Final Report

Lower Walnut Creek Aquatic Sampling, Spring 1998

Prepared for

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ACRONYMS AND ABBREVIATIONS

BDCWG	Big Dry Creek Watershed Group
DOE RFFO	Department of Energy Rocky Flats Field Office
EPT	Ephemeroptera, Plecoptera, and Trichoptera
HBI	Hilsenhoff biotic index
NPDES	National Pollutant Discharge Elimination System
RBP	Rapid Bioassessment Protocols
RFETS	Rocky Flats Environmental Technology Site

INTRODUCTION

As part of the Big Dry Creek Watershed Group (BDCWG), the cities of Westminster, Broomfield, and Northglenn have conducted a combined water quality monitoring program on Big Dry Creek since 1988. Rocky Flats Environmental Technology Site (RFETS) is located west of the area being monitored by the cities, and the Department of Energy Rocky Flats Field Office (DOE RFFO) also participates in the BDCWG. As such, the DOE RFFO has agreed to monitor several upstream locations along Walnut Creek and near the confluence of Walnut Creek and Big Dry Creek. The purpose of the monitoring is to provide biannual assessments of the aquatic habitat, and the condition and abundance of aquatic life. This information is needed by decision makers to protect and preserve the aquatic integrity of the streams.

The questions being addressed by this sampling include:

- What is the quality of the aquatic habitat in Lower Walnut Creek?
- What are the richness and abundance of the benthic macroinvertebrates in Lower Walnut Creek?
- What fish species are present in Lower Walnut Creek?
- What is the condition of the benthic macroinvertebrate and fish populations in Lower Walnut Creek, and how do they compare to downstream areas?

METHODS

Six locations (sites) were selected along Walnut Creek and near the confluence of Walnut Creek and Big Dry Creek for aquatic sampling in spring 1998. They included one site at Rocky Flats Environmental Technology Site (RFETS) and five others located east of RFETS. These sites were sampled in 1994 as part of a study conducted by Wright Water Engineers, Inc. (WWE 1995). Figure 1 shows the location of the six sample sites. The same site names used by WWE were used again for ease of reference: D1, D2, W1, W2, BD1, and BD2. Methodology followed the *Rapid Bioassessment Protocols* (RBPs) *for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish* (U.S. EPA 1989) as a minimum standard. These protocols require sampling of fish and benthic macroinvertebrates, habitat characterization of sampling locations, water chemistry information, and water flow levels. The benthic macroinvertebrate sampling in spring 1998 used the RBP III for benthic macroinvertebrates (U.S. EPA 1989). Fish sampling used the RBP V (U.S. EPA 1989). Some modifications to these protocols were necessary because of the habitat constraints in the Lower Walnut and Big Dry Creek drainages. These modifications included compositing kicknet samples, combining sweeps from different habitats, and making the decision to seine for fish instead of electroshocking. The activities conducted at each of the six sampling sites are described below:

Habitat was assessed following the RBP (U.S. EPA 1989), with one assessment for each site. Both physical and water quality data were collected at the time of sampling or within a few days thereafter. Water quality data collected included pH, temperature, dissolved oxygen, stream flow, conductivity, and turbidity. The following modifications were made to the habitat assessment to assist in comparing data from samples collected downstream by the cities. The modifications included:

- Length and width were measured at each site.
- The length of each site was divided into 50-ft transects, or cells, and the transects were staked.
- Flow measurements were taken at each transect.
- All deposits were measured and composition noted.
- Banks were measured for percent vegetation/stable, percent vegetation/unstable, percent rock/stable, and percent exposed soils.
- Substrate percentages were determined for each cell via a random count of 100 grabs.
- Percent embeddedness was estimated for each cell.
- Slope of the bank was estimated.

- All instream structures were measured (boulders, vegetative mattes, log jams, etc.)
- The length of each riffle, pool, and run was measured at each site.
- The type of vegetation was measured and noted along the banks.
- The lengths of overhanging vegetation and undercut banks were measured.

These modifications followed the procedures employed by the City of Northglenn staff (see sample habitat completion sheets, Appendix A).

Two types of benthic macroinvertebrate sampling were conducted. The first type used a Hess sampler. Three replicate samples were taken in different riffle sections of the stream at each of the six sites (assuming three riffles were present in sampling area). Each replicate remained an individual sample. In the field, samples were placed into labeled jars containing a 70 percent ethanol solution for preservation, and were delivered to the laboratory for analysis. The maximum mesh size of nets used with samplers was 250 μm.

The second method of collecting benthic macroinvertebrate samples used a Kicknet type of sampler (or equivalent). Four samples were collected from each habitat (bank, riffle, run, pool) at each site, and were composited into one site sample. The composite samples were preserved and shipped as described previously.

Fish were sampled using minnow (fish) seines and traps. Minnow seining was conducted twice (each time on different days) throughout the entire length of the stream in the sample area. Additionally, four minnow traps were placed at each site. (Note: the small stream channel size and low flow conditions at the time of sampling made electroshocking an inappropriate method for this effort. Furthermore, electroshocking would not have been effective if the stream's conductivity were high. Field crews identified and enumerated fish species at the sites, as well as measuring lengths and weights and noting any anomalies on individuals. Any fish that could not be field identified were placed into labeled jars containing a 70 percent ethanol solution for later identification.

Field data sheets and forms used for sampling are presented in Appendix A. Benthic macroinvertebrate samples were sent to a subcontractor (Chadwick and Associates) for identification to the lowest possible taxon, enumeration, and summary by diversity index, taxa richness, and family biotic index (e.g., Hilsenhoff biotic index [HBI], Ephemeroptera, Plecoptera, and Trichoptera [EPT] index, scraper ratios, etc.). The results from these identifications and summaries are presented in Tables 5–7 and Figures 2–5.

ANALYSIS

Analysis of the data collected followed the recommendations provided in the RBP (U.S. EPA 1989). The benthic macroinvertebrate metrics included:

- Species richness
- Modified HBI
- Ratio of scrapers and filtering collectors
- Ratio of EPT and chironomidae abundance
- Percent contribution of dominant taxa
- EPT index
- Community similarity indices.

Fish metrics included species richness.

RESULTS AND DISCUSSION

STUDY AREA

The study area for the Lower Walnut Creek monitoring extends from one site just west of Indiana Avenue on RFETS to the confluence of Walnut Creek and Big Dry Creek, just southwest of Highway 36. The six sites are all within Jefferson County, with four sites along Walnut Creek and two sites in Big Dry Creek. In Big Dry Creek, one site is above and one below the confluence with Walnut Creek (Figure 1, Table 1). These six sites were used for an aquatic biological assessment in 1994 (WWE 1995). Habitat characterization, and fish and benthic macroinvertebrate sampling were conducted at each of the six sites during late March through April 1998. Appendix B contains photographs of each site, which documents the conditions during the 1998 spring sampling.

HABITAT CHARACTERISTICS

Walnut Creek is an intermittent stream with its headwaters originating on the west side of RFETS. From RFETS, Walnut Creek meanders through a suburban setting that includes ranchettes, subdivisions, municipal open space, and pasture land until reaching the confluence with Big Dry Creek. Stream-side vegetation includes grasses, various wetland species, willow, leadplant and chokecherry shrubs, and trees.

All six of the 1998 sampling sites (Table 1) are in the transition zone between the foothills and the plains. Aquatic habitats and, correspondingly, aquatic life in Walnut Creek are limited by water availability and discharge rates, especially at the upstream sites, D1 and D2. Traveling downstream from the first sampling site, D1 (Figure 1), to the confluence with Big Dry Creek, water availability and stream discharge rates increase.

Stream discharge is highly modified by human activities. Many ditches and reservoirs have been in place for decades, altering stream flows from natural conditions. Present flow conditions depend on the management of these man-made additions to the watershed. Two examples of man-altered conditions are:

1. RFETS must maintain water quality standards under a National Pollutant Discharge Elimination System (NPDES) permit, currently relying on batch testing and discharging to meet the standards (RMRS 1996, *Pond Operations Plan*). The batch discharging perpetuates the intermittent flow conditions and limits the aquatic habitat available at the sampling sites immediately east of the Pond Operations Area (i.e., D1 and D2, Figure 1).

2. Between D2 and W1 (Figure 1), real estate development is occurring in the uplands adjacent to both sides of the creek. Excavation and construction remove vegetation and increase the potential for runoff and sedimentation in the creek. Aquatic habitats in sampling sites below these developments are altered, at least temporarily, during this sampling session.

The following habitat characteristics apply, in general, to all six sampling sites. Sampling sites generally contained three macrohabitat types—riffles, runs, and pools—with the exception of site D2, which had no pool habitat. Cobble and gravel substrates in riffle habitats provide some of the most productive conditions for aquatic life. Riffle habitats at all sites contained some portion of cobble and gravel substrates (Table 2), but also revealed some level of sedimentation (Table 3). Pool habitats generally had sand and silt substrates. Stream discharge varied widely during the sampling period, with flows reaching near flood conditions during the week of 13 April, following a weekend snowstorm. Water clarity was slightly turbid to turbid throughout Walnut Creek, and conductivity fluctuated widely during sampling (Table 4).

Habitat characteristics that differentiated some sampling sites from others were 1) the overall habitat scoring, 2) the amount of macrohabitats available, and 3) the proportions of substrate types. The overall habitat scoring is the result of a habitat assessment that incorporates a variety of habitat parameters according to EPA's Rapid Bioassessment Protocols (U.S. EPA 1989). See Appendix A for an example field data sheet that contains a list of the parameters used during habitat assessment. The amount of macrohabitats available and the proportions of substrate types present at each site give additional information as to the site's habitat suitability and potential productivity.

Site D1 had the lowest habitat score (51, Table 2), the lowest proportion of riffle habitat (17.5 percent, Table 2), and the highest proportion of silt substrate (42 percent, Table 3), compared to the other sampling sites. Site D1 is situated immediately downstream from a small impoundment, the Walnut/Indiana Pond. The habitat conditions likely result from the batch discharging regime from upstream containment ponds, and from the high sediment output from the Walnut/Indiana Pond. Additionally, this portion of Walnut Creek is often dry in the late summer and fall months, except when batch discharging is occurring (see Figure 4-2, WWE 1995). The dry periods at D1 severely limit the aquatic habitat at this site.

Site D2 had the largest proportion of riffle habitat (87.5 percent, Table 2) and contained the most cobble substrate (90 percent, Table 3). These conditions contributed to one of the highest habitat scores (93, Table 2). This reach of Walnut Creek now receives water from the Broomfield Diversion Ditch, Woman Creek Reservoir, Dry Creek Valley Ditch, and the toe drain of Great Western Reservoir. Flows from these sources can be quite large at times and apparently are relatively free of sediment. In aggregate, these flows create some high-quality aquatic habitat at this site in Walnut Creek.

Site W1 was noteworthy because of the large proportion of run habitat (60.6 percent, Table 2) and a relatively large proportion of gravel and sand substrate (40 and 30 percent, respectively, Table 3). The gravel substrate provides higher-quality habitat for aquatic production, but the sand and silt (20 percent, Table 3) suggest some siltation as well. These conditions combine with a large proportion of overhanging trees and shrubs to produce an average habitat score (67, Table 2) at sampling site W1.

Site W2 is most comparable to site W1, and had typical habitat conditions (76, Table 2) for Walnut Creek. This site had a large proportion of run habitat (52.8 percent, Table 2) and contained moderate levels of sand and silt (25 and 20 percent, respectively, Table 3). These substrate proportions indicate that some siltation is occurring. The siltation at this sampling site may be explained by its proximity to Highway 36. Winter highway sand and gravel application may add to stream siltation as snowplows push sand and gravel down the embankment into the creek. Additionally, upstream real estate development may also be adding to siltation at this site.

The last two sampling stations, BD1 and BD2 (Figure 1), both received high habitat scores (85 and 94, respectively, Table 2). In fact, BD2 received the highest score of the six sampling sites. These two sites are in Big Dry Creek and contain large, deep pools, as well as riffle habitat and meandering runs (Table 2). Additionally, the sites contained many areas of undercut banks with overhanging vegetation and submerged logs. This was typically not the case in Walnut Creek, with the exception of the high-quality riffle habitat at D2. These Big Dry Creek sites appear to provide good habitat for aquatic life, especially fish. However, the Aquatic Monitoring Program in Big Dry Creek (Aquatic Associates 1998) reported, "In areas upstream from municipal wastewater discharges…extremely low flows may negatively affect the aquatic community…especially during low base flow conditions." Areas upstream from municipal wastewater discharges would include sampling sites BD1 and BD2. Therefore, although habitat conditions at these two sites appeared to be of good quality in March and April 1998, productivity may be limited by water availability during other times of the year.

Compared to sampling efforts in Lower Walnut Creek in 1994, the habitat scores at site D2 in 1998 improved. This may be due to the addition of the Woman Creek Reservoir diversion channel, although discharges from Woman Creek Reservoir are infrequent (i.e., up to three times per year). A more likely explanation is that flooding in the spring of 1995 flushed accumulated sediments from this site with water volumes that reached 25-year flood levels, thus improving riffle habitat.

At the remaining sites, habitat appears to have declined somewhat from 1994 to 1998. With the exception of site BD2, where the habitat scores were essentially the same, habitat scores declined from 1994 (WWE 1995) to 1998, although it is difficult to say specifically how the habitats changed without consulting the original Aquatic Habitat Assessment Field Data Sheets (U.S. EPA 1989). One possible explanation is that real estate development in the Walnut Creek basin has decreased water availability and increased siltation, embedding cobble and gravel beds.

MACROINVERTEBRATES

Sampling for benthic macroinvertebrates was conducted at the six sites during March and April 1998. Samples were collected using two techniques: Hess sampling in riffles using three replicates, and kicknet sweeps combined from four habitat types. Table 5 presents the results of macroinvertebrate sampling as relative abundance of taxa per site, by method. The Hess sampling results are relative abundance derived from combining the three replicates. Unsummarized results provided by Chadwick and Associates are presented in Appendix C. RBP III metrics and other community parameters for Lower Walnut Creek are presented in Table 6 and Figures 2–10.

Benthic macroinvertebrate communities in the six sampling sites were represented by 14 orders, including 63 separate taxa. Hess sample results demonstrated that Diptera (midges and flies) taxa were predominant at all sites, with Ephemeroptera (mayflies) and to a lesser extent, Tricoptera (caddisflies) providing most of the remaining abundance. Kicknet sampling also revealed a predominant Dipteran taxa, with the exception of samples from D2 and W2. Kicknet samples from these sites show an abundance of the Ephemeropteran species, *Baetis tricaudatus* (Table 5). Regardless of sampling method, Dipteran abundance typically resulted from the presence of one Chironomidae species, *Cricotopus tremulus.* One exception to this trend was at D1, where *Diamesa* sp. were most abundant. The D1 site also lacked in abundance of Ephemeroptera and Tricoptera, unlike other sites downstream. Other groups—including hemiptera (true bugs), ologochaeta (free-living worms), hirudinea (leaches), amphipoda (scuds), gastropoda (snails), Turbellaria (flatworms), and Nematoda (roundworms)—were encountered occasionally but were not abundant at any of the six sampling sites. Cambaridae (crayfish) were either captured or observed at all six sampling sites and were likely *Orconectes* sp.

Before this study, there was considerable interest in finding Plecoptera (stoneflies) in Lower Walnut Creek, because these insects need a constant source of cold, well-oxygenated water to survive. In late summer of 1994, stoneflies were found at site D2 (EG&G 1995, Table D-13) in low abundance (K-H 1998b, Ecology Database). Given the habitat scores and flows at D2, it is not surprising that stoneflies have been found at this site; however, none was found at D2 or any of the remaining five sampling sites during the 1998 spring sampling. Additional late-season sampling may yield stoneflies in Lower Walnut Creek.

Seven RBP III metrics and two other metrics were used to further evaluate the macroinvertebrate data. The total number of organisms per square meter and the Shannon-Weaver Diversity Index were used, in addition to the RBP III metrics, to make comparisons among sites. The seven RBP III metrics were 1) number of taxa, 2) a modified Hilsenhoff biotic index (this is a family-based biotic index), 3) ratio of scrapers to filtering collectors, 4) EPT index, 5) ratio of EPT to Chironomidae abundance, 6) percent contribution of dominant taxon, and 7) ratio of shredders to the total benthic community. Community loss index typically is used as an eighth metric with RBP III, but for the community loss index to be calculated, a reference site must be included. Under the Lower Walnut Creek sampling plan (K-H 1998a), it was not considered appropriate at the time to declare a reference site. One possible reference site for the future would be the Big Dry Creek site 0.5BD, as used under the BDCWG sampling scheme (Aquatic Associates 1998).

The RBP III metrics, Shannon-Weaver Index, and total organisms are presented in Table 6 and Figures 2–5 for Hess sampling only. Table 7 presents total organisms and total taxa for kicknet samples. RBP III metrics were not calculated for kicknet samples. The following paragraphs relate the nine metrics (seven RBP III and two others) resulting from Hess sampling for macroinvertebrates at the six sampling sites.

Based on Hess sampling, the total number of taxa was greatest at the Big Dry Creek sampling site BD2 (25, Table 6; Figure 2), and site D1 had the fewest taxa (12, Table 6, Figure 2). Site D2 also had a relatively greater number of taxa compared to other sites. The trend of these three sites generally follows the habitat conditions (e.g., habitat scores; Table 2, Figure 2). Total taxa at Site W2 was unexpectedly high given the habitat scoring (Table 6, Figure 2).

The modified Hilsenhoff biotic index compares the abundance of disturbance, and pollution-tolerant species to the abundance of all taxa in the community. The higher the index, the more tolerant the macroinvertebrate community is to disturbance or pollution. D1 and BD2 had the highest modified Hilsenhoff biotic index among the six sampling sites, suggesting that more pollution-tolerant communities are present at these sites than at the four other sites (Table 6, Figure 2). Sites W2 and BD1 had fewer pollution-tolerant macroinvertebrate communities. Similar indices were reported in 1994 (WWE 1995). It is interesting to note that sites in Lower Walnut Creek had similar or lower modified Hilsenhoff biotic index values when compared to sites in Big Dry Creek (Appendix C, Aquatics Associates 1998).

Insects in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) are generally sensitive to water quality and habitat degradation. When the total number of EPT taxa is greater at one site than at another, the first site has better water quality and/or habitat than the second. The total number of EPT taxa (EPT index) was greatest at D2 (8, Table 6; Figure 3). Sites D1 and W1 had the lowest EPT index. It is interesting that these two sites are upstream (D1) and downstream (W1) from D2 (Figure 1). Once again, riffle habitat is the key to supporting EPT insects. D2 has superior riffle habitat to D1 and W1.

The EPT/Chironomidae Ratio compares the EPT, which is generally pollution intolerant, to the Chironomid group, which are pollution tolerant. Surprisingly, D2 had a relatively low EPT/Chironomidae abundance ratio (0.33, Table 6). W2 had the highest ratio (0.92, Table 6), indicating a more balanced macroinvertebrate community. D1 had the lowest ratio (<0.01, Table 6), which is attributed to the lack of EPTs, the poor-quality habitat, and the lack of water at this site during substantial portions of the year. Site BD2 had a low ratio as well (0.07, Table 6), attributed to the abundance of midges (*Cricotopus tremulus*) in one Hess sample (Appendix C).

A healthy macroinvertebrate community should contain a balance of many different taxa. Conversely, stressed communities are dominated continually by one or two taxa. The Percent Contribution of Dominant Taxa metric was highest at site BD2 (72 percent, Table 6, Figure 2), which means that one taxon contributed 72 percent to the overall abundance in the macroinvertebrate community. This is explained by the fact that two Hess samples from this site had midge counts that were an order of magnitude higher than any of the other sample sites. Sites D1 and BD1 also had relatively high percentages (63 and 60 percent, respectively, Table 6, Figure 2). The other sites had lower percentages, with site W1 the lowest (30 percent, Table 6, Figure 2). Therefore, sites D2, W1, and W2 have relatively balanced macroinvertebrate communities.

The ratio of scrapers to filter collectors is designed to detect organic enrichment in aquatic macroinvertebrate communities. However, filter collectors may be intolerant to pollutants, making the metric somewhat misleading. Site D1 had the highest ratio (17.0, Table 6, Figure 2), which is not surprising, given that D1 site conditions alternate from a dry creek bed to moderate flows, which flush algal growth and plant matter downstream. Surprisingly, site D2 had the lowest ratio (0.85, Table 6, Figure 2), indicating some organic enrichment compared to the other sites. BD2 also had a low ratio (0.96, Table 6, Figure 2) when compared to the other sites. Ratios were much lower in Big Dry Creek (Aquatic Associates 1998).

The ratio of shredders to total number of individuals collected regardless of feeding group was greatest at sites BD2 and BD1 (0.78 and 0.60, respectively, Table 6, Figure 4). The lowest ratios came from sites D1 and W1 (0.24 and 0.30, respectively, Table 6, Figure 4).

Healthy aquatic communities exhibit a balance of many different macroinvertebrate taxa. Diversity stems from high taxa richness without any one or two groups dominating in abundance. The Shannon-Weaver index (H') is used to determine the evenness of community diversity. A higher H' value indicates more even diversity. Sites with the greatest diversity, as calculated using the Shannon-Weaver index, were D2 and W1 (Table 6, Figure 4). These sites had a more even distribution of taxa abundance within the macroinvertebrate communities. Alternatively, sites with a large number of total organisms, such as BD2 (Table 6, Figure 5), but with great numbers from only a few groups (e.g., *Cricotopus tremulus* from BD2, Appendix C) had low H'. D1 also had a low H', as a result of two dominant species within the 12 taxa found there (Table 6, Appendix C). These results follow trends in habitat conditions when considered with Percent Contribution of Dominant Taxa. For example, BD2 had a high habitat score but also a high contribution from one taxon and thus a low H'. Conversely, D2 had a high habitat score and a more even contribution from many taxa. Therefore, D2 had a high H'. D2 has many more abundant taxa than BD2 and therefore is more diverse. When considering all the macroinvertebrate metrics taken at the six sampling sites, sites W1 and D2 (Table 1, Figure 1) have the most robust and diverse macroinvertebrate communities, because they have a relatively even distribution of taxa, high EPT index, and low contribution from dominant taxa.

Based on macroinvertebrate metrics, the water at sites D2 and W1 is of good quality and apparently devoid of pollutants, and the habitat is adequate and shows no signs of physical disturbance. However, the habitat score for site W1 would not indicate one of the highest macroinvertebrate communities in Lower Walnut Creek, although it is difficult to make strong conclusions on the health of the macroinvertebrate and fish communities on the basis of a single sampling event.

Metrics from site D1 indicate the presence of environmental stress. Site D1 appears to have an impoverished macroinvertebrate community, based on low taxa richness, low EPT index, high percent contribution from dominant taxa, and an overall low number of organisms. This is most likely due to a lack of adequate habitat and, fundamentally, a lack of water. As indicated in the Habitat Results, this site sustains major desiccation for relatively long periods of time as a result of the batch discharging from RFETS. On the other hand, based on this sampling session, the ratio of scrapers to filter collectors does not indicate problems with pollutants. Therefore, it appears that the lack of a robust macroinvertebrate community and the presence of only a transient fish community are due simply to a lack of water at site D1. Again, this discussion is based only on a single sampling event, and site conditions may improve in later years or different seasons.

Although direct comparisons of macroinvertebrate communities from 1994 (WWE 1995) to 1998 are not possible because of differences in sampling methods, general trends are evident in the two resulting data sets. Taxa richness was highest at sites D2 and W2 during both years, and the modified HBI was nearly the same or had slightly declined over time (with the exception of D1, where the modified HBI was higher in 1998 than in 1994). The contribution of dominant taxa was highest at D1, BD1, and BD2 during both years.

Comparing the macroinvertebrate communities of Lower Walnut Creek in spring 1998 to those of Big Dry Creek in spring 1997 (Aquatic Associates 1998), many differences in the RBP metrics are apparent. The number of taxa in Big Dry Creek during spring 1997 was always higher (1 to 16 more taxa per site) than at Lower Walnut Creek sites during 1998. The modified HBI values were generally higher in Big Dry Creek than in Lower Walnut Creek one year later. The percent contribution of dominant taxa was generally higher at the downstream sites of Big Dry Creek (i.e., below the confluence with Walnut Creek) in 1997 than at upstream sites in 1998. The EPT index and the ratios of EPT to Chironomidae, and scrapers to filter collectors, were typically higher in upstream sites in 1998 than in Big Dry Creek downstream sites in 1997. The shredder/total-abundance ratio and the total number of organisms per square meter were always higher in downstream sites in 1997. These metrics seem to indicate better water quality in upstream sites in Lower Walnut Creek and the Big Dry Creek site above the confluence with Walnut Creek. However, these sampling events likely took place under different conditions, because the sampling events in Big Dry Creek were conducted one year earlier than those in Lower Walnut Creek. Thus, it is possible that most of the differences in RBP metrics result from year-to-year variations in the macroinvertebrate communities.

FISH SURVEYS

Fish surveys were conducted at all six sampling sites in late March and April 1998. Although backpack electroshocking was considered as a survey method, it was thought that conductivities in Lower Walnut Creek and Big Dry Creek may be too high for the electroshocker to work properly. The suspected high conductivity levels were based on studies in Big Dry Creek (Cline 1998, pers. comm.). Instead of electroshocking, fish surveys were done using a minnow seine. Although this method is semi-quantitative, it still allowed biologists to assess the fish communities in Lower Walnut Creek. Surveys were conducted during runoff conditions in April. As a result, the high water may have affected the number of fish captured.

Table 8 presents presence/absence information for fish at the six sampling sites. This table shows a general trend of increasing diversity and abundance going downstream, with the most abundance in Big Dry Creek. This trend is most likely due to recurrent dry periods at upstream sites in Lower Walnut Creek, especially site D1.

All species found are native to Colorado. The longnose dace, creek chub, and white sucker are cool headwater fishes, whereas the fathead minnows are ubiquitous, silt-tolerant fish. The green sunfish is a warm-water species that is typically found in still waters in rivers or ponds.

According to Walnut Creek study reports prior to 1998 (WWE 1995, EG&G 1992), no fish species other than fathead minnows had ever been observed in the stream reach below the RFETS ponds (i.e., the Walnut Creek Stream reach from the RFETS A-4 Pond to Simms Street). These fathead minnows likely exist in Lower Walnut Creek as a result of pond water discharge practices at RFETS. When discharging occurs, fish are carried downstream from the RFETS A-4 and the Indiana Street ponds. During the 1998 sampling, however, creek chubs were discovered at site D2 (Figure 1, Table 8). With the many sources of water from different creeks converging on this site (i.e., D2), many opportunities exist for fish introduction or re-introduction. A plausible explanation for the recent occurrence of creek chubs at this site is that they entered the site from one of the many diversion ditches or emigrated upstream from Big Dry Creek.

Furthermore, Wright Water Engineers (WWE 1995) reported that fish sampling was conducted in Big Dry Creek by the Colorado Division of Wildlife in 1992 above and below the confluence of Walnut Creek. These locations approximate sites BD1 and BD2. During the Division of Wildlife surveys, the same five species of fish were found as in 1998 below the confluence with Walnut Creek. Above the Walnut Creek confluence, however, the Division of Wildlife found a total of eight species, whereas in 1998, only three were found. The species missing above the confluence of Walnut Creek are the Johnny darter, longnosed sucker, white sucker, green sunfish, and small mouth bass. The most likely cause of the difference is the different sampling methods used. The Division of Wildlife used electroshocking, and this study used seining. However, these results may also show that upstream sites in Big Dry Creek are replenished by fish populations from downstream or from tributaries (Sites W2 and BD1 vs. BD2, Table 8).

Compared to surveys of Big Dry Creek in 1997 (Aquatic Associates) upstream of the two confluence sites, similar species diversity was observed. Five fish species were collected both at a site 0.5 miles below Standley Lake (Site BDC-0.5; Aquatic Associates 1998) in spring 1997 and in Big Dry Creek in spring 1998. However, the species compositions of the two sampling events were different. No green sunfish were captured in spring 1997, but Johnny darters and longnose suckers were captured. Johnny darters and longnose suckers were not observed in 1998, but green sunfish and fathead minnows were observed. However, it is difficult to draw any strong conclusions from only one sampling event in a single season.

CONCLUSIONS AND RECOMMENDATIONS

Aquatic life in Walnut Creek is limited by stream flow, which has been greatly modified from natural flow conditions. However, this assessment presents findings of good habitat and a relatively healthy macroinvertebrate community, which equates to relatively good water quality. Current real estate development may be affecting water quality somewhat by creating increased siltation. However, as construction is completed and the developed areas are revegetated, this disturbance may disappear. Water quality is good in Walnut Creek, and no indications were found that pollution is limiting aquatic life. However, only a single sampling event has been conducted recently, and further sampling is needed to fully document conditions.

More than any other factor, the lack of water due to batch discharges limits aquatic life in Lower Walnut Creek, especially at site D1. The lack of distinguishable habitats and a riparian zone immediately below the RFETS ponds further limits the aquatic communities at D1 (WWE 1995). A change to a limited continuous flow regime at RFETS would do much to enhance aquatic communities (fish and macroinvertebrates) within the downstream stretch from the A-4 Pond to the Broomfield diversion ditch.

Based on habitat scores (U.S. EPA 1989), habitat at site D2 appears to have improved since 1994, most likely as a result of recent flood events. Habitat at site BD2 in Big Dry Creek has stayed unchanged, as determined by habitat scoring. At sites D1, W1, W2, and BD1, habitat quality appears to have declined. Possible explanations for the decline include increased real estate development in upland areas, and at site D1, the continued batch discharging has likely continued to add silt and sand to substrates. Overall, man-made changes in and upgradient of Walnut Creek have enhanced some stretches (e.g., site D2), but may have degraded others (e.g., site W2).

Past sampling events have found Plecoptera (stoneflies) in Lower Walnut Creek (K-H Ecology Database 1998b), but none was found during spring 1998 sampling. Lower Walnut Creek does produce other important aquatic insects in the EPT group, in the orders Ephemeroptera (mayflies) and Trichoptera (caddisflies), and the presence of stoneflies may have been overstated in the past, particularly given their low abundance in Lower Walnut Creek in 1994. It is likely that Lower Walnut Creek is a replenishing source of EPT to Big Dry Creek, but is not a source of fish.

Fish diversity in Lower Walnut Creek is much lower than in Big Dry Creek. Fish species are limited to those that can survive the intermittent flows in this tributary. Diversity does increase with an increasing proximity to Big Dry Creek (e.g., site W2, Table 8, Figure 1), indicating a likely influx from Big Dry Creek.

Differences in RBP metrics for macroinvertebrate communities were noted in a comparison of the Lower Walnut Creek site to Big Dry Creek sites sampled by Aquatic

Associates in 1997. Although the differences in metrics that were noted indicated better water quality in upstream sites in both Walnut Creek and Big Dry Creek, simple year-to-year variation cannot be ruled out as an explanation. Therefore, future comparisons should be made during the same season of the same year when possible.

We have the following recommendations:

- Present these findings to the BDCWG
- Continue monitoring habitat and aquatic life at the six sampling sites, especially in the fall of 1998
- Consider using electroshocking methods, and compare the options for bank and backpack shocking methods versus seining
- Incorporate City of Broomfield and City of Westminster surface-water information (if available) into future aquatic monitoring reports.
- Continue to coordinate with the BDCWG to ensure compatibility of sampling programs.
- Compare macroinvertebrate communities in Big Dry Creek with those in Lower Walnut Creek using data from the same season of the same year.

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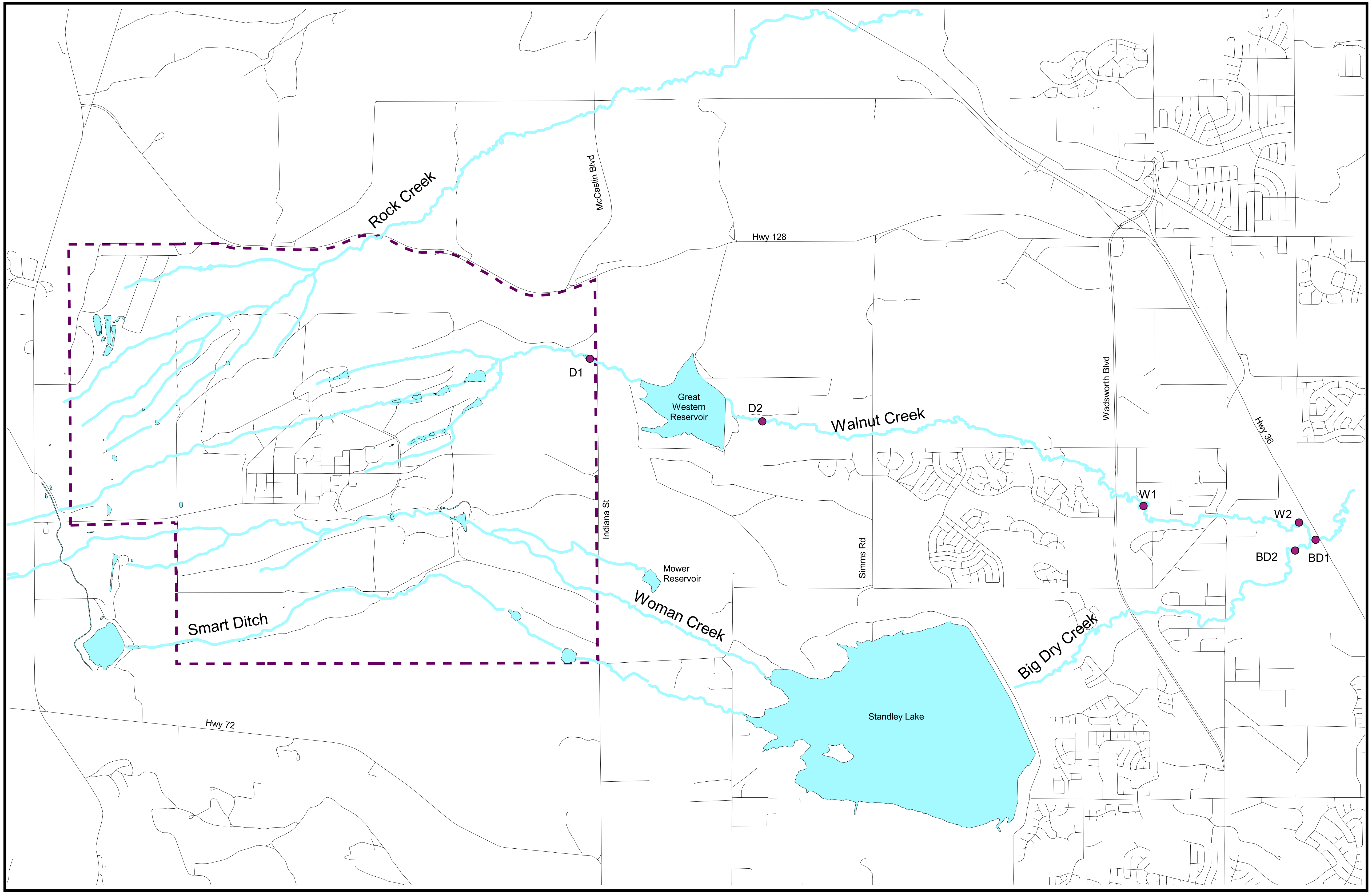
Figures



Lower Walnut Creek
1998 Aquatic Sampling Sites

Figure 1.

LEGEND

Aquatic Sites
Lakes
Streams
Roads
Rocky Flats Boundary

Data Sources:
RFETS boundary provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991, Hydrology and roads provided by USGS - (date unknown)

N

1:46249

0 0.5 1 Miles

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Exponent tm

M. Fink aquatics.apr 9/08/98

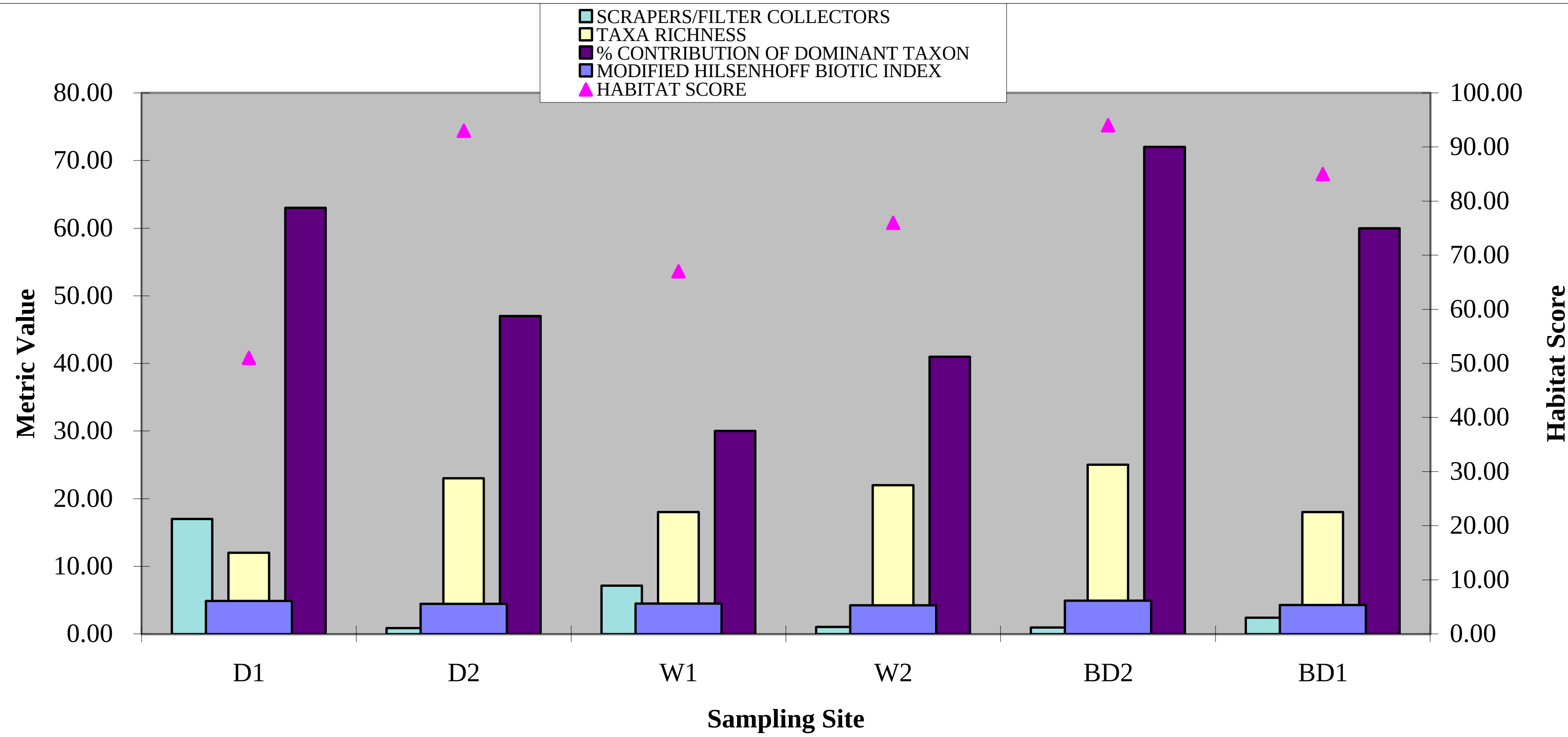


Figure 2. Values of Metrics and Habitat Scores, Lower Walnut Creek, March/April, 1998

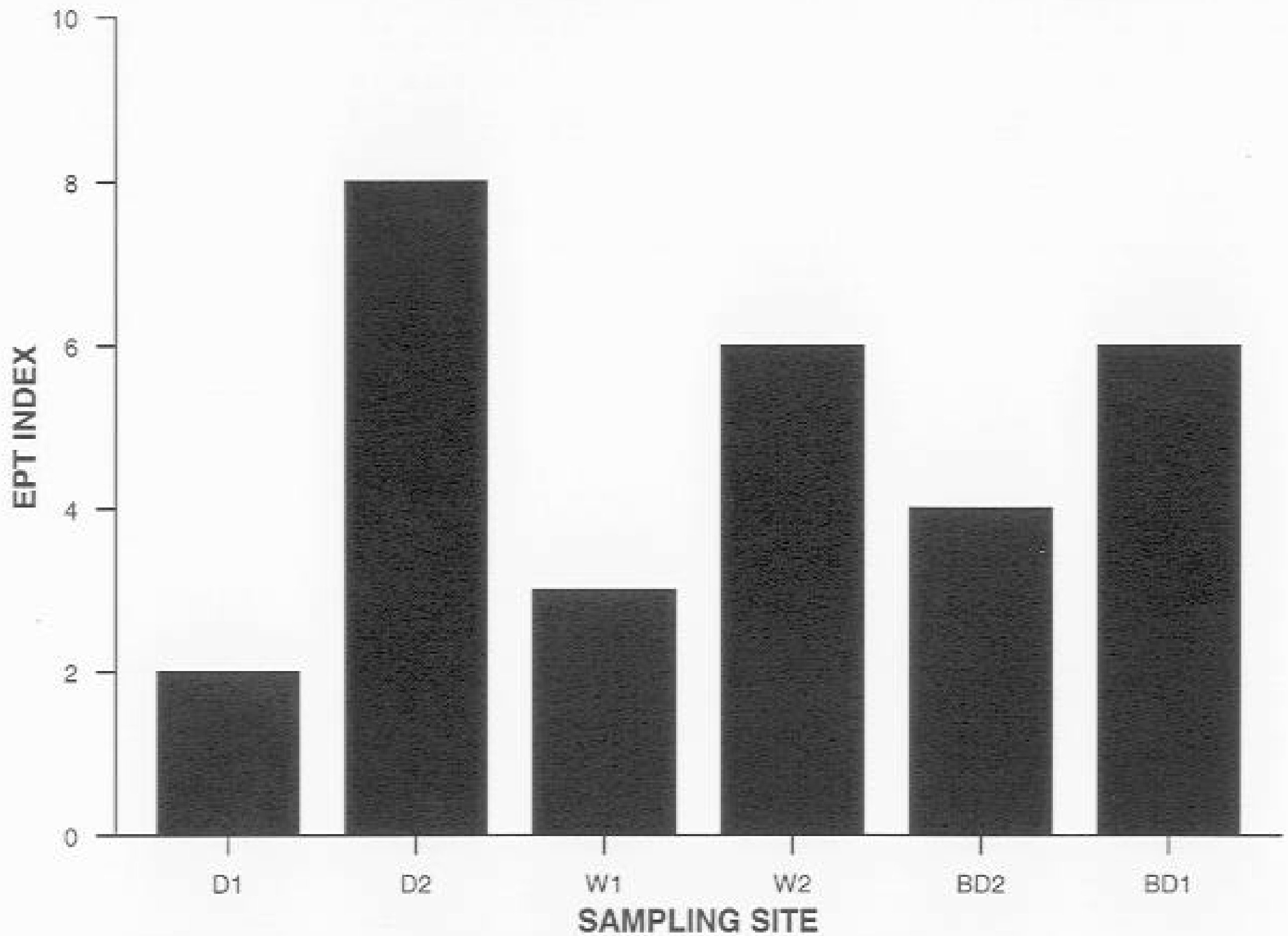
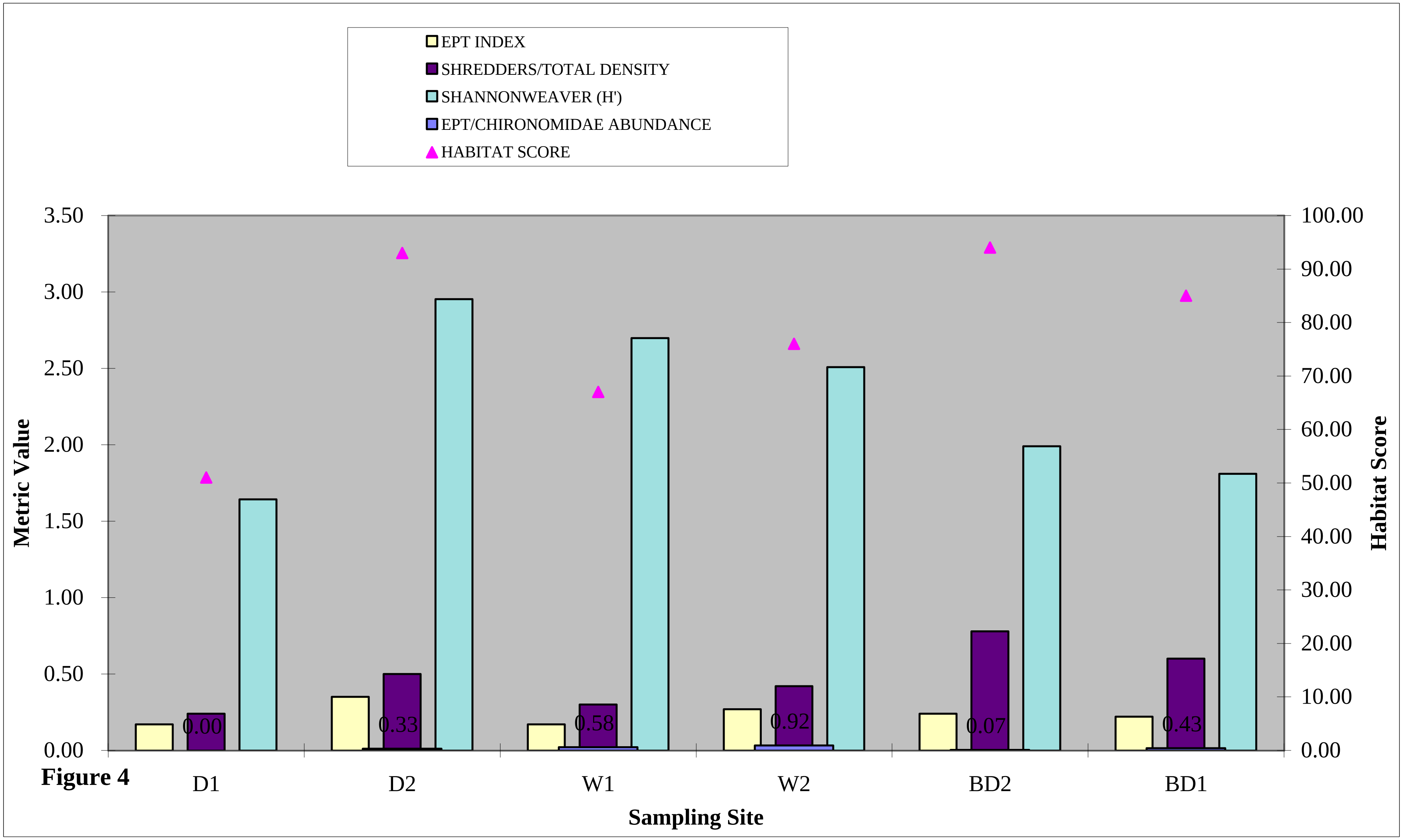


Figure 3. EPT index for spring 1998 aquatic sampling.



EPT INDEX
SHREDDERS/TOTAL DENSITY
SHANNONWEAVER (H')
EPT/CHIRONOMIDAE ABUNDANCE
HABITAT SCORE
Metric Value
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Habitat Score
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
0.33
0.58
0.92
0.07
0.43
D1
D2
W1
W2
BD2
BD1
Sampling Site

Figure 4

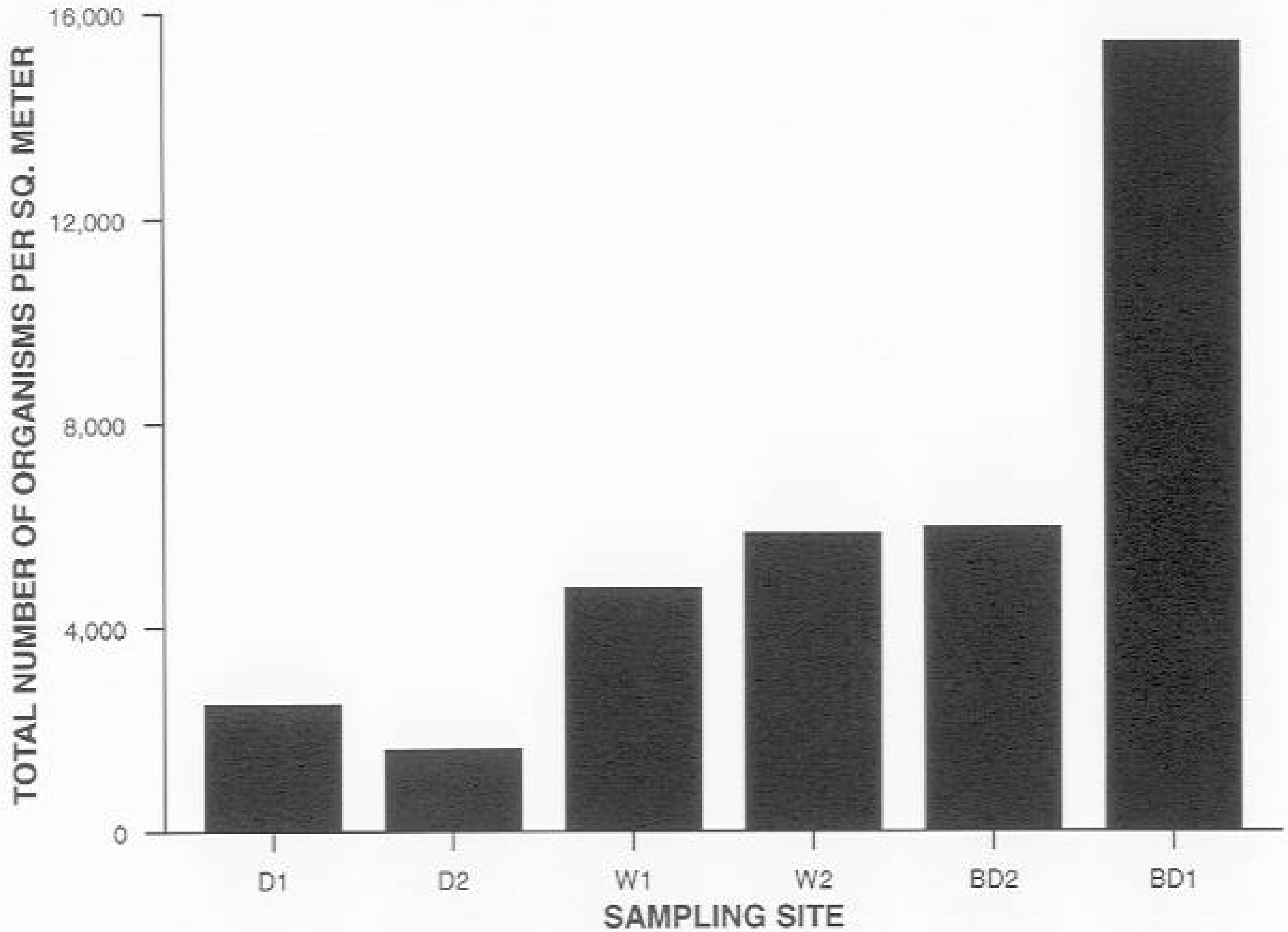


Figure 5. Total number of organisms for spring 1998 aquatic sampling.

i:\datamgmt\cbam\98_aquatic\WCsp98_b.pre 090498

Tables

TABLE 1. AQUATIC SAMPLING LOCATIONS IN LOWER WALNUT CREEK, SPRING 1998

Sample Site	Location	Stream Type
D1	Rocky Flats Environmental Technology Site, upstream from Indiana Avenue	Transitional foothills-plains
D2	City of Broomfield property, downstream from Great Western Reservoir	Transitional foothills-plains
W1	City of Westminster Walnut Creek Open Space, downstream from Wadsworth Blvd.	Transitional foothills-plains
W2	Hawn Parcel (private), access through City of Westminster Open Space, downstream from rip-rap structure along Highway 36 and east of Church Ranch Blvd.	Transitional foothills-plains
BD2	Hawn Parcel (private), access through City of Westminster Open Space, on Big Dry Creek upstream of confluence with Walnut Creek	Transitional foothills-plains
BD1	Hawn Parcel (private), access through City of Westminster Open Space, on Big Dry Creek downstream of confluence with Walnut Creek	Transitional foothills-plains

TABLE 2. PROPORTIONS OF AQUATIC MACROHABITATS IN LOWER WALNUT CREEK, 1998

Site	Riffle (%)	Run (%)	Pool (%)	Habitat Score
D1	17.5	31.3	51.2	51
D2	87.5	12.5	0.0	93
W1	22.4	60.6	17.0	67
W2	31.5	52.8	15.7	76
BD2	51.6	21.1	27.3	94
BD1[a]	28.7	39.0	32.3	85

[a] BD1 only has four cells, compared to six cells at all other sample sites.

Note: Habitat scores are derived from the quality of three principal categories:

1. substrate, flow, & cover
2. channel morphology
3. channel alteration, including scouring and deposition.

TABLE 3. PROPORTIONS OF SUBSTRATES AT AQUATIC SAMPLING SITES, 1998

Site	Bedrock (%)	Boulder (%)	Cobble (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
D1	0	0.5	24.5	12.3	18.7	42	2
D2	0	0	90	1	8	1	0
W1	5	0	0	40	30	20	5
W2	0	0	40	10	25	20	5
BD2	0	0	70	5	20	5	0
BD1[a]	0	1	40	10	25	20	4

[a] BD1 only has four cells, compared to six cells at all other sample sites.

TABLE 4. PHYSICAL WATER CHEMISTRY MEASURES IN LOWER WALNUT CREEK, 1998

Site	Date	Temperature (^oC)	Dissolved Oxygen (mg/L)	pH (s.u.)	Conductivity (*m* S/L)
BD2	4/6/98	6.5	12.8	7.83	1,534
BD2	4/20/98	13.3	16	9.20	1,009
BD1	4/22/98	14.0	9.7	--	280
BD1	4/24/98	8.9	15	--	402
BD1[a]	4/14/98	11.3	10.8	8.39	1,130
D1	3/25/98	9.6	11.09	7.39	400
D1	3/27/98	9.4	--	7.72	500
D2	3/26/98	11.5	8.5	7.50	477
D2	3/27/98	12.8	--	7.86	497
D2	4/1/98	11.6	12.3	7.98	539
D2	4/6/98	11.5	8.5	7.50	477
W1	4/1/98	11.3	12.6	7.85	424
W1	4/23/98	6.4	11.9	8.43	796
W2	4/14/98	9.1	9.6	8.38	1,015
W2	4/22/98	13.6	9.3	--	344
W2	4/24/98	9.4	14.9	--	327

-- = no reading taken

[a] BD1 only has four cells, compared to six cells at all other sample sites.

TABLE 5. RELATIVE ABUNDANCE OF LOWER WALNUT CREEK MACROINVERTEBRATES BASED ON HESS AND KICKNET SAMPLES, SPRING 1998

			Sample Sites											
			D1		D2		W1		W2		BD2		BD1	
Division	Order	Species	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet
ANNELIDA	Hirudinea	Mooreobdella microstoma	0.93			0.96		0.64						
ANNELIDA	Oligoheata	Aulodrilus americanus			0.19									
ANNELIDA	Oligoheata	Eiseniella tetraedra									0.18		0.22	
ANNELIDA	Oligoheata	Homochaeta naidina		1.18										
ANNELIDA	Oligoheata	Lumbriculus sp.	0.93											
ANNELIDA	Oligoheata	Unid. Immature Tubificidae w/ Capilliform Chaetae			1.45				0.34		0.13		0.79	
ANNELIDA	Oligoheata	Unid. Immature Tubificidae w/o Capilliform Chaetae		3.54	1.26		0.99		2.06	0.33	0.05		0.34	
	Total: [a]		**0.93**	**1.18**	**0.19**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.18**	**0.00**	**0.22**	**0.00**
CRUSTACEA	Amphipoda	Crangonyx sp.									1.25	2.54		
CRUSTACEA	Amphipoda	Hyalella azteca			1.70	0.32	2.10	3.82	0.46				0.29	0.86
	Total:		**0.00**	**0.00**	**1.70**	**0.32**	**2.10**	**3.82**	**0.46**	**0.00**	**1.25**	**2.54**	**0.29**	**0.86**
GASTROPODA	NA	Fossaria sp.												0.43
GASTROPODA	NA	Physa sp.	3.12	1.97							0.08			
	Total:		**3.12**	**1.97**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**	**0.00**	**0.00**	**0.43**
HYDRACARINA	NA	Sperchon/Sperchonopsis			1.07	0.32	0.27		0.46	0.17	2.46	1.41	8.80	0.86
INSECTA	Coleoptera	Dubiraphia quadrinotata					0.06		0.34					
INSECTA	Coleoptera	Helophorus sp.						1.27						
INSECTA	Coleoptera	Microcylloepus pusillus												0.43
INSECTA	Coleoptera	Tropisternus sp.				0.32								
	Total:		**0.00**	**0.00**	**0.00**	**0.32**	**0.06**	**1.27**	**0.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.43**
INSECTA	Diptera	Brillia sp.						1.91		0.83				
INSECTA	Diptera	Ceratopogon sp.							0.12		0.05			
INSECTA	Diptera	Chelifera sp.			0.19			1.27	0.34	0.66			0.67	
INSECTA	Diptera	Chironomus sp.		2.76	3.33								0.56	2.05
INSECTA	Diptera	Corynoneura sp.					0.57							
INSECTA	Diptera	Cricotopus tremulus	23.77	14.57	46.98	19.11	29.25	16.56	40.95	20.00	71.62	61.97	59.81	53.56
INSECTA	Diptera	Demicryptochironomus sp.										2.89	0.12	
INSECTA	Diptera	Diamesa sp.	62.47	43.31	2.08	3.82	2.80		0.57					
INSECTA	Diptera	Dicrotendipes sp.		2.76										
INSECTA	Diptera	Empididae							0.34					
INSECTA	Diptera	Hemerodromia sp.			1.07	1.27	0.42		0.69	0.66	0.05		0.89	
INSECTA	Diptera	Heterotrissocladius sp.	6.07	8.66	4.21	1.27	17.89	20.38	0.40		2.59	2.89		
INSECTA	Diptera	Limonia sp.		0.39										
INSECTA	Diptera	Mallochohelea sp.	0.69	5.91	2.52	1.59		0.64	0.12		0.18	0.28	0.22	
INSECTA	Diptera	Micropsectra sp.			4.21	1.27								
INSECTA	Diptera	Muscidae									0.05			

TABLE 5. (cont.)

			Sample Sites											
			D1		D2		W1		W2		BD2		BD1	
Division	Order	Species	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet	Hess	Kicknet
INSECTA	Diptera	Pagastia sp.	0.69											
INSECTA	Diptera	Polypedilum sp.		5.91							5.66	2.89		
INSECTA	Diptera	Rheotanytarsus sp.					0.69							
INSECTA	Diptera	Simulium sp.				1.27	2.67	3.18	12.59	7.27	0.05		0.67	
INSECTA	Diptera	Thienemanniella sp.					6.17	1.91			1.30			
INSECTA	Diptera	Tipula sp.				0.96	0.27		0.57	0.66	1.12		0.45	0.43
INSECTA	Diptera	Zavrelimyia sp.			6.29	6.37	1.05	3.82			6.07	5.70		
	Total:		**93.68**	**84.25**	**70.88**	**36.94**	**61.78**	**49.68**	**56.68**	**30.08**	**88.72**	**76.62**	**63.40**	**56.03**
INSECTA	Ephemeroptera	Baetis magnus		0.39	0.63	8.92								
INSECTA	Ephemeroptera	Baetis tricaudatus			7.74	36.62	30.09	43.31	22.90	66.78	0.21	1.13	17.68	34.05
INSECTA	Ephemeroptera	Caenis amica		0.39	0.44	0.32								
INSECTA	Ephemeroptera	Heptagenia sp.									0.05	0.28		
INSECTA	Ephemeroptera	Tricorythodes minutus			1.89	4.14	0.27		0.22		2.81	15.49	1.63	3.02
	Total:		**0.00**	**0.79**	**10.69**	**50.00**	**30.37**	**43.31**	**23.13**	**66.78**	**3.07**	**16.90**	**19.31**	**37.07**
INSECTA	Hemiptera	Corisella sp.										0.56		
INSECTA	Hemiptera	Hesperocorixa sp.	0.12	7.87										
INSECTA	Hemiptera	Notonecta sp.		0.39										
INSECTA	Hemiptera	Trichocorixa sp.										0.28		
	Total:		**0.12**	**8.27**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.85**	**0.00**	**0.00**
INSECTA	Odonata	Argia sp.				0.32								
INSECTA	Odonata	Gomphus sp.									0.18			
	Total:		**0.00**	**0.00**	**0.00**	**0.32**	**0.00**	**0.00**	**0.00**	**0.00**	**0.18**	**0.00**	**0.00**	**0.00**
INSECTA	Trichoptera	Agraylea sp.			0.63	0.32		0.64						0.86
INSECTA	Trichoptera	Ceratopsyche oslari			0.19									
INSECTA	Trichoptera	Cheumatopsyche sp.	0.40		10.69	8.92	3.37	0.64	12.49	1.98	3.07	0.85	5.84	3.02
INSECTA	Trichoptera	Helicopsyche borealis			0.19	0.32								
INSECTA	Trichoptera	Hydropsyche morosa							0.12					
INSECTA	Trichoptera	Hydropsyche occidentalis							0.22		0.26			
INSECTA	Trichoptera	Hydropsyche simulans											0.89	
INSECTA	Trichoptera	Hydroptila sp.							2.53	0.66	0.39	0.85		
INSECTA	Trichoptera	Limnephilus/Philarctus	0.53											
	Total:		**0.93**	**0.00**	**11.70**	**9.55**	**3.37**	**1.27**	**15.36**	**2.64**	**3.71**	**1.69**	**6.73**	**3.88**
NEMATODA	NA	Unid. Nematoda					1.05		1.15		0.18		0.12	0.43
PELECYPODA	NA	Pisidium sp.				0.32								
TURBELLARIA	NA	Dugesia dorotocephala	0.28		1.07	0.96								

NA – not applicable

[a] This total does not include the unidentified immature species.

TABLE 6. SPRING 1998 BDCWG HESS SAMPLER MACROINVERTEBRATE METRICS SUMMARY

Metric	D1	D2	W1	W2	BD2	BD1
Number of taxa	12	23	18	22	25	18
Modified Hilsenhoff biotic index	6.08	5.55	5.60	5.26	6.14	5.35
EPT index	2	8	3	6	6	4
EPT/Chironomidae abundance	0.00	0.33	0.58	0.92	0.07	0.43
Contribution of dominant taxon (%)	63	47	30	41	72	60
Scrapers/filter collectors	17.00	0.85	7.13	1.03	0.96	2.39
Shredders/total abundance	0.24	0.50	0.30	0.42	0.78	0.60
Shannon-Weaver (H')	1.64	2.95	2.70	2.51	1.81	1.99
Total number of organisms per sq. meter	2,470	1,590	4,752	5,820	15,428	5,940

TABLE 7. SPRING 1998 BDCWG KICKNET SAMPLER MACROINVERTEBRATE METRICS SUMMARY

Metric	D1	D2	W1	W2	BD2	BD1
Total number of organisms per sq. meter	254	314	157	605	1,420	928
Number of taxa	15	23	14	11	15	12

TABLE 8. LIST OF FISH SPECIES COLLECTED IN LOWER WALNUT CREEK, 1998

	Sampling Sites					
Species	D1	D2	W1	W2	BD2	BD1
Creek chub		X		X	X	X
Longnose dace			X	X	X	X
White sucker				X		X
Green sunfish				X		X
Fathead minnow	X	X	X	X	X	X

Appendix A

Sample Data Sheets

BIG DRY CREEK SAMPLE COLLECTION FORM

Waterbody Name______________________ Location______________________
Reach/Milepoint______________________ Lat/Long______________________
County________________State___________ Aquatic Ecoregion______________
Station Name (Sampsite)________________ Project ID______________________
Observers____________________________ Hydrologic Unit Code___________
Date________________________________ Agency_______________________
Start Time_____________Finish Time_____ Field Notebook________________
Reason for Survey____
____

Sample ID	Sample Code	Collection Date	Collector(s)	Sample Type	Collection Method	Comments

Form Completed By ____Date ______________________
Print Sign

AQUATIC SAMPLE SITE DRAWING FORM

Waterbody Name________________________________
Reach/Milepoint ________________________________
County_________________ State___________________
Station Name (Sampsite)_________________________
Observers_______________________________________
Date____
Start Time______________ Finish Time____________

Location____
Lat/Long____
Aquatic Ecoregion_______________________________
Project ID _____________________________________
Hydrologic Unit Code ___________________________
Agency____
Field Notebook__________________________________

Reason for Survey ____
____

Form Completed by ____Date___________________
Print Sign

BIG DRY CREEK AQUATIC SAMPLING CHAIN OF CUSTODY FORMS

Contractor: Exponent Environmental Group
Date:_______________________________ Form #_______________
Laboratory: Chadwick and Associates Page __________of_____

Sample ID	Sample Present (check-off)	Sample Type

Relinquished By	Received By	Date/Time

Problems:

FISH FIELD COLLECTION DATA SHEET

Station Name (Sampsite) ______________________ Project ID ___________________________
Observers___________________________________ Date________________________________
Drainage ___________________________________ Field Notebook______________________
Start Time_____________ Finish Time___________ Sampling Duration____________________
Sampling Distance (m) ________________________ Sampling Area ______________________
Habitat Complexity/Quality (excellent good fair poor very poor)
Flow (flood bankfull moderate low)
Weather ____________________________________
Gear Used __________________________________ Gear/Crew Performance________________
Fish (preserved) Number of Individuals__________ Number of Anomalies__________

	Adults		Juveniles		Anomalies*
Genus/Species	Number	Weight	Number	Weight	Number

Comments:____
____
____
____

Form Completed by____Date_________________________
Print Sign

(*) Discoloration, deformities, eroded fins, excessive mucus, excessive external parasites, fungus, poor condition, reddening, tumors, and ulcers.

MACROBENTHIC IMPAIRMENT ASSESSMENT SHEET

Waterbody Name______________________________ Location______________________________
Reach/Milepoint______________________________ Lat/Long______________________________
County________________ State________________ Aquatic Ecoregion______________________
Station Name (Sampsite)________________________ Project ID_____________________________
Observers___________________________________ Hydrologic Unit Code___________________
Date__________________ Agency_______________________________
Start Time_____________ Finish Time____________ Field Notebook________________________
Reason for Survey____
____

1. Detection of impairment: Impairment detected (Complete Items 2-6) No impairment detected (Stop here)

2. Biological impairment indicator:
   - _______Benthic macroinvertebrates
   - _______absence of EPT taxa
   - _______dominance of tolerant species
   - _______low benthic abundance
   - _______low taxa richness
   - _______other
   - _______Other aquatic communities
   - _______periphyton
   - _______filamentous
   - _______other
   - _______macrophytes
   - _______slimes

3. Brief description of problem: ____
   ____
   Year and date of previous survey:____
   Survey data available in:____

4. Cause (indicate major cause): organic enrichment toxicants flow habitat limitations
   other______________________________

5. Estimated areal extent of problem (m^2) and length of stream reach affected (m) where applicable:_
   ____

6. Suspected source(s) of problem
   - _______Point source
   - _______urban runoff
   - _______agricultural runoff
   - _______silvicultural runoff
   - _______livestock
   - _______landfill
   - _______mine
   - _______dam or diversion
   - _______channelization or snagging
   - _______natural
   - _______other
   - _______unknown

Comments:____
____
____
____
____

Form Completed by:____Date________________
Print Sign

FISH IMPAIRMENT ASSESSMENT SHEET

Waterbody Name______________________________ Location______________________________
Reach/Milepoint ______________________________ Lat/Long______________________________
County________________ Sate__________________ Aquatic Ecoregion______________________
Station Name (Sampsite)________________________ Project ID____________________________
Observers______________________________ Hydrologic Unit Code___________________
Date__________________ Agency______________________________
Start Time______________ Finish Time____________ Field Notebook________________________
Reason for Survey____
____

1. Detection of impairment: Impairment detected (Complete Items 2-6) No impairment detected (Stop here)

1. Biological impairment indicator:

Fish
- _______sensitive species reduced/absent
- _______dominance of tolerant species
- _______skewed trophic structure
- _______abundance reduced/unusually high
- _______biomass reduced/unusually high
- _______hybrid or exotic abundance unusually high
- _______poor size class representation
- _______high incidence of anomalies

Other aquatic communities
- _______macroinvertebrates
- _______periphyton
- _______macrophytes

2. Brief description of problem:____
____

4. Cause (indicate major cause): organic enrichment toxicants flow sediment temperature poor habitat other__________________________

5. Estimated areal extent of problem (m^2) and length of stream reach affected (m) where applicable:_____
____

7. Suspected source(s) of problem

- _______Point source
- _______urban runoff
- _______agricultural runoff
- _______silvicultural runoff
- _______livestock
- _______lanfill
- _______mine
- _______dam or diversion
- _______channelization or snagging
- _______natural
- _______other
- _______unknown

Comments:____
____
____
____

Form Completed by ____Date__________________
Print Sign

PHYSICAL CHARACTERIZATION/WATER QUALITY
FIELD DATA SHEET

Waterbody Name______________________________ Location_____________________________________
Reach/Milepoint ______________________________ Lat/Long_____________________________________
County________________ State_________________ Aquatic Ecoregion____________________________
Station Name (Sampsite)_______________________ Project ID ____________________________________
Observers____________________________________ Hydrologic Unit Code __________________________
Date____ Agency_______________________________________
Start Time_____________ Finish Time___________ Field Notebook_________________________________
Form Completed by ____
Reason for Survey ____
____

RIPARIAN ZONE/INSTREAM FEATURES:
Predominant Surrounding Land Use:
Forest Field/Pasture Agriculture Residential Commercial Industrial Other ________________________________
Local Watershed Erosion: None Moderate Heavy
Local Watershed NPS Pollution: No evidence Some Potential Sources Obvious Sources
Estimated Stream Width (m): ____________________ Estimated Stream Depth (m) Riffle__________Run___________Pool___________
High Water Mark (m):__________________Velocity: _____________________Dam Present: Yes No Channelized: Yes No
Canopy Cover: Open Party Open Partly Shaded Shaded

SEDIMENT/SUBSTRATE:
Sediment Odors: Normal Sewage Petroleum Chemical Anaerobic None Other________________________________
Sediment Oils: Absent Slight Moderate Profuse
Sediment Deposits: Sludge Sawdust Paper Fiber Sand Relict Shells Other________________________________
Are the undersides of stones which are not deeply imbedded black? Yes No

Inorganic Substrate Components			Organic Substrate Components		
Substrate Type	Diameter	Percent Composition in Sampling Area	Substrate Type	Characteristicr	Percent Percent Composition In Sampling Area
Bedrock			Detritus	Sticks, Wood, Coarse Plant Materials (CPON)	
Boulder	>256mm (10”)		Muck-Mud	Black, Very Fine Organic (FPOM)	
Cobble	64-256mm (2.5-10”)		Marl	Grey, Shell Fragments	
Gravel	2-64mm (0.1-2.5”)				
Sand	00.6-2.00mm (gritty)				
Silt	0.004-0.6mm				
Clay	<0.004mm(slick)				

WATER QUALITY:

Temperature [C] ________Dissolved Oxygen_______________pH_____________Conductivity____________Other__________________________
Instruments(s) Used:____
Stream Type: Coldwater Warmwater
Water Odors: Normal Sewage Petroleum Chemical None Other__________________________
Water Surface Oils: Slick Sheen Globs Flecks None
Tubidity: Clear Slightly Turbid Turbid Opaque Water Color____________________________________

WEATHER CONDITIONS:

Temperature [C]________________Clouds (0-8)____________Precipitation____________________Wind__________________________
Photograph Numbers (if taken)____

Comments:____
____
____
____

Form Completed by____Date___________________________
Print Sign

AQUATIC HABITAT ASSESSMENT FIELD DATA SHEET

Waterbody Name ______________________________ Location _____________________________________
Reach/Milepoint_______________________________ Lat/Long_____________________________________
County________________ State_________________ Aquatic Ecoregion______________________________
Station Name (Sampsite)________________________ Project ID____________________________________
Observers_____________________________________ Hydrologic Unit Code__________________________
Date__________________ Agency_______________________________________
Start Time_____________ Finish Time__________ Field Notebook________________________________
Reason For Survey____
____

	Category			
Habitat Parameter	Excellent	Good	Fair	Poor
1. Bottom substrate/available cover (a)	Greater than 50% rubble, gravel, submerged logs, undercut banks, or other stable habitat 16-20	30-50% rubble, gravel, or other stable habitat. Adequate habitat. 11-15	10-30% rubble, gravel, or other stable habitat. Habitat availability less than adequate. 6-10	Less than 10% rubble, gravel, or other stable habitat. Lack of habitat is obvious. 0-5
2. Embeddedness (b)	Gravel, cobble, and boulder particle are between 0-25% surrounded by fine sediment. 16-20	Gravel, cobble, and boulder particles are between 25-50% surrounded by fine sediment. 11-15	Gravel, cobble, and boulder particles are between 50-75% surrounded by fine sediment. 6-10	Gravel, cobble, and boulder particles are over 75% surrounded by fine sediment. 0-5
3. Less than or equal to 0.15 cms (5cfs) at rep. low flow (a) or >0.15 cms (5 cfs) Velocity/depth	Cold>0.05 cms (2cfs) Warm >0.15 cms (5 cfs) 10-20 Slow (<0.3 m/s), deep (>0.5m); slow, shallow (<0.5m): fast (>0.3m/s), deep; fast, shallow habitats all present. 16-20	Cold 0.03-0.05 cms (1-2cfs) Warm 0.05-0.15 cms (2-5cfs) 11-15 Only 3 of the 4 habitat categories present (missing riffles or runs receive lower score than missing points). 11-15	Cold 0.01-0.03 cms (.5-1cfs) Warm 0.03-0.05 cms (1-2cfs) 6-10 Only 2 of the 4 habitat categories present (missing riffles/runs receive lower score). 6-10	Cold <0.01 cms (.5cfs) Warm <0.03 cms (1cfs) 0-5 Dominated by one velocity/depth category (usually pool). 0-5
4. Channel alteration (a)	Little or no enlargement of islands or point bars, and/or no channelization 12-15	Some new increasing bar formation, mostly from coarse gravel; and/or some channelization present. 8-11	Moderate depostition of new gravel, coarse sand on old and new bars; pools partially filled w/silt; and/or embankments on both banks. 4-7	Heavy deposits of fine material, increased bar development, most pools filled w/silt; and/or extensive channelization. 0-5
5. Bottom scouring and deposition	Less than 5% of the bottom affected by scouring and deposition. 12-15	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools. 8-11	30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools. 4-7	More than 50% of the bottom changing nearly year long. Pools almost absent due to deposition. Only large rocks in riffle exposed. 0-3

	Category			
Habitat Parameter	Excellent	Good	Fair	Poor
6. Pool/riffle, run/bend ratio (distance between riffles divided by stream width) (a)	5-7. Variety of habitat. Deep riffles and pools. 12-15	7-15. Adequate depth in pools and riffles. Bends provide habitat. 8-11	15-25. Occasional riffle or bend. Bottom contours provide some habitat. 4-7	>25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat. 0-3
7. Bank stability (a)	Stable. No evidence of erosion or bank failure. Side slopes generally <30%. Little potential for future problem. 9-10	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods 6-8	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks. High erosion potential during extreme high flow. 3-5	Unstable. Many eroded areas. Side slopes >60% common. “Raw” areas frequent along straight sections and bends. 0-2
8. Bank vegetative stability (b)	Over 80% of the streambank surfaces covered by vegetation or boulders and cobble. 9-10	50-79% of the streambank surfaces covered by vegetation, gravel, or larger material. 6-8	25-49% of the streambank surfaces covered by vegetation, gravel, or larger material. 3-5	Less than 25% of the streambank faces covered by vegetation, gravel, or larger material. 0-2
9. Streambank cover (b)	Dominant vegetation is shrub. 9-10	Dominant vegetation is of free form. 6-8	Dominant vegetation is grass or forbs. 3-5	Over 50% of the stream bank has no vegetation and dominant material is soil, rock bridge materials, culverts, or mine tailings. 0-2
Column Totals				
	Score			

Comments:____

____

____

____

____

Form Completed by____________________________________Date__________________

Print Sign

Date 4/3/97

Site 0.5 (Church Ranch)

Cell 1
Riffle 15'7"
Run 15'7"
Pool 18'9"

Cell 2
Pool 50'

133'
9.8

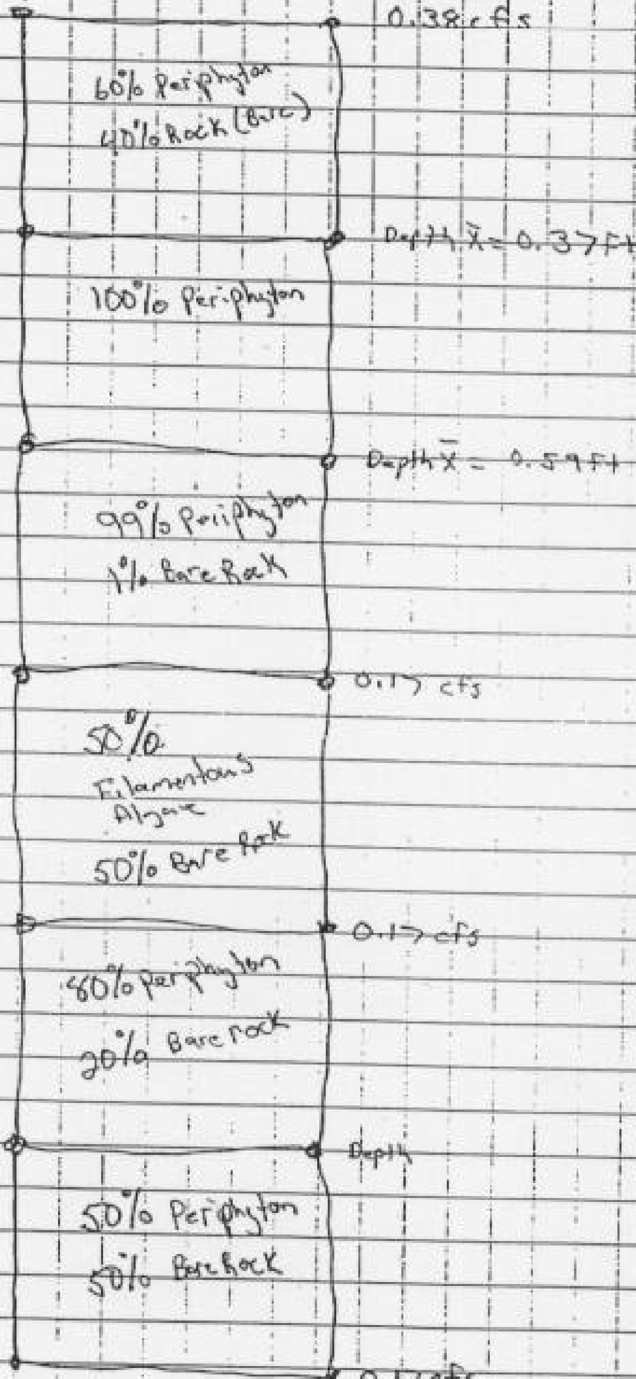
Cell 3
Pool 27'9"
Run 20'6"
Riffle 3'8"

Cell 4
Riffle 50'

Cell 5
Riffle 14'0"
Pool 36'

5.7
74'

Cell 6
Pool 27'6"
Run 10'0"
Riffle 4'6"



Total 292'

ADBR = 104/13.54 = 7.7

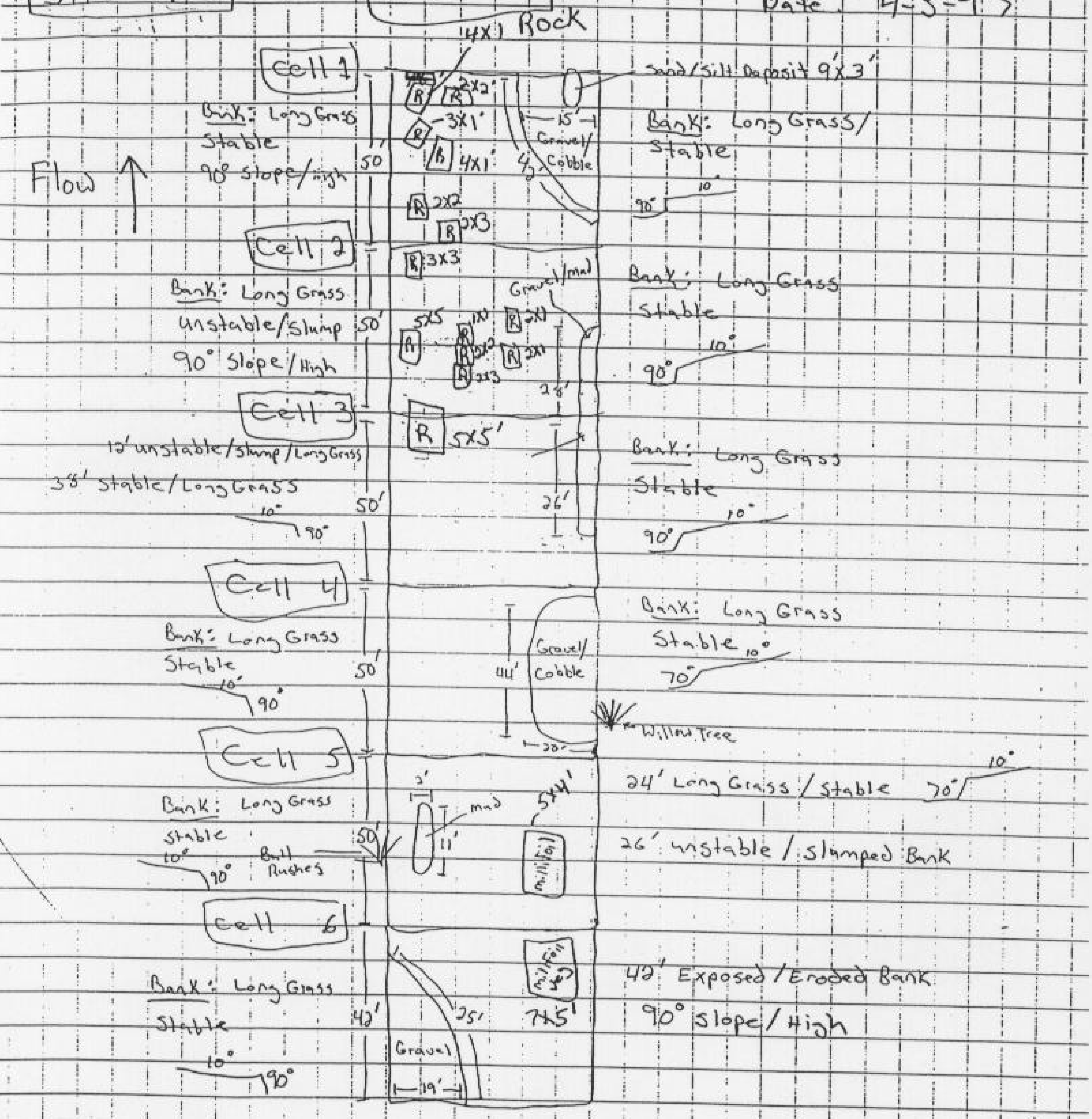
Avg. Flow = 0.22 cFs

~~RRP Ratio = 30% Riffle; 16% Run; 55% Pool~~
~~Riffle = 88' = .30~~
Run = 46' = .16
Pool = 160' = .55

Site 0.51

Habitat

Date: 4-3-97



Slope $\bar{x}$ = 36°

Slope $\bar{x}$ = 23°

Appendix B

Photographic Documentation

Figure B-1. Aquatic site D-1 on Walnut Creek at Rocky Flats looking westward from Indiana Street.

Figure B-2. Aquatic site D-1 on Walnut Creek at Rocky Flats looking westward from Indiana Street.

Figure B-3. Aquatic site D-2 on Walnut Creek below Great Western Reservoir looking eastward near the upper end of the study area.

Figure B-4. Aquatic site D-2 on Walnut Creek below Great Western Reservoir looking eastward near the lower end of the study area.

Figure B-5. Aquatic site W-1 on Walnut Creek near Wadsworth Blvd. on Westminster Open Space looking eastward near the upper end of the study area.

Figure B-6. Aquatic site W-1 on Walnut Creek near Wadsworth Blvd. on Westminster Open Space looking northwest from the lower end of the study area.

Figure B-7. Aquatic site W-2 on Walnut Creek southwest of the Church Ranch exit on Hwy. 36 looking northwest from the middle of the study area.

Figure B-8. Aquatic site W-2 on Walnut Creek southwest of the Church Ranch exit on Hwy. 36 looking southwest from the upper end of the study area.

Figure B-9. Aquatic site BD-2 on Big Dry Creek west of Hwy. 36 looking north from the upper end of the study area.

Figure B-10. Aquatic site BD-2 on Big Dry Creek west of Hwy. 36 looking east from near the middle of the study area.

Figure B-11. Aquatic site BD-1 on Big Dry Creek west of Hwy. 36 looking east from the upper end of the study area.

Figure B-12. Aquatic site BD-1 on Big Dry Creek west of Hwy. 36 looking west from the lower end of the study area.

Appendix C

Site Data

MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, D1
SAMPLED: 3-25-98

TAXA	HESS 1	HESS 2	HESS 3	COMPOSITE	SWEEP 4
INSECTA					
EPHEMEROPTERA					
Baetis magnus					1
Caenis amica					1
TRICHOPTERA					
Cheumatopsyche sp.	10		20	10	
Limnephilus/Philarctus			40	13	
HEMIPTERA					
Hesperocorixa sp.	10			3	20
Notonecta sp.					1
DIPTERA					
Chironomus sp.					7
Cricotopus tremulus	300	60	1400	587	37
Diamesa sp.	860	1310	2460	1543	110
Dicrotendipes sp.					7
Heterotrissocladius sp.	50		400	150	22
Limonia sp.					1
Mallochohelea sp.	20	10	20	17	15
Pagastia sp.	50			17	
Polypedilum sp.					15
TURBELLARIA					
Dugesia dorotocephala			20	7	
ANNELIDA					
OLIGOCHAETA					
Homochaeta naidina					3
Lumbriculus sp.	20	10	40	23	
Unid. Immature Tubificidae w/o Capilliform Chaetae					9
HIRUDINEA					
Mooreobdella microstoma		10	60	23	
GASTROPODA					
Physa sp.	10		220	77	5

MACROINVERTEBRATE DENSITY
CLIENT: EXPONENT
SITE: BIG DRY CREEK, D1
SAMPLED: 3-25-98

TOTAL (#/sq. meter)	1330	1400	4680	2470	254
NUMBER OF TAXA	9	5	10	12	15
SHANNON-WEAVER (H')	1.59	0.44	1.82	1.64	
MODIFIED HILSENHOFF BIOTIC INDEX	6.08	6.03	6.14	6.08	
SCRAPERS/FILTER COLLECTORS	10.00	0.00	20.00	17.00	
EPT/CHIRONOMIDAE ABUNDANCE	0.00	0.00	0.00	0.00	
% CONTRIBUTION OF DOMINANT TAXON	65	94	53	63	
EPT INDEX	1	0	2	2	
SHREDDERS/TOTAL DENSITY	0.22	0.04	0.31	0.24	

MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, D2
SAMPLED: 3-26-98

TAXA	HESS 5	HESS 6	HESS 7	COMPOSITE	SWEEP 8
INSECTA					
EPHEMEROPTERA					
Baetis magnus		10	20	10	28
Baetis tricaudatus	170	170	30	123	115
Caenis amica		10	10	7	1
Tricorythodes minutus	30	50	10	30	13
TRICHOPTERA					
Agraylea sp.			30	10	1
Ceratopsyche oslari		10		3	
Cheumatopsyche sp.	150	190	170	170	28
Helicopsyche borealis	10			3	1
ODONATA					
Argia sp.					1
COLEOPTERA					
Tropisternus sp.					1
DIPTERA					
Chelifera sp.		10		3	
Chironomus sp.	120	40		53	
Cricotopus tremulus	1200	620	420	747	60
Diamesa sp.	60	40		33	12
Hemerodromia sp.	20	20	10	17	4
Heterotrissocladius sp.	120	40	40	67	4
Mallochohelea sp.	50	60	10	40	5
Micropsectra sp.		180	20	67	4
Simulium sp.					4
Tipula sp.					3
Zavrelimyia sp.	60	180	60	100	20
TURBELLARIA					
Dugesia dorotocephala			50	17	3

MACROINVERTEBRATE DENSITY
CLIENT: EXPONENT
SITE: BIG DRY CREEK, D2
SAMPLED: 3-26-98

TAXA	HESS 5	HESS 6	HESS 7	COMPOSITE	SWEEP 8
ANNELIDA					
OLIGOCHAETA					
Aulodrilus americanus	10			3	
Unid. Immature Tubificidae w/ Capilliform Chaetae	40	30		23	
Unid. Immature Tubificidae w/o Capilliform Chaetae	30	20	10	20	
HIRUDINEA					
Mooreobdella microstoma					3
CRUSTACEA					
AMPHIPODA					
Hyalella azteca	40	40		27	1
HYDRACARINA					
Sperchon/Sperchonopsis		20	30	17	1
PELECYPODA					
Pisidium sp.					1
TOTAL (#/sq. meter)	2110	1740	920	1590	314
NUMBER OF TAXA	15	19	15	23	23
SHANNON-WEAVER (H')	2.45	3.19	2.73	2.95	
MODIFIED HILSENHOFF BIOTIC INDEX	5.91	5.64	5.10	5.55	
SCRAPERS/FILTER COLLECTORS	1.81	0.60	0.52	0.85	
EPT/CHIRONOMIDAE ABUNDANCE	0.23	0.40	0.50	0.33	
% CONTRIBUTION OF DOMINANT TAXON	57	36	46	47	
EPT INDEX	4	6	6	8	
SHREDDERS/TOTAL DENSITY	0.65	0.38	0.46	0.50	

MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, W1
SAMPLED: 3-30-98

TAXA	HESS 9	HESS 10	HESS 11	COMPOSITE	SWEEP 12
INSECTA					
EPHEMEROPTERA					
Baetis tricaudatus	3840	110	340	1430	68
Tricorythodes minutus	20		20	13	
TRICHOPTERA					
Agraylea sp.					1
Cheumatopsyche sp.	480			160	1
COLEOPTERA					
Dubiraphia quadrinotata		10		3	
Helophorus sp.					2
DIPTERA					
Brillia sp.					3
Chelifera sp.					2
Corynoneura sp.		80		27	
Cricotopus tremulus	480	1410	2280	1390	26
Diamesa sp.	100		300	133	
Hemerodromia sp.	60			20	
Heterotrissocladius sp.	1610	480	460	850	32
Mallochohelea sp.					1
Rheotanytarsus sp.	100			33	
Simulium sp.	380			127	5
Thienemanniella sp.	190	80	610	293	3
Tipula sp.			40	13	
Zavrelimyia sp.			150	50	6
ANNELIDA					
OLIGOCHAETA					
Unid. Immature Tubificidae w/o Capilliform Chaetae			140	47	
HIRUDINEA					
Mooreobdella microstoma					1
NEMATODA					
Unid. Nematoda	120	10	20	50	
CRUSTACEA					
AMPHIPODA					
Hyalella azteca	140	120	40	100	6

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MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, W1
SAMPLED: 3-30-98

TAXA	HESS 9	HESS 10	HESS 11	COMPOSITE	SWEEP 12
HYDRACARINA					
Sperchon/Sperchonopsis	40			13	
TOTAL (#/sq. meter)	7560	2300	4400	4752	157
NUMBER OF TAXA	13	8	11	18	14
SHANNON-WEAVER (H')	2.31	1.74	2.30	2.70	
MODIFIED HILSENHOFF BIOTIC INDEX	4.86	6.00	5.93	5.60	
SCRAPERS/FILTER COLLECTORS	5.67	0.00	0.00	7.13	
EPT/CHIRONOMIDAE ABUNDANCE	1.75	0.05	0.90	0.58	
% CONTRIBUTION OF DOMINANT TAXON	51	61	52	30	
EPT INDEX	3	1	2	3	
SHREDDERS/TOTAL DENSITY	0.06	0.61	0.53	0.30	

MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, W2
SAMPLED: 4-13-98

TAXA	HESS 17	HESS 18	HESS 19	COMPOSITE	SWEEP 20
INSECTA					
EPHEMEROPTERA					
Baetis tricaudatus	1340	1040	1620	1333	404
Tricorythodes minutus			40	13	
TRICHOPTERA					
Cheumatopsyche sp.	160	1140	880	727	12
Hydropsyche morosa			20	7	
Hydropsyche occidentalis		40		13	
Hydroptila sp.	40	60	340	147	4
COLEOPTERA					
Dubiraphia quadrinotata			60	20	
DIPTERA					
Brillia sp.					5
Ceratopogon sp.	20			7	
Chelifera sp.	20	40		20	4
Cricotopus tremulus	2520	1850	2780	2383	121
Diamesa sp.	100			33	
Empididae		40	20	20	
Hemerodromia sp.	40	40	40	40	4
Heterotrissocladius sp.		70		23	
Mallochohelea sp.	20			7	
Simulium sp.	200	1140	860	733	44
Tipula sp.	80		20	33	4
ANNELIDA					
OLIGOCHAETA					
Unid. Immature Tubificidae w/ Capilliform Chaetae	60			20	
Unid. Immature Tubificidae w/o Capilliform Chaetae	180		180	120	2
NEMATODA					
Unid. Nematoda	200			67	
CRUSTACEA					
AMPHIPODA					
Hyalella azteca	60		20	27	
HYDRACARINA					
Sperchon/Sperchonopsis	40		40	27	1

MACROINVERTEBRATE DENSITY
CLIENT: EXPONENT
SITE: BIG DRY CREEK, W2
SAMPLED: 4-13-98

TOTAL (#/sq. meter)	5080	5460	6920	5820	605
NUMBER OF TAXA	16	10	14	22	11
SHANNON-WEAVER (H')	2.32	2.29	2.41	2.51	
MODIFIED HILSENHOFF BIOTIC INDEX	5.44	5.15	5.19	5.26	
SCRAPERS/FILTER COLLECTORS	3.83	0.63	1.15	1.03	
EPT/CHIRONOMIDAE ABUNDANCE	0.59	1.19	1.04	0.92	
% CONTRIBUTION OF DOMINANT TAXON	50	34	40	41	
EPT INDEX	3	4	5	6	
SHREDDERS/TOTAL DENSITY	0.52	0.34	0.40	0.42	

MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, BD2
SAMPLED: 4-2-98

TAXA	HESS 13	HESS 14	HESS 15	COMPOSITE	SWEEP 16
INSECTA					
EPHEMEROPTERA					
Baetis tricaudatus	60	40		33	16
Heptagenia sp.	20			7	4
Tricorythodes minutus	100	360	840	433	220
TRICHOPTERA					
Cheumatopsyche sp.	260	760	400	473	12
Hydropsyche occidentalis		120		40	
Hydroptila sp.	20	80	80	60	12
ODONATA					
Gomphus sp.		40	40	27	
HEMIPTERA					
Corisella sp.					8
Trichocorixa sp.					4
DIPTERA					
Ceratopogon sp.	20			7	
Cricotopus tremulus	3500	15560	14090	11050	880
Demicryptochironomus sp.					41
Hemerodromia sp.	20			7	
Heterotrissocladius sp.	800	400		400	41
Mallochohelea sp.	40	40		27	4
Muscidae	20			7	
Polypedilum sp.	200	400	2020	873	41
Simulium sp.	20			7	
Thienemanniella sp.	200	400		200	
Tipula sp.	160	280	80	173	
Zavrelimyia sp.	400	1600	810	937	81
ANNELIDA					
OLIGOCHAETA					
Eiseniella tetraedra	80			27	
Unid. Immature Tubificidae w/ Capilliform Chaetae	60			20	
Unid. Immature Tubificidae w/o Capilliform Chaetae	20			7	
NEMATODA					
Unid. Nematoda	40	40		27	
CRUSTACEA					
AMPHIPODA					
Crangonyx sp.	340	80	160	193	36
HYDRACARINA					
Sperchon/Sperchonopsis	260	520	360	380	20
GASTROPODA					
Physa sp.			40	13	

MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, BD2
SAMPLED: 4-2-98

TOTAL (#/sq. meter)	6640	20720	18920	15428	1420
NUMBER OF TAXA	22	16	11	25	15
SHANNON-WEAVER (H')	2.67	1.59	1.44	1.81	
MODIFIED HILSENHOFF BIOTIC INDEX	5.95	5.81	6.66	6.14	
SCRAPERS/FILTER COLLECTORS	3.21	0.59	0.01	0.96	
EPT/CHIRONOMIDAE ABUNDANCE	0.09	0.07	0.08	0.07	
% CONTRIBUTION OF DOMINANT TAXON	53	75	74	72	
EPT INDEX	5	5	3	6	
SHREDDERS/TOTAL DENSITY	0.58	0.78	0.86	0.78	

MACROINVERTEBRATE DENSITY

CLIENT: EXPONENT
SITE: BIG DRY CREEK, BD1
SAMPLED: 4-13-98

TAXA	HESS 21	HESS 22	HESS 23	COMPOSITE	SWEEP 24
INSECTA					
EPHEMEROPTERA					
Baetis tricaudatus	2160	360	630	1050	316
Tricorythodes minutus	160	100	30	97	28
TRICHOPTERA					
Agraylea sp.					8
Cheumatopsyche sp.	760	280		347	28
Hydropsyche simulans	160			53	
COLEOPTERA					
Microcylloepus pusillus					4
DIPTERA					
Chelifera sp.	120			40	
Chironomus sp.		100		33	19
Cricotopus tremulus	5440	4800	420	3553	497
Demicryptochironomus sp.			20	7	
Hemerodromia sp.	120	40		53	
Mallochohelea sp.	40			13	
Simulium sp.	80	20	20	40	
Tipula sp.	40	40		27	4
ANNELIDA					
OLIGOCHAETA					
Eiseniella tetraedra	40			13	
Unid. Immature Tubificidae w/ Capilliform Chaetae	70		70	47	
Unid. Immature Tubificidae w/o Capilliform Chaetae	30		30	20	
NEMATODA					
Unid. Nematoda		20		7	4
CRUSTACEA					
AMPHIPODA					
Hyalella azteca	40		10	17	8
HYDRACARINA					
Sperchon/Sperchonopsis	1200	340	30	523	8
GASTROPODA					
Fossaria sp.					4

MACROINVERTEBRATE DENSITY
CLIENT: EXPONENT
SITE: BIG DRY CREEK, BD1
SAMPLED: 4-13-98

TOTAL (#/sq. meter)	10460	6100	1260	5940	928
NUMBER OF TAXA	15	10	9	18	12
SHANNON-WEAVER (H')	2.18	1.29	1.89	1.99	
MODIFIED HILSENHOFF BIOTIC INDEX	5.16	5.68	5.20	5.35	
SCRAPERS/FILTER COLLECTORS	2.16	1.20	32.00	2.39	
EPT/CHIRONOMIDAE ABUNDANCE	0.60	0.15	1.50	0.43	
% CONTRIBUTION OF DOMINANT TAXON	52	79	50	60	
EPT INDEX	4	3	2	4	
SHREDDERS/TOTAL DENSITY	0.52	0.81	0.33	0.60	