tree canopy is estimated to be greater than 70 percent. This site is located in a low density residential neighborhood. The creek's substrate consists mainly of rocks and sediment. Leaf litter input is high at this location and would be a constituent of the substrate at that time of year, also providing food and habitat for aquatic macroinvertebrates.

UC - 03

UC-03 is located near the intersection of Bluemound Road and 124th Street. This site is also situated just upstream from the confluence of the south branch of Underwood Creek to the mainstem.

The water depth is again, normally less than 1 foot under baseline flow conditions. The creeks' substrate is comprised mainly of rocks and gravel. Underwood Creek becomes channelized with concrete immediately downstream of this site. The streambanks are vegetated, mainly with weeds and deciduous plants. The riparian area is mainly grass buffered space. A tree canopy does not exist at this site. There is a parking lot, medical facility, package shipping company and major roadways immediately adjacent to the creek. The neighborhood is mainly industrial with some residential properties (approximately 25%). Construction and stream revitalization have occurred immediately downstream (east and just prior to the confluence with the south branch) of the location.

Before: Failing concrete streambank, downstream of UC-03

After: Revitalized streambank

UC-04 is located near Greenfield Avenue and 116th Street, immediately adjacent to Greenfield Park. This site is positioned on the south branch of Underwood Creek.

The water depth is typically less than 1 foot under normal baseline flow conditions. The area surrounding UC-04 is primarily trees with some scrub brush and grassy areas. Greenfield Park and a golf course are located immediately south of this site. The neighborhood is primarily residential and county park land. Underwood Creek flows into an underground culvert immediately downstream of this location. The creeks substrate consists mostly of sediment with rocks and gravel and it is partially channelized with concrete. Leaf litter input is high in this location and a fairly extensive tree canopy is present (estimated at greater than 70 percent). There is a large screen preventing debris from entering into the underground culvert.

UC - 04

UC-05 is located downstream of site UC-04 near Underwood Creek Parkway and I-94 in Krueger Park. It is the last site sampled on the south branch before it joins with the mainstem of Underwood Creek. Sampling occurs below the Milwaukee County Zoo outfall which serves as a drainage point for the Zoo's Lake Evinrude (contains stormwater, pumping from a deep well, and may receive cooling water and other fresh water) and other stormwater inputs.

UC – 05
Zoo Outfall (left) entering Underwood Creek

The creek depth is less than 1 foot under normal baseline conditions. The area surrounding the creek consists primarily of trees and low growth vegetation. There is a freeway, Krueger Park, and a parkway nearby. A limited tree canopy does exist in this area (estimated at approximately 50 percent) and would supply leaf litter to the creek in the fall. The creek substrate is concrete as it has been channelized in this area.

UC–06 is located just south of Watertown Plank Road on 115th Street and is the first sampling location after the confluence of Underwood Creek mainstem and the south branch of Underwood Creek.

The water depth at this site is typically less than ½ foot. The creek is situated within a concrete lined channel and attached algal growth in the summer months can be quite dense. The immediate area consists of industrial, residential, recreational, and some commercial land uses. The riparian area is mainly grass buffered space with some low growing shrubs and scrub trees. There are some trees along the concrete channel; however, none of these extends over the creek therefore, a tree canopy does not exist. Minnows and aquatic insects have been observed at this site.

UC - 06

UC-07 is located at approximately 107th and Fisher Parkway. The site is situated at the northwest corner of the Milwaukee County Grounds and is the last site sampled prior to the convergence of Underwood Creek with the Menomonee River. A USGS gaging station is located just upstream of this location. It is important to note that sampling occurs immediately downstream of a drop structure.

The water depth is typically less than 1 foot at this location. The riparian area consists of trees, low growing vegetation and grassy areas. There is a minimal tree canopy in this location (estimated at approximately 10 percent). The immediate area is mostly residential, a large shopping mall is located approximately ½ mile to the north and there is a freeway and major urban thoroughfare upstream. The creek is channelized and the bottom substrate is comprised of concrete.

UC – 07: Note drop structure

Sampling Schedule and Variables

Surface water quality monitoring is budgeted for 8 surveys per year. Highlights include:

- Sampling typically begins in April and ends in November (a complete listing of surface water quality sampling dates for Underwood Creek can be found in Appendix B).

- Underwood Creek sites are sampled concurrently with Honey Creek sites. This arrangement facilitates impact assessment of the two creeks on Menomonee River water quality.

- The variable list for the Underwood Creek monitoring effort is identical to other MMSD surface water quality surveys (see Appendix A).

- A total of 8 surveys are conducted, approximately one per month.

- The sampling and analyses for polyaromatic hydrocarbons (PAH's), mercury and heavy metals are conducted twice per year in conjunction with the routinely sampled variables. This sampling consists of 1 dry event, defined as 4 continuous days without significant precipitation and 1 wet event, defined as greater than ¼ inch precipitation in the Underwood Creek watershed. Precipitation data (for determining the occurrence of these events) is obtained from MMSD weather station WS 1219 located in Elm Grove at 13600 W. Juneau Boulevard. Precipitation data are located in Appendix C.

- Post project sampling is anticipated for 3 to 5 years to fully document water quality changes due to MMSD's efforts.

Sampling Dates

- 2003:
  This was the first year that Underwood Creek surveys were conducted. Sampling began on May 5 and was concluded on October 27. In August and September samples were collected twice. A total of 8 surveys were conducted.

- 2004:
  Sampling began on April 5 and concluded on November 2. A total of 8 surveys were conducted.

- 2005:
  Sampling began on April 19 and concluded on November 14. A total of 8 surveys were conducted.

Individual Underwood Creek sampling dates organized by site can be found in Appendix B.

Field Sampling and Measurements

Field sampling typically commences in the morning hours and is completed by early afternoon. Field surface water quality measurements (temperature, pH, specific conductance and dissolved oxygen) are obtained using the Hydrolab® DataSonde or MiniSonde units. The Hydrolab® Sonde unit is calibrated either the day before or the morning of the survey. The calibration information is maintained in a logbook. Field data for individual surveys can be found in Appendix B. General weather conditions as well as any unusual field conditions or other anomalies are noted. Water quality samples for other analyses are collected and transported to the MMSD Central Laboratory. Whenever possible, samples are obtained from mid-stream. Due to the shallow depth at most Underwood Creek sites, samples are either hand dipped or a bucket is utilized. Every effort is made to maintain sample integrity. Collected samples are stored on ice and kept in coolers until delivered to the MMSD Central Laboratory.

Field Measurements: Hydrolab® MiniSonde 4a

Field Measurements:
Panasonic Toughbook® laptop computer.

Samples are also kept in preserved bottles where applicable. Appropriate chain of custody forms are completed by Water Quality and Laboratory Staff. A trip blank is prepared in the morning prior to departing for the survey. A statistical data summary can be found in Appendix E.

RESULTS/DISCUSSION

Water Quality Index (WQI) Evaluation

MMSD's Water Quality Research Department has developed a Water Quality Index (WQI) that is used as an assessment tool for evaluating river and creek water quality. Based on nationally recognized indices and established water quality criteria, eleven variables are mathematically calculated into subindex (SI) and final index values and translated into descriptive categories, i.e., excellent, good, fair, bad, very bad, and worst water quality. The raw data for each variable are transformed to comparable scales so that no one variable is more important than another, yielding a subindex value. The subindex value is then ranked: good, fair, bad, etc. The final index value is a combination (geometric mean) of all subindices. Note that as the index values increase water quality improves (Table 4). The variables used to calculate the WQI are: dissolved oxygen, total phosphorus, soluble phosphorus, ammonia, un-ionized ammonia, fecal coliform bacteria, suspended solids, total organic carbon, chloride, copper, and zinc. These variables are known to cause stress to aquatic life, are by-products of human activity, and can be measured against known criteria. A more detailed explanation of the MMSD WQI can be found in: MMSD Development of a Water Quality Index for the Milwaukee Metropolitan Sewerage District, 1994.

The WQI was used to evaluate the Underwood Creek water quality database. The annual average WQI values are presented below (Table 3).

Table 3: 2003-2005 Underwood Creek Annual Average WQI Values.

	Underwood Creek			UC South Branch		UC Mainstem – Below convergence	
Year	**UC-01**	**UC-02**	**UC-03**	**UC-04**	**UC-05**	**UC-06**	**UC-07**
2003	53.32	45.07	70.23	55.46	27.86	57.04	62.57
2004	55.29	63.15	62.96	54.41	42.42	60.10	60.61
2005	26.45	39.20	64.62	55.70	22.60	49.12	38.75
3 yr avg	**45.02**	**49.14**	**65.94**	**55.19**	**30.96**	**55.42**	**53.98**
	Bad	Bad	Fair	Fair	Bad	Fair	Fair
			Best Site		**Worst Site**		
Index Key: Excellent = 100, Good = 75-99, Fair = 50-74, Bad = 25-49, Very Bad = 1-24, Worst = <1							

In overall terms, most of the annual WQI average values generated for Underwood Creek for the years 2003 – 2005 fell into the "fair" to "bad" categories. Of the 21 annual WQI averages produced, 62% were ranked as "fair", 33% were ranked as "bad" and 5% were ranked as "very bad". No annual final WQI numbers resided in the "excellent" or "worst" categories. UC-03 was the best ranked site for the three year period (3 year average = 65.94) and the WQI consistently fell into the "fair" water quality category; while UC-05 was the worst ranked site (3 year average = 30.96) and habitually displayed WQI values in the "bad" and "very bad" categories. The year 2004 was the best year on average with 6 of the 7 sites exhibiting WQI values in the "fair" category. Additionally, the WQI for 5 of the 7 Underwood Creek sites worsened in 2005; with 4

of these falling from the “fair: to “bad” category and 1 site falling from the “bad” to the “very bad” category. Consequently, the year 2005 was the worst year on average.

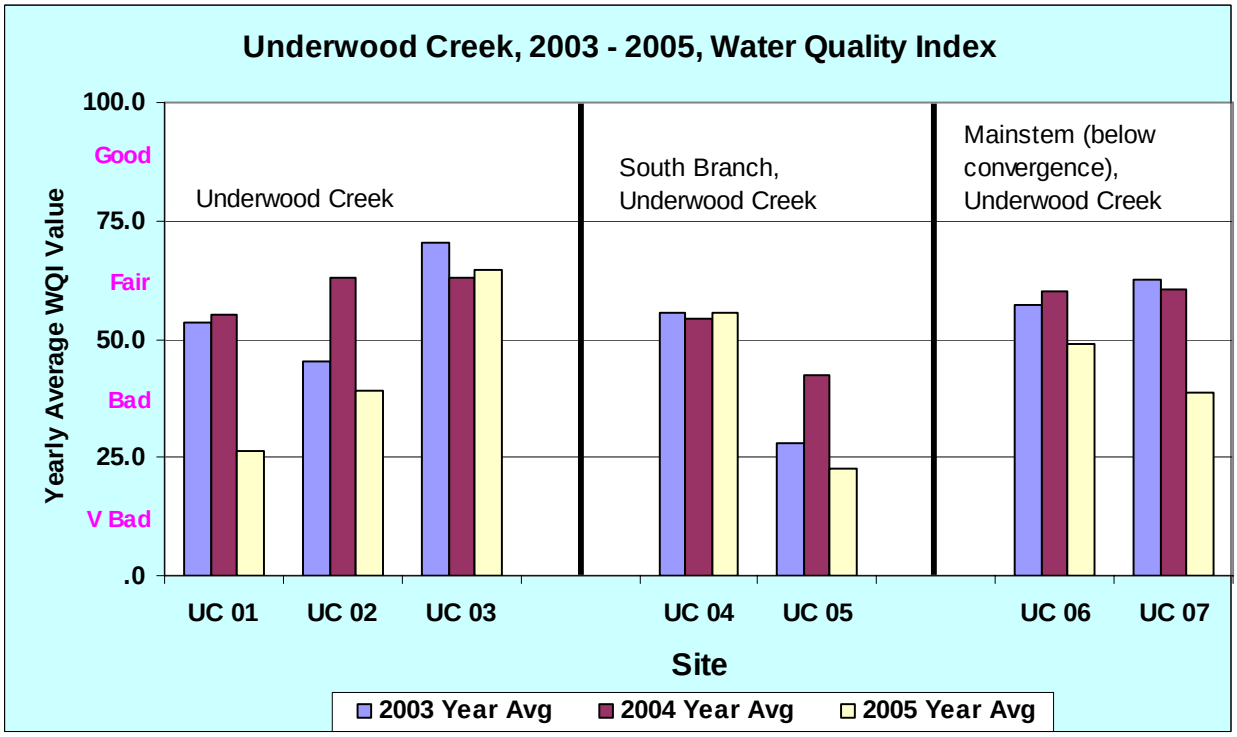


Figure 4: Water Quality Index, Underwood Creek, Sites 1 – 7, 2003 – 2005,

A graphical representation of the annual average (2003 – 2005) WQI values for all sites on Underwood Creek can be found in Figure 4.

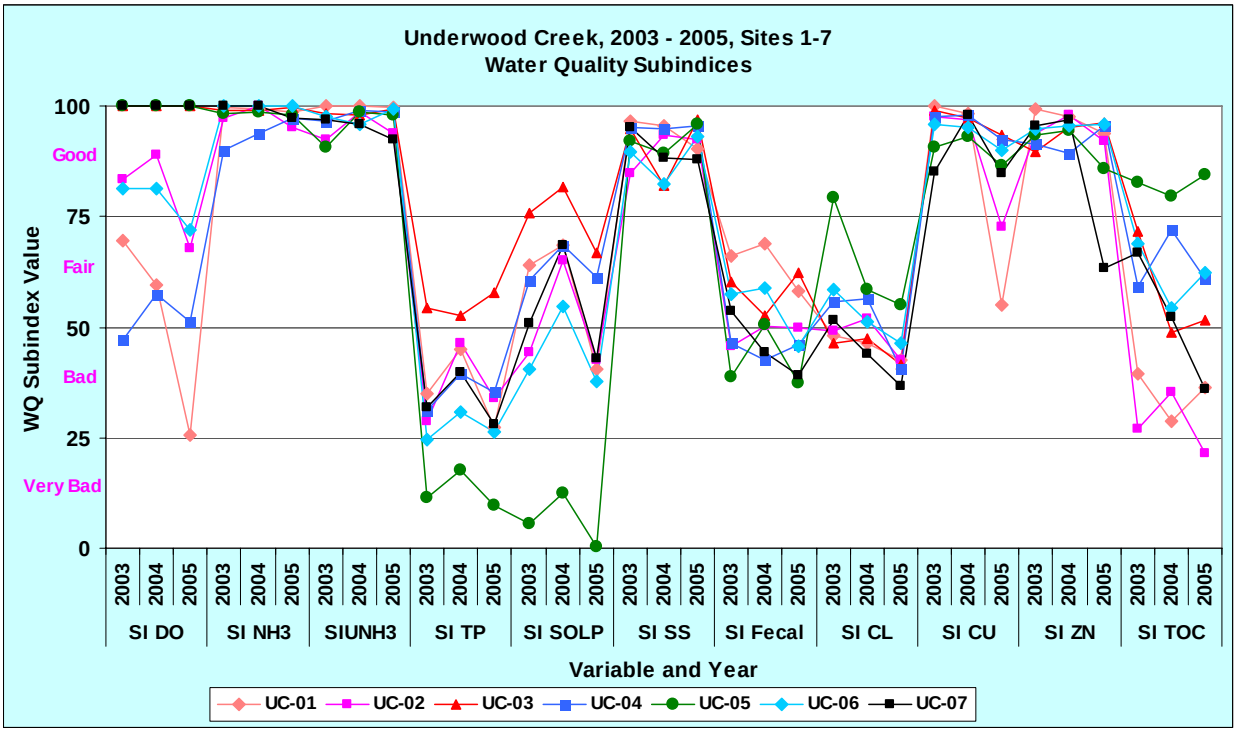
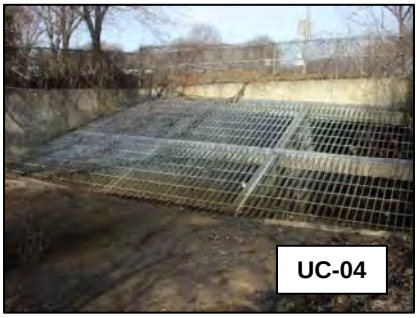


Figure 5: Water Quality Subindices, Underwood Creek, Sites 1 – 7, 2003 - 2005

Again, on average, the best year across all sites was 2004, followed by 2003. Generally, the year 2005 experienced degradation in the WQI at all sites when compared to the previous 2 years except UC-04. This site remained very consistent, exhibiting a slight improvement in the WQI in 2005. Based on the annual averages, water quality improves in the upper reaches of Underwood Creek as it heads downstream; water quality becomes worse when moving downstream in the south branch of Underwood Creek; and with the exception of the year 2005, improves slightly in the lower reaches (mainstem) when moving downstream. Figure 5 illustrates the predominant individual subindex variables contributing to lower WQI values. For all sites, generally, total phosphorus (TP), soluble phosphorus (SP), fecal coliform bacteria (fecal), chloride (CL), and to a lesser extent total organic carbon (TOC) drag the final WQI value downward toward poorer water quality. Conversely, the subindices for ammonia (NH3), un-ionized ammonia (UNH3), suspended solids (SS), copper (CU) and zinc (ZN) were consistently ranked as "good" with copper and zinc dropping to "fair" on a few occasions. Dissolved oxygen (DO) generally displayed subindex values in the "good" and "fair" ranges and on the two occasions that it did receive a "bad" ranking, it almost certainly had a negative effect on the final WQI value. Total organic carbon (TOC) ranged from "good" to "bad" water quality with one "very bad" subindex value. On a site to site basis, ammonia, un-ionized ammonia, suspended solids, copper, and zinc remained generally steady. Dissolved oxygen, total phosphorus, soluble phosphorus, fecal coliforms, and total organic carbon displayed more variability in the subindex values. On a site by site basis, all subindices remained fairly consistent, never fluctuating out of its yearly ranking more than once.



UC-03 statistically similar to UC-04, 06, 07

Fair Water Quality

Underwood Creek sites were also compared statistically using the software package - *Statistica*®. WQI data were utilized for this comparison.

Final index values for all years (2003 – 2005) were compared using an independent T-test on a site-by-site basis (i.e. UC-01 was compared to UC-02, UC-03, UC-04, UC-05, UC-06, and UC-07 etc.). The specific results of this analysis can be found in Appendix F. Statistically, water quality at UC-05 was significantly different from all other Underwood Creek sites, verifying the WQI's analysis and finding of the worst water quality of all sites examined. Water quality at UC-03 (best site by WQI analysis) was found to be significantly different from UC-01 and UC-02 but not significantly different from water quality at UC-04, UC-06, and UC-07. This is not surprising given the WQI results at these locations; UC-03, UC-04, UC-06, and UC-07 were the only sites ranking as "fair" water quality while the other Underwood Creek sites (UC-01, UC-02, and UC-05) were ranked as "bad" water quality.

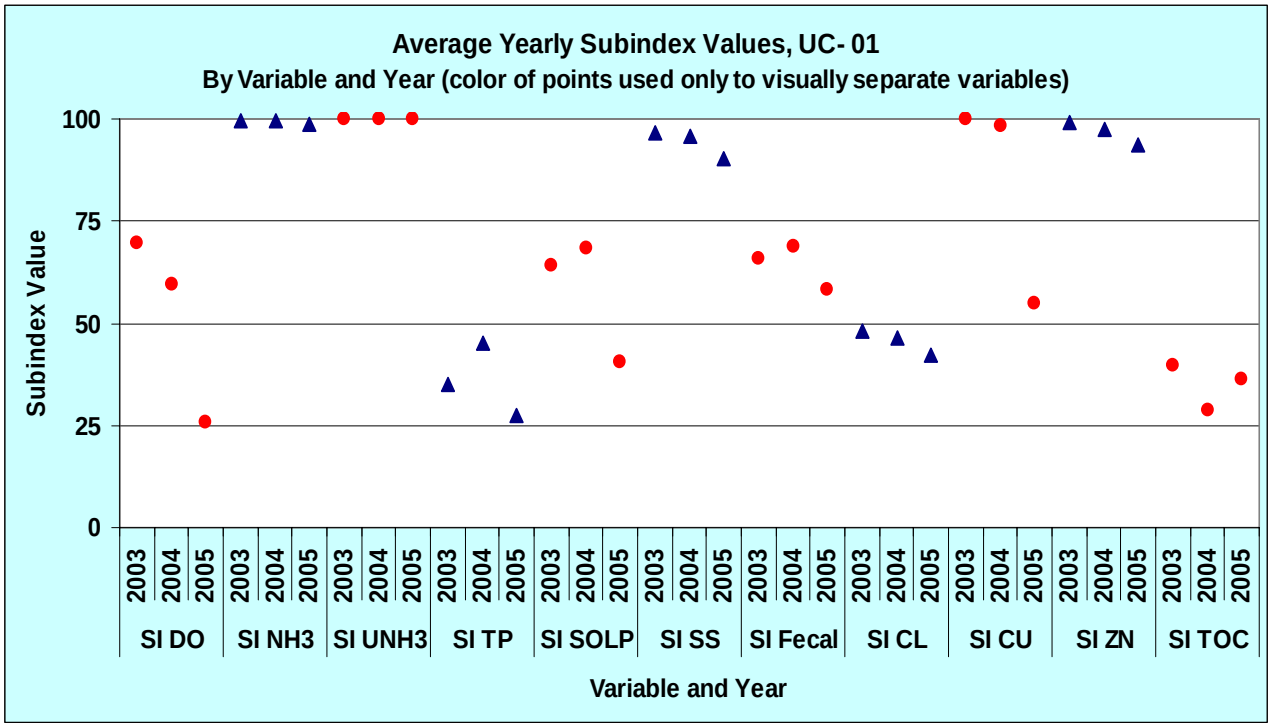


Figure 6: UC-01, Water Quality Subindices, 2003-2005

UC-01 displayed 2 years in the lower range of "fair" water quality and one year in the very low range of "bad" water quality (Figure 4, Table 3). The highest annual WQI average occurred in 2004 when the index reached 55.3. The lowest annual WQI average occurred in 2005 when the index reached 26.4. The 3 year annual average was 45.02. Total phosphorus, soluble phosphorus, and fecal coliform bacteria achieved their highest index values in 2004 (Figure 6) contributing to the highest annual WQI attained in 2004. Dissolved oxygen, total phosphorus, soluble phosphorus, fecal coliform bacteria, suspended solids, chlorides, copper, and zinc all received their lowest subindex values in 2005 causing the lowest WQI rating of the years examined. Dissolved oxygen, soluble phosphorus and copper exhibited the most influence on the bad water quality observed in 2005. Note that dissolved oxygen dropped from a "fair" subindex ranking to a very low (almost "very bad") "bad" subindex value. Soluble phosphorus dropped from "fair" to "bad" water quality and copper dropped from "excellent" and "good" to "fair" water quality.

This site displayed a general declining trend in the WQI for the 3 year sampling period and its 1-year future forecast (a predicted value calculated by using known values; these known values are obtained from existing x-values and y-values, and the new value is predicted by using linear regression) (Figure 7). This trend was not of strong significance with an R^2 value of 0.1486. The declining trend and predication are most likely due to the significant degradation of water quality seen in 2005.

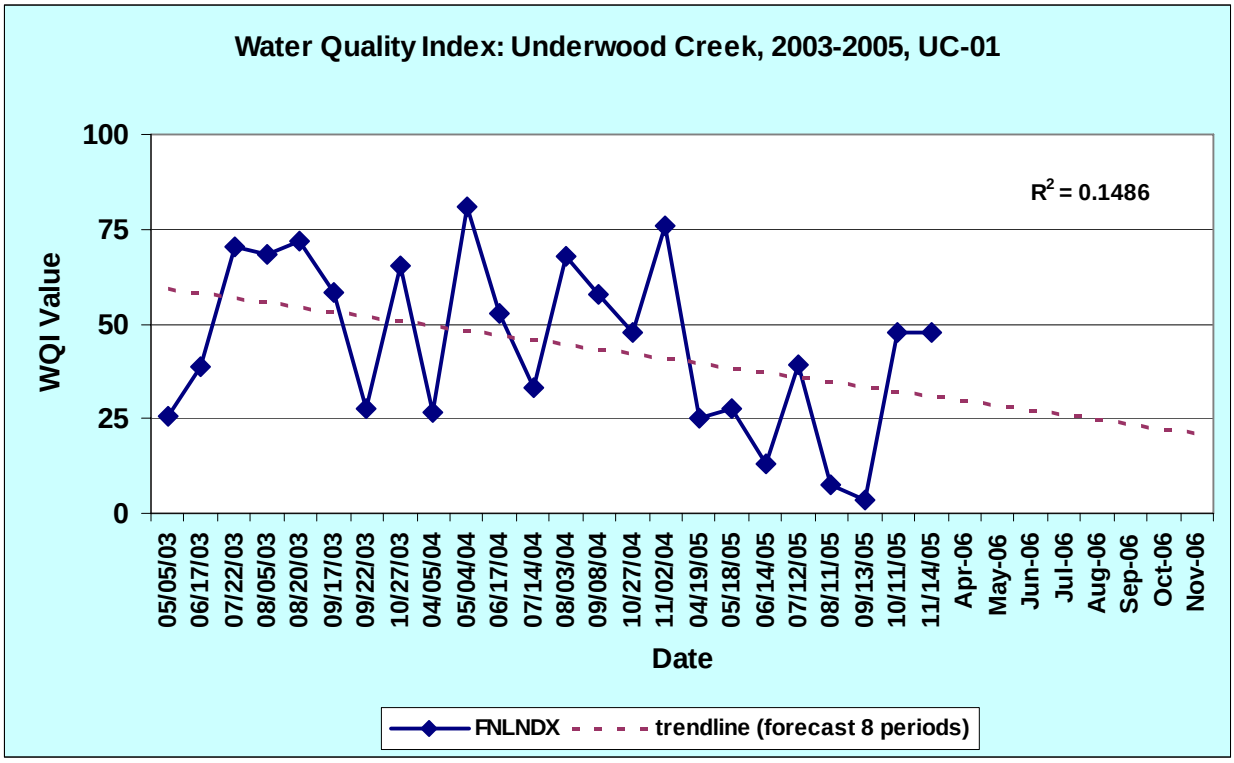


Figure 7: Water Quality Index, 2003-2005, UC-01

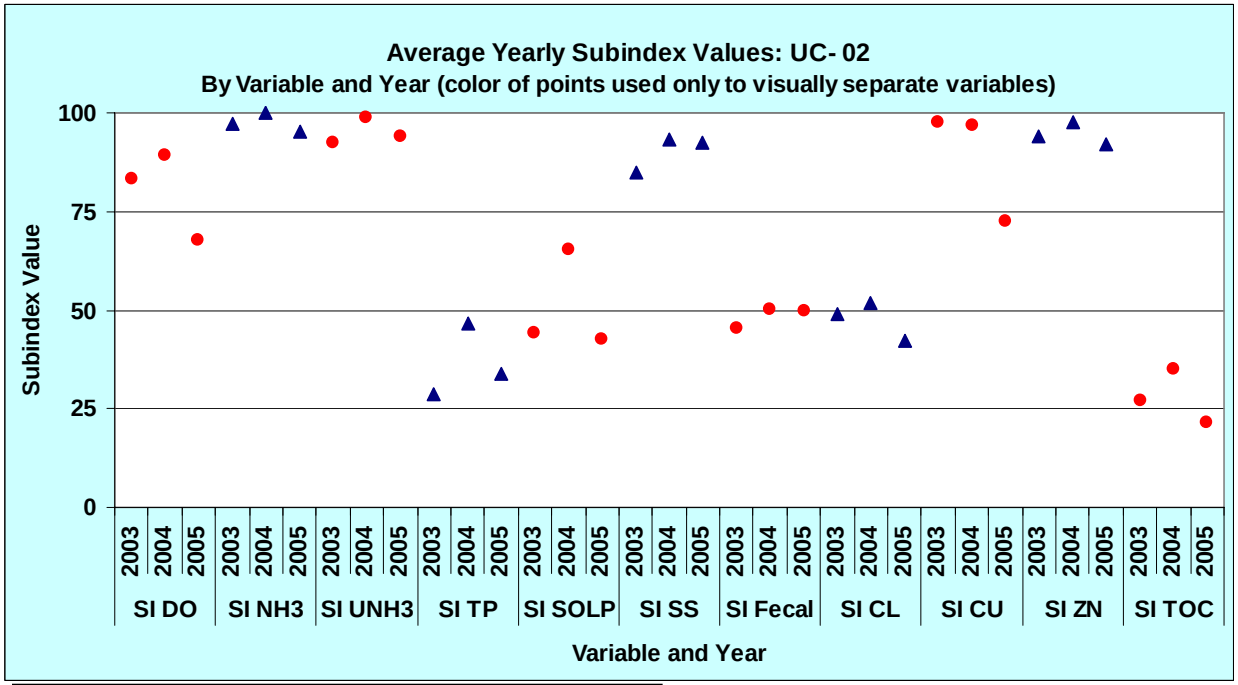


Figure 8: UC-02, Water Quality Subindices, 2003-2005

The WQI at UC-02 revealed one year in the mid range of "fair" water quality and two years of "bad" water quality (Figure 4, Table 3).

The highest annual WQI average occurred in 2004 when the index reached 63.15. The lowest annual WQI average occurred in 2005 when the index reached 39.2. The 3 year annual average was 49.14. Dissolved oxygen, ammonia, un-ionized ammonia, total phosphorus, soluble phosphorus, suspended solids, fecal coliform bacteria, chlorides, zinc, and total organic carbon achieved their highest index values in 2004 (Figure 8) contributing to the highest annual WQI attained in 2004. Dissolved oxygen, ammonia, soluble phosphorus, chlorides, copper, zinc, and total organic carbon all received their lowest subindex values in 2005 causing the lowest WQI rating of the years examined. Dissolved oxygen, chlorides, copper, and total organic carbon exhibited the most influence on the bad water quality observed in 2005. Note that dissolved oxygen dropped from a "good" subindex ranking to a '"fair" subindex value. Copper dropped from a "good" subindex value to a "fair" ranking, and total organic carbon fell from "bad" to "very bad".

This site exhibited a very slight improving trend in the WQI for the three year sampling period and its one-year future forecast (Figure 9). This trend was not significant with an R^2 value of 0.0012.

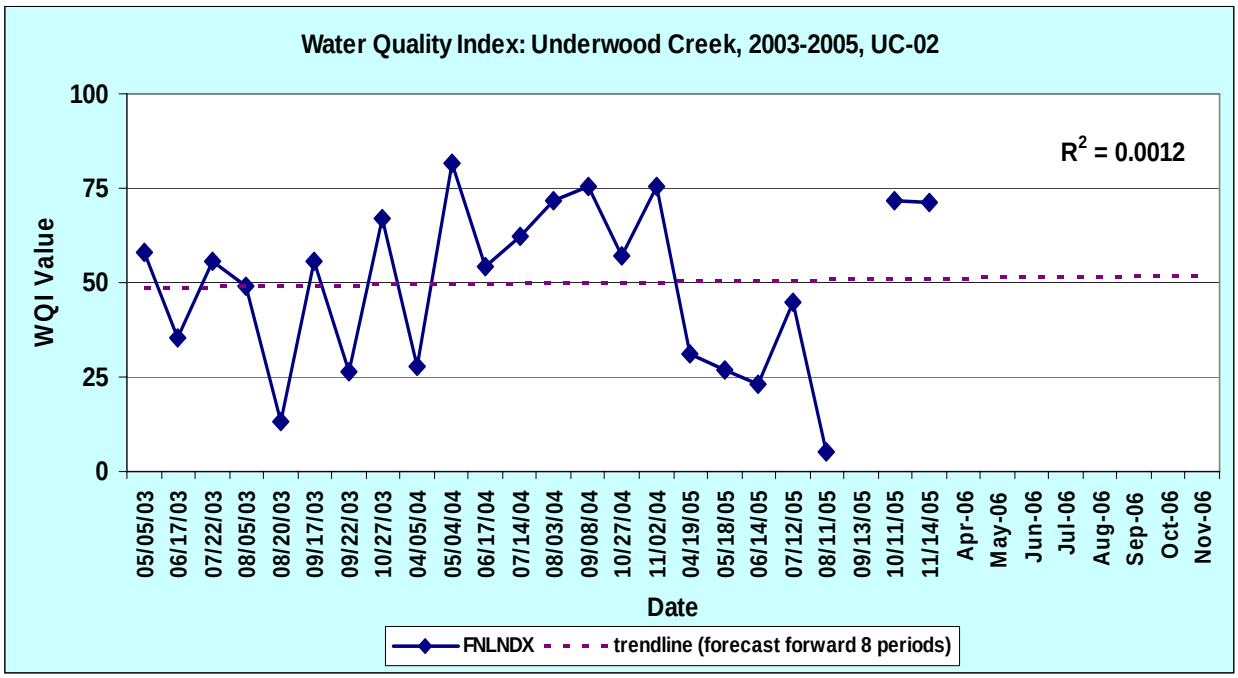


Figure 9: Water Quality Index, 2003-2005, UC-02

UC-03 was very consistently ranked in the mid to upper range of "fair" water quality (Figure 4, Table 3). The highest annual WQI average occurred in 2003 when the index reached 70.23. The lowest annual WQI average occurred in 2004 when the index reached 62.96. The 3 year annual average was 65.9. This site demonstrated the best water quality of all the Underwood Creek locations. The subindices were also very consistent (Figure 10). The only subindex variables that changed rankings were soluble phosphorus and total organic carbon. Both of these variables dropped down to the next category. Soluble phosphorus dropped from "good" to "fair" and total organic carbon dropped from "fair" to "bad" water quality. Copper and total organic carbon achieved their highest index values in 2003 contributing to the highest annual WQI reached in 2003. The dissolved oxygen subindex was always ranked at "excellent". Ammonia, un-ionized ammonia, total phosphorus, suspended solids, fecal coliform bacteria and

total organic carbon all received their lowest subindex values in 2004 causing the lowest WQI rating of the years examined. The subindex variables exerting the most influence in maintaining "fair" water quality were dissolved oxygen, ammonia, un-ionized ammonia, copper, zinc, and (to a lesser extent) suspended solids as these were always ranked as "good". The subindices

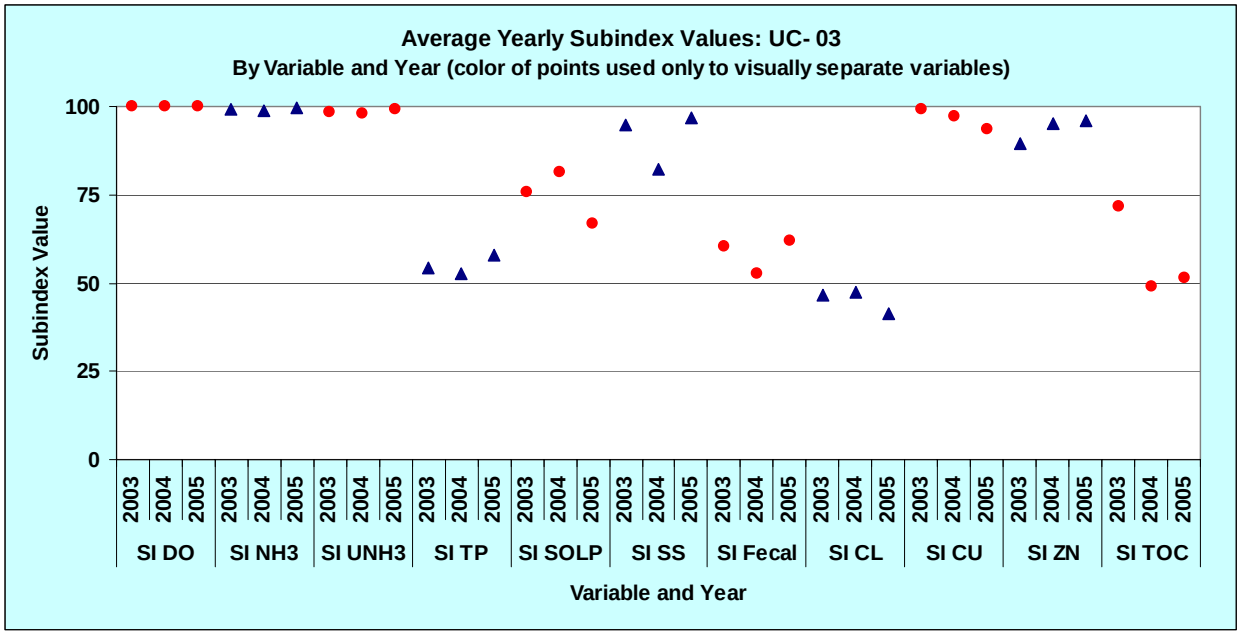


Figure 10: UC-03, Water Quality Subindices, 2003-2005

generally contributing to degradation of water quality were total phosphorus, fecal coliform bacteria, chlorides and total organic carbon.

This site displayed a very weak improving trend in the WQI for the 3 year sampling period and its 1-year future forecast (Figure 11). This trend was not of any significance with an R^2 value of 0.0001.

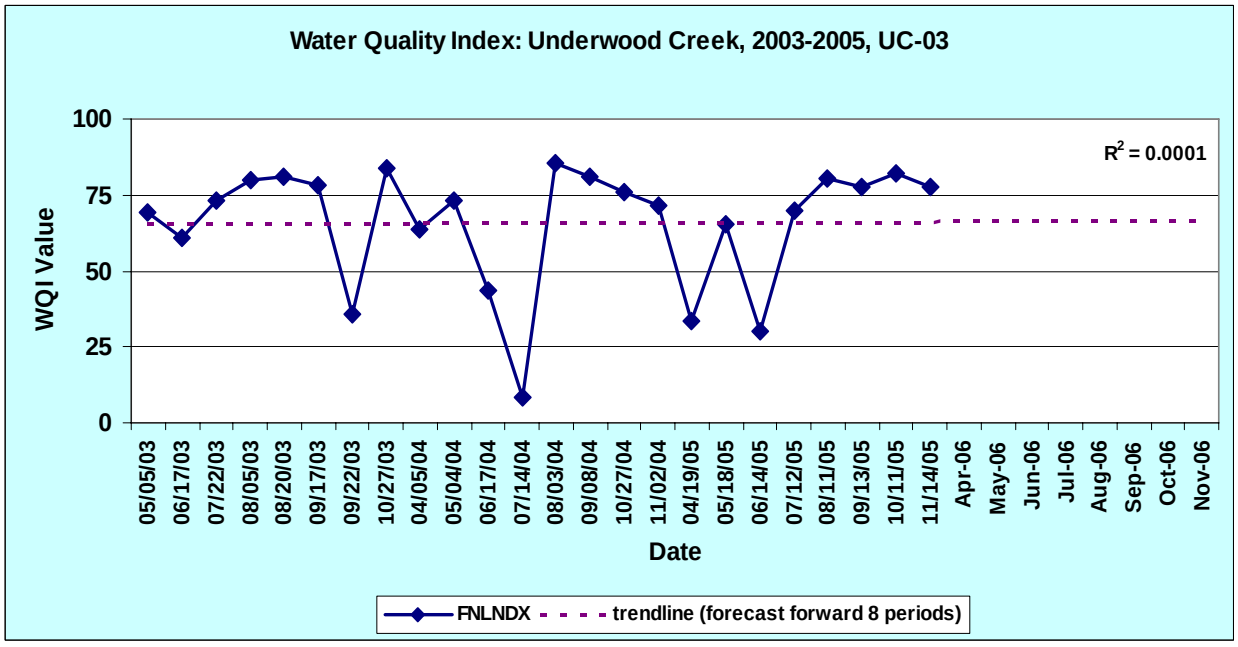


Figure 11: Water Quality Index, 2003-2005, UC-03

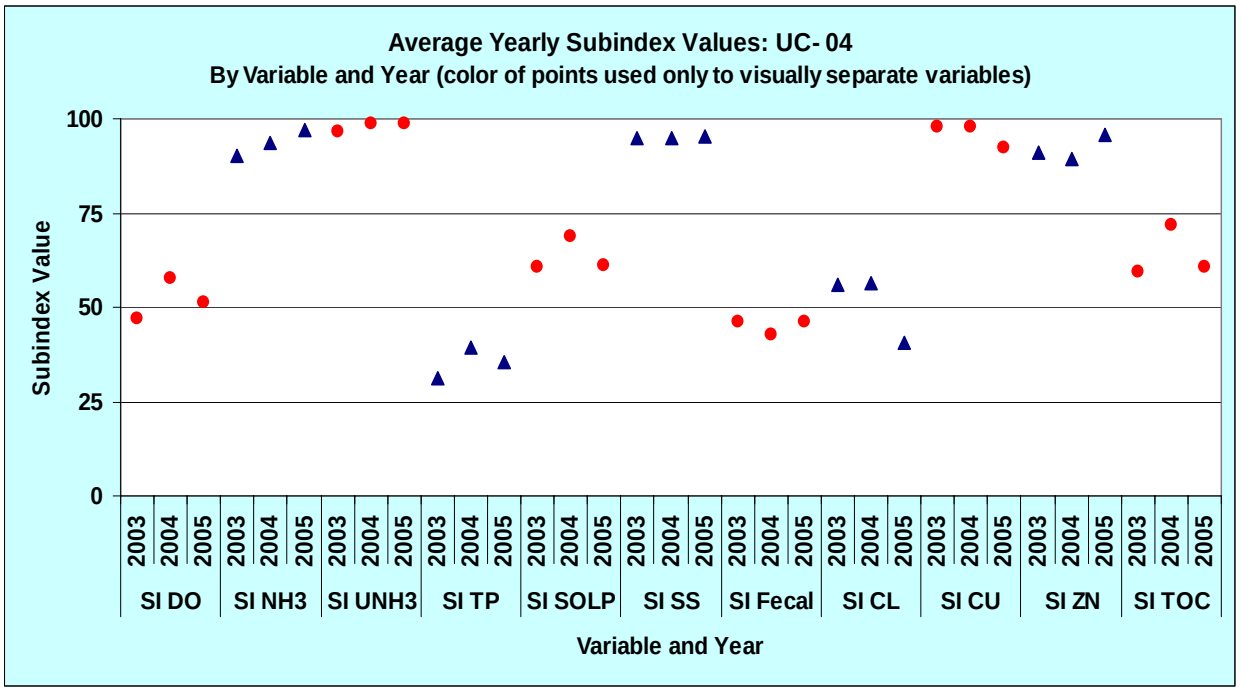


Figure 12: UC-04, Water Quality Subindices, 2003-2005

UC-04 was very consistently ranked in the low range of "fair" water quality and in fact exhibited the most stable water quality of all Underwood Creek locations (Figure 4, Table 3). The highest annual WQI average occurred in 2005 when the index reached 55.70; however, 2003 was very close to this value with a WQI average of 55.46. The lowest annual WQI average occurred in 2004 when the index reached 54.41. The 3 year annual average was 55.19. The WQI subindices were also very consistent (Figure 12). The only subindex variables that changed rankings were dissolved oxygen and chlorides. Dissolved oxygen was ranked as "bad" in 2003 and "fair" for the other years. Chlorides dropped from "fair" to "bad" in 2005. Ammonia, suspended solids, and zinc achieved their highest index values in 2005 contributing to the highest annual WQI reached in 2005. Suspended solids, fecal coliform bacteria, and zinc all received their lowest subindex values in 2004 contributing to the lowest WQI rating of the years examined. The subindex variables exerting the most influence in maintaining "fair" water quality were ammonia, un-ionized ammonia, suspended solids, copper, and zinc as these were always ranked as "good". The subindices generally contributing to degrading water quality were total phosphorus and fecal coliform bacteria. These variables were always ranked as "bad" water quality. Chlorides also played a role in the low subindex value of 2005 when it was ranked as "bad". The soluble phosphorus and total organic carbon subindices were always rated as "fair".

This site displayed a very weak declining trend in the WQI for the 3 year sampling period and its 1-year future forecast (Figure 13). This trend was not of any significance with an R^2 value of 0.0022.

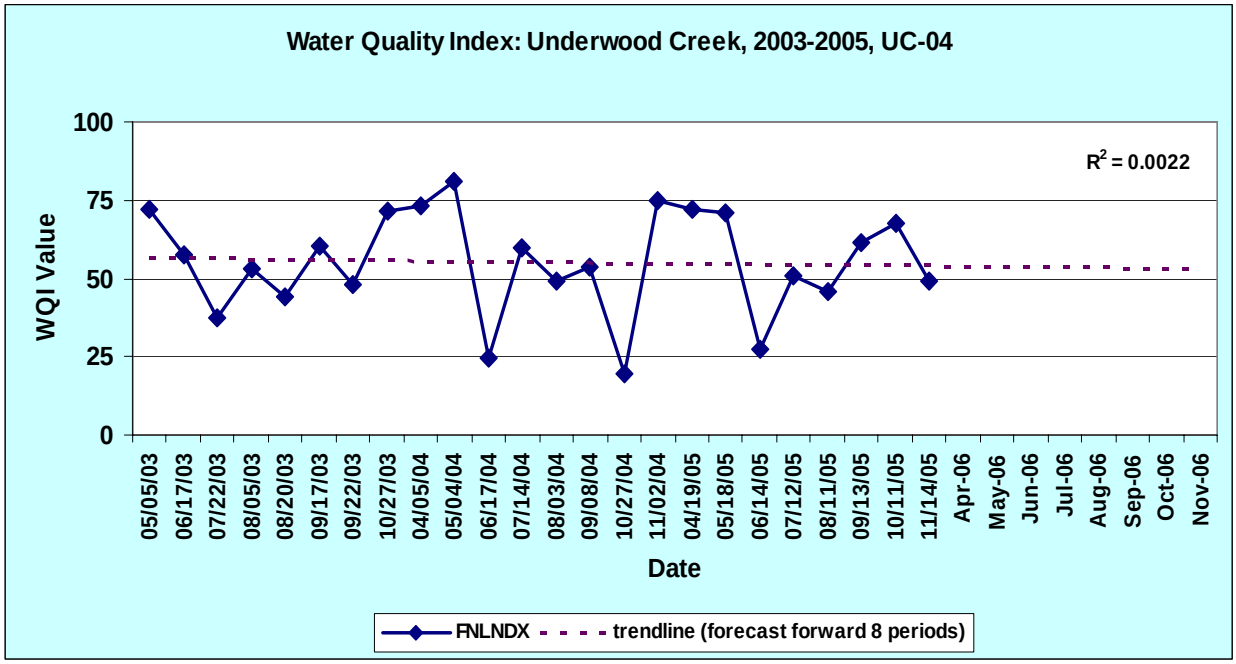


Figure 13: Water Quality Index, 2003-2005, UC-04

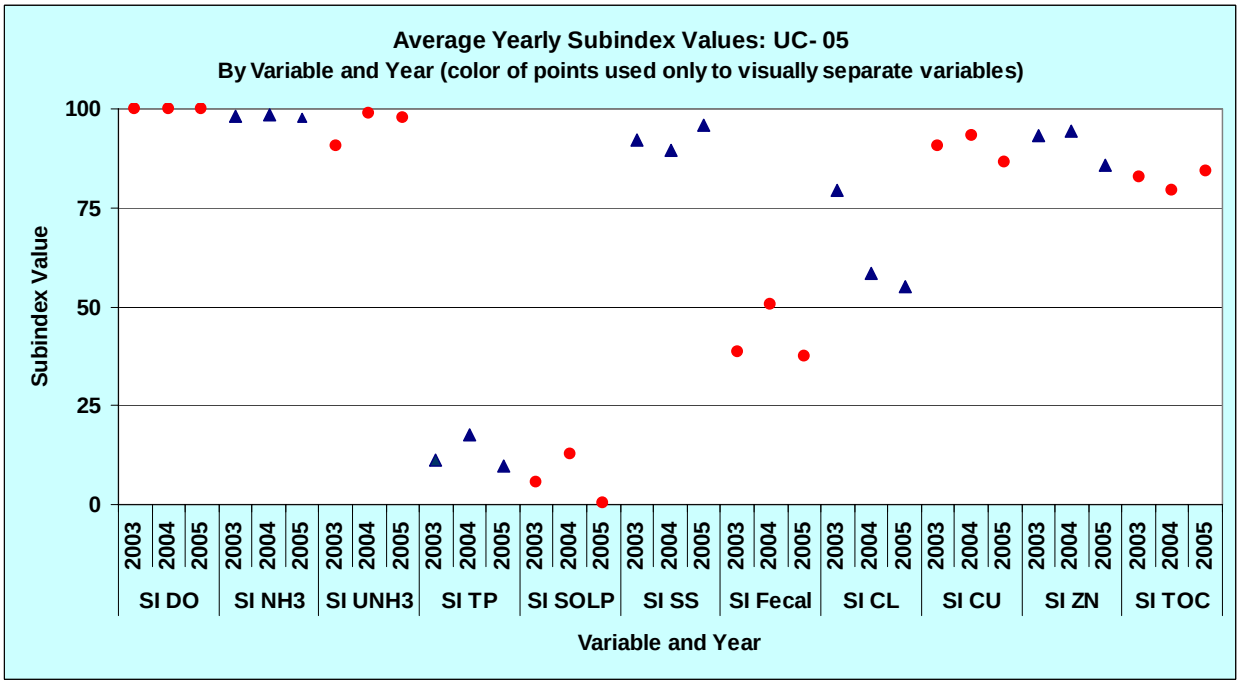


Figure 14: UC-05, Water Quality Subindices, 2003-2005

The WQI at UC-05 revealed a site that was always rated as “bad” or “very bad” water quality. This location by WQI standards displayed the worst water quality of all Underwood Creek sites

(Figure 4, Table 3). The 3 year annual average was 30.96, signifying “bad” water quality. The highest annual WQI average occurred in 2004 when the index reached 42.42; representing “bad” water quality. The lowest annual WQI average occurred in 2005 when the index reached 22.60, indicating “very bad” water quality. The WQI subindices were fairly consistent (Figure 14). The subindex variables that changed rankings were soluble phosphorus, fecal coliform bacteria, and chlorides. Soluble phosphorus was rated as “very bad” water quality in 2003 and 2004 and dropped to “worst” in 2005. Fecal coliforms went from “bad” water quality in 2003 to “fair” in 2004; dropping back to “bad” in 2005. Chlorides dropped from “good” in 2003 to “fair” in 2004 and 2005. Ammonia, un-ionized ammonia, total phosphorus, soluble phosphorus, fecal coliform bacteria, copper, and zinc achieved their highest index values in 2004 contributing to the highest annual WQI achieved in 2005. Of these variables, fecal coliform bacteria, total phosphorus, and soluble phosphorus likely exerted the most influence on the WQI in 2004. Ammonia, total phosphorus, soluble phosphorus, fecal coliform bacteria, chlorides, copper, and zinc all received their lowest subindex values in 2005 contributing to the lowest WQI rating of the years examined. Of these variables, soluble phosphorus potentially contributed the most influence to the “very bad” water quality value when it degraded from “very bad” to “worst” with a subindex value of 0.32 (Table 4). The subindex variables exerting the most weight in maintaining “bad” water quality were dissolved oxygen, ammonia, un-ionized ammonia, suspended solids, copper, zinc, and total organic carbon as these were always ranked as “good” and probably prevented the WQI from dropping to a “very bad” ranking. The subindices

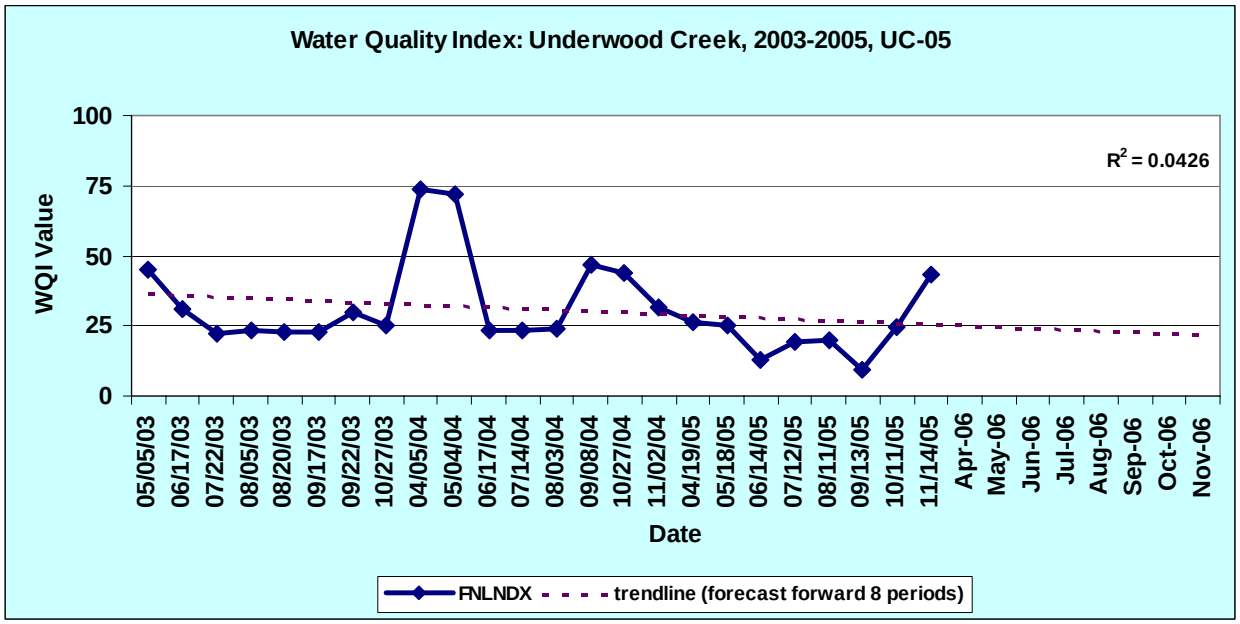


Figure 15: Water Quality Index, 2003-2005, UC-05

generally contributing to degrading water quality were total phosphorus and soluble phosphorus as they were always rated in the “very bad” water quality category (except as noted above, i.e. 2005 soluble phosphorus). Fecal coliform bacteria also played a role in the low WQI values as it generally was ranked in the “bad” category. It should be noted that dissolved oxygen values could be influenced by the Zoo/Lake Evinrude outfall located immediately upstream of the sampling location. The water entering Underwood Creek from this outfall may serve as a source of aeration therefore, dissolved oxygen could be affected through the physical nature of this aeration. This outfall most likely is exerting a strong influence on the other water quality parameters as well. The water quality status (as determined by trophic state) in Lake Evinrude is considered to be Eutrophic (Sabre

2006). This status is indicative of nutrient rich conditions (high phosphorus) which can lead to blooms of algae and other nuisance aquatic plants.

This site displayed a very weak declining trend in the WQI for the 3 year sampling period and its 1-year future forecast (Figure 15). This trend was not of any significance with an R^2 value of 0.0426.

The WQI at UC-06 revealed a site that was always rated as “fair” or “bad” water quality (Figure 4, Table 3). The 3 year annual average was 55.42, indicating “fair” water quality. The highest annual WQI average occurred in 2004 when the index reached 60.10; representing “fair” water quality. The lowest annual WQI average occurred in 2005 when the index reached 49.12; indicating “bad” water quality (note this value resides at the top of the range, close to “fair”). The WQI subindices were generally stable (Figure 16). The subindex variables that changed

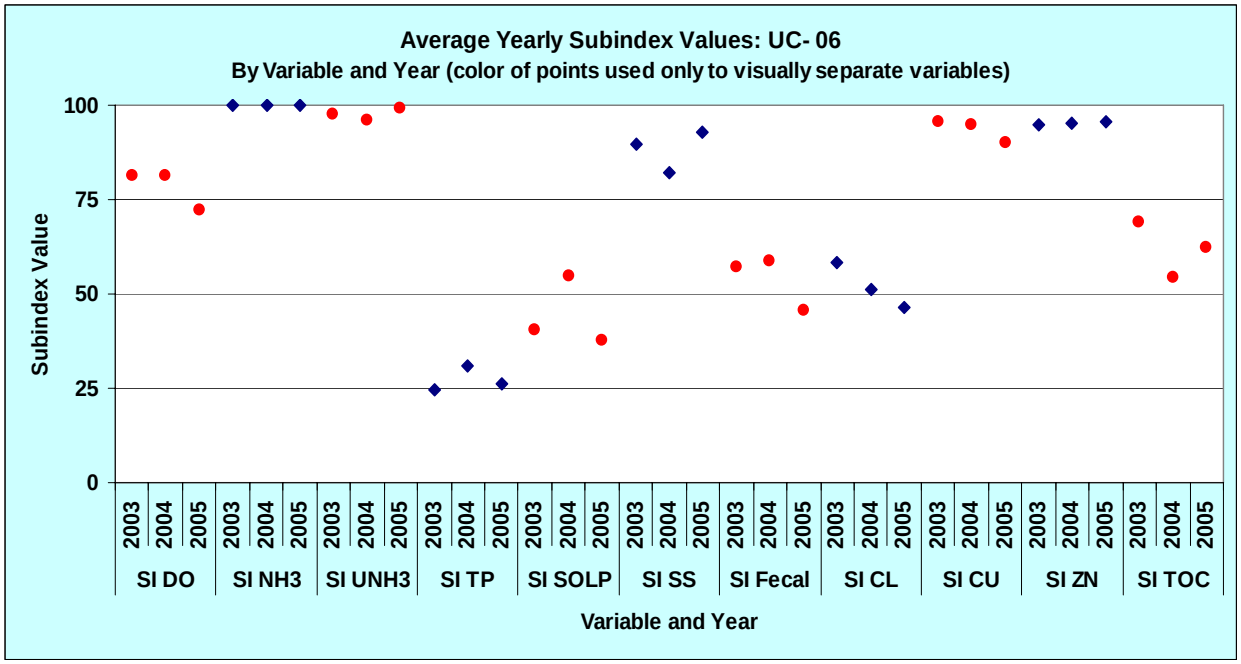


Figure 16: UC-06, Water Quality Subindices, 2003-2005

rankings were total phosphorus, soluble phosphorus, fecal coliform bacteria, and chlorides. Total phosphorus improved from “very bad” water quality in 2003 to “bad” in 2004 and 2005. Soluble phosphorus was rated as “bad” water quality in 2003 and 2005 and ranked as “fair” in 2004. Fecal coliforms were ranked as “fair” in 2003 and 2004 and dropped to “bad” in 2005. Chlorides dropped from “fair” in 2003 and 2004 to “bad” 2005. Total phosphorus, soluble phosphorus, and fecal coliform bacteria achieved their highest index values in 2004 contributing to the highest annual WQI achieved in 2004. Dissolved oxygen, soluble phosphorus, fecal coliforms, chlorides, and copper all received their lowest subindex values in 2005 contributing to the lowest WQI rating of the years examined. Of these variables, dissolved oxygen, soluble phosphorus, fecal coliforms, and chlorides potentially contributed the most influence to the “bad” water quality value when they degraded from a higher ranking. The subindex variables exerting the most weight in maintaining generally “fair” water quality were dissolved oxygen, ammonia, un-ionized ammonia, suspended solids, copper, and zinc, as these were always ranked as “good”, except dissolved oxygen in 2005. The subindices generally contributing to degrading water quality were total phosphorus and soluble phosphorus as they were generally rated in the

"bad" water quality category. Fecal coliform bacteria and chlorides also played a role in lower WQI values, especially when they fell into a more degraded water quality category.

UC-06 displayed a weak declining trend in the WQI for the 3 year sampling period and its 1-year future forecast (Figure 17). This trend was not of any significance with an R^2 value of 0.0535.

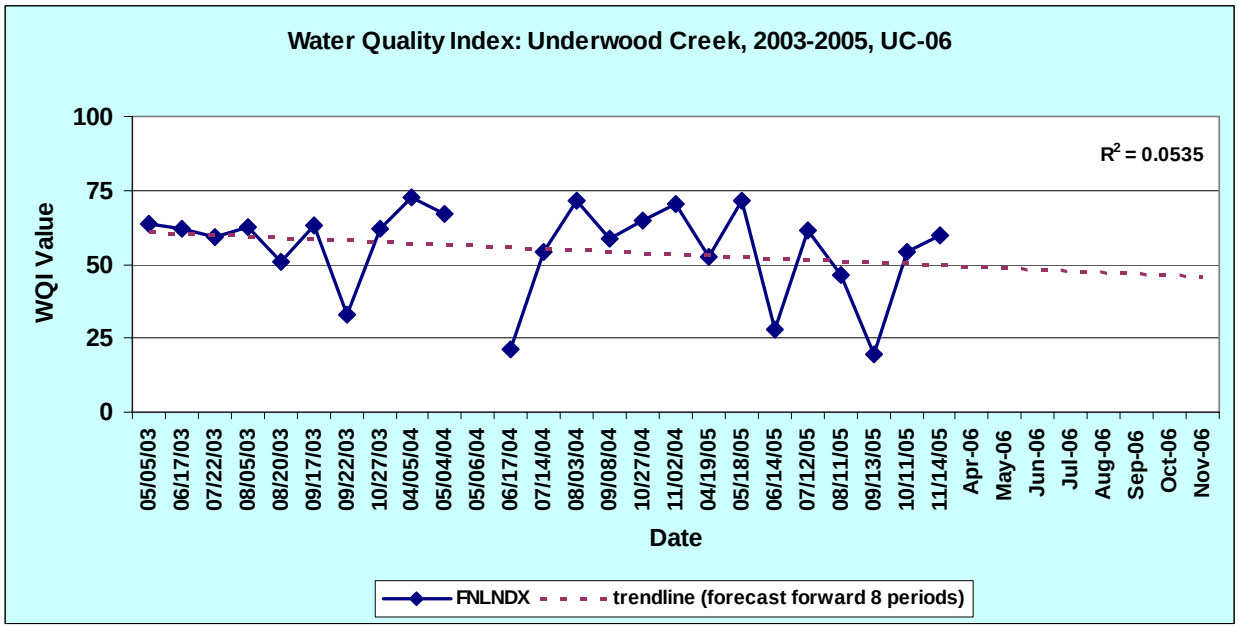


Figure 17: Water Quality Index, 2003-2005, UC-06

The WQI at UC-07 was generally rated as "fair" water quality, with the exception of 2005 when the index value dropped into the "bad" category. The 3 year annual average was 53.98 or "fair" water quality. The highest annual WQI

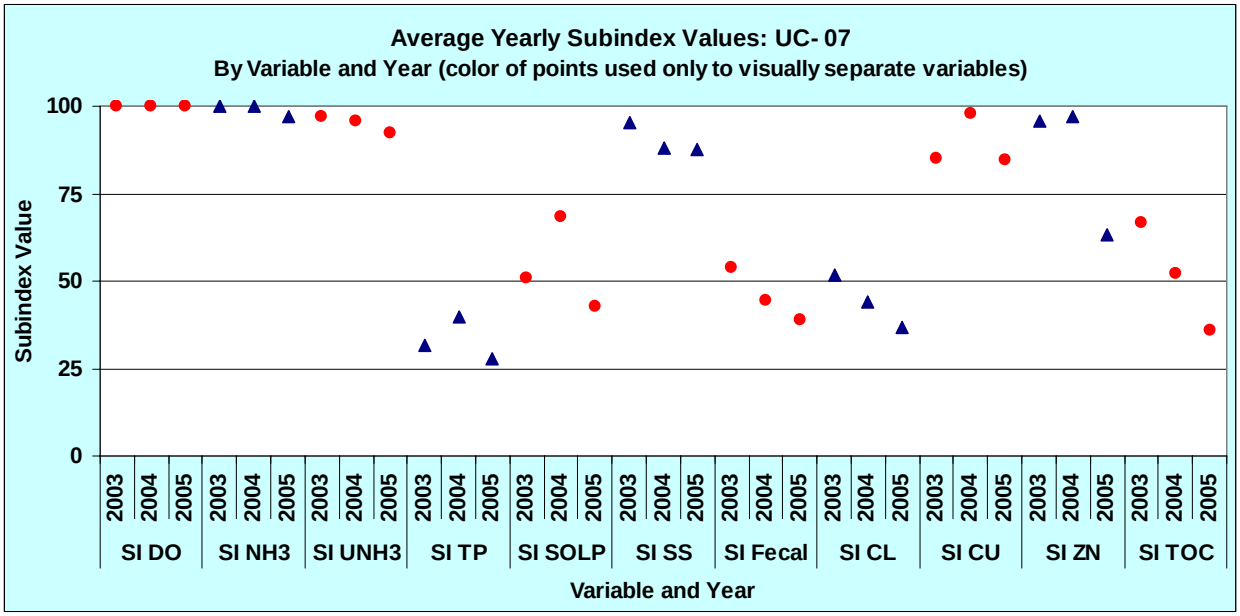


Figure 18: UC-07, Water Quality Subindices, 2003-2005

average occurred in 2003 when the index reached 62.57, representing "fair" water quality. The lowest annual WQI average occurred in 2005 when the index reached 38.75; indicating "bad" water quality. Most of the WQI

subindices were generally consistent (Figure 18). The subindex variables that changed rankings were soluble phosphorus, fecal coliform bacteria, chlorides, zinc, and total organic carbon. Soluble phosphorus was rated as "fair" water quality in 2003 and 2004 and dropped to "bad" in 2005. Fecal coliforms went from "fair" water quality in 2003 to "bad" in 2004 and 2005. Chlorides dropped from "fair" in 2003 to "bad" in 2004 and 2005. Zinc dropped from "good" in 2003 and 2004 to "fair" in 2005 and total organic carbon dropped from "fair" in 2003 and 2004 to "bad" in 2005. Ammonia, un-ionized ammonia, suspended solids, fecal coliforms, chlorides, and total organic carbon achieved their highest index values in 2003 contributing to the highest annual WQI achieved in 2003. Of these variables, fecal coliform bacteria, and chlorides likely exerted the most influence on the WQI in 2003 as their index values were ranked in the "fair" category. These variables for the other years examined always fell into "bad" water quality. Total organic carbon and suspended solids also influenced the WQI in 2003. Ammonia, un-ionized ammonia, total phosphorus, soluble phosphorus, suspended solids, fecal coliform bacteria, chlorides, copper, zinc, and total organic carbon all received their lowest subindex values in 2005 contributing to the lowest WQI rating of the years examined. Of these variables, soluble phosphorus, zinc, and total organic carbon potentially contributed the most influence to the "bad" water quality value in 2005. The WQI value for these constituents all dropped into a lower water quality category, with zinc moving from "good" to "bad". The subindex variables exerting the most weight in maintaining the WQI were dissolved oxygen, ammonia, un-ionized ammonia, suspended solids, copper, and zinc. These constituents were always ranked as "good" (except zinc in 2005) and probably prevented the WQI from degrading. The subindices generally contributing to degrading water quality were total phosphorus, fecal coliforms, and chlorides as they were usually ranked in the "bad" water quality. Soluble phosphorus and total organic carbon also contributed to the overall "fair" water quality of the site since they usually exhibited "fair" subindex ranking (except in 2005). It should be noted that dissolved oxygen is definitely influenced by sampling location. Water quality samples are collected immediately downstream of a weir structure which provides enough agitation to keep D.O. levels high.

UC-07 displayed a declining trend in the WQI for the 3 year sampling period and its 1-year future forecast (Figure 19). This trend was not of any significance with an R^2 value of 0.1561. Even though the trendline was not significant at UC-07, it was the strongest of all the Underwood Creek locations.

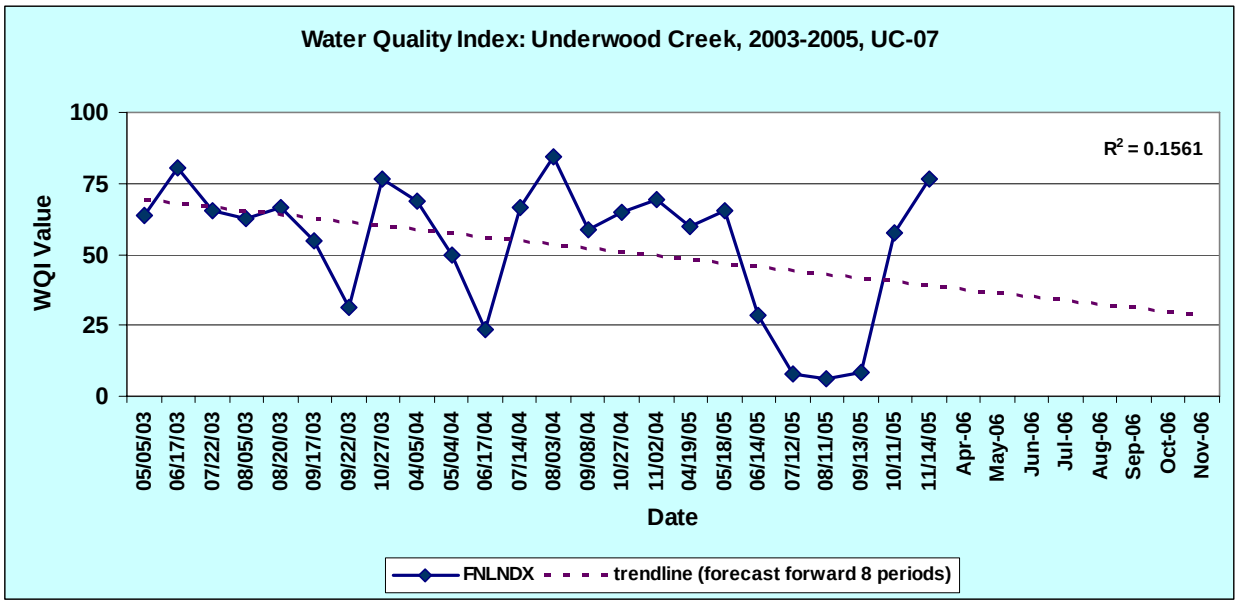


Figure 19: Water Quality Index, 2003-2005, UC-07

In general, an examination of the individual subindex numbers for the entire 2003-2005 WQI database reveals the parameters influencing the WQI on Underwood Creek. In general, higher subindex values ("fair" and "good" water quality) for dissolved oxygen, ammonia, un-ionized ammonia, the metals copper and zinc, and suspended solids existed most of the time and contributed by and large to "fair" water quality. Whenever a final WQI value trended lower ("bad" and "very bad" water quality) however, the primary components accounting for these reduced numbers generally included higher concentrations of total phosphorus, soluble phosphorus, fecal coliform bacteria, chlorides, and total organic carbon. Dissolved oxygen, copper, zinc, and total organic carbon values also played a role in lowering a few WQI readings. Table 4 contains Water Quality Index – average yearly subindex (SI) and annual values.

Table 4: Water Quality Index: Subindices and Annual Averages

Variable	Year	UC-01	UC-02	UC-03	UC-04	UC-05	UC-06	UC-07
SI DO	2003	69.63	83.47	100.00	46.94	100.00	81.23	100.00
	2004	59.61	89.10	100.00	57.52	100.00	81.16	100.00
	2005	25.74	67.80	100.00	51.10	100.00	72.04	100.00
SI NH3	2003	99.69	97.27	99.06	90.08	98.13	100.00	99.92
	2004	99.38	99.92	98.91	93.67	98.67	99.92	99.92
	2005	98.67	95.09	99.69	97.19	97.89	100.00	97.11
SIUNH3	2003	100.00	92.45	98.35	96.64	90.60	97.55	96.93
	2004	100.00	98.71	97.84	98.79	98.73	95.89	95.73
	2005	99.81	93.83	99.29	98.61	97.84	99.34	92.30
SI TP	2003	35.00	28.56	54.16	31.03	11.41	24.63	31.81
	2004	45.08	46.52	52.50	39.43	17.54	30.77	39.88
	2005	27.47	33.88	57.86	35.31	9.85	26.28	27.86
SI SOLP	2003	64.11	44.38	75.89	60.66	5.63	40.49	50.74
	2004	68.42	65.21	81.57	68.63	12.60	54.58	68.46
	2005	40.58	42.66	66.81	61.19	.32	37.63	42.94
SI SS	2003	96.45	84.86	94.92	95.00	92.02	89.50	95.31
	2004	95.58	93.42	82.16	94.83	89.33	82.31	88.23
	2005	90.35	92.40	96.88	95.46	95.82	92.95	87.82
SI Fecal	2003	65.96	45.54	60.30	46.21	38.76	57.28	53.64
	2004	68.78	50.05	52.72	42.65	50.54	58.79	44.24
	2005	58.09	49.95	62.11	46.00	37.49	45.68	39.10
SI CL	2003	48.01	49.09	46.38	55.85	79.26	58.39	51.67
	2004	46.45	51.96	47.27	56.38	58.35	51.30	43.99
	2005	42.41	42.41	41.39	40.62	55.06	46.25	36.81
SI CU	2003	100.00	97.50	99.11	97.68	90.72	95.72	85.00
	2004	98.39	96.97	97.14	98.04	93.22	95.00	98.04
	2005	55.00	72.50	93.57	92.50	86.43	90.00	84.65
SI ZN	2003	99.22	93.84	89.64	91.24	93.39	94.96	95.52
	2004	97.48	97.76	95.10	89.14	94.32	95.38	96.92
	2005	93.84	92.10	96.08	95.52	85.72	95.80	63.30
SI TOC	2003	39.61	26.91	71.79	59.19	82.82	68.98	66.79
	2004	28.78	35.24	48.88	71.97	79.42	54.20	52.22
	2005	36.21	21.56	51.46	60.86	84.30	62.25	35.86

		Year	UC-01	UC-02	UC-03	UC-04	UC-05	UC-06	UC-07
Excellent	100								
Good	75-99	2003	53.3	45.1	70.2	55.5	27.9	57.0	62.6
Fair	50-74	2004	55.3	63.2	63.0	54.4	42.4	60.1	60.6
Bad	25-49	2005	26.4	39.2	64.6	55.7	22.6	49.1	38.8
Very Bad	1-24								
Worst	< 1								

KEY:

WQI = Good WQI = Fair

WQI = Bad WQI = Very Bad

NOTE: When the SI value = 100, the WQI rank is equal to excellent water quality. When the SI value is less than 1, the WQI rank is equal to worst water quality.

Precipitation

Water quality is affected by many factors, including precipitation. On an average annual basis, Milwaukee officially receives 31.5 inches of precipitation at Mitchell Field (period of record - 59 years). In very general terms, two of the years, 2003 and 2005 in the Underwood Creek sampling period of 2003, 2004 and 2005 registered lower than normal annual precipitation at Mitchell Field (Table 5). The sampling year 2004 was slightly wetter than average. Specific annual precipitation percent decreases/increases compared to the 59-year precipitation annual average are as follows: 2003 (-29%), 2004 (+4.5%), and 2005 (-18%). A few individual monthly precipitation averages were higher than historical monthly averages, as measured at Mitchell Field. These months included: November 2003; May, June and August 2004; and September and November 2005. On the other hand, there were many more months with lower than average precipitation. For example, June, August, September, and October 2003; April, September, and October 2004; as well as April, May, June, July, August, and October 2005 registered monthly precipitation noticeably below the Mitchell Field historical average (Table 5).

Table 5: Monthly, Average and Total Precipitation (Inches) – Milwaukee Mitchell Field

Year	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Annual
2003	2.61	3.65	1.49	2.43	0.57	1.65	1.51	3.94	22.30
2004	1.87	8.18	4.07	3.25	3.43	0.24	1.47	2.38	32.94
2005	1.41	2.62	2.23	2.60	1.29	4.17	0.95	3.65	25.92
59 Year Average	3.00	3.34	3.60	3.11	3.13	3.19	2.29	2.18	31.52

More localized precipitation data are also measured at various MMSD weather stations (WS). One District station, WS1219, resides in the Underwood Creek watershed at 13600 W. Juneau Boulevard (Legion Drive) at the Elm Grove Village Hall. A summary of Underwood Creek WS1219 data can be found in Table 6 below and the raw data are located in Appendix C. Annual precipitation totals for 2003, 2004 and 2005 at WS 1219 mirrored data at Mitchell Field with 2003 and 2005 being drier than average and 2004 registering wetter than average (Table 6). As you would expect, most of the highest precipitation months measured at Mitchell Field also exhibited the highest precipitation at the Underwood Creek weather station including: November 2003; May, and June 2004; and September and November 2005. Similarly, many of the driest months determined officially at Mitchell Field additionally registered below normal precipitation at the Underwood Creek weather station including June, July, August, September, and October 2003; April, September, and October 2004; in addition to April, May, June, July, August, and October 2005 (Table 6).

Table 6: Underwood Creek Total Monthly, Average, and Total Precipitation (Inches) – Weather Station (WS) 1219

Year	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Annual
2003	2.94	4.39	1.85	1.59	0.56	1.82	1.66	4.38	19.19
2004	2.40	8.84	4.13	3.14	3.10	0.26	1.76	2.41	26.04
2005	1.08	2.77	1.89	2.15	1.53	4.36	0.51	4.27	18.56
59 Year Mitchell Average	3.00	3.34	3.60	3.11	3.13	3.19	2.29	2.18	31.52
WS 1219 3 Yr. Avg.	2.14	5.33	2.62	2.29	1.73	2.15	1.31	3.69	21.26

The adverse effects of wet weather on water quality in an urban environment are well documented. Masterson and Bannerman (1994) found that stormwater discharges affected the following: exceedance of water quality criteria, contaminated sediment, excessive high and low flows, sedimentation, bioaccumulation and toxicity, and poor habitat. All of these factors affect the biological integrity of urban streams.

The impact of rainfall was analyzed for the three year sampling period utilizing a linear correlation yielding the following results (Table 7, Figure 20):

Table 7: 2003-2005 Underwood Creek Water Quality Index vs. 3-Day Precipitation.

	Spearman Rank Order Correlations MD pairwise deleted **Marked correlations are significant at p <.05000**			
Pair of Variables	Valid N	Spearman R	t(N-2)	p-level
SIDO & 3 day precip (ws1219)	168	-0.026203	-0.33772	0.736002
SITNH3 & 3 day precip (ws1219)	168	-0.027904	-0.35965	0.719564
SIUNNH3 & 3 day precip (ws1219)	168	0.005095	0.06565	0.947736
SITP & 3 day precip (ws1219)	168	-0.110387	-1.43098	0.154317
SISOLP & 3 day precip (ws1219)	168	-0.075164	-0.97117	0.332876
SISS & 3 day precip (ws1219)	**168**	**-0.156139**	**-2.03669**	**0.043270**
SILGFEC & 3 day precip (ws1219)	**168**	**-0.481508**	**-7.07840**	**0.000000**
SICHLOR & 3 day precip (ws1219)	**168**	**0.305971**	**4.14075**	**0.000055**
SICU & 3 day precip (ws1219)	**168**	**-0.331177**	**-4.52210**	**0.000012**
SIZN & 3 day precip (ws1219)	**168**	**-0.344994**	**-4.73568**	**0.000005**
SITOC & 3 day precip (ws1219)	168	0.044917	0.57930	0.563174
FNLNDX & 3 day precip (ws1219)	166	-0.081049	-1.04136	0.299239

SI = SubIndex
Appendix D contains a variable abbreviations table.

Suspended solids, log fecal coliform, copper, and zinc were all negatively impacted by rainfall (as rainfall increases, the WQI value for these variables deteriorates) and most likely the subsequent associated stormwater runoff. The concentrations of these variables in Underwood Creek increased with rainfall; this was a statistically valid correlation. The Wisconsin Department of Natural Resources estimates that within the State, approximately 40% of our streams and 90% of our inland lakes are degraded or threatened due to nonpoint source pollution or polluted stormwater runoff (WDNR 2001). Chlorides exhibited a positive correlation (as rainfall increases, the WQI value for this variable improves). It is possible that precipitation is exhibiting a dilutional effect on chloride concentrations. Note that a statistically significant correlation was not found between the final WQI and 3-day precipitation and this is illustrated in Figure 20.

Again, the trendline illustrated in Figure 20 was not significant and is the exact opposite of what one would expect to see with increasing rainfall amounts. This is most likely due to the limited amount of precipitation greater than 0.25 inches received during the study period (on or preceding sampling dates). These were marginal events, not typical of a more significant rainfall that would generate a greater load of stormwater to the creek. Of the 24 sampling dates, only 3 had a 3-day average precipitation of 0.25 or greater. Precipitation and discharge data with associated sample dates can be found in Appendix C.

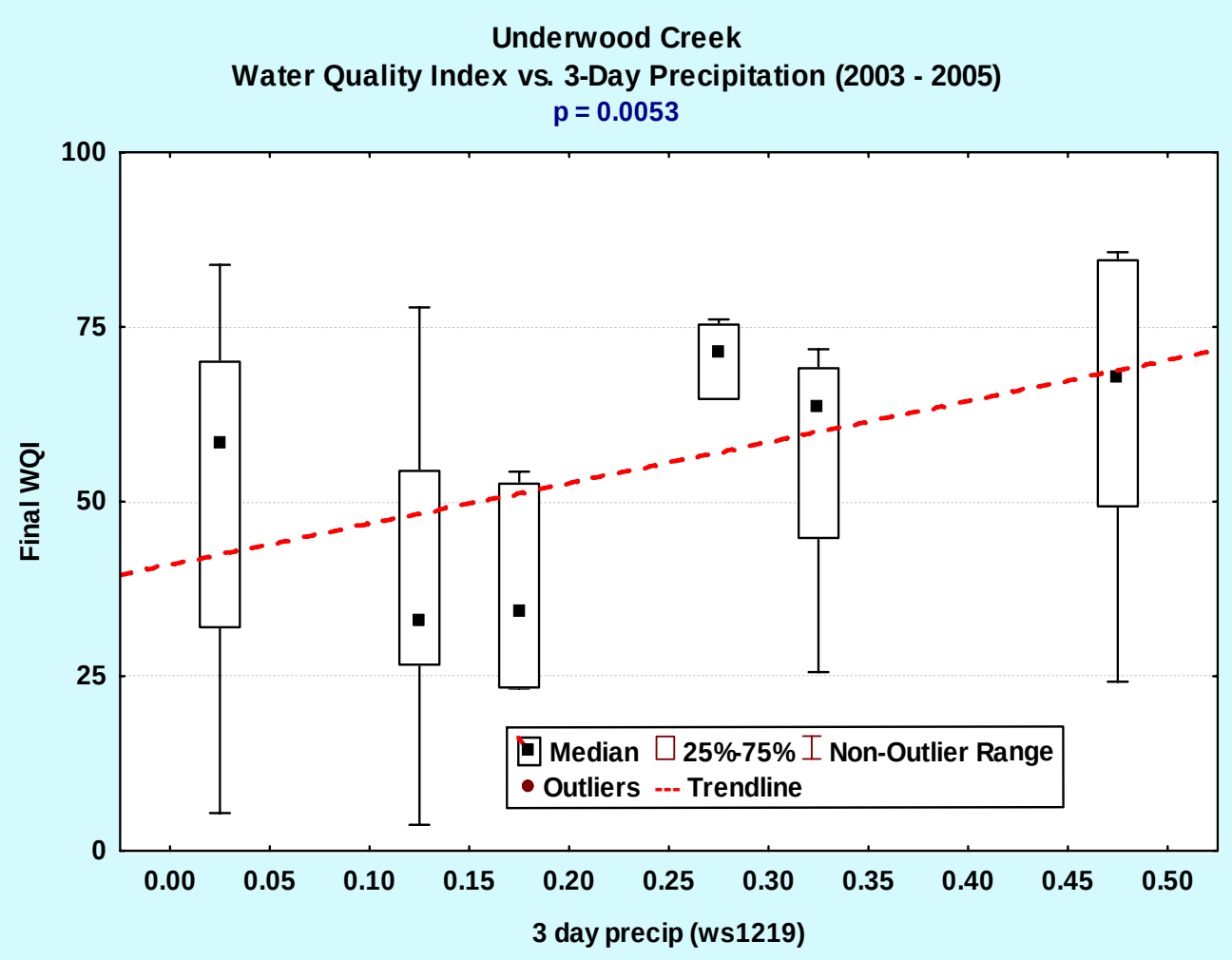


Figure 20: Water Quality Index vs. 3-Day Precipitation

Water Quality Trends – Dissolved Oxygen

Water Quality Standards and Criteria for Toxic Substances for Wisconsin surface waters (WDNR 1998) were established to preserve and/or enhance the quality of the state's waters. They protect the health of the public, fish, and the aquatic community as well as the waterway as a whole. Standards and Criteria also serve as measuring tools when water resource management decisions are made and are utilized in this evaluation. Variance categories have been developed for specific waters that could not meet the statutory objectives of the water quality standards. Portions of Underwood Creek (all of Underwood Creek below Juneau Boulevard: WDNR - NR 104) are classified as a special variance category watercourse. For the purposes of this report, the Full Fish and Aquatic Life Water Quality Standard was utilized to evaluate the potential effect of MMSD watercourse improvements.

The dissolved oxygen (DO) concentration in a waterbody is one of the key indicators of its overall health. The Wisconsin State Surface Water Warm Water Quality Standard is a minimum of 5.0 mg/L DO to support full fish and aquatic life. The State variance classification is not less than 2 mg/L at any time for parts of Underwood Creek.

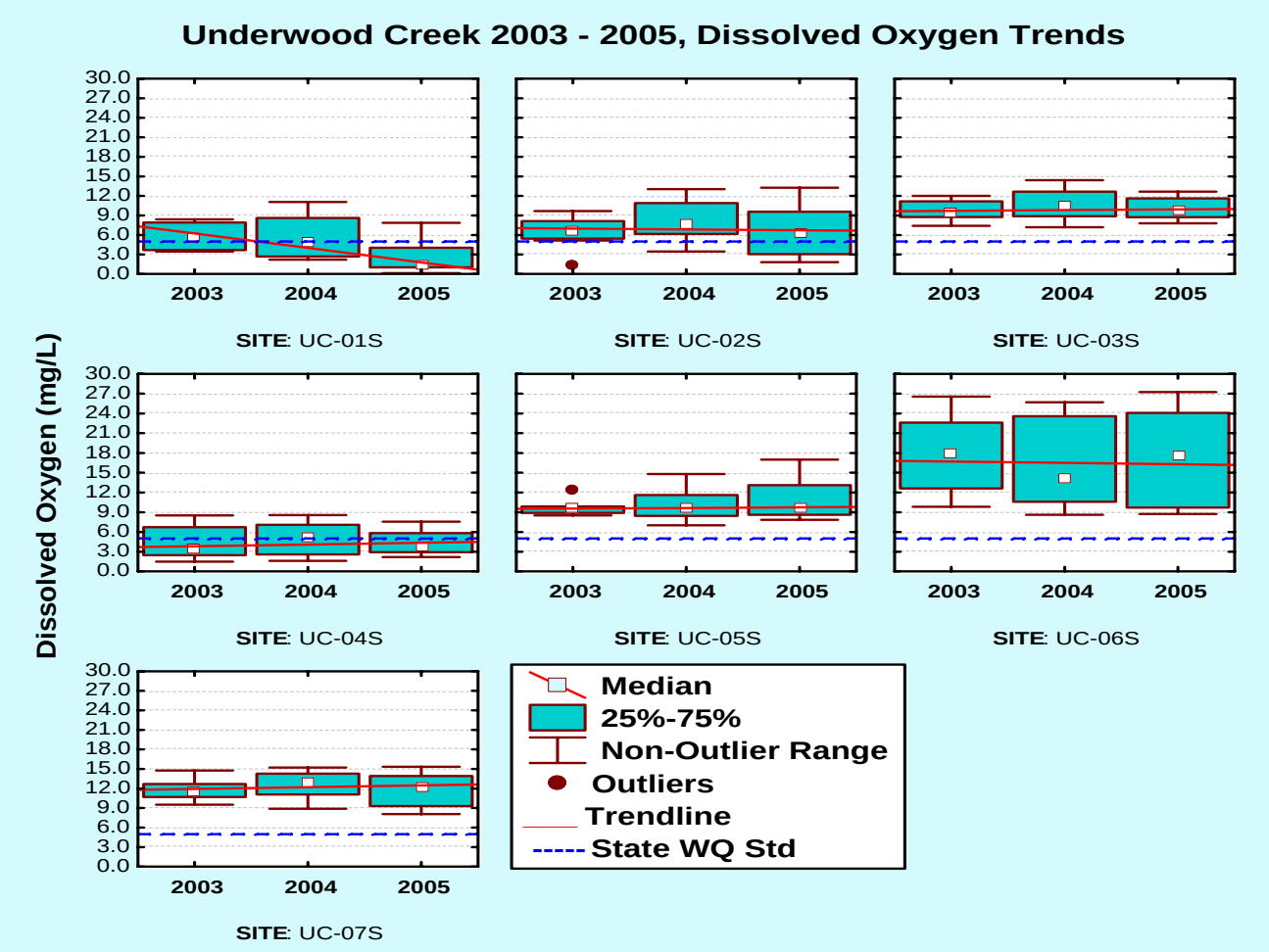


Figure 21: Dissolved Oxygen Trends, Underwood Creek, 2003 - 2005

Generally speaking, the majority of sites had 50% or more of the values above the State Warm Water Standard (Figures 21 and 22). No appreciable trend was noted at any Underwood Creek site except for UC-01 which displayed a declining trend (Figure 21). This trend was most likely due to the low D.O. values observed in 2005. Note that the WQI rating for this variable was "bad" in 2005 with a value of 25.7; while the previous two years were rated as "fair". Otherwise dissolved oxygen remained fairly steady throughout the 3 year period. Sites UC-3, UC-5, UC-6,

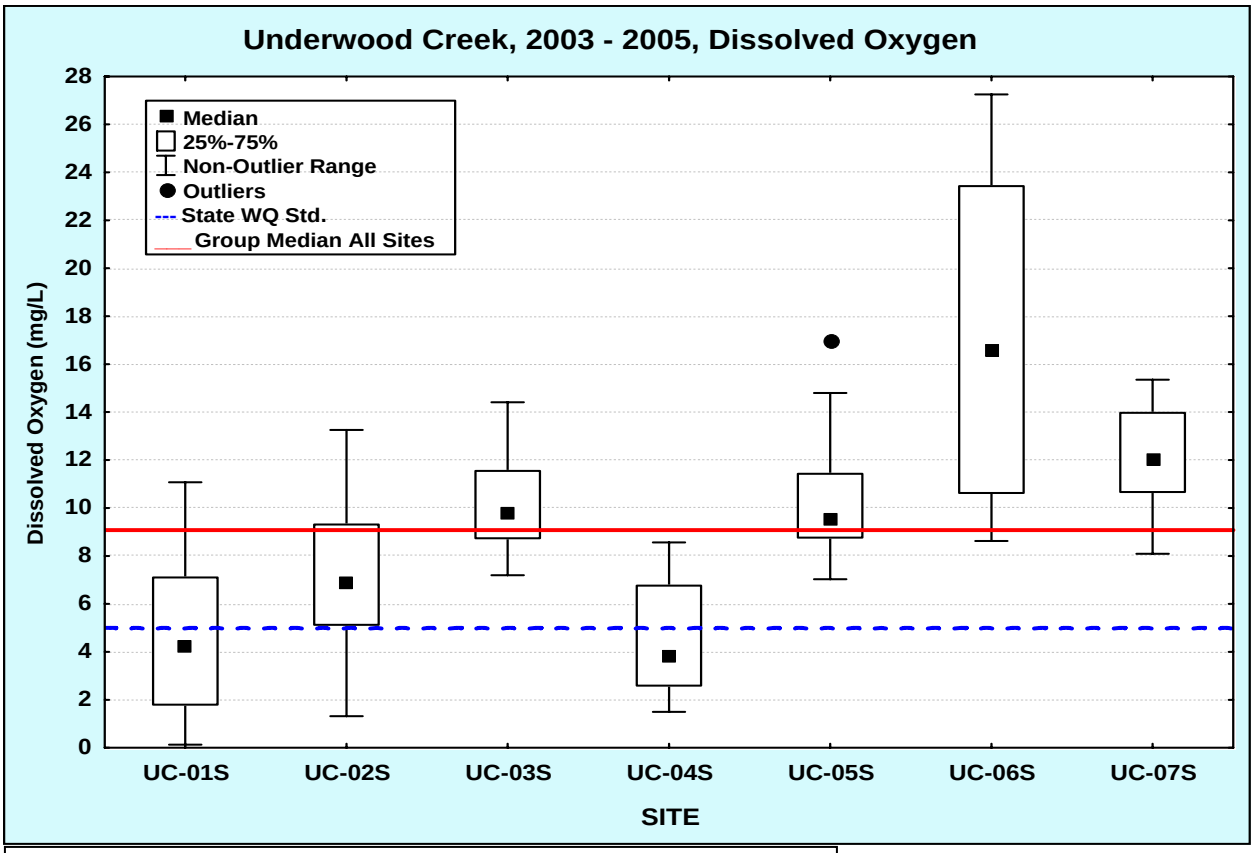


Figure 22: Underwood Creek, 2003 – 2005, Dissolved Oxygen
State Water Quality Standard = 5.0 mg/L

and UC-7 had 100% of the values above the standard (Figures 21, 22). For the three year period examined, UC-6 had the highest median value followed by UC-7, UC-3, and UC-5 respectively. UC-06 is a shallow, channelized site with an open canopy and is subject to super saturation of dissolved oxygen caused by attached algae; this most likely was a significant source of dissolved oxygen, contributing to the highest median value. UC-4 displayed the lowest median value of the 7 sites and all of its' dissolved oxygen values were below the group median for all sites and the median fell below the State Warm Water Standard. UC-1 had the 2nd lowest median value of all the sites with the site median and most dissolved oxygen values falling below the group median. The median value at UC-01 was also below the State Warm Water Standard.

Water Quality Trends – Fecal Coliform Bacteria

Fecal coliform bacteria are used as microbiological indicators of the safety of surface water for swimming or other body contact. The presence of fecal coliforms indicates contamination from

the intestinal tracts of warm-blooded animals. The State of Wisconsin Surface Water Warm Water Quality Standard for fecal coliform bacteria (Membrane Filter (MF) method) may not exceed 200 per 100 mL as a geometric mean based on not less than 5 samples per month, nor exceed 400 per 100 mL in more than 10% of all samples during any month in recreational waters. Portions of Underwood Creek are considered a special variance water and therefore the standard is a maximum of 1000 colony forming units (CFU) per 100 mL, also based on five samples per month. The recreational waters standard of 400 per 100 mL was utilized for this analysis (2.6 log fecal coliform bacteria per 100 mL).

Most of the fecal coliform values, at all sites and in each year examined, exceeded the Wisconsin State Warm Water Standard during the 3 year sampling period (Figures 23, 24). In fact, with the exception of UC-01, UC-03 (2003, 2004) and UC-06 (2004), nearly 100% of the median fecal coliform values were all above the standard. Slight upward trends were exhibited at UC-06 and UC-07; other Underwood Creek site fecal values remained generally steady. UC-01 and UC-03 appear to be the best sites in relation to other Underwood Creek sites. Notably, these two sites were the only locations where the fecal coliform subindex values were always rated as "fair" by the WQI. UC-05 appears to be the worst site with the highest median values exhibited in the years 2003 and 2005. This agrees with the WQI's finding of UC-05 being the worst site from a water quality perspective; fecal coliform bacteria values were a prominent contributor to the low index rating.

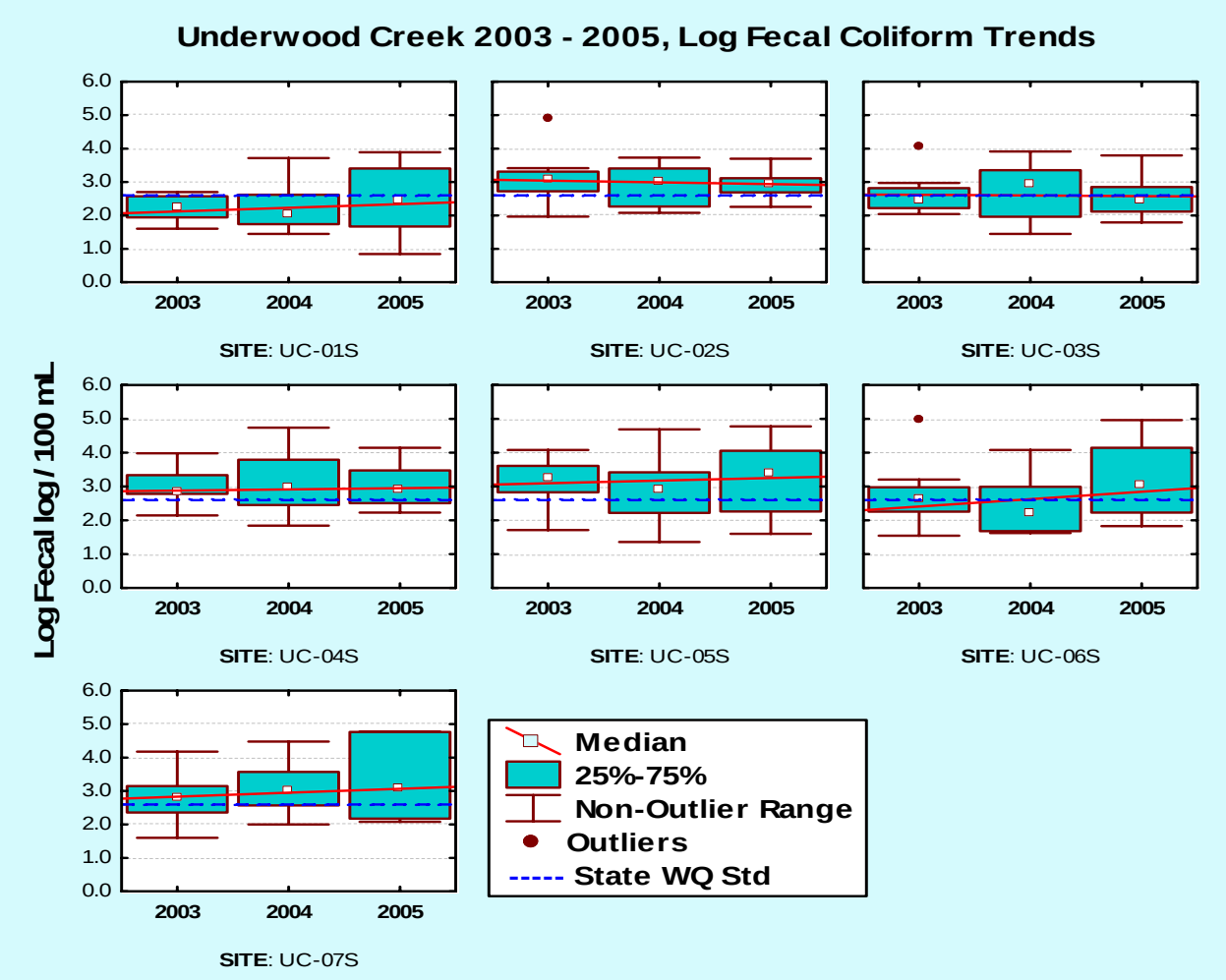


Figure 23: Log Fecal Coliform Trends, Underwood Creek, 2003 - 2005

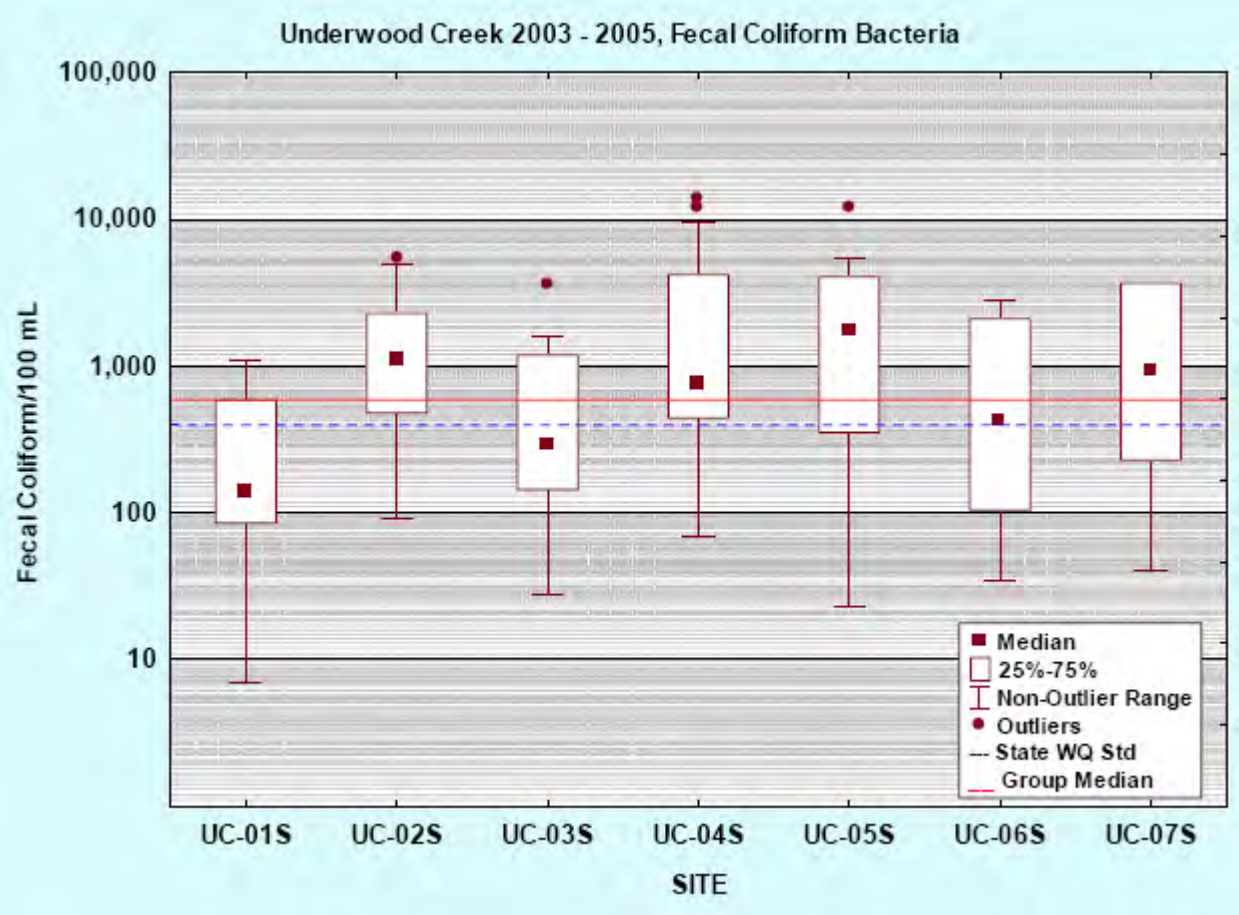


Figure 24: Underwood Creek, 2003-2005, Fecal Coliform Bacteria
State Water Quality Standard = 400/100 mL

UC-5 had the highest median values of all the sites, followed by UC-2, UC-7, and UC-4 respectively, all of which displayed median values above the State Standard and above the overall group median (all sites, all years). The high fecal values at UC-5 most likely contributed to this site receiving the lowest WQI ranking of all Underwood Creek sites. The median values at UC-1 and UC-3 were the only ones that fell below the State Standard. Additionally, the overall group median (all sites, all years, Figure 24) was above the State Water Quality Standard.

Water Quality Trends – Suspended Solids

Solids are another important water quality variable to monitor. Streets and lawns greatly contribute to suspended solids loads in residential urban settings (USGS 1999). High concentrations of solids can have serious negative water quality impacts. Elevated solids levels can adversely affect drinking water, aquatic organisms, and light penetration. Suspended solids (SS) consist of inorganic (non-living, for example – clay, silt, etc.) and organic particles (algae, bacteria, detritus, etc.) and generally are those materials that give water its turbidity or cloudiness. Suspended solids include all solids that are suspended in the water and will not pass through a filter. While a Wisconsin State Water Quality Standard for suspended solids does not exist, the American Fisheries Society (1979) recommends the maximum concentration of suspended solids “not to exceed 25 mg/L” for a high level of protection.

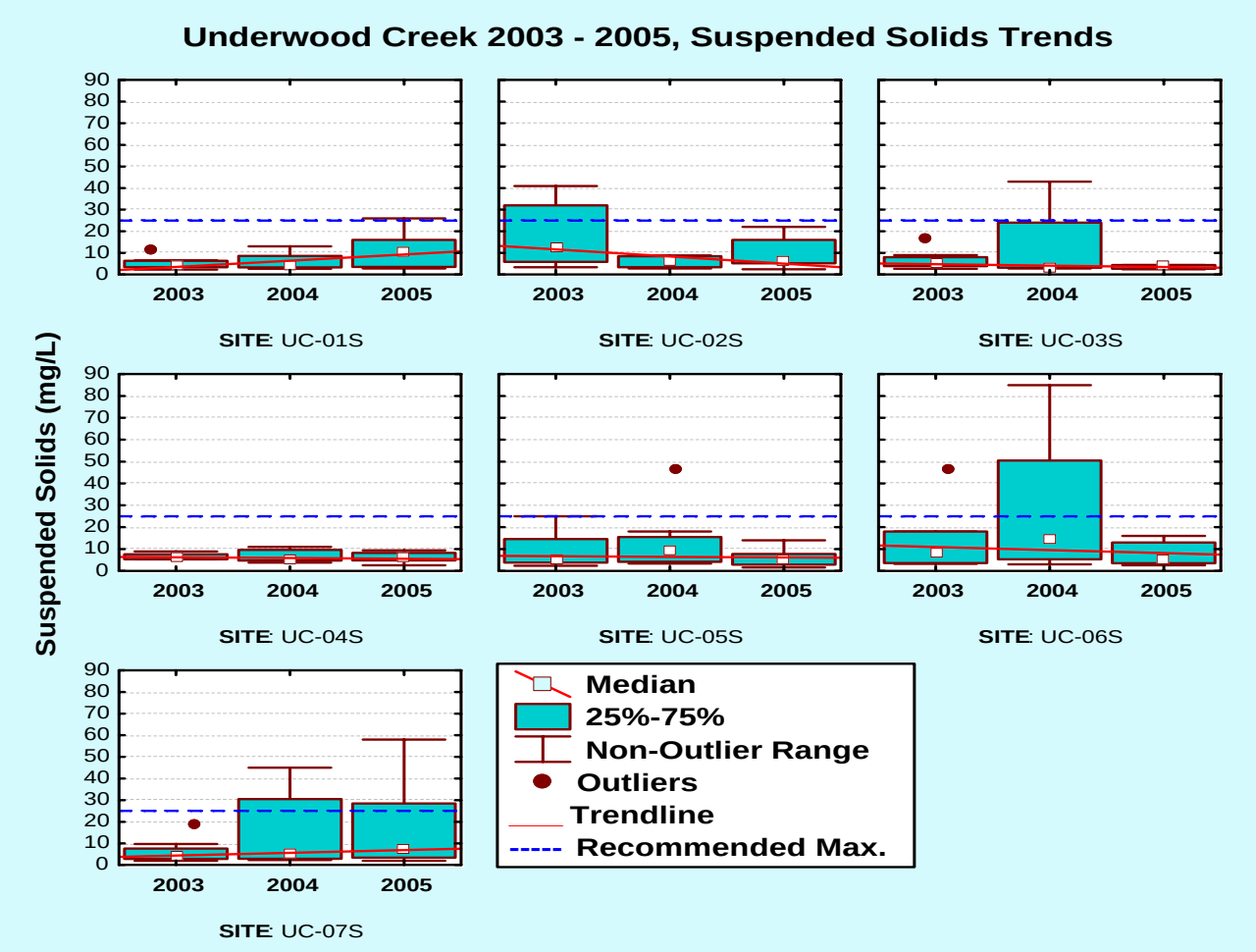


Figure 25: Suspended Solids Trends, Underwood Creek, 2003 - 2005

Most suspended solid values were below the recommended maximum concentration and all of the median values were below the recommended maximum (Figures 25, 26).

An appreciable trend at any one site did not exist, however, UC-02 and to a lesser extent, UC-06 did reveal a slight downward trend; UC-01 and UC-07 did exhibit slight upward trends. While UC-04 exhibited the most consistent values and medians over the three year period; UC-03 had the lowest and generally consistent medians and this contributed to the site receiving the highest WQI ranking of all Underwood Creek locations.

UC-06 had the highest overall median value of all sites while UC-03 had the lowest median. The group median (all sites, all years) was well below the recommended maximum value (Figure 26). The individual site medians and almost all values, with the exception of outliers, were also below the recommended maximum. This verifies the WQI rating of “good” for suspended solids in Underwood Creek.

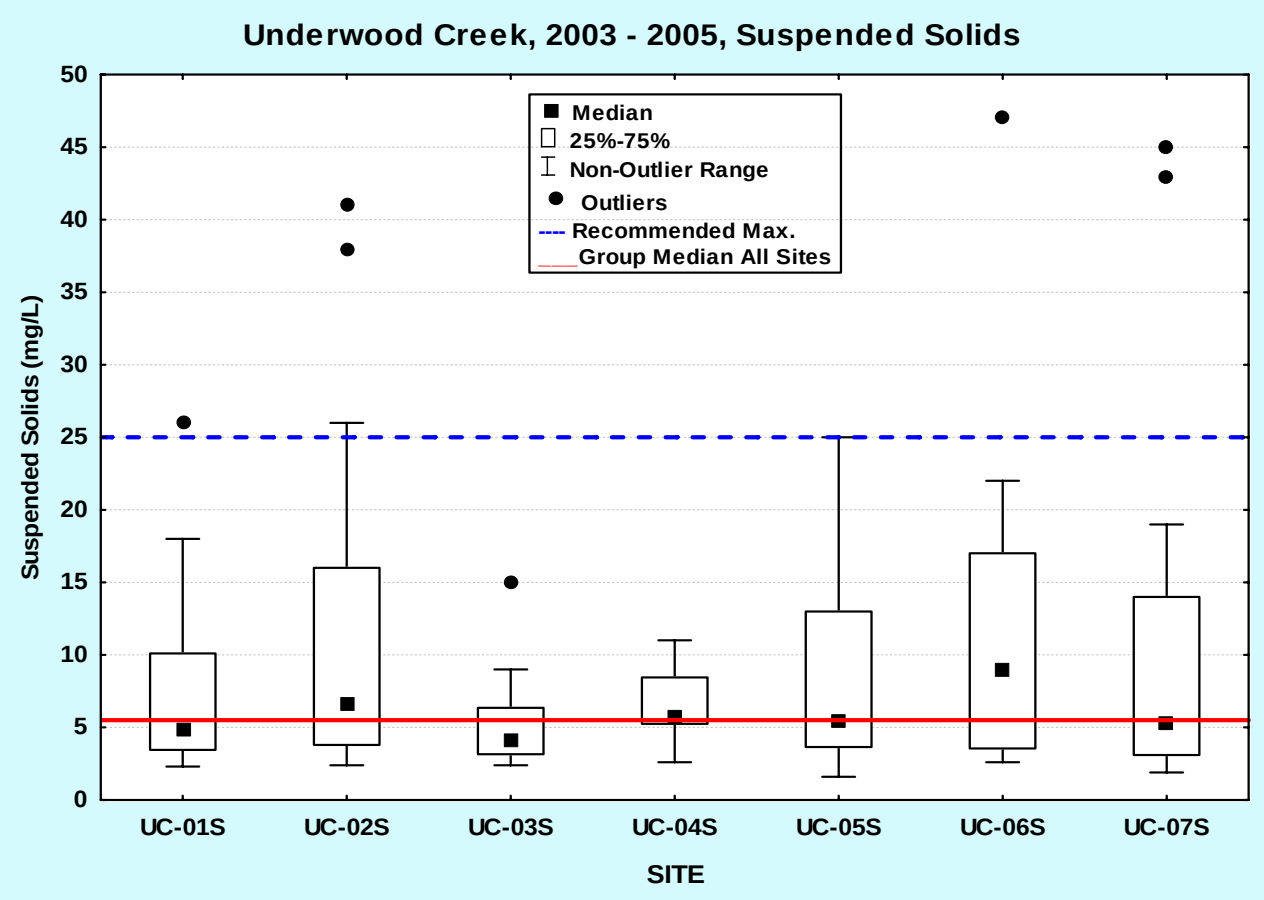


Figure 26: Underwood Creek, 2003 – 2005, Suspended Solids
Recommended Maximum = 25 mg/L

Water Quality Trends – Phosphorus

Phosphorus in the form of phosphate is a major nutrient required for plant nutrition and is essential for life. Streets and lawns are the largest contributors of total and dissolved phosphorus loads in a residential urban basin (USGS 1999). In fact, USGS found that commercial fertilizers comprised 54% of the total phosphorus input in this area (USGS 1998a). High phosphate concentrations can overstimulate excess plant growth, which can lead to accelerated aging of a waterway. Soluble phosphorus is the form most readily available to aquatic plant communities. There are no Wisconsin State Surface Water Quality Standards for phosphorus; the recommended maximum concentrations for total phosphorus and soluble phosphorus are 0.02 mg/L and 0.01 mg/L respectively (MMSD Oct. 2004), and were utilized for the purposes of this report. The current EPA criterion (total phosphorus) for Ecoregion VII which includes Wisconsin is 0.08 mg/L (USEPA 2000). The planning standard utilized by the Southeastern Wisconsin Regional Planning Commission (SEWRPC 2007) for total phosphorus is 0.1 mg/L.

Nearly all phosphorus data in Underwood Creek, both total and soluble, exceeded the recommended maximum concentrations at every site (Figures 27, 28, 29, 30). Much of the phosphorus data were several fold higher than the recommended amounts.

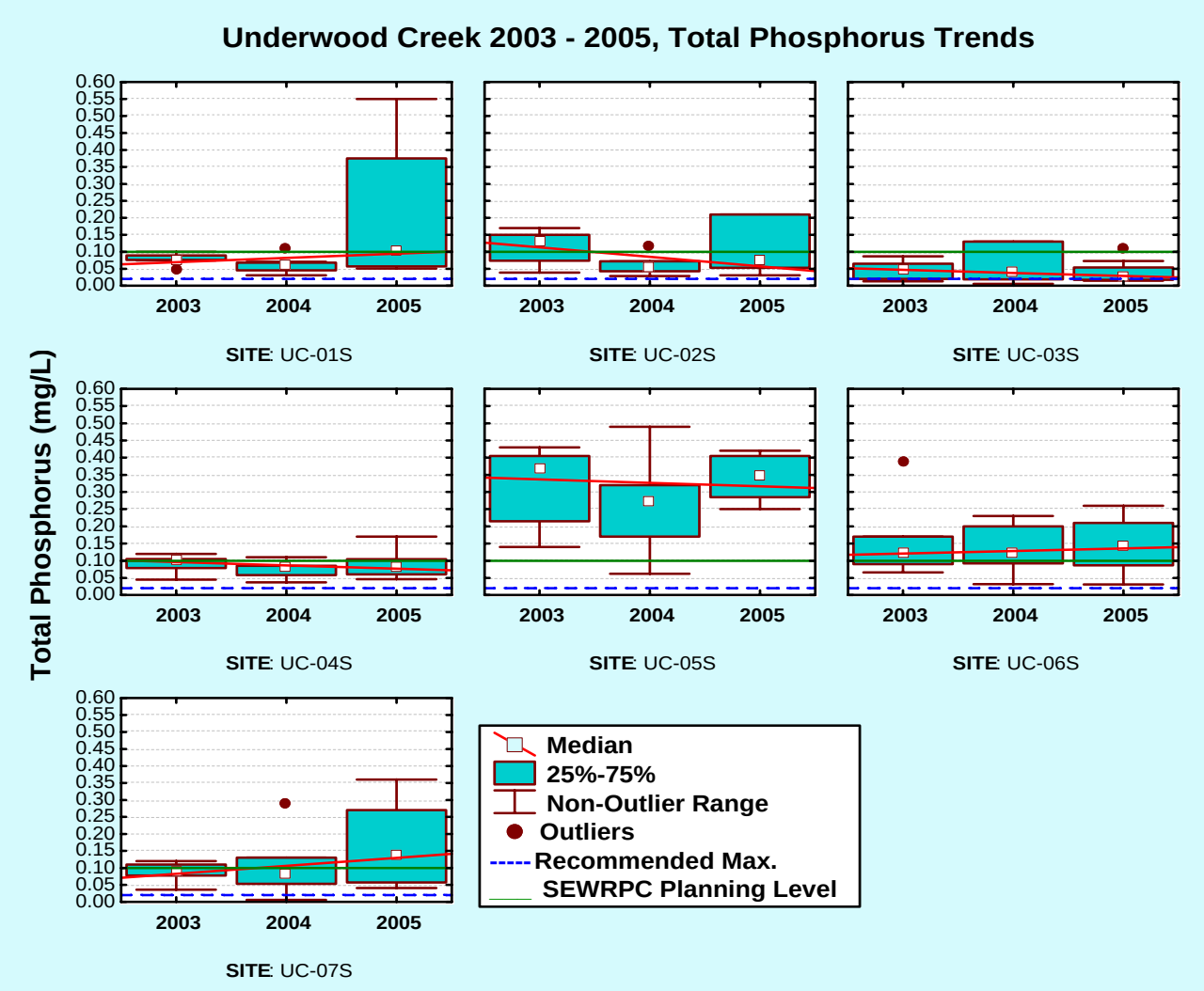


Figure 27: Total Phosphorus Trends, Underwood Creek, 2003 - 2005

Almost all of the total phosphorus values (Figure 27, 28) at all Underwood Creek sites were above the recommended maximum concentration for total phosphorus, indicating nutrient rich conditions. All of the median values at all sites were above the recommended maximum. Additionally, all sites except UC-03 displayed at least one yearly median value above the SEWRPC planning level of 0.10. UC-02 and to a lesser extent, UC-05 had decreasing trendlines; while UC-01, UC-06 and UC-07 displayed increasing trends. The trendlines at the other UC sites were generally steady or slightly declining. In terms of the highest total phosphorus values for all three years examined, UC-05 was the worst site; with all total phosphorus values exceeding the recommended maximum and nearly all values exceeding the SEWRPC planning level. This also verifies the “very bad” WQ subindex rating for all three years at this location. The high in-stream phosphorus content at UC-05 most certainly contributed to the lowest and worst overall WQI ranking of all sites. Total phosphorus values were the lowest at UC-03 when compared to other UC sites for the three year study period. Nearly all of the values were below the SEWRPC planning level. In fact, the WQ subindex was always ranked as

"fair" at this site. These values contributed to the highest and best overall WQI ranking of all Underwood Creek sites.

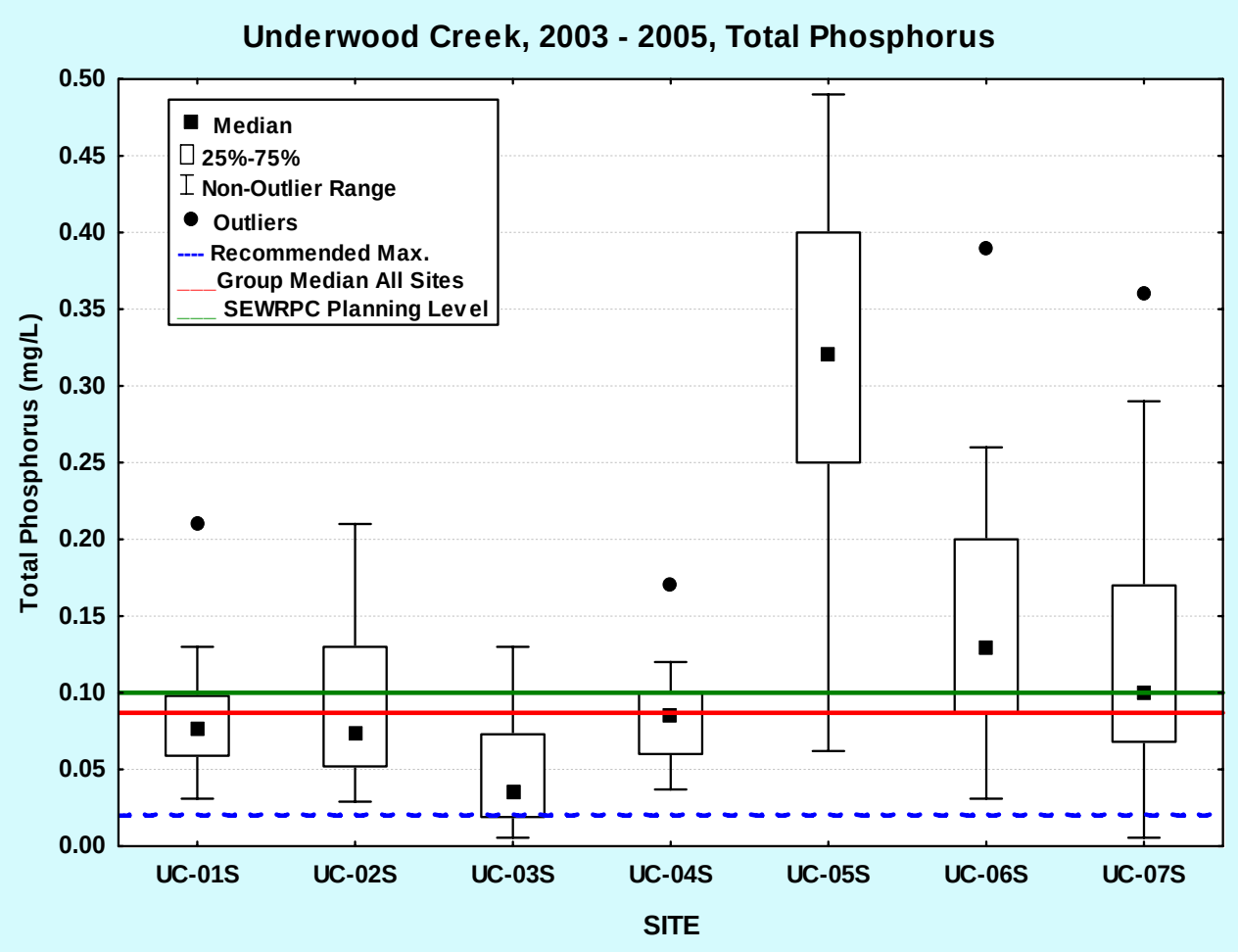


Figure 28: Underwood Creek, 2003 – 2005, Total Phosphorus
Recommended Maximum = 0.02 mg/L

Looking at the combined data (all years) UC-05 had the highest median value of all sites while UC-03 had the lowest median, as expected from previous discussion. This is consistent with the WQI which ranked UC-05 as "very bad" and UC-03 as "fair". It is possible that one source of elevated phosphorus at UC-05 is the Lake Evinrude outfall. WDNR data for the years 2000 – 2004 indicated values that were 10 times greater than what is needed to determine a eutrophic condition (nutrient rich, high productivity, possibility of extensive algal blooms and aquatic plant growth) Total phosphorus values were in the 500 – 540 µg/L range; eutrophic conditions are indicated with values > 50 µg/L (Sabre 2006). UC-03 was rated as the best site by the WQI and was the only site that experienced "fair" water quality total phosphorus subindex ratings for all three years. The group median (all sites, all years) was well above the recommended maximum value (Figure 28), but was below the SEWRPC planning level. The individual site medians and almost all values were also above the recommended maximum. UC-01, UC-02, UC-03, and UC-04 median values were below the SEWRPC planning level while UC-05 and UC-06 were above the planning level. The median value at UC-07 was mainly at the SEWRPC planning

level. UC-03 and UC-07 were the only sites that displayed some total phosphorus values below the recommended maximum.

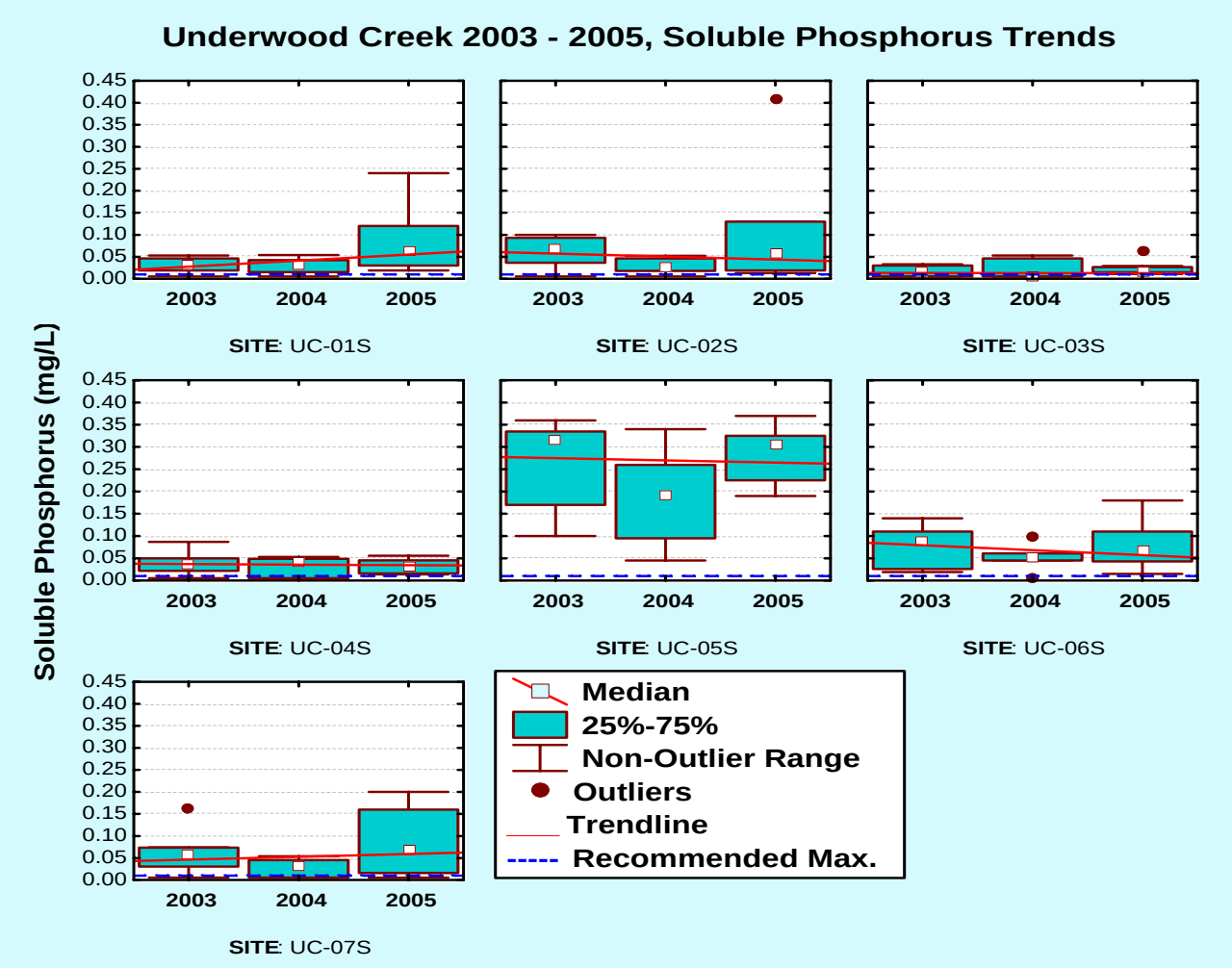


Figure 29: Soluble Phosphorus Trends, Underwood Creek, 2003 - 2005

Soluble phosphorus was similar to total phosphorus in Underwood Creek with most of the values above the recommended maximum concentration for soluble phosphorus (Figures 29, 30). UC-03 had median values either at or below the recommended concentration and the values here were generally steady. In terms of soluble phosphorus, UC-03 was the best site. In fact, the WQI subindex for soluble phosphorus was always ranked as “fair” to “good” during the three year study period. Again, UC-05 was the worst site and these high values most certainly contributed to the low WQI ranking. A slight increasing trend was observed at UC-01 and UC-07. Slight decreasing trends were noted at UC-02, UC-05, and UC-06. The remaining sites displayed relatively steady trends. None of these trends were significant.

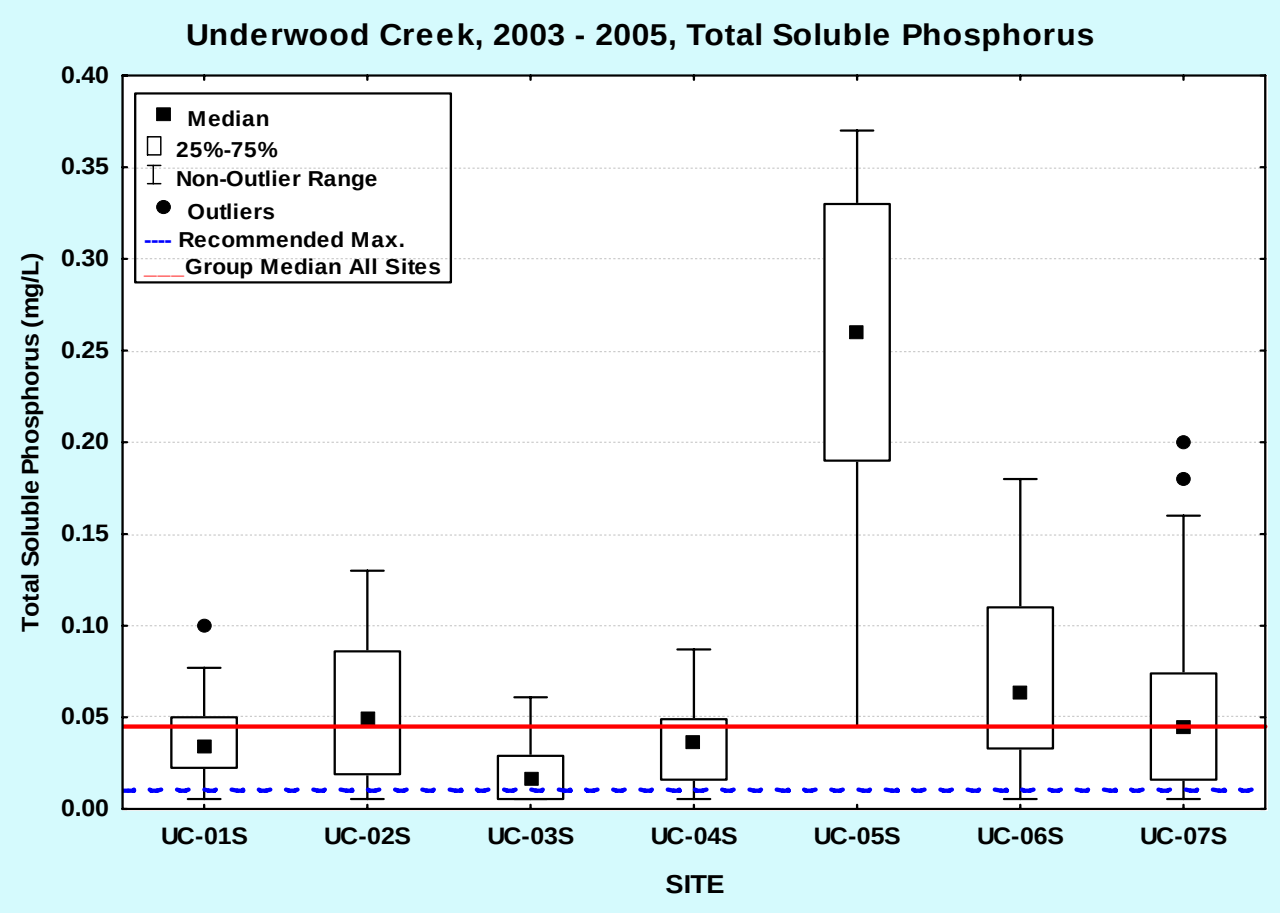


Figure 30: Underwood Creek, 2003 – 2005, Soluble Phosphorus
Recommended Maximum = 0.01 mg/L

Looking at the combined data, UC-05 by far, exhibited the highest median value of all sites while UC-03 had the lowest median. The three year median at UC-05 was greater than 3 times the median values at other Underwood Creek sites. Again, this is consistent with the WQI which ranked UC-05 as “very bad” and UC-03 as “fair”. UC-03 was rated as the best site by the WQI. The group median (all sites, all years) was well above the recommended maximum value of 0.01 mg/L (Figure 30). The individual site medians and almost all values were also above the recommended maximum. UC-05 was the only site that did not display some values below the recommended maximum. UC-03 had some values at and below the recommended maximum and almost all of the soluble phosphorus data was below the group median.

Water Quality Trends – Nitrogen Series

Un-ionized Ammonia

Ammonia is a compound normally found in low concentrations in most waters. Present in wastewater discharges, it can also be formed from the degradation of nitrogenous organic matter. The available evidence indicates that the toxicity of ammonia can depend on ionic composition, pH, and temperature. The mechanisms of these effects are poorly understood, but

the pH dependence strongly suggests that joint toxicity of un-ionized ammonia and the ammonium ion is an important component (USEPA 1999). Un-ionized ammonia is the more toxic form, because it is a neutral molecule and thus is able to diffuse across the epithelial membranes of aquatic organisms much more readily than the charged ammonium ion (USEPA 1999). In one study, the LC_{50} (lethal concentration to kill 50% of the population) for nonsalmonid fish ranged from 0.14 to 4.60 mg/L of un-ionized ammonia. For salmonid fish, the LC_{50} was 0.083 to 1.09 mg/L (AWMFH 1992). Invertebrates and aquatic plants are more tolerant of un-ionized ammonia than fish (AWMFH 1992).

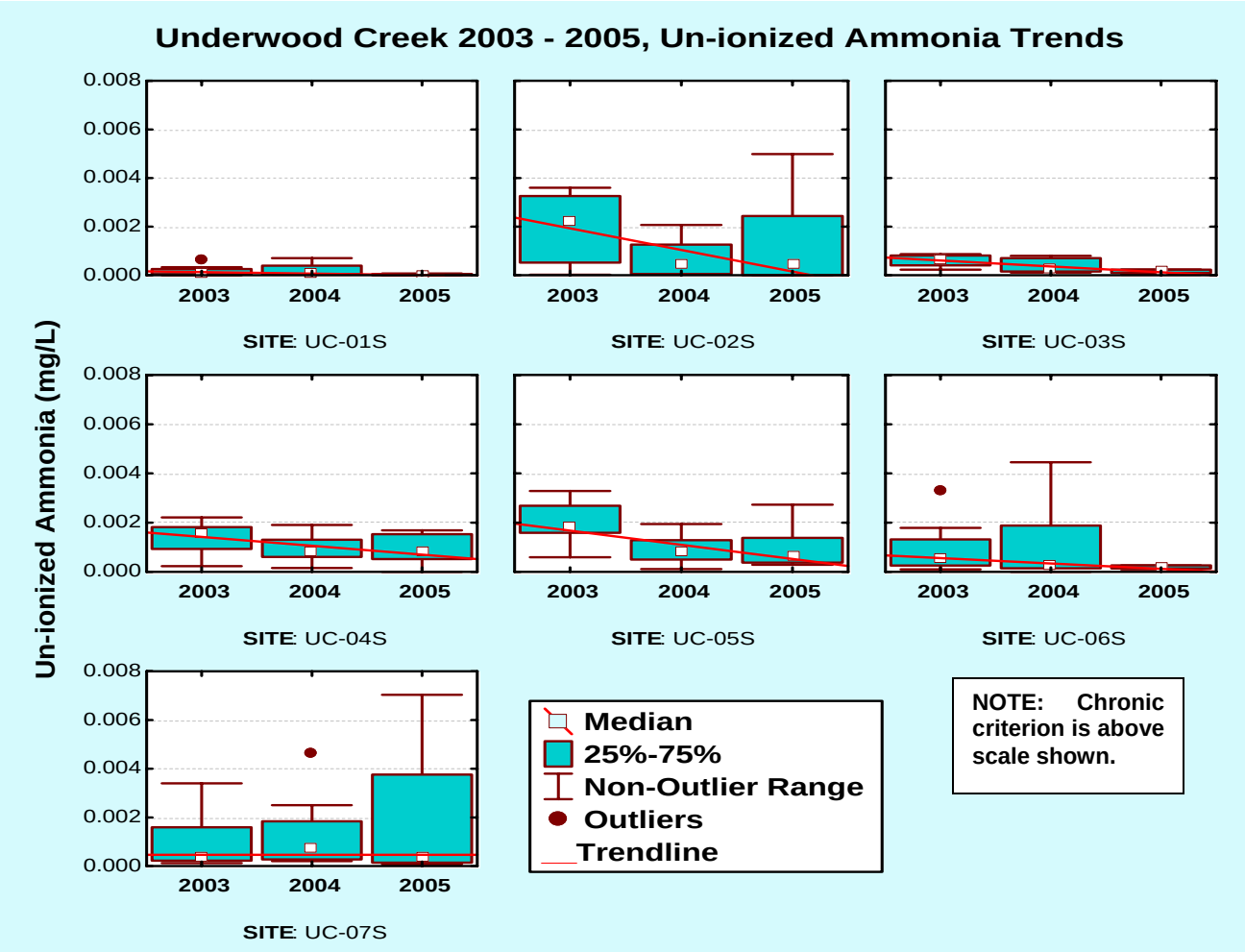


Figure 31: Un-ionized Ammonia Trends, Underwood Creek, 2003 - 2005

Ammonia criteria were developed by the USEPA for the protection of aquatic life. The Wisconsin State Surface Water Warm Water Chronic Criterion for un-ionized ammonia is 0.04 mg/L (Figures 31, 32). Many sites registered values below the method detection limit (0.0002 mg/L). 100% of the values for un-ionized ammonia were below the chronic criterion. The trend at sites UC-02, UC-03, UC-04 UC-05, and UC-06 was decreasing. The trend at UC-01 and UC-07 was steady. These low ammonia values contributed to better water quality ratings in the WQI analysis.

UC-04 followed by UC-05 had the highest median values of all sites while UC-01, followed by UC-03, UC-06, and UC-07 had the lowest median values. The group median (all sites, all years) was well below the Chronic Criterion (Figure 32), as were the individual site medians and all values including outliers. UC-03 and UC-01 values were entirely below the group median with the exception of outliers at UC-03.

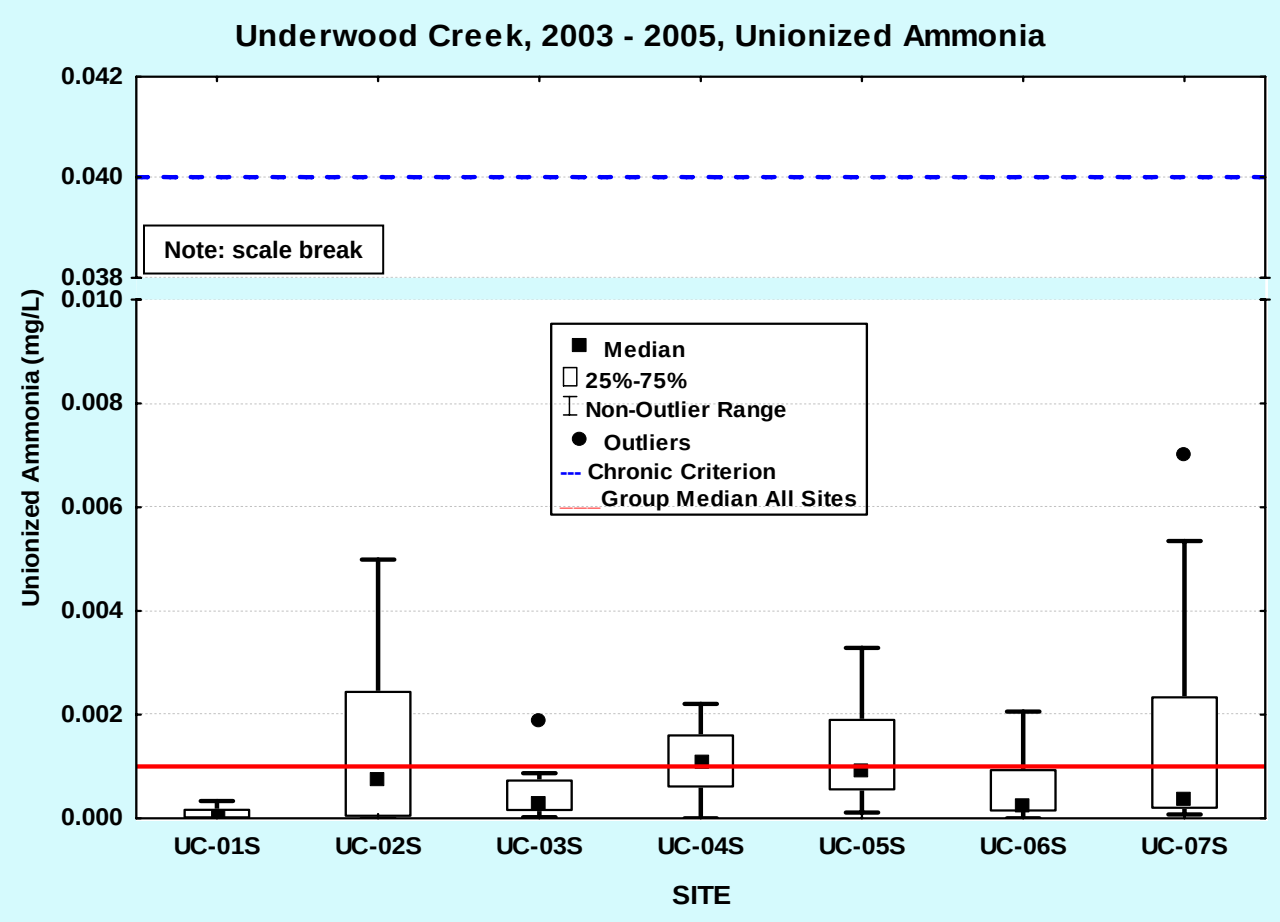


Figure 32: Underwood Creek, 2003 – 2005, Un-ionized Ammonia
Chronic Criterion = 0.04 mg/L

Total Kjeldahl Nitrogen (TKN)

Total Kjeldahl Nitrogen is a useful measure of the organic content of a water source. TKN is the combination of organic nitrogen and ammonia nitrogen. There are no State of Wisconsin standards for TKN; therefore, an EPA criterion was used for this evaluation. Southeast Wisconsin is included in the EPA's level III Ecoregion 53. This comes from the Ambient Water Quality Criteria Conditions for Rivers and Streams in Nutrient Ecoregion VII (USEPA 2000). The intent of developing ecoregional nutrient criteria is to represent conditions of surface waters that are minimally impacted by human activities and thus protect against the adverse effects of nutrient over-enrichment from cultural eutrophication. State water quality inventories and listings of impaired waters consistently rank nutrient over-enrichment as a top contributor to use impairments. The values used generally represent nutrient levels that protect against adverse effects of over-enrichment (USEPA 2000).

The EPA values used represent the 25th percentile (P25) of the population (all data collected from all seasons) of all streams represented in the region since no reference stream has been identified. The P25 value for Ecoregion 53 is 0.65 mg/L. This would indicate that all Underwood Creek sites for almost all years exhibited annual median values that surpassed EPA nutrient criteria (Figures 33, 34); therefore, over-enrichment is a problem with regard to TKN.

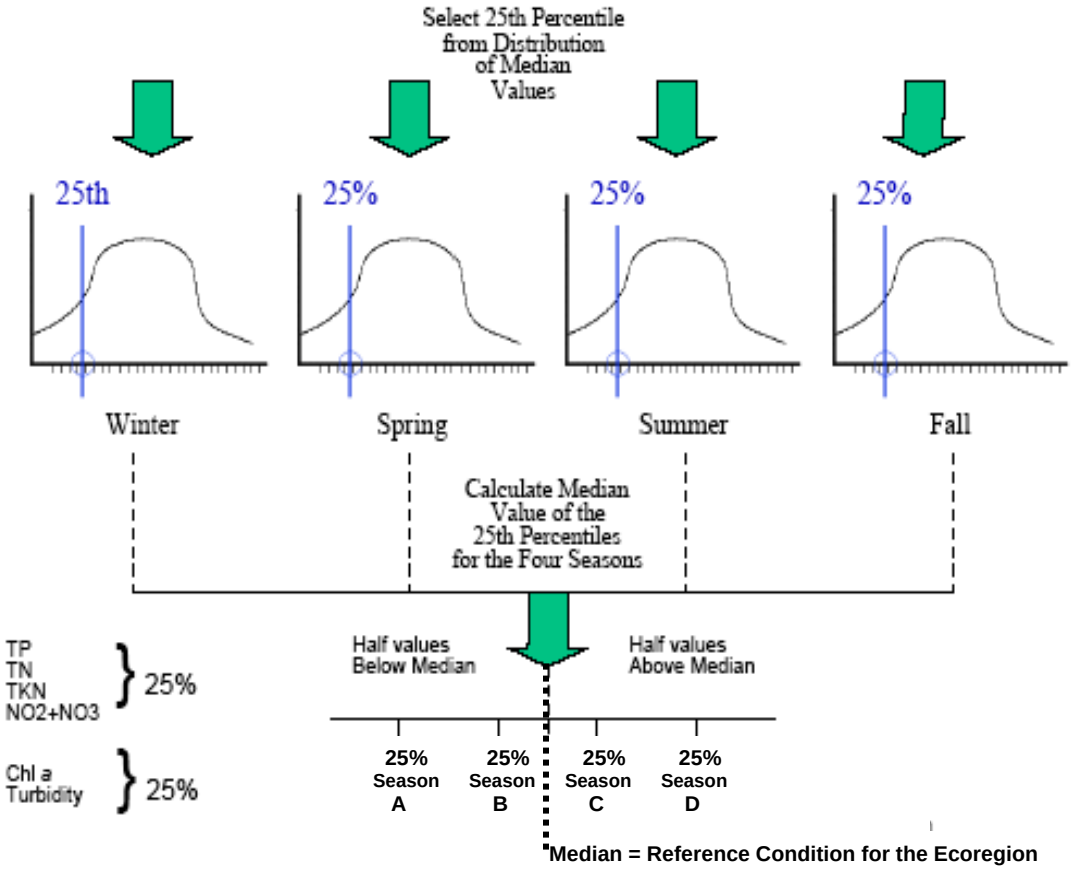


Illustration from: USEPA December 2000. Ambient Water Quality Criteria Recommendations.

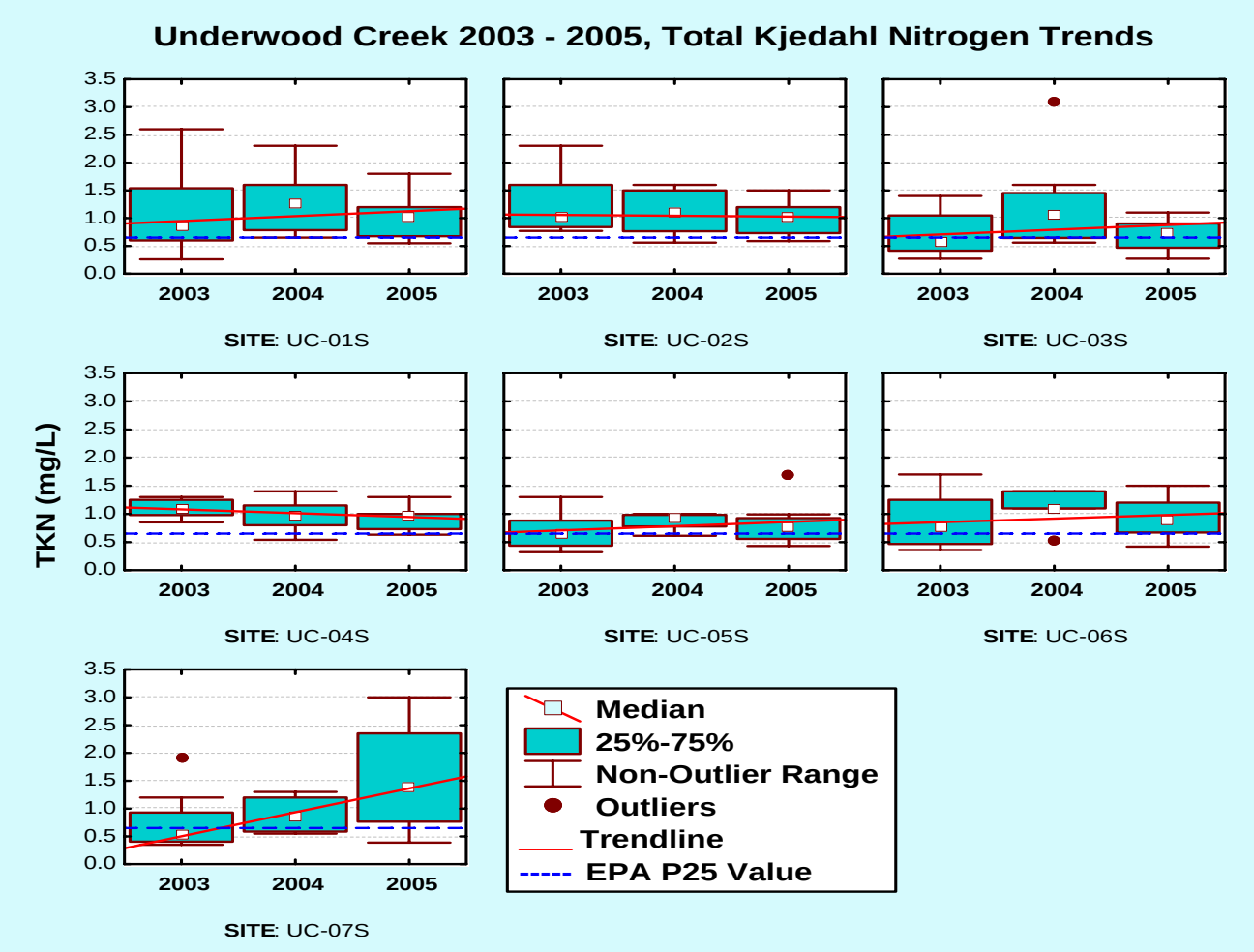


Figure 33: Total Kjeldahl Nitrogen Trends, Underwood Creek, 2003 - 2005

Most of the total kjeldahl nitrogen (TKN) values at all Underwood Creek sites were above the EPA P25 value and most of the median values at all sites were above the EPA nutrient criterion (Figure 33). The trend is site dependent. Certainly, UC-07 exhibited the strongest trend which was increasing (water quality degradation). Very slight increasing trends were seen at UC-01, UC-03, UC-05, and UC-06, while UC-02 remained steady and UC-04 displayed a slight decreasing (toward improving water quality) trend.

In terms of the TKN values, UC-02, UC-04, UC-06, and UC-01 were the worst sites. UC-03, followed by UC-05 were the best sites.

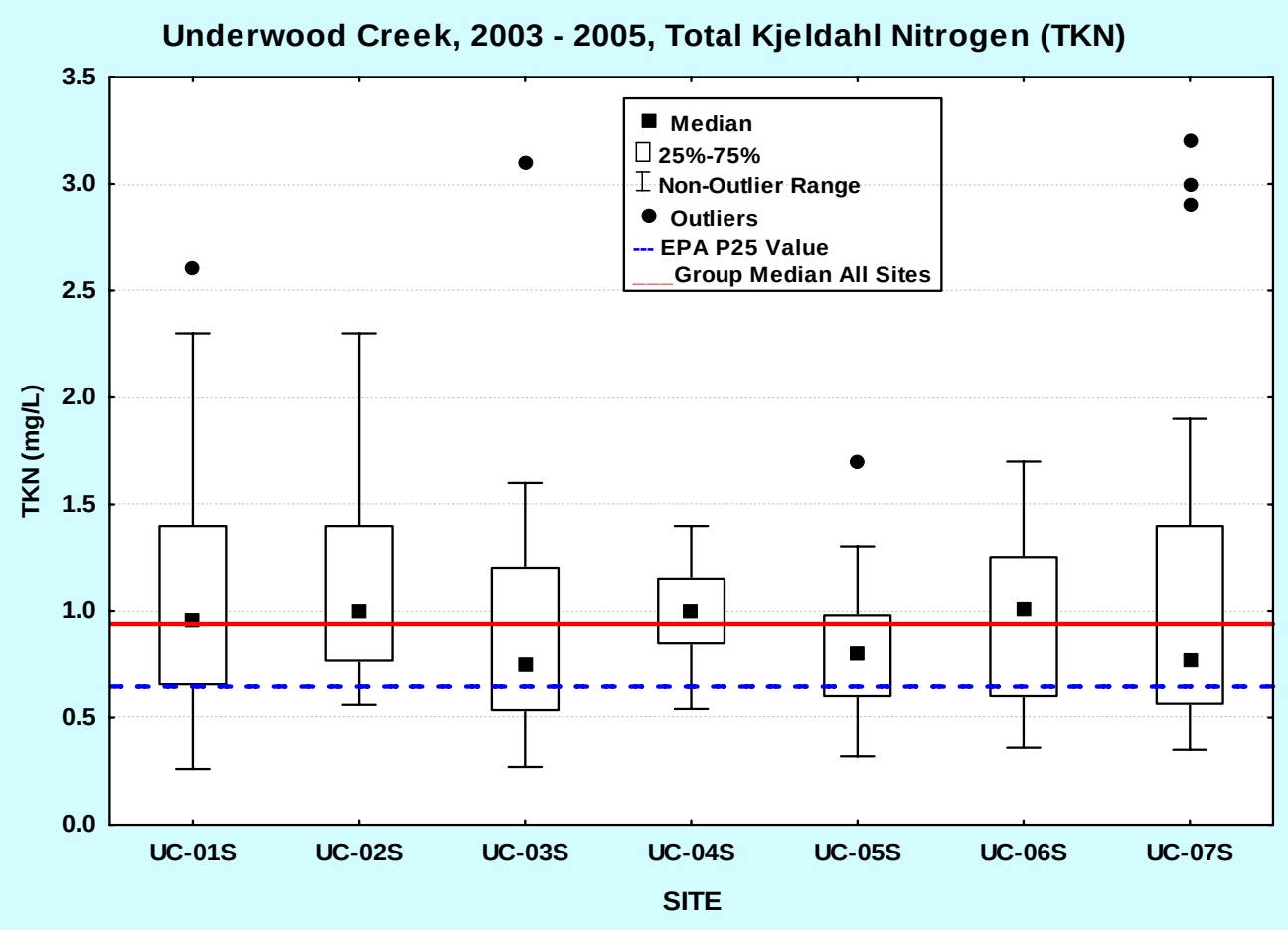


Figure 34: Underwood Creek, 2003 – 2005, Total Kjeldahl Nitrogen
EPA P25 Value = 0.65 mg/L

UC-02, UC-04, and UC-06 had the highest median values of all sites and were all above the group median (all years, all sites), while UC-03 had the lowest median and was below the group median. This is consistent with the WQI which ranked UC-03 as "fair". UC-03 was rated as the best site by the WQI. The group median (all sites, all years) was above the EPA P25 Value (Figure 34). The individual site medians and almost all values were also above the EPA criterion. UC-03 had the most values below the P25 criterion.

Nitrates and Nitrites

Nitrates can be toxic to warm-blooded animals. High rates of nitrification (a biological process in which ammonia is converted to nitrite and nitrate) can severely deplete the dissolved oxygen content of water. Sources of nitrate in surface water include domestic wastewater, leaching from soil, barnyard or feedlot runoff, industrial wastewater discharges, and land use. Nitrate concentrations can be elevated due to fertilizers on lawns and gardens. These fertilizers become aquatic pollutants during stormwater runoff events. Nitrate is a major nutrient necessary for plant growth and is produced during nitrification. Nitrites are the intermediate products of nitrification and are usually found in low concentrations in the natural environment. Nitrites are normally a transitory phase between nitrification and denitrification (a process where nitrate is

converted to gaseous nitrogen) (AWMFH 1992). Nitrite concentrations in surface water can increase if enriched bottom material (excess nutrients) is disturbed and resuspended into the water column (AWMFH 1992).

State of Wisconsin surface water standards do not currently exist for nitrate and nitrite; therefore the EPA criterion was used for evaluation. The EPA values used represent the 25th percentile of the population (all data) of all streams represented in the region since no reference stream has been identified. Values for nitrate and nitrite have been added together for a P25 of 0.94 mg/L

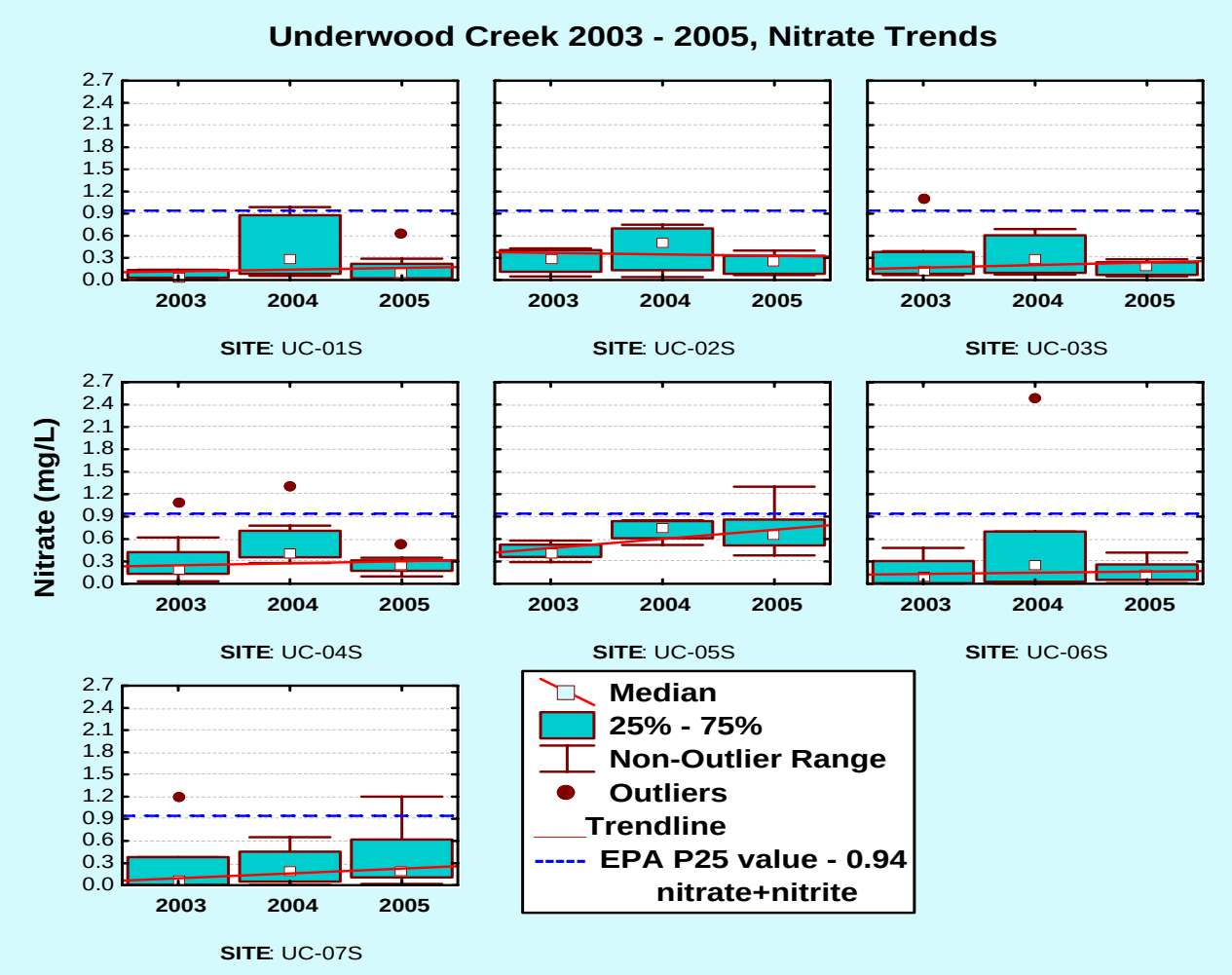


Figure 35: Nitrate Trends, Underwood Creek, 2003 - 2005

Looking at nitrate values (Figures 35, 36), Underwood Creek sites would not be considered over-enriched for all years sampled. All median values and all values that reside in the 25 – 75th percentiles were below the criterion. There was a slight increasing trend at UC-03, UC-05, and UC-07 while all other sites remained generally steady. The year, 2004, exhibited the highest nitrate values. UC-05 generally had the highest median nitrate values.

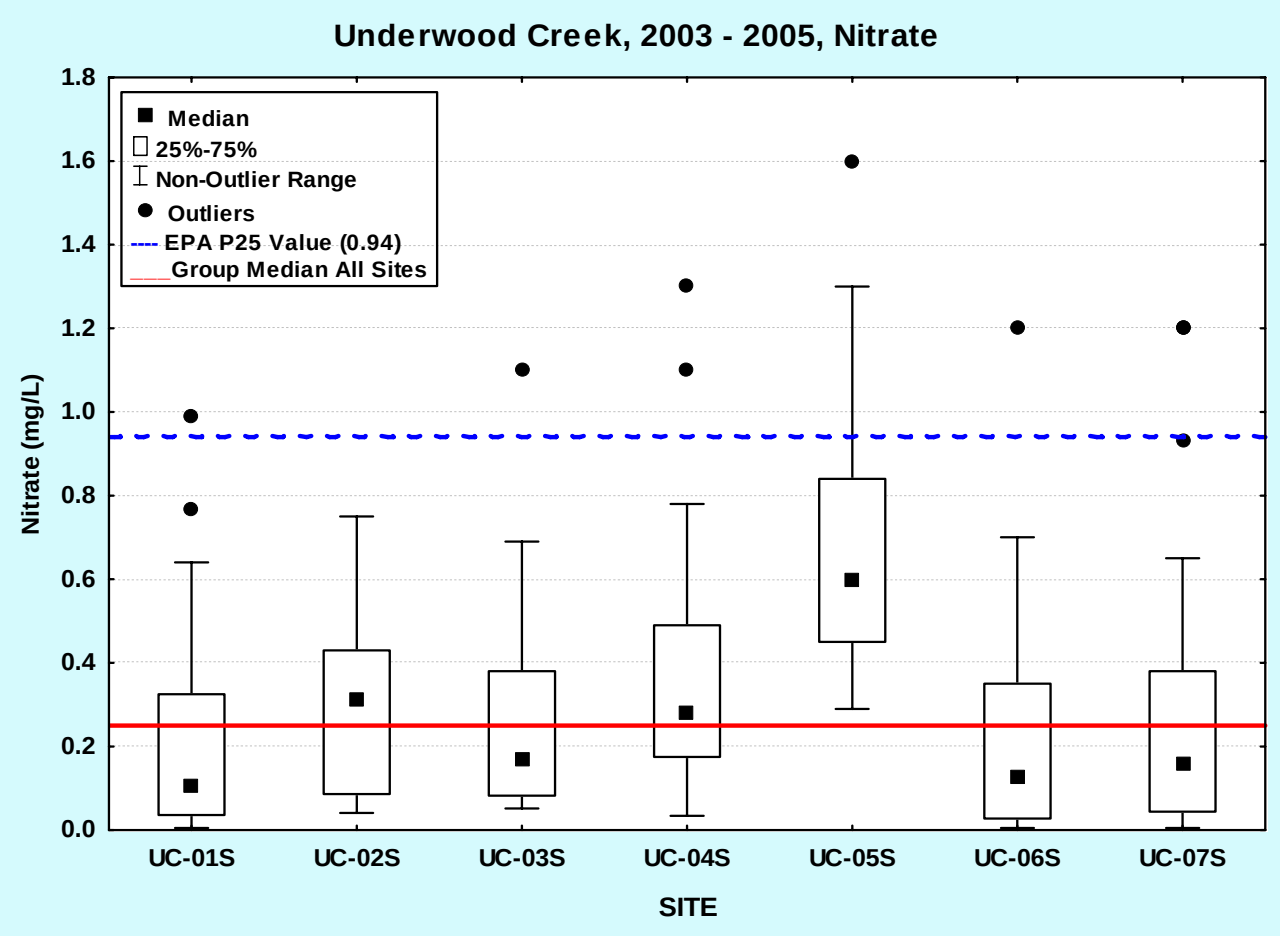


Figure 36: Underwood Creek, 2003 – 2005, Nitrate

The combined data clearly illustrates that UC-05 had the highest median value of all sites and was well above the overall group median (all years, all sites), while UC-01, UC-03, UC-06, and UC-07 had the lowest medians and were below the group median. The group median was well below the EPA P25 Value (Figure 36). The individual site medians and almost all values were also below the EPA criterion. UC-01 had the most values below the P25 criterion, while UC-05 had some values (other than outliers) above the criterion.

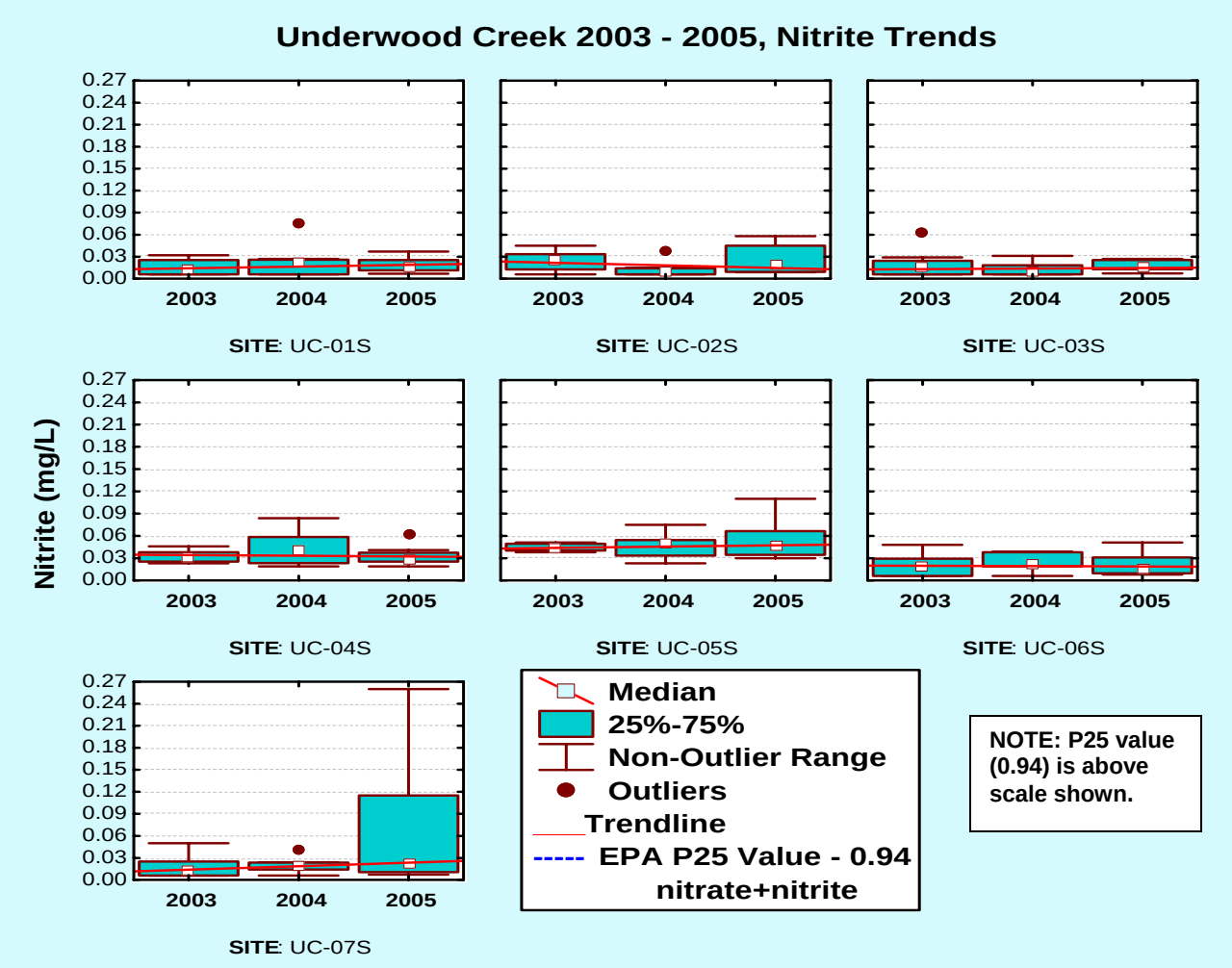


Figure 37: Nitrite Trends, Underwood Creek, 2003 - 2005

100% of the nitrite values (Figures 37, 38) were well below the EPA P25 value at all Underwood Creek sites. A discernible trend was not displayed at any site, with site specific median values throughout the three year period remaining generally steady. UC-04 and UC-05 had median values generally at or above 0.03 mg/L while the other Underwood Creek sites were generally below 0.03 mg/L. UC-07 in the year 2005 showed the greatest variability in its' data.

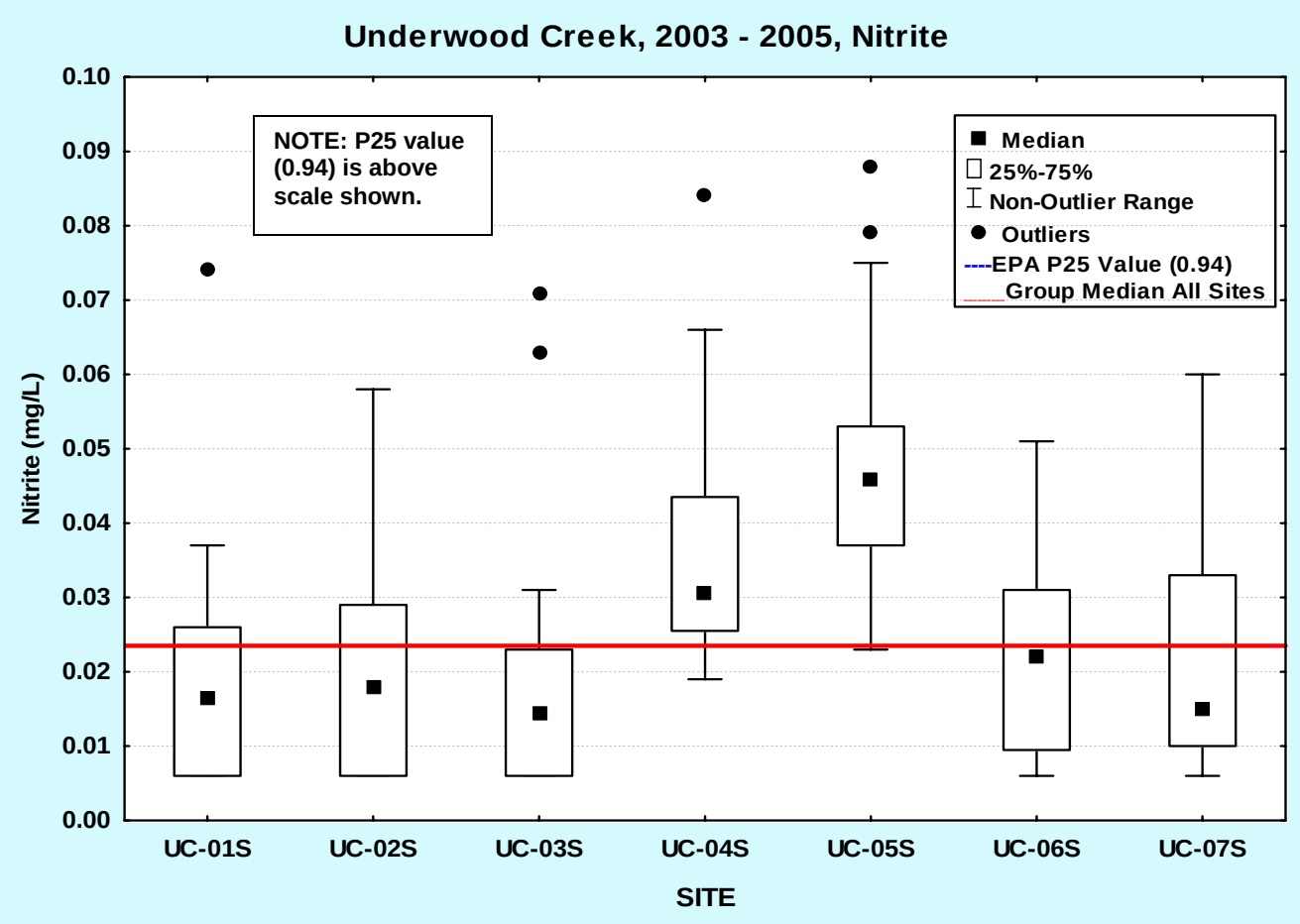


Figure 38: Underwood Creek, 2003 – 2005, Nitrite

Again, the combined data clearly illustrates that UC-05 had the highest median value of all sites and was well above the overall group median (all years, all sites). UC-04 was also above the group median. UC-01, UC-02, UC-03, UC-06, and UC-07 were all below the group median value. UC-03 and UC-07 had the lowest median values. The group median was well below the EPA P25 Value (Figures 37, 38).

Water Quality Trends – Specific Conductance

Specific conductance is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water. The principal inorganic anions (negatively charged ions) dissolved in fresh water include the carbonates, chlorides, sulfates, and nitrates; the principal cations (positively charged ions) are sodium, potassium, calcium, and magnesium (USEPA 2002, Stormwater Effects Handbook). Pure water, such as distilled water, will have a very low specific conductance, and sea water will have a high specific conductance. Rainwater often dissolves airborne gasses and dust while it is in the air, and thus often has a higher conductance than distilled water (USGS 2006, Water Science for Schools) Specific conductance can be used as a pollutant tracer and is helpful in monitoring

changes to the chemical makeup of the water column. Conductance measurements provide an indication of water ion and dissolved solids concentrations. A water quality standard, criterion, or maximum was not used for comparison with this data.

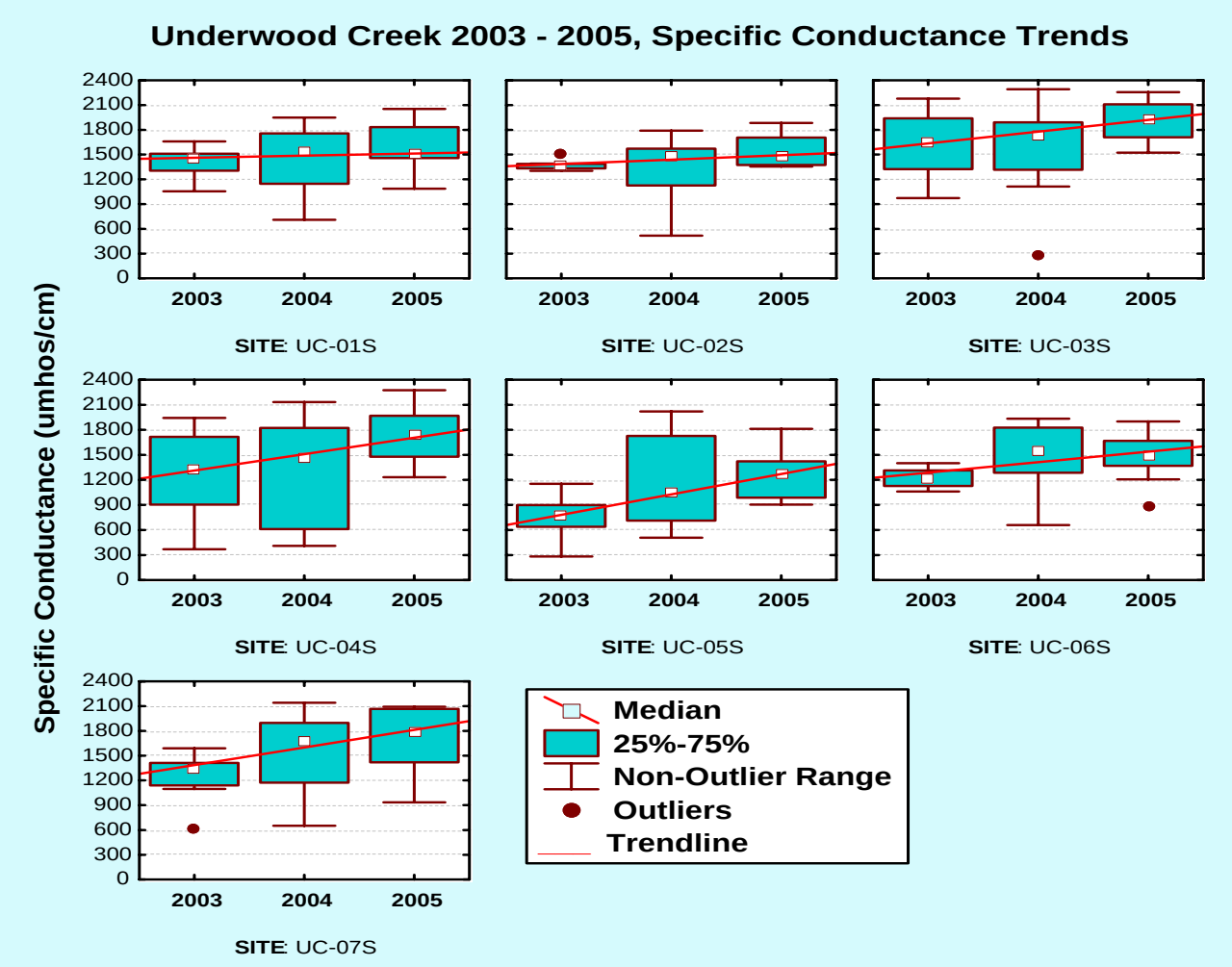


Figure 39: Specific Conductance Trends, Underwood Creek, 2003 - 2005

UC-03 had the highest median specific conductance (Figures 39, 40) while UC-05 had the lowest median. UC-03 lies on the mainstem of Underwood Creek, just before its confluence with the south branch of the creek. It is possible that the high specific conductance levels at this site are indicative of the total accumulation of pollutant loading on the creek to this point. The creek could reasonably be expected to contain higher concentrations of various ions that could be measured by specific conductance. The lowest median at UC-05 could be influenced by the Milwaukee County Zoo's Lake Evinrude outfall located immediately above the sampling point at this site; which basically serves as a stormwater detention pond and also may contain cooling water. Lake water and stormwater generally have lower specific conductance values than creek/river water. WDNR (2003-2004) reported specific conductance values generally around

500 umhos (WDNR 2008). All sites except UC-01 and UC-02 show a fairly steep increasing trend in regard to conductance values.

All of the sites are located near to or next to major roadways and all lie in urbanized areas (increased impervious surface). Road run-off could potentially contribute substances that might increase conductance at these sites. The impact of run-off on specific conductance would be dependent on the volume of water entering the creek and how concentrated the substances are (for example, road salt). Precipitation is another factor that can affect specific conductance. While the initial runoff during a rain event may contain substances that increase conductivity, it is not unusual to see conductance values temporarily drop during a rain event.

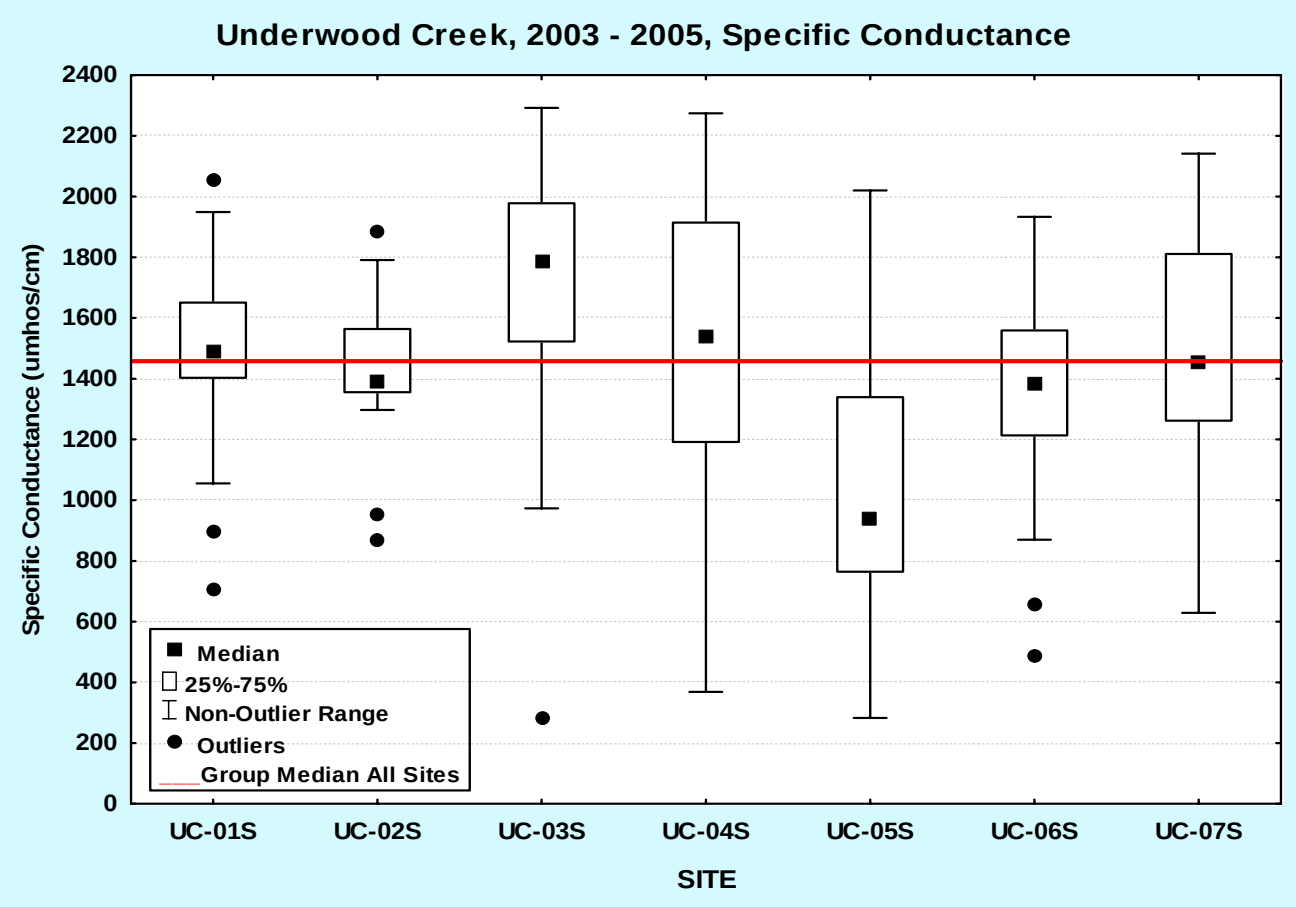


Figure 40: Underwood Creek, 2003 – 2005, Specific Conductance

The combined data clearly illustrates that UC-03 had the highest median value of all sites and was well above the overall group median (all years, all sites). UC-04 and UC-01 were also above the group median. UC-02, UC-05, UC-06, and UC-07 were all at or below the group median value.

Water Quality Trends – Chloride

Chlorides, one of many dissolved ions found in surface water, have electrochemical and catalytic functions in both plant and animal metabolic processes. Chloride may get into surface water from several sources including: rocks containing chlorides; agricultural runoff; wastewater from industries; water softeners; wastewater treatment plant effluent; and road salting. Chloride inputs from road salting are of particular concern in this area and seasonal data have shown generally higher chloride values occurring in the winter months (USGS 2007). The USGS (2007) had noted a positive relationship between chlorides and increasing urban land use in the southeastern Wisconsin area. Chlorides can corrode metals, affect the taste of food products, (Iowa 2003) and contaminate freshwater streams and lakes. Freshwater fish and aquatic communities cannot survive in high levels of chlorides. Excessively high concentrations of chloride can cause osmotic shock in freshwater organisms. They also serve as a good tracer of water quality. The State Water Quality Criteria for chlorides are 757 mg/L for the Acute Criteria and 395 mg/L for the Chronic Criteria (WDNR 2000).

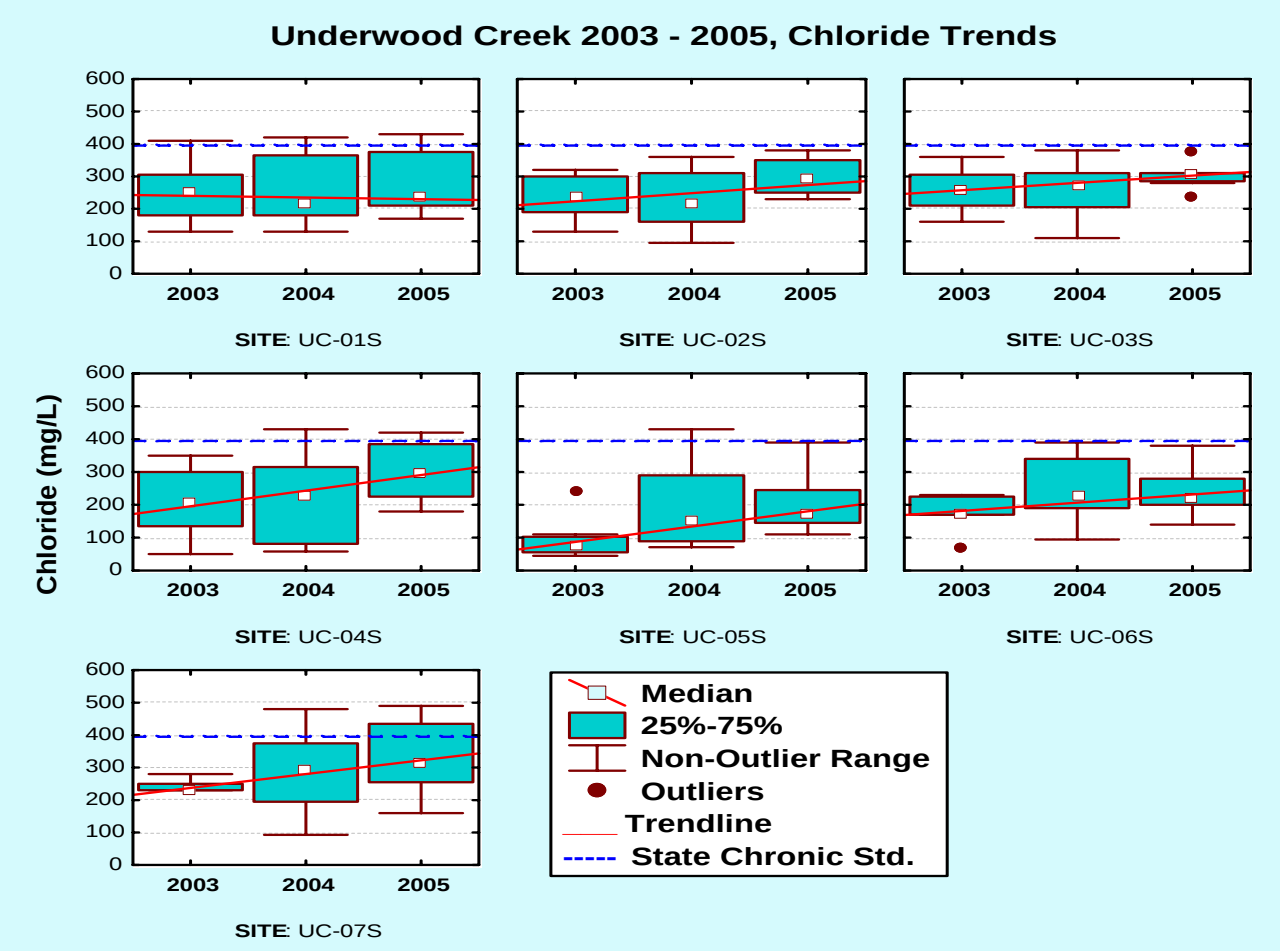


Figure 41: Chloride Trends, Underwood Creek, 2003 - 2005

Most of the chloride values in Underwood Creek (all sites) fell below the chronic value of 395 mg/L throughout the three-year sampling period (Figures 41, 42). Median and generally the

majority of values were the highest at UC-03 and UC-07. The lowest median and generally lowest chlorides were found at UC-05. Trends are increasing at all Underwood Creek sites except UC-01 which exhibited a steady trend. The chloride data supports the rising specific conductance trends seen in the creek and generally supports the conductivity data overall.

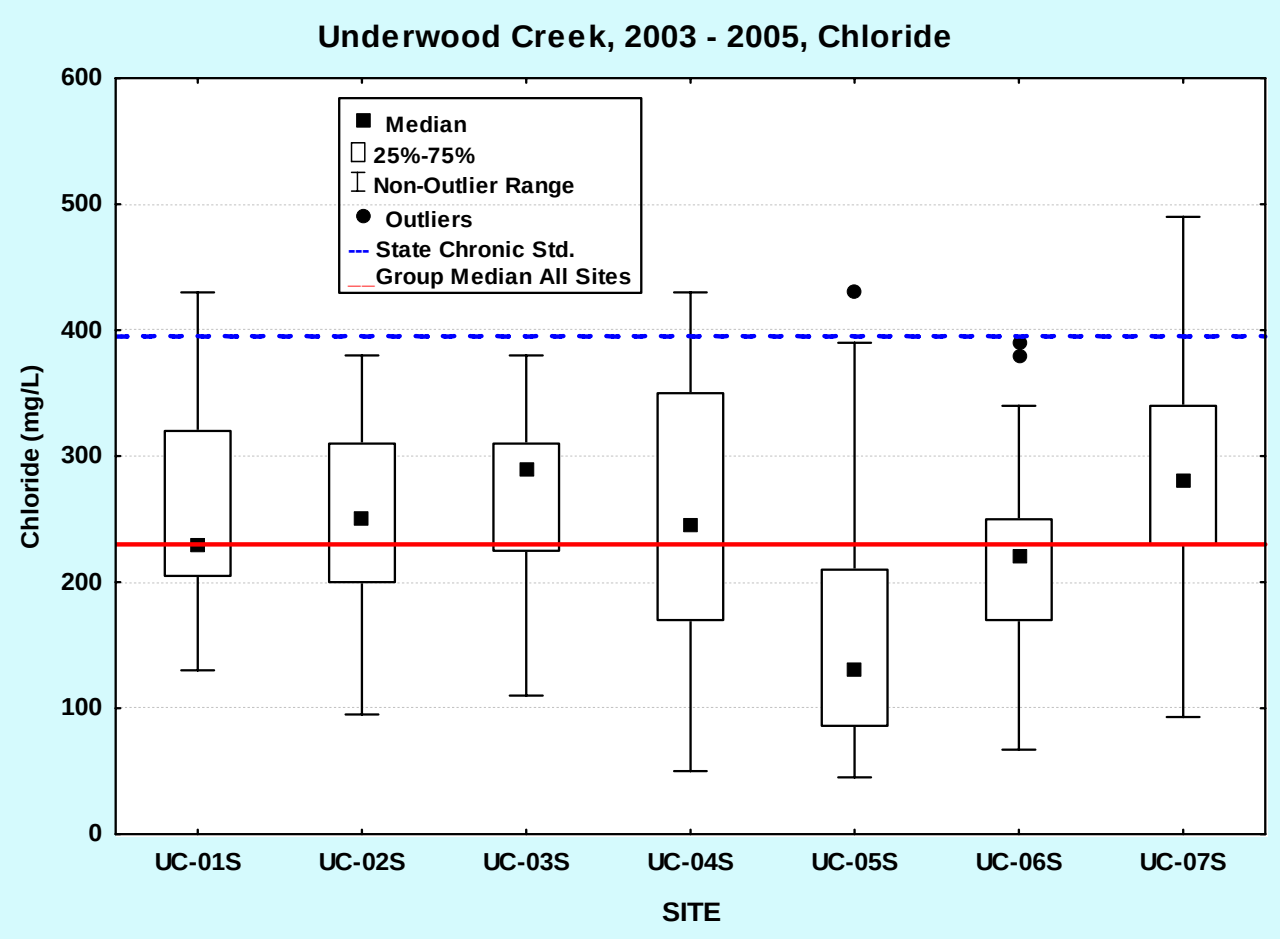


Figure 42: Underwood Creek, 2003 – 2005, Chloride
State Chronic Standard = 395 mg/L

The combined data clearly illustrates that the majority of chloride values were below the State Chronic Standard of 395 mg/L and that UC-03 had the highest median value of all sites, followed by UC-07. Again, this could be indicative of accruing pollutant loading to Underwood Creek. UC-03 and UC-07 were well above the overall group median (all years, all sites). UC-02 and UC-04 were also above the group median. UC-01, UC-05, and UC-06 were all at or below the group median value with UC-05 being well below the group median and State Chronic Standard. As previously discussed, UC-05 is most likely influenced by the Lake Evinrude outfall. In the case of chlorides (as in specific conductance), the outfall water could be serving as a dilutional factor.

Water Quality Trends – Toxic Pollutants

Toxic pollutants are generally substances that may cause disease, birth defects, or death or may negatively affect reproduction, development, or disease resistance (UWEX 1995). The impacts of these chemicals are of environmental concern for both aquatic systems as well as human health.

Polycyclic Aromatic Hydrocarbons (PAH's)

Polycyclic Aromatic Hydrocarbons (PAH's) are formed from the incomplete combustion of fossil fuels and organic matter. There are more than 100 chemicals classified as PAH's. They are also a component of many petroleum products, creosote, asphalt, cigarette smoke, and vehicle exhaust. A majority of PAH's are considered carcinogenic and high concentrations in sediment are associated with high incidences of liver tumors in fish. Water quality standards or criteria were not available for comparison with this data.

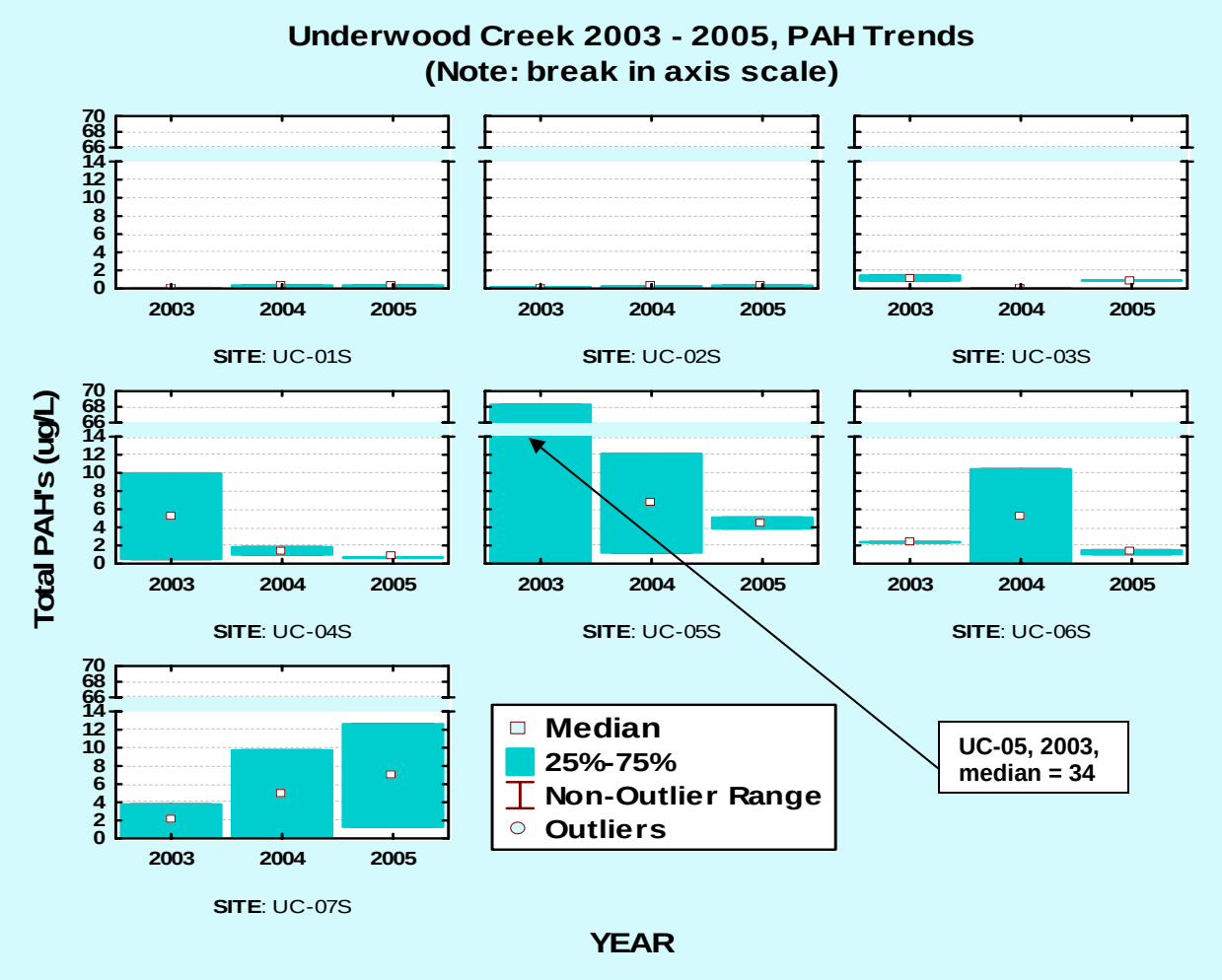


Figure 43: PAH Trends, Underwood Creek, 2003 - 2005

Each year represents two sample values from the two event samplings (event sampling described on page 16 – Sampling Schedule and Variables) therefore, caution should be utilized when examining data trends. All

values in each year for total PAH's at UC-01, UC-02, and UC-03 fall below 1 µg/L and the trendline for each of these sites is steady (Figure 43). The trend for UC-04, UC-05, and UC-06 is declining. The trend at UC-07 is increasing. The highest median occurs at UC-05 while the lowest occurs at UC-01 and UC-02. Caution should be taken in regard to all trends due to the very limited number of data points.

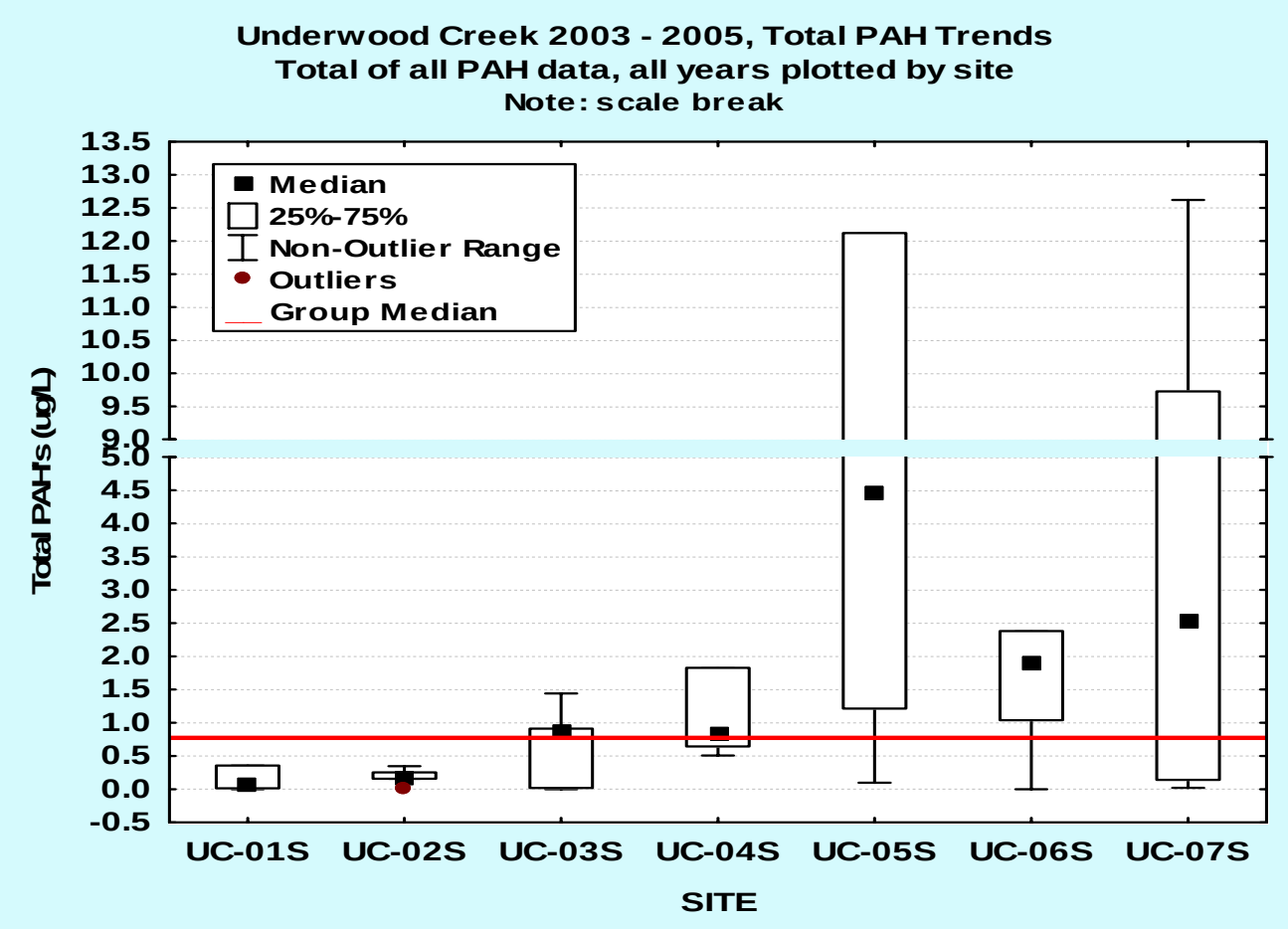


Figure 44: Total PAH Trends, Underwood Creek, 2003 - 2005

The combined data (Figure 44) shows that for all years examined, the lowest medians occurred at UC-01, UC-02, UC-03, UC-04, and UC-06 with UC-02 having the lowest median of all sites. The highest median occurred at UC-05 which also had the highest extreme value of all sites, followed by UC-07. UC-05 and UC-07 individual medians were well above the overall group median (all years, all sites). UC-03, UC-04 and UC-06 were also above the group median. UC-01 and UC-02 were below the group median value.

Additionally, wet event PAH's were compared to dry event data. Generally, PAH's were present in higher concentrations during wet events than during dry periods (again, caution should be exercised as this analysis was based upon only 3 wet data points and 3 dry data points). Whenever dry PAH values exceeded wet PAH values, it occurred in the year 2005. This is most likely due to rain that took place during the dry event sampling in 2005 (Appendix C – graph).

Mercury

Mercury is a highly toxic element that is found naturally and as an introduced contaminant in the environment (USGS 2000). Mercury can be released into the atmosphere from fuel combustion and industrial processes. It is also present in many fungicides, bactericides, paints, medical wastes, and paper products. Mercury enters the aquatic environment largely from atmospheric deposition but in some cities, scrap metal piles can be a significant source. According to USGS monitoring, scrap metal piles are the primary source of mercury in the area surrounding the Milwaukee harbor (UWEX 1995). Once in the surface water, mercury enters a complex cycle in which one form can be converted to another, of which methylmercury is the most toxic form (USGS 2000). Mercury can have acute and chronic toxic effects on aquatic organisms as well as humans. Some of these include damaging developing embryos and altering genetic and enzymatic systems (USGS 2000).

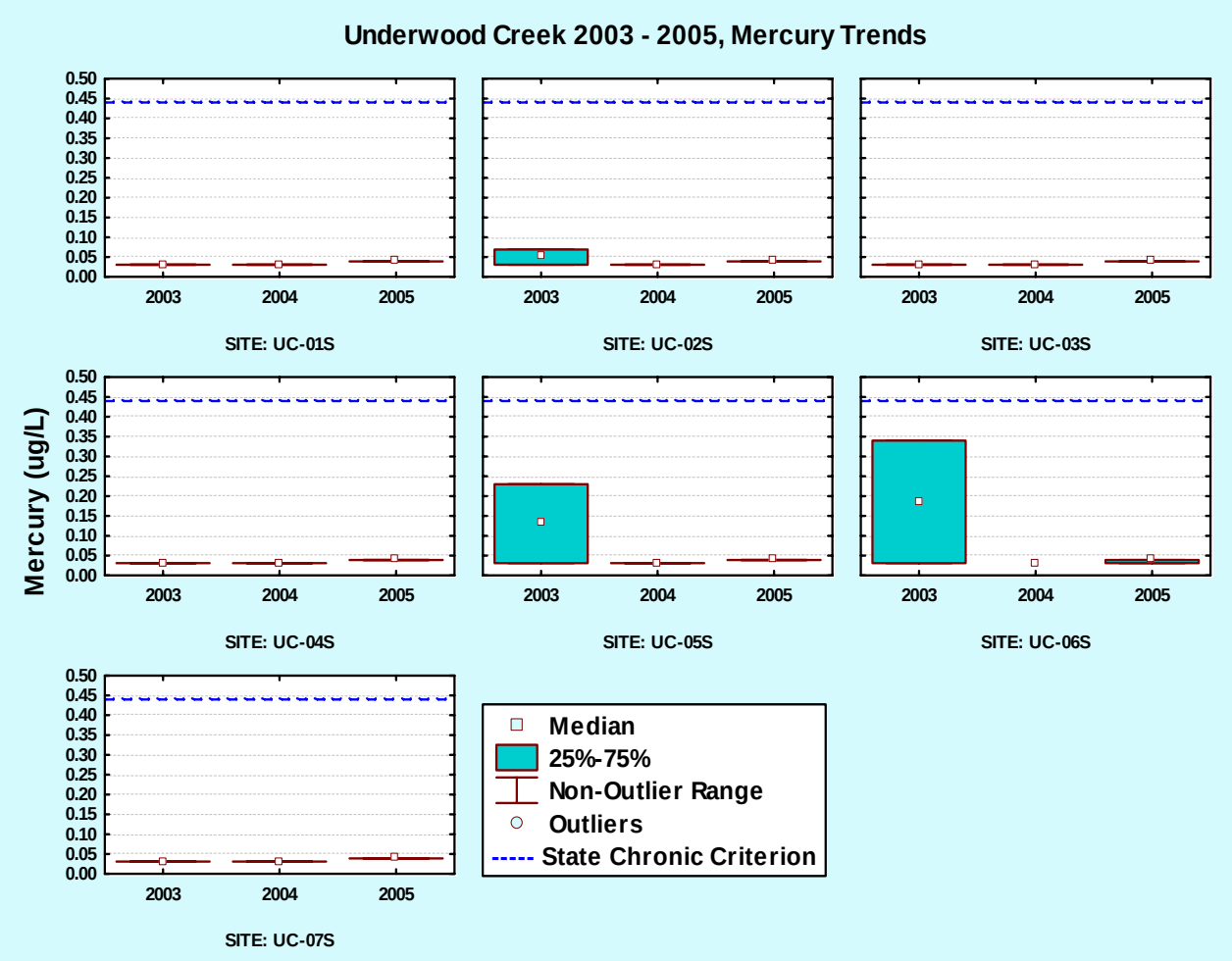


Figure 45: Mercury Trends, Underwood Creek, 2003 - 2005

The State Chronic Criterion (Limited Aquatic Life) value for mercury is 0.44 µg/L (WDNR 2000). Each year represents two sample values from the two event samplings (event sampling described on page 16 – Sampling Schedule and Variables) therefore, caution should be exercised when looking at any data trends. Mercury data for UC-01, UC-03, UC-04,

and UC-07 resulted in levels that were less than 0.05 µg/L and produced a flat trend (Figure 45). The data trend for UC-02 was also steady even though some mercury values were above 0.05 in 2003. UC-05 and UC-06 had mercury detected at higher values in 2003, mercury levels returned to less than 0.05 µg/L in 2004 and 2005. This resulted in a declining trendline at the two sites. All Underwood Creek sites displayed mercury levels below the State Chronic Criterion.

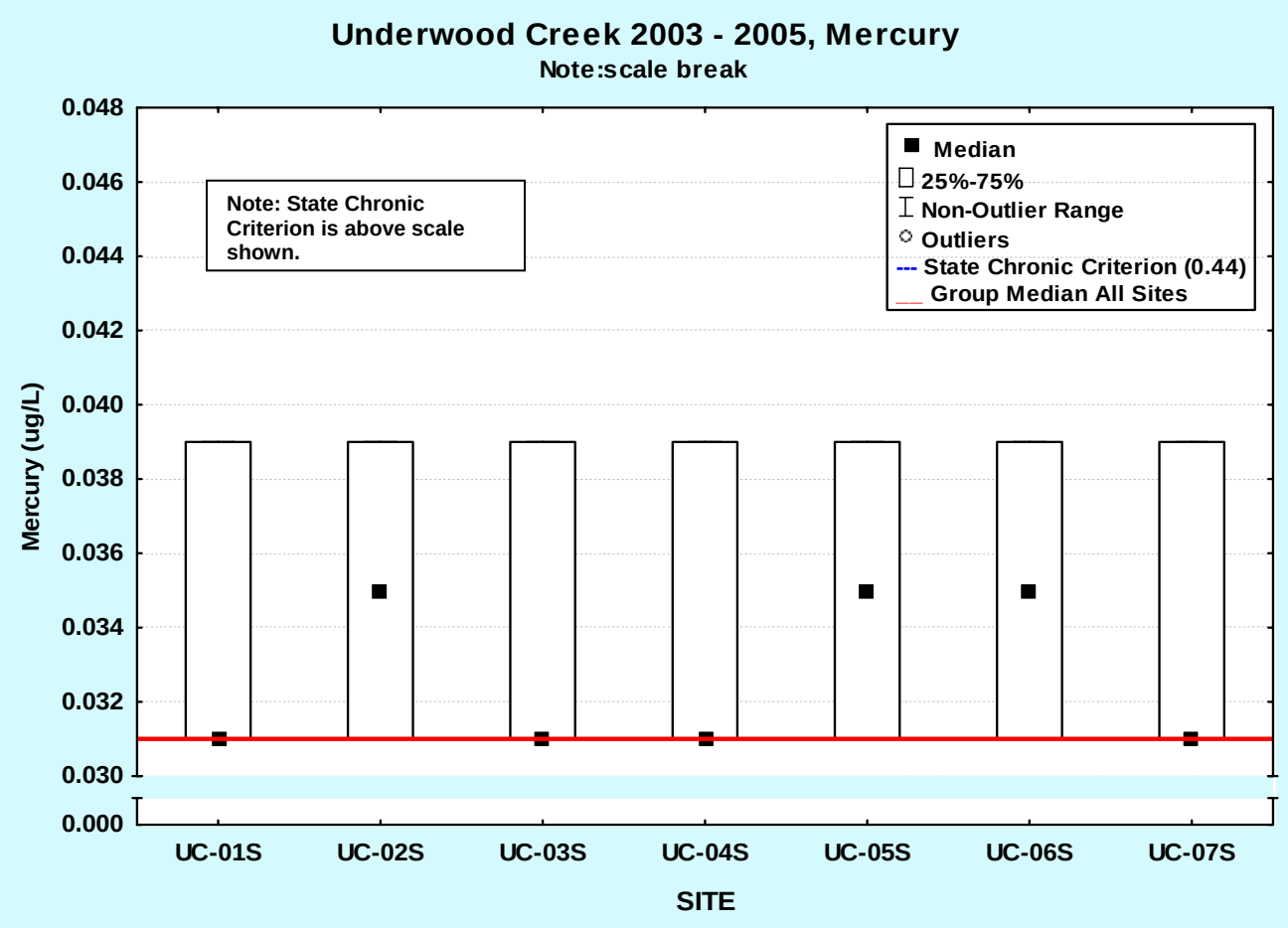


Figure 46: Underwood Creek, 2003 – 2005, Mercury

The combined data (Figure 46) again, clearly illustrates that all mercury values for the three year period examined were well below the State Chronic Criterion of 0.44 ug/L. UC-01, UC-03, UC-04, and UC-07 all exhibited medians that were at the group median (all data, all sites) while UC-02, UC-05, and UC-06 were above the group median.

Water Quality Trends – Heavy Metals

Heavy metals are natural components of all ecosystems and are essential trace elements for plants and animals. Human activities have increased the input of metals from land to water. Sources of metals include; urban runoff, scrap metal piles, emissions from burning coal and oil, municipal waste, paints, plated metals and wood that contain preservatives (UWEX 1995). In high concentrations, heavy metals including cadmium, chromium, nickel, copper, zinc, and lead are of environmental concern and can be moderately to highly toxic to plants, fish, and other aquatic organisms, as well as to humans. Heavy metals can display both chronic and acute toxicity. Some metals are known to be carcinogenic. Water hardness (specifically the ions causing hardness) can have a dramatic effect on water quality criteria and many of the heavy metal criteria depend on water hardness (EPA, Stormwater Effects Handbook). Hardness alleviates metals toxicity, because calcium and magnesium ions help keep fish from absorbing metals such as lead, arsenic, and cadmium into their bloodstream through their gills. The greater the hardness, the more difficult it is for toxic metals to be absorbed through the gills (USGS, General Information on Hardness).

It should be noted that the State of Wisconsin Discharge Permit for Surface Waters (Wisconsin Pollutant Discharge Elimination System Permit – WPDES) specifies that non-detected analytical results (value is below the method detection limit) should be recorded as a "0" value for purposes of calculating averages for discharge compliance reports. In order to maintain consistency among years of monitoring data and with permit specifications, the number "0" has been applied to all non-detected values for calculation purposes.

No heavy metals were shown to be toxic according to Wisconsin State Chronic Criteria. Copper, lead, zinc, cadmium, chromium, and nickel data are presented below (the criteria are based upon a hardness of 260).

NOTE: Each year represents only two sample values from the two event samplings (event sampling described on page 16 – Sampling Schedule and Variables) so caution should be exercised when examining any data trends.

Copper

Copper in the environment has its origins from natural as well as human sources. It is an abundant trace element found in the earth's crust and is a naturally occurring element that is generally present in surface waters (EPA 2007). Copper is a micronutrient for both plants and animals at low concentrations and is recognized as essential to virtually all plants and animals; however, it may become toxic to some forms of aquatic life at elevated concentrations (EPA 2007). Major cultural inputs of copper include preservative, industrial processes, pesticides, and corrosion of copper piping. Other anthropogenic sources with copper-bearing discharges include mining, leather and leather products, fabricated metal products, and electric equipment (EPA 2007). The Wisconsin State Surface Water Warm Water Chronic Criterion for copper is 27 µg/L.

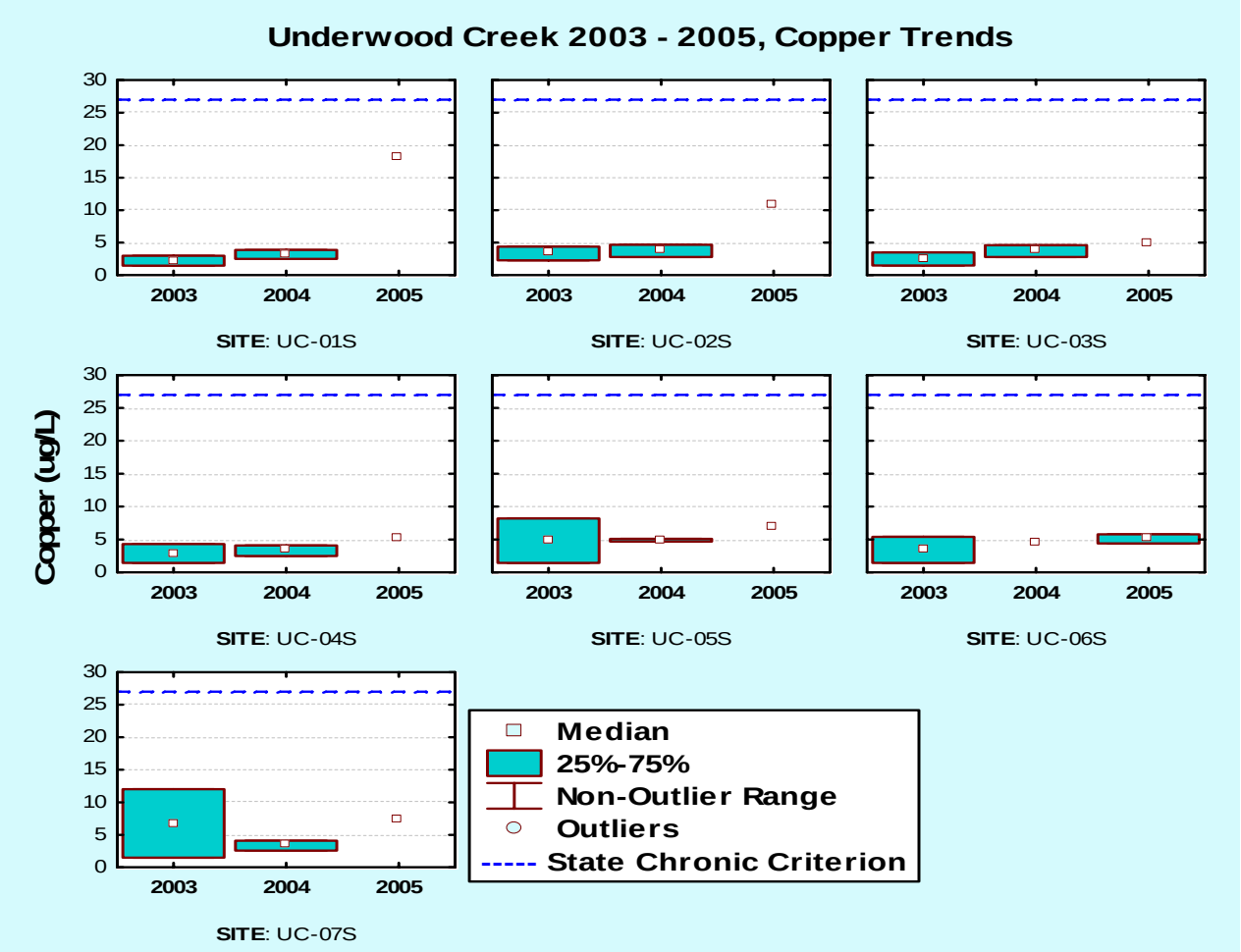


Figure 47: Copper Trends, Underwood Creek, 2003 - 2005

Copper data for the three-year sampling period on Underwood Creek were below the State Warm Water Chronic Criterion, without exception (Figure 47). Copper trends at UC-03, UC-04, UC-05, UC-06, and UC-07 were slightly increasing. Copper trends at UC-01 and UC-02 were sharply increasing due to the considerably higher values in the data set being achieved in 2005. These values were still well under the chronic criterion. UC-05 exhibited the highest median values of all Underwood Creek sites, while UC-01 had the lowest median copper values of all sites. Overall, the year 2005 had the highest copper values and the year 2003 had the lowest copper values.

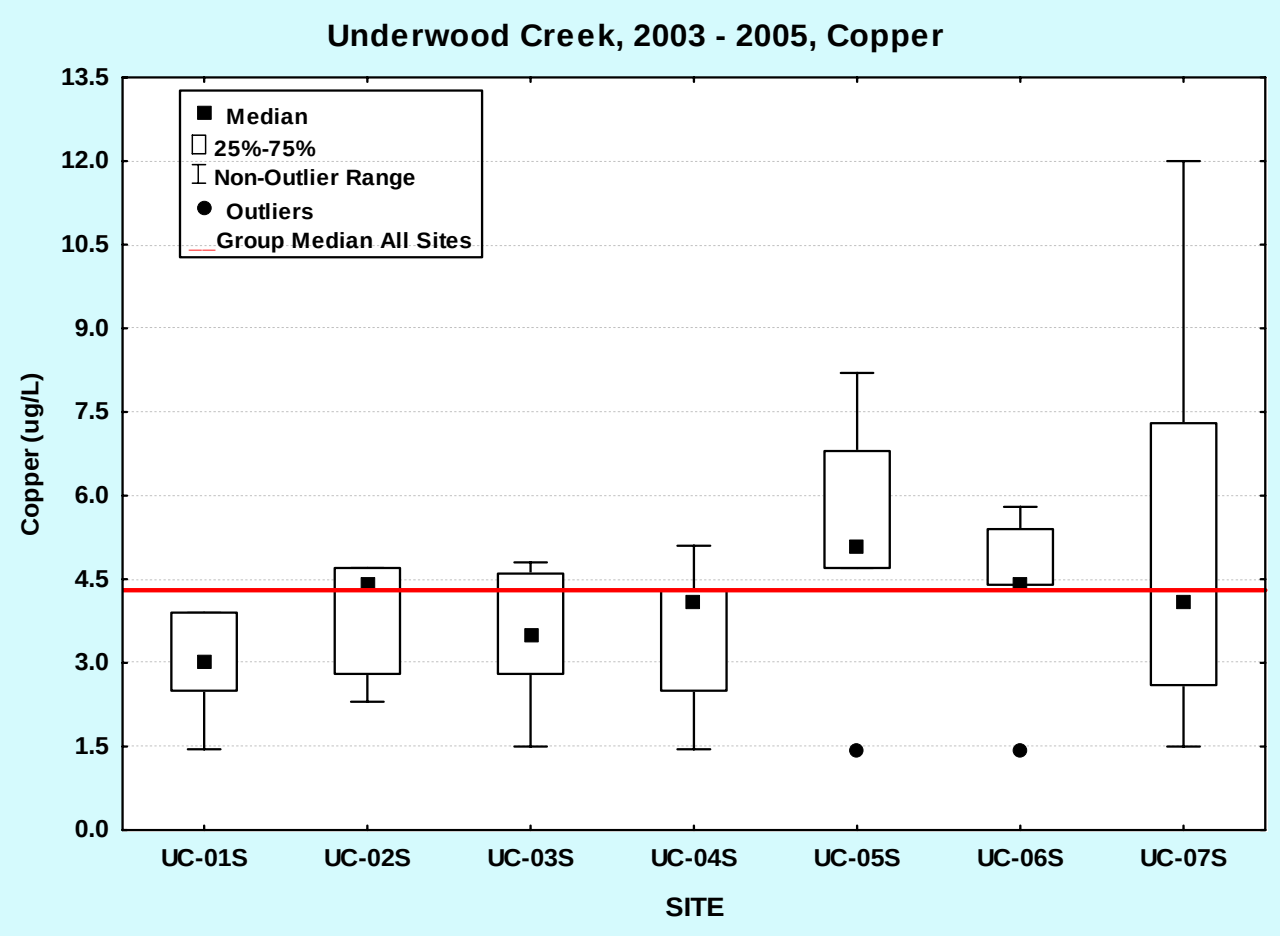


Figure 48: Underwood Creek, 2003 – 2005, Copper
State Chronic Criterion = 27 ug/L

The combined data (Figure 48) shows that for all years examined, the lowest medians occurred at UC-01, UC-03, and UC-04 with UC-01 having the lowest median of all sites. The highest median occurred at UC-05, followed by UC-06 and UC-02, which were above the overall group median (all years, all sites). UC-01, UC-03, UC-04, and UC-07 were below the group median value. All combined data were well below the Wisconsin State Warmwater Chronic Criterion of 27 ug/L.

Lead

Lead can occur naturally or as a result of human inputs. It has historically been used as an indicator for other toxic pollutants in urban stormwater (UWEX 1995). Lead is a human health concern as well as an aquatic life concern. Its human health effects include damage to the nervous system and kidneys, high blood pressure and digestive disorders (UWEX 1995). Precipitation, dry decomposition, the burning of coal and leaded gasoline, battery production, lead-based paints, industrial and domestic wastewater discharges, and urban runoff affect lead concentration levels. The Wisconsin State Warm Water Chronic Criterion for lead is 70 µg/L.

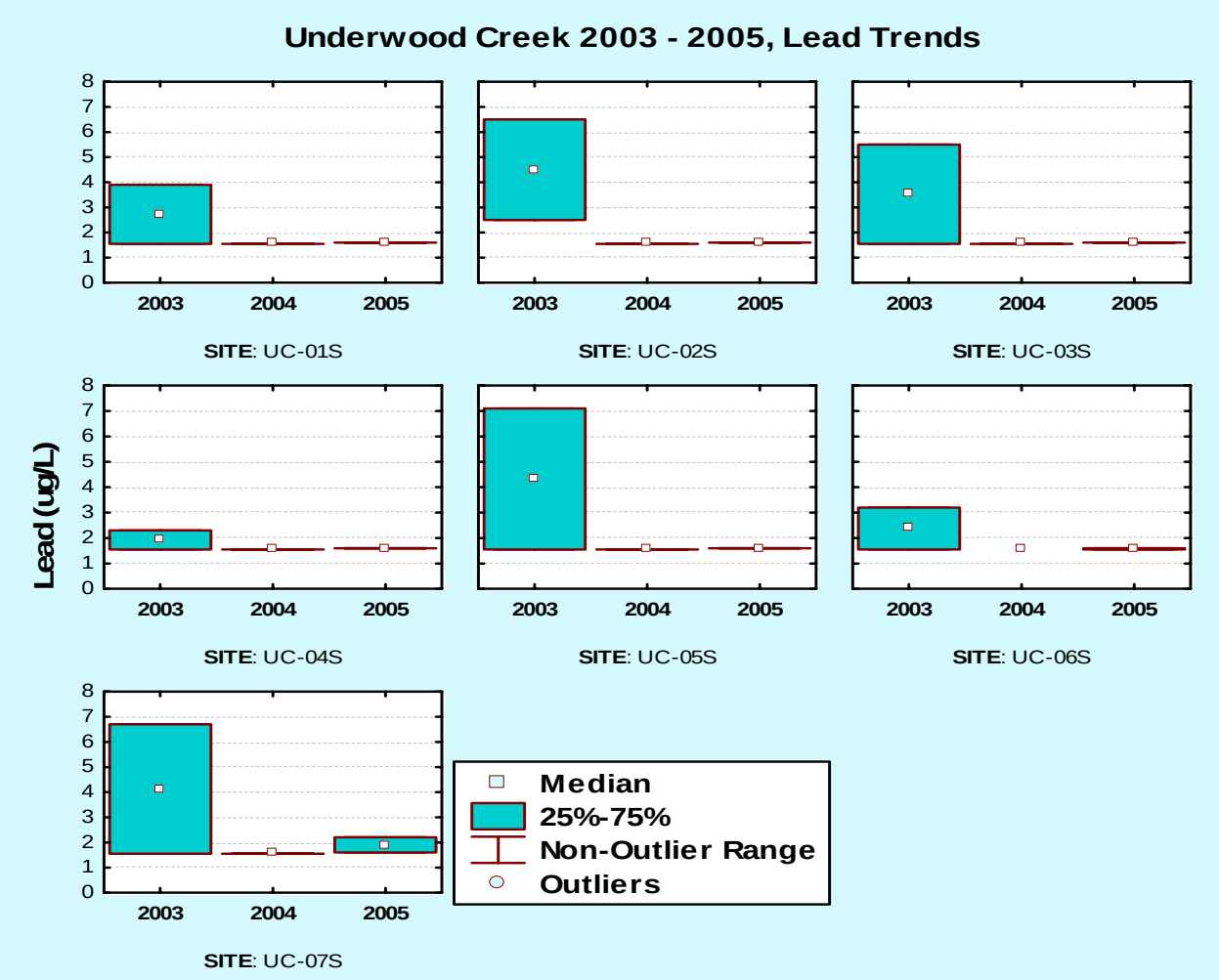


Figure 49: Lead Trends, Underwood Creek, 2003 - 2005

One hundred percent (100%) of the lead data on Underwood Creek for the three-year sampling period were well below the Wisconsin Warm Water Chronic Criterion (Figure 49). UC-04 had the lowest overall lead concentrations. UC-05, UC-07, and UC-02 had the highest overall lead concentrations, respectively. Overall, the year 2003 exhibited the highest median values while the year 2004 exhibited the lowest median values (note that 2005 values were very close to 2004). The trend at all sites was noticeably downward, except at UC-04 which displayed a slightly downward trend.

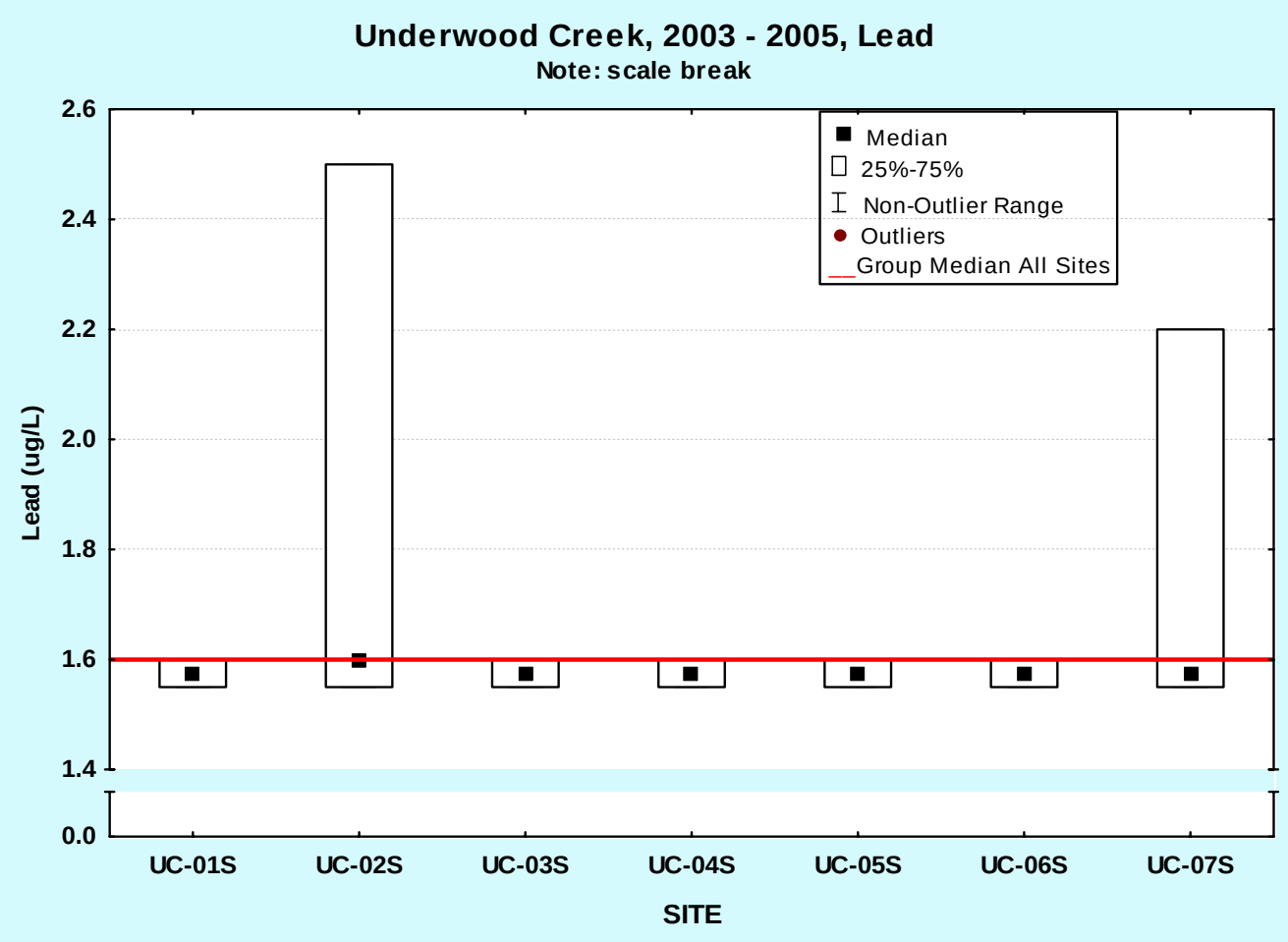


Figure 50: Underwood Creek, 2003 – 2005, Lead
State Chronic Criterion = 70 ug/L

The combined data (Figure 50) shows that the medians for all sites examined were virtually the same with UC-02 being slightly higher than the other sites. The individual site medians were below the group median except for UC-02 which was at the group median. All combined data were well below the Wisconsin State Warmwater Chronic Criterion of 70 ug/L.

Zinc

Zinc is fairly common in nature. Zinc typically does not create human health problems but it can be toxic to aquatic life (UWEX 1995). Industrial and cultural sources include galvanized pipes, brass, other alloys, rubber vulcanization, paints, cosmetics, drugs, fertilizers, and insecticides. Another primary source is vehicle traffic. Concentrations of zinc appear to be directly correlated with the volume of traffic on streets that drain into the storm sewer system (UWEX 1995). USGS (1998) hypothesized whether the increase in vehicular use (auto use outstripped population growth by 4 times) contributed to rising or steady zinc concentrations despite remedial steps taken in White Rock Lake (Texas). The hypothesized connection was attributed to automobile tires which contain zinc; each time the tire runs over the road, it leaves a residue of zinc that can

run off into streams and enter ground-water systems (USGS 1998). The Wisconsin State Surface Water Warm Water Chronic Criterion for zinc is 278 µg/L.

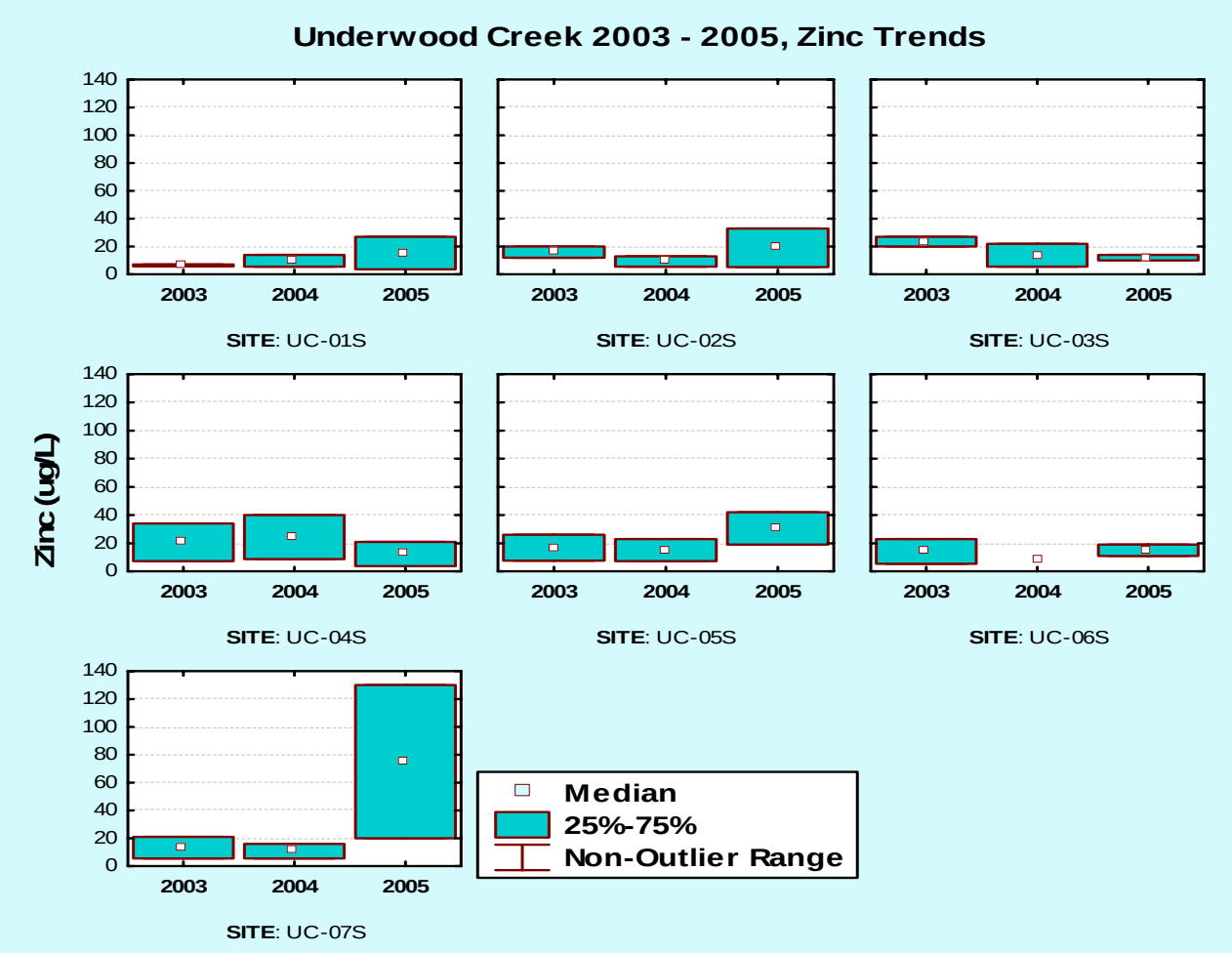


Figure 51: Zinc Trends, Underwood Creek, 2003 - 2005

Zinc data for the three-year sampling period on Underwood Creek were 100% below the State Warm Water Chronic Criterion and are presented above (Figure 51). Overall, the year 2005 exhibited the highest median values while the year 2004 exhibited the lowest median values. UC-06 had a flat trend for the three years examined, UC-01, UC-02, UC-05; and UC-07 displayed increasing trends; with the trendline at UC-07 showing an appreciable upward slope. The trendline at sites UC-03 and UC-04 was decreasing.

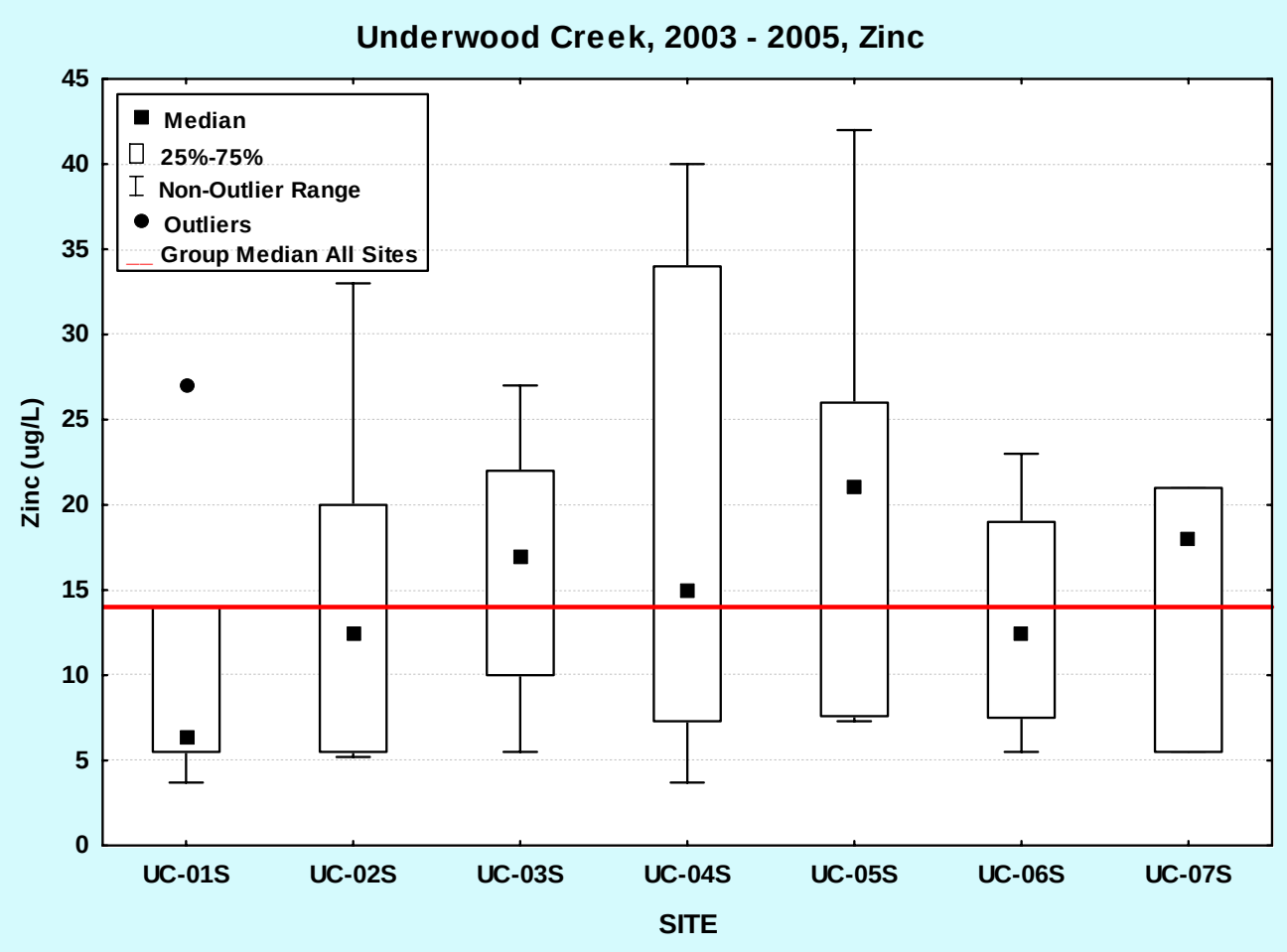


Figure 52: Underwood Creek, 2003 – 2005, Zinc
State Chronic Criterion = 278 ug/L

The combined data (Figure 52) shows that for all years studied, the lowest medians occurred at UC-01, UC-02, and UC-06 with UC-01 having the lowest median of all sites. The highest median occurred at UC-05, followed by UC-07, UC-03 and UC-04, which were above the overall group median (all years, all sites). UC-01, UC-02, and UC-06 were below the group median value. All combined data were well below the State Chronic Criterion of 278 ug/L.

Cadmium

Cadmium is found mainly in the earth's crust and commonly along with zinc and copper deposits. Cadmium is utilized mostly for electroplating and for nickel cadmium batteries, pigments (paint), coatings, stabilizers in plastics and synthetic products, and alloys (CCME 2002). Many of these uses tend to make the element available to water that comes into contact with wastes (Mebane 2006). Cadmium concentrations can become elevated in waters that are influenced by sources such as mining, minerals processing, and combustion of fossil fuel (Mebane 2006). Another source of cadmium is landfill leachate (CCME 2002); it can enter the atmosphere through vaporization at high temperatures in metallurgical processes and fossil fuel combustion (Mebane 2006). Cadmium can be directly released into drinking water from the corrosion of some galvanized plumbing and watermain pipe materials (CCME 2002).

Short-term exposure to cadmium above recommended levels can cause nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver damage, convulsions, shock and renal failure. Long-term exposure above guidelines can potentially cause emphysema, kidney and liver damage, and softening of the bones (CCME 2002). Cadmium is toxic to freshwater fish, invertebrates, and aquatic plants and it is most likely to settle to the bottom sediments where it can affect bottom dwelling aquatic life (CCME 2002). As with other heavy metals, toxicity is affected by water hardness.

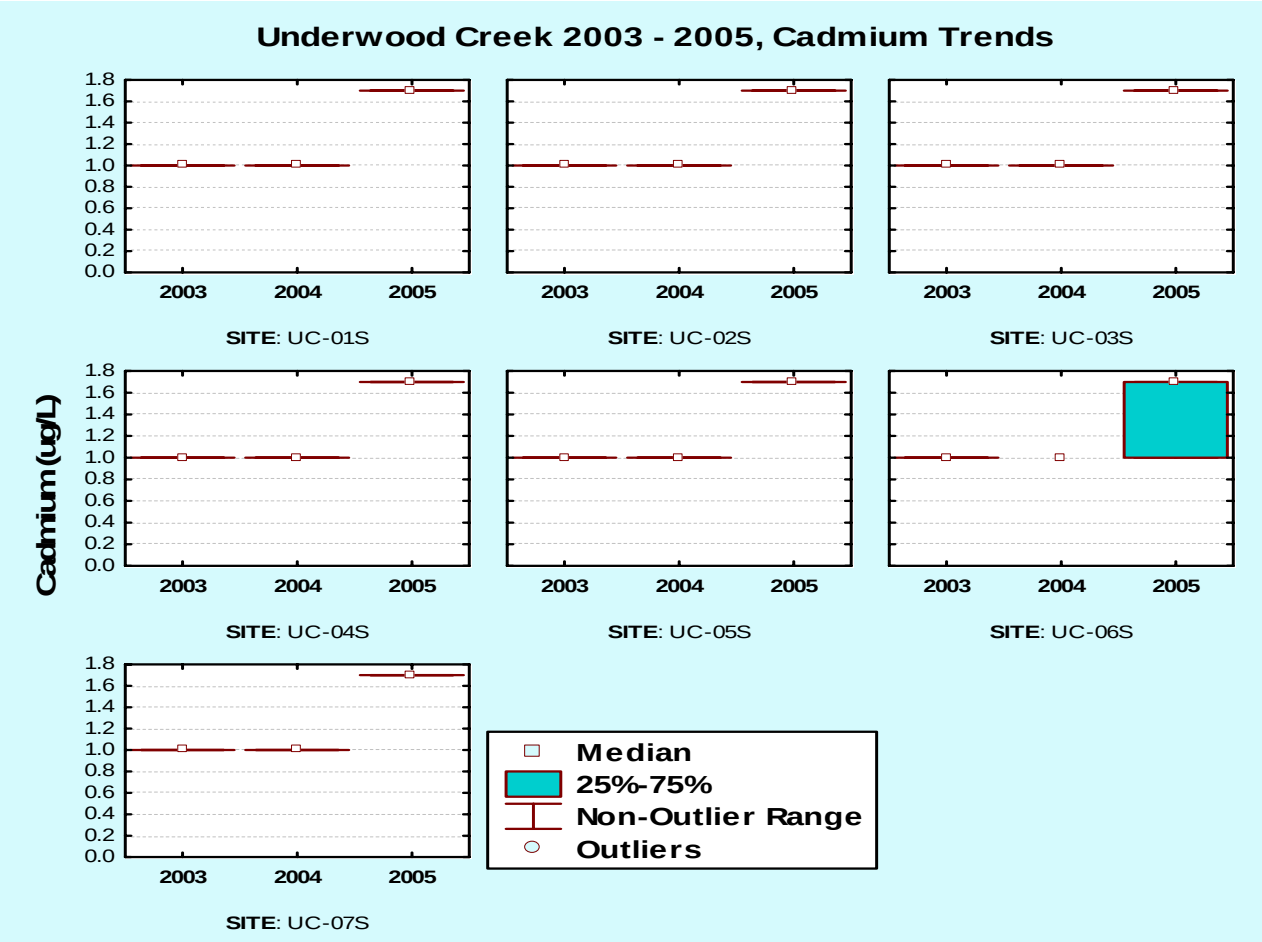


Figure 53: Cadmium Trends, Underwood Creek, 2003 - 2005

The State of Wisconsin Warm Water Chronic Criterion for cadmium is 5.2 µg/L. Cadmium values for the three-year sampling period on Underwood Creek were 100% below the State Warm Water Chronic Criterion and are presented above (Figure 53). Overall, the year 2005 exhibited the highest median values. The years 2003 and 2004 had identical median values. All Underwood Creek sites showed an increasing trendline due to the higher medians observed in 2005.

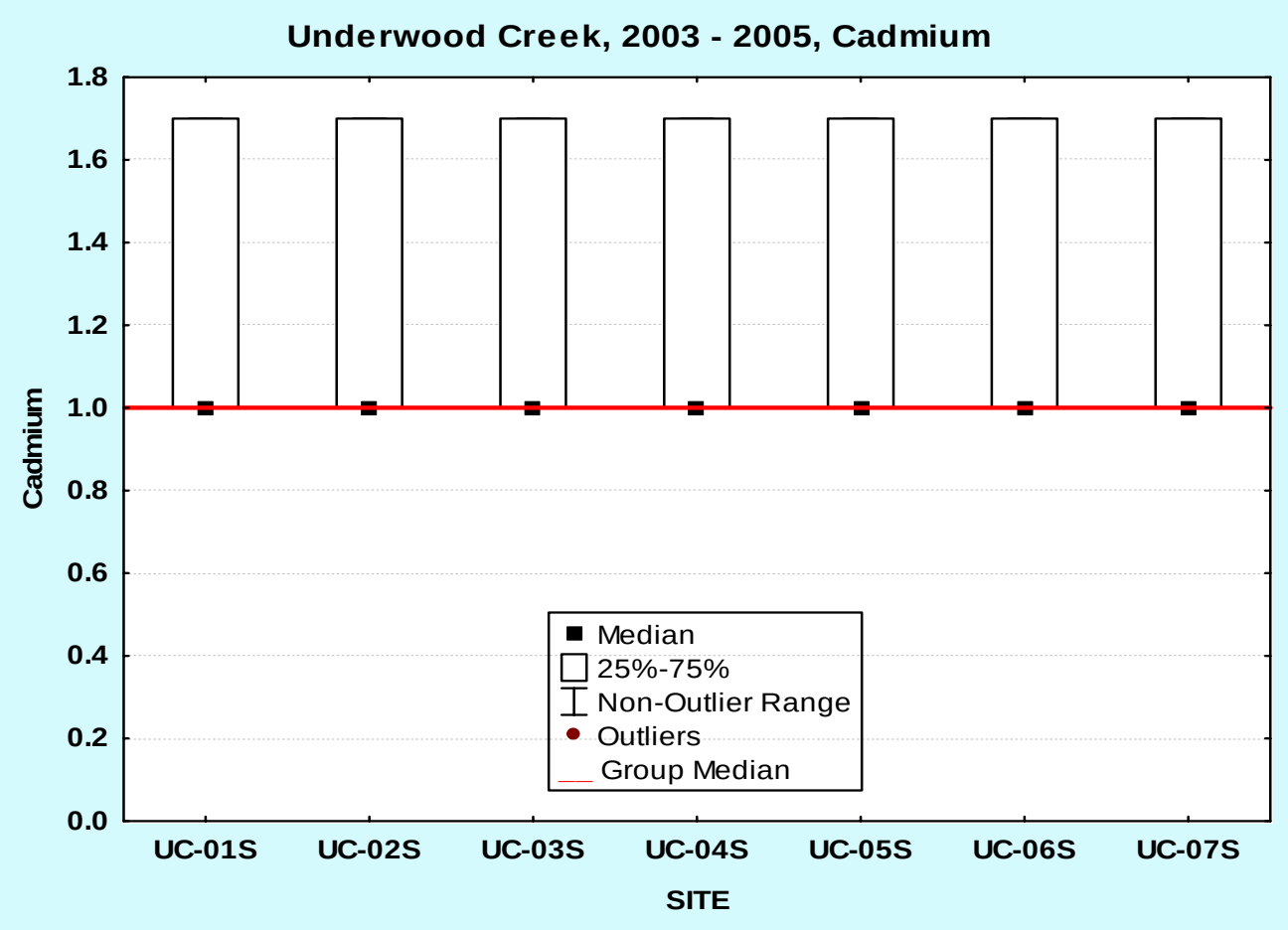


Figure 54: Underwood Creek, 2003 – 2005, Cadmium
State Chronic Criterion = 5.2 ug/L

The combined data (Figure 54) shows that the medians for all sites examined were the same. The individual site medians were at or equal to the group median. All combined data were well below the State Chronic Criterion of 5.2 ug/L.

Chromium

Chromium can exist in different valent forms (Cr^{-2} to Cr^{+6}) and occurs naturally and non-naturally. The most frequently occurring forms are trivalent (Cr^{+3}) and hexavalent (Cr^{+6}) chromium (NPS 1997). Cr^{+3} is naturally occurring and is essential for good health (WDHFS 2000). Cr^{+6} rarely occurs naturally (NPS 1997). Some major industrial sources include chromate pigments in dyes, paints, inks, and plastics; chromates added as anti-corrosive agents to paints, primers and other surface coatings; chrome plating; particles released during smelting of ferro-chromium ore; welding fumes from stainless steel or nonferrous chromium alloys; and impurities present in Portland cement (OSHA 2006). Cr^{+6} is the most toxic form causing lung cancer; irritation or damage to the nose, throat, and lung; irritation or damage to the eyes and skin; digestive problems; kidney damage; liver damage; immune system function; and reproductive effects (OSHA 2006). These health effects vary from person to person depending on exposure level and length, mode of exposure (inhalation, touch, oral), individual health, personal habits

(smoking, drinking), heredity, and previous exposure to chemicals including chromium and medicines (WDHFS 2000). Cr^{+6} has been associated with the following effects to aquatic life: gill damage, abnormal enzyme activity, altered blood chemistry, lower resistance to pathogenic organics, behavioral modifications, disrupted feeding, histopathology, osmoregulatory upset, alterations in populations structure and species diversity indices, and inhibition of photosynthesis (NPS 1997).

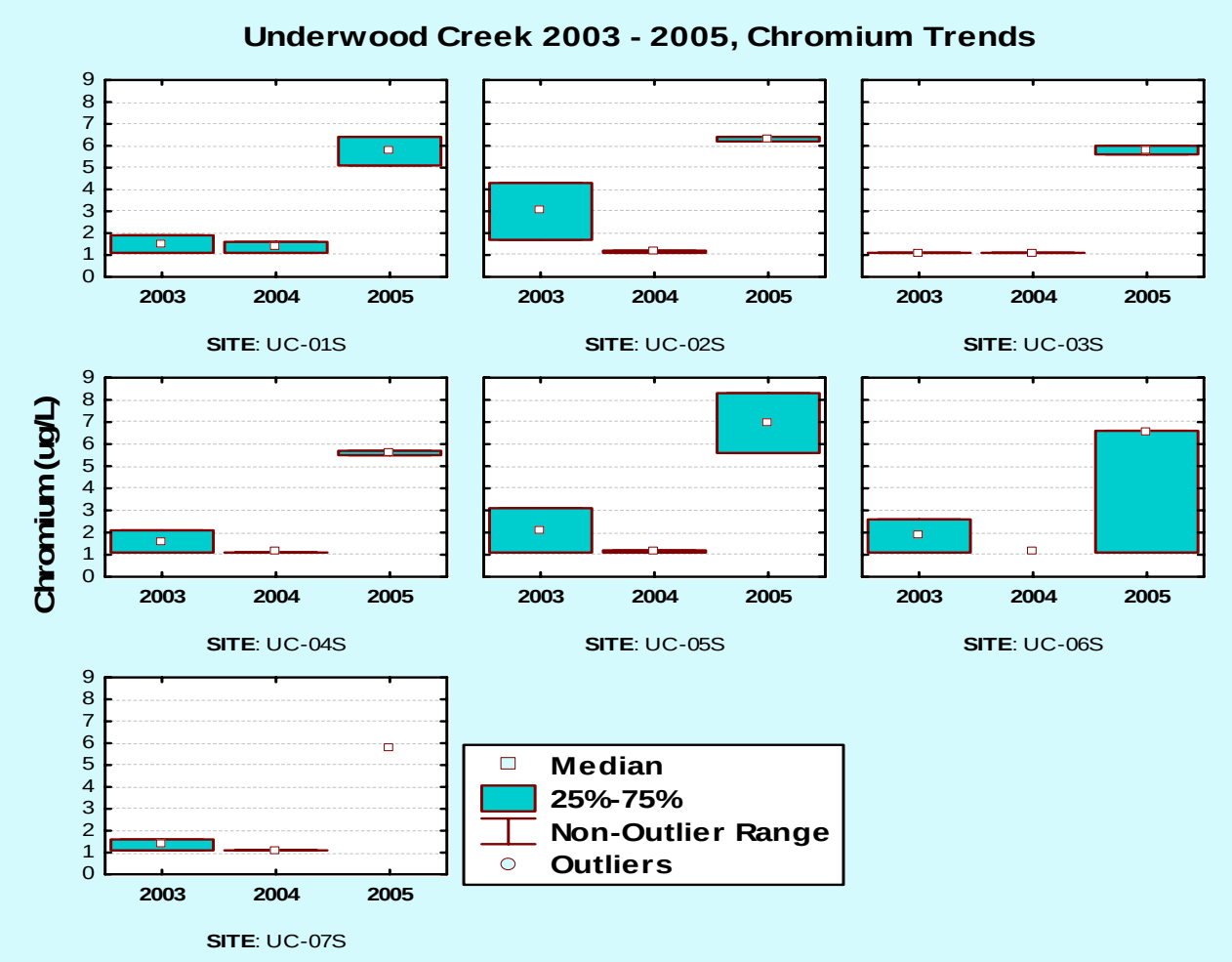


Figure 55: Chromium Trends, Underwood Creek, 2003 - 2005

The State of Wisconsin Warm Water Chronic Criterion for chromium is 288.96 (Cr^{+3}) and 10.98 (Cr^{+6}) µg/L. Chromium values for the three-year sampling period on Underwood Creek were 100% below the State Warm Water Chronic Criterion and are presented above (Figure 55).

Overall, the year 2005 exhibited the highest median values while the years 2003 and 2004 exhibited the much lower and similar median values. All Underwood Creek sites showed an increasing trend most likely due to the much higher median values exhibited in 2005 (in general 4 to 5 times higher than 2003 and 2004). It should be noted that machine (ICP) detection limits (MDL's) in 2005 were adjusted higher by the MMSD Central Laboratory. MDL's changed from 2.2 ug/L in 2003 and 2004 to 6.1 µg/L in 2005. Therefore due to the aforementioned limited data

(generally 2 data points per year, per site) and the adjusted MDL's, the higher median values noted in 2005 could be a technical artifact and not an environmental change. In general, half of the data fell at or below the MDL (UC 3, 4, and 7) and half displayed values above the MDL (UC 1, 2, 5 and 6).

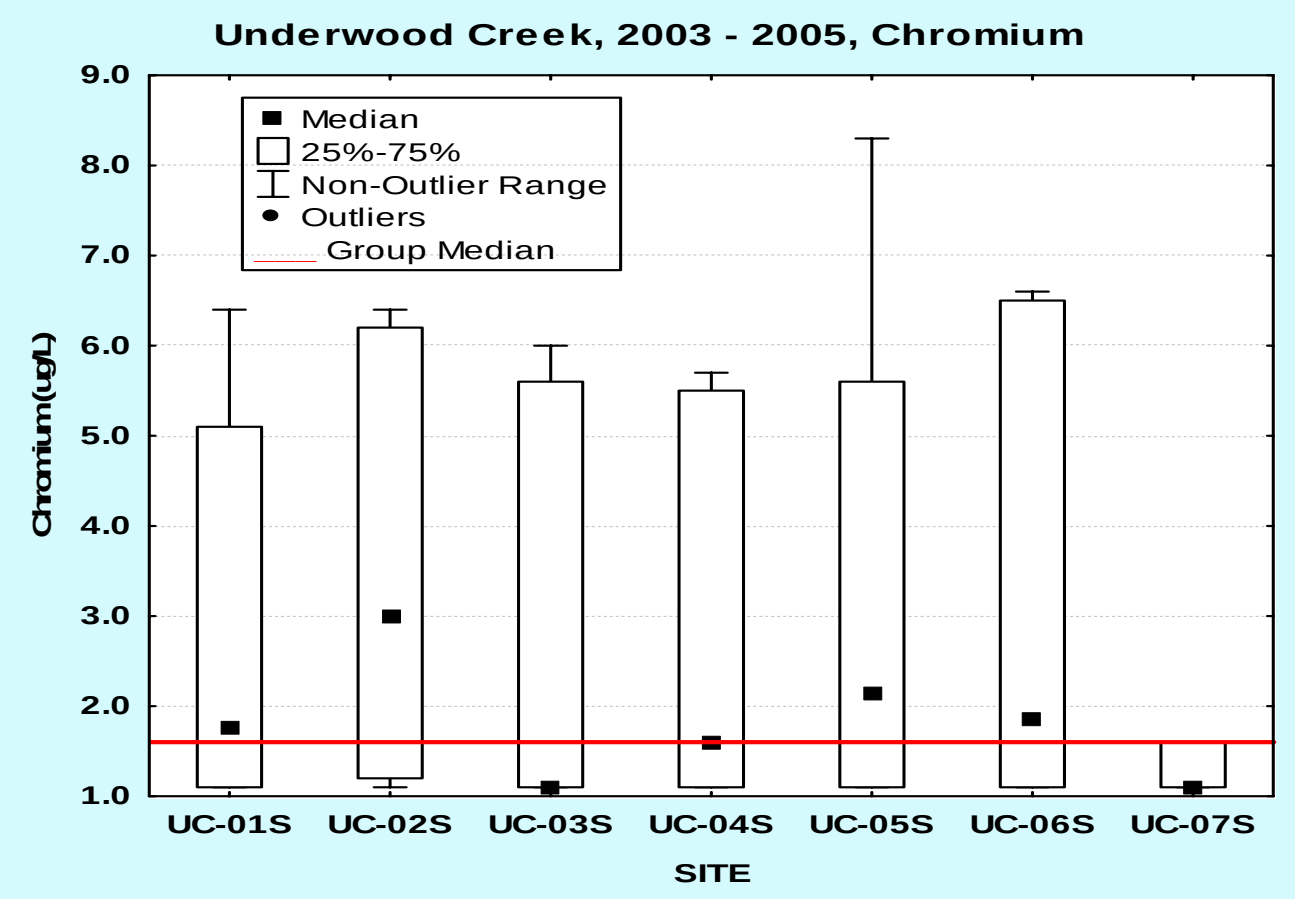


Figure 56: Underwood Creek, 2003 – 2005, Chromium
State Chronic Criterion = 288.96 (Cr^{+3}) and 10.98 (Cr^{+6}) µg/L

The combined data (Figure 56) shows that for all years studied, the lowest medians occurred at UC-03 and UC-07 with UC-03 having the lowest median of all sites. The median value at UC-03 was just slightly lower than the value at UC-07. The highest medians occurred at UC-02, followed by UC-05, UC-06 and UC-01, which were above the overall group median (all years, all sites). UC-03 and UC-07 were below the group median value. All combined data were well below the State Chronic Criterion of 288.96 (Cr^{+3}) and 10.98 (Cr^{+6}) µg/L.

Nickel

Nickel occurs naturally in the earth's crust, generally combined with other elements. Nickel is primarily utilized to produce alloys. Nickel is a primary component in stainless steel. Other uses include rechargeable batteries; coinage; foundry products; electroplating; catalysts; pigments in ceramics or paints. In general, the list of applications includes buildings and infrastructure,

chemical production, communications, energy supply, food preparation, water treatment and travel (NI 1998). Nickel enters the environment in a number ways; electroplating industries, fossil fuel burning power plants, trash incineration, from the production of alloys or nickel compounds (through the stack), released in wastewater (eco-usa.net 2007) or from vehicle related sources of roadway pollution (break linings, pavement material) (MRBP 2007). Nickel enters the aquatic environment through the weathering of rocks and as a result of human activities, primarily the burning of fossil fuels, street refuse and dust, industrial pollution, atmospheric fallout, and vehicle related sources (MRBP 2007).

The State of Wisconsin Warm Water Chronic Criterion for nickel is 426.3 µg/L. Nickel values for the three-year sampling period on Underwood Creek were 100% below the State Warm Water Chronic Criterion and are presented below (Figure 57).

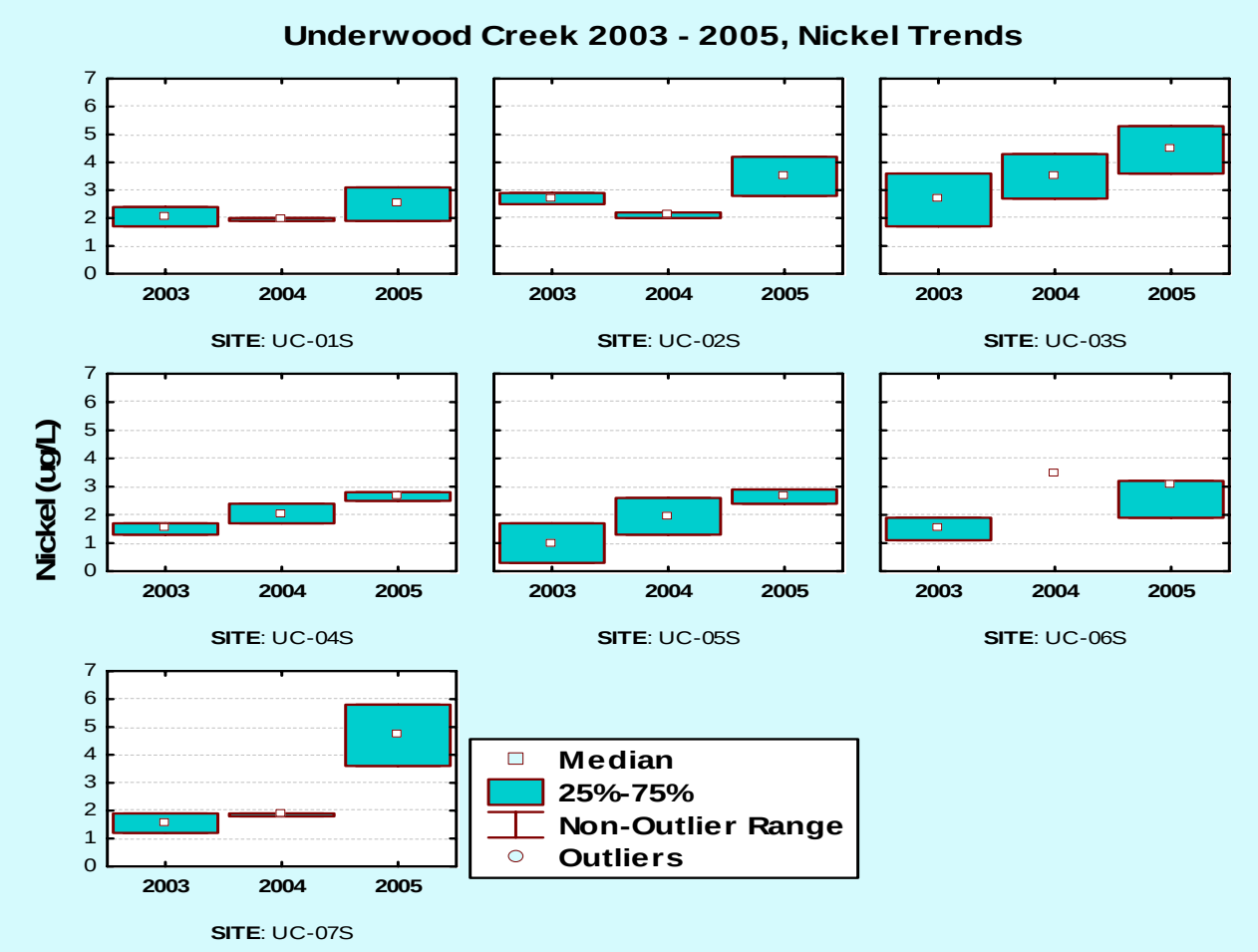


Figure 57: Nickel Trends, Underwood Creek, 2003 - 2005

In general, the year 2005 exhibited the highest median values and the year 2003 had the lowest median values. UC-06 was the only site that experienced a highest median value in a different year (2004). UC-02 was the only site that had a lowest median value in a year other then 2003, this occurred in 2004. All Underwood Creek sites showed an increasing trend most likely due to

the highest median values seen in 2005. The trendline slope at UC-01 and UC-02 was not as steep as seen at the other Underwood Creek sites.

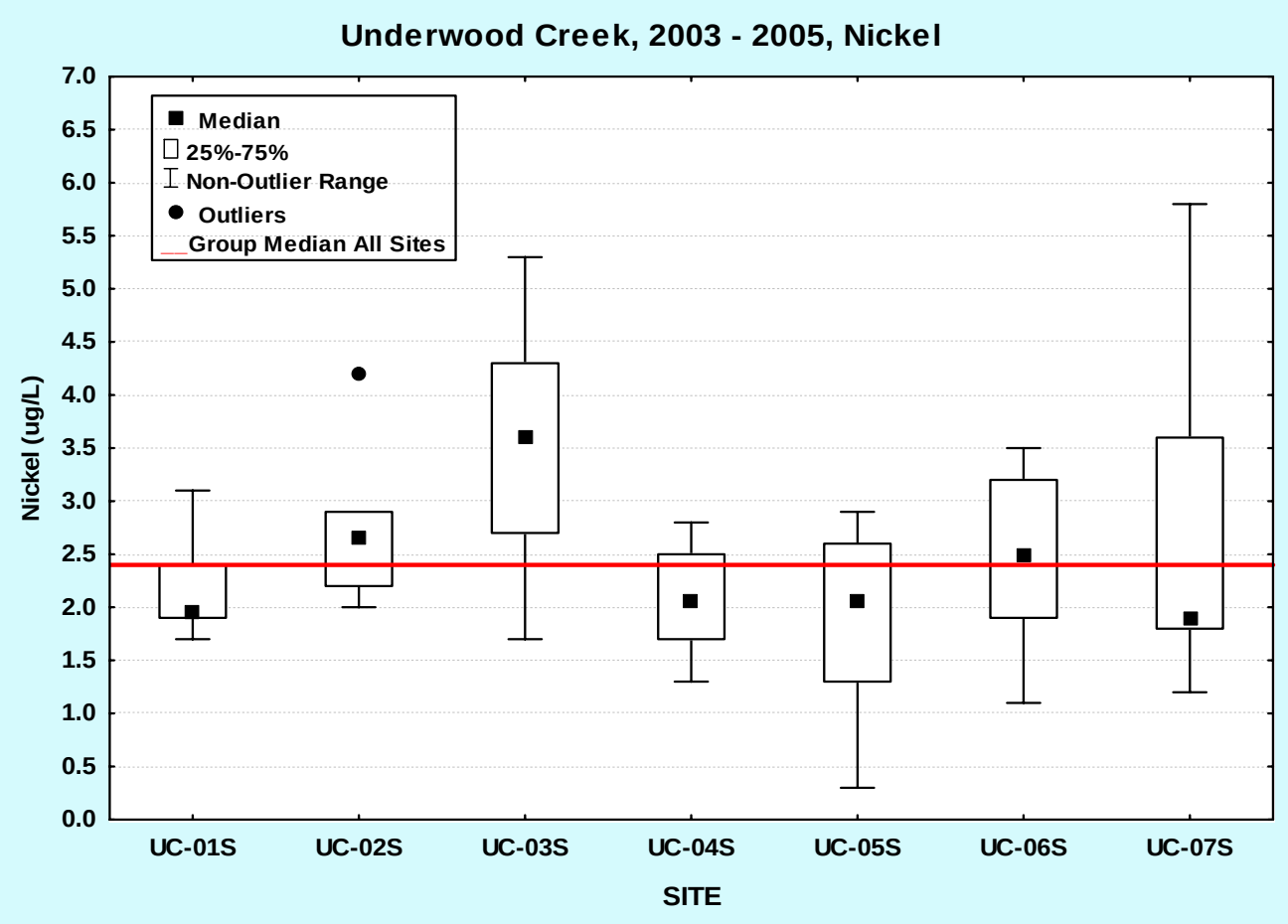


Figure 58: Underwood Creek, 2003 – 2005, Nickel
State Chronic Criterion = 426.3 ug/L

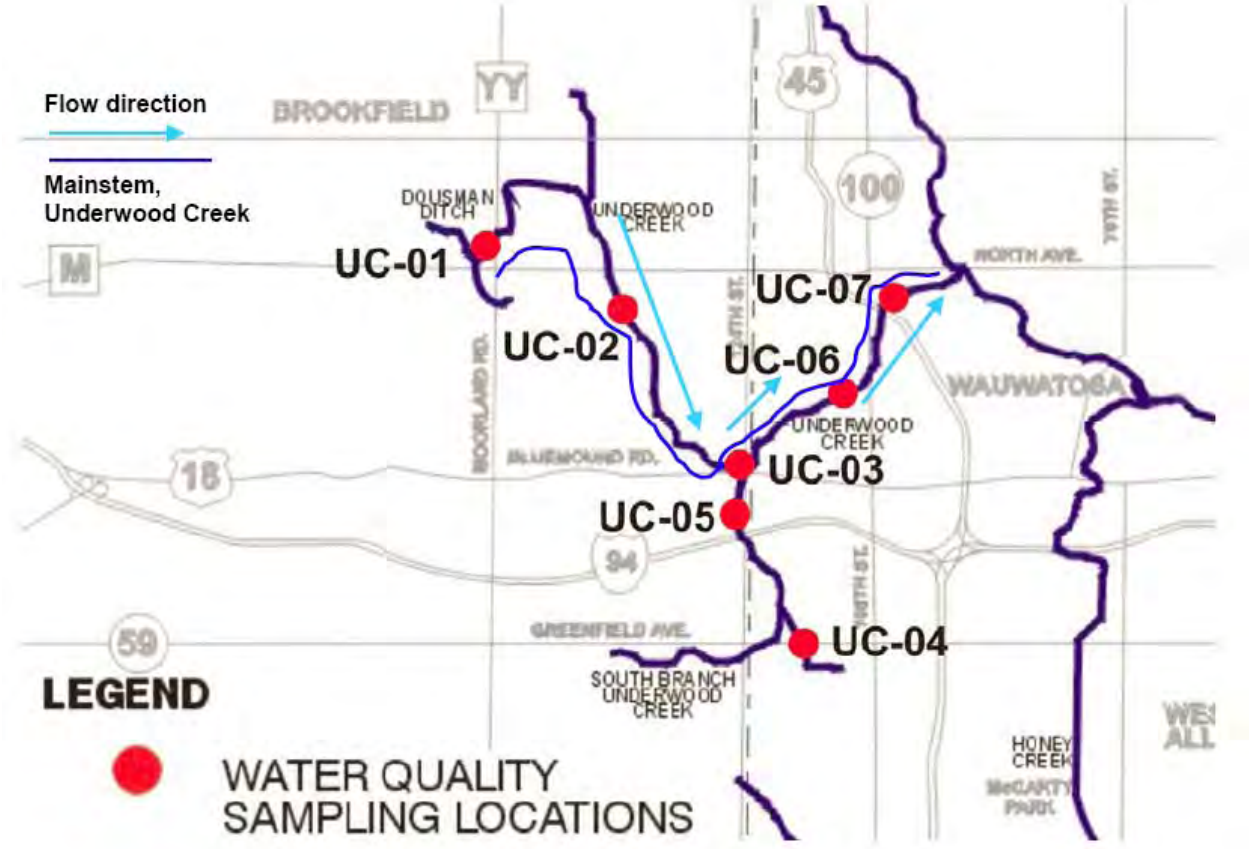
The combined data (Figure 58) shows that for all years studied, the lowest medians occurred at UC-01, UC-04, UC-05, and UC-07 which all had very similar median values with UC-07 having the lowest median of all sites. The highest median occurred at UC-03, followed by UC-02, and UC-06, which were above the overall group median (all years, all sites). UC-01, UC-04, UC-05, and UC-07 were below the group median value. All combined data were well below the State Chronic Criterion of 426.3 µg/L.

Summary

Underwood Creek is a small perennial stream that is tributary to the Menomonee River. Much of the creek has been channelized and diverted from its original course. The Underwood Creek subwatershed receives runoff from storms and is subject to flooding, consequently increasing the storm and flood water loading to the Menomonee River.

The Milwaukee Metropolitan Sewerage District (MMSD) and other governmental entities are working to reduce the risk of serious damage caused by flooding. The Underwood Creek Rehabilitation Project comprises a portion of a comprehensive approach for flood risk reduction by the MMSD and also seeks to improve habitat and ecological value to the creek.

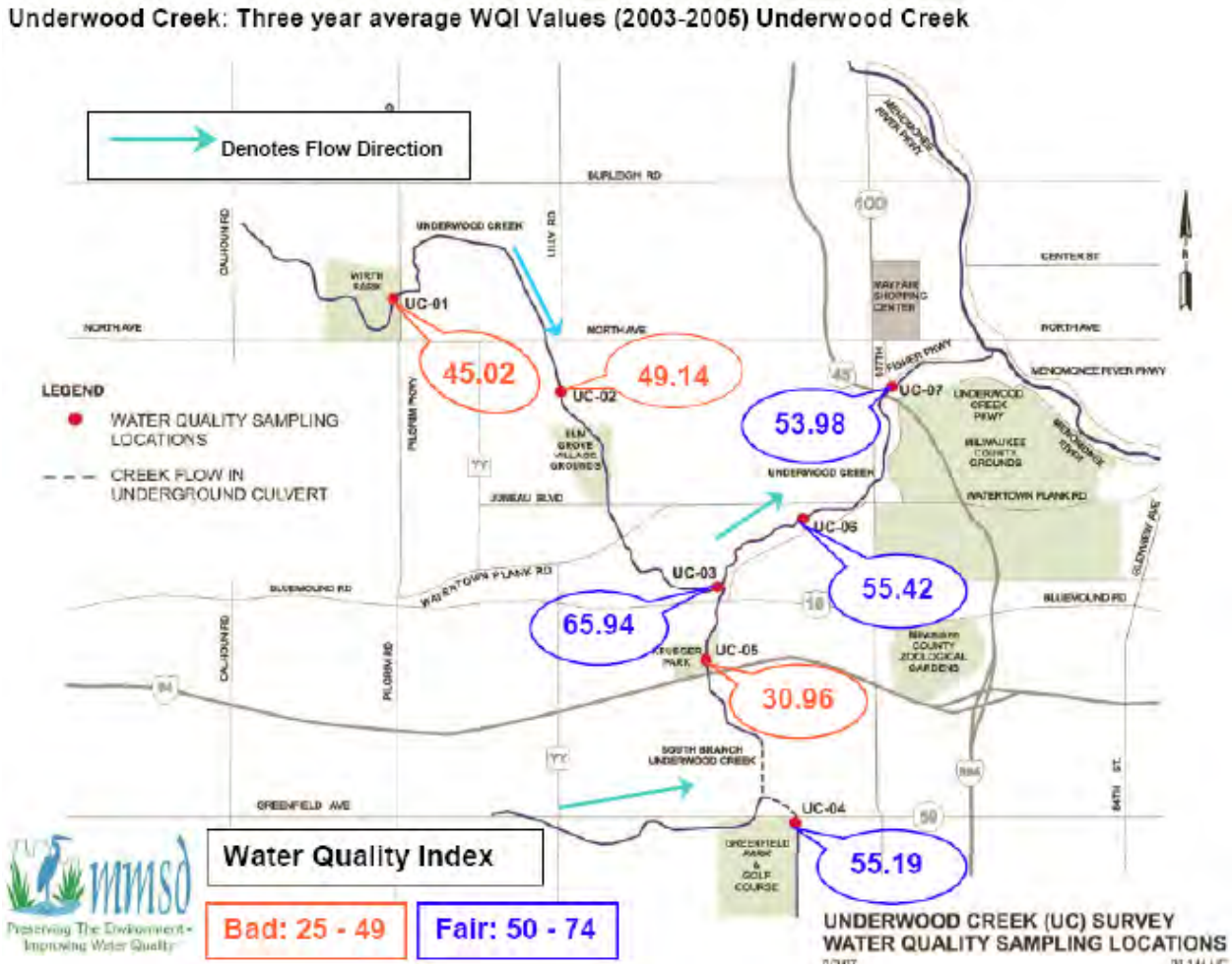
Monitoring of surface water quality in Underwood Creek began in May of 2003 and encompasses 7 sampling sites; 5 located on the mainstem and 2 located on the south branch of the creek (see figure below).



Samples for several dozen variables are collected and analyzed. In general; some parameters, including dissolved oxygen, suspended solids, un-ionized ammonia, nitrate, nitrite, chloride, mercury, copper, lead, zinc, cadmium, chromium, and nickel were found to be at levels conducive to good water quality. At other times, conventional pollutants, including fecal coliform bacteria, total phosphorus, soluble phosphorus, total kjeldahl nitrogen, and to a lesser extent, dissolved oxygen were at levels indicating poor water quality. Toxic pollutants (PAH's, mercury)

were present in Underwood Creek. PAH's and mercury were present at all sites in all years at low levels.

A Water Quality Index (WQI) was developed by MMSD's Water Quality Research Department that is utilized as an assessment tool when evaluating river and creek water quality. The WQI is based on nationally recognized indices and established water quality criteria. Water quality variables are mathematically translated into descriptive categories, i.e. numeric categories; <1, 1-24, 25-49, 50-74, 75-99, >99 are translated to worst, very bad, bad, fair, good, and excellent respectively. Note that as water quality improves, the WQI number increases. The WQI was used to evaluate the Underwood Creek water quality database. The three-year averaged values are presented below along with associated Underwood Creek sampling sites.

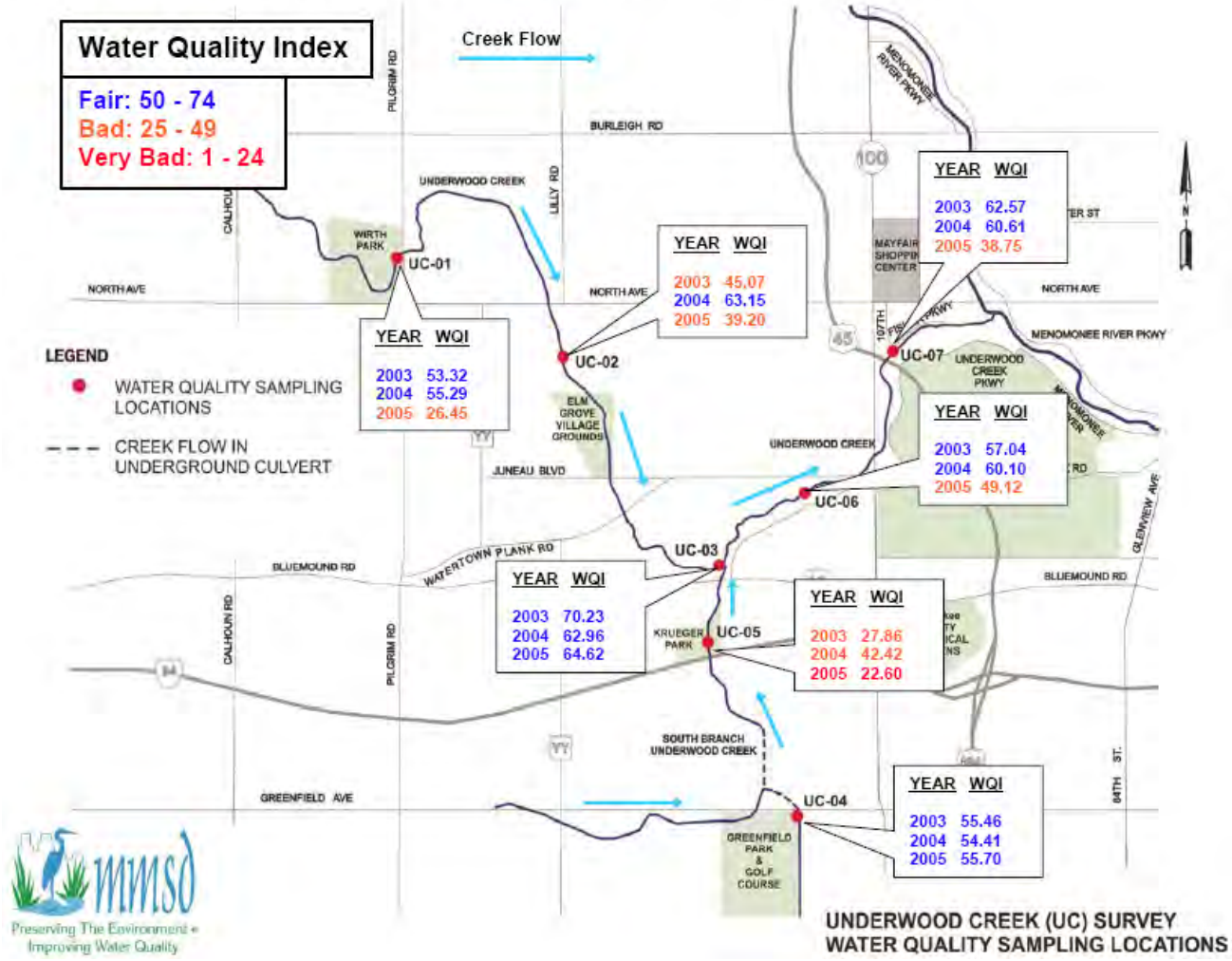


The WQI regularly classified Underwood Creek as either "fair" or "bad" water quality. UC-03 was ranked as the best overall site with a 3-year average WQI of 65.94. UC-05 was rated as the worst overall site with a 3-year average WQI of 30.96. The water quality of UC-05 was also found to be statistically different from all other Underwood Creek sites (based on final index values). This is most likely due to land usage and drainage in the area surrounding UC-05.

One year annual WQI averages also displayed a similar result (see chart below). UC-03 had the highest annual average of all locations in the year 2003 with a WQI of 70.23. UC-05 had the lowest annual average of all locations in the year 2005 with a WQI of 22.60 indicating "very bad"

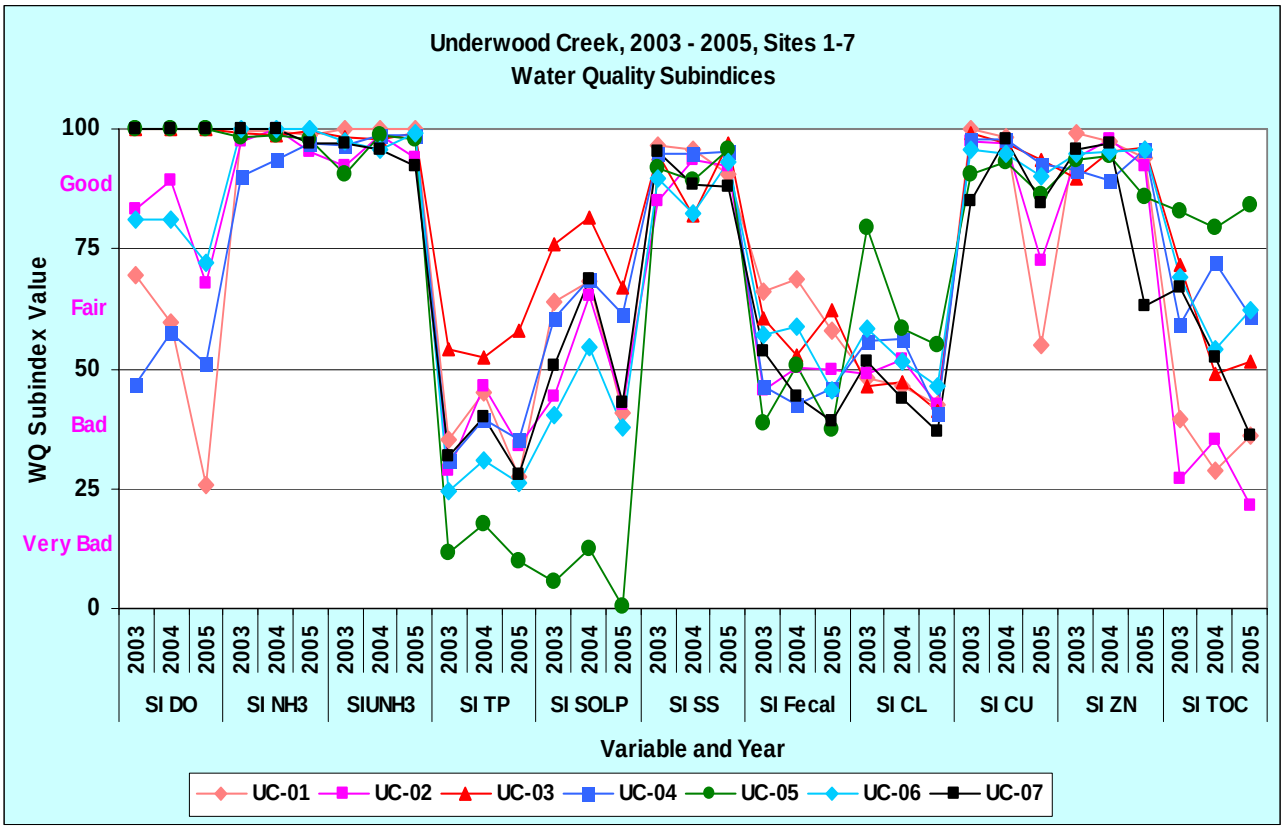
water quality. The year 2004 was the best year on average with 6 of the 7 sites exhibiting WQI values in the "fair" category; UC-05 was the only site that never achieved a "fair" water quality rating. The year 2005 was the worst year on average with 5 of the 7 Underwood Creek sites experiencing degradation in water quality; 4 locations dropped to "bad" from "fair" water quality and 1 site dropped to "very bad" from "bad" water quality. UC-04 had the most consistent WQI ratings of all sites and did experience a slight improvement in 2005 from the previous year. In general terms and based on annual WQI averages, water quality improves in the upper reaches of Underwood Creek as it heads downstream; water quality degrades when moving downstream in the South Branch; and improves slightly in the lower mainstem when moving downstream. It appears that UC-05 is exhibiting a strong degrading influence on the sites located downstream (UC-06 and UC-07).

Underwood Creek: Annual Average WQI Values (2003-2005) Underwood Creek



In general and for all locations, total phosphorus (TP), soluble phosphorus (SOLP), fecal coliform bacteria (FC), chloride (CL), and to a lesser extent, total organic carbon (TOC) pull the final WQI value downward toward poorer water quality (see chart below). Total phosphorus and soluble phosphorus were the two most important variables contributing to the bad water quality at UC-05 and most definitely influenced its' "bad" and "very bad" WQI ranking. Conversely and in general for all locations; the subindices (SI) for ammonia (NH3), un-ionized ammonia (UNH3),

suspended solids (SS), copper (CU) and zinc(ZN) were consistently ranked as “good”. UC-03 displayed the highest total and soluble phosphorus subindex rankings of all Underwood Creek sites and this played an important role in its recurrently better water quality. Dissolved oxygen (DO) was generally rated as “good” or “fair” and on the few occasions when it received a “bad” ranking, it almost certainly had a negative effect on the final WQI value.



All of the subindices displayed consistency in regard to their yearly rankings and never fluctuated out of a subindex category more than once. Ammonia, un-ionized ammonia, suspended solids, copper, and zinc were generally more stable than dissolved oxygen, total phosphorus, soluble phosphorus, fecal coliform bacteria, and total organic carbon (on a site-by-site basis).

The impact of precipitation on the water quality of Underwood Creek was also examined utilizing a linear correlation. The following statistically valid correlations were found:

- Negative Correlation (negatively impacted by rainfall; as rainfall increases, the WQI deteriorates):
    - Suspended Solids
    - Fecal Coliform Bacteria
    - Copper
    - Zinc
- Positive Correlation (as rainfall increases, the WQI improves):
    - Chlorides

All correlation results are presented in the table below.

Pair of Variables	Valid N	Spearman R	t(N-2)	p-level
SIDO & 3 day precip (ws1219)	168	-0.026203	-0.33772	0.736002
SITNH3 & 3 day precip (ws1219)	168	-0.027904	-0.35965	0.719564
SIUNNH3 & 3 day precip (ws1219)	168	0.005095	0.06565	0.947736
SITP & 3 day precip (ws1219)	168	-0.110387	-1.43098	0.154317
SISOLP & 3 day precip (ws1219)	168	-0.075164	-0.97117	0.332876
SISS & 3 day precip (ws1219)	**168**	**-0.156139**	**-2.03669**	**0.043270**
SILGFEC & 3 day precip (ws1219)	**168**	**-0.481508**	**-7.07840**	**0.000000**
SICHLOR & 3 day precip (ws1219)	**168**	**0.305971**	**4.14075**	**0.000055**
SICU & 3 day precip (ws1219)	**168**	**-0.331177**	**-4.52210**	**0.000012**
SIZN & 3 day precip (ws1219)	**168**	**-0.344994**	**-4.73568**	**0.000005**
SITOC & 3 day precip (ws1219)	168	0.044917	0.57930	0.563174
FNLNDX & 3 day precip (ws1219)	166	-0.081049	-1.04136	0.299239

Spearman Rank Order Correlations
MD pairwise deleted
Marked correlations are significant at p <.05000

WS = rain gauge station
SI = Subindex

Appendix D contains a variable abbreviations list

Water quality variables were also examined as to their compliance with various water quality standards, criteria, or recommended maxima. The following table summarizes this analysis which was based on three years of combined data.

(NOTE: multiple sites listed only if median values were virtually the same or equal)

Water Quality Variable	Mostly met or exceeded	Mostly failed to meet	Best UC Site(s)	Worst UC Site(s)
Dissolved Oxygen	√		UC-06	UC-04
Fecal Coliform Bacteria (Log)		√	**UC-01**	**UC-05**
Suspended Solids	√		**UC-03**	UC-06
Total Phosphorus		√	**UC-03**	**UC-05**
Soluble Phosphorus		√	**UC-03**	**UC-05**
Un-ionized Ammonia	√		**UC-01**	UC-04
Total Kjeldahl Nitrogen		√	**UC-03**	UC-06
Nitrate	√		**UC-01**	**UC-05**
Nitrite	√		**UC-03**	**UC-05**
Specific Conductance	Not available		UC-05	**UC-05**
Chloride	√		UC-05	UC-03
Polycyclic Aromatic Hydrocarbons	Not available		UC-02	**UC-05**
Mercury	√		**UC 1,3,**4,7	**UC** 2,**5**,6
Copper	√		**UC-01**	**UC-05**
Lead	√		**UC 1,3,**4,5,6,7	UC-02
Zinc	√		**UC-01**	**UC-05**
Cadmium	√		All medians equal	
Chromium	√		**UC 3**, 7	UC-02
Nickel	√		UC-07	UC-03

Of the 17 variables with existing water quality guidelines or regulations (standards, criteria, recommended maxima) only 4 failed to meet the criteria most of the time; these were fecal coliform bacteria, total phosphorus, soluble phosphorus, and total kjeldahl nitrogen. Thirteen variables mostly met or exceeded water quality criteria. The worst site was UC-05 based on its

median values for the variables examined and the best site was UC-03, this is in agreement with the analysis performed utilizing the MMSD Water Quality Index.

The Underwood Creek Rehabilitation and County Grounds Flood Management Project not only creates a floodwater storage facility that will help to reduce the risk of flooding conditions in the Menomonee River (downstream of the Underwood Creek confluence) but also rehabilitates a portion of Underwood Creek. This work is being done in an environmentally friendly manner and will provide improvements to aquatic habitat and public safety. It is anticipated that this project will ultimately improve the water quality of Underwood Creek and potentially the Menomonee River.

Underwood Creek, bioengineered channel.

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APPENDIX A

UNDERWOOD CREEK
Number of Samples Generated by Variable per Survey

Test Description	UC Creek (7 Sites)
Depth	7
Temperature	7
Dissolved Oxygen	7
pH	7
Specific Conductance	7
Total Kjeldahl Nitrogen	7
Ammonia-Nitrogen	7
Nitrate-Nitrogen	7
Nitrite-Nitrogen	7
Total Phosphorus	7
Dissolved Phosphorus	7
Total Organic Carbon	7
Total Inorganic Carbon	7
Dissolved Organic Carbon	7
Biochemical Oxygen Demand – 5 Day	7
Biochemical Oxygen Demand – 20 Day	7
Total Alkalinity	7
Hardness (Calculated from Calcium and Magnesium)	7
Total Solids	7
Total Suspended Solids	7
Volatile Suspended Solids	7
Dissolved Solids	7
Turbidity	7
Chlorides	7
Fecal Coliform Bacteria	7
Chlorophyll *a*	7
Copper*	7
Lead*	7
Chromium*	7
Zinc*	7
Cadmium*	7
Calcium*	7
Magnesium*	7
Arsenic*	7
Mercury*	7
Nickel*	7
Selenium*	7
Silver*	7
PAH's*	7

*Sampled 2 times/year (wet event and dry event)

APPENDIX B

2003 – 2005 UNDERWOOD CREEK: HYDROLAB® DATA

DATE	TIME	SITE	Depth	Temp.	D.O.	pH	S. Cond.
5/5/03	11:04	UC-01S	0.2	9.79	7.51	7.31	1660
6/17/03	11:18	UC-01S	0.1	17.17	8.28	7.15	1484
7/22/03	11:37	UC-01S	0.1	17.41	8.38	7.09	1430
8/5/03	10:30	UC-01S	0.1	17.34	4.72	7.14	1055
8/20/03	10:24	UC-01S	0.1	17.23	3.7	7	1199
9/17/03	10:46	UC-01S	0.1	15.48	3.61	6.89	1537
9/22/03	9:49	UC-01S	0.1	15.34	3.46	6.92	1414
10/27/03	11:12	UC-01S	0.1	8.27	6.7	6.7	1456
4/5/04	10:27	UC-01S	0.4	5.81	11.08	7.26	1949
5/4/04	10:54	UC-01S	0.3	11.73	10.7	7.3	1641
6/17/04	10:02	UC-01S	0.5	19.07	4.88	7.08	899
7/14/04	12:01	UC-01S	0.2	19.88	6.53	7.17	1392
8/3/04	11:09	UC-01S	0.1	17.58	2.79	6.86	1509
9/8/04	10:39	UC-01S	0.2	14.58	2.56	6.97	1541
10/27/04	10:25	UC-01S	0.3	11.5	2.19	6.62	1875
11/2/04	10:53	UC-01S	0.3	9.37	5.22	6.71	709
4/19/05	10:59	UC-01S	0.3	14.31	7.86	7.18	2053
5/18/05	10:48	UC-01S	0.4	13.24	6.69	7.09	1492
6/14/05	11:59	UC-01S	0.2	22.34	1.23	6.99	1886
7/12/05	11:06	UC-01S	0.2	17.75	1.23	6.83	1782
8/11/05	10:36	UC-01S	0.3	19.48	0.79	6.84	1495
9/13/05	11:06	UC-01S	0.1	19.63	0.13	6.71	1481
10/11/05	11:51	UC-01S	0.2	11.59	1.29	6.57	1435
11/14/05	10:17	UC-01S	0.3	6.55	1.41	6.44	1086
5/5/03	10:51	UC-02S	0.2	9.55	9.31	7.66	1362
6/17/03	11:06	UC-02S	0.2	15.78	6.97	7.79	1381
7/22/03	11:25	UC-02S	0.1	18.77	5.13	7.75	1371
8/5/03	10:19	UC-02S	0.1	18.81	5.74	7.9	1391
8/20/03	10:09	UC-02S	0.1	20.95	1.32	7.51	1303
9/17/03	10:26	UC-02S	0.1	15.72	6.87	7.63	1504
9/22/03	9:33	UC-02S	0.1	15.71	6.36	7.67	869
10/27/03	11:00	UC-02S	0.1	6.8	9.66	7.16	1370
4/5/04	10:14	UC-02S	0.2	4.23	13.05	7.81	1791
5/4/04	10:43	UC-02S	0.2	10.52	13.03	8.07	1583
6/17/04	9:54	UC-02S	0.5	18.4	7.6	7.61	954
7/14/04	11:16	UC-02S	0.2	19.47	7.53	7.86	1297
8/3/04	10:50	UC-02S	0.2	20.79	6.88	7.84	1463
9/8/04	10:23	UC-02S	0.4	16.99	5.46	7.87	1474
10/27/04	10:14	UC-02S	0.4	11.17	3.45	6.98	1564
11/2/04	10:36	UC-02S	0.4	9.14	8.75	7.17	518
4/19/05	10:30	UC-02S	0.3	14.3	13.26	8.05	1884
5/18/05	10:32	UC-02S	0.4	13.13	9.1	7.71	1477
6/14/05	11:41	UC-02S	0.3	22.05	4.31	7.41	1375

DATE	TIME	SITE	Depth	Temp.	D.O.	pH	S. Cond.
7/12/05	10:47	UC-02S	0.3	20.22	3.06	7.44	1705
8/11/05	10:47	UC-02S	0.2	21.29	1.81	7.44	1613
9/13/05	10:48	UC-02S	0.1				
10/11/05	11:41	UC-02S	0.3	10.55	6.36	7.26	1476
11/14/05	10:07	UC-02S	0.4	4.65	9.56	7.11	1356
5/5/03	10:36	UC-03S	0.1	9.43	9.49	7.76	973
6/17/03	10:45	UC-03S	0.1	15.64	8.57	7.76	1525
7/22/03	11:12	UC-03S	0.1	14.88	9.27	7.3	1880
8/5/03	10:09	UC-03S	0.1	17.93	8.91	7.51	1784
8/20/03	9:51	UC-03S	0.1	15.64	11.56	7.48	2179
9/17/03	10:13	UC-03S	0.1	15.45	10.76	7.51	1998
9/22/03	9:16	UC-03S	0.1	15.29	7.39	7.17	1153
10/27/03	10:49	UC-03S	0.1	10.46	12	7.16	1496
4/5/04	9:55	UC-03S	0.2	4.48	14.41	8.02	1891
5/4/04	10:31	UC-03S	0.1	10.22	13.76	8.12	1698
6/17/04	9:34	UC-03S	0.2	18.14	11.53	7.39	281
7/14/04	11:00	UC-03S	0.1	19.1	7.2	7.63	1521
8/3/04	10:34	UC-03S	0.1	18.62	10	7.41	1890
9/8/04	10:12	UC-03S	0.2	14.92	10.95	7.45	2292
10/27/04	10:01	UC-03S	0.2	12.23	8.28	7.01	1783
11/2/04	10:18	UC-03S	0.2	9.23	9.45	7.23	1112
4/19/05	10:16	UC-03S	0.2	14.31	12.65	8.03	1958
5/18/05	10:18	UC-03S	0.2	12.78	11.97	7.87	1700
6/14/05	11:28	UC-03S	0.1	19.96	7.77	7.54	1721
7/12/05	10:30	UC-03S	0.2	13.51	8.98	7.07	1921
8/11/05	10:10	UC-03S	0.2	13.99	9.18	7.29	2110
9/13/05	10:35	UC-03S	0.1	16	8.48	6.9	2111
10/11/05	11:21	UC-03S	0.2	14.38	11.25	7.32	2256
11/14/05	9:53	UC-03S	0.3	7.01	10.03	7.17	1524
5/5/03	10:09	UC-04S	0.1	10	8.52	7.39	662
6/17/03	10:15	UC-04S	0.1	15.1	2.64	7.27	1942
7/22/03	10:50	UC-04S	0.1	19.31	2.33	7.19	1398
8/5/03	9:51	UC-04S	0.1	19.39	2.61	7.36	1150
8/20/03	9:30	UC-04S	0.1	21.5	1.5	7.21	1545
9/17/03	9:53	UC-04S	0.1	16.59	4	7.24	1273
9/22/03	8:54	UC-04S	0.1	17.15	5.99	7.05	369
10/27/03	10:29	UC-04S	0.1	7.45	7.47	6.95	1887
4/5/04	9:34	UC-04S	0.3	3.28	8.56	7.46	2133
5/4/04	10:11	UC-04S	0.1	9.7	7.32	7.54	1645
6/17/04	9:22	UC-04S	0.3	19.62	6.65	7.21	410
7/14/04	10:24	UC-04S	0.1	19.04	3.57	7.3	1279
8/3/04	10:11	UC-04S	0.2	20.52	1.6	7.11	1661
9/8/04	9:45	UC-04S	0.3	18.16	2.33	7.3	1985
10/27/04	9:44	UC-04S	0.4	13.49	2.87	6.84	772
11/2/04	9:58	UC-04S	0.4	10.57	6.87	6.87	452
4/19/05	9:56	UC-04S	0.2	11.93	7.57	7.5	1979
5/18/05	10:00	UC-04S	0.2	12.84	5.83	7.44	1887

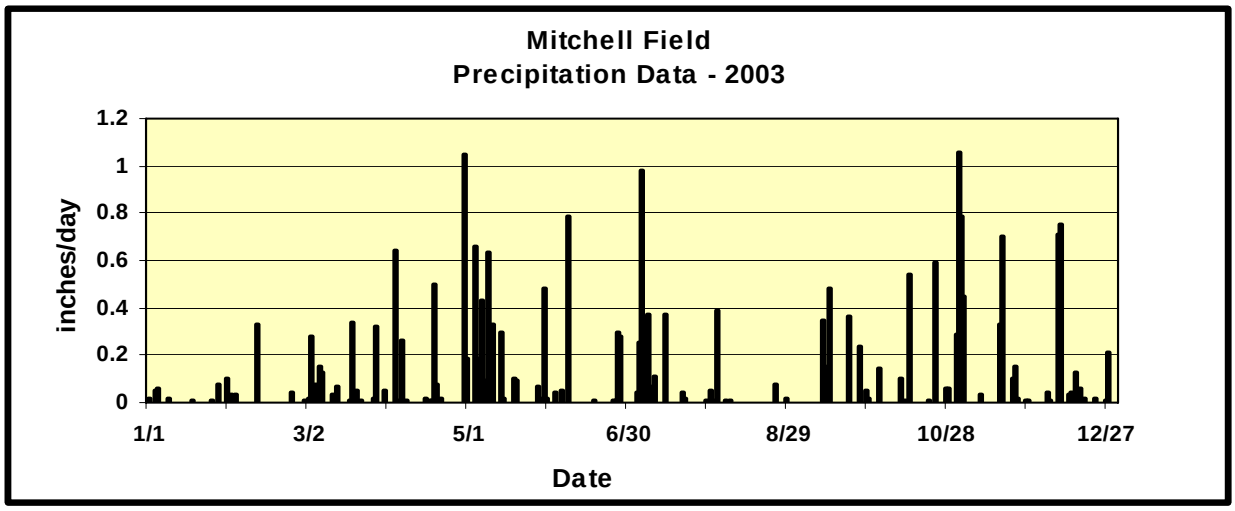
DATE	TIME	SITE	Depth	Temp.	D.O.	pH	S. Cond.
6/14/05	11:08	UC-04S	0.1	21.1	3.61	7.22	1233
7/12/05	9:55	UC-04S	0.3	20.56	2.58	7.24	1961
8/11/05	9:48	UC-04S	0.2	22.12	2.19	7.31	1537
9/13/05	10:16	UC-04S	0.2	21.64	3.28	7.22	1420
10/11/05	10:57	UC-04S	0.3	12.45	5.83	7.13	2274
11/14/05	9:34	UC-04S	0.3	6.74	4.09	6.77	1572
5/5/03	10:26	UC-05S	0.1	9.81	9.87	8.43	1153
6/17/03	10:36	UC-05S	0.1	14.69	9.85	7.91	848
7/22/03	11:01	UC-05S	0.1	18.24	9.77	7.73	951
8/5/03	10:00	UC-05S	0.1	17.86	9.08	8.01	627
8/20/03	9:41	UC-05S	0.1	19.64	8.68	7.76	731
9/17/03	10:03	UC-05S	0.1	16.01	9.42	7.69	650
9/22/03	9:09	UC-05S	0.1	16.3	8.51	7.5	283
10/27/03	10:40	UC-05S	0.1	10.64	12.27	7.52	817
4/5/04	9:46	UC-05S	0.3	6.85	12.62	7.68	2020
5/4/04	10:23	UC-05S	0.3	11.36	14.8	7.7	2015
6/17/04	9:32	UC-05S	0.3	18.69	8.07	7.49	509
7/14/04	10:52	UC-05S	0.1	18.06	10.58	7.68	1262
8/3/04	10:24	UC-05S	0.1	18.6	8.85	7.7	821
9/8/04	9:57	UC-05S	0.3	17.02	9.46	7.66	1440
10/27/04	9:53	UC-05S	0.3	13.89	7.03	7.18	798
11/2/04	10:10	UC-05S	0.2	11.33	9.66	7.24	628
4/19/05	10:07	UC-05S	0.2	11.85	17.01	7.94	1811
5/18/05	10:10	UC-05S	0.2	11.76	13.53	7.87	1414
6/14/05	11:19	UC-05S	0.1	18.1	9.3	7.54	928
7/12/05	10:08	UC-05S	0.3	17.32	8.28	7.48	1265
8/11/05	9:59	UC-05S	0.3	19.1	7.86	7.61	904
9/13/05	10:27	UC-05S	0.2	18.94	8.96	7.58	1047
10/11/05	11:12	UC-05S	0.3	13.66	12.72	7.45	1434
11/14/05	9:44	UC-05S	0.3	9.82	10.28	7.12	1263
5/5/03	11:20	UC-06S	0.1	9.94	10.67	8.07	1061
6/17/03	11:46	UC-06S	0.1	22.77	26.57	8.69	1400
7/22/03	11:59	UC-06S	0.1	21.14	23.27	8.53	1366
8/5/03	10:45	UC-06S	0.1	21.32	14.53	8.33	1262
8/20/03	10:48	UC-06S	0.1	23.46	19.92	8.61	1237
9/17/03	11:01	UC-06S	0.1	18.46	15.77	8.12	1194
9/22/03	10:07	UC-06S	0.1	16.73	9.82	7.69	487
10/27/03	11:29	UC-06S	0.1	11.13	21.92	8.42	1219
4/5/04	10:44	UC-06S	0.2	7.51	20.65	8.23	1933
5/4/04	11:16	UC-06S	0.1	14.49	23.58	8.58	1826
5/6/04	11:20	UC-06S					
6/17/04	10:28	UC-06S	0.2	19	8.62	7.63	660
7/14/04	12:18	UC-06S	0.1	23.1	14.21	8.11	1503
8/3/04	11:42	UC-06S	0.2	24.07	25.7	8.43	1533
9/8/04	10:54	UC-06S	0.2	18.46	12.75	8.51	1579
10/27/04	10:48	UC-06S	0.2	12.32	10.59	7.35	1285
11/2/04	11:08	UC-06S	0.2	10.41	11.07	7.41	870

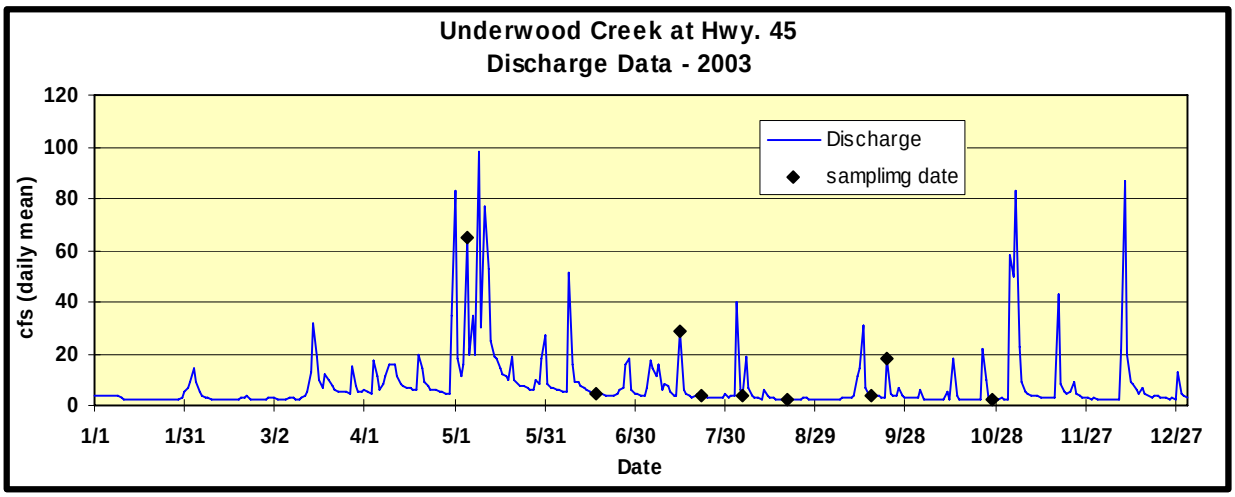
DATE	TIME	SITE	Depth	Temp.	D.O.	pH	S. Cond.
4/19/05	11:18	UC-06S	0.2	17.59	24.98	8.66	1901
5/18/05	11:04	UC-06S	0.3	15.64	18.84	8.48	1714
6/14/05	12:17	UC-06S	0.1	22.06	9.67	7.78	1539
7/12/05	11:39	UC-06S	0.2	20.48	9.72	7.72	1208
8/11/05	11:11	UC-06S	0.2	20.71	8.75	7.7	1370
9/13/05	11:22	UC-06S	0.1	22.85	17.44	8.18	1462
10/11/05	12:06	UC-06S	0.2	14.25	27.25	8.56	1668
11/14/05	10:32	UC-06S	0.3	8.24	24.08	8.2	1478
5/5/03	11:34	UC-07S	0.1	10.4	10.87	8.22	1097
6/17/03	11:58	UC-07S	0.1	24.54	12.98	8.55	1591
7/22/03	12:10	UC-07S	0.1	23.27	12.35	8.47	1427
8/5/03	11:01	UC-07S	0.1	23.13	10.93	8.62	1358
8/20/03	11:02	UC-07S	0.1	24.31	10.56	8.31	1396
9/17/03	11:12	UC-07S	0.1	19.28	12.43	8.31	1185
9/22/03	10:19	UC-07S	0.1	17.01	9.52	7.99	629
10/27/03	11:38	UC-07S	0.1	10.7	14.77	8.52	1339
4/5/04	10:53	UC-07S	0.2	8.2	15.22	8.52	2141
5/4/04	11:27	UC-07S	0.2	16.23	14.06	8.66	1979
6/17/04	10:38	UC-07S	0.3	19.64	8.91	7.78	652
7/14/04	12:27	UC-07S	0.1	24.8	14.48	8.66	1581
8/3/04	11:55	UC-07S	0.2	25.53	11.73	8.29	1770
9/8/04	11:06	UC-07S	0.2	18.84	13.88	8.25	1815
10/27/04	10:58	UC-07S	0.3	12.18	10.78	7.7	1458
11/2/04	11:23	UC-07S	0.2	10.82	11.4	7.82	890
4/19/05	11:29	UC-07S	0.2	19.46	13.55	8.79	2092
5/18/05	11:16	UC-07S	0.2	15.69	13.64	8.59	2057
6/14/05	12:35	UC-07S	0.1	24.58	10.83	8.12	1807
7/12/05	11:56	UC-07S	0.2	20.72	8.09	7.61	935
8/11/05	11:29	UC-07S	0.2	21.55	8.57	7.92	1448
9/13/05	11:32	UC-07S	0.1	24.34	10.03	8.14	1391
10/11/05	12:15	UC-07S	0.3	14.14	14.22	8.2	2077
11/14/05	10:45	UC-07S	0.3	6.71	15.35	8.03	1741

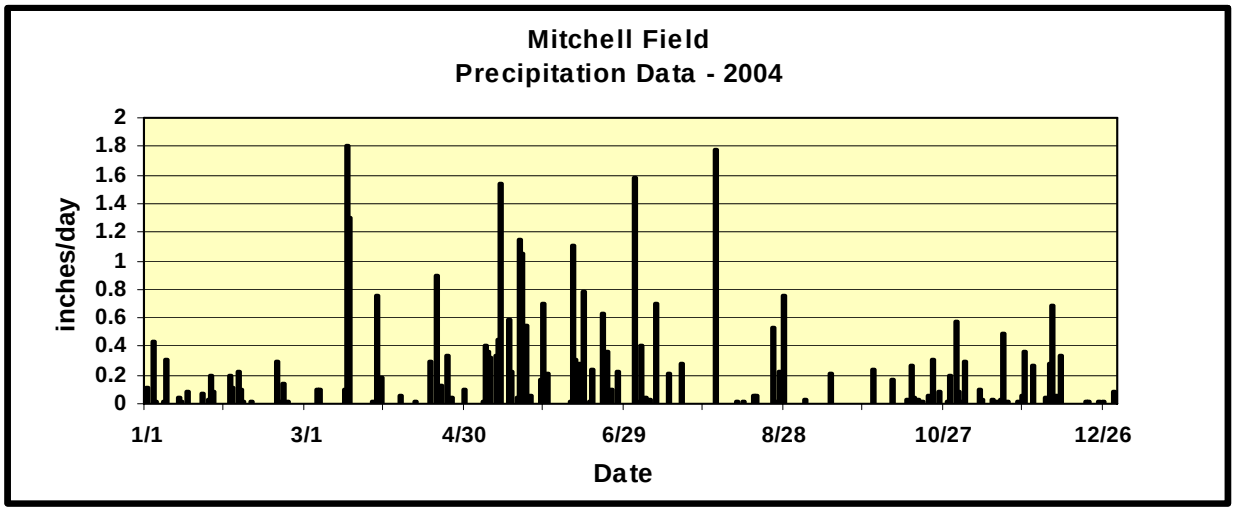
APPENDIX C

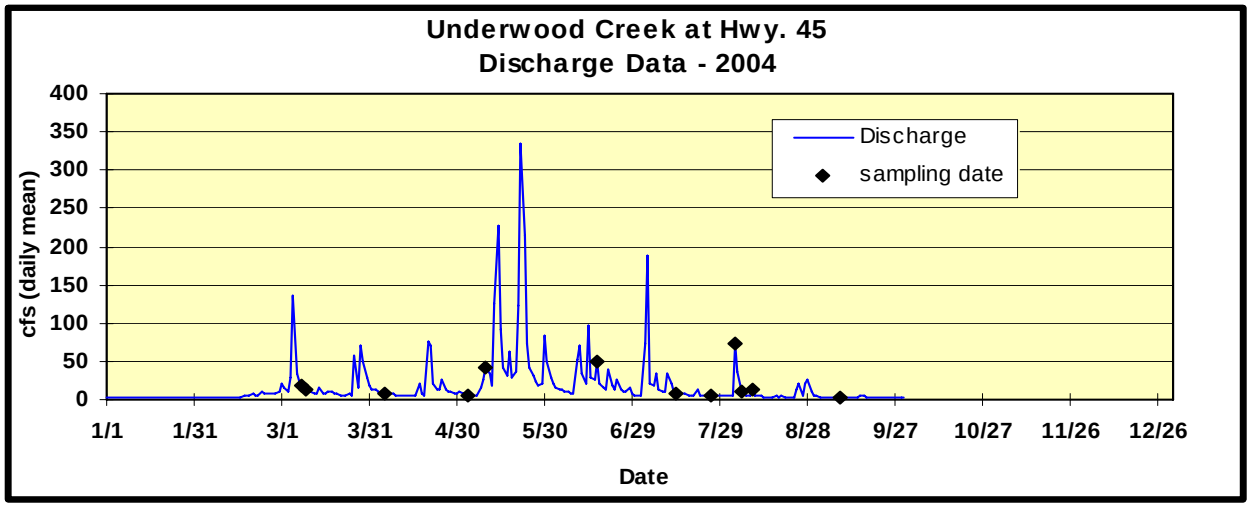
UNDERWOOD CREEK PRECIPITATION DATA and DISCHARGE DATA: 2003 – 2005
(WS 1219 Precipitation, unless noted otherwise)

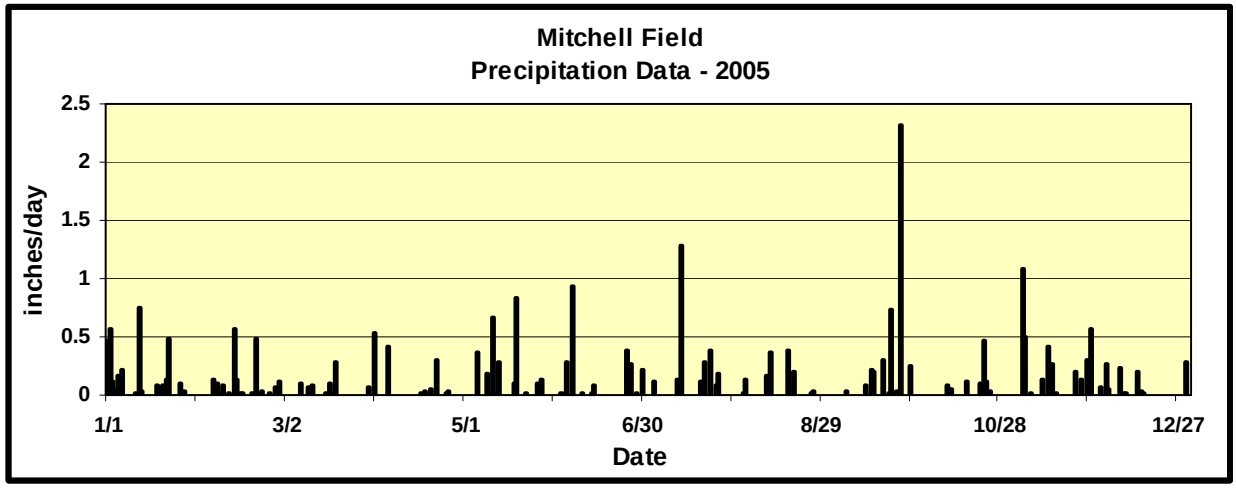
NOTE: Discharge data is presented with associated water quality sampling date.

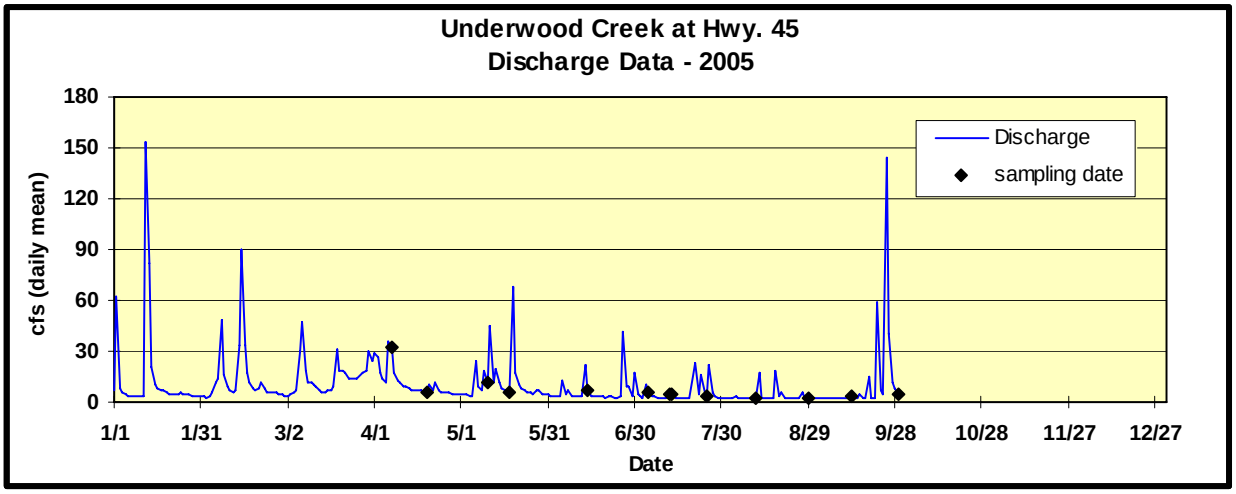


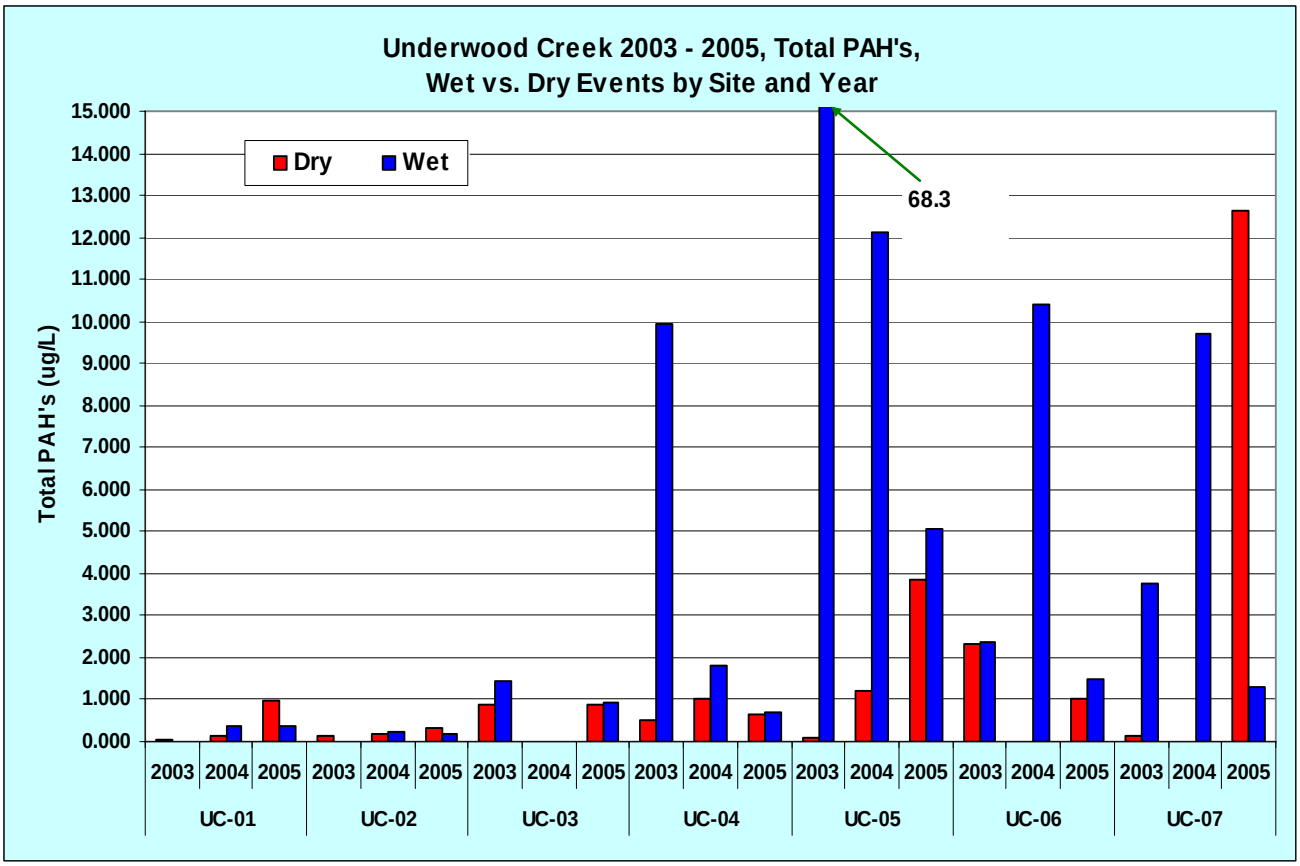



Mitchell Field
Precipitation Data - 2004
inches/day
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1
3/1
4/30
6/29
8/28
10/27
12/26
Date


Underwood Creek at Hwy. 45
Discharge Data - 2004
cfs (daily mean)
400
350
300
250
200
150
100
50
0
Discharge
sampling date
1/1
1/31
3/1
3/31
4/30
5/30
6/29
7/29
8/28
9/27
10/27
11/26
12/26
Date


Mitchell Field
Precipitation Data - 2005
inches/day
2.5
2
1.5
1
0.5
0
1/1
3/2
5/1
6/30
8/29
10/28
12/27
Date


Underwood Creek at Hwy. 45
Discharge Data - 2005
cfs (daily mean)
180
150
120
90
60
30
0
Discharge
sampling date
1/1
1/31
3/2
4/1
5/1
5/31
6/30
7/30
8/29
9/28
10/28
11/27
12/27
Date



Wet Event Data vs. Dry Event Data
Underwood Creek 2003 – 2005
(Note: total of 3 wet sample data points and 3 dry sample data points)

UNDERWOOD CREEK PRECIPITATION DATA: 2003 – 2005
(WS 1219 Precipitation)

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
1/1/03	0.00			2/18/03	0.00		
1/2/03	0.02			2/19/03	0.00		
1/3/03	0.00			2/20/03	0.00		
1/4/03	0.03			2/21/03	0.00		
1/5/03	0.00			2/22/03	0.00		
1/6/03	0.00			2/23/03	0.00		
1/7/03	0.00			2/24/03	0.00		
1/8/03	0.00			2/25/03	0.00		
1/9/03	0.01			2/26/03	0.00		
1/10/03	0.00			2/27/03	0.00		
1/11/03	0.00			2/28/03	0.00	0.19	
1/12/03	0.00			3/1/03	0.00		
1/13/03	0.00			3/2/03	0.01		
1/14/03	0.00			3/3/03	0.03		
1/15/03	0.00			3/4/03	0.19		
1/16/03	0.00			3/5/03	0.00		
1/17/03	0.00			3/6/03	0.00		
1/18/03	0.00			3/7/03	0.11		
1/19/03	0.00			3/8/03	0.13		
1/20/03	0.00			3/9/03	0.00		
1/21/03	0.00			3/10/03	0.00		
1/22/03	0.00			3/11/03	0.00		
1/23/03	0.00			3/12/03	0.03		
1/24/03	0.00			3/13/03	0.03		
1/25/03	0.00			3/14/03	0.00		
1/26/03	0.00			3/15/03	0.00		
1/27/03	0.00			3/16/03	0.00		
1/28/03	0.01			3/17/03	0.00		
1/29/03	0.00			3/18/03	0.01		
1/30/03	0.00			3/19/03	0.21		
1/31/03	0.00	0.07		3/20/03	0.07		
2/1/03	0.00			3/21/03	0.01		
2/2/03	0.01			3/22/03	0.01		
2/3/03	0.02			3/23/03	0.00		
2/4/03	0.00			3/24/03	0.01		
2/5/03	0.00			3/25/03	0.00		
2/6/03	0.00			3/26/03	0.00		
2/7/03	0.00			3/27/03	0.04		
2/8/03	0.00			3/28/03	0.31		
2/9/03	0.00			3/29/03	0.00		
2/10/03	0.00			3/30/03	0.00		
2/11/03	0.16			3/31/03	0.07	1.27	
2/12/03	0.00			4/1/03	0.00		
2/13/03	0.00			4/2/03	0.00		
2/14/03	0.00			4/3/03	0.01		
2/15/03	0.00			4/4/03	0.31		
2/16/03	0.00			4/5/03	0.00		
2/17/03	0.00			4/6/03	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
4/7/03	0.79			5/29/03	0.00		
4/8/03	0.06			5/30/03	0.58		
4/9/03				5/31/03	0.08	4.39	
4/10/03				6/1/03			
4/11/03				6/2/03	0.00		
4/12/03				6/3/03	0.04		
4/13/03				6/4/03	0.00		
4/14/03				6/5/03	0.00		
4/15/03	0.00			6/6/03	0.02		
4/16/03	0.00			6/7/03	0.00		
4/17/03	0.01			6/8/03	0.95		
4/18/03	0.00			6/9/03	0.00		
4/19/03	0.56			6/10/03	0.07		
4/20/03	0.08			6/11/03	0.00		
4/21/03	0.05			6/12/03	0.00		
4/22/03	0.00			6/13/03	0.00		
4/23/03	0.00			6/14/03	0.00		
4/24/03	0.00			6/15/03	0.00		
4/25/03	0.00			6/16/03	0.00		
4/26/03	0.00			6/17/03	0.00		
4/27/03	0.00			6/18/03	0.00		
4/28/03	0.00			6/19/03	0.01		
4/29/03	0.00			6/20/03	0.00		
4/30/03	1.07	2.94		6/21/03	0.00		
5/1/03	0.36			6/22/03	0.00		
5/2/03	0.00			6/23/03	0.00		
5/3/03	0.00			6/24/03	0.00		
5/4/03	0.52			6/25/03	0.19		
5/5/03	0.44			6/26/03	0.01		
5/6/03	0.00			6/27/03	0.35		
5/7/03	0.41			6/28/03	0.21		
5/8/03	0.00			6/29/03	0.00		
5/9/03	0.91			6/30/03	0.00	1.85	
5/10/03	0.04			7/1/03	0.00		
5/11/03	0.73			7/2/03	0.00		
5/12/03	0.00			7/3/03	0.00		
5/13/03	0.00			7/4/03	0.10		
5/14/03	0.08			7/5/03	0.15		
5/15/03	0.01			7/6/03	0.24		
5/16/03				7/7/03	0.03		
5/17/03				7/8/03	0.41		
5/18/03				7/9/03	0.07		
5/19/03				7/10/03	0.03		
5/20/03				7/11/03	0.10		
5/21/03				7/12/03	0.00		
5/22/03				7/13/03	0.00		
5/23/03				7/14/03	0.00		
5/24/03				7/15/03	0.46		
5/25/03				7/16/03	0.00		
5/26/03				7/17/03	0.00		
5/27/03	0.00			7/18/03	0.00		
5/28/03	0.23			7/19/03	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
7/20/03	0.00			9/10/03	0.00		
7/21/03	0.00			9/11/03	0.00		
7/22/03	0.00			9/12/03	0.26		
7/23/03	0.00			9/13/03	0.38		
7/24/03	0.00			9/14/03	0.52		
7/25/03	0.00			9/15/03	0.00		
7/26/03	0.00			9/16/03	0.00		
7/27/03	0.00			9/17/03	0.00		
7/28/03	0.00			9/18/03	0.00		
7/29/03	0.00			9/19/03	0.01		
7/30/03	0.00			9/20/03	0.00		
7/31/03	0.00	1.59		9/21/03	0.02		
8/1/03	0.00			9/22/03	0.40		
8/2/03	0.00			9/23/03	0.00		
8/3/03	0.10			9/24/03	0.00		
8/4/03	0.00			9/25/03	0.00		
8/5/03	0.00			9/26/03	0.18		
8/6/03	0.32			9/27/03	0.00		
8/7/03	0.00			9/28/03	0.02		
8/8/03	0.00			9/29/03	0.03		
8/9/03	0.00			9/30/03	0.00	1.82	
8/10/03	0.00			10/1/03	0.00		
8/11/03	0.01			10/2/03	0.00		
8/12/03	0.10			10/3/03	0.18		
8/13/03	0.00			10/4/03	0.00		
8/14/03	0.00			10/5/03	0.00		
8/15/03	0.00			10/6/03	0.00		
8/16/03	0.00			10/7/03	0.00		
8/17/03	0.00			10/8/03	0.00		
8/18/03	0.00			10/9/03	0.00		
8/19/03	0.00			10/10/03	0.00		
8/20/03	0.00			10/11/03	0.16		
8/21/03	0.00			10/12/03	0.00		
8/22/03	0.00			10/13/03	0.01		
8/23/03	0.00			10/14/03	0.58		
8/24/03	0.00			10/15/03	0.00		
8/25/03	0.02			10/16/03	0.00		
8/26/03	0.00			10/17/03	0.00		
8/27/03	0.00			10/18/03	0.00		
8/28/03	0.00			10/19/03	0.00		
8/29/03	0.01			10/20/03	0.00		
8/30/03	0.00			10/21/03	0.00		
8/31/03	0.00	0.56		10/22/03	0.00		
9/1/03	0.00			10/23/03	0.00		
9/2/03	0.00			10/24/03	0.73		
9/3/03	0.00			10/25/03	0.00		
9/4/03	0.00			10/26/03	0.00		
9/5/03	0.00			10/27/03	0.00		
9/6/03	0.00			10/28/03	0.00		
9/7/03	0.00			10/29/03	0.00		
9/8/03	0.00			10/30/03	0.00		
9/9/03	0.00			10/31/03	0.00	1.66	

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
11/1/03	0.00			12/23/03	0.00		
11/2/03	1.46			12/24/03	0.00		
11/3/03	0.94			12/25/03	0.00		
11/4/03	0.48			12/26/03	0.00		
11/5/03	0.00			12/27/03	0.00		
11/6/03	0.00			12/28/03	0.18		
11/7/03	0.00			12/29/03	0.00		
11/8/03	0.00			12/30/03	0.00		
11/9/03	0.00			12/31/03	0.00	1.89	
11/10/03	0.04			1/1/04	0.00		
11/11/03	0.00			1/2/04	0.04		
11/12/03	0.00			1/3/04	0.00		
11/13/03	0.00			1/4/04	0.24		
11/14/03	0.00			1/5/04	0.00		
11/15/03	0.00			1/6/04	0.00		
11/16/03	0.00			1/7/04	0.00		
11/17/03	0.29			1/8/04	0.00		
11/18/03	0.87			1/9/04	0.00		
11/19/03	0.00			1/10/04	0.00		
11/20/03	0.00			1/11/04	0.00		
11/21/03	0.00			1/12/04	0.00		
11/22/03	0.17			1/13/04	0.00		
11/23/03	0.11			1/14/04	0.00		
11/24/03	0.00			1/15/04	0.00		
11/25/03	0.00			1/16/04	0.00		
11/26/03	0.00			1/17/04	0.21		
11/27/03	0.02			1/18/04	0.00		
11/28/03	0.00			1/19/04	0.00		
11/29/03	0.00			1/20/04	0.00		
11/30/03	0.00	4.38		1/21/04	0.00		
12/1/03	0.00			1/22/04	0.00		
12/2/03	0.00			1/23/04	0.14		
12/3/03	0.00			1/24/04	0.00		
12/4/03	0.00			1/25/04	0.01		
12/5/03	0.02			1/26/04	0.16		
12/6/03	0.00			1/27/04	0.01		
12/7/03	0.00			1/28/04	0.00		
12/8/03	0.00			1/29/04	0.00		
12/9/03	0.77			1/30/04	0.00		
12/10/03	0.85			1/31/04	0.00	0.81	
12/11/03	0.00			2/1/04	0.00		
12/12/03	0.00			2/2/04	0.16		
12/13/03	0.00			2/3/04	0.02		
12/14/03	0.01			2/4/04	0.00		
12/15/03	0.00			2/5/04	0.18		
12/16/03	0.06			2/6/04	0.06		
12/17/03	0.00			2/7/04	0.00		
12/18/03	0.00			2/8/04	0.00		
12/19/03	0.00			2/9/04	0.00		
12/20/03	0.00			2/10/04	0.00		
12/21/03	0.00			2/11/04	0.00		
12/22/03	0.00			2/12/04	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
2/13/04	0.00			4/5/04	0.00		
2/14/04	0.00			4/6/04	0.04		
2/15/04	0.00			4/7/04	0.00		
2/16/04	0.00			4/8/04	0.00		
2/17/04	0.00			4/9/04	0.00		
2/18/04	0.00			4/10/04	0.00		
2/19/04	0.00			4/11/04	0.00		
2/20/04	0.06			4/12/04	0.00		
2/21/04	0.00			4/13/04	0.00		
2/22/04	0.08			4/14/04	0.00		
2/23/04	0.00			4/15/04	0.00		
2/24/04	0.00			4/16/04	0.00		
2/25/04	0.00			4/17/04	0.33		
2/26/04	0.00			4/18/04	0.02		
2/27/04	0.00			4/19/04	0.00		
2/28/04	0.00			4/20/04	1.51		
2/29/04		0.48		4/21/04	0.12		
3/1/04	0.14			4/22/04	0.00		
3/2/04	0.00			4/23/04	0.00		
3/3/04	0.01			4/24/04	0.18		
3/4/04	0.95			4/25/04	0.13		
3/5/04	0.60			4/26/04	0.00		
3/6/04	0.00			4/27/04	0.00		
3/7/04	0.06			4/28/04	0.00		
3/8/04	0.00			4/29/04	0.00		
3/9/04	0.00			4/30/04	0.07	2.40	
3/10/04	0.01			5/1/04	0.00		
3/11/04	0.01			5/2/04	0.00		
3/12/04	0.00			5/3/04	0.00		
3/13/04	0.06			5/4/04	0.00		
3/14/04	0.12			5/5/04	0.00		
3/15/04	0.00			5/6/04	0.00		
3/16/04	0.00			5/7/04	0.06		
3/17/04	0.12			5/8/04	0.44		
3/18/04	0.12			5/9/04	0.16		
3/19/04	0.01			5/10/04	0.94		
3/20/04	0.00			5/11/04	0.00		
3/21/04	0.00			5/12/04	0.09		
3/22/04	0.00			5/13/04	0.89		
3/23/04	0.00			5/14/04	1.28		
3/24/04	0.09			5/15/04	0.00		
3/25/04	0.33			5/16/04	0.00		
3/26/04	0.53			5/17/04	0.29		
3/27/04	0.03			5/18/04	0.26		
3/28/04	0.95			5/19/04	0.00		
3/29/04	0.00			5/20/04	0.61		
3/30/04	0.13			5/21/04	1.11		
3/31/04	0.00	4.27		5/22/04	1.10		
4/1/04	0.00			5/23/04	0.52		
4/2/04	0.00			5/24/04	0.00		
4/3/04	0.00			5/25/04	0.05		
4/4/04	0.00			5/26/04	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
5/27/04	0.00			7/18/04	0.00		
5/28/04	0.00			7/19/04	0.00		
5/29/04	0.15			7/20/04	0.00		
5/30/04	0.79			7/21/04	0.08		
5/31/04	0.10	8.84		7/22/04	0.00		
6/1/04	0.00			7/23/04	0.00		
6/2/04	0.00			7/24/04	0.00		
6/3/04	0.00			7/25/04	0.00		
6/4/04	0.00			7/26/04	0.00		
6/5/04	0.00			7/27/04	0.00		
6/6/04	0.00			7/28/04	0.00		
6/7/04	0.00			7/29/04	0.00		
6/8/04	0.00			7/30/04	0.01		
6/9/04	0.01			7/31/04	0.00	3.14	
6/10/04	1.10			8/1/04	0.00		
6/11/04	0.65			8/2/04	0.01		
6/12/04	0.10			8/3/04	1.49		
6/13/04	0.00			8/4/04	0.00		
6/14/04	0.51			8/5/04	0.00		
6/15/04	0.00			8/6/04	0.00		
6/16/04	0.00			8/7/04	0.00		
6/17/04	0.57			8/8/04	0.00		
6/18/04	0.00			8/9/04	0.04		
6/19/04	0.00			8/10/04	0.00		
6/20/04	0.00			8/11/04	0.00		
6/21/04	0.54			8/12/04	0.00		
6/22/04	0.00			8/13/04	0.00		
6/23/04	0.08			8/14/04	0.00		
6/24/04	0.26			8/15/04	0.00		
6/25/04	0.00			8/16/04	0.00		
6/26/04	0.00			8/17/04	0.09		
6/27/04	0.31			8/18/04	0.03		
6/28/04	0.00			8/19/04	0.00		
6/29/04	0.00			8/20/04	0.00		
6/30/04	0.00	4.13		8/21/04	0.00		
7/1/04	0.00			8/22/04	0.00		
7/2/04	0.00			8/23/04	0.00		
7/3/04	1.96			8/24/04	0.32		
7/4/04	0.09			8/25/04	0.00		
7/5/04	0.00			8/26/04	0.00		
7/6/04	0.12			8/27/04	0.48		
7/7/04	0.28			8/28/04	0.64		
7/8/04	0.00			8/29/04	0.00		
7/9/04	0.05			8/30/04	0.00		
7/10/04	0.00			8/31/04	0.00	3.10	
7/11/04	0.52			9/1/04	0.00		
7/12/04	0.00			9/2/04	0.00		
7/13/04	0.00			9/3/04	0.00		
7/14/04	0.00			9/4/04	0.00		
7/15/04	0.00			9/5/04	0.00		
7/16/04	0.03			9/6/04	0.01		
7/17/04	0.00			9/7/04	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
9/8/04	0.00			10/30/04	0.28		
9/9/04	0.00			10/31/04	0.00	1.76	
9/10/04	0.00			11/1/04	0.66		
9/11/04	0.00			11/2/04	0.11		
9/12/04	0.00			11/3/04	0.00		
9/13/04	0.00			11/4/04	0.26		
9/14/04	0.00			11/5/04	0.00		
9/15/04	0.25			11/6/04	0.00		
9/16/04	0.00			11/7/04	0.00		
9/17/04	0.00			11/8/04	0.00		
9/18/04	0.00			11/9/04	0.00		
9/19/04	0.00			11/10/04	0.08		
9/20/04	0.00			11/11/04	0.01		
9/21/04	0.00			11/12/04	0.00		
9/22/04	0.00			11/13/04	0.00		
9/23/04	0.00			11/14/04	0.00		
9/24/04	0.00			11/15/04	0.04		
9/25/04	0.00			11/16/04	0.00		
9/26/04	0.00			11/17/04	0.00		
9/27/04	0.00			11/18/04	0.01		
9/28/04	0.00			11/19/04	0.66		
9/29/04	0.00			11/20/04	0.00		
9/30/04	0.00	0.26		11/21/04	0.00		
10/1/04	0.33			11/22/04	0.00		
10/2/04	0.00			11/23/04	0.00		
10/3/04	0.00			11/24/04	0.00		
10/4/04	0.00			11/25/04	0.00		
10/5/04	0.00			11/26/04	0.04		
10/6/04	0.00			11/27/04	0.41		
10/7/04	0.00			11/28/04	0.00		
10/8/04	0.11			11/29/04	0.00		
10/9/04	0.00			11/30/04	0.13	2.41	
10/10/04	0.00			12/1/04	0.00		
10/11/04	0.00			12/2/04	0.00		
10/12/04	0.00			12/3/04	0.00		
10/13/04	0.00			12/4/04	0.00		
10/14/04	0.01			12/5/04	0.10		
10/15/04	0.15			12/6/04	0.35		
10/16/04	0.06			12/7/04	0.88		
10/17/04	0.00			12/8/04	0.00		
10/18/04	0.01			12/9/04	0.04		
10/19/04	0.04			12/10/04	0.33		
10/20/04	0.00			12/11/04	0.00		
10/21/04	0.00			12/12/04	0.00		
10/22/04	0.01			12/13/04	0.00		
10/23/04	0.58			12/14/04	0.00		
10/24/04	0.00			12/15/04	0.00		
10/25/04	0.00			12/16/04	0.00		
10/26/04	0.08			12/17/04	0.00		
10/27/04	0.00			12/18/04	0.00		
10/28/04	0.00			12/19/04	0.00		
10/29/04	0.10			12/20/04	0.01		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
12/21/04	0.00			2/11/05	0.00		
12/22/04	0.00			2/12/05	0.00		
12/23/04	0.00			2/13/05	0.46		
12/24/04	0.00			2/14/05	0.11		
12/25/04	0.00			2/15/05	0.04		
12/26/04	0.00			2/16/05	0.00		
12/27/04	0.00			2/17/05	0.00		
12/28/04	0.00			2/18/05	0.00		
12/29/04	0.00			2/19/05	0.00		
12/30/04	0.02			2/20/05	0.80		
12/31/04	0.00	1.73		2/21/05	0.00		
1/1/05	0.42			2/22/05	0.02		
1/2/05	0.45			2/23/05	0.00		
1/3/05	0.05			2/24/05	0.00		
1/4/05	0.03			2/25/05	0.04		
1/5/05	0.19			2/26/05	0.00		
1/6/05	0.37			2/27/05	0.05		
1/7/05	0.00			2/28/05	0.05	1.71	
1/8/05	0.00			3/1/05	0.00		
1/9/05	0.00			3/2/05	0.00		
1/10/05	0.00			3/3/05	0.00		
1/11/05	0.00			3/4/05	0.00		
1/12/05	1.44			3/5/05	0.00		
1/13/05	0.00			3/6/05	0.00		
1/14/05	0.00			3/7/05	0.04		
1/15/05	0.00			3/8/05	0.00		
1/16/05	0.00			3/9/05	0.00		
1/17/05	0.00			3/10/05	0.08		
1/18/05	0.09			3/11/05	0.04		
1/19/05	0.00			3/12/05	0.01		
1/20/05	0.02			3/13/05	0.00		
1/21/05	0.15			3/14/05	0.00		
1/22/05	0.16			3/15/05	0.00		
1/23/05	0.00			3/16/05	0.01		
1/24/05	0.00			3/17/05	0.15		
1/25/05	0.00			3/18/05	0.05		
1/26/05	0.00			3/19/05	0.47		
1/27/05	0.00			3/20/05	0.00		
1/28/05	0.00			3/21/05	0.00		
1/29/05	0.00			3/22/05	0.00		
1/30/05	0.00			3/23/05	0.00		
1/31/05	0.00	3.37		3/24/05	0.00		
2/1/05	0.00			3/25/05	0.00		
2/2/05	0.00			3/26/05	0.00		
2/3/05	0.00			3/27/05	0.00		
2/4/05	0.00			3/28/05	0.00		
2/5/05	0.00			3/29/05	0.00		
2/6/05	0.05			3/30/05	0.20		
2/7/05	0.06			3/31/05	0.00	1.05	
2/8/05	0.00			4/1/05	0.33		
2/9/05	0.03			4/2/05	0.00		
2/10/05	0.00			4/3/05	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
4/4/05	0.00			5/26/05	0.00		
4/5/05	0.00			5/27/05	0.16		
4/6/05	0.41			5/28/05	0.00		
4/7/05	0.00			5/29/05	0.00		
4/8/05	0.00			5/30/05	0.00		
4/9/05	0.00			5/31/05	0.00	2.77	
4/10/05	0.00			6/1/05	0.00		
4/11/05	0.00			6/2/05	0.00		
4/12/05	0.00			6/3/05	0.00		
4/13/05	0.00			6/4/05	0.00		
4/14/05	0.00			6/5/05	0.24		
4/15/05	0.00			6/6/05	0.00		
4/16/05	0.02			6/7/05	0.00		
4/17/05	0.00			6/8/05	0.00		
4/18/05	0.00			6/9/05	0.00		
4/19/05	0.00			6/10/05	0.00		
4/20/05	0.15			6/11/05	0.03		
4/21/05	0.00			6/12/05	0.00		
4/22/05	0.16			6/13/05	0.42		
4/23/05	0.00			6/14/05	0.00		
4/24/05	0.00			6/15/05	0.00		
4/25/05	0.01			6/16/05	0.00		
4/26/05	0.00			6/17/05	0.00		
4/27/05	0.00			6/18/05	0.00		
4/28/05	0.00			6/19/05	0.00		
4/29/05	0.00			6/20/05	0.00		
4/30/05	0.00	1.08		6/21/05	0.00		
5/1/05	0.00			6/22/05	0.00		
5/2/05	0.00			6/23/05	0.00		
5/3/05	0.00			6/24/05	0.00		
5/4/05	0.00			6/25/05	0.26		
5/5/05	0.00			6/26/05	0.74		
5/6/05	0.42			6/27/05	0.00		
5/7/05	0.00			6/28/05	0.00		
5/8/05	0.00			6/29/05	0.00		
5/9/05	0.37			6/30/05	0.20	1.89	
5/10/05	0.00			7/1/05	0.00		
5/11/05	0.62			7/2/05	0.00		
5/12/05	0.00			7/3/05	0.00		
5/13/05	0.23			7/4/05	0.38		
5/14/05	0.00			7/5/05	0.00		
5/15/05	0.00			7/6/05	0.00		
5/16/05	0.00			7/7/05	0.00		
5/17/05	0.00			7/8/05	0.00		
5/18/05	0.00			7/9/05	0.00		
5/19/05	0.95			7/10/05	0.00		
5/20/05	0.00			7/11/05	0.00		
5/21/05	0.00			7/12/05	0.13		
5/22/05	0.02			7/13/05	0.03		
5/23/05	0.00			7/14/05	0.00		
5/24/05	0.00			7/15/05	0.00		
5/25/05	0.00			7/16/05	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
7/17/05	0.00			9/7/05	0.14		
7/18/05	0.00			9/8/05	0.00		
7/19/05	0.00			9/9/05	0.00		
7/20/05	0.31			9/10/05	0.00		
7/21/05	0.40			9/11/05	0.00		
7/22/05	0.00			9/12/05	0.00		
7/23/05	0.36			9/13/05	0.41		
7/24/05	0.00			9/14/05	0.00		
7/25/05	0.03			9/15/05	0.10		
7/26/05	0.51			9/16/05	0.02		
7/27/05	0.00			9/17/05	0.00		
7/28/05	0.00			9/18/05	0.00		
7/29/05	0.00			9/19/05	0.37		
7/30/05	0.00			9/20/05	0.00		
7/31/05	0.00	2.15		9/21/05	0.00		
8/1/05	0.00			9/22/05	1.20		
8/2/05	0.00			9/23/05	0.00		
8/3/05	0.03			9/24/05	0.01		
8/4/05	0.02			9/25/05	1.98		
8/5/05	0.00			9/26/05	0.00		
8/6/05	0.00			9/27/05	0.00		
8/7/05	0.00			9/28/05	0.13		
8/8/05	0.00			9/29/05	0.00		
8/9/05	0.00			9/30/05	0.00	4.36	
8/10/05	0.01			10/1/05	0.00		
8/11/05	0.05			10/2/05	0.00		
8/12/05	0.43			10/3/05	0.00		
8/13/05	0.00			10/4/05	0.00		
8/14/05	0.00			10/5/05	0.00		
8/15/05	0.00			10/6/05	0.00		
8/16/05	0.00			10/7/05	0.00		
8/17/05	0.00			10/8/05	0.00		
8/18/05	0.54			10/9/05	0.00		
8/19/05	0.00			10/10/05	0.00		
8/20/05	0.13			10/11/05	0.01		
8/21/05	0.00			10/12/05	0.05		
8/22/05	0.00			10/13/05	0.00		
8/23/05	0.00			10/14/05	0.00		
8/24/05	0.00			10/15/05	0.00		
8/25/05	0.00			10/16/05	0.00		
8/26/05	0.00			10/17/05	0.29		
8/27/05	0.32			10/18/05	0.00		
8/28/05	0.00			10/19/05	0.00		
8/29/05	0.00			10/20/05	0.00		
8/30/05	0.00			10/21/05	0.00		
8/31/05	0.00	1.53		10/22/05	0.06		
9/1/05	0.00			10/23/05	0.09		
9/2/05	0.00			10/24/05	0.01		
9/3/05	0.00			10/25/05	0.00		
9/4/05	0.00			10/26/05	0.00		
9/5/05	0.00			10/27/05	0.00		
9/6/05	0.00			10/28/05	0.00		

DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT	DATE	DAILY TOTAL	MONTHLY TOTAL	COMMENT
10/29/05	0.00			12/20/05	0.00		
10/30/05	0.00			12/21/05	0.00		
10/31/05	0.00	0.51		12/22/05	0.00		
11/1/05	0.00			12/23/05	0.00		
11/2/05	0.00			12/24/05	0.00		
11/3/05	0.00			12/25/05	0.00		
11/4/05	0.00			12/26/05	0.00		
11/5/05	1.34			12/27/05	0.00		
11/6/05	0.57			12/28/05	0.02		
11/7/05	0.00			12/29/05	0.00		
11/8/05	0.02			12/30/05	0.30		
11/9/05	0.00			12/31/05	0.00	1.06	
11/10/05	0.00						
11/11/05	0.00						
11/12/05	0.22						
11/13/05	0.00						
11/14/05	0.22						
11/15/05	0.48						
11/16/05	0.06						
11/17/05	0.00						
11/18/05	0.00						
11/19/05	0.00						
11/20/05	0.00						
11/21/05	0.00						
11/22/05	0.00						
11/23/05	0.11						
11/24/05	0.00						
11/25/05	0.17						
11/26/05	0.00						
11/27/05	0.40						
11/28/05	0.68						
11/29/05	0.00						
11/30/05	0.00	4.27					
12/1/05	0.05						
12/2/05	0.00						
12/3/05	0.18						
12/4/05	0.06						
12/5/05	0.00						
12/6/05	0.00						
12/7/05	0.00						
12/8/05	0.14						
12/9/05	0.08						
12/10/05	0.00						
12/11/05	0.00						
12/12/05	0.00						
12/13/05	0.00						
12/14/05	0.20						
12/15/05	0.03						
12/16/05	0.00						
12/17/05	0.00						
12/18/05	0.00						
12/19/05	0.00						

APPENDIX D

SUMMARY STATISTICS, UNDERWOOD CREEK WATER QUALITY DATA

Variable Abbreviations Table

Variable:	**pH**	**TEMP**	**DO**	**AMMONIA**	**NITRITE**	**NITRATE**	**PHOS**	**SOLPHOS**	**SOLSIL**	**CHLA**
Full Name:	pH	Temperature	Dissolved Oxygen	Ammonia	Nitrite	Nitrate	Phosphorus	Soluble Phosphorus	Soluble Silica	Chloro-phyll a
Variable:	**SS**	**VSS**	**TS**	**FECAL**	**SPEC**	**CHLOR**	**AA_CD**	**CR**	**CU**	**NI**
Full Name:	Suspended Solids	Volatile Suspended Solids	Total Solids	Fecal Coliform Bacteria	Specific Conductance	Chloride	Cadmium	Chromium	Copper	Nickel
Variable:	**AA_PB**	**ZN**	**CA**	**MG**	**AA_AG**	**AA_AS**	**AA_SE**	**DS**	**LFC**	**HARD**
Full Name:	Lead	Zinc	Calcium	Magnesium	Silver	Arsenic	Selenium	Dissolved Solids	Log Fecal Coliform Bacteria	Hardness
Variable:	**SCHII**	**TURB**	**BOD5**	**BOD20**	**IXLITE**	**TNOC**	**TNIC**	**TNDOC**	**TALK**	**ECOLIQT**
Full Name:	Secchi Disk	Turbidity	5 day Biological Oxygen Demand	20 day Biological Oxygen Demand	Photometer	Total Organic Carbon	Total Inorganic Carbon	Total Dissolved Organic Carbon	Total Alkalinity	*Escherichia coli* E. coli

The following notations apply to all the following Summary Statistics, Underwood Creek Water Quality Data:

ND – No Data.
Method Detection Limit is the “Minimum” Value for data.

APPENDIX E

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-01, Pilgrim Road in Wirth Park

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.0	14.8	5.8	0.054	0.012	0.34	1.10	0.080	0.031	ND	9.44
Standard Error	0.1	1.3	0.8	0.016	0.005	0.28	0.29	0.005	0.006	ND	3.26
Median	7.0	16.3	5.7	0.052	0.008	0.05	0.84	0.079	0.033	ND	5.36
Mode	ND	ND	ND	ND	0.000	ND	ND	0.077	ND	ND	ND
Standard Deviation	0.2	3.7	2.2	0.045	0.014	0.79	0.81	0.015	0.018	ND	9.21
Sample Variance	0.0	13.3	4.6	0.002	0.000	0.63	0.66	0.000	0.000	ND	84.91
Kurtosis	0.1	0.0	-2.3	0.593	-1.719	7.91	0.33	1.629	-0.378	ND	1.27
Skewness	-0.3	-1.3	0.1	0.868	0.508	2.81	1.22	-0.719	-0.566	ND	1.55
Range	0.6	9.1	4.9	0.140	0.032	2.30	2.34	0.049	0.053	0.00	25.22
Minimum	6.7	8.3	3.5	0.000	0.000	0.00	0.26	0.051	0.000	0.00	2.58
Maximum	7.3	17.4	8.4	0.140	0.032	2.30	2.60	0.100	0.053	0.00	27.80
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.2	3.1	1.8	0.038	0.012	0.66	0.68	0.012	0.015	ND	7.70

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	5.3	1.4	898.8	4290	6011	1404	251.3	0.0	1.0	1.5	2.1
Standard Error	1.1	0.6	41.1	4102	5714	68	32.7	0.0	1.0	1.5	0.3
Median	4.4	0.8	935.0	160	245	1443	250.0	0.0	1.0	1.5	2.1
Mode	ND	0.0	ND	ND	ND	ND	ND	0.0	ND	ND	ND
Standard Deviation	3.1	1.7	116.2	11602	16161	192	92.5	0.0	1.3	2.1	0.5
Sample Variance	9.4	2.9	13498.2	134599779	261169631	36704	8555.4	0.0	1.8	4.5	0.2
Kurtosis	3.4	-1.0	2.8	8	8	1	-0.1	ND	ND	ND	ND
Skewness	1.7	0.7	-1.6	3	3	-1	0.3	ND	ND	ND	ND
Range	9.7	4.3	350.0	32960	45988	605	280.0	0.0	1.9	3.0	0.7
Minimum	2.3	0.0	650.0	40	12	1055	130.0	0.0	0.0	0.0	1.7
Maximum	12.0	4.3	1000.0	33000	46000	1660	410.0	0.0	1.9	3.0	2.4
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	2.6	1.4	97.1	9699	13511	160	77.3	0.0	12.1	19.1	4.4

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-01, Pilgrim Road in Wirth Park

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	ug/L	ug/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	mg/L	CFU/100 mL	mg/L
STATISTICS											
Mean	2.0	6.4	99.50	41.00	0.0	4.7	0.0	0.0	893.5	2.4	415
Standard Error	2.0	0.7	10.50	3.00	0.0	4.7	0.0	0.0	40.5	0.3	35
Median	2.0	6.4	99.50	41.00	0.0	4.7	0.0	0.0	931.7	2.2	415
Mode	ND	ND	ND	ND	0.0	ND	0.0	0.0	ND	ND	ND
Standard Deviation	2.8	1.0	14.85	4.24	0.0	6.6	0.0	0.0	114.6	0.9	49
Sample Variance	7.6	1.0	220.50	18.00	0.0	44.2	0.0	0.0	13124.7	0.8	2450
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	2.8	5.0	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-1.6	2.1	ND
Range	3.9	1.4	21.00	6.00	0.0	9.4	0.0	0.0	340.3	2.9	70
Minimum	0.0	5.7	89.00	38.00	0.0	0.0	0.0	0.0	647.7	1.6	380
Maximum	3.9	7.1	110.00	44.00	0.0	9.4	0.0	0.0	988.0	4.5	450
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	24.8	8.9	133.41	38.12	0.0	59.7	0.0	0.0	95.8	0.8	445

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	meters	NTU	mg/L	mg/L	meters	mg/L	mg/L	mg/L	mg/L
STATISTICS									
Mean	ND	3.6	1.3	8.2	ND	10.5	60.8	9.5	254
Standard Error	ND	0.6	0.5	0.4	ND	1.4	5.0	1.3	22
Median	ND	2.9	1.0	7.8	ND	10.0	61.0	9.4	255
Mode	ND	ND	0.0	7.9	ND	ND	61.0	ND	310
Standard Deviation	ND	1.8	1.5	1.2	ND	4.0	14.3	3.7	62
Sample Variance	ND	3.2	2.1	1.5	ND	16.3	203.4	13.5	3855
Kurtosis	ND	-0.5	-1.7	4.7	ND	0.4	1.0	-0.1	-1
Skewness	ND	1.1	0.4	2.1	ND	0.2	-0.9	0.1	0
Range	0.0	4.7	3.6	3.8	0.0	13.1	43.0	11.4	180
Minimum	0.0	1.9	0.0	7.2	0.0	3.9	33.0	3.6	150
Maximum	0.0	6.6	3.6	11.0	0.0	17.0	76.0	15.0	330
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	1.5	1.2	1.0	ND	3.4	11.9	3.1	52

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-01, Pilgrim Road in Wirth Park

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.0	13.7	5.7	0.058	0.022	0.93	1.28	0.062	0.028	ND	11.79
Standard Error	0.1	1.8	1.2	0.019	0.009	0.58	0.20	0.009	0.007	ND	4.50
Median	7.0	13.2	5.1	0.039	0.023	0.29	1.25	0.064	0.031	ND	6.36
Mode	ND	ND	ND	ND	0.000	0.09	ND	ND	0.000	ND	ND
Standard Deviation	0.3	5.0	3.5	0.053	0.024	1.64	0.56	0.024	0.020	ND	12.72
Sample Variance	0.1	24.7	12.3	0.003	0.001	2.69	0.31	0.001	0.000	ND	161.72
Kurtosis	-1.3	-1.1	-0.9	0.857	2.977	6.95	0.16	1.750	-0.758	ND	1.32
Skewness	-0.3	-0.2	0.8	1.437	1.496	2.59	0.69	0.819	-0.519	ND	1.37
Range	0.7	14.1	8.9	0.149	0.074	4.84	1.65	0.079	0.054	0.00	35.88
Minimum	6.6	5.8	2.2	0.011	0.000	0.06	0.65	0.031	0.000	0.00	1.52
Maximum	7.3	19.9	11.1	0.160	0.074	4.90	2.30	0.110	0.054	0.00	37.40
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.2	4.2	2.9	0.044	0.020	1.37	0.47	0.020	0.016	ND	10.63

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	6.1	2.2	908.8	811	513	1439	258.8	0.0	0.8	3.2	2.0
Standard Error	1.3	0.3	97.3	631	322	154	39.9	0.0	0.8	0.7	0.0
Median	4.7	2.1	985.0	115	100	1525	215.0	0.0	0.8	3.2	2.0
Mode	ND	2.6	1100.0	ND	ND	ND	420.0	0.0	ND	ND	ND
Standard Deviation	3.6	1.0	275.3	1785	911	436	112.9	0.0	1.1	1.0	0.1
Sample Variance	13.3	1.0	75783.9	3184795	829628	190430	12755.4	0.0	1.3	1.0	0.0
Kurtosis	0.3	-1.6	0.3	8	7	0	-1.1	ND	ND	ND	ND
Skewness	1.0	0.3	-1.1	3	3	-1	0.6	ND	ND	ND	ND
Range	10.4	2.6	800.0	5172	2677	1240	290.0	0.0	1.6	1.4	0.1
Minimum	2.6	1.0	400.0	28	23	709	130.0	0.0	0.0	2.5	1.9
Maximum	13.0	3.6	1200.0	5200	2700	1949	420.0	0.0	1.6	3.9	2.0
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	3.0	0.8	230.1	1492	761	365	94.4	0.0	10.2	8.9	0.6

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-01, Pilgrim Road in Wirth Park

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	7.0	82.50	34.50	0.9	2.7	0.0	0.0	902.7	2.3	345
Standard Error	0.0	7.0	47.50	20.50	0.4	2.7	0.0	0.0	97.7	0.3	205
Median	0.0	7.0	82.50	34.50	0.9	2.7	0.0	0.0	979.2	2.1	345
Mode	0.0	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	9.9	67.18	28.99	0.6	3.8	0.0	0.0	276.4	0.7	290
Sample Variance	0.0	98.0	4512.50	840.50	0.3	14.6	0.0	0.0	76423.8	0.5	84050
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	0.2	1.4	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-1.1	1.1	ND
Range	0.0	14.0	95.00	41.00	0.8	5.4	0.0	0.0	799.4	2.3	410
Minimum	0.0	0.0	35.00	14.00	0.5	0.0	0.0	0.0	396.4	1.4	140
Maximum	0.0	14.0	130.00	55.00	1.3	5.4	0.0	0.0	1195.8	3.7	550
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	88.9	603.54	260.48	5.3	34.3	0.0	0.0	231.1	0.6	2605

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	3.7	0.8	9.2	ND	12.8	56.3	12.5	235
Standard Error	ND	1.1	0.5	1.1	ND	2.9	12.7	4.8	27
Median	ND	2.5	0.0	8.2	ND	12.2	59.5	9.0	245
Mode	ND	ND	0.0	8.2	ND	ND	ND	ND	ND
Standard Deviation	ND	3.2	1.5	3.2	ND	5.9	25.3	8.3	77
Sample Variance	ND	10.1	2.1	10.1	ND	34.6	642.3	69.3	5857
Kurtosis	ND	5.7	2.2	0.5	ND	-2.1	0.6	ND	1
Skewness	ND	2.4	1.8	1.1	ND	0.4	-0.7	1.6	-1
Range	0.0	9.5	3.8	9.8	0.0	13.1	60.0	15.5	230
Minimum	0.0	1.8	0.0	5.2	0.0	6.9	23.0	6.5	90
Maximum	0.0	11.2	3.8	15.0	0.0	20.0	83.0	22.0	320
Count	0	8	8	8	0	4	4	3	8
Confidence Level (95.0%)	ND	2.7	1.2	2.7	ND	9.4	40.3	20.7	64

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-01, Pilgrim Road in Wirth Park

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	6.8	15.6	2.6	0.041	0.019	0.17	1.02	0.209	0.085	ND	9.62
Standard Error	0.1	1.8	1.0	0.033	0.004	0.08	0.14	0.076	0.027	ND	4.86
Median	6.8	16.0	1.3	0.011	0.016	0.09	1.02	0.104	0.061	ND	4.37
Mode	ND	ND	1.2	0.000	ND	ND	1.20	0.051	ND	ND	ND
Standard Deviation	0.3	5.2	2.9	0.093	0.011	0.21	0.40	0.214	0.075	ND	13.74
Sample Variance	0.1	26.7	8.7	0.009	0.000	0.05	0.16	0.046	0.006	ND	188.84
Kurtosis	-0.9	-0.3	0.2	7.846	-0.185	3.77	0.90	-0.397	1.864	ND	6.86
Skewness	-0.2	-0.5	1.4	2.792	0.987	1.92	0.88	1.207	1.437	ND	2.57
Range	0.7	15.8	7.7	0.270	0.030	0.62	1.25	0.499	0.221	0.00	41.79
Minimum	6.4	6.6	0.1	0.000	0.007	0.02	0.55	0.051	0.019	0.00	1.01
Maximum	7.2	22.3	7.9	0.270	0.037	0.64	1.80	0.550	0.240	0.00	42.80
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.2	4.3	2.5	0.078	0.009	0.18	0.34	0.179	0.063	ND	11.49

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	11.0	4.2	958.8	1939	3245	1589	281.3	0.0	5.8	18.0	2.5
Standard Error	2.9	1.0	66.2	1085	2450	108	35.4	0.0	0.7	0.0	0.6
Median	10.1	4.1	955.0	335	285	1494	240.0	0.0	5.8	18.0	2.5
Mode	ND	ND	1100.0	ND	ND	ND	ND	0.0	ND	ND	ND
Standard Deviation	8.2	2.7	187.3	3069	6929	304	100.1	0.0	0.9	ND	0.8
Sample Variance	66.6	7.4	35069.6	9417696	48009343	92484	10012.5	0.0	0.8	ND	0.7
Kurtosis	0.0	0.0	1.4	1	7	0	-1.2	ND	ND	ND	ND
Skewness	0.8	0.7	-0.9	2	3	0	0.7	ND	ND	ND	ND
Range	23.2	8.0	610.0	7793	19983	967	260.0	0.0	1.3	0.0	1.2
Minimum	2.8	1.2	590.0	7	17	1086	170.0	0.0	5.1	18.0	1.9
Maximum	26.0	9.2	1200.0	7800	20000	2053	430.0	0.0	6.4	18.0	3.1
Count	8	8	8	8	8	8	8	2	2	1	2
Confidence Level (95.0%)	6.8	2.3	156.6	2566	5793	254	83.7	0.0	8.3	ND	7.6

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-01, Pilgrim Road in Wirth Park

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	13.5	103.00	43.50	0.6	0.0	0.0	0.0	947.8	2.5	440
Standard Error	0.0	13.5	7.00	4.50	0.6	0.0	0.0	0.0	65.5	0.4	40
Median	0.0	13.5	103.00	43.50	0.6	0.0	0.0	0.0	940.3	2.4	440
Mode	0.0	ND	ND	ND	ND	0.0	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	19.1	9.90	6.36	0.8	0.0	0.0	0.0	185.3	1.1	57
Sample Variance	0.0	364.5	98.00	40.50	0.6	0.0	0.0	0.0	34333.4	1.2	3200
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	1.2	-1.1	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.9	-0.1	ND
Range	0.0	27.0	14.00	9.00	1.1	0.0	0.0	0.0	594.8	3.0	80
Minimum	0.0	0.0	96.00	39.00	0.0	0.0	0.0	0.0	587.2	0.8	400
Maximum	0.0	27.0	110.00	48.00	1.1	0.0	0.0	0.0	1182.0	3.9	480
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	171.5	88.94	57.18	7.0	0.0	0.0	0.0	154.9	0.9	508

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	4.5	1.2	7.6	ND	12.2	64.6	11.2	266
Standard Error	ND	1.4	0.5	1.6	ND	2.4	5.8	2.4	20
Median	ND	2.6	1.1	7.9	ND	10.0	69.0	7.4	275
Mode	ND	ND	0.0	ND	ND	7.6	ND	ND	310
Standard Deviation	ND	3.9	1.3	4.5	ND	6.3	15.4	6.2	57
Sample Variance	ND	15.2	1.7	20.3	ND	39.7	237.3	39.0	3227
Kurtosis	ND	2.3	-2.8	0.6	ND	-2.2	3.0	-2.3	0
Skewness	ND	1.8	0.0	-0.1	ND	0.2	-1.3	0.3	-1
Range	0.0	10.9	2.5	15.0	0.0	15.6	50.0	14.9	170
Minimum	0.0	1.8	0.0	0.0	0.0	4.4	34.0	4.1	160
Maximum	0.0	12.7	2.5	15.0	0.0	20.0	84.0	19.0	330
Count	0	8	8	8	0	7	7	7	8
Confidence Level (95.0%)	ND	3.3	1.1	3.8	ND	5.8	14.2	5.8	47

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-02, Lilly Road & Marcella Street

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.6	15.3	6.4	0.121	0.023	0.42	1.25	0.145	0.090	ND	8.15
Standard Error	0.1	1.7	0.9	0.029	0.006	0.19	0.19	0.041	0.035	ND	4.35
Median	7.7	15.8	6.6	0.116	0.026	0.29	1.03	0.130	0.070	ND	3.28
Mode	ND	ND	ND	ND	0.000	ND	ND	0.130	ND	ND	ND
Standard Deviation	0.2	4.8	2.6	0.083	0.016	0.54	0.55	0.115	0.099	ND	12.31
Sample Variance	0.1	23.2	6.8	0.007	0.000	0.29	0.30	0.013	0.010	ND	151.57
Kurtosis	2.8	-0.1	1.5	-0.530	-0.744	6.44	0.50	5.087	5.520	ND	5.99
Skewness	-1.4	-0.9	-0.8	0.355	-0.416	2.45	1.21	2.089	2.178	ND	2.41
Range	0.7	14.2	8.3	0.248	0.045	1.65	1.53	0.371	0.320	0.00	36.11
Minimum	7.2	6.8	1.3	0.012	0.000	0.05	0.77	0.039	0.000	0.00	1.19
Maximum	7.9	21.0	9.7	0.260	0.045	1.70	2.30	0.410	0.320	0.00	37.30
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.2	4.0	2.2	0.069	0.014	0.45	0.46	0.096	0.083	ND	10.29

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	18.1	3.1	843.8	11319	4996	1319	238.8	0.0	3.0	3.4	2.7
Standard Error	5.3	1.2	43.0	10244	3730	67	24.2	0.0	1.3	1.1	0.2
Median	12.5	2.2	880.0	1100	1110	1371	240.0	0.0	3.0	3.4	2.7
Mode	ND	0.0	880.0	1100	ND	ND	ND	0.0	ND	ND	ND
Standard Deviation	15.0	3.3	121.5	28974	10549	190	68.5	0.0	1.8	1.5	0.3
Sample Variance	226.1	10.8	14769.6	839476389	111285284	36166	4698.2	0.0	3.4	2.2	0.1
Kurtosis	-1.3	-1.6	6.9	8	8	6	-1.3	ND	ND	ND	ND
Skewness	0.7	0.6	-2.6	3	3	-2	-0.3	ND	ND	ND	ND
Range	37.6	7.9	370.0	82907	30850	635	190.0	0.0	2.6	2.1	0.4
Minimum	3.4	0.0	550.0	93	150	869	130.0	0.0	1.7	2.3	2.5
Maximum	41.0	7.9	920.0	83000	31000	1504	320.0	0.0	4.3	4.4	2.9
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	12.6	2.7	101.6	24223	8819	159	57.3	0.0	16.5	13.3	2.5

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-02, Lilly Road & Marcella Street

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	4.5	16.0	79.50	34.00	0.0	5.0	0.0	0.0	825.6	3.1	345
Standard Error	2.0	4.0	20.50	9.00	0.0	5.0	0.0	0.0	45.7	0.3	95
Median	4.5	16.0	79.50	34.00	0.0	5.0	0.0	0.0	867.5	3.0	345
Mode	ND	ND	ND	ND	0.0	ND	0.0	ND	ND	3.0	ND
Standard Deviation	2.8	5.7	28.99	12.73	0.0	7.1	0.0	0.0	129.3	0.8	134
Sample Variance	8.0	32.0	840.50	162.00	0.0	50.0	0.0	0.0	16712.9	0.7	18050
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	7.1	3.3	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-2.6	1.3	ND
Range	4.0	8.0	41.00	18.00	0.0	10.0	0.0	0.1	400.1	3.0	190
Minimum	2.5	12.0	59.00	25.00	0.0	0.0	0.0	0.0	512.0	2.0	250
Maximum	6.5	20.0	100.00	43.00	0.0	10.0	0.0	0.1	912.1	4.9	440
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	25.4	50.8	260.48	114.36	0.0	63.5	0.0	0.4	108.1	0.7	1207

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	10.2	1.7	8.9	ND	11.8	56.5	10.2	238
Standard Error	ND	2.1	0.8	1.0	ND	0.8	5.8	0.8	25
Median	ND	11.0	1.0	8.2	ND	12.5	54.0	11.0	230
Mode	ND	12.6	0.0	ND	ND	13.0	ND	11.0	320
Standard Deviation	ND	6.0	2.1	2.8	ND	2.3	16.5	2.4	69
Sample Variance	ND	36.0	4.5	7.6	ND	5.1	271.7	5.7	4821
Kurtosis	ND	0.3	-0.2	4.0	ND	-0.7	-1.2	-1.1	-2
Skewness	ND	0.6	1.0	1.8	ND	-0.4	0.1	0.1	0
Range	0.0	17.9	5.6	9.0	0.0	6.6	46.0	6.8	170
Minimum	0.0	3.4	0.0	6.0	0.0	8.4	35.0	7.2	150
Maximum	0.0	21.3	5.6	15.0	0.0	15.0	81.0	14.0	320
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	5.0	1.8	2.3	ND	1.9	13.8	2.0	58

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-02, Lilly Road & Marcella Street

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.7	13.8	8.2	0.039	0.010	0.80	1.11	0.061	0.030	ND	5.05
Standard Error	0.1	2.1	1.2	0.013	0.005	0.42	0.14	0.011	0.007	ND	2.09
Median	7.8	14.1	7.6	0.027	0.007	0.51	1.10	0.052	0.026	ND	2.67
Mode	ND	ND	ND	ND	0.000	ND	1.60	ND	ND	ND	ND
Standard Deviation	0.4	5.9	3.4	0.036	0.013	1.20	0.40	0.030	0.018	ND	5.90
Sample Variance	0.1	34.8	11.4	0.001	0.000	1.44	0.16	0.001	0.000	ND	34.84
Kurtosis	-0.1	-1.2	-0.5	1.227	2.304	6.86	-1.68	2.978	-0.638	ND	3.15
Skewness	-1.1	-0.4	0.5	1.473	1.473	2.56	0.02	1.556	-0.431	ND	1.87
Range	1.1	16.6	9.6	0.100	0.037	3.66	1.04	0.091	0.052	0.00	17.49
Minimum	7.0	4.2	3.5	0.010	0.000	0.04	0.56	0.029	0.000	0.00	0.41
Maximum	8.1	20.8	13.1	0.110	0.037	3.70	1.60	0.120	0.052	0.00	17.90
Count	8	8	8	8	8	8	8	7	7	0	8
Confidence Level (95.0%)	0.3	4.9	2.8	0.030	0.011	1.00	0.34	0.027	0.017	ND	4.93

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	8.1	2.1	846.3	1640	1703	1331	228.1	0.0	0.6	3.8	2.1
Standard Error	2.5	0.6	95.2	648	785	145	32.8	0.0	0.6	1.0	0.1
Median	6.6	1.7	905.0	1065	720	1469	215.0	0.0	0.6	3.8	2.1
Mode	6.6	1.4	1100.0	ND	340	ND	ND	0.0	ND	ND	ND
Standard Deviation	7.2	1.6	269.2	1832	2219	409	92.7	0.0	0.8	1.3	0.1
Sample Variance	51.9	2.7	72455.4	3357629	4925964	167360	8599.6	0.0	0.7	1.8	0.0
Kurtosis	5.7	4.2	1.7	2	4	1	-1.1	ND	ND	ND	ND
Skewness	2.3	1.6	-1.4	1	2	-1	0.0	ND	ND	ND	ND
Range	22.2	5.7	800.0	5280	6450	1273	265.0	0.0	1.2	1.9	0.2
Minimum	2.8	0.0	300.0	120	150	518	95.0	0.0	0.0	2.8	2.0
Maximum	25.0	5.7	1100.0	5400	6600	1791	360.0	0.0	1.2	4.7	2.2
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	6.0	1.4	225.0	1532	1856	342	77.5	0.0	7.6	12.1	1.3

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-02, Lilly Road & Marcella Street

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	6.5	69.50	31.00	0.6	1.8	0.0	0.0	838.2	2.9	305
Standard Error	0.0	6.5	40.50	20.00	0.6	1.8	0.0	0.0	96.0	0.2	185
Median	0.0	6.5	69.50	31.00	0.6	1.8	0.0	0.0	900.3	3.0	305
Mode	0.0	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	9.2	57.28	28.28	0.8	2.5	0.0	0.0	271.6	0.6	262
Sample Variance	0.0	84.5	3280.50	800.00	0.7	6.5	0.0	0.0	73788.1	0.4	68450
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	1.4	-1.8	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-1.3	-0.1	ND
Range	0.0	13.0	81.00	40.00	1.2	3.6	0.0	0.0	802.8	1.7	370
Minimum	0.0	0.0	29.00	11.00	0.0	0.0	0.0	0.0	293.4	2.1	120
Maximum	0.0	13.0	110.00	51.00	1.2	3.6	0.0	0.0	1096.2	3.7	490
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	82.6	514.60	254.12	7.6	22.9	0.0	0.0	227.1	0.5	2351

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	5.0	0.7	8.5	ND	10.8	51.3	11.1	243
Standard Error	ND	1.5	0.4	2.1	ND	1.8	10.7	3.5	26
Median	ND	3.0	0.0	7.6	ND	10.7	60.0	8.8	265
Mode	ND	ND	0.0	ND	ND	ND	65.0	ND	280
Standard Deviation	ND	4.4	1.2	5.8	ND	3.5	21.4	6.0	73
Sample Variance	ND	19.1	1.5	34.1	ND	12.4	456.3	36.6	5340
Kurtosis	ND	1.9	0.0	0.6	ND	-1.1	2.9	ND	5
Skewness	ND	1.7	1.4	0.6	ND	0.2	-1.7	1.5	-2
Range	0.0	11.8	2.7	19.0	0.0	8.2	45.0	11.4	233
Minimum	0.0	2.2	0.0	0.0	0.0	6.8	20.0	6.6	77
Maximum	0.0	14.0	2.7	19.0	0.0	15.0	65.0	18.0	310
Count	0	8	8	8	0	4	4	3	8
Confidence Level (95.0%)	ND	3.7	1.0	4.9	ND	5.6	34.0	15.0	61

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-02, Lilly Road & Marcella Street

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.5	15.2	6.8	0.131	0.025	0.23	1.03	0.170	0.107	ND	7.59
Standard Error	0.1	2.4	1.5	0.060	0.007	0.05	0.12	0.082	0.053	ND	3.42
Median	7.4	14.3	6.4	0.070	0.019	0.25	1.00	0.074	0.056	ND	3.01
Mode	7.4	ND	ND	0.000	ND	ND	1.20	ND	ND	ND	ND
Standard Deviation	0.3	6.4	4.1	0.160	0.019	0.13	0.31	0.216	0.140	ND	9.04
Sample Variance	0.1	41.2	16.7	0.025	0.000	0.02	0.09	0.047	0.020	ND	81.66
Kurtosis	1.1	-0.7	-0.9	0.309	-0.024	-1.84	-0.34	5.232	5.007	ND	0.73
Skewness	1.0	-0.5	0.4	1.042	1.146	-0.05	0.01	2.245	2.176	ND	1.29
Range	0.9	17.4	11.5	0.420	0.049	0.33	0.91	0.609	0.397	0.00	23.86
Minimum	7.1	4.7	1.8	0.000	0.009	0.07	0.59	0.031	0.013	0.00	0.44
Maximum	8.1	22.1	13.3	0.420	0.058	0.40	1.50	0.640	0.410	0.00	24.30
Count	7	7	7	7	7	7	7	7	7	0	7
Confidence Level (95.0%)	0.3	5.9	3.8	0.148	0.017	0.12	0.28	0.200	0.130	ND	8.36

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	9.0	3.0	962.9	1391	1267	1555	294.3	0.0	6.3	11.0	3.5
Standard Error	2.7	0.7	67.1	618	376	72	21.1	0.0	0.1	0.0	0.7
Median	5.9	3.2	940.0	870	1300	1477	290.0	0.0	6.3	11.0	3.5
Mode	5.2	ND	1200.0	ND	ND	ND	250.0	0.0	ND	ND	ND
Standard Deviation	7.1	1.9	177.6	1634	995	191	55.9	0.0	0.1	ND	1.0
Sample Variance	51.0	3.7	31557.1	2669481	990657	36405	3128.6	0.0	0.0	ND	1.0
Kurtosis	0.5	-0.8	-1.3	6	0	0	-1.2	ND	ND	ND	ND
Skewness	1.3	-0.5	0.5	2	1	1	0.5	ND	ND	ND	ND
Range	19.6	5.4	440.0	4820	2850	528	150.0	0.0	0.2	0.0	1.4
Minimum	2.4	0.0	760.0	180	150	1356	230.0	0.0	6.2	11.0	2.8
Maximum	22.0	5.4	1200.0	5000	3000	1884	380.0	0.0	6.4	11.0	4.2
Count	7	7	7	7	7	7	7	2	2	1	2
Confidence Level (95.0%)	6.6	1.8	164.3	1511	921	176	51.7	0.0	1.3	ND	8.9

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-02, Lilly Road & Marcella Street

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	19.1	86.00	35.50	0.4	0.0	0.0	0.0	953.8	2.9	365
Standard Error	0.0	13.9	14.00	7.50	0.4	0.0	0.0	0.0	66.1	0.2	65
Median	0.0	19.1	86.00	35.50	0.4	0.0	0.0	0.0	918.0	2.9	365
Mode	0.0	ND	ND	ND	ND	0.0	ND	0.0	ND	ND	ND
Standard Deviation	0.0	19.7	19.80	10.61	0.6	0.0	ND	0.0	175.0	0.4	92
Sample Variance	0.0	386.4	392.00	112.50	0.3	0.0	ND	0.0	30620.4	0.2	8450
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-1.3	1.6	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	0.6	0.2	ND
Range	0.0	27.8	28.00	15.00	0.8	0.0	0.0	0.0	435.8	1.4	130
Minimum	0.0	5.2	72.00	28.00	0.0	0.0	0.0	0.0	757.6	2.3	300
Maximum	0.0	33.0	100.00	43.00	0.8	0.0	0.0	0.0	1193.4	3.7	430
Count	2	2	2	2	2	2	1	2	7	7	2
Confidence Level (95.0%)	0.0	176.6	177.89	95.30	5.3	0.0	ND	0.0	161.8	0.4	826

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	5.6	2.1	8.4	ND	13.1	59.3	12.2	250
Standard Error	ND	1.7	0.6	1.5	ND	1.8	5.5	2.0	24
Median	ND	3.1	2.5	7.6	ND	14.5	63.0	13.0	280
Mode	ND	ND	0.0	ND	ND	ND	63.0	ND	280
Standard Deviation	ND	4.4	1.6	3.9	ND	4.5	13.4	5.0	63
Sample Variance	ND	19.2	2.5	15.2	ND	19.9	179.9	24.7	3967
Kurtosis	ND	-1.0	-0.8	2.0	ND	-0.5	0.6	-1.8	-1
Skewness	ND	1.0	-0.5	1.4	ND	-0.8	-0.9	-0.3	-1
Range	0.0	10.5	4.2	11.5	0.0	11.9	38.0	12.5	160
Minimum	0.0	2.0	0.0	4.5	0.0	6.1	37.0	5.5	150
Maximum	0.0	12.5	4.2	16.0	0.0	18.0	75.0	18.0	310
Count	0	7	7	7	0	6	6	6	7
Confidence Level (95.0%)	ND	4.0	1.5	3.6	ND	4.7	14.1	5.2	58

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-03, 124th & Bluemound Road

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	su	C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/m3
STATISTICS											
Mean	7.5	14.3	9.7	0.096	0.018	0.29	0.72	0.045	0.017	ND	3.95
Standard Error	0.1	1.0	0.6	0.016	0.007	0.12	0.15	0.010	0.005	ND	2.15
Median	7.5	15.4	9.4	0.082	0.015	0.13	0.58	0.046	0.017	ND	1.53
Mode	7.8	15.6	ND	ND	0.000	ND	ND	ND	0.000	ND	ND
Standard Deviation	0.2	2.9	1.6	0.044	0.021	0.35	0.42	0.027	0.014	ND	6.08
Sample Variance	0.1	8.3	2.5	0.002	0.000	0.12	0.18	0.001	0.000	ND	36.93
Kurtosis	-1.3	0.0	-0.9	2.752	2.771	4.89	-0.63	-1.238	-1.863	ND	6.45
Skewness	0.0	-1.0	0.2	1.680	1.548	2.15	0.92	0.268	-0.248	ND	2.51
Range	0.6	8.5	4.6	0.137	0.063	1.03	1.13	0.074	0.033	0.00	17.74
Minimum	7.2	9.4	7.4	0.053	0.000	0.07	0.27	0.013	0.000	0.00	0.76
Maximum	7.8	17.9	12.0	0.190	0.063	1.10	1.40	0.087	0.033	0.00	18.50
Count	8	8	8	8	8	8	8	8	7	0	8
Confidence Level (95.0%)	0.2	2.4	1.3	0.037	0.018	0.29	0.35	0.023	0.013	ND	5.08

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	mg/L	mg/L	mg/L	CFU/100 mL	MPN/100 mL	umhos/cm	mg/L	ug/L	ug/L	ug/L	ug/L
STATISTICS											
Mean	6.7	1.0	1025.0	1808	3764	1624	258.8	0.0	0.0	2.5	2.7
Standard Error	1.6	0.4	96.7	1459	3321	147	23.6	0.0	0.0	1.0	1.0
Median	5.2	0.5	995.0	310	430	1655	260.0	0.0	0.0	2.5	2.7
Mode	ND	0.0	1200.0	ND	ND	ND	ND	0.0	0.0	ND	ND
Standard Deviation	4.6	1.2	273.5	4127	9394	416	66.6	0.0	0.0	1.4	1.3
Sample Variance	21.3	1.5	74800.0	17034536	88250570	172980	4441.1	0.0	0.0	2.0	1.8
Kurtosis	3.9	-0.2	0.2	8	8	-1	-1.0	ND	ND	ND	ND
Skewness	1.9	1.0	0.3	3	3	0	0.0	ND	ND	ND	ND
Range	14.4	3.2	880.0	11890	26880	1206	200.0	0.0	0.0	2.0	1.9
Minimum	2.6	0.0	620.0	110	120	973	160.0	0.0	0.0	1.5	1.7
Maximum	17.0	3.2	1500.0	12000	27000	2179	360.0	0.0	0.0	3.5	3.6
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	3.9	1.0	228.6	3450	7854	348	55.7	0.0	0.0	12.7	12.1

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-03, 124th & Bluemound Road

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	2.8	23.5	104.50	42.00	0.0	5.5	0.0	0.0	1018.3	2.6	430
Standard Error	2.8	3.5	15.50	6.00	0.0	5.5	0.0	0.0	97.9	0.2	60
Median	2.8	23.5	104.50	42.00	0.0	5.5	0.0	0.0	990.9	2.5	430
Mode	ND	ND	ND	ND	0.0	ND	0.0	0.0	ND	ND	ND
Standard Deviation	3.9	4.9	21.92	8.49	0.0	7.8	0.0	0.0	277.0	0.7	85
Sample Variance	15.1	24.5	480.50	72.00	0.0	60.5	0.0	0.0	76746.6	0.4	7200
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	0.2	3.4	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	0.3	1.8	ND
Range	5.5	7.0	31.00	12.00	0.0	11.0	0.0	0.0	893.0	2.0	120
Minimum	0.0	20.0	89.00	36.00	0.0	0.0	0.0	0.0	603.0	2.0	370
Maximum	5.5	27.0	120.00	48.00	0.0	11.0	0.0	0.0	1496.0	4.1	490
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	34.9	44.5	196.95	76.24	0.0	69.9	0.0	0.0	231.6	0.5	762

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	9.2	1.1	7.1	ND	6.4	64.8	5.7	298
Standard Error	ND	0.9	0.5	0.4	ND	1.3	6.7	1.2	31
Median	ND	8.5	0.0	6.9	ND	5.6	68.5	4.6	345
Mode	ND	ND	0.0	7.1	ND	ND	80.0	ND	370
Standard Deviation	ND	2.6	1.5	1.3	ND	3.7	18.9	3.4	89
Sample Variance	ND	7.0	2.1	1.6	ND	13.5	356.5	11.3	7879
Kurtosis	ND	0.6	-2.2	4.5	ND	2.1	-0.3	3.2	-1
Skewness	ND	1.1	0.6	1.9	ND	1.5	-0.7	1.7	-1
Range	0.0	7.9	2.9	4.1	0.0	11.1	56.0	10.3	230
Minimum	0.0	6.4	0.0	5.9	0.0	2.9	31.0	2.7	140
Maximum	0.0	14.2	2.9	10.0	0.0	14.0	87.0	13.0	370
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	2.2	1.2	1.1	ND	3.1	15.8	2.8	74

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-03, 124th & Bluemound Road

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.5	13.4	10.7	0.073	0.010	0.66	1.24	0.308	0.017	ND	4.67
Standard Error	0.1	1.9	0.9	0.026	0.004	0.37	0.30	0.266	0.009	ND	1.53
Median	7.4	13.6	10.5	0.053	0.007	0.29	1.05	0.041	0.000	ND	3.96
Mode	ND	ND	ND	ND	0.000	0.07	1.30	ND	0.000	ND	ND
Standard Deviation	0.4	5.3	2.5	0.074	0.012	1.05	0.84	0.703	0.023	ND	4.32
Sample Variance	0.1	27.6	6.3	0.006	0.000	1.11	0.71	0.494	0.001	ND	18.65
Kurtosis	-0.5	-0.8	-0.9	4.327	-0.917	6.87	3.55	6.921	-1.092	ND	0.17
Skewness	0.5	-0.5	0.3	1.929	0.688	2.57	1.79	2.627	0.984	ND	0.89
Range	1.1	14.6	7.2	0.233	0.031	3.13	2.54	1.900	0.053	0.00	12.39
Minimum	7.0	4.5	7.2	0.007	0.000	0.07	0.56	0.000	0.000	0.00	0.41
Maximum	8.1	19.1	14.4	0.240	0.031	3.20	3.10	1.900	0.053	0.00	12.80
Count	8	8	8	8	8	8	8	7	7	0	8
Confidence Level (95.0%)	0.3	4.4	2.1	0.062	0.010	0.88	0.70	0.650	0.022	ND	3.61

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	128.0	21.8	1148.8	1887	1300	1559	258.8	0.0	0.0	3.7	3.5
Standard Error	119.0	19.8	150.8	992	675	218	29.6	0.0	0.0	0.9	0.8
Median	3.4	1.7	1150.0	830	450	1741	275.0	0.0	0.0	3.7	3.5
Mode	3.2	0.0	1100.0	ND	ND	ND	ND	0.0	0.0	ND	ND
Standard Deviation	336.5	55.9	426.5	2807	1909	617	83.7	0.0	0.0	1.3	1.1
Sample Variance	113211.2	3126.2	181926.8	7877631	3644111	380158	7012.5	0.0	0.0	1.6	1.3
Kurtosis	8.0	7.9	0.4	4	3	2	0.3	ND	ND	ND	ND
Skewness	2.8	2.8	0.2	2	2	-1	-0.5	ND	ND	ND	ND
Range	957.2	160.0	1340.0	8172	5443	2011	270.0	0.0	0.0	1.8	1.6
Minimum	2.8	0.0	560.0	28	57	281	110.0	0.0	0.0	2.8	2.7
Maximum	960.0	160.0	1900.0	8200	5500	2292	380.0	0.0	0.0	4.6	4.3
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	281.3	46.7	356.6	2346	1596	515	70.0	0.0	0.0	11.4	10.2

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-03, 124th & Bluemound Road

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	13.8	108.50	46.50	1.0	2.7	0.0	0.0	1020.8	2.7	465
Standard Error	0.0	8.3	41.50	19.50	0.5	2.7	0.0	0.0	109.7	0.3	185
Median	0.0	13.8	108.50	46.50	1.0	2.7	0.0	0.0	1096.9	2.9	465
Mode	0.0	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	11.7	58.69	27.58	0.6	3.8	0.0	0.0	310.4	0.9	262
Sample Variance	0.0	136.1	3444.50	760.50	0.4	14.6	0.0	0.0	96320.6	0.8	68450
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.7	-1.1	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.7	-0.2	ND
Range	0.0	16.5	83.00	39.00	0.9	5.4	0.0	0.0	878.0	2.5	370
Minimum	0.0	5.5	67.00	27.00	0.6	0.0	0.0	0.0	517.0	1.4	280
Maximum	0.0	22.0	150.00	66.00	1.5	5.4	0.0	0.0	1395.0	3.9	650
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	104.8	527.31	247.77	5.8	34.3	0.0	0.0	259.5	0.7	2351

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	263.1	1.5	7.0	ND	9.1	63.8	9.3	283
Standard Error	ND	255.3	0.8	2.1	ND	1.3	5.4	1.5	24
Median	ND	4.7	0.0	6.0	ND	10.9	66.0	9.4	290
Mode	ND	ND	0.0	0.0	ND	12.0	ND	ND	290
Standard Deviation	ND	722.1	2.1	6.1	ND	3.8	15.2	4.3	68
Sample Variance	ND	521399.0	4.6	36.6	ND	14.2	230.5	18.5	4564
Kurtosis	ND	8.0	-1.5	-0.7	ND	-1.7	-1.3	0.4	0
Skewness	ND	2.8	0.8	0.4	ND	-0.6	-0.2	0.5	0
Range	0.0	2047.8	4.7	17.0	0.0	9.6	43.0	13.9	200
Minimum	0.0	2.2	0.0	0.0	0.0	3.4	42.0	3.1	180
Maximum	0.0	2050.0	4.7	17.0	0.0	13.0	85.0	17.0	380
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	603.7	1.8	5.1	ND	3.2	12.7	3.6	56

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-03, 124th & Bluemound Road

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	su	C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/m3
STATISTICS											
Mean	7.4	14.0	10.0	0.050	0.024	0.17	0.70	0.040	0.023	ND	6.90
Standard Error	0.1	1.3	0.6	0.017	0.007	0.03	0.10	0.012	0.006	ND	4.78
Median	7.3	14.2	9.6	0.037	0.017	0.20	0.75	0.028	0.017	ND	1.16
Mode	ND	ND	ND	ND	0.013	0.24	ND	ND	0.015	ND	ND
Standard Deviation	0.4	3.6	1.8	0.049	0.020	0.09	0.28	0.034	0.016	ND	13.52
Sample Variance	0.2	12.9	3.1	0.002	0.000	0.01	0.08	0.001	0.000	ND	182.91
Kurtosis	-0.7	2.6	-1.4	-0.079	5.762	-1.82	-0.91	1.857	5.063	ND	6.89
Skewness	0.6	-0.5	0.3	0.942	2.300	-0.34	-0.19	1.611	2.176	ND	2.60
Range	1.1	13.0	4.9	0.140	0.064	0.23	0.83	0.095	0.050	0.00	39.16
Minimum	6.9	7.0	7.8	0.000	0.007	0.05	0.27	0.015	0.011	0.00	0.44
Maximum	8.0	20.0	12.7	0.140	0.071	0.28	1.10	0.110	0.061	0.00	39.60
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.3	3.0	1.5	0.041	0.017	0.08	0.24	0.028	0.014	ND	11.31

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	mg/L	mg/L	mg/L	CFU/100 mL	MPN/100 mL	umhos/cm	mg/L	ug/L	ug/L	ug/L	ug/L
STATISTICS											
Mean	4.9	1.6	1246.3	1120	1053	1913	302.5	0.0	5.8	4.8	4.5
Standard Error	1.5	0.7	78.1	747	648	88	13.9	0.0	0.2	0.0	0.8
Median	3.8	1.0	1250.0	265	245	1940	305.0	0.0	5.8	4.8	4.5
Mode	4.4	0.0	1500.0	ND	ND	ND	310.0	0.0	ND	ND	ND
Standard Deviation	4.2	2.0	221.0	2112	1834	248	39.2	0.0	0.3	ND	1.2
Sample Variance	17.3	3.9	48826.8	4462166	3363047	61615	1535.7	0.0	0.1	ND	1.4
Kurtosis	7.1	0.5	-0.6	7	5	-1	2.6	ND	ND	ND	ND
Skewness	2.6	1.0	-0.4	3	2	0	0.7	ND	ND	ND	ND
Range	12.6	5.4	630.0	6138	5288	732	140.0	0.0	0.4	0.0	1.7
Minimum	2.4	0.0	870.0	62	12	1524	240.0	0.0	5.6	4.8	3.6
Maximum	15.0	5.4	1500.0	6200	5300	2256	380.0	0.0	6.0	4.8	5.3
Count	8	8	8	8	8	8	8	2	2	1	2
Confidence Level (95.0%)	3.5	1.7	184.7	1766	1533	208	32.8	0.0	2.5	ND	10.8

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-03, 124th & Bluemound Road

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	12.0	140.00	58.50	0.8	0.0	0.0	0.0	1241.4	2.5	595
Standard Error	0.0	2.0	20.00	9.50	0.1	0.0	0.0	0.0	77.5	0.2	95
Median	0.0	12.0	140.00	58.50	0.8	0.0	0.0	0.0	1245.6	2.4	595
Mode	0.0	ND	ND	ND	ND	0.0	ND	0.0	ND	ND	ND
Standard Deviation	0.0	2.8	28.28	13.44	0.2	0.0	ND	0.0	219.1	0.7	134
Sample Variance	0.0	8.0	800.00	180.50	0.0	0.0	ND	0.0	48005.5	0.4	18050
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.6	0.8	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.4	1.1	ND
Range	0.0	4.0	40.00	19.00	0.3	0.0	0.0	0.0	629.6	2.0	190
Minimum	0.0	10.0	120.00	49.00	0.7	0.0	0.0	0.0	867.6	1.8	500
Maximum	0.0	14.0	160.00	68.00	0.9	0.0	0.0	0.0	1497.2	3.8	690
Count	2	2	2	2	2	2	1	2	8	8	2
Confidence Level (95.0%)	0.0	25.4	254.12	120.71	1.6	0.0	ND	0.0	183.2	0.5	1207

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	7.8	1.4	4.9	ND	8.5	68.4	7.9	328
Standard Error	ND	2.4	0.6	1.2	ND	2.2	9.8	2.0	21
Median	ND	5.0	1.1	5.6	ND	7.9	78.0	6.5	335
Mode	ND	ND	0.0	0.0	ND	15.0	ND	14.0	390
Standard Deviation	ND	6.7	1.6	3.3	ND	5.9	26.0	5.3	60
Sample Variance	ND	44.7	2.5	10.8	ND	34.4	673.6	28.4	3593
Kurtosis	ND	2.2	-0.9	-0.6	ND	-2.2	1.4	-2.2	-2
Skewness	ND	1.7	0.6	-0.7	ND	0.0	-1.4	0.1	0
Range	0.0	19.3	4.1	9.1	0.0	13.3	73.0	12.3	150
Minimum	0.0	2.5	0.0	0.0	0.0	1.7	19.0	1.7	240
Maximum	0.0	21.8	4.1	9.1	0.0	15.0	92.0	14.0	390
Count	0	8	8	8	0	7	7	7	8
Confidence Level (95.0%)	ND	5.6	1.3	2.7	ND	5.4	24.0	4.9	50

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-04, 116th & Greenfield Avenue

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.2	15.8	4.4	0.259	0.032	0.33	1.10	0.091	0.038	ND	9.06
Standard Error	0.1	1.7	0.9	0.032	0.003	0.13	0.06	0.008	0.009	ND	3.86
Median	7.2	16.9	3.3	0.250	0.031	0.19	1.10	0.100	0.035	ND	4.23
Mode	ND	ND	ND	ND	0.038	ND	1.10	0.100	0.050	ND	ND
Standard Deviation	0.1	4.8	2.6	0.091	0.008	0.36	0.17	0.024	0.026	ND	10.92
Sample Variance	0.0	23.4	6.9	0.008	0.000	0.13	0.03	0.001	0.001	ND	119.16
Kurtosis	-0.1	-0.3	-1.3	-1.247	-0.505	2.95	-0.87	0.961	1.221	ND	1.01
Skewness	-0.7	-0.8	0.6	0.437	0.658	1.83	-0.48	-1.092	0.629	ND	1.54
Range	0.4	14.1	7.0	0.240	0.023	1.07	0.45	0.075	0.087	0.00	29.19
Minimum	7.0	7.5	1.5	0.150	0.023	0.03	0.85	0.045	0.000	0.00	1.21
Maximum	7.4	21.5	8.5	0.390	0.046	1.10	1.30	0.120	0.087	0.00	30.40
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.1	4.0	2.2	0.076	0.007	0.30	0.14	0.020	0.022	ND	9.13

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	6.6	1.6	828.8	2364	2552	1278	210.0	0.0	1.1	2.2	1.5
Standard Error	0.5	0.7	128.4	1219	1039	195	37.8	0.0	1.1	2.2	0.2
Median	6.5	1.1	900.0	705	1250	1336	205.0	0.0	1.1	2.2	1.5
Mode	5.3	0.0	1200.0	ND	ND	ND	350.0	0.0	ND	ND	ND
Standard Deviation	1.4	1.9	363.3	3448	2938	550	107.0	0.0	1.5	3.0	0.3
Sample Variance	2.1	3.5	131955.4	11890198	8634567	302802	11457.1	0.0	2.2	9.2	0.1
Kurtosis	-0.7	-0.8	-0.7	3	0	-1	-0.9	ND	ND	ND	ND
Skewness	0.9	0.7	-0.7	2	1	-1	0.0	ND	ND	ND	ND
Range	3.6	4.8	980.0	9560	7236	1573	300.0	0.0	2.1	4.3	0.4
Minimum	5.3	0.0	220.0	140	64	369	50.0	0.0	0.0	0.0	1.3
Maximum	8.9	4.8	1200.0	9700	7300	1942	350.0	0.0	2.1	4.3	1.7
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	1.2	1.6	303.7	2883	2457	460	89.5	0.0	13.3	27.3	2.5

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-04, 116th & Greenfield Avenue

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	1.2	20.7	79.50	31.30	0.0	2.5	0.0	0.0	822.1	3.0	320
Standard Error	1.2	13.4	50.50	21.70	0.0	2.5	0.0	0.0	128.5	0.2	210
Median	1.2	20.7	79.50	31.30	0.0	2.5	0.0	0.0	894.0	2.8	320
Mode	ND	ND	ND	ND	0.0	ND	0.0	0.0	ND	ND	ND
Standard Deviation	1.6	18.9	71.42	30.69	0.0	3.5	0.0	0.0	363.6	0.6	297
Sample Variance	2.6	356.4	5100.50	941.78	0.0	12.0	0.0	0.0	132199.6	0.3	88200
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.7	0.2	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.7	0.6	ND
Range	2.3	26.7	101.00	43.40	0.0	4.9	0.0	0.0	981.1	1.8	420
Minimum	0.0	7.3	29.00	9.60	0.0	0.0	0.0	0.0	213.6	2.1	110
Maximum	2.3	34.0	130.00	53.00	0.0	4.9	0.0	0.0	1194.7	4.0	530
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	14.6	169.6	641.66	275.72	0.0	31.1	0.0	0.0	304.0	0.5	2668

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	8.1	2.9	11.6	ND	7.9	53.5	6.8	238
Standard Error	ND	0.7	0.4	1.4	ND	0.4	7.9	0.5	35
Median	ND	7.3	3.2	12.0	ND	7.8	61.0	6.3	270
Mode	ND	ND	ND	14.0	ND	6.7	65.0	6.2	270
Standard Deviation	ND	2.0	1.2	3.8	ND	1.2	22.2	1.3	100
Sample Variance	ND	3.9	1.5	14.6	ND	1.4	494.6	1.7	9993
Kurtosis	ND	-1.0	6.2	-0.6	ND	-2.1	0.0	0.3	0
Skewness	ND	0.7	-2.4	0.3	ND	0.3	-1.0	0.7	-1
Range	0.0	5.5	3.9	11.4	0.0	2.7	65.0	4.2	280
Minimum	0.0	5.8	0.0	6.6	0.0	6.7	15.0	5.0	60
Maximum	0.0	11.3	3.9	18.0	0.0	9.4	80.0	9.2	340
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	1.7	1.0	3.2	ND	1.0	18.6	1.1	84

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-04, 116th & Greenfield Avenue

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.2	14.3	5.0	0.201	0.044	0.56	0.97	0.073	0.029	ND	13.57
Standard Error	0.1	2.2	0.9	0.026	0.008	0.12	0.09	0.009	0.009	ND	8.20
Median	7.3	15.8	5.1	0.205	0.041	0.40	0.98	0.080	0.040	ND	2.62
Mode	7.3	ND	ND	0.110	ND	0.36	ND	ND	0.000	ND	ND
Standard Deviation	0.3	6.1	2.7	0.075	0.023	0.34	0.27	0.024	0.023	ND	23.20
Sample Variance	0.1	37.4	7.1	0.006	0.001	0.12	0.07	0.001	0.001	ND	538.19
Kurtosis	-1.0	-0.4	-2.0	-1.524	-0.429	2.82	0.00	0.119	-2.004	ND	3.87
Skewness	-0.3	-0.8	0.0	0.023	0.703	1.70	-0.04	0.034	-0.458	ND	2.06
Range	0.7	17.2	7.0	0.200	0.065	1.02	0.86	0.073	0.053	0.00	65.19
Minimum	6.8	3.3	1.6	0.110	0.019	0.28	0.54	0.037	0.000	0.00	0.21
Maximum	7.5	20.5	8.6	0.310	0.084	1.30	1.40	0.110	0.053	0.00	65.40
Count	8	8	8	8	8	8	8	7	7	0	8
Confidence Level (95.0%)	0.2	5.1	2.2	0.063	0.019	0.29	0.22	0.022	0.021	ND	19.39

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	6.8	2.1	802.5	9124	3243	1292	216.4	0.0	0.0	3.3	2.1
Standard Error	1.0	0.5	148.2	6703	1919	239	48.4	0.0	0.0	0.8	0.3
Median	5.5	2.0	910.0	985	860	1462	225.0	0.0	0.0	3.3	2.1
Mode	11.0	2.0	ND	ND	860	ND	ND	0.0	0.0	ND	ND
Standard Deviation	2.9	1.5	419.3	18958	5427	676	136.8	0.0	0.0	1.1	0.5
Sample Variance	8.4	2.3	175792.9	359390941	29451792	457485	18726.8	0.0	0.0	1.3	0.2
Kurtosis	-1.2	1.8	-1.7	7	6	-2	-1.3	ND	ND	ND	ND
Skewness	0.8	0.9	-0.4	3	2	0	0.2	ND	ND	ND	ND
Range	7.2	5.1	1050.0	54930	15955	1723	372.0	0.0	0.0	1.6	0.7
Minimum	3.8	0.0	250.0	70	45	410	58.0	0.0	0.0	2.5	1.7
Maximum	11.0	5.1	1300.0	55000	16000	2133	430.0	0.0	0.0	4.1	2.4
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	2.4	1.3	350.5	15849	4537	565	114.4	0.0	0.0	10.2	4.4

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-04, 116th & Greenfield Avenue

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	24.4	71.50	30.00	0.6	1.8	0.0	0.0	795.7	3.1	300
Standard Error	0.0	15.6	38.50	18.00	0.6	1.8	0.0	0.0	148.3	0.3	170
Median	0.0	24.4	71.50	30.00	0.6	1.8	0.0	0.0	905.3	3.0	300
Mode	0.0	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	22.1	54.45	25.46	0.8	2.5	0.0	0.0	419.5	1.0	240
Sample Variance	0.0	486.7	2964.50	648.00	0.7	6.5	0.0	0.0	175944.9	0.9	57800
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-1.7	-0.4	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.4	0.4	ND
Range	0.0	31.2	77.00	36.00	1.2	3.6	0.0	0.0	1056.5	2.9	340
Minimum	0.0	8.8	33.00	12.00	0.0	0.0	0.0	0.0	239.0	1.8	130
Maximum	0.0	40.0	110.00	48.00	1.2	3.6	0.0	0.0	1295.5	4.7	470
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	198.2	489.19	228.71	7.6	22.9	0.0	0.0	350.7	0.8	2160

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	7.5	1.6	12.4	ND	6.4	55.3	7.4	246
Standard Error	ND	1.1	0.7	1.5	ND	1.3	15.3	1.7	40
Median	ND	6.9	1.3	13.0	ND	5.1	67.0	7.4	295
Mode	ND	ND	0.0	13.0	ND	5.1	ND	ND	310
Standard Deviation	ND	3.1	1.9	4.1	ND	2.2	26.5	2.4	113
Sample Variance	ND	9.7	3.5	16.8	ND	4.8	702.3	5.8	12778
Kurtosis	ND	-1.2	-1.0	1.1	ND	ND	ND	ND	-2
Skewness	ND	0.5	0.6	-0.9	ND	1.7	-1.6	ND	-1
Range	0.0	8.7	4.8	13.4	0.0	3.8	49.0	3.4	287
Minimum	0.0	4.0	0.0	4.6	0.0	5.1	25.0	5.7	93
Maximum	0.0	12.6	4.8	18.0	0.0	8.9	74.0	9.1	380
Count	0	8	8	8	0	3	3	2	8
Confidence Level (95.0%)	ND	2.6	1.6	3.4	ND	5.5	65.8	21.6	95

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-04, 116th & Greenfield Avenue

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.2	16.2	4.4	0.133	0.033	0.26	0.92	0.088	0.032	ND	5.79
Standard Error	0.1	2.1	0.7	0.025	0.005	0.05	0.08	0.014	0.006	ND	2.05
Median	7.2	16.7	3.9	0.115	0.029	0.24	0.97	0.080	0.033	ND	3.58
Mode	7.2	ND	5.8	0.110	ND	ND	1.00	ND	0.016	ND	ND
Standard Deviation	0.2	5.9	1.9	0.071	0.014	0.14	0.22	0.039	0.017	ND	5.79
Sample Variance	0.0	34.4	3.5	0.005	0.000	0.02	0.05	0.002	0.000	ND	33.58
Kurtosis	2.4	-1.5	-0.7	0.659	3.342	1.90	0.29	2.127	-1.975	ND	1.38
Skewness	-1.2	-0.4	0.6	-0.599	1.719	1.22	0.25	1.357	0.153	ND	1.49
Range	0.7	15.4	5.4	0.220	0.044	0.44	0.67	0.124	0.042	0.00	16.88
Minimum	6.8	6.7	2.2	0.000	0.019	0.10	0.63	0.046	0.014	0.00	0.52
Maximum	7.5	22.1	7.6	0.220	0.063	0.54	1.30	0.170	0.056	0.00	17.40
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.2	4.9	1.6	0.059	0.011	0.11	0.18	0.033	0.014	ND	4.84

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	6.2	2.5	1076.3	2944	2106	1733	302.5	0.0	5.6	5.1	2.7
Standard Error	0.8	0.4	80.6	1684	1011	123	32.7	0.0	0.1	0.0	0.2
Median	5.8	2.6	1075.0	915	665	1730	300.0	0.0	5.6	5.1	2.7
Mode	9.4	3.4	1200.0	ND	ND	ND	ND	0.0	ND	ND	ND
Standard Deviation	2.4	1.2	227.9	4763	2859	347	92.5	0.0	0.1	ND	0.2
Sample Variance	5.6	1.5	51941.1	22688313	8174227	120172	8564.3	0.0	0.0	ND	0.0
Kurtosis	-0.6	1.5	-1.7	5	4	-1	-2.0	ND	ND	ND	ND
Skewness	0.2	-1.1	0.1	2	2	0	0.0	ND	ND	ND	ND
Range	6.8	3.8	620.0	13830	8370	1041	240.0	0.0	0.2	0.0	0.3
Minimum	2.6	0.0	780.0	170	230	1233	180.0	0.0	5.5	5.1	2.5
Maximum	9.4	3.8	1400.0	14000	8600	2274	420.0	0.0	5.7	5.1	2.8
Count	8	8	8	8	8	8	8	2	2	1	2
Confidence Level (95.0%)	2.0	1.0	190.5	3982	2390	290	77.4	0.0	1.3	ND	1.9

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-04, 116th & Greenfield Avenue

VARIABLE	*PB*	*ZN*	*CA*	*MG*	*AG*	*AS*	*SE*	*HG*	*DS*	*LFC*	*HARD*
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	10.5	90.00	46.00	0.4	0.0	0.0	0.0	1070.0	3.0	420
Standard Error	0.0	10.5	10.00	2.00	0.4	0.0	0.0	0.0	80.8	0.2	40
Median	0.0	10.5	90.00	46.00	0.4	0.0	0.0	0.0	1069.8	2.9	420
Mode	0.0	ND	ND	ND	ND	0.0	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	14.8	14.14	2.83	0.6	0.0	0.0	0.0	228.4	0.7	57
Sample Variance	0.0	220.5	200.00	8.00	0.4	0.0	0.0	0.0	52171.7	0.4	3200
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-1.6	-0.6	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	0.1	0.6	ND
Range	0.0	21.0	20.00	4.00	0.9	0.0	0.0	0.0	624.5	1.9	80
Minimum	0.0	0.0	80.00	44.00	0.0	0.0	0.0	0.0	772.9	2.2	380
Maximum	0.0	21.0	100.00	48.00	0.9	0.0	0.0	0.0	1397.4	4.1	460
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	133.4	127.06	25.41	5.5	0.0	0.0	0.0	191.0	0.6	508

VARIABLE	*SCHII*	*TURB*	*BOD5*	*BOD20*	*IXLITE*	*TNOC*	*TNIC*	*TNDOC*	*TALK*
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	6.7	1.9	10.0	ND	7.7	71.9	6.8	291
Standard Error	ND	1.0	0.7	1.6	ND	0.7	5.1	0.4	15
Median	ND	6.4	2.2	8.4	ND	6.7	73.0	6.2	285
Mode	ND	ND	0.0	ND	ND	ND	ND	6.0	260
Standard Deviation	ND	2.8	1.8	4.5	ND	2.0	13.4	1.2	43
Sample Variance	ND	7.6	3.4	20.2	ND	3.8	180.1	1.3	1841
Kurtosis	ND	1.6	-1.1	-1.3	ND	-0.4	-1.0	-0.9	-1
Skewness	ND	1.0	0.3	0.6	ND	1.2	0.3	1.1	0
Range	0.0	9.0	4.8	12.3	0.0	4.9	37.0	2.6	120
Minimum	0.0	3.3	0.0	4.7	0.0	6.1	55.0	5.9	230
Maximum	0.0	12.2	4.8	17.0	0.0	11.0	92.0	8.5	350
Count	0	8	8	8	0	7	7	7	8
Confidence Level (95.0%)	ND	2.3	1.5	3.8	ND	1.8	12.4	1.1	36

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-05, 121st & Underwood Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.8	15.4	9.7	0.125	0.049	0.50	0.69	0.318	0.263	ND	5.10
Standard Error	0.1	1.3	0.4	0.020	0.006	0.09	0.12	0.040	0.036	ND	0.94
Median	7.7	16.2	9.6	0.098	0.043	0.41	0.63	0.365	0.315	ND	5.68
Mode	ND	ND	ND	0.098	0.042	ND	ND	0.390	ND	ND	ND
Standard Deviation	0.3	3.5	1.2	0.057	0.016	0.26	0.33	0.113	0.103	ND	2.66
Sample Variance	0.1	12.5	1.4	0.003	0.000	0.07	0.11	0.013	0.011	ND	7.05
Kurtosis	1.7	-0.7	3.9	3.444	6.366	5.41	0.36	-1.313	-1.001	ND	-1.47
Skewness	1.2	-0.7	1.7	1.864	2.456	2.24	0.93	-0.692	-0.920	ND	-0.34
Range	0.9	9.8	3.8	0.170	0.050	0.81	0.98	0.290	0.260	0.00	7.11
Minimum	7.5	9.8	8.5	0.080	0.038	0.29	0.32	0.140	0.100	0.00	1.40
Maximum	8.4	19.6	12.3	0.250	0.088	1.10	1.30	0.430	0.360	0.00	8.51
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.3	3.0	1.0	0.048	0.014	0.22	0.27	0.094	0.086	ND	2.22

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	9.4	2.5	515.0	3154	2674	758	94.4	0.0	1.6	4.1	0.9
Standard Error	3.0	1.0	53.5	1376	1228	91	22.3	0.0	1.6	4.1	0.9
Median	5.5	1.8	510.0	1800	1300	774	76.5	0.0	1.6	4.1	0.9
Mode	ND	0.0	480.0	ND	1300	ND	ND	0.0	ND	ND	ND
Standard Deviation	8.4	2.8	151.2	3893	3472	256	63.2	0.0	2.2	5.8	1.2
Sample Variance	71.1	7.6	22857.1	15154568	12054141	65719	3994.6	0.0	4.8	33.6	1.4
Kurtosis	0.3	2.0	0.5	5	7	1	5.0	ND	ND	ND	ND
Skewness	1.3	1.5	-0.5	2	3	0	2.1	ND	ND	ND	ND
Range	22.6	8.2	480.0	11948	10540	870	195.0	0.0	3.1	8.2	1.7
Minimum	2.4	0.0	240.0	52	460	283	45.0	0.0	0.0	0.0	0.0
Maximum	25.0	8.2	720.0	12000	11000	1153	240.0	0.0	3.1	8.2	1.7
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	7.0	2.3	126.4	3255	2903	214	52.8	0.0	19.7	52.1	10.8

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-05, 121st & Underwood Parkway

VARIABLE	*PB*	*ZN*	*CA*	*MG*	*AG*	*AS*	*SE*	*HG*	*DS*	*LFC*	*HARD*
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	3.6	16.8	53.50	14.90	0.0	2.6	0.0	0.1	505.6	3.1	195
Standard Error	3.6	9.2	22.50	5.10	0.0	2.6	0.0	0.1	52.2	0.3	75
Median	3.6	16.8	53.50	14.90	0.0	2.6	0.0	0.1	507.0	3.2	195
Mode	ND	ND	ND	ND	0.0	ND	0.0	ND	ND	ND	ND
Standard Deviation	5.0	13.0	31.82	7.21	0.0	3.7	0.0	0.2	147.7	0.7	106
Sample Variance	25.2	169.3	1012.50	52.02	0.0	13.5	0.0	0.0	21801.1	0.5	11250
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	0.7	1.6	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.6	-1.0	ND
Range	7.1	18.4	45.00	10.20	0.0	5.2	0.0	0.2	464.2	2.4	150
Minimum	0.0	7.6	31.00	9.80	0.0	0.0	0.0	0.0	230.8	1.7	120
Maximum	7.1	26.0	76.00	20.00	0.0	5.2	0.0	0.2	695.0	4.1	270
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	45.1	116.9	285.89	64.80	0.0	33.0	0.0	1.5	123.4	0.6	953

VARIABLE	*SCHII*	*TURB*	*BOD5*	*BOD20*	*IXLITE*	*TNOC*	*TNIC*	*TNDOC*	*TALK*
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	7.5	2.1	8.8	ND	4.8	34.4	3.7	141
Standard Error	ND	2.9	1.0	0.6	ND	1.1	3.1	0.7	13
Median	ND	3.4	1.2	8.5	ND	3.0	35.5	2.7	140
Mode	ND	ND	0.0	ND	ND	ND	37.0	2.3	140
Standard Deviation	ND	8.3	2.9	1.8	ND	3.1	8.7	2.1	36
Sample Variance	ND	68.4	8.3	3.4	ND	9.8	76.3	4.3	1267
Kurtosis	ND	3.3	1.9	1.5	ND	-1.1	1.8	-0.6	3
Skewness	ND	1.9	1.4	0.1	ND	0.9	-0.9	0.9	-1
Range	0.0	23.5	8.1	6.4	0.0	7.9	29.0	5.5	114
Minimum	0.0	2.1	0.0	5.6	0.0	2.1	17.0	1.9	66
Maximum	0.0	25.6	8.1	12.0	0.0	10.0	46.0	7.4	180
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	6.9	2.4	1.5	ND	2.6	7.3	1.7	30

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-05, 121st & Underwood Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.5	14.5	10.1	0.099	0.046	0.81	0.88	0.257	0.189	ND	11.69
Standard Error	0.1	1.5	0.9	0.018	0.006	0.12	0.06	0.050	0.037	ND	7.22
Median	7.7	15.5	9.6	0.125	0.049	0.74	0.94	0.270	0.190	ND	4.66
Mode	7.7	ND	ND	0.130	ND	ND	0.91	0.270	ND	ND	ND
Standard Deviation	0.2	4.3	2.5	0.051	0.016	0.34	0.16	0.133	0.098	ND	20.41
Sample Variance	0.0	18.9	6.3	0.003	0.000	0.12	0.03	0.018	0.010	ND	416.65
Kurtosis	-0.6	-0.7	0.4	-0.998	0.188	5.11	-0.20	1.325	-0.127	ND	7.71
Skewness	-1.1	-0.7	0.9	-0.808	0.337	2.11	-1.25	0.464	0.017	ND	2.76
Range	0.5	11.8	7.8	0.139	0.052	1.08	0.39	0.428	0.295	0.00	59.75
Minimum	7.2	6.9	7.0	0.011	0.023	0.52	0.61	0.062	0.045	0.00	2.15
Maximum	7.7	18.7	14.8	0.150	0.075	1.60	1.00	0.490	0.340	0.00	61.90
Count	8	8	8	8	8	8	8	7	7	0	8
Confidence Level (95.0%)	0.2	3.6	2.1	0.043	0.014	0.29	0.13	0.123	0.091	ND	17.06

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	13.5	4.1	760.0	7047	2635	1187	196.1	0.0	0.6	4.9	2.0
Standard Error	5.2	1.2	125.1	6005	1803	212	48.8	0.0	0.6	0.2	0.7
Median	9.0	2.3	720.0	855	445	1042	155.0	0.0	0.6	4.9	2.0
Mode	13.0	ND	ND	ND	ND	ND	ND	0.0	ND	ND	ND
Standard Deviation	14.6	3.4	354.0	16986	5101	598	137.9	0.0	0.8	0.3	0.9
Sample Variance	213.2	11.4	125285.7	288515834	26016629	358078	19017.8	0.0	0.7	0.1	0.8
Kurtosis	4.9	-1.6	-1.0	8	7	-1	-0.5	ND	ND	ND	ND
Skewness	2.1	0.7	0.4	3	3	1	1.0	ND	ND	ND	ND
Range	43.6	8.3	970.0	48977	14870	1511	359.0	0.0	1.2	0.4	1.3
Minimum	3.4	1.1	330.0	23	130	509	71.0	0.0	0.0	4.7	1.3
Maximum	47.0	9.4	1300.0	49000	15000	2020	430.0	0.0	1.2	5.1	2.6
Count	8	8	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	12.2	2.8	295.9	14200	4264	500	115.3	0.0	7.6	2.5	8.3

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-05, 121st & Underwood Parkway

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	15.2	67.00	20.50	0.8	0.0	0.0	0.0	746.5	2.9	250
Standard Error	0.0	7.9	13.00	4.50	0.3	0.0	0.0	0.0	127.9	0.4	50
Median	0.0	15.2	67.00	20.50	0.8	0.0	0.0	0.0	704.5	2.9	250
Mode	0.0	ND	ND	ND	ND	0.0	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	11.1	18.38	6.36	0.4	0.0	0.0	0.0	361.7	1.0	71
Sample Variance	0.0	123.2	338.00	40.50	0.2	0.0	0.0	0.0	130798.9	1.0	5000
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.9	0.6	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	0.4	0.4	ND
Range	0.0	15.7	26.00	9.00	0.6	0.0	0.0	0.0	1013.3	3.3	100
Minimum	0.0	7.3	54.00	16.00	0.5	0.0	0.0	0.0	283.0	1.4	200
Maximum	0.0	23.0	80.00	25.00	1.1	0.0	0.0	0.0	1296.3	4.7	300
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	99.7	165.18	57.18	3.9	0.0	0.0	0.0	302.4	0.8	635

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	12.1	3.8	15.6	ND	5.5	46.0	5.1	202
Standard Error	ND	6.4	2.0	6.4	ND	0.7	5.9	0.4	27
Median	ND	4.2	2.2	8.9	ND	5.0	44.0	5.1	195
Mode	ND	ND	0.0	16.0	ND	ND	ND	ND	ND
Standard Deviation	ND	18.2	5.7	18.2	ND	1.9	15.6	1.1	76
Sample Variance	ND	331.2	32.0	332.6	ND	3.7	244.7	1.1	5768
Kurtosis	ND	6.6	5.7	6.3	ND	4.1	-1.3	-1.1	-1
Skewness	ND	2.5	2.3	2.4	ND	1.9	-0.3	-0.4	0
Range	0.0	52.4	17.0	59.0	0.0	5.8	41.0	2.8	231
Minimum	0.0	3.4	0.0	0.0	0.0	3.7	23.0	3.5	89
Maximum	0.0	55.8	17.0	59.0	0.0	9.5	64.0	6.3	320
Count	0	8	8	8	0	7	7	7	8
Confidence Level (95.0%)	ND	15.2	4.7	15.2	ND	1.8	14.5	1.0	63

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-05, 121st & Underwood Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	7.6	15.1	11.0	0.097	0.054	0.72	0.83	0.343	0.284	ND	7.25
Standard Error	0.1	1.3	1.1	0.031	0.010	0.10	0.14	0.023	0.023	ND	0.93
Median	7.6	15.5	9.8	0.050	0.046	0.66	0.78	0.345	0.305	ND	7.80
Mode	ND	ND	ND	ND	0.046	ND	ND	ND	ND	ND	ND
Standard Deviation	0.3	3.7	3.2	0.089	0.027	0.29	0.40	0.065	0.064	ND	2.64
Sample Variance	0.1	13.8	10.0	0.008	0.001	0.08	0.16	0.004	0.004	ND	6.97
Kurtosis	0.7	-2.0	0.3	1.738	1.676	1.55	3.35	-1.593	-1.050	ND	-0.85
Skewness	-0.2	-0.2	1.0	1.526	1.468	1.14	1.64	-0.198	-0.462	ND	-0.65
Range	0.8	9.3	9.2	0.250	0.080	0.92	1.27	0.170	0.180	0.00	7.30
Minimum	7.1	9.8	7.9	0.030	0.030	0.38	0.43	0.250	0.190	0.00	2.80
Maximum	7.9	19.1	17.0	0.280	0.110	1.30	1.70	0.420	0.370	0.00	10.10
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.2	3.1	2.6	0.074	0.023	0.24	0.33	0.054	0.054	ND	2.21

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	5.8	3.0	753.8	11881	32949	1258	202.5	0.0	7.0	6.8	2.7
Standard Error	1.4	0.7	73.5	7427	29607	107	32.1	0.0	1.4	0.0	0.3
Median	4.9	2.4	735.0	2500	3100	1264	170.0	0.0	7.0	6.8	2.7
Mode	ND	2.4	ND	ND	ND	ND	ND	0.0	ND	ND	ND
Standard Deviation	4.0	1.9	207.8	21006	83741	302	90.7	0.0	1.9	ND	0.4
Sample Variance	16.1	3.5	43169.6	441258749	7012489669	91419	8221.4	0.0	3.6	ND	0.1
Kurtosis	1.7	1.4	0.5	5	8	0	2.0	ND	ND	ND	ND
Skewness	1.3	1.4	0.0	2	3	1	1.4	ND	ND	ND	ND
Range	12.4	5.6	690.0	59960	239952	907	280.0	0.0	2.7	0.0	0.5
Minimum	1.6	1.2	410.0	40	48	904	110.0	0.0	5.6	6.8	2.4
Maximum	14.0	6.8	1100.0	60000	240000	1811	390.0	0.0	8.3	6.8	2.9
Count	8	8	8	8	8	8	8	2	2	1	2
Confidence Level (95.0%)	3.4	1.6	173.7	17562	70009	253	75.8	0.0	17.2	ND	3.2

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-05, 121st & Underwood Parkway

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	30.5	76.00	27.00	0.8	0.0	0.0	0.0	747.9	3.2	300
Standard Error	0.0	11.5	1.00	1.00	0.0	0.0	0.0	0.0	73.7	0.4	0
Median	0.0	30.5	76.00	27.00	0.8	0.0	0.0	0.0	730.2	3.4	300
Mode	0.0	ND	ND	ND	ND	0.0	0.0	0.0	ND	ND	300
Standard Deviation	0.0	16.3	1.41	1.41	0.1	0.0	0.0	0.0	208.3	1.1	0
Sample Variance	0.0	264.5	2.00	2.00	0.0	0.0	0.0	0.0	43408.2	1.3	0
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	0.6	-1.0	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	0.1	-0.3	ND
Range	0.0	23.0	2.00	2.00	0.1	0.0	0.0	0.0	694.7	3.2	0
Minimum	0.0	19.0	75.00	26.00	0.7	0.0	0.0	0.0	402.5	1.6	300
Maximum	0.0	42.0	77.00	28.00	0.8	0.0	0.0	0.0	1097.2	4.8	300
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	0.0	146.1	12.71	12.71	0.6	0.0	0.0	0.0	174.2	0.9	0

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	4.8	3.3	8.9	ND	4.8	42.0	3.5	198
Standard Error	ND	1.3	1.4	2.0	ND	0.6	5.7	0.4	14
Median	ND	3.7	2.4	8.8	ND	4.6	47.0	3.8	190
Mode	ND	ND	2.6	14.0	ND	ND	ND	ND	220
Standard Deviation	ND	3.8	3.9	5.6	ND	1.5	15.1	1.2	38
Sample Variance	ND	14.2	15.0	31.4	ND	2.2	229.3	1.4	1479
Kurtosis	ND	7.0	4.1	-1.2	ND	-0.3	-0.2	-0.4	1
Skewness	ND	2.6	1.9	-0.2	ND	0.1	-1.0	-0.9	1
Range	0.0	11.5	12.0	16.0	0.0	4.4	41.0	3.2	120
Minimum	0.0	2.4	0.0	0.0	0.0	2.6	16.0	1.5	150
Maximum	0.0	13.9	12.0	16.0	0.0	7.0	57.0	4.7	270
Count	0	8	8	8	0	7	7	7	8
Confidence Level (95.0%)	ND	3.1	3.2	4.7	ND	1.4	14.0	1.1	32

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-06, 115th Street & Underwood Creek Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	8.3	18.1	17.8	0.023	0.018	0.25	0.88	0.153	0.076	ND	33.49
Standard Error	0.1	1.8	2.1	0.011	0.006	0.15	0.17	0.037	0.017	ND	17.81
Median	8.4	19.8	17.8	0.010	0.018	0.09	0.76	0.125	0.088	ND	7.62
Mode	ND	ND	ND	0.000	0.000	0.00	ND	0.170	0.110	ND	ND
Standard Deviation	0.3	5.2	6.1	0.031	0.018	0.41	0.49	0.104	0.048	ND	50.36
Sample Variance	0.1	26.8	36.8	0.001	0.000	0.17	0.24	0.011	0.002	ND	2536.19
Kurtosis	0.2	-0.9	-1.4	0.872	-0.735	4.74	-0.77	4.752	-1.932	ND	0.58
Skewness	-0.8	-0.8	0.0	1.318	0.471	2.18	0.72	2.049	-0.113	ND	1.52
Range	1.0	13.5	16.8	0.084	0.048	1.20	1.34	0.324	0.121	0.00	125.93
Minimum	7.7	9.9	9.8	0.000	0.000	0.00	0.36	0.066	0.019	0.00	2.07
Maximum	8.7	23.5	26.6	0.084	0.048	1.20	1.70	0.390	0.140	0.00	128.00
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.3	4.3	5.1	0.026	0.015	0.35	0.41	0.087	0.040	ND	42.10

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	13.5	3.6	835.0	12557	1943	1153	178.4	0.0	1.3	2.7	1.5
Standard Error	5.9	2.1	97.5	12065	1440	102	18.8	0.0	1.3	2.7	0.4
Median	8.2	1.6	850.0	420	595	1228	170.0	0.0	1.3	2.7	1.5
Mode	ND	2.9	850.0	ND	ND	ND	170.0	0.0	ND	ND	ND
Standard Deviation	15.6	5.6	275.7	34124	4074	289	53.1	0.0	1.8	3.8	0.6
Sample Variance	244.1	31.4	76000.0	1164420135	16600198	83339	2821.1	0.0	3.4	14.6	0.3
Kurtosis	4.7	6.0	2.1	8	8	5	2.5	ND	ND	ND	ND
Skewness	2.1	2.4	-0.3	3	3	-2	-1.3	ND	ND	ND	ND
Range	43.8	16.0	980.0	96965	11939	913	163.0	0.0	2.6	5.4	0.8
Minimum	3.2	0.0	320.0	35	61	487	67.0	0.0	0.0	0.0	1.1
Maximum	47.0	16.0	1300.0	97000	12000	1400	230.0	0.0	2.6	5.4	1.9
Count	7	7	8	8	8	8	8	2	2	2	2
Confidence Level (95.0%)	14.4	5.2	230.5	28528	3406	241	44.4	0.0	16.5	34.3	5.1

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-06, 115th Street & Underwood Creek Parkway

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	1.6	11.5	67.50	29.50	0.0	4.0	0.0	0.2	755.0	2.8	290
Standard Error	1.6	11.5	26.50	15.50	0.0	4.0	0.0	0.2	81.3	0.4	130
Median	1.6	11.5	67.50	29.50	0.0	4.0	0.0	0.2	840.0	2.6	290
Mode	ND	ND	ND	ND	0.0	ND	0.0	ND	ND	ND	ND
Standard Deviation	2.3	16.3	37.48	21.92	0.0	5.6	0.0	0.2	215.2	1.0	184
Sample Variance	5.1	264.5	1404.50	480.50	0.0	31.2	0.0	0.1	46321.3	1.0	33800
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	3.4	3.5	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-1.8	1.5	ND
Range	3.2	23.0	53.00	31.00	0.0	7.9	0.0	0.3	633.5	3.4	260
Minimum	0.0	0.0	41.00	14.00	0.0	0.0	0.0	0.0	311.8	1.5	160
Maximum	3.2	23.0	94.00	45.00	0.0	7.9	0.0	0.3	945.3	5.0	420
Count	2	2	2	2	2	2	2	2	7	8	2
Confidence Level (95.0%)	20.3	146.1	336.71	196.95	0.0	50.2	0.0	2.2	199.0	0.9	1652

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	6.8	2.7	10.4	ND	6.7	47.9	5.4	199
Standard Error	ND	1.4	1.0	1.5	ND	0.8	4.9	0.7	20
Median	ND	5.7	2.5	8.5	ND	6.8	52.0	4.9	225
Mode	ND	ND	0.0	7.8	ND	ND	57.0	ND	240
Standard Deviation	ND	3.8	2.8	4.2	ND	2.3	13.9	1.9	55
Sample Variance	ND	14.8	8.1	17.5	ND	5.5	193.3	3.5	3050
Kurtosis	ND	0.9	0.0	1.8	ND	-2.0	0.8	-2.1	2
Skewness	ND	1.1	0.8	1.5	ND	0.1	-1.2	0.4	-2
Range	0.0	11.9	7.9	11.8	0.0	5.9	42.0	4.5	156
Minimum	0.0	2.3	0.0	7.2	0.0	4.0	21.0	3.4	84
Maximum	0.0	14.2	7.9	19.0	0.0	9.9	63.0	7.9	240
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	3.2	2.4	3.5	ND	2.0	11.6	1.6	46

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-06, 115th Street & Underwood Creek Parkway

VARIABLE	*PH*	*TEMP*	*DO*	*AMMONIA*	*NITRITE*	*NITRATE*	*TKN*	*PHOS*	*SOLPHOS*	*SOLSIL*	*CHLA*
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	8.0	16.2	15.9	0.034	0.023	0.57	1.05	0.126	0.050	ND	25.69
Standard Error	0.2	2.1	2.3	0.014	0.004	0.29	0.12	0.031	0.013	ND	10.22
Median	8.2	16.5	13.5	0.022	0.023	0.26	1.10	0.106	0.048	ND	17.23
Mode	ND	ND	ND	0.000	ND	ND	1.10	ND	ND	ND	ND
Standard Deviation	0.5	6.0	6.5	0.039	0.012	0.82	0.34	0.075	0.032	ND	28.92
Sample Variance	0.2	35.6	42.1	0.002	0.000	0.67	0.12	0.006	0.001	ND	836.31
Kurtosis	-1.8	-1.3	-1.5	1.079	0.913	5.80	-0.52	-1.237	1.845	ND	0.00
Skewness	-0.4	0.0	0.6	1.369	-0.498	2.33	-0.86	0.413	-0.081	ND	1.05
Range	1.2	16.6	17.1	0.110	0.039	2.50	0.88	0.198	0.098	0.00	78.22
Minimum	7.4	7.5	8.6	0.000	0.000	0.00	0.52	0.032	0.000	0.00	0.58
Maximum	8.6	24.1	25.7	0.110	0.039	2.50	1.40	0.230	0.098	0.00	78.80
Count	8	8	8	8	8	8	8	6	6	0	8
Confidence Level (95.0%)	0.4	5.0	5.4	0.032	0.010	0.69	0.29	0.079	0.033	ND	24.18

VARIABLE	*SS*	*VSS*	*TS*	*FECAL*	*ECOLIQT*	*SPEC*	*CHLOR*	*CD*	*CR*	*CU*	*NI*
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	25.8	7.1	912.5	1915	1420	1399	228.1	0.0	0.0	4.4	2.7
Standard Error	10.9	2.3	108.6	1294	887	156	34.5	0.0	0.0	0.0	0.8
Median	11.0	4.1	980.0	250	120	1518	215.0	0.0	0.0	4.4	2.7
Mode	ND	ND	1200.0	ND	ND	ND	ND	0.0	0.0	4.4	ND
Standard Deviation	32.6	6.5	307.0	3881	2661	442	97.5	0.0	0.0	0.0	1.1
Sample Variance	1064.7	42.4	94278.6	15061857	7082942	195373	9513.8	0.0	0.0	0.0	1.3
Kurtosis	0.5	-2.0	-0.4	8	7	0	-0.3	ND	ND	ND	ND
Skewness	1.4	0.5	-1.0	3	3	-1	0.5	ND	ND	ND	ND
Range	82.4	15.0	780.0	11958	8169	1273	295.0	0.0	0.0	0.0	1.6
Minimum	2.6	1.0	420.0	42	31	660	95.0	0.0	0.0	4.4	1.9
Maximum	85.0	16.0	1200.0	12000	8200	1933	390.0	0.0	0.0	4.4	3.5
Count	9	8	8	9	9	8	8	2	2	2	2
Confidence Level (95.0%)	25.1	5.4	256.7	2983	2046	370	81.5	0.0	0.0	0.0	10.2

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-06, 115th Street & Underwood Creek Parkway

VARIABLE	*PB*	*ZN*	*CA*	*MG*	*AG*	*AS*	*SE*	*HG*	*DS*	*LFC*	*HARD*
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	13.3	77.00	35.00	1.1	0.0	0.0	0.0	885.8	2.5	340
Standard Error	0.0	5.8	23.00	15.00	0.5	0.0	0.0	0.0	112.9	0.3	120
Median	0.0	13.3	77.00	35.00	1.1	0.0	0.0	0.0	973.0	2.4	340
Mode	0.0	ND	ND	ND	ND	0.0	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	8.1	32.53	21.21	0.8	0.0	0.0	0.0	319.5	0.9	170
Sample Variance	0.0	66.1	1058.00	450.00	0.6	0.0	0.0	0.0	102059.4	0.8	28800
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.1	-0.9	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-1.1	0.6	ND
Range	0.0	11.5	46.00	30.00	1.1	0.0	0.0	0.0	861.7	2.5	240
Minimum	0.0	7.5	54.00	20.00	0.5	0.0	0.0	0.0	335.0	1.6	220
Maximum	0.0	19.0	100.00	50.00	1.6	0.0	0.0	0.0	1196.7	4.1	460
Count	2	2	2	2	2	2	2	2	8	9	2
Confidence Level (95.0%)	0.0	73.1	292.24	190.59	6.9	0.0	0.0	0.0	267.1	0.7	1525

VARIABLE	*SCHII*	*TURB*	*BOD5*	*BOD20*	*IXLITE*	*TNOC*	*TNIC*	*TNDOC*	*TALK*
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	19.6	3.5	19.4	ND	8.5	54.0	8.1	234
Standard Error	ND	9.1	1.8	9.5	ND	0.9	7.0	2.0	22
Median	ND	4.3	2.5	12.0	ND	8.6	56.0	6.7	250
Mode	ND	ND	0.0	12.0	ND	10.0	56.0	ND	280
Standard Deviation	ND	25.7	5.3	26.9	ND	1.7	14.1	3.4	62
Sample Variance	ND	661.2	27.8	723.5	ND	3.0	198.0	11.7	3855
Kurtosis	ND	2.5	7.2	7.4	ND	-5.7	1.9	ND	-1
Skewness	ND	1.7	2.6	2.7	ND	0.0	-0.8	1.5	-1
Range	0.0	71.6	17.0	85.0	0.0	3.2	34.0	6.4	160
Minimum	0.0	2.8	0.0	0.0	0.0	6.8	35.0	5.6	140
Maximum	0.0	74.4	17.0	85.0	0.0	10.0	69.0	12.0	300
Count	0	8	9	8	0	4	4	3	8
Confidence Level (95.0%)	ND	21.5	4.1	22.5	ND	2.8	22.4	8.5	52

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-06, 115th Street & Underwood Creek Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	8.2	17.7	17.6	0.014	0.024	0.15	0.96	0.156	0.086	ND	18.26
Standard Error	0.1	1.7	2.7	0.009	0.006	0.05	0.12	0.028	0.021	ND	8.08
Median	8.2	19.0	18.1	0.000	0.019	0.11	0.90	0.155	0.074	ND	9.53
Mode	ND	ND	ND	0.000	ND	ND	ND	ND	ND	ND	ND
Standard Deviation	0.4	4.9	7.5	0.027	0.017	0.14	0.35	0.079	0.060	ND	22.86
Sample Variance	0.2	24.0	56.3	0.001	0.000	0.02	0.12	0.006	0.004	ND	522.46
Kurtosis	-1.9	0.7	-1.9	1.534	-1.317	0.71	-0.57	-0.978	-1.002	ND	6.34
Skewness	0.0	-1.0	0.0	1.680	0.668	1.10	0.07	-0.195	0.547	ND	2.46
Range	1.0	14.6	18.5	0.068	0.043	0.41	1.08	0.229	0.165	0.00	68.45
Minimum	7.7	8.2	8.8	0.000	0.008	0.01	0.42	0.031	0.015	0.00	4.35
Maximum	8.7	22.9	27.3	0.068	0.051	0.42	1.50	0.260	0.180	0.00	72.80
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.3	4.1	6.3	0.022	0.015	0.12	0.29	0.066	0.050	ND	19.11

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	8.5	3.4	978.8	23677	47618	1543	256.3	0.0	6.6	5.8	3.2
Standard Error	1.8	1.2	53.3	14998	29801	76	22.4	0.0	0.1	0.0	0.0
Median	7.5	2.3	950.0	510	790	1509	240.0	0.0	6.6	5.8	3.2
Mode	13.0	0.0	1200.0	ND	ND	ND	220.0	0.0	ND	ND	ND
Standard Deviation	5.0	3.3	150.8	39682	84291	216	63.2	0.0	0.1	ND	0.1
Sample Variance	25.1	10.9	22755.4	1574670296	7104914973	46569	3998.2	0.0	0.0	ND	0.0
Kurtosis	-1.8	-0.7	-0.8	0	5	0	0.9	ND	ND	ND	ND
Skewness	0.3	0.8	0.7	1	2	0	1.1	ND	ND	ND	ND
Range	12.8	8.8	400.0	91932	239924	693	190.0	0.0	0.1	0.0	0.1
Minimum	3.2	0.0	800.0	68	76	1208	190.0	0.0	6.5	5.8	3.1
Maximum	16.0	8.8	1200.0	92000	240000	1901	380.0	0.0	6.6	5.8	3.2
Count	8	8	8	7	8	8	8	2	2	1	2
Confidence Level (95.0%)	4.2	2.8	126.1	36700	70469	180	52.9	0.0	0.6	ND	0.6

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-06, 115th Street & Underwood Creek Parkway

VARIABLE	*PB*	*ZN*	*CA*	*MG*	*AG*	*AS*	*SE*	*HG*	*DS*	*LFC*	*HARD*
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	12.5	98.50	40.00	1.0	0.0	0.0	0.0	970.2	3.2	410
Standard Error	0.0	1.5	11.50	5.00	0.1	0.0	0.0	0.0	53.2	0.5	50
Median	0.0	12.5	98.50	40.00	1.0	0.0	0.0	0.0	942.5	2.7	410
Mode	0.0	ND	ND	ND	ND	0.0	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	2.1	16.26	7.07	0.2	0.0	0.0	0.0	150.4	1.3	71
Sample Variance	0.0	4.5	264.50	50.00	0.0	0.0	0.0	0.0	22606.9	1.7	5000
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.7	-1.5	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	0.7	0.7	ND
Range	0.0	3.0	23.00	10.00	0.3	0.0	0.0	0.0	401.1	3.1	100
Minimum	0.0	11.0	87.00	35.00	0.9	0.0	0.0	0.0	795.4	1.8	360
Maximum	0.0	14.0	110.00	45.00	1.1	0.0	0.0	0.0	1196.5	5.0	460
Count	2	2	2	2	2	2	2	2	8	7	2
Confidence Level (95.0%)	0.0	19.1	146.12	63.53	1.6	0.0	0.0	0.0	125.7	1.2	635

VARIABLE	*SCHII*	*TURB*	*BOD5*	*BOD20*	*IXLITE*	*TNOC*	*TNIC*	*TNDOC*	*TALK*
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	4.0	3.9	10.3	ND	7.5	52.3	6.2	244
Standard Error	ND	0.5	1.3	1.8	ND	1.2	3.2	1.3	7
Median	ND	4.4	3.0	8.3	ND	6.9	50.0	5.7	245
Mode	ND	ND	0.0	16.0	ND	11.0	49.0	ND	240
Standard Deviation	ND	1.4	3.8	5.2	ND	3.0	7.9	3.1	18
Sample Variance	ND	2.0	14.3	26.7	ND	8.8	62.3	9.7	341
Kurtosis	ND	-1.3	-0.7	-2.0	ND	-1.7	1.5	-0.9	1
Skewness	ND	-0.4	0.8	0.4	ND	0.2	1.0	0.6	-1
Range	0.0	3.9	9.8	12.7	0.0	7.2	23.0	8.2	60
Minimum	0.0	1.9	0.0	4.3	0.0	3.8	43.0	2.8	210
Maximum	0.0	5.8	9.8	17.0	0.0	11.0	66.0	11.0	270
Count	0	8	8	8	0	6	6	6	8
Confidence Level (95.0%)	ND	1.2	3.2	4.3	ND	3.1	8.3	3.3	15

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-07, 107th Street & Fisher Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	8.4	19.1	11.8	0.021	0.015	0.27	0.75	0.102	0.060	ND	6.97
Standard Error	0.1	2.1	0.6	0.014	0.007	0.16	0.19	0.019	0.017	ND	1.47
Median	8.4	21.2	11.6	0.000	0.013	0.08	0.54	0.093	0.056	ND	6.43
Mode	8.3	ND	ND	0.000	0.000	0.00	ND	0.100	ND	ND	ND
Standard Deviation	0.2	5.9	1.7	0.038	0.018	0.43	0.54	0.054	0.048	ND	4.15
Sample Variance	0.0	34.4	2.8	0.001	0.000	0.19	0.29	0.003	0.002	ND	17.24
Kurtosis	0.2	-1.2	0.1	5.145	1.808	4.79	2.63	3.979	2.422	ND	-0.43
Skewness	-0.8	-0.8	0.5	2.224	1.389	2.15	1.75	1.636	1.223	ND	0.74
Range	0.6	14.1	5.3	0.110	0.050	1.20	1.55	0.184	0.160	0.00	11.66
Minimum	8.0	10.4	9.5	0.000	0.000	0.00	0.35	0.036	0.000	0.00	2.44
Maximum	8.6	24.5	14.8	0.110	0.050	1.20	1.90	0.220	0.160	0.00	14.10
Count	8	8	8	8	7	7	8	8	8	0	8
Confidence Level (95.0%)	0.2	4.9	1.4	0.032	0.017	0.40	0.45	0.045	0.040	ND	3.47

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	6.3	0.7	807.5	2481	2388	1253	225.7	0.0	0.8	6.8	1.6
Standard Error	2.0	0.4	71.3	1802	1806	104	18.9	0.0	0.8	5.3	0.4
Median	4.5	0.0	855.0	675	670	1349	230.0	0.0	0.8	6.8	1.6
Mode	ND	0.0	ND	230	ND	ND	230.0	0.0	ND	ND	ND
Standard Deviation	5.7	1.1	201.7	5097	5108	293	50.0	0.0	1.1	7.4	0.5
Sample Variance	32.3	1.1	40678.6	25979755	26087107	85961	2495.2	0.0	1.3	55.1	0.2
Kurtosis	3.9	1.1	3.2	8	8	3	4.6	ND	ND	ND	ND
Skewness	1.9	1.4	-1.7	3	3	-1	-1.9	ND	ND	ND	ND
Range	17.1	2.8	630.0	14960	14890	962	160.0	0.0	1.6	10.5	0.7
Minimum	1.9	0.0	370.0	40	110	629	120.0	0.0	0.0	1.5	1.2
Maximum	19.0	2.8	1000.0	15000	15000	1591	280.0	0.0	1.6	12.0	1.9
Count	8	8	8	8	8	8	7	2	2	2	2
Confidence Level (95.0%)	4.7	0.9	168.6	4261	4270	245	46.2	0.0	10.2	66.7	4.4

Summary Statistics, Underwood Creek Water Quality Data: 2003, Site UC-07, 107th Street & Fisher Parkway

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	3.4	10.5	62.00	28.00	0.0	3.7	0.0	0.0	801.2	2.8	270
Standard Error	3.4	10.5	26.00	16.00	0.0	3.7	0.0	0.0	72.0	0.3	130
Median	3.4	10.5	62.00	28.00	0.0	3.7	0.0	0.0	849.2	2.8	270
Mode	ND	ND	ND	ND	0.0	ND	0.0	0.0	ND	2.4	ND
Standard Deviation	4.7	14.8	36.77	22.63	0.0	5.2	0.0	0.0	203.5	0.8	184
Sample Variance	22.4	220.5	1352.00	512.00	0.0	26.6	0.0	0.0	41423.2	0.6	33800
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	2.9	1.0	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-1.6	0.4	ND
Range	6.7	21.0	52.00	32.00	0.0	7.3	0.0	0.0	632.0	2.6	260
Minimum	0.0	0.0	36.00	12.00	0.0	0.0	0.0	0.0	364.5	1.6	140
Maximum	6.7	21.0	88.00	44.00	0.0	7.3	0.0	0.0	996.5	4.2	400
Count	2	2	2	2	2	2	2	2	8	8	2
Confidence Level (95.0%)	42.6	133.4	330.36	203.30	0.0	46.4	0.0	0.0	170.2	0.6	1652

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	4.6	1.9	7.4	ND	7.0	43.8	5.6	187
Standard Error	ND	1.7	0.8	1.1	ND	0.9	4.3	0.6	21
Median	ND	2.6	1.2	8.1	ND	6.3	49.5	5.1	210
Mode	ND	ND	0.0	ND	ND	10.0	50.0	ND	210
Standard Deviation	ND	4.8	2.2	3.3	ND	2.4	12.0	1.8	56
Sample Variance	ND	23.1	4.7	10.5	ND	6.0	144.5	3.2	3157
Kurtosis	ND	4.3	-1.1	4.7	ND	-2.2	1.1	-2.0	1
Skewness	ND	2.1	0.6	-1.9	ND	0.3	-1.4	0.3	-2
Range	0.0	14.0	5.5	11.0	0.0	5.5	35.0	4.5	150
Minimum	0.0	1.5	0.0	0.0	0.0	4.5	20.0	3.4	80
Maximum	0.0	15.5	5.5	11.0	0.0	10.0	55.0	7.9	230
Count	0	8	8	8	0	8	8	8	7
Confidence Level (95.0%)	ND	4.0	1.8	2.7	ND	2.0	10.0	1.5	52

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-07, 107th Street & Fisher Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	8.2	17.0	12.6	0.027	0.020	0.45	1.13	0.106	0.029	ND	17.42
Standard Error	0.1	2.2	0.8	0.012	0.004	0.26	0.31	0.034	0.008	ND	10.75
Median	8.3	17.5	12.8	0.018	0.021	0.20	0.86	0.085	0.033	ND	3.37
Mode	8.7	ND	ND	ND	ND	ND	ND	ND	0.000	ND	ND
Standard Deviation	0.4	6.4	2.2	0.035	0.011	0.74	0.88	0.091	0.022	ND	30.40
Sample Variance	0.2	40.5	4.8	0.001	0.000	0.54	0.77	0.008	0.000	ND	924.23
Kurtosis	-1.9	-1.3	-0.9	6.572	1.849	6.16	5.84	3.231	-1.333	ND	4.82
Skewness	-0.2	0.0	-0.5	2.475	0.127	2.43	2.33	1.490	-0.592	ND	2.22
Range	1.0	17.3	6.3	0.110	0.040	2.20	2.65	0.290	0.054	0.00	86.21
Minimum	7.7	8.2	8.9	0.000	0.000	0.00	0.55	0.000	0.000	0.00	1.09
Maximum	8.7	25.5	15.2	0.110	0.040	2.20	3.20	0.290	0.054	0.00	87.30
Count	8	8	8	8	8	8	8	7	7	0	8
Confidence Level (95.0%)	0.3	5.3	1.8	0.029	0.009	0.62	0.73	0.084	0.020	ND	25.42

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	15.6	5.7	952.5	5401	1643	1536	287.9	0.0	0.0	3.4	1.9
Standard Error	6.4	2.4	117.7	4127	905	184	45.4	0.0	0.0	0.8	0.0
Median	5.4	2.4	1025.0	1000	570	1676	295.0	0.0	0.0	3.4	1.9
Mode	ND	1.0	1300.0	ND	ND	ND	ND	0.0	0.0	ND	ND
Standard Deviation	18.2	6.7	332.8	10919	2560	521	128.5	0.0	0.0	1.1	0.1
Sample Variance	332.7	44.6	110735.7	119218414	6552164	271679	16510.4	0.0	0.0	1.1	0.0
Kurtosis	-0.5	1.0	-0.6	7	6	0	-0.5	ND	ND	ND	ND
Skewness	1.2	1.3	-0.8	3	2	-1	-0.1	ND	ND	ND	ND
Range	42.7	19.0	890.0	29900	7570	1489	387.0	0.0	0.0	1.5	0.1
Minimum	2.3	0.0	410.0	100	130	652	93.0	0.0	0.0	2.6	1.8
Maximum	45.0	19.0	1300.0	30000	7700	2141	480.0	0.0	0.0	4.1	1.9
Count	8	8	8	7	8	8	8	2	2	2	2
Confidence Level (95.0%)	15.2	5.6	278.2	10098	2140	436	107.4	0.0	0.0	9.5	0.6

Summary Statistics, Underwood Creek Water Quality Data: 2004, Site UC-07, 107th Street & Fisher Parkway

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	0.0	8.0	76.50	37.50	0.8	2.1	0.0	0.0	936.9	3.1	340
Standard Error	0.0	8.0	21.50	16.50	0.3	2.1	0.0	0.0	118.5	0.3	120
Median	0.0	8.0	76.50	37.50	0.8	2.1	0.0	0.0	1013.4	3.0	340
Mode	0.0	ND	ND	ND	ND	ND	0.0	0.0	ND	ND	ND
Standard Deviation	0.0	11.3	30.41	23.33	0.4	3.0	0.0	0.0	335.2	0.8	170
Sample Variance	0.0	128.0	924.50	544.50	0.2	8.8	0.0	0.0	112372.5	0.6	28800
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.4	0.7	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.9	0.6	ND
Range	0.0	16.0	43.00	33.00	0.6	4.2	0.0	0.0	929.7	2.5	240
Minimum	0.0	0.0	55.00	21.00	0.5	0.0	0.0	0.0	367.0	2.0	220
Maximum	0.0	16.0	98.00	54.00	1.1	4.2	0.0	0.0	1296.7	4.5	460
Count	2	2	2	2	2	2	2	2	8	7	2
Confidence Level (95.0%)	0.0	101.6	273.18	209.65	3.7	26.7	0.0	0.0	280.3	0.7	1525

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	9.1	4.8	15.8	ND	8.7	49.9	7.8	220
Standard Error	ND	4.3	1.8	5.4	ND	1.0	4.3	0.6	20
Median	ND	4.2	3.0	9.9	ND	7.6	53.0	7.2	240
Mode	ND	ND	ND	ND	ND	ND	53.0	7.0	250
Standard Deviation	ND	12.2	5.1	15.4	ND	2.8	12.1	1.8	55
Sample Variance	ND	149.2	26.3	236.9	ND	7.8	145.6	3.1	3057
Kurtosis	ND	4.0	3.3	2.9	ND	0.4	-0.3	0.6	0
Skewness	ND	2.1	1.8	1.8	ND	1.3	-0.6	0.8	-1
Range	0.0	35.8	16.0	44.8	0.0	7.6	36.0	5.6	140
Minimum	0.0	0.7	0.0	4.2	0.0	6.4	30.0	5.4	130
Maximum	0.0	36.5	16.0	49.0	0.0	14.0	66.0	11.0	270
Count	0	8	8	8	0	8	8	8	8
Confidence Level (95.0%)	ND	10.2	4.3	12.9	ND	2.3	10.1	1.5	46

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-07, 107th Street & Fisher Parkway

VARIABLE	PH	TEMP	DO	AMMONIA	NITRITE	NITRATE	TKN	PHOS	SOLPHOS	SOLSIL	CHLA
units	*su*	*C*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/m3*
STATISTICS											
Mean	8.2	18.4	11.8	0.076	0.070	0.39	1.55	0.203	0.086	ND	14.40
Standard Error	0.1	2.1	1.0	0.052	0.033	0.15	0.34	0.074	0.028	ND	4.57
Median	8.1	20.1	12.2	0.005	0.023	0.21	1.40	0.140	0.069	ND	9.08
Mode	ND	ND	ND	0.000	ND	ND	1.40	ND	0.016	ND	25.30
Standard Deviation	0.4	6.0	2.8	0.148	0.094	0.44	0.97	0.208	0.078	ND	12.91
Sample Variance	0.1	36.0	7.6	0.022	0.009	0.19	0.94	0.043	0.006	ND	166.74
Kurtosis	0.2	0.9	-1.8	5.203	1.429	0.46	-0.94	2.778	-1.642	ND	-1.00
Skewness	0.4	-1.1	-0.2	2.281	1.571	1.36	0.61	1.719	0.429	ND	0.75
Range	1.2	17.9	7.3	0.420	0.253	1.18	2.61	0.609	0.200	0.00	34.84
Minimum	7.6	6.7	8.1	0.000	0.007	0.02	0.39	0.041	0.000	0.00	1.56
Maximum	8.8	24.6	15.4	0.420	0.260	1.20	3.00	0.650	0.200	0.00	36.40
Count	8	8	8	8	8	8	8	8	8	0	8
Confidence Level (95.0%)	0.3	5.0	2.3	0.124	0.079	0.36	0.81	0.174	0.066	ND	10.80

VARIABLE	SS	VSS	TS	FECAL	ECOLIQT	SPEC	CHLOR	CD	CR	CU	NI
units	*mg/L*	*mg/L*	*mg/L*	*CFU/100 mL*	*MPN/100 mL*	*umhos/cm*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
STATISTICS											
Mean	17.2	7.2	1062.5	23661	47649	1694	332.5	0.0	5.8	7.3	4.7
Standard Error	7.8	2.9	80.7	11087	29283	145	40.8	0.0	0.0	0.0	1.1
Median	7.0	4.6	1035.0	1100	5345	1774	315.0	0.0	5.8	7.3	4.7
Mode	ND	0.0	1300.0	ND	ND	ND	ND	0.0	ND	ND	ND
Standard Deviation	22.2	8.2	228.2	29332	82825	411	115.4	0.0	ND	ND	1.6
Sample Variance	490.7	67.5	52078.6	860378681	6859904898	168606	13307.1	0.0	ND	ND	2.4
Kurtosis	0.4	0.7	-0.9	-3	5	0	-1.0	ND	ND	ND	ND
Skewness	1.4	1.3	-0.4	0	2	-1	0.0	ND	ND	ND	ND
Range	56.0	23.0	620.0	59880	239860	1157	330.0	0.0	0.0	0.0	2.2
Minimum	2.0	0.0	680.0	120	140	935	160.0	0.0	5.8	7.3	3.6
Maximum	58.0	23.0	1300.0	60000	240000	2092	490.0	0.0	5.8	7.3	5.8
Count	8	8	8	7	8	8	8	2	1	1	2
Confidence Level (95.0%)	18.5	6.9	190.8	27128	69243	343	96.4	0.0	ND	ND	14.0

Summary Statistics, Underwood Creek Water Quality Data: 2005, Site UC-07, 107th Street & Fisher Parkway

VARIABLE	PB	ZN	CA	MG	AG	AS	SE	HG	DS	LFC	HARD
units	*ug/L*	*ug/L*	*mg/L*	*mg/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*mg/L*	*CFU/100 mL*	*mg/L*
STATISTICS											
Mean	1.1	75.0	79.00	31.50	0.9	0.0	5.0	0.0	1045.3	3.4	325
Standard Error	1.1	55.0	31.00	14.50	0.0	0.0	5.0	0.0	85.9	0.5	135
Median	1.1	75.0	79.00	31.50	0.9	0.0	5.0	0.0	1032.6	3.0	325
Mode	ND	ND	ND	ND	ND	0.0	ND	0.0	ND	ND	ND
Standard Deviation	1.6	77.8	43.84	20.51	0.0	0.0	7.1	0.0	243.1	1.3	191
Sample Variance	2.4	6050.0	1922.00	420.50	0.0	0.0	50.0	0.0	59095.7	1.6	36450
Kurtosis	ND	ND	ND	ND	ND	ND	ND	ND	-0.6	-2.6	ND
Skewness	ND	ND	ND	ND	ND	ND	ND	ND	-0.5	0.2	ND
Range	2.2	110.0	62.00	29.00	0.1	0.0	10.0	0.0	674.1	2.7	270
Minimum	0.0	20.0	48.00	17.00	0.9	0.0	0.0	0.0	622.0	2.1	190
Maximum	2.2	130.0	110.00	46.00	0.9	0.0	10.0	0.0	1296.1	4.8	460
Count	2	2	2	2	2	2	2	2	8	7	2
Confidence Level (95.0%)	14.0	698.8	393.89	184.24	0.4	0.0	63.5	0.0	203.2	1.2	1715

VARIABLE	SCHII	TURB	BOD5	BOD20	IXLITE	TNOC	TNIC	TNDOC	TALK
units	*meters*	*NTU*	*mg/L*	*mg/L*	*meters*	*mg/L*	*mg/L*	*mg/L*	*mg/L*
STATISTICS									
Mean	ND	13.5	7.1	14.1	ND	13.3	51.5	11.2	212
Standard Error	ND	7.1	2.3	5.3	ND	3.3	8.5	3.0	23
Median	ND	3.5	4.5	9.0	ND	11.0	55.5	10.0	235
Mode	ND	ND	16.0	ND	ND	ND	ND	10.0	260
Standard Deviation	ND	20.2	6.4	15.1	ND	8.7	20.7	8.0	65
Sample Variance	ND	408.6	41.0	227.2	ND	75.5	430.3	63.6	4200
Kurtosis	ND	2.6	-1.5	6.3	ND	3.2	2.1	2.5	4
Skewness	ND	1.9	0.6	2.4	ND	1.7	-1.1	1.4	-2
Range	0.0	55.0	16.0	45.7	0.0	25.6	62.0	23.9	195
Minimum	0.0	1.7	0.0	4.3	0.0	5.4	15.0	3.1	65
Maximum	0.0	56.7	16.0	50.0	0.0	31.0	77.0	27.0	260
Count	0	8	8	8	0	7	6	7	8
Confidence Level (95.0%)	ND	16.9	5.4	12.6	ND	8.0	21.8	7.4	54

APPENDIX F: WQI Statistical Comparison of UC Sites Utilizing an Independent T-test

(Means are calculated using all Water Quality Final Index data (2003-2005)

(**Red indicates that a statistically significant difference exists**)

T-test comparing UC-01 to UC-02

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-01S
Group 2: UC-02S

Variable	Mean UC-01S	Mean UC-02S	t-value	df	p	Valid N UC-01S	Valid N UC-02S	Std.Dev. UC-01S	Std.Dev. UC-02S	F-ratio Variances	p Variances
FNLNDX	45.01744	49.57371	-0.703996	45	0.485062	24	23	22.46504	21.87785	1.054399	0.903661

T-test comparing UC-01 to UC-03

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-01S
Group 2: UC-03S

Variable	Mean UC-01S	Mean UC-03S	t-value	df	p	Valid N UC-01S	Valid N UC-03S	Std.Dev. UC-01S	Std.Dev. UC-03S	F-ratio Variances	p Variances
FNLNDX	**45.01744**	**65.93702**	**-3.37151**	**46**	**0.001523**	**24**	**24**	**22.46504**	**20.47720**	**1.203576**	**0.660506**

T-test comparing UC-01 to UC-04

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-01S
Group 2: UC-04S

Variable	Mean UC-01S	Mean UC-04S	t-value	df	p	Valid N UC-01S	Valid N UC-04S	Std.Dev. UC-01S	Std.Dev. UC-04S	F-ratio Variances	p Variances
FNLNDX	45.01744	55.18665	-1.78184	46	0.081377	24	24	22.46504	16.64429	1.821731	0.157844

T-test comparing UC-01 to UC-05

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-01S
Group 2: UC-05S

Variable	Mean UC-01S	Mean UC-05S	t-value	df	p	Valid N UC-01S	Valid N UC-05S	Std.Dev. UC-01S	Std.Dev. UC-05S	F-ratio Variances	p Variances
FNLNDX	**45.01744**	**30.96160**	**2.497097**	**46**	**0.016163**	**24**	**24**	**22.46504**	**15.99195**	**1.973384**	**0.110176**

T-test comparing UC-01 to UC-06

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-01S
Group 2: UC-06S

Variable	Mean UC-01S	Mean UC-06S	t-value	df	p	Valid N UC-01S	Valid N UC-06S	Std.Dev. UC-01S	Std.Dev. UC-06S	F-ratio Variances	p Variances
FNLNDX	45.01744	55.41910	-1.87120	46	0.067685	24	24	22.46504	15.39249	2.130084	0.076205

T-test comparing UC-01 to UC-07

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-01S
Group 2: UC-07S

Variable	Mean UC-01S	Mean UC-07S	t-value	df	p	Valid N UC-01S	Valid N UC-07S	Std.Dev. UC-01S	Std.Dev. UC-07S	F-ratio Variances	p Variances
FNLNDX	45.01744	53.97831	-1.35050	46	0.183462	24	24	22.46504	23.49353	1.093659	0.831852

T-test comparing UC-02 to UC-03

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-02S
Group 2: UC-03S

Variable	Mean UC-02S	Mean UC-03S	t-value	df	p	Valid N UC-02S	Valid N UC-03S	Std.Dev. UC-02S	Std.Dev. UC-03S	F-ratio Variances	p Variances
FNLNDX	**49.57371**	**65.93702**	**-2.64849**	**45**	**0.011111**	**23**	**24**	**21.87785**	**20.47720**	**1.141480**	**0.753918**

T-test comparing UC-02 to UC-04

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-02S
Group 2: UC-04S

Variable	Mean UC-02S	Mean UC-04S	t-value	df	p	Valid N UC-02S	Valid N UC-04S	Std.Dev. UC-02S	Std.Dev. UC-04S	F-ratio Variances	p Variances
FNLNDX	49.57371	55.18665	-0.992545	45	0.326239	23	24	21.87785	16.64429	1.727743	0.200491

T-test comparing UC-02 to UC-05

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-02S
Group 2: UC-05S

Variable	Mean UC-02S	Mean UC-05S	t-value	df	p	Valid N UC-02S	Valid N UC-05S	Std.Dev. UC-02S	Std.Dev. UC-05S	F-ratio Variances	p Variances
FNLNDX	**49.57371**	**30.96160**	**3.339946**	**45**	**0.001691**	**23**	**24**	**21.87785**	**15.99195**	**1.871572**	**0.143040**

T-test comparing UC-02 to UC-06

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-02S
Group 2: UC-06S

Variable	Mean UC-02S	Mean UC-06S	t-value	df	p	Valid N UC-02S	Valid N UC-06S	Std.Dev. UC-02S	Std.Dev. UC-06S	F-ratio Variances	p Variances
FNLNDX	49.57371	55.41910	-1.06306	45	0.293425	23	24	21.87785	15.39249	2.020188	0.101034

T-test comparing UC-02 to UC-07

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-02S
Group 2: UC-07S

Variable	Mean UC-02S	Mean UC-07S	t-value	df	p	Valid N UC-02S	Valid N UC-07S	Std.Dev. UC-02S	Std.Dev. UC-07S	F-ratio Variances	p Variances
FNLNDX	49.57371	53.97831	-0.664441	45	0.509799	23	24	21.87785	23.49353	1.153153	0.740876

T-test comparing UC-03 to UC-04

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-03S
Group 2: UC-04S

Variable	Mean UC-03S	Mean UC-04S	t-value	df	p	Valid N UC-03S	Valid N UC-04S	Std.Dev. UC-03S	Std.Dev. UC-04S	F-ratio Variances	p Variances
FNLNDX	65.93702	55.18665	1.995794	46	0.051897	24	24	20.47720	16.64429	1.513598	0.327223

T-test comparing UC-03 to UC-05

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-03S
Group 2: UC-05S

Variable	Mean UC-03S	Mean UC-05S	t-value	df	p	Valid N UC-03S	Valid N UC-05S	Std.Dev. UC-03S	Std.Dev. UC-05S	F-ratio Variances	p Variances
FNLNDX	**65.93702**	**30.96160**	**6.594744**	**46**	**0.000000**	**24**	**24**	**20.47720**	**15.99195**	**1.639600**	**0.243205**

T-test comparing UC-03 to UC-06

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-03S
Group 2: UC-06S

Variable	Mean UC-03S	Mean UC-06S	t-value	df	p	Valid N UC-03S	Valid N UC-06S	Std.Dev. UC-03S	Std.Dev. UC-06S	F-ratio Variances	p Variances
FNLNDX	65.93702	55.41910	2.011420	46	0.050161	24	24	20.47720	15.39249	1.769796	0.178573

T-test comparing UC-03 to UC-07

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-03S
Group 2: UC-07S

Variable	Mean UC-03S	Mean UC-07S	t-value	df	p	Valid N UC-03S	Valid N UC-07S	Std.Dev. UC-03S	Std.Dev. UC-07S	F-ratio Variances	p Variances
FNLNDX	65.93702	53.97831	1.879845	46	0.066471	24	24	20.47720	23.49353	1.316302	0.515125

T-test comparing UC-04 to UC-05

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-04S
Group 2: UC-05S

Variable	Mean UC-04S	Mean UC-05S	t-value	df	p	Valid N UC-04S	Valid N UC-05S	Std.Dev. UC-04S	Std.Dev. UC-05S	F-ratio Variances	p Variances
FNLNDX	**55.18665**	**30.96160**	**5.141602**	**46**	**0.000005**	**24**	**24**	**16.64429**	**15.99195**	**1.083247**	**0.849586**

T-test comparing UC-04 to UC-06

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-04S
Group 2: UC-06S

Variable	Mean UC-04S	Mean UC-06S	t-value	df	p	Valid N UC-04S	Valid N UC-06S	Std.Dev. UC-04S	Std.Dev. UC-06S	F-ratio Variances	p Variances
FNLNDX	55.18665	55.41910	-0.050230	46	0.960157	24	24	16.64429	15.39249	1.169264	0.710836

T-test comparing UC-04 to UC-07

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-04S
Group 2: UC-07S

Variable	Mean UC-04S	Mean UC-07S	t-value	df	p	Valid N UC-04S	Valid N UC-07S	Std.Dev. UC-04S	Std.Dev. UC-07S	F-ratio Variances	p Variances
FNLNDX	55.18665	53.97831	0.205601	46	0.838010	24	24	16.64429	23.49353	1.992352	0.105347

T-test comparing UC-05 to UC-06

T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip)
Group 1: UC-05S
Group 2: UC-06S

Variable	Mean UC-05S	Mean UC-06S	t-value	df	p	Valid N UC-05S	Valid N UC-06S	Std.Dev. UC-05S	Std.Dev. UC-06S	F-ratio Variances	p Variances
FNLNDX	**30.96160**	**55.41910**	**-5.39808**	**46**	**0.000002**	**24**	**24**	**15.99195**	**15.39249**	**1.079407**	**0.856189**

T-test comparing UC-05 to UC-07

Variable	Mean UC-05S	Mean UC-07S	t-value	df	p	Valid N UC-05S	Valid N UC-07S	Std.Dev. UC-05S	Std.Dev. UC-07S	F-ratio Variances	p Variances
T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip) Group 1: UC-05S Group 2: UC-07S											
FNLNDX	**30.96160**	**53.97831**	**-3.96759**	**46**	**0.000252**	**24**	**24**	**15.99195**	**23.49353**	**2.158209**	**0.071358**

T-test comparing UC-06 to UC-07

Variable	Mean UC-06S	Mean UC-07S	t-value	df	p	Valid N UC-06S	Valid N UC-07S	Std.Dev. UC-06S	Std.Dev. UC-07S	F-ratio Variances	p Variances
T-tests; Grouping: **SITE** (UC subindex values A 03 04 05 with precip) Group 1: UC-06S Group 2: UC-07S											
FNLNDX	55.41910	53.97831	0.251306	46	0.802697	24	24	15.39249	23.49353	2.329586	0.047979