Environmental Integrity Index
Phase I & II (2011-2012) Watershed Summary Report

Short Report SR-13-18 Completed October 2013

Andrew Clamann, Aaron Richter and Emily Yeoman

On the cover: EII sampled watersheds are shown outlined with dark bold lines with internal subwatersheds color-coded to reflect the EII total score from 2011 and 2012. Subwatershed scores are derived from the site(s) within each reach that are indicated on the map. Additional information regarding these scores and facets of these scores can be found in the watershed summary sections of this report.

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EII Phase I & II (2011-2012) Watershed Report

Andrew Clamann
Environmental Scientist
Environmental Resource Management Division
Watershed Protection Department
City of Austin

Environmental Integrity Index (EII) Phase I & II data collected during 2011 and 2012 are presented and evaluated within the context of historical EII data. Forty-five watersheds throughout the greater Austin area were sampled to assess environmental conditions. These values are in use as part of the Citywide WPDRD masterplan in prioritizing subwatersheds to address through Capital Improvement Projects, regulations and/or other programs. The values are also used in the WPD Business Plan as performance measures for water quality maintenance.

Introduction

Since 1990, the City of Austin has conducted water quality monitoring on the lakes, creeks and streams in and around the Austin area. With the rapid growth of the Austin metropolitan area, this sampling has enabled us to track changes in environmental quality in our streams. Originally, city-wide monitoring of surface water relied largely on citizen volunteer support under a program called Water Watchdogs, which primarily targeted Austin's urban streams. City Staff and volunteers began collecting surface water samples in 1991 and continued to sample through 1999 with decreasing reliance on volunteers.

The Environmental Integrity Index (EII) was developed and tested in the urban watersheds in 1994 and 1995 and initiated citywide monitoring in 1996, absorbing and collaborating with the Water Watchdog program. During this transition the EII was expanded for use as part of technical assessments used in the citywide Watershed Protection and Development Review Department (WPDRD) masterplan. By the end of 2000, water quality monitoring frequency became a quarterly event and the biological and habitat surveys were completed once per year. 45 City of Austin planning watersheds were grouped into three phases and sampled on a three-year rotating basis with approximately 50 sites sampled per year. Phase 1 primarily included the urban watersheds sampled under the original Water Watchdog program while Phase 2 and Phase 3 included primarily suburban and developing watersheds (Figure 1 and Table 1). Phase 1 watersheds were sampled in '00, '03, '06, Phase 2 watersheds were sampled in '01, '04, '07 and Phase 3 watersheds were sampled in '02, '05 and '08.

In 2009, following the completion of three full cycles of the three-phase rotation (2000-2008), the watersheds were regrouped into two phases for sampling on a two-year rotating schedule (Figure 2 and Table 2). The result of regrouping includes an increased frequency of site visits to improve the resolution of temporal trend evaluation, and will facilitate meeting the frequency requirements of the TCEQ for potential evaluation in the Clean Rivers Program. The current two-phase cycle involves the monitoring of 122 sample sites within 45 watersheds in the City's planning area.

This report presents data collected for the EII monitoring program in 2011 and 2012 and covers the associated water quality, habitat, and biological data. Data from the previous decade of EII sampling events are included for comparison within the watershed summary sections of the report. Biological data including diatom and benthic macroinvertebrate species lists and metrics are presented in Appendix A and B respectively. Raw water chemistry data is presented in Appendix C.

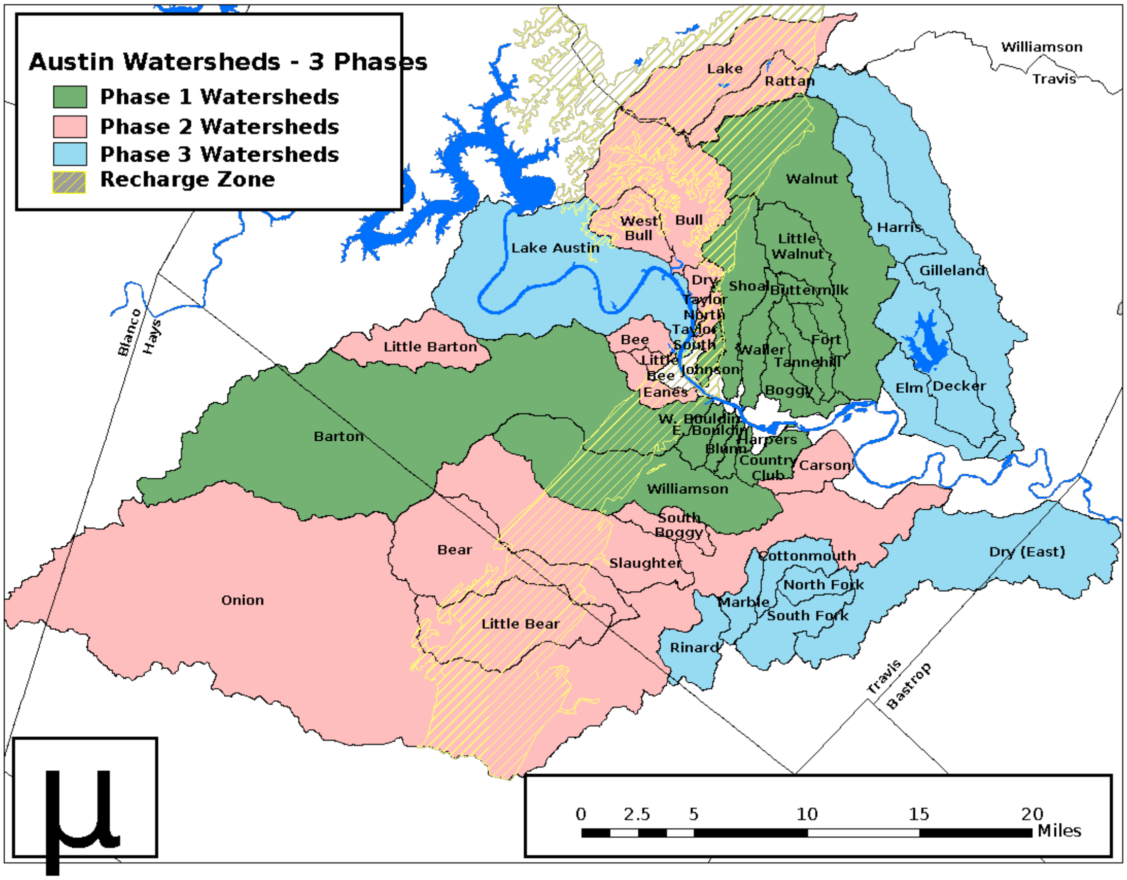

Figure 1. Historic three-phase rotation of watersheds sampled from 1999 to 2008.

Phase I 2000, 2003, 2006	Phase II 2001, 2004, 2007	Phase IIII 2002, 2005, 2008
Barton Creek	Bear Creek	Cottonmouth
Blunn Creek	Bee Creek	Decker Creek
Boggy Creek	Bull Creek	Dry Creek
Buttermilk Creek	Carson Creek	Elm Creek
Country Club Creek	Dry Creek	Gilleland Creek
East Bouldin Creek	Eanes Creek	Harris Branch
Fort Branch	Huck's Slough	Lake Austin (6 tribs)
Harpers Branch	Lake Creek	Marble Creek
Johnson Creek	Little Barton Creek	North Fork Dry Creek
Little Walnut Creek	Little Bear Creek	Rinard Creek
Shoal Creek	Little Bee Creek	South Fork Dry Creek
Tannehill Branch	Onion Creek	

Waller Creek	Rattan Creek
Walnut Creek	Slaughter Creek
West Bouldin Creek	South Boggy Creek
Williamson Creek	Taylor Slough (North)
	Taylor Slough (South)

Table 1. EII Watersheds grouped by the historic 3-phase rotation of 1999-2008

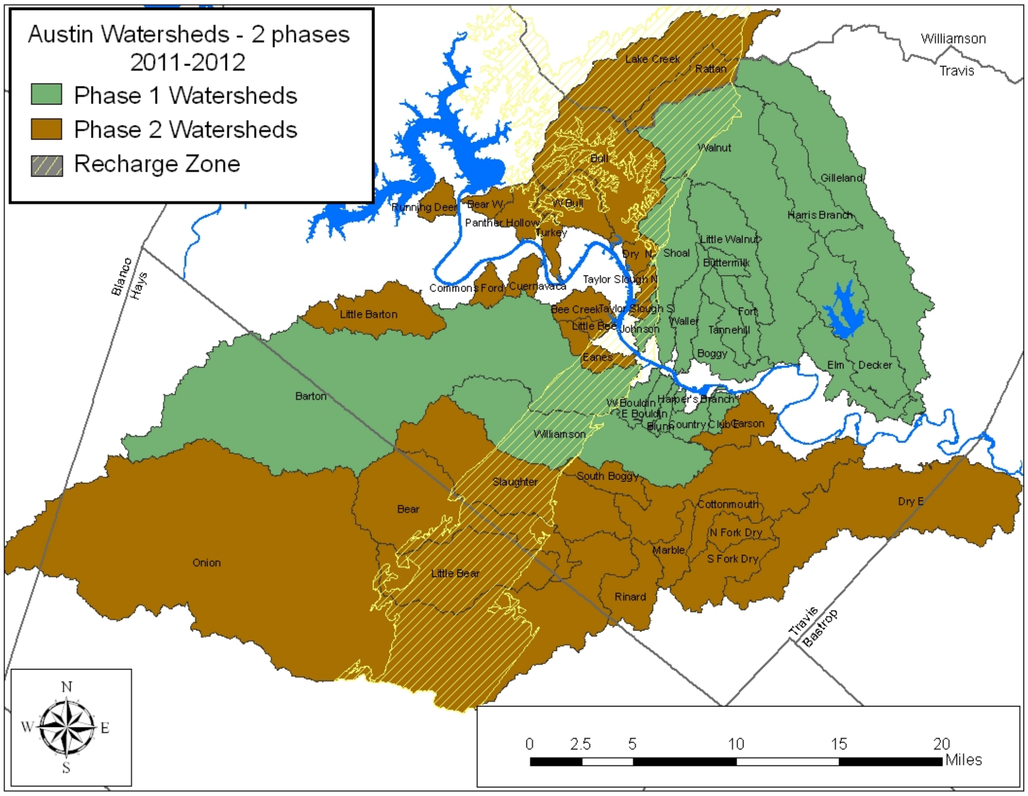

Figure 2. Current two-phase rotation of watersheds sampled from in 2009 to 2012

Phase I – 2009, 2011	Phase II – 2010, 2012
Barton Creek	Bear Creek
Blunn Creek	Bee Creek
Boggy (north) Creek	Bull Creek
Buttermilk Creek	Carson Creek
Country Club Creek	Cottonmouth Creek
Decker Creek	Dry Creek East
East Bouldin Creek	Dry (north) Creek
Elm Creek	Eanes Creek
Fort Branch	Lake Austin (6 tribs)
Gilleland Creek	Lake Creek
Harpers Branch	Little Barton Creek
Harris Branch	Little Bear Creek
Johnson Creek	Little Bee Creek
Little Walnut Creek	Marble Creek
Shoal Creek	North Fork Dry
Tannehill Branch	Onion Creek
Waller Creek	Rattan Creek
Walnut Creek	Rinard
West Bouldin Creek	Slaughter Creek
Williamson Creek	South Boggy Creek

South Fork Dry
Taylor Slough (North)
Taylor Slough (South)
West Bull

Table 2. EII Watersheds grouped by the current 2-phase rotation of 2009-2010

Methods

During the 2011-2012 Phase I & II sampling periods there were a total of 122 water quality sampling sites in 45 watersheds (Table 3 and 4). All data was collected adhering to the Water Resource Evaluation Standard Operating Procedures Manual (COA SOP 2010). As part of these procedures, the collection of quarterly water quality sample at any given site is contingent upon there being baseflow conditions (COA SOP section 3.5). This reduces the influence of recent stormwater or drought conditions. Annual biological samples collected in the late Spring or Summer may be collected from intermittent pools under drought conditions if it is the only available habitat.

Field measurements are collected with a multiprobe instrument (Hach Hydrolab) during the quarterly water quality and annual biological sampling events:

- Dissolved Oxygen (mg/L)
- Specific Conductivity (µS/cm)
- pH (Standard Units)
- Water Temperature (ºC)

Water samples submitted to the LCRA lab were analyzed for:

- Ammonia as N (mg/L)
- Nitrate as N (mg/L)
- Orthophosphorus as P (mg/L) (for Barton, Bull, Onion and Walnut sites only)
- Total Suspended Solids (mg/L) (for Barton, Bull, Onion and Walnut sites only)
- *E. coli* bacteria (col/100ml) (for Barton, Bull, Onion and Walnut sites only)

Water samples were analyzed at the COA lab for:

- Turbidity (NTU)
- *E. coli* bacteria (col/100ml)
- Orthophosphorus as P (mg/L) (for sites other than Barton, Bull, Onion and Walnut)
- Total Suspended Solids (mg/L) (for sites other than Barton, Bull, Onion and Walnut)

The physical and biological monitoring event occurs annually in the summer and includes:

- Benthic macroinvertebrate and diatom surveys (COA SOP section 5.0)
- Stream and reach stability assessment (Pfankuch, 1975)
- Non-contact recreational assessment (COA SOP section 6.1)
- Habitat assessment (Barbour et al. 1999)
- Flow measurement (COA SOP section 2.6)

Data from all sampling events (quarterly water quality events and one biological event) for a given year are analyzed, in part, through the use of eight sub-index categories, and one overall watershed score that are calculated for each watershed and normalized relative to the other watersheds for that year (for detailed description of calculation methods, see the EII Methodology Report (COA-ERM 1999-01). Index reporting categories are:

- Aquatic Life Use Score
- Benthic Macroinvertebrate Score
- Diatom Score
- Water Quality Score
- Contact Recreation Score
- Non-Contact Recreation Score
- Sediment Quality Score
- Physical Integrity Score
- Overall Watershed Score

EII monitoring sites were selected to represent stream reaches within each watershed. Reach boundaries were determined based on patterns in geology, hydrology and land use. This provides the ability to evaluate trends over time, while providing the flexibility to move site locations as necessary. Sample site and the corresponding reach designations are listed in Tables 3 and 4.

Table 3. 2011 EII Phase I Monitoring Schedule*

Watershed	Site #	Site Name	2011 Mar WQ	Jun WQ	Jun Bio	Sep WQ
Barton	44	Barton Creek @ Stark Pool	B	B	B	n
Barton	46	Barton Creek @ Shield Ranch Pool	B	B	B	n
Barton	48	Barton Creek @ Hwy71 below Little Barton	B	B	B	B
Barton	49	Barton Creek @ Ogletree	B	B	B	n
Barton	51	Barton Creek @ Lost Creek	B	B	B	n
Barton	879	Barton Creek between dams u/s BSP	B	B	n	n
Blunn	362	Blunn @ Long Bow	B	B	B	n
Blunn	364	Blunn upstream of Stacy Pool	B	n	n	n
Blunn	180	Blunn @ Riverside Dr	B	n	n	n
Boggy	2754	Boggy Creek @ Manor Rd	B	B	B	B
Boggy	837	Boggy Creek @ Nile Rd	B	B	B	B
Boggy	493	Boggy Creek @ Delwau	B	n	n	n
Buttermilk	3861	Buttermilk @ Victory Christian Center	B	n	n	n
Buttermilk	782	Buttermilk @ Providence Avenue	n	n	n	n
Buttermilk	851	Buttermilk @ Little Walnut Creek	B	B	B	B
Country Club East	1475	East Country Club @ ACC	n	n	n	n
Country Club West	850	West Country Club @ East Oltorf	B	B	B	n
Country Club West	1474	West Country Club @ Kreig Field	n	n	n	n
Decker Creek	1196	Decker Creek @ Lindell	n	n	n	n
Decker Creek	1974	Decker Creek @ Gilbert	B	B	B	B
East Bouldin	121	East Bouldin Creek @ Alpine Road	n	n	n	n
East Bouldin	119	East Bouldin Creek @ Elizabeth St	B	B	B	n
East Bouldin	1338	East Bouldin Creek @ Post Oak	B	n	n	n
Elm	1204	Elm Creek @ FM 973	n	n	n	n
Elm	3614	Elm Creek @ Austins Colony	n	n	n	n
Fort Branch	126	Fort Branch @ Glencrest	B	n	n	n
Fort Branch	125	Fort Branch upstream of Manor Rd	n	n	B	n
Fort Branch	898	Fort Branch @ Carson Hill Rd	n	n	n	n
Fort Branch	123	Fort Branch @ North Boggy Creek	n	n	n	n
Gilleland	1193	Gilleland Creek @ South Railroad Ave	B	B	B	B
Gilleland	1914	Gilleland Creek @ Cameron Rd	B	B	B	B
Gilleland	1194	West Gilleland Creek @ Cameron Rd	B	n	n	n
Gilleland	1191	Gilleland Creek @ West Parsons St	B	B	B	B
Gilleland	1192	Gilleland Creek @ FM973	B	B	B	B
Gilleland	886	Gilleland Creek @ FM969	B	B	B	B
Harper's Branch	844	Harper's Branch @ Woodland	B	n	n	n
Harris	1199	Harris Branch Creek @ Crystal Bend Dr	B	n	n	n
Harris	1201	Harris Branch Creek @ Boyce Ln	B	B	B	B
Johnson Creek	897	Johnson Creek @ Woodmont	n	n	n	n
Little Walnut	838	Little Walnut Creek @ Golden Meadow Rd	B	n	B	n
Little Walnut	3860	Little Walnut Creek @ Georgian	B	B	B	n
Little Walnut	3857	Little Walnut Creek @ Cameron Rd	B	B	B	B
Little Walnut	634	Little Walnut Creek @ US183	B	B	B	B

Shoal	118	Shoal Creek downstream of Crosscreek	B	n	n	n
Shoal	117	Shoal Creek @ Shoal Edge Courtt	B	n	n	n
Shoal	116	Shoal Creek @ 24th St	B	B	B	B
Shoal	122	Shoal Creek upstream of 1st St	B	B	B	B
Tannehill	3858	Tannehill Creek @ Berkman Dr	B	n	n	n
Tannehill	843	Tannehill Creek @ Lovell Dr	B	B	B	n
Tannehill	1476	Tannehill Creek @ Desirable Dr	B	n	n	n
Waller	780	Waller Creek @ 51st St	B	n	n	n
Waller	624	Waller Creek @ 23rd St (USGS)	B	B	B	B
Waller	38	Waller downstream of Cesar Chavez	B	B	B	B
Walnut	463	Wells Branch @ Walnut Metro Park	B	B	B	n
Walnut	895	Walnut Creek downstream of Metric	B	B	B	B
Walnut	464	Walnut Creek downstream of IH35	B	n	n	n
Walnut	502	Walnut Creek @ Old Manor	B	B	B	n
Walnut	503	Walnut Creek @ SP Railroad Bridge	B	n	n	n
West Bouldin	3856	West Bouldin Creek @ Cardinal & Locke	B	n	n	n
West Bouldin	3854	West Bouldin Creek @ Oltorf	B	B	B	B
West Bouldin	2794	West Bouldin Creek @ Post Oak	n	n	n	n
Williamson	490	Williamson Creek @ Hwy71	n	n	n	n
Williamson	491	Williamson Creek @ IH35	n	n	n	n
Williamson	223	Williamson Creek @ McKinney Falls	B	B	B	B

* B = baseflow n = no flow S = storm flow blue = Samples were taken grey = Samples were not taken blank = site not visited

Table 4. 2012 EII Phase II Monitoring Schedule*

Watershed	Site #	Site Name	2011	2012			
			Dec	Mar	Apr-May	Jul	Sep
			WQ	WQ	Bio	WQ	WQ
Bear	4112	Bear Creek @ Bear Creek Pass	B	B	B	B	n
Bear	3935	Bear Creek @ Escondido	n	n	n	n	n
Bear	1087	Bear Creek @ Twin Creeks Rd	n	B	B	B	n
Bee	1104	Bee @ Loop 360	B	B	B	B	B
Bee	322	Bee @ Roadrunner Rd	B	B	B	B	B
Bee	319	Bee @ Lake Austin	B	B	B	B	n
Bull	151	Trib 6 @ Bull Creek	B	B	B	B	B
Bull	1164	Bull Creek Trib 5 d/s Hanks Tract Prop. Line	B	B	B	B	B
Bull	349	Bull Creek above Trib 7 (Franklin)	B	B	B	B	B
Bull	920	Bull Creek @ St Edwards Park above Dam	B	B	B	n	B
Bull	350	Bull Creek @ Loop 360	B	B	B	B	B
Carson	1096	Carson Creek @ Hoecke Ln	B	B	B	n	n
Carson	1094	Carson Creek @ Shady Springs Subdivision	B	B	B	B	B
Cottonmouth	1206	Cottonmouth Creek @ Dee Gabriel-Collins	n	B	B	n	B
Dry Creek South	1211	Dry Creek South @ Pearce Rd	B	B	B	n	B
Dry Creek South	1210	Dry Creek South @ Wolf Ln	B	B	B	n	B
Dry North	1109	Dry Creek North @ FM 2222	B	B	B	n	n
Dry North	1108	Dry Creek North @ Mt Bonnel Rd	B	B	B	B	n
Eanes	1106	Eanes Creek @ Camp Craft Rd	B	B	n	n	n
L.A.Bear West	1224	Bear Creek (West) @ Fritz Hughes Park Rd.	B	B	B	B	B
L.A.Commons Ford	1048	Commons Ford Trib in C. F. Metro Park	B	B	B	n	n
L.A.Cuernevaca	1222	Cuernevaca @ River Hills Rd.	B	B	B	n	n
L.A.Panther Hollow	1223	Panther Hollow Creek @ Big View Rd.	B	B	B	n	n
L.A.Running Deer	316	Running Deer @ Running Deer Trail	B	B	B	n	n
L.A.Turkey Creek	1221	Turkey Creek @ City Park Rd	n	B	B	n	n
Lake Creek	1100	Lake Creek below Meadowheath Dr	B	B	B	B	B
Lake Creek	3978	Lake Creek @ Shadowbrook Club	B	B	n	n	n
Lake Creek	1098	Lake Creek @ Sugar Berry Cove	B	B	n	n	n
Little Barton	1115	Little Barton @ Hamilton Pool Rd	B	B	B	n	n
Little Barton	1114	Little Barton @ Great Divide Dr	B	B	B	B	n
Little Barton	77	Little Barton @ Barton Creek	B	B	B	B	B
Little Bear	3374	Little Bear @ Ashmun Property	n	B	B	n	n
Little Bear	1101	Little Bear @ Bear Creek	n	B	B	B	n
Marble	232	Marble Creek @ Thaxton	n	B	B	n	n
Marble	231	Marble Creek above Onion Creek	B	B	B	B	B
North Fork Dry	1217	North Fork Dry Creek @ FM 812	n	B	n	n	n
Onion	4595	Onion Creek @ Hudson tract	n	B	B	B	B
Onion	612	Onion Creek nr Driftwood (Hwy 150)	n	B	B	B	B
Onion	236	Onion Creek @ Twin Creeks Rd	B	B	B	B	B

Onion	241	Onion Creek above Footbridge	B	B	B	B	B
Onion	255	Onion Creek @ Mckinney Falls d/s Lower Falls	B	B	B	B	B
Onion	1366	Onion Creek @ South Austin Regional	B	B	B	B	B
Rattan	1009	Rattan Creek above Parmer	n	n	n	n	n
Rattan	1097	Rattan Creek @ Shadowbrook Circle	n	n	n	n	n
Rinard	1220	Rinard Creek @ FM 1327	n	B	n	n	n
Rinard	1219	Rinard Creek @ Fm 1327 & Bradshaw Rd					
Rinard	5398	Rinard Creek Below SH 45	n	n	n	n	B
Rinard	233	Rinard Creek @ Bradshaw	B	B	B	B	B
Slaughter	623	Slaughter Creek @ FM 1826 (USGS)	B	B	B	n	n
Slaughter	1082	Slaughter @ Pine Valley Dr	B	B	n	n	n
South Fork Dry	1215	South Fork Dry Creek @ US183	n	B	n	n	n
South Fork Dry	1216	South Fork Dry Creek @ FM 812	B	B	B	B	n
Taylor Slough (N)	3969	Taylor Slough North @ Mayfield Pk	B	B	B	B	B
West Bull	148	West Bull Creek @ Bell Mt. Rd	B	B	B	n	B
West Bull	343	West Bull Creek above Bull Creek	B	B	B	n	n

* B = baseflow n = no flow S = storm flow blue = Samples were taken grey = Samples were not taken blank = site not visited

Results

As described in the Methods section, data is normalized and scored by sub-index categories in order to rate the environmental integrity of each watershed or sub-watershed. The scores of the eight sub-index categories are averaged to provide an overall EII total watershed score. The total score can vary from year to year based on climatic influences, development within the watershed, minor changes in methods and other variables. Figure 3 lists the each watershed from the lowest to the highest ten-year average total score (2000-2010 shown in blue), for comparison to the current total scores (2011-2012). The ten year average is based on a total of four scores per watershed (three cycles on a three-year rotation and one cycle on the current two-year rotation).

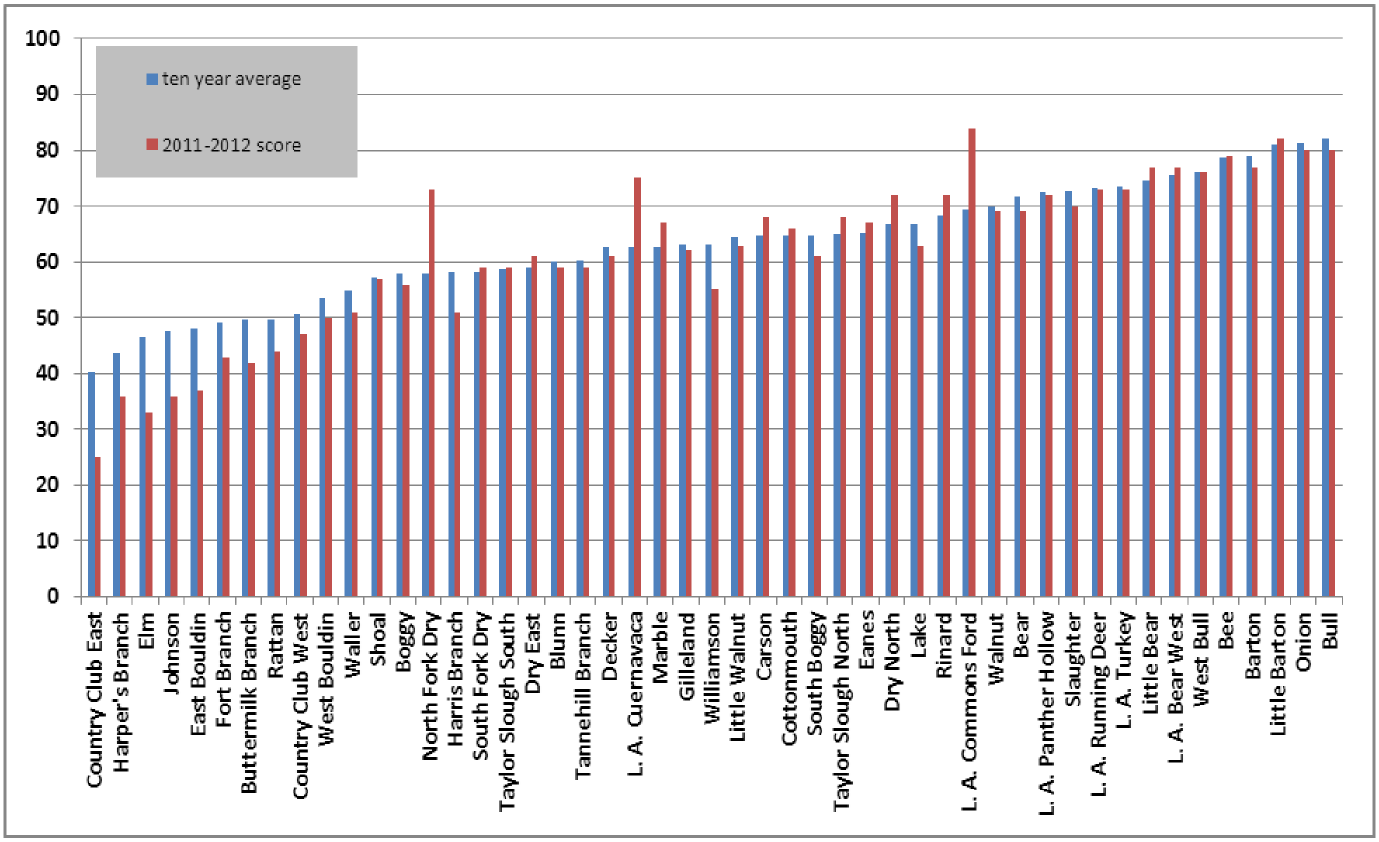

Figure 3. Overall EII total watershed scores. Watersheds are listed in ascending order of their corresponding ten year average total score. The current (2011-2012) total score indicates that most watershed scores were similar to average score.

As shown by the graph, most watersheds are similar to their ten-year average with notable exception. Three of the watersheds (L.A.Cuernavaca, L.A.Panther Hollow and North Fork Dry Creek) exhibited a significant increase in the current EII score above their 10 year average score (Fig 3). The two Lake Austin watersheds (Cuernavaca and Panther Hollow) exhibited the same higher-than-average scores in 2010. Some of these score improvements can be attributed to improved benthic macroinvertebrate and non-contact recreation scores, and lower concentrations of *E.coli*. In general, 2009-2010 total scores were consistent with the ten year average score. Watersheds that had significantly lower current scores than their ten-year average were small watersheds that are more susceptible to significant impacts during the drought conditions witnessed in the current cycle.

Water chemistry data for each watershed for the 2011-2012 sample events are presented as box and whisker graphs in Figures 4a – 4i. The whiskers indicate the minimum/maximum values and the boxes indicate the interquartile (25/75) range. The median and mean of each data set are shown as stars and horizontal lines respectively. Although dense, the graphs indicate the general range of these data among watersheds and allows for easy comparison and identification of outliers. A more detailed evaluation of spatial and temporal trends within a watershed can be facilitated by reviewing the box and whisker graphs by reach and year in the watershed summary sections of this report.

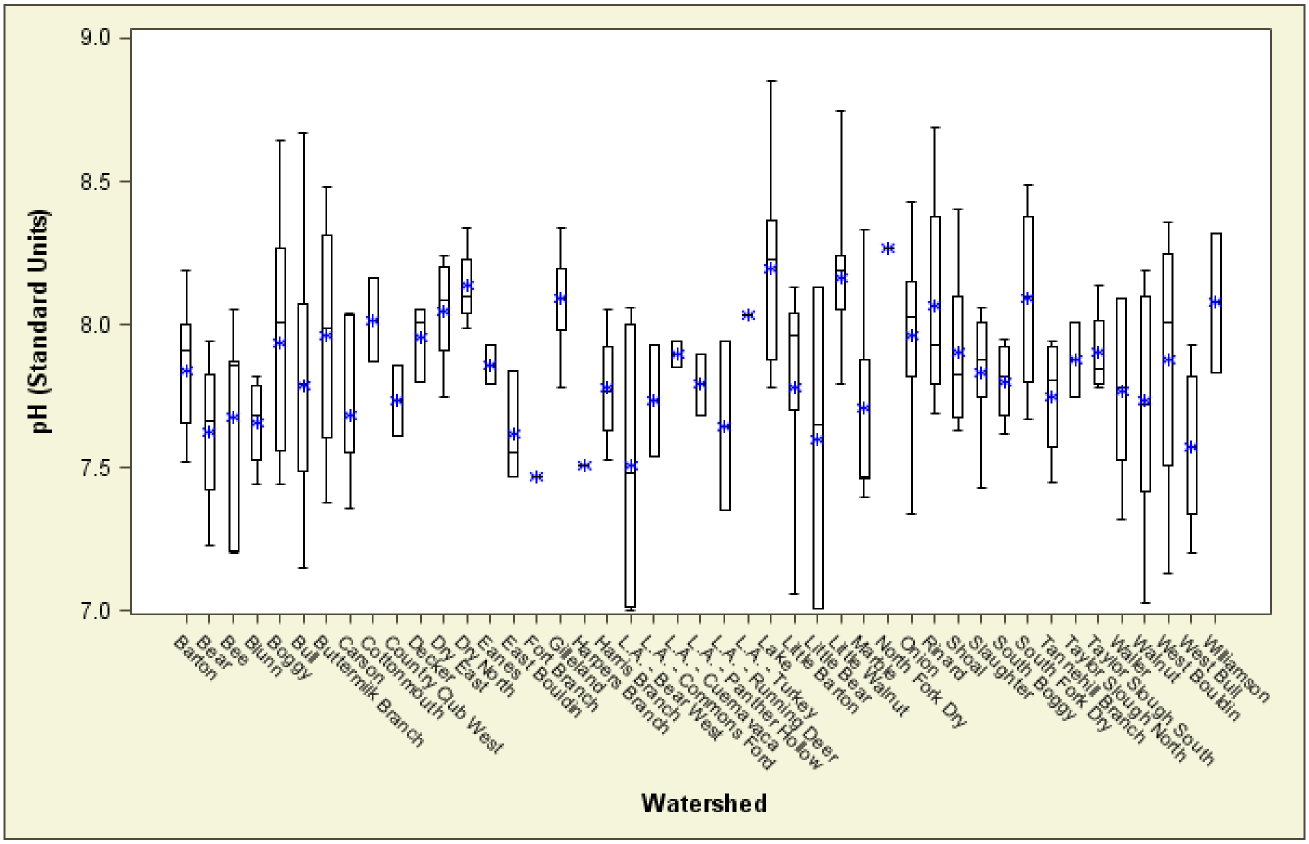

Figure 4a. pH data from quarterly samples collected from 2011 and 2012 for all watersheds

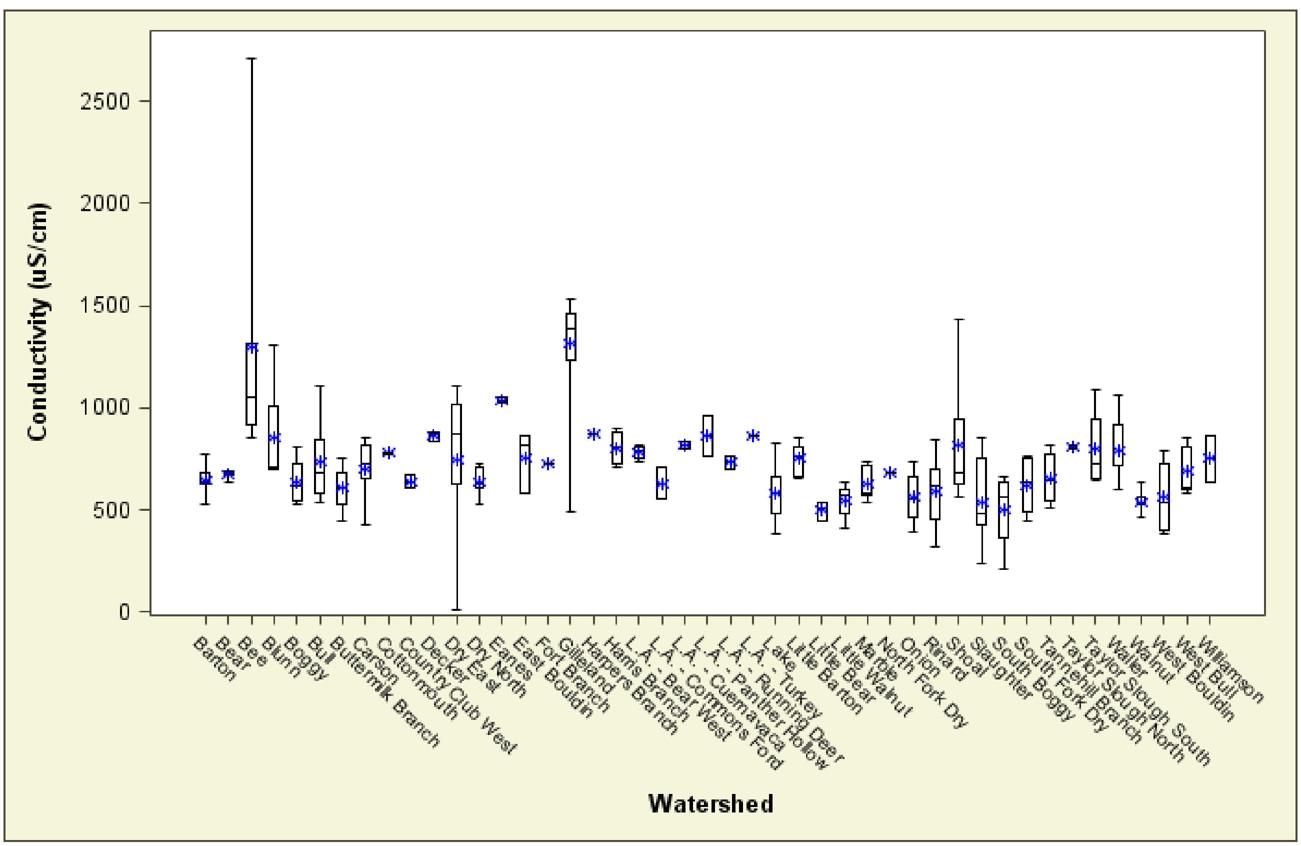

Figure 4b. Conductivity data from quarterly samples collected from 2011 and 2012 for all watersheds

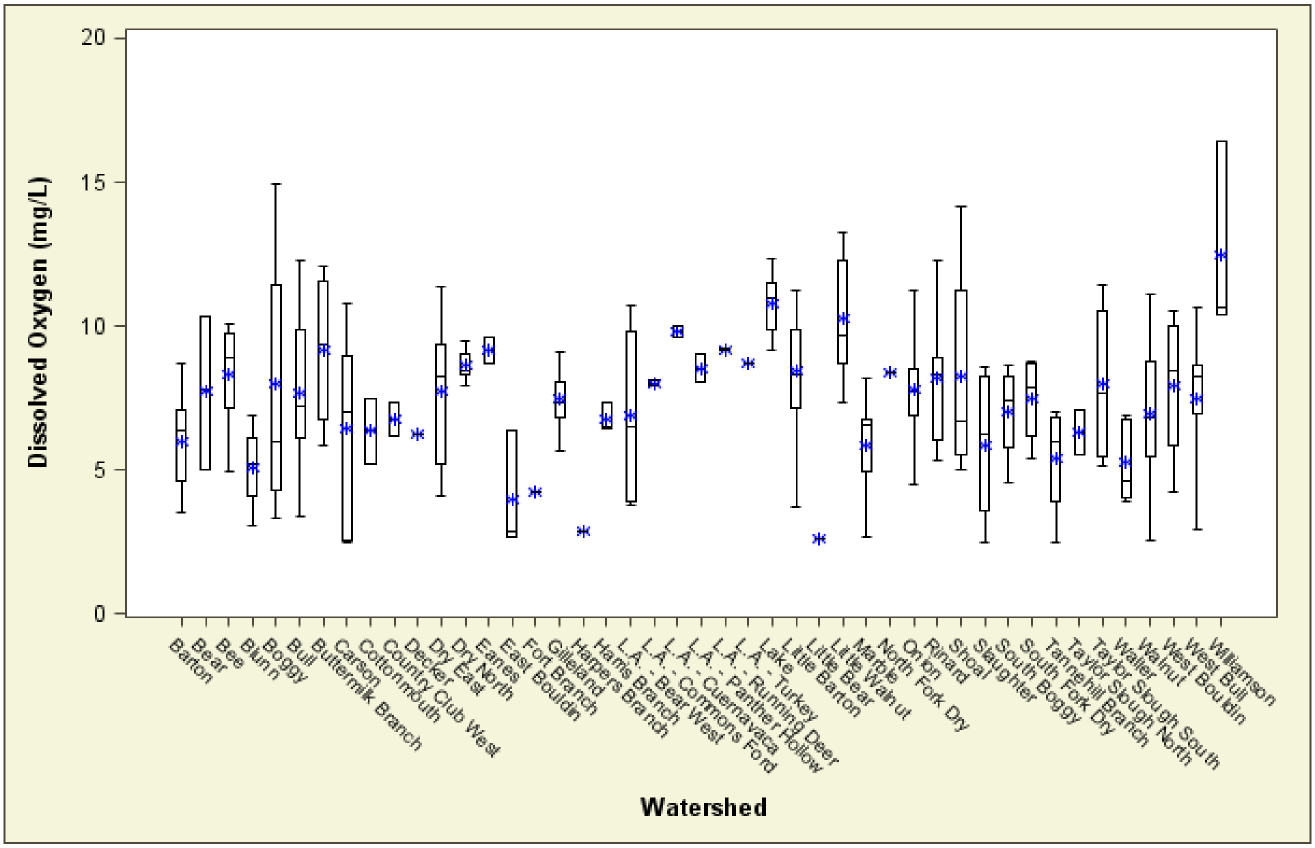

Figure 4c. Dissolved oxygen data from quarterly samples collected from 2011 and 2012 for all watersheds

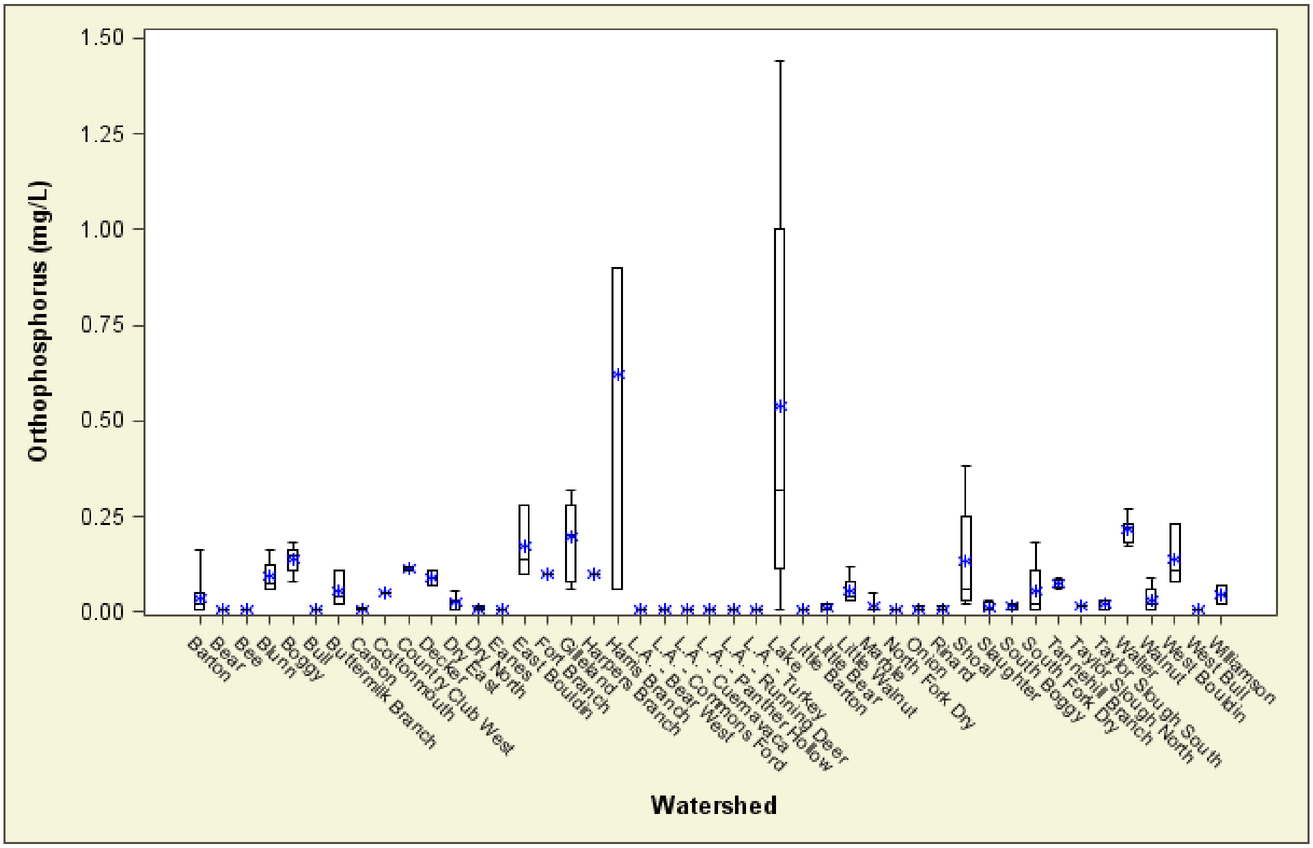

Figure 4d. Orthophosphorus data from quarterly samples collected from 2011 and 2012 for all watersheds

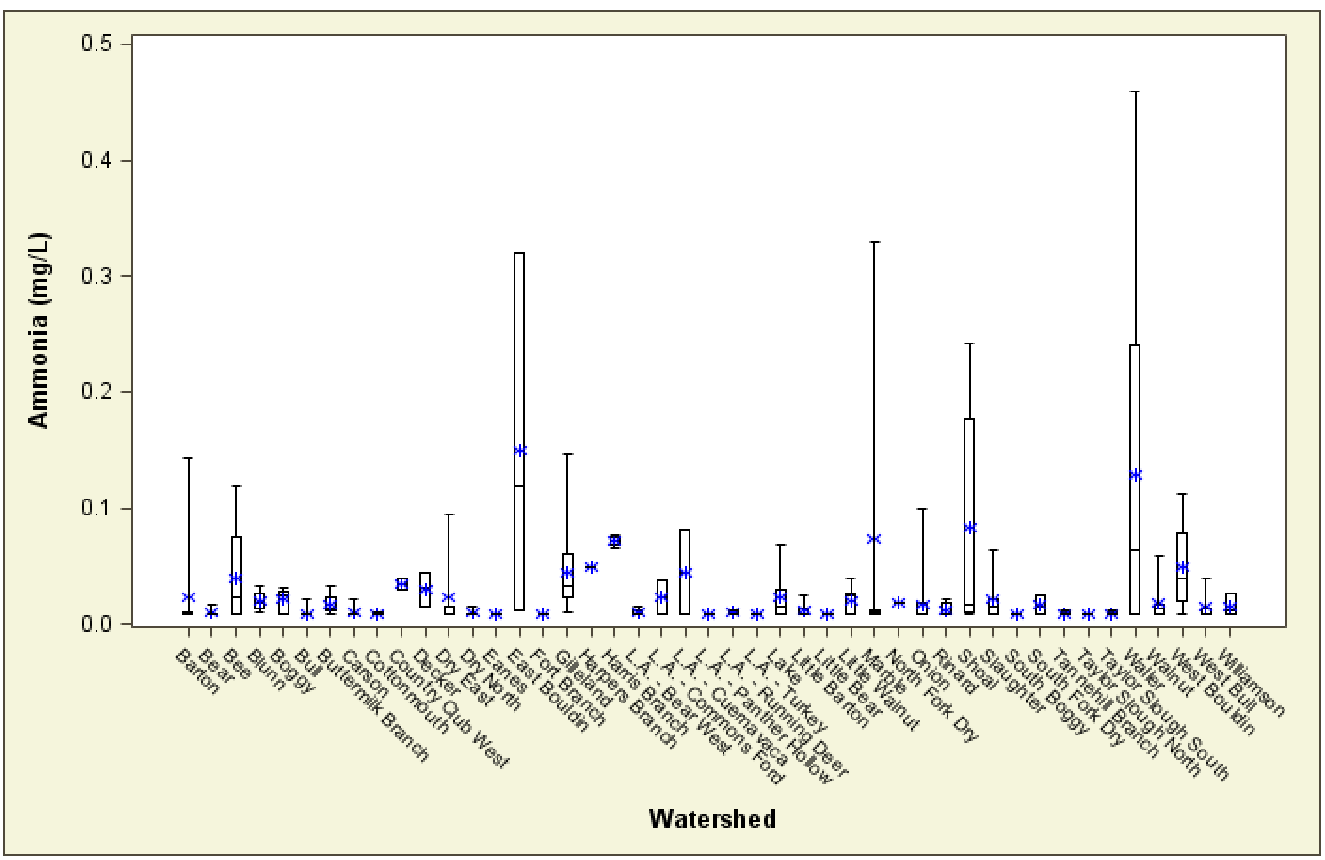

Figure 4e. Ammonia data from quarterly samples collected from 2011 and 2012 for all watersheds

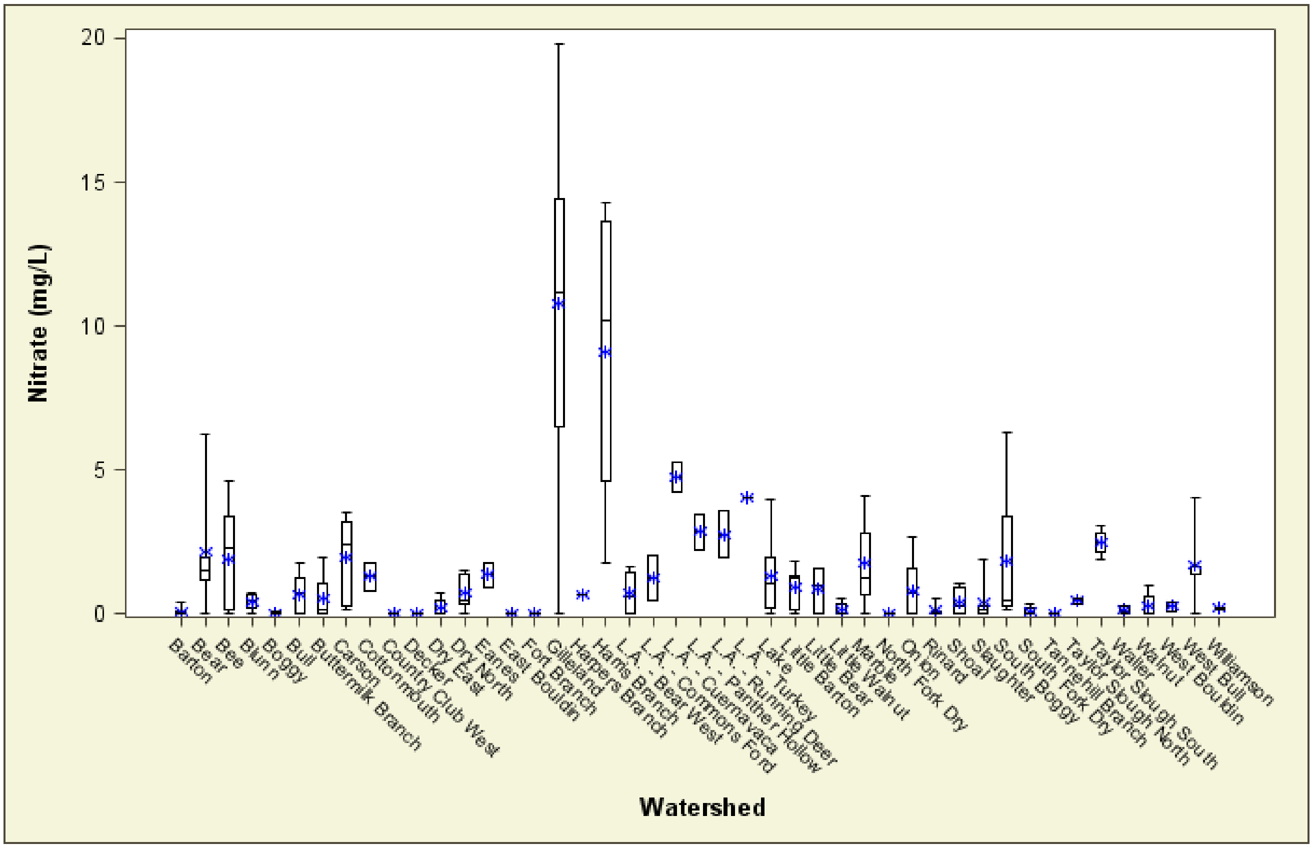

Figure 4f. Nitrate data from quarterly samples collected from 2011 and 2012 for all watersheds

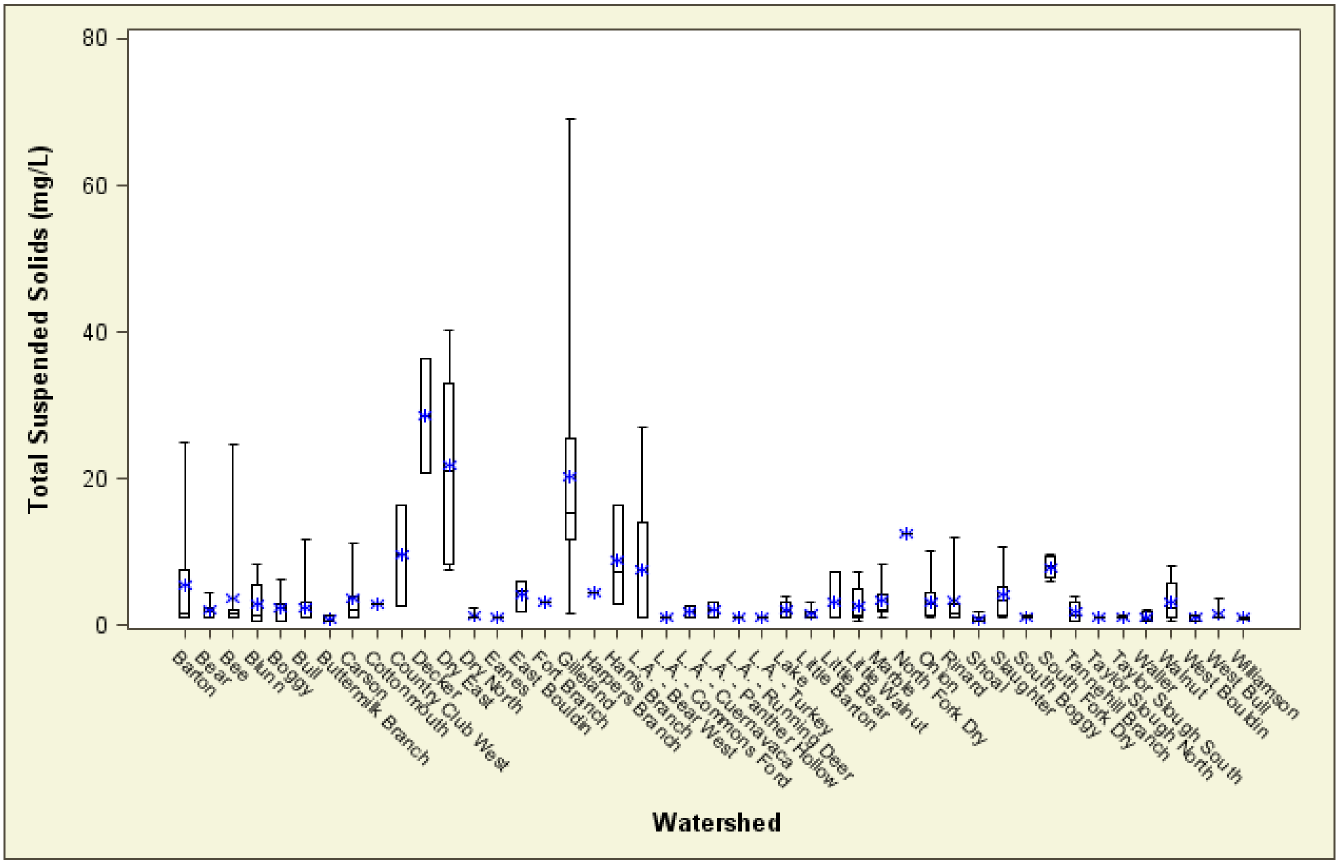

Figure 4g. TSS data from quarterly samples collected from 2011 and 2012 for all watersheds

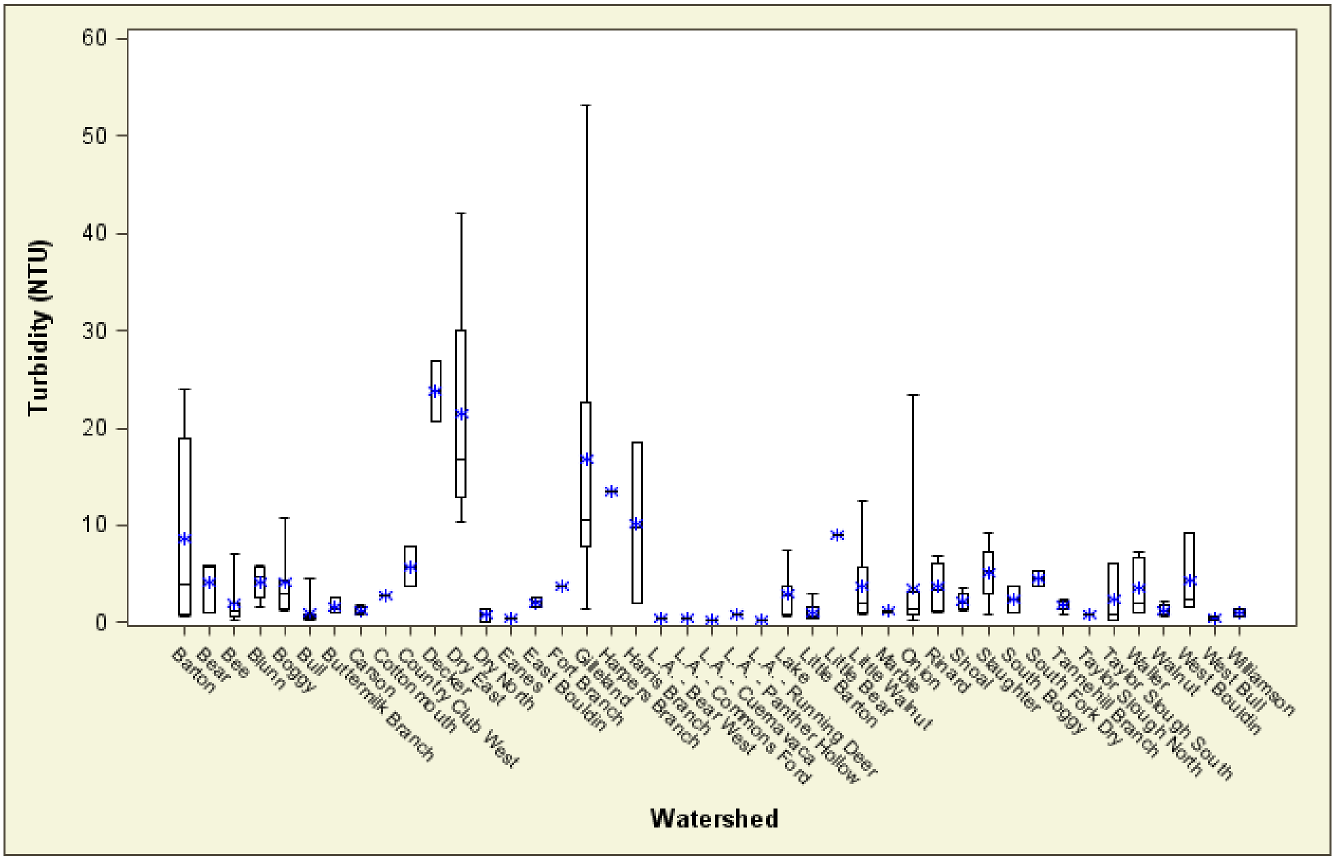

Figure 4h. Turbidity data from quarterly samples collected from 2011 and 2012 for all watersheds

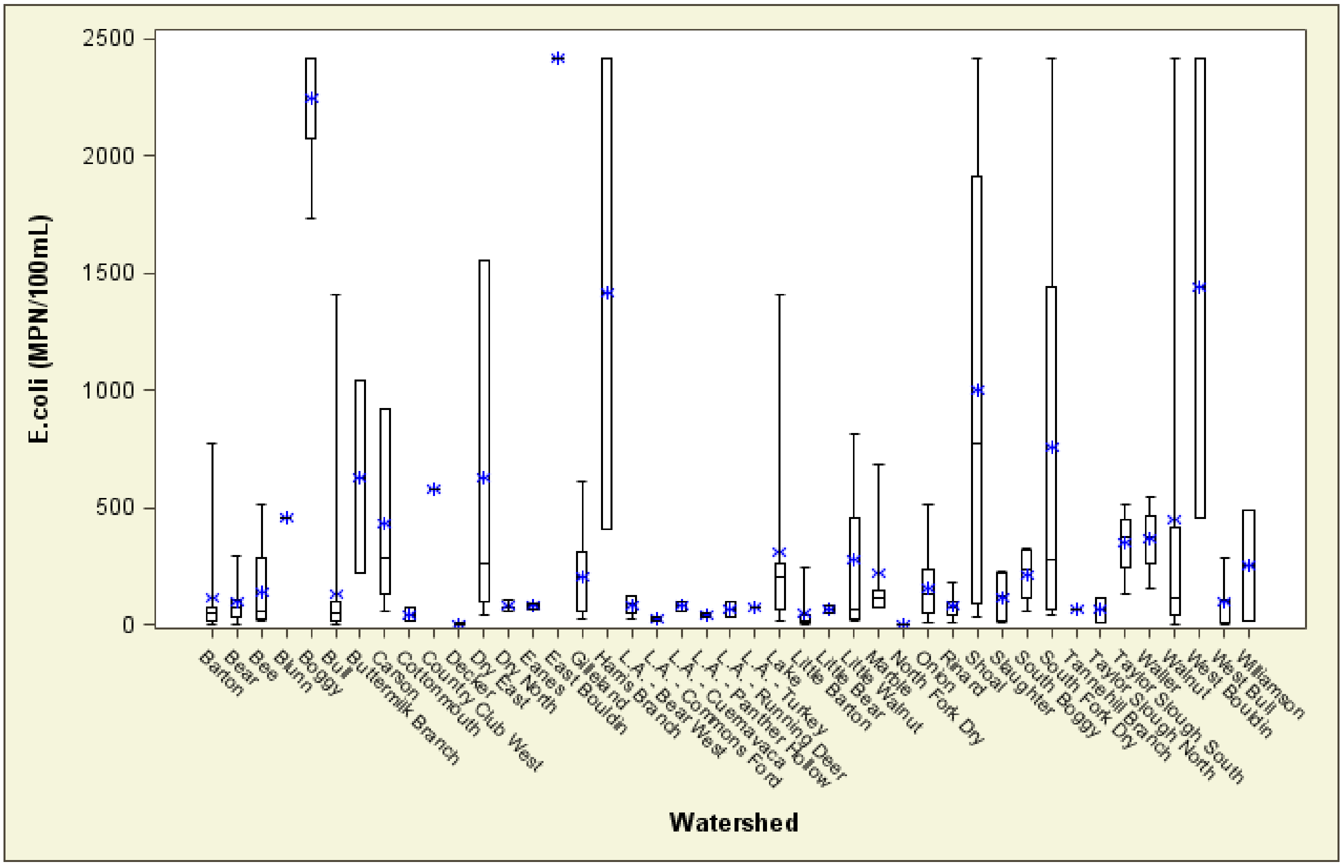

Figure 4i. Bacteria data from quarterly samples collected from 2011 and 2012 for all watersheds

As shown in Figure 4a, pH levels were all within expected range. Baseflow and spring flow in Austin-area streams are typically weakly basic (between 7.5 and 8.5) due to the geology and soil which are dominated by limestone.

Conductivity (Figure 4b) was also generally within expected range (500-1000) with a few notable exceptions. Bee Creek sites had very high conductivity. Additional samples appear to indicate the source is residential (salt water pool), and the lower-than-normal dilution (due to drought-induced low baseflow) exacerbates the downstream conductivity levels. At the time of this report production, attempts are being made to address the issue. The other watershed with chronically high conductivity is Gilleland Creek. Gilleland Creek typically has high conductivity due to the treated wastewater-driven baseflow.

Dissolved oxygen levels (Figure 4c) are largely affected by flow rate, temperature and nutrient input. Although low flow and high temperatures tend to lower the ability for water to maintain dissolved oxygen, stagnant pools with nutrient inputs can reach high daytime dissolved oxygen levels. While the majority of concentrations were between the expected range of 5.0 and 10.0 mg/L, a few watersheds were typically above or below this range. Williamson, Lake and Little Walnut were generally above 10.0 mg/L while East Bouldin, Fort Branch, Harpers Branch and Little Bear were below 5.0 mg/L. During the abnormally extreme drought conditions experienced during the 2011-2012 sample years, it is not surprising that observed dissolved oxygen levels were of a wide range.

Nutrient load is assessed by Nitrate as N, Ammonia and N and orthophosphorus as P as shown in Figures 4d, 4e and 4f. Elevated nutrients were apparent in several watersheds. Gilleland and Harris Branch have historically had chronically higher nutrient concentrations than the other EII watersheds, and the 2011-2012 sample years were no different. The baseflow of both streams are largely influenced by municipal treated wastewater. Also influenced by treated wastewater, Lake Creek has chronically high orthophosphorus. East Bouldin, Waller and Shoal Creek both appear to have elevated nutrients in addition to several other streams in the urban core.

As shown in Figures 4g and 4h, suspended sediment is shown to be elevated in several Austin watersheds based on both turbidity and total suspended solids (TSS) concentrations. The changing gradient and soil composition from the Balcones Escarpment of west Austin to the Blackland Prairie of east Austin must be taken into consideration. Higher sediment load should be expected to occur in the Blackland Prairie than the Balcones Escarpment. Watersheds that were high in turbidity and TSS during the previous sample years and are still high in 2011-2012 include Gilleland, Harris Branch, Decker, Dry Creek (east) and North Fork Dry. Some sites in other watersheds had unexpected turbidity and/or TSS including Barton, Harpers Branch, and Bear West (a tributary of Lake Austin).

Elevated bacteria levels (as indicated by *E.coli* concentrations) may pose the most significant health risk in Austin's streams. The source of bacteria in surface water is diverse and often difficult to isolate. Aging wastewater line infrastructure, episodic wasterwater overflows and lift station problems and failing septic systems are all a reality of urban and suburban life. Other sources include mammalian waste both direct and carried by storm runoff from pets, wildlife, livestock and humans. Watersheds with elevated *E.coli* concentrations whose median sample values met or exceeded 500 MPN for the 2011-2012 sample events included Boggy, Buttermilk, Dry East, Harris Branch, Shoal, South Fork Dry, and West Bouldin. With the exception of South Fork Dry, all of these watersheds were noted in the previous biennial EII report to have concerns for elevated bacteria, and all of these watersheds had discreet samples that exceeded 1,000 MPN. Some watersheds, such as Country Club West, East Bouldin , Bull, Lake and Walnut had single samples that were in excess of 1,000 MPN, but may not indicate a chronic problem.

Results of benthic macroinvertebrate sampling for the 2011-2012 summer events indicate that despite the impacts of the recent drought, most sites were similar to, or better than, their historic averages (Fig 5). This can be explained in part because prior to 2008, benthic macroinvertebrates were not sampled at sites that did not have flow. Sites without flow had received a score of "0", which artificially lowered historic scores. Starting in 2008, benthic macroinvertebrates were sampled from pools when baseflow was not observed in order to document and evaluate the aquatic life that these reaches support even during drought conditions.

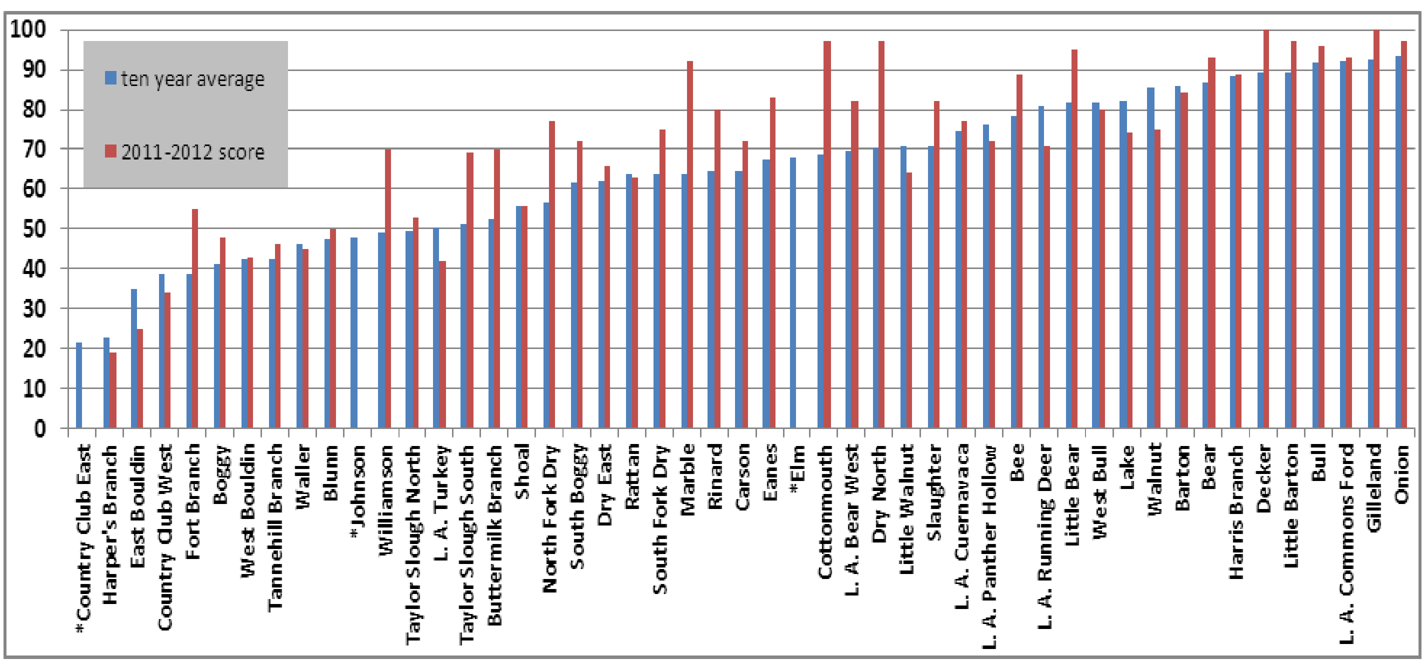

Figure 5. Benthic macroinvertebrate sub-index score for EII watersheds. Watersheds are listed in ascending order of their corresponding ten year average benthic macroinvertebrate sub-index score. The current (2011-2012) sub-index score shows that most watersheds scored higher than their average score. Watersheds with an asterisk (*) indicate sites that were dry during 2011-2012, therefore they should not be interpreted as a score of zero.

Notable improvements included Cottonmouth, Marble, Dry North, and Williamson which increased more than 20 points above their historic average. Details results of the individual metric parameters and species lists for each site can be reviewed in Appendix A of this report. Sites that score well for the benthic macroinvertebrate sub-index generally have good diversity (>20 taxa), an average pollution tolerance value higher than 6, a moderate to low percentage of predators (<25%) and several (>4) tax of mayflies, stoneflies and caddisflies. Watersheds with reliable flow and lower impervious cover generally maintain benthic macroinvertebrate communities with higher integrity.

Due to the ongoing drought, several sites were completely dry and were therefore not sampled. Some watersheds which normally have baseflow had stopped flowing during the r sample season, but maintained pools. These pools contained a concentration of life and the higher-than-normal scores reflected the increased diversity captured in kicknets. This appears to be true for several of the eastern watersheds such as Fort Branch, Marble, Rinard, Cottonmouth, Dry, Buttermilk and Carson.

Similar to the benthic macroinvertebrate scores, the diatom community generally showed 2011-2012 scores that were the same or better than the respective historic average (Fig 6). This is consistent with a general increase of scores in the 2009-2010 sample years. Similarity of current scores to historic average is likely due to a more consistent sample protocol than benthic macroinvertebrates. Detailed results of the individual diatom metrics and species lists for each site can be found in Appendix B of this report.

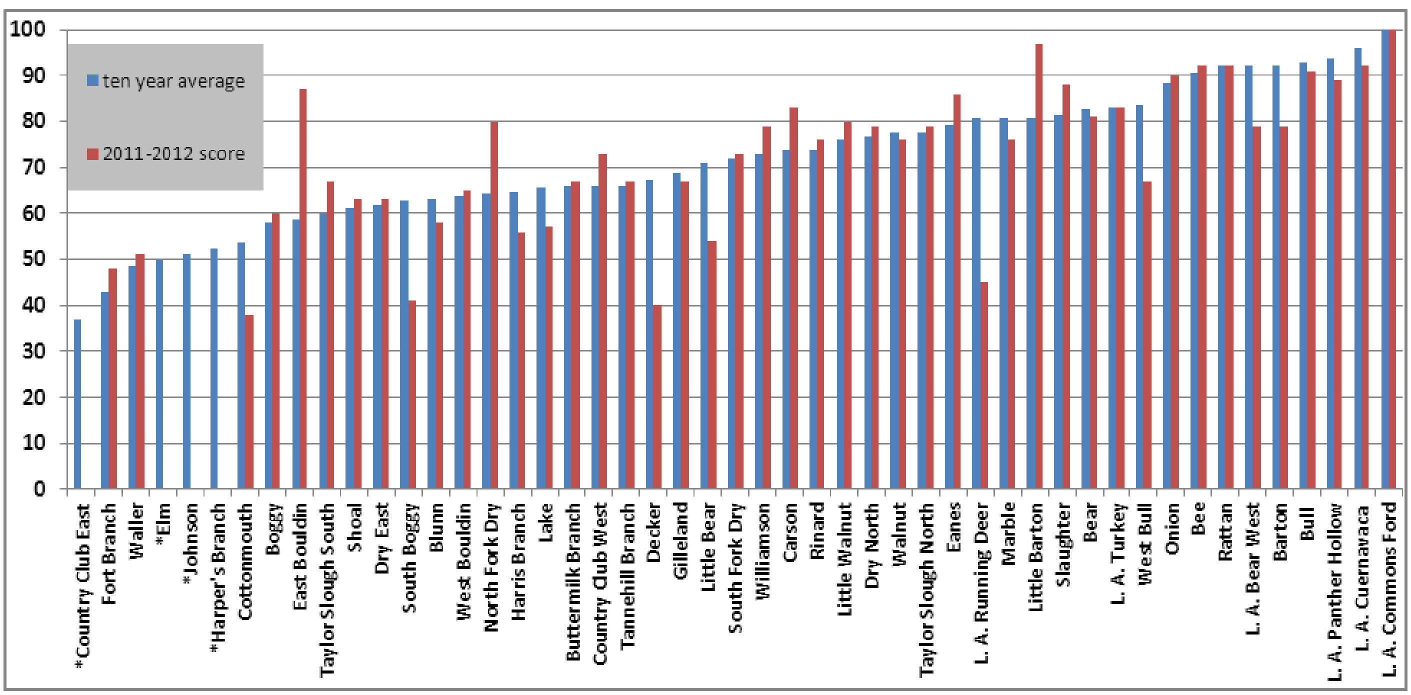

Figure 6. Diatom sub-index score for EII watersheds. Watersheds are listed in ascending order of their corresponding ten year average diatom sub-index score. The current (2011-2012) sub-index score shows that all but five watersheds scored higher than their average score. Watersheds with an asterisk (*) indicate sites that either the site was dry, or had inadequate diatom habitat in 2011-2012 , therefore they should not be interpreted as a score of zero.

In both diatom and benthic sub-index scores, the aquatic life scores are generally higher in watersheds that are sub-urban and/or less intensely developed indicating a correlation between historic development practices and stream integrity.

Recommendations

The 2009-2010 EII report indicated concerns for bacteria in Johnson and Taylor Slough South, nutrients in Harris Branch, and conductivity/nutrients/sediment load in Dry Creek East. Based on the 2011-2012 data presented in this report and the historical and reach-based data presented in the individual watershed summaries, additional evaluation and/or follow-up monitoring may be warranted. The following watersheds have been identified accordingly for the following reasons:

Bee Creek: Conductivity levels are elevated at the middle reach and downstream reach. The increase in conductivity was exacerbated under the 2012 drought conditions. During a routine follow-up of the 2012 EII event, the source was identified to be a salt-water pool discharging to the creek. Attempts are underway to address the conductivity inputs.

Boggy Creek: All *E.coli* concentrations for Boggy Creek (east) were above 1,500 MPN (several above 2,000) MPN. Observations for at least one location indicated human contamination. Since other parameters (i.e. conductivity, nutrients, turbidity) did not appear high, the source of the bacteria may be localized and preventable.

Johnson Creek: Mean values for *E.coli* for Johnson Creek has historically been high, and was included as a topic of concern in the previous EII report. Unfortunately Johnson Creek was dry during the recent sample events due to drought, so no new information has been acquired. Therefore, Johnson Creek is still a candidate for additional scrutiny for bacteria levels.

Taylor Slough South: Mean values for *E.coli* for Taylor Slough South has historically been high, and was included as a topic of concern in the previous EII report. Bacteria concentrations in Taylor Slough South is still elevated and is a candidate for additional scrutiny concurrent with Johnson Creek.

Harris Branch: All three nutrients assessed in the EII program (orthophosphorous, ammonia, nitrate) were chronically elevated in the 2009-2010 sample events and appear to be increasing since 2002. A review of the reach data indicates nutrient concentrations in the bottom half of the watershed are significantly higher than the headwaters. There are two permitted wastewater discharges in the downstream reach. This watershed also shows elevated E.coli which may be a result of episodic wastewater spills. Current efforts of the City of Austin are underway to take smaller wastewater facilities, such as package plants and lift stations, off-line in Harris and Gilleland. Future sampling should review if these efforts reduce nutrient and bacteria concentrations.

Dry Creek East: Chronically elevated conductivity, nutrients, TSS, and turbidity are coupled with increasing *E.coli* concentrations in the downstream reach. The specific source of these issues is unclear. Soil disturbance due to development, agricultural inputs and waste water infrastructure should be evaluated in the context of the parameter trends

Buttermilk, Shoal, South Fork Dry, and West Bouldin: Additional evaluation for elevated *E.coli* concentrations.

Acknowledgments

This report was produced by the COA Watershed Protection Department, Water Resource Evaluation section led by Ed Peacock. Report sections and appendices were assembled by Andrew Clamann and Emily Yeoman. GIS maps were created by Kathryn Murray. Field support for water quality sampling in 2011 through 2012 was primarily provided by Mateo Scoggins, Mary Gilroy, Andrew Clamann, Staryn Wagner, Todd Jackson and Alex Duncan of the Surfacewater Evaluation team. Data management, EII scores, summary graphs and assistance in the field were supported by Chris Herrington, Robert Clayton and Aaron Richter of the Watershed Modeling and Analysis team. Additional field assistance was provided by Environmental Resource Management staff. The cumulative efforts of these teams provide a large, comprehensive, and quality assured dataset that resides within a database that has high utility and flexibility.

Watershed Summaries

The following summaries present a review of each watershed listed in alphabetical order. Each watershed section is eleven pages in length and includes: a summary sheet, a land use map, an aerial photograph, data summary graphs (box and whisker graph), score summary graphs (line graphs) and two pages of site photographs. Details of each section are described below:

Summary sheet – This sheet includes a brief list of watershed facts that describe the physical and development characteristics of the watershed.. An overview map is located at the top right-hand corner of the page which shows the corresponding Phase watersheds relative to the featured watershed. The flow presence graphic for all sites in the watershed sampled over the span of the past decade is presented in the middle of the page. A table with an overview of the physicochemical, nutrient, sediment and biological data from the current sampling year is located in the middle of the summary sheet. The mean, minimum and maximum values for each parameter are presented with comments which discuss the results in general terms. The complete data set for the site data from 2011 and 2012 is provided in Appendix C. The last table on the summary sheet shows EII scores by reach, from downstream to upstream, and year for each sub-index and total reach score.

Land use and aerial photograph maps – The land use map shows both current and historical sampling sites within the featured watershed. Property parcels are color coded to reflect land use designations as determined by current COA GIS date (2006 with updates). Dark bold outlines indicate the watershed boundaries, and the interior sub-watershed reach boundaries. The aerial photograph map uses 2011 aerial photography (winter "leaf-off") with both current and historical sampling sites, in addition to other development related features within the watershed.

Data summary graphs – The five pages following the maps present the water quality parameter in box-and-whisker graphs by reach and by year (Fig. 7) to facilitate evaluation of both temporal and spatial trends. The most downstream site is the first reach (i.e. BER1), and increase in number toward the headwaters. Reach data for a given year is presented left to right, downstream to upstream (i.e. mouth to headwater) in order to facilitate the evaluation of spatial trends within the watershed. Reach data are clustered by sample year from historical to current (left to right). A thin solid line through each graph indicates the median value for each parameter for all EII data since 1999 to provide context to conceptualize what may be above or below "average".

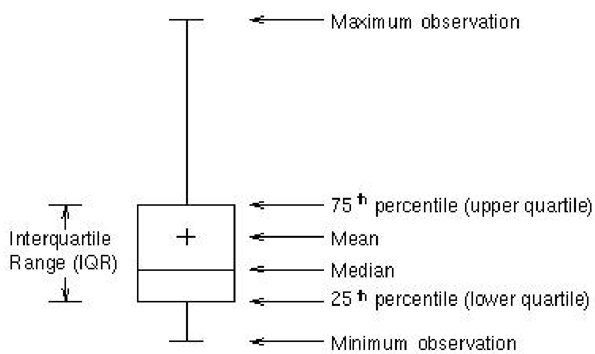

Figure 7. Legend for box-and-whisker plots

Summary graphs – EII sub-index and total scores for each reach over the past decade are presented as line graphs. Smaller watersheds with only a single reach will appear as a single set of points, while larger watersheds with multiple reaches will appear as multiple line graphs which can be evaluated for spatial trends within the watershed from upstream to downstream (left to right).

Site photographs – Photographs for each site were selected from previous site visits based on their ability to represent the characteristics of the site. The photo title indicates the site number, transect number, perspective (upstream/downstream or upriffle/downriffle) and date. For example, a photo title of 44_t03-us-09_17_2008 indicates that the photo was taken at site number 44 at transect 3, of the upstream reach on Sep 17, 2008.