city of austin
Watershed Protection

COMPARISON OF AUSTIN-AREA STREAM SEDIMENTS TO SEDIMENT QUALITY GUIDELINES.

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ABSTRACT

Existing sediment data collected by local, state, and federal agencies from the stream beds and spring pools of the Austin area were compared to human-exposure and environmental toxicity criteria in order to identify the source and location of potential threats to human and ecosystem health. Polycyclic aromatic hydrocarbons (PAH) parameters were found to be in excess of sediment quality guidelines more frequently, and also were more spatially widespread than any other parameter type assessed. The majority (96%) of parameters evaluated for human health toxicity were below Protective Concentration Limits (PCLs), although data for PAHs, metals, and pesticides were found in Austin-area sediments at levels indicating potential ecosystem toxicity. Applicability of the PCL levels to Austin-area streams is questionable, since a complete exposure pathway may not exist, thus making the use of the PCL criteria an extremely conservative measure of potential adverse human health effects from stream sediments.

INTRODUCTION

The City of Austin (CoA), in conjunction with the U.S. Geological Survey (USGS), Lower Colorado River Authority (LCRA), and Texas Natural Resource Conservation Commission (TNRCC), has been collecting sediment samples from the stream beds and spring discharge pools of the Austin area since the late 1970s. Typical collection methodologies are outlined in the Surface Water Quality Monitoring Procedures Manual (TNRCC, 1999), and consist of composite sample collection with Teflon scoops into non-reactive glass bowls where samples are thoroughly mixed prior to storage in glass containers for transport to analysis laboratories. Study of contaminant concentrations in sediment yield a more long-term view of the contaminant load in a stream system, particularly in relation to water quality grab sampling. However, the high costs for sediment sampling often restrict the number of locations and sample frequencies. By comparing existing sediment data to sediment quality criteria, not only will problem areas be more clearly identified, the focus of sediment sampling projects may be better refined to maximize sampling budget dollars.

METHODOLOGY

Two levels of contamination in sediment must be considered in order to make a more comprehensive assessment of contamination in sediment. Toxic effects on human health due to dermal contact or ingestion of sediment while wading and swimming in natural waterways will be assessed using current Protective Concentration Levels (PCL) established by the TNRCC (2002). Applicability of the PCLs to Austin-area streams is questionable, since a complete exposure pathway may not exist. The PCL criteria developed by the TNRCC consider incidental ingestion of sediment, dermal contact with sediment, and consumption of fish as the relevant exposure pathways. Both routine consumption of fish and incidental ingestion of sediment during recreation in Austin-area streams are clearly limited by the ephemeral flows and typically shallow depths of urban streams, the majority of which have bedrock channels with transitory sediment deposits. In fact, TNRCC has explicitly stated that the PCL criteria do not apply to Barton Springs Pool (2002) because swimmers are not routinely exposed to bedded sediments. However, existing data are compared to PCL criteria in an extremely conservative attempt to assess the potential adverse effects of stream sediments on human health in the Austin area until a more accurate method is determined.

Ecological effects will be assessed using both consensus-based Probable Effect Concentration (PEC) and Threshold Effect Concentrations (TEC), established by MacDonald et al (2000). The TEC concentrations allow for the prediction of the absence of sediment toxicity, while PEC concentrations provide a basis for predicting the presence of sediment toxicity (MacDonald et al, 2000).

Sediment data from 179 sites in the Austin area representing 53 delineated watersheds (as recognized by the City of Austin Drainage Criteria Manual) were analyzed from 1978 to the present for 212 different chemical parameters for which a PCL exists, yielding a total of nearly 26,000 data points. Data were collected by multiple agencies including the City of Austin, the Texas Natural Resource Conservation Commission, and the LCRA using typical collection methodologies. No censored result (i.e., non-detect results or “less-than” values) above the PCL for a given parameter was included in the analysis or in the count of total results for that parameter. No BMP (wet pond, OSTC, and inlet filter) or dry drainage ditch sediment sample was included in the assessment, as the analysis goal was to study ambient conditions in waterways where humans might recreate.

For similar reasons, large-volume sediment samples (LVSS) were analyzed separately as these data are representative of the sediment that is suspended in the water column during storm events, a time when recreation is unlikely to occur and clearly a deviation from baseline conditions. LVSS data included in these analyses were collected by the USGS in May and June 2000 from four sample sites in two watersheds (Barton Creek and Williamson Creek) for 21 metal parameters. Although PCL criteria exist for all 21 parameters, PEC/TEC guidelines exist for only eight metal parameters.

All data included in analyses are stored in the Field Sampling Database (FSDB) of the City of Austin Environmental Resource Management Division.

RESULTS

Ambient Sediment Data compared to PCL

Of the 217 sediment parameters assessed for potential human toxicity using the PCL values, 209 (or approximately 96%) had no detected exceedances of the PCL in any measured value. The average number of samples per parameters was approximately 121, with more than 80% of the parameters having 10 or more measured values. Parameters for which no value above the PCL was detected are listed in appendix A. Of the eight sediment parameters with detected values above respective PCLs, presented in Table 1, three parameters have had only one detection above the PCL, representing less than 1% of the total data set for those parameters. In fact, the high value for manganese occurred in 1988 and has not exceeded the PCL since that time. Although the lead and manganese detections above the PCL are clearly cause for concern, the dominance of elevated polycyclic aromatic hydrocarbons (PAHs) in the list is evident, with benzo(a)pyrene exhibiting the highest number of measurements at levels potentially harmful to humans. Benzo(a)pyrene is a potential human carcinogen (Montgomery and Welkom, 1990) formed during incomplete combustion of organic materials, often leaching into water from coal tar and asphalt. Evaluation of available water data, however, indicates that benzo(a)pyrene has never been detected in the 38 ambient Austin-area surface or groundwater samples taken to date, and has been detected in BMPs (Austin Recreation Center Oil/Sediment Treatment Chamber, Central Market Wet Pond) only during storm flow conditions.

Table 1. Sediment data in the Austin area above PCL criteria.

Chemical Name	First Sample	Last Sample	Total # of Samples	Number above PCL	% Above PCL	Date of Last PCL Exceedance
LEAD	Mar-81	Feb-02	384	1	0.26	Aug-00
BENZO(K)FLUORANTHENE	Sep-91	Feb-02	197	1	0.51	Aug-00
MANGANESE	Mar-87	Jul-00	109	1	0.92	Apr-88
BENZO(A)ANTHRACENE	Sep-91	Feb-02	245	4	1.63	Aug-00
INDENO(1,2,3-CD)PYRENE	Sep-91	Feb-02	245	5	2.04	Aug-00
BENZO(B)FLUORANTHENE	Sep-91	Feb-02	197	6	3.05	Aug-00
DIBENZ(A,H)ANTHRACENE	Sep-91	Feb-02	245	13	6.40	Aug-00
BENZO(A)PYRENE	Sep-91	Feb-02	241	35	17.07	Sep-01

Additionally, all measurements of ambient water concentrations of the other PAH parameters in question (benzo(k)fluoranthene, benzo(a)anthracene, indeno(1,2,3-CD)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene) were less than detection limit in all samples. However, both manganese and lead have been detected in ambient water samples in Austin above human health surface water risk-based exposure limits (RBEL).

Benzo(a)pyrene not only represents the parameter with the most detected values above the PCL, it also is found in more watersheds than any other parameter, with measured sediment concentrations at levels with direct human health effects. Benzo(a)pyrene has been found in five Town Lake contributing watersheds (Barton Creek, East Bouldin Creek, Harper’s Branch Creek, Shoal Creek, and Waller Creek) in addition to Bull Creek and Onion Creek. Although the largest number of detected values above the PCL has occurred in the Barton Creek watershed, the relative number of samples collected in the Barton Creek watershed does not immediately identify it as the most problematic watershed. In fact, both Harper’s Branch and Taylor Slough North watersheds have exhibited greater-than PCL concentrations in all sediments samples, although only two events (in 1996 and again in 2000 as part of the EII sampling efforts) have occurred for either watershed. Table 2 presents results for the eight parameters with detected results above the PCL summarized by watershed.

Table 2. Percent of sediment data samples in the Austin-area above the PCL by watershed.

Chemical Name	Barton Creek	Bull Creek	East Bouldin Creek	Harper's Branch	Lake Austin	Onion Creek	Shoal Creek	Taylor Slough (North)	Waller Creek
BENZO(A)ANTHRACENE	0.00	0.00	18.18	0.00	0.00	11.11	0.00	0.00	11.11
BENZO(A)PYRENE	20.59	10.00	55.56	100.00	0.00	20.00	50.00	100.00	50.00
BENZO(B)FLUORANTHENE	2.94	0.00	12.50	0.00	0.00	12.50	0.00	0.00	33.33
BENZO(K)FLUORANTHENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.67
DIBENZ(AH)ANTHRACENE	1.54	10.00	54.55	50.00	0.00	20.00	0.00	0.00	37.50
INDENO(1_2_3-CD)PYRENE	1.33	0.00	18.18	0.00	0.00	11.11	0.00	0.00	11.11
LEAD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00
MANGANESE	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00

In order to stretch monitoring dollars, typical CoA sediment sample collection is conducted at the mouths of Austin-area creeks as part of a rotating monitoring program known as the Environmental Integrity Index. While useful in identifying watersheds where contamination may be impacting human health, this methodology restricts the ability to locate specific sites where toxic pollution may exist. In some cases, however, additional sediment monitoring provides a GIS-based approach to identifying more locations of sediment contamination, as shown in Map 1.

In Bull Creek, the only PAH samples above PCL limits were found at a spring discharge (Spicewood Parkway Spring) at the headwaters of a small tributary in the northern portion of the watershed, with no other detected values of either contaminant at eight other sites distributed throughout the watershed.

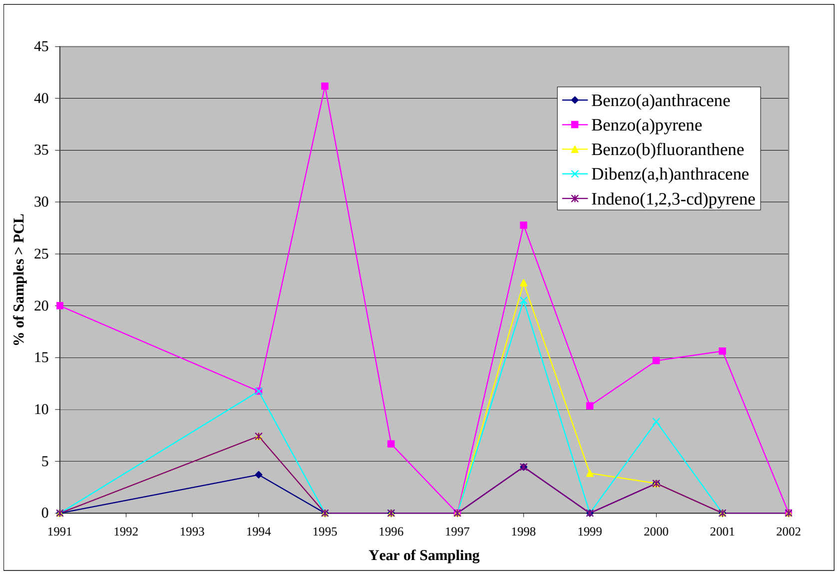
In Shoal Creek, the elevated benzo(a)pyrene samples were detected at three of five sites—two sites at the headwaters of small tributaries within the upper mid-reaches of the watershed as well as the mouth near the creek's confluence with Town Lake. In Waller Creek, all exceedances of the PCL for PAH and metal parameters occurred near 24th Street in both mainstem Waller Creek and the Hemphill Tributary to Waller Creek, with no values above the PCL detected at the mouth of Waller Creek. In East Bouldin Creek, PAH contamination was found at six of eight sites throughout the watershed, including at the confluence with Town Lake.

In Barton Creek, all PAH contamination above the PCL was found in the lower reach of the watershed above and below Barton Springs Pool, home of the endangered Barton Springs salamander and a popular swimming area for many Austinites.

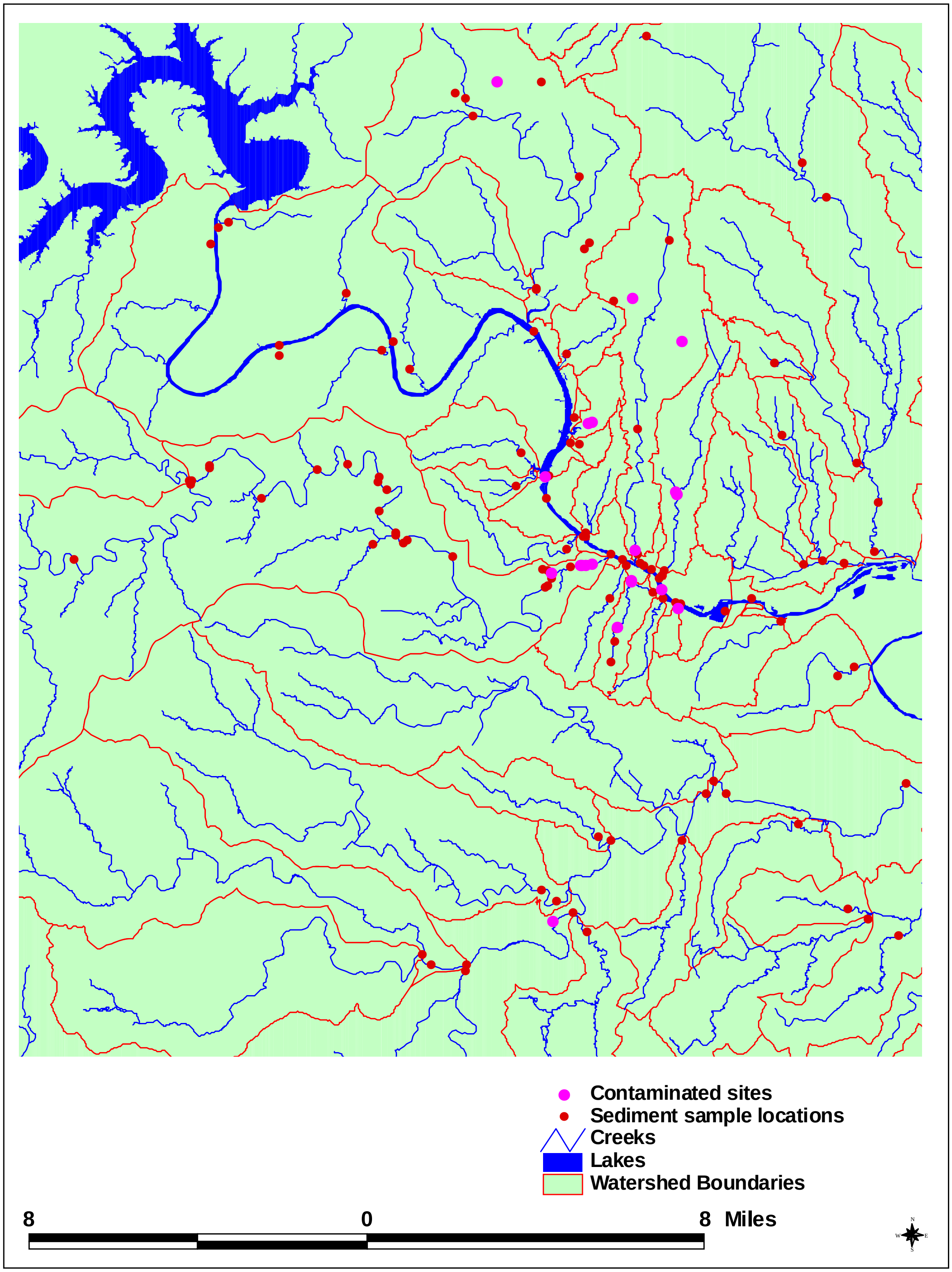
In Onion Creek, all PAH contamination was found near the Onion Creek Country Club in the mid-reach of the watershed, with no other values above the PCL in either upstream or downstream sites.

The limited data set, though still robust for sediment data, does not allow for strong conclusions to be drawn about temporal patterns in the parameters with measured values in exceedance of the PCL. However, as shown in Figure 1, no clearly increasing trends are evident in percentage of samples by parameter in excess of the PCL, when data for the entire city are aggregated for analysis. In fact, benzo(a)pyrene PCL exceedances may even be decreasing in relative number of occurrences over time.

Figure 1. Austin-area percentage of PCL exceedances over time by parameter.



Map 1. Austin-area sediment sample sites with detected values above the PCL in relation to all sampling locations analyzed.



Ambient Sediment Data compared to PEC/TEC values

Comparison of Austin-area ambient sediment data to PEC values reveals that for 23 of 26 parameters for which PEC exist, at least one measured value was above the PEC. Only data for naphthalene, polychlorinated biphenyls (PCBs), and heptachlor epoxide had no measured values above the PEC. Table 3 presents a summary of results for parameters with values above the PEC. Parameters with less than 1% of the data set above the PEC or with no detected value above the PEC in the last five years will not be considered in further analyses of ambient sediment data in comparison to the PEC, as it may be assumed that these parameters are not of a primary concern. Although chlordane consistently exhibited environmental toxicity for all samples with a detection limit below the PCL value, no measurement since 1995 has been made by a method with a detection limit below the PCL and thus an accurate assessment of recent chlordane problems is impossible.

Table 3. Sediment data in the Austin area above PEC values.

Chemical Name	First Sample	Last Sample	Total # Samples	PEC (mg/Kg)	Last detect above PEC	# samples above PEC	% Above PEC
ZINC	Mar-81	Feb-02	378	459	May-98	1	0.26
ENDRIN	Aug-78	Feb-02	319	0.207	Nov-94	1	0.31
ARSENIC	Mar-81	Feb-02	358	33	Jan-98	2	0.56
GAMMA-BHC (LINDANE)	Aug-78	Feb-02	323	0.00499	Nov-94	2	0.62
NICKEL	Aug-89	Feb-02	155	48.6	Sep-90	1	0.65
DIELDRIN	Aug-78	Feb-02	324	0.0618	Mar-95	3	0.93
COPPER	Mar-81	Feb-02	366	149	Nov-00	4	1.09
CHROMIUM	Mar-87	Feb-02	270	111	Aug-00	3	1.11
MERCURY	Mar-81	Feb-02	350	1.06	May-94	4	1.14
FLUORENE	Sep-91	Feb-02	245	0.536	Aug-00	3	1.22
ANTHRACENE	Sep-91	Feb-02	245	0.845	Aug-00	3	1.22
CADMIUM	Mar-81	Feb-02	348	4.98	Dec-98	8	2.30
LEAD	Mar-81	Feb-02	384	128	Aug-00	13	3.39
DDT	Aug-78	Feb-02	342	0.0629	Jun-99	14	4.09
DDD	Aug-78	Feb-02	336	0.028	Oct-99	38	11.31
CHLORDANE	Nov-80	Sep-01	148	0.0176	Mar-95	21	14.19
DDE	Aug-78	Feb-02	346	0.0313	Jul-00	51	14.74
BENZO(A)PYRENE	Sep-91	Feb-02	241	1.45	Sep-01	37	15.35
PHENANTHRENE	Sep-91	Feb-02	245	1.17	Sep-01	39	15.92
BENZO(A)ANTHRACENE	Sep-91	Feb-02	245	1.05	Sep-01	41	16.73
CHRYSENE	Sep-91	Feb-02	245	1.29	Sep-01	49	20.00
FLUORANTHENE	May-85	Feb-02	250	2.23	Sep-01	54	21.60
PYRENE	May-85	Feb-02	250	1.52	Sep-01	63	25.20

Analyses of the reduced list of contaminants with measured values above the PEC by watershed are presented in Table 4 as number of samples exceeding PEC values as a percentage of the total number of samples within that watershed. Note that metal data above the PEC are relatively limited in size and scope. Cadmium and chromium are each seen above the PEC in only three watersheds, lead is seen above the PEC in only four watersheds, and copper exceeds the PEC in only one watershed. PAHs above the PEC, however, are fairly widespread and found in a comparatively larger percentage of the samples. Surprisingly, DDT and related by-products DDD and DDE are still found in Austin-area bed sediments despite a ban on the domestic sale and use of DDT since late 1972 (EPA, 1975).

As with the sediment data screening against the PCL, PAHs in excess of the PEC were found in both sampling events (1996 and 2000) for the Harper's Branch and Taylor Slough (North) watersheds. Pyrene is the parameter with the most widespread occurrence of measured values above the PEC, although benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and phenanthrene are found in at least nine watersheds, including several Town Lake contributing watersheds and Lake Austin, sources of Austin's drinking water. Analysis of ambient water data reveals that none of these PAH parameters has been detected in Austin-area waterways. However, the pesticides (as recently as 1996) and metals (as recently as 1999) listed in Table 4 have been found at values above respective RBELs in Austin creeks and lakes, primarily during storm events measured by USGS storm composite sampling efforts.

Table 4. Percent of sediment data samples in the Austin-area above the PEC by watershed

Watershed Name	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Chrysene	Fluoranthene	Fluorene	Phenanthrene	Pyrene	Cd	Cr	Cu	Pb	DDD	DDE	DDT
Barton Creek	.	20.00	20.59	20.00	22.67	.	16.00	29.33	1.33	.	4.94	.	4.62	1.41	2.90
Blunn Creek	.	.	.	33.33	33.33	.	.	66.67	.	.	.	.	.	.	.
Bull Creek	.	9.09	10.00	18.18	9.09	.	.	18.18	.	.	.	.	.	.	.
Buttermilk Branch	.	.	.	.	.	.	.	50.00	.	.	.	.	.	.	.
E. Bouldin Creek	9.09	63.64	55.56	72.73	72.73	9.09	54.55	72.73	.	.	.	16.67	12.50	25.00	.
Fort Branch	.	.	.	.	16.67	.	.	16.67	.	.	.	.	16.67	.	.
Harper's Branch	.	100.00	100.00	100.00	100.00	.	100.00	100.00	.	.	.	.	.	.	.
Johnson Creek	.	.	.	.	.	.	.	.	.	.	.	.	.	50.00	50.00
Lake Austin	.	.	.	.	.	.	.	.	.	4.55	.	.	.	.	.
Little Bear Creek	.	.	.	.	.	.	.	.	50.00	.	.	.	.	.	.
Onion Creek	11.11	11.11	20.00	11.11	11.11	11.11	11.11	22.22	.	.	.	.	.	.	.
Shoal Creek	.	50.00	62.50	60.00	60.00	.	50.00	70.00	.	.	.	6.25	18.75	18.75	6.25
Taylor Slough North	.	100.00	100.00	100.00	100.00	.	100.00	100.00	.	.	.	.	.	.	.
Taylor Slough South	.	50.00	.	50.00	100.00	.	50.00	50.00	.	.	.	.	.	.	.
Town Lake	.	8.00	16.67	16.00	21.43	.	12.00	20.00	5.13	0.83	.	6.87	24.39	33.07	8.00
Waller Creek	11.11	55.56	62.50	77.78	77.78	11.11	66.67	77.78	.	12.50	.	10.00	.	.	.
W. Bouldin Creek	.	.	.	.	.	.	25.00	.	.	.	.	.	.	50.00	.

Comparison of ambient sediment data to TEC screening levels further confirms results of PEC assessments, as shown in Table 5. Only the parameter naphthalene had no measured values above the TEC. Although values above the TEC for a given parameter do not predict sediment toxicity, the TEC is an accurate predictor of the absence of toxicity. Thus, only one of the 26 parameters assessed can be removed from the list of potentially toxic contaminants in Austin-area sediments. Interestingly, more than 30% of all samples for the parameters cadmium, lead, and DDE were above the TEC, although the percent exceedance of the PEC for these parameters was substantially less, suggesting a strong potential for toxicity.

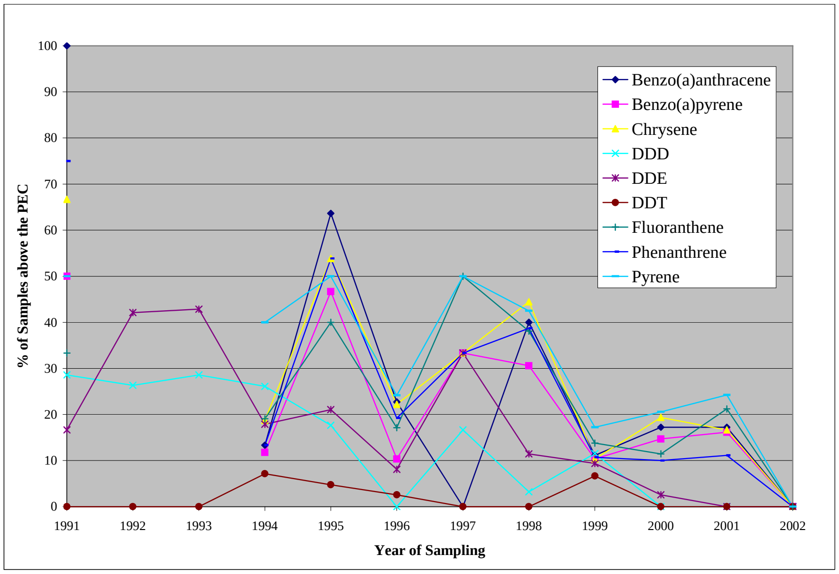
Analysis of measured parameter concentrations in relation to the TEC on a watershed basis are presented in appendix B, due to size considerations. As values below the TEC indicate the absence of sediment toxicity, the listing in appendix B may be used to identify watersheds for which there is an absence of predicted toxicity on a parameter-by-parameter basis. In summary, 21 of 53 watersheds assessed had no exceedance of the TEC for any metal parameter; 36 of 53 watersheds assessed had no exceedance of the TEC for any pesticide parameter; and 31 of 52 watersheds assessed (the Panther Hollow watershed had no data) had no exceedance of the TEC for any PAH parameter. Only three watersheds (Barton Creek, Eanes Creek, and Town Lake) had any exceedance of the TEC for polychlorinated biphenyls (PCBs) in sediment.

Table 5. Sediment data in the Austin area compared to TEC values.

Chemical Name	Total # of Samples	First Sample	Last Sample	% Above TEC	Date of last TEC exceedance
ENDRIN	319	Aug-78	Feb-02	0.31	Nov-94
GAMMA-BHC (LINDANE)	323	Aug-78	Feb-02	0.62	Nov-94
HEPTACHLOR EPOXIDE	321	Aug-78	Feb-02	0.62	Nov-94
FLUORENE	245	Sep-91	Feb-02	1.22	Aug-00
POLYCHLORINATED BIPHENYL (PCB)	315	Aug-78	Feb-02	1.59	Mar-99
ANTHRACENE	245	Sep-91	Feb-02	2.45	Aug-00
CHROMIUM	270	Mar-87	Feb-02	2.96	Aug-00
NICKEL	155	Aug-89	Feb-02	5.16	Jul-00
MERCURY	348	Mar-81	Feb-02	5.46	Feb-01
COPPER	366	Mar-81	Feb-02	6.56	Oct-01
ZINC	378	Mar-81	Feb-02	8.47	Sep-00
DIELDRIN	320	Aug-78	Feb-02	11.25	Jul-00
ARSENIC	352	Mar-81	Feb-02	13.35	Feb-02
TOTAL CHLORDANE	148	Nov-80	Sep-01	14.86	Mar-95
PHENANTHRENE	245	Sep-91	Feb-02	19.18	Sep-01
BENZO(A)ANTHRACENE	245	Sep-91	Feb-02	19.59	Sep-01
DDT	342	Aug-78	Feb-02	21.93	Jul-00
CHRYSENE	245	Sep-91	Feb-02	24.08	Sep-01
DDD	336	Aug-78	Feb-02	25.30	Jul-00
BENZO(A)PYRENE	205	Sep-91	Feb-02	25.85	Sep-01
PYRENE	250	May-85	Feb-02	30.80	Sep-01
FLUORANTHENE	250	May-85	Feb-02	32.40	Sep-01
DDE	346	Aug-78	Feb-02	34.68	Jul-00
LEAD	384	Mar-81	Feb-02	38.54	Sep-01
CADMIUM	348	Mar-81	Feb-02	38.79	May-99

The results of an examination of the temporal patterns of PEC exceedances are presented in Figure 2 for the top 10 problem parameters, excluding chlordane (since no data have been analyzed with a detection limit below the PEC since 1995) and the early DDT, DDD, and DDE data. Although a decreasing trend in percent exceedance over time is evident, similar to observed PCL exceedance temporal patterns, for all parameters when data for the entire city is aggregated for analysis, the effects of changing sample size and sample location as a result of changing monitoring objectives is not considered.

Figure 2. PEC exceedances over time by parameter for the entire city.



LVSS Data Analysis

No measurements were made for any of the 21 metal parameters analyzed in which the PCL was exceeded, and no measurements above the PEC for any of the eight parameter for which PEC/TEC criteria existed, indicating a lack of clearly identifiable presence of metal toxicity in suspended sediments in Williamson and Barton creeks.

Additionally, no measurements were made of mercury above the TEC, indicating the absence of mercury toxicity in the suspended sediments that were analyzed.

However, seven of eight metal parameters for which TEC exist had measured values greater than the TEC, suggesting the metal toxicity is not completely absent from suspended sediments in Barton and Williamson creeks.

Evaluating these parameters on a watershed basis reveals that in one Williamson Creek LVSS sample, six of eight metal parameters (excluding only copper and mercury) had measured values above the TEC (although none of these values were above the ERM). In the seven LVSS samples evaluated from Barton Creek, data for seven of eight metal parameters had at least one measurement above the TEC (excluding mercury). Approximately 86% of the nickel measurements (six of seven samples) had concentrations above TEC values, and 71% of the samples (five of seven) had measured concentrations of arsenic and chromium above the TEC values. Only zinc, however, exhibited concentrations above both the TEC and the ERM, with 43% (three of seven samples) of the data exceeding the ERM.

DISCUSSION

Relevance of the application of the PCL to human health protection from contaminated sediments in Austin-area streams is highly questionable and, in fact, the TNRCC has explicitly stated that the criteria do not apply to Barton Springs Pool, perhaps the most popular swimming area in the City of Austin. However, the value of repeated comparison of sediment data against available screening criteria to identify potential future problem areas is unquestionable, and the geographic analyses (where data permit) do isolate some areas in Austin as parameter-specific locations with sediment toxicity problems. The PCL values do clearly represent an extremely conservative estimate of potential human health effect levels in Austin-area streams, as more accurate criteria would be significantly greater considering the limited exposure pathways present in Austin-area streams for transfer of toxic effects from sediment to humans.

Regardless of the debate about the applicability of PCL screening to ambient sediment data, the measured values that are in exceedance of the PEC reveal that for PAHs in particular, some ambient sediment samples in the Austin area are exhibiting toxic concentrations as PEC are considered to be accurate predictors of sediment toxicity. Additionally, the presence of metals and pesticides in Austin storm water for several of the parameters with measured sediment values above the PEC clearly demand future study.

Analyses of the LVSS data available to date indicate that while metal toxicity is not clearly identifiable in the suspended sediments of Williamson and Barton creeks, the preponderance of values above the TEC reveal the presence of elevated levels that could become environmental problems if sources of contamination are not addressed. As this sediment is suspended during large storm events, it may not pose a direct threat to human health from ingestion or dermal contact due to recreation, although it must be realized that suspended sediments in Barton Creek are transported to Town Lake, a source of drinking water for the City of Austin.

Using the results from these comparisons of existing data to sediment quality objectives to identify potential chemicals of concern that could enable a reduced list of priority analytes could stretch limited laboratory analysis dollars. It also could enable future sediment-sampling efforts to focus less on city-wide screening and more on the identification of the sources of toxic sediment concentration. This would better direct possible remediation efforts.

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Information on the technical reports and data related to this study can be obtained from:
City of Austin- Watershed Protection and Development Review Department
Phone: 974-2550

Appendix A. Table of sediment parameters for which no value above the PCL has been measured.

Chemical Name	First Sample	Last Sample	Total # of Samples
1_1_1_2-TETRACHLOROETHANE	Sep-94	Sep-94	6
1_1_1-TRICHLOROETHANE	Sep-94	Dec-97	11
1_1_2_2-TETRACHLOROETHANE	Sep-94	Dec-97	11
1_1_2-TRICHLOROETHANE	Sep-94	Dec-97	11
1_1-DICHLOROETHANE	Sep-94	Dec-97	11
1_1-DICHLOROETHYLENE	Sep-94	Dec-97	11
1_1-DICHLOROPROPENE	Sep-94	Sep-94	6
1_2_3-TRICHLOROBENZENE	Sep-94	Dec-97	7
1_2_3-TRICHLOROPROPANE	Sep-94	Dec-97	7
1_2_4_5-TETRACHLOROBENZENE	Mar-96	Feb-02	151
1_2_4-TRICHLOROBENZENE	Jul-94	Feb-02	180
1_2_4-TRIMETHYLBENZENE	Sep-94	Sep-94	6
1_2-DIBROMO-3-CHLOROPROPANE	Sep-94	Dec-97	7
1_2-DIBROMOETHANE	Sep-94	Dec-97	7
1_2-DICHLOROBENZENE	Jul-94	Feb-02	194
1_2-DICHLOROETHANE	Sep-94	Dec-97	11
1_2-DICHLOROPROPANE	Sep-94	Dec-97	11
1_2-DIPHENYLHYDRAZINE	Jul-94	Feb-02	80
1_3_5-TRIMETHYLBENZENE	Sep-94	Sep-94	6
1_3-DICHLOROBENZENE	Jul-94	Feb-02	194
1_3-DICHLOROPROPANE	Sep-94	Sep-94	6
1_4-DICHLOROBENZENE	Jul-94	Feb-02	194
1-METHYLNAPHTHALENE	Sep-97	Sep-97	2
1-NAPHTHYLAMINE	Jun-98	Feb-02	122
2_2-DICHLOROPROPANE	Sep-94	Sep-94	6
2_3_4_6-TETRACHLOROPHENOL	Jun-98	Feb-02	122
2_4_5-TP (SILVEX)	Aug-78	Feb-02	91
2_4_5-TRICHLOROPHENOL	Mar-95	Feb-02	172
2_4_5-TRICHLOROPHENOXYACETIC ACID	Aug-78	Feb-02	116
2_4_6-TRICHLOROPHENOL	Jul-94	Feb-02	187
2_4-DB (BUTOXON)	May-94	Jan-98	10
2_4-DICHLOROPHENOL	Jul-94	Feb-02	187
2_4-DICHLOROPHENOXYACETIC ACID	Aug-78	Feb-02	150
2_4-DIMETHYLPHENOL	Jul-94	Feb-02	187
2_4-DINITROPHENOL	Jul-94	Feb-02	187
2_4-DINITROTOLUENE	Jul-94	Feb-02	187
2_6-DICHLOROPHENOL	Jun-98	Feb-02	122
2_6-DINITROTOLUENE	Jul-94	Feb-02	180
2-CHLOROETHYL VINYL ETHER	Sep-94	Dec-97	7
2-CHLORONAPHTHALENE	Jul-94	Aug-01	25
2-CHLOROPHENOL	Jul-94	Feb-02	187
2-CHLOROTOLUENE	Sep-94	Sep-94	6
2-HEXANONE	Dec-97	Dec-97	1
3-METHYLCHOLANTHRENE	Jun-98	Feb-02	122
3-NITROANILINE	Mar-95	Feb-02	165
4_6-DINITRO-2-METHYLPHENOL	Jul-94	Feb-02	187
4-AMINOBIPHENYL	Jun-98	Feb-02	122
4-BROMOPHENYL PHENYL ETHER	Jul-94	Feb-02	187
4-CHLORO-3-METHYLPHENOL	Sep-94	Feb-02	132
4-CHLOROANILINE	Mar-95	Feb-02	165
4-CHLOROPHENYL PHENYL ETHER	Jul-94	Feb-02	187
4-CHLOROTOLUENE	Sep-94	Sep-94	6
4-METHYLPHENOL (P-CRESOL)	Mar-95	Sep-97	8
4-NITROANILINE	Mar-95	Feb-02	165
4-NITROPHENOL	Jul-94	Feb-02	187
7_12-DIMETHYLBENZO(A)ANTHRACENE	Jun-98	Feb-02	122
ACENAPHTHENE	Sep-91	Feb-02	245
ACENAPHTHYLENE	Sep-91	Feb-02	245
ACETONE	Dec-97	Dec-97	1
ACETOPHENONE	Jun-98	Feb-02	122
ACROLEIN	Sep-94	Dec-97	7
ACRYLONITRILE	Sep-94	Dec-97	10
ALDRIN	Aug-78	Feb-02	325
ALPHA-BHC (BENZENE HEXACHLORIDE)	Aug-81	Feb-02	250
ALUMINUM	Sep-91	Jul-00	65
ANILINE	Mar-96	Feb-02	150
ANTHRACENE	Sep-91	Feb-02	245
ANTIMONY	Jun-96	Jun-96	1
ARSENIC	Mar-81	Feb-02	358
ATRAZINE (AATREX)	Sep-91	Feb-02	23
AZINPHOS METHYL (GUTHION)	May-94	Feb-02	82
BARIUM	Feb-88	Jul-96	25
BENZENE	Sep-94	Dec-97	11
BENZIDINE	Jul-94	Feb-02	172
BENZO(E)PYRENE	Jan-98	Jan-98	4
BENZO(GHI)PERYLENE	Sep-91	Feb-02	245
BENZOIC ACID	Mar-95	Feb-02	150
BENZYL ALCOHOL	Mar-95	Feb-02	156
BERYLLIUM	Jun-96	Jun-96	1
BETA-BHC (BENZENE HEXACHLORIDE)	Sep-91	Feb-02	245
BIS(2-CHLOROETHOXY)METHANE	Jul-94	Feb-02	187
BIS(2-CHLOROETHYL)ETHER	Jul-94	Feb-02	187
BIS(2-CHLOROISOPROPYL)ETHER	Jul-94	Feb-02	187
BIS(2-ETHYLHEXYL)PHTHALATE	May-85	Feb-02	183
BORON	Mar-95	Mar-95	4
BROMOBENZENE	Sep-94	Sep-94	6

(BUTYLMETHYLKETONE)							
2-METHYLNAPHTHALENE	Mar-95	Feb-02	165	BROMOCHLOROMETHANE	Sep-94	Sep-94	6
2-METHYLPHENOL (O-CRESOL)	Mar-95	Oct-01	155	BROMODICHLOROMETHANE	Aug-95	Dec-97	5
2-NITROANILINE	Mar-95	Feb-02	165	BROMOFORM	Sep-94	Dec-97	11
2-NITROPHENOL	Jul-94	Feb-02	187	BUTYL BENZYL PHTHALATE	Jul-94	Feb-02	180
2-PICOLINE	Aug-99	Feb-02	72	CADMIUM	Mar-81	Feb-02	348
3_3'-DICHLOROBENZIDINE	Jul-94	Feb-02	187	CARBARYL (SEVIN)	Mar-96	Feb-02	125

Chemical Name	**First Sample**	**Last Sample**	**Total # of Samples**	**Chemical Name**	**First Sample**	**Last Sample**	**Total # of Samples**
CARBAZOLE	Mar-96	Feb-02	141	HEXACHLOROBENZENE (HCB)	Aug-89	Feb-02	321
CARBON DISULFIDE	Dec-97	Dec-97	1	HEXACHLOROBUTADIENE	Jul-94	Feb-02	193
CARBON TETRACHLORIDE	Sep-94	Dec-97	11	HEXACHLOROCYCLOPENTADIENE	Jul-94	Feb-02	187
CHLOROBENZENE	Sep-94	Dec-97	11	HEXACHLOROETHANE	Jul-94	Feb-02	187
CHLOROETHANE	Sep-94	Dec-97	11	ISOPHORONE	Jul-94	Feb-02	187
CHLOROFORM	Sep-94	Dec-97	11	ISOPROPYLBENZENE (CUMENE)	Sep-94	Sep-94	6
CHLORPYRIFOS (DURSBAN)	May-94	Feb-02	154	MALATHION	Aug-89	Feb-02	149
CHROMIUM	Mar-87	Feb-02	270	2-METHYL-4-CHLOROPHENOXYACETIC ACID	Sep-88	Jan-98	11
CHRYSENE	Sep-91	Feb-02	245	MCPP (MECOPROP)	May-94	Jan-98	10
CIS-1_3-DICHLOROPROPENE	Sep-94	Dec-97	11	MERCURY	Mar-81	Feb-02	350
CIS-CHLORDANE	Jun-94	Jun-94	1	METHOXYCHLOR	Aug-78	Feb-02	294
CIS-NONACHLOR	Jul-95	Jun-99	73	METHYL BROMIDE (BROMOMETHANE)	Sep-94	Dec-97	11
COPPER	Mar-81	Feb-02	366	METHYL CHLORIDE (CHLOROMETHANE)	Sep-94	Dec-97	11
COUMAPHOS (CO-RAL)	May-94	Mar-98	29	METHYL PARATHION	May-94	Mar-98	28
DDD	Aug-78	Feb-02	336	NALED (DIBROM)	May-94	May-97	20
DDE	Aug-78	Feb-02	346	NAPHTHALENE	Sep-91	Feb-02	251
DDT	Aug-78	Feb-02	342	N-BUTYLBENZENE	Sep-94	Sep-94	6
DELTA-BHC (BENZENE HEXACHLORIDE)	Sep-91	Feb-02	245	NICKEL	Aug-89	Feb-02	155
DIAZINON	Aug-78	Feb-02	174	NITRATE AS N	Jun-94	Sep-98	5
DIBENZO(AJ)ACIRIDINE	Jun-98	Feb-02	122	NITROBENZENE	Jul-94	Feb-02	187
DIBENZOFURAN	Mar-95	Feb-02	165	N-NITROSODIETHYLAMINE	Aug-99	Feb-02	72
DIBROMOCHLOROMETHANE	Sep-94	Dec-97	11	N-NITROSODIMETHYLAMINE	Jul-94	Feb-02	172
DIBROMOMETHANE	Sep-94	Dec-97	7	N-NITROSO-DI-N-BUTYLAMINE	Aug-99	Feb-02	72
DICAMBA (BANVEL)	Sep-91	Feb-02	29	N-NITROSO-DI-N-PROPYLAMINE	Jul-94	Feb-02	140
DICHLORODIFLUOROMETHANE	Dec-97	Dec-97	1	N-NITROSODIPHENYLAMINE	Jul-94	Feb-02	118
DICHLORVOS	May-94	Mar-98	29	N-NITROSOPIPERIDINE	Jun-98	Feb-02	122
DIELDRIN	Aug-78	Feb-02	324	N-PROPYLBENZENE	Sep-94	Sep-94	6
DIETHYL PHTHALATE	Jul-94	Feb-02	187	O-XYLENE	Sep-94	Dec-97	7
DIMETHOATE	May-94	Mar-98	29	PARATHION (PARATHION ETHYL)	Aug-78	Feb-02	153
DIMETHYL PHTHALATE	Jul-94	Feb-02	187	PENTACHLOROBENZENE	Aug-95	Feb-02	151
DI-N-BUTYL PHTHALATE	Jul-94	Feb-02	187	PENTACHLORONITROBENZENE	Jun-98	Feb-02	122
DI-N-OCTYL PHTHALATE	Jul-94	Feb-02	187	PENTACHLOROPHENOL	Aug-89	Feb-02	259
DINOSEB	May-94	Feb-02	16	PHENANTHRENE	Sep-91	Feb-02	245
DISULFOTON	May-94	Mar-98	29	PHENOL	Jul-94	Feb-02	187
ENDOSULFAN	May-82	Jul-00	62	PHORATE (THIMET)	May-94	Mar-98	29
ENDOSULFAN I	Sep-91	Feb-02	239	PICLORAM	Aug-99	Aug-99	4
ENDOSULFAN II	Sep-91	Feb-02	240	POLYCHLORINATED BIPHENYL (PCB)	Aug-78	Feb-02	316
ENDOSULFAN SULFATE	Aug-89	Feb-02	262	PROMETON (PRAMITOL)	Sep-91	Sep-91	13
ENDRIN	Aug-78	Feb-02	319	PRONAMIDE (KERB)	Jun-98	Feb-02	122

Chemical Name	First Sample	Last Sample	Total # of Samples
ENDRIN ALDEHYDE	Sep-91	Feb-02	231
ENDRIN KETONE	Sep-97	Feb-02	120
EPN (SANTOX)	May-94	Mar-98	29
ETHYLBENZENE	Sep-94	Dec-97	11
FLUORANTHENE	May-85	Feb-02	250
FLUORENE	Sep-91	Feb-02	245
GAMMA-BHC (LINDANE)	Aug-78	Feb-02	323
HEPTACHLOR	Aug-78	Feb-02	318
HEPTACHLOR EPOXIDE	Aug-78	Feb-02	321
PROPAZINE	Sep-91	Sep-91	13
PYRENE	May-85	Feb-02	250
PYRIDINE	Aug-95	Feb-02	145
SEC-BUTYLBENZENE	Sep-94	Sep-94	6
SELENIUM	Apr-78	Feb-99	50
SILVER	Feb-88	Feb-02	145
SIMAZINE	Sep-91	Sep-91	13
STYRENE	Sep-94	Dec-97	7
SULFOTEPP (BLADAFUME)	May-94	Mar-98	29
TERT-BUTYLBENZENE	Sep-94	Sep-94	6
TETRACHLOROETHYLENE	Sep-94	Dec-97	11
THALLIUM	Jun-96	Jun-96	1
TOLUENE	Sep-94	Dec-97	11
TOTAL CHLORDANE	Nov-80	Sep-01	148
TOXAPHENE	Aug-78	Feb-02	319
TRANS-1_2-DICHLOROETHENE	Sep-94	Dec-97	11
TRANS-1_3-DICHLOROPROPENE	Sep-94	Dec-97	11
TRANS-NONACHLOR	Jul-95	Jun-99	73
TRICHLOROETHYLENE (TCE)	Aug-95	Jul-96	4
TRICHLOROFLUOROMETHANE	Sep-94	Dec-97	7
VINYL ACETATE	Dec-97	Dec-97	1
VINYL CHLORIDE	Sep-94	Dec-97	11
XYLENES	Aug-95	Jul-96	4
ZINC	Mar-81	Feb-02	378

Appendix B. Sediment data in comparison to TEC values by watershed and parameter type.

Metals

- Excluding the following watersheds for which no sediment sample was in excess of the TEC for metals: Bear Creek, Bear Creek West, Buttermilk Branch, Carson Creek, Colorado River, Country Club Creek, Decker Creek, Elm Creek, Fort Branch Creek, Gilleland Creek, Harris Branch, Little Barton Creek, Long Hollow Creek, Marble Creek, Panther Hollow Creek, Rinard Creek, Short Spring Branch, Taylor Slough South, Turkey Creek, Wells Branch Creek, and West Bull Creek.

Watershed	**Ar**	**Cd**	**Cr**	**Cu**	**Pb**	**Hg**	**Ni**	**Zn**
Barton Creek	16.44	10.67	0.00	8.64	2.47	1.32	0.00	1.23
Bee Creek	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00
Blunn Creek	0.00	50.00	0.00	0.00	0.00	0.00	100.00	0.00
Boggy Creek	0.00	50.00	.	0.00	0.00	0.00	0.00	0.00
Bull Creek	0.00	36.36	0.00	0.00	0.00	0.00	0.00	0.00
Cottonmouth Creek	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00
Dry Creek (North)	0.00	33.33	.	0.00	0.00	0.00	0.00	0.00
Dry Creek (South)	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Eanes	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00
East Bouldin Creek	0.00	27.27	0.00	0.00	83.33	9.09	0.00	8.33
Harper's Branch	0.00	50.00	.	0.00	100.00	0.00	100.00	0.00
Huck's Slough	50.00	50.00	.	0.00	0.00	0.00	0.00	0.00
Johnson Creek	0.00	50.00	.	0.00	100.00	0.00	0.00	0.00
Lake Austin	13.64	61.90	9.09	0.00	18.18	4.76	0.00	0.00
Lake Creek	100.00	50.00	.	0.00	0.00	0.00	0.00	0.00
Little Bear Creek	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00
Little Bee Creek	0.00	0.00	.	0.00	50.00	0.00	0.00	0.00
Little Walnut Creek	0.00	50.00	.	0.00	0.00	0.00	0.00	0.00
North Fork Dry Creek	0.00	100.00	0.00	0.00	0.00	0.00	100.00	0.00
Onion Creek	0.00	0.00	0.00	0.00	11.11	0.00	0.00	11.11
Rattan Creek	0.00	50.00	.	0.00	0.00	0.00	0.00	0.00
Shoal Creek	41.67	46.15	10.00	0.00	43.75	7.14	20.00	12.50
Slaughter Creek	0.00	0.00	.	0.00	0.00	0.00	0.00	50.00
South Boggy Creek	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00
South Fork Dry Creek	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Tannehill Branch	0.00	50.00	.	0.00	0.00	0.00	0.00	0.00
Taylor Slough (North)	50.00	0.00	.	0.00	100.00	0.00	0.00	0.00
Town Lake	16.39	66.67	2.48	14.04	84.73	11.97	10.00	20.16
Waller Creek	0.00	11.11	12.50	0.00	50.00	0.00	0.00	10.00
Walnut Creek	14.29	42.86	0.00	0.00	0.00	0.00	0.00	0.00
West Bouldin Creek	50.00	33.33	0.00	33.33	25.00	33.33	100.00	0.00
Williamson Creek	0.00	33.33	.	0.00	0.00	0.00	0.00	0.00

Pesticides and PCBs

- Excluding the following watersheds for which no sediment sample was in exceedance of the TEC: Bear Creek, Bear Creek West, Bee Creek, Blunn Creek, Boggy Creek, Bull Creek, Carson Creek, Cottonmouth Creek, Decker Creek, Dry Creek South, Elm Creek, Gilleland Creek, Harris Branch Creek, Huck’s Slough, Lake Creek, Little Barton Creek, Little Bear Creek, Little Bee Creek, Little Walnut Creek, Long Hollow Creek, Marble Creek, North Fork Dry Creek, Onion Creek, Panther Hollow Creek, Rattan Creek, Rinard Creek, Short Spring Branch Creek, Slaughter Creek, South Boggy Creek, South Fork Dry Creek, Tannehill Branch Creek, Turkey Creek, Walnut Creek, Wells Branch Creek, West Bull Creek, and Williamson Creek.

Watershed	Chlordane	DDD	DDE	DDT	Dieldrin	Endrin	Lindane	Heptachlor Epoxide	PCBs
Lake Austin	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00
Barton Creek	0.00	4.62	4.23	5.80	0.00	1.39	1.37	1.39	1.47
Buttermilk Branch	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00
Colorado River	.	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00
Country Club Creek	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00
Dry Creek (North)	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00
Eanes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.33
East Bouldin Creek	0.00	12.50	62.50	25.00	12.50	0.00	0.00	0.00	0.00
Fort Branch	0.00	16.67	33.33	33.33	16.67	0.00	0.00	0.00	0.00
Harper's Branch	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00
Johnson Creek	0.00	0.00	50.00	50.00	50.00	0.00	0.00	0.00	0.00
Shoal Creek	28.57	43.75	50.00	31.25	37.50	0.00	0.00	0.00	0.00
Taylor Slough (North)	0.00	0.00	50.00	50.00	50.00	0.00	0.00	0.00	0.00
Taylor Slough (South)	0.00	50.00	50.00	50.00	50.00	0.00	0.00	0.00	0.00
Town Lake	35.19	57.72	70.08	43.20	22.33	0.00	0.00	0.97	3.49
Waller Creek	25.00	11.11	44.44	11.11	11.11	0.00	0.00	0.00	0.00
West Bouldin Creek	0.00	0.00	50.00	25.00	25.00	0.00	0.00	0.00	0.00

PAHs

- Excluding results for naphthalene for which no sample was in excess of the TEC for any watershed.
- Excluding the following watersheds for which no sediment samples was in exceedance of the TEC: Bear Creek, Bear Creek West, Bee Creek, Boggy Creek, Carson Creek, Colorado River adjacent, Cottonmouth Creek, Decker Creek, Dry Creek North, Dry Creek South, Elm Creek, Gilleland Creek, Harris Branch Creek, Johnson Creek, Lake Austin, Lake Creek, Little Barton Creek, Little Bear Creek, Little Walnut Creek, Long Hollow Creek, Marble Creek, North Fork Dry Creek, Rattan Creek, Rinard Creek, Short Spring Branch Creek, Slaughter Creek, Tannehill Branch Creek, Turkey Creek, Wells Branch Creek, West Bull Creek, and Williamson Creek.

Watershed	**Anthracene**	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Chrysene**	**Fluoranthene**	**Fluorene**	**Phenanthrene**	**Pyrene**
Barton Creek	1.33	20.00	22.06	24.00	34.67	0.00	18.67	30.67
Blunn Creek	0.00	33.33	100.00	66.67	66.67	0.00	33.33	66.67
Bull Creek	0.00	18.18	20.00	18.18	18.18	0.00	9.09	18.18
Buttermilk Branch	0.00	50.00	50.00	50.00	50.00	0.00	50.00	50.00
Country Club Creek	0.00	50.00	50.00	50.00	50.00	0.00	0.00	50.00
Eanes	0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00
East Bouldin Creek	9.09	72.73	77.78	81.82	90.91	9.09	63.64	90.91
Fort Branch	0.00	0.00	0.00	0.00	16.67	0.00	0.00	16.67
Harper's Branch	50.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00
Huck's Slough	0.00	0.00	50.00	0.00	50.00	0.00	0.00	0.00
Little Bee Creek	0.00	0.00	0.00	0.00	50.00	0.00	0.00	0.00
Onion Creek	11.11	11.11	20.00	11.11	22.22	11.11	11.11	22.22
Shoal Creek	0.00	60.00	75.00	60.00	80.00	0.00	60.00	80.00
South Boggy Creek	0.00	0.00	0.00	0.00	50.00	0.00	0.00	50.00
South Fork Dry Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Taylor Slough (North)	0.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00
Taylor Slough (South)	0.00	50.00	100.00	100.00	100.00	0.00	50.00	100.00
Town Lake	0.00	12.00	33.33	20.00	32.14	0.00	16.00	33.33
Waller Creek	22.22	55.56	87.50	88.89	88.89	11.11	66.67	88.89
Walnut Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.29
West Bouldin Creek	0.00	0.00	0.00	0.00	25.00	0.00	25.00	0.00