10320 Little Patuxent Parkway, Suite 1140
Columbia, Maryland 21044
410.715.0824

ANCHOR QEA

Memorandum

November 17, 2016

To: Kristen Keene, Maryland Environmental Service

From: Karin Olsen, P.G. Anchor QEA

Re: Elk River Sampling – River Beach Samples

Program Overview

On behalf of the Maryland Department of Transportation's Port Administration (MPA) and the Maryland Environmental Service (MES) sampling was conducted at two River Beach locations in the nearshore Elk River to assess the existing environmental conditions. The River Beach sampling efforts were initiated based on environmental concerns expressed by citizen members of the Pearce Creek Implementation Committee (PCIC). The purpose of this Memorandum is to summarize the results of the spring 2016 sediment quality characterization, water quality characterization, benthic community sample, and benthic bioassay sampling for each of the two locations (Figure 1).

Technical Approach

The data collection and analytical approach for the River Beach locations was consistent with the Pearce Creek Dredged Material Containment Facility (DMCF) Exterior Monitoring Program (Anchor QEA 2016). The River Beach samples function as a discrete sample set and will be evaluated independently from the samples collected in conjunction with the Pearce Creek DMCF Exterior Monitoring Program.

Sediment Quality Characterization

Undisturbed sediments were collected from the sediment-water interface to a depth of 6 inches using a Ponar grab sampler. Samples were submitted for metals, grain size, moisture content, specific gravity, total organic carbon (TOC), nitrate+nitrite, total Kjeldahl nitrogen (TKN), ammonia, total phosphorus, and sulfide. Chemical concentrations in bulk sediment samples were compared to sediment quality guidelines for freshwater samples (MacDonald et al. 2000).

Water Quality Monitoring

Surface water samples were collected from the mid-depth of the water column. Samples were submitted for dissolved metals, total suspended solids, phosphorus, hardness, ammonia, nitrate, and TKN analysis. Physical parameters, including temperature, dissolved oxygen (DO), pH, and salinity, were also recorded at each sampling location. Chemical concentrations in the surface water samples were compared to the U.S. Environmental Protection Agency's (USEPA) (2016) and the State of

Maryland Code of Regulations (COMAR 26.08.02.03-2) freshwater acute water quality criteria for aquatic life.

Benthic Community Sampling

Benthic community (bottom-dwelling organisms) samples were collected to determine community composition, abundance (number of benthic organisms), and diversity (number of different types of species). The results were used to calculate benthic community metrics, including the number of unique taxa, species abundance, Shannon-Wiener Species Diversity Index, abundance of pollution-indicative taxa, abundance of pollution-sensitive taxa, abundance of carnivore and omnivore taxa, tolerance, evenness, species richness, and Simpson's Dominance Index. The Chesapeake Benthic Index of Biotic Integrity (B-IBI) was not calculated as a metric for the spring sampling event because it is only applicable to samples collected from the July 15 through September 30 timeframe.

Benthic Bioassays

Sediments from one location was submitted for benthic bioassay testing. Benthic bioassays were acute, 10-day whole sediment tests using the freshwater amphipod *Hyalella azteca*. Testing was conducted according to the USEPA's *Methods for Measuring the Toxicity and Bioaccumulation of Sediment Associated Contaminants with Freshwater Invertebrates* (USEPA 2000). *Hyalella azteca* survival data for the whole sediment bioassays was statistically compared to the survival in control sediment. A control sediment is a non-impacted sediment sample that that is used to evaluate the results of a test.

Field Investigation

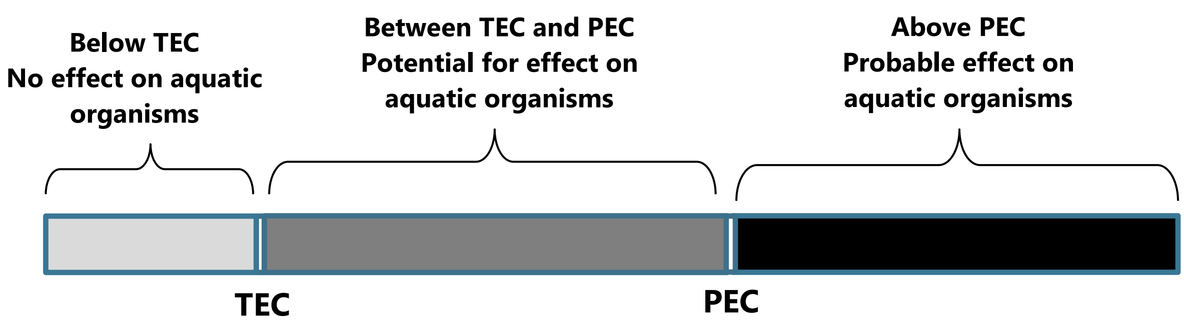
The methods and procedures for the collection of field samples, sampling schedule, rationale for the sampling design, and design assumptions for locating and selecting environmental samples were carried out in accordance with the Sampling and Analysis Plan (Anchor QEA 2015) and the methods used for the Pearce Creek DMCF Exterior Monitoring Program (Anchor QEA 2016a,b). Sampling procedures were consistent with USEPA protocols or other approved sample collection standards. A complete list of analytes, target detection limits, and analytical methodologies is provided in the Sampling and Analysis Plan (Anchor QEA 2015).

Two River Beach (RB) sampling locations were included in this investigation. One location was near the future dredged material inflow location for the Pearce Creek DMCF (location RB-01), and one location (location RB-02) was near the area where Stemmers Run discharges into the Elk River. Sampling locations were determined in the field using a Trimble ProXRS Differential Global Positioning System (DGPS) with an accuracy of 1 to 3 meters (m). Northing and easting coordinates for the sampling locations are provided in Table 1 and are shown in Figure 2.

Sediment Quality Characterization

Concentrations of detected analytes in sediment samples were compared to consensus-based sediment quality guidelines for freshwater sediment, where available (MacDonald et al. 2000). Threshold effect concentrations (TECs) and probable effect concentrations (PECs) are derived based on empirical data from laboratory and field studies (MacDonald et al. 2000). The TEC values represent concentrations below which adverse biological effects are unlikely, and PEC values represent concentrations above which adverse biological effects are probable (MacDonald et al. 2000). Concentrations that are between the TEC and PEC represent the concentrations at which adverse biological effects might occur, as shown below.

Data Evaluation Using Sediment Quality Guidelines



Results of the sediment quality characterization are summarized in Table 2. Sample RB-01 was primarily silts and clays (70%) with some sand (21%). Sample RB-02 was composed of 91% coarse grained sand and 8% gravel. TOC and all nutrients were detected at substantially higher concentrations at RB-01 than at RB-02. TOC was detected at concentrations of 2.9% and 0.15% at RB-01 and RB-02, respectively. Nitrate + nitrite was detected at concentrations of 4.2 and 1.6 mg/kg at RB-01 and RB-02, respectively. TKN was approximately ten times higher at RB-01 (2,200 mg/kg) than at RB-02 (210 mg/kg). Ammonia was detected at RB-01 (150 mg/kg) but not at RB-02. Total phosphorus was 15 times higher at RB-01 (620 mg/kg) than at RB-02 (42 mg/kg). Sulfide concentrations were approximately 50 times greater at RB-01 (460 mg/kg) than at RB-02 (9.8 mg/kg).

Each of the 13 tested metals was detected in both sediment samples. Metal concentrations detected at RB-01 were generally higher than concentrations detected at RB-02, which is most likely related to a grain size effect because the sediments at RB-02 were comprised mostly of sand. Only one metal, nickel, was detected at a concentration between the TEC (22.7 mg/kg) and the PEC (48.6 mg/kg) at RB-01 (33 mg/kg). None of the metals detected at RB-02 exceeded TECs.

Water Quality Characterization

Analytes detected in the surface water were compared to the USEPA and the State of Maryland freshwater acute and chronic water quality criteria. Criteria were derived from the USEPA *National Recommended Water Quality Criteria* (USEPA 2016) and the Code of Maryland Regulations (COMAR 26.08.02.03-2). For dissolved metals, the State of Maryland freshwater water quality criteria for the protection of aquatic life are the same as the USEPA criteria (Table 3) and are directly comparable to the results.

The State of Maryland allows, but does not require, that freshwater criteria be adjusted based on water hardness. The freshwater water quality criteria for the protection of aquatic life for cadmium, chromium, copper, lead, nickel, and zinc were calculated using the minimum hardness value (86 mg/L) and was applied to both samples as a conservative evaluation of water quality. The hardness-adjusted criteria were more conservative than the non-adjusted values for the surface water samples.

Results of the water quality characterization are summarized in Table 3. Hardness and nutrients were reported at similar concentrations between both surface water samples. Hardness was 86 mg/kg in both samples. Total phosphorus was 0.049 mg/L at RB-01, but was not detected at RB-02. The total suspended solid concentration was 11 mg/L at RB-01 and 8.4 mg/L at RB-02, ammonia was 0.2 mg/L at RB-01 and 0.15 mg/L at RB-02, and nitrate was 0.85 mg/L at RB-01 and 0.83 mg/L at RB-02. TKN was not detected in either of surface water samples.

Nine of the 16 tested metals were detected in both surface water samples (aluminum, antimony, arsenic, chromium, copper, iron, manganese, nickel, and zinc). Metals were detected at similar concentrations at RB-01 and RB-02. None of the metals exceeded the acute or chronic freshwater criteria for the protection of aquatic life in either sample.

Benthic Community

Benthic (or bottom-dwelling) organisms are important indicators of stress in aquatic systems because they can integrate the effects of environmental conditions during long periods of time. Benthic organisms are also important food for many fish, providing an important link to higher trophic levels. Most benthic organisms tend to thrive only in some habitats (for example, sandy versus muddy sediments), and groups of benthic organisms collected at sampling locations are generally comprised of species that are adapted to a specific habitat. Sampling locations are considered “normal” or “healthy” when the benthic organisms collected from that location are primarily the species that are specifically adapted to live in that particular habitat.

Results of the benthic community sampling are summarized in Tables 4 and 5. The bottom salinity for each location was 0.2 ppt (Table 1); therefore, they were both classified as tidal freshwater. A taxonomic list and mean abundance of the benthic fauna collected are presented in Table 4. A list of the benthic fauna collected in individual replicates collected at each location is provided in Table 5. Benthic metrics are summarized in Table 6.

Total benthic abundance (total number of organisms per m^2) was 1,907 organisms/m^2 at RB-01 and 2,333 organisms/m^2 at RB-02 (Table 6). Twenty benthic taxa were collected from the River Beach locations (Table 5). Fourteen taxa were collected at RB-01 —Diptera (6 taxa), Oligochaeta (2 taxa), Polychaete (1 taxon), Bivalves (2 taxa), and Crustacea (3 taxon). Fifteen taxa were collected at RB-02—Diptera (6 taxa), Crustacea (4 taxa), Bivalves (1 taxon), Polychaete (1 taxon), and Oligochaeta (3 taxa). Oligochaetes (aquatic worms; *Tubificoides* spp.) were the dominant taxa at both RB-01 and RB-02 (Table 4).

Species richness is a comparison of how many taxa are in a sample compared to how many individuals are in a sample. Lower values indicate that the total benthic abundance at a location is dominated by a few taxa and does not represent a diverse benthic community. Locations RB-01 and RB-02 had similar values for species richness, 2.6 and 2.5, respectively (Table 6).

Evenness is a measure of how evenly the individuals collected at a location are distributed among the taxa collected at that location, with a value of 1 indicating that the individuals are distributed as evenly as possible. Evenness values were similar between locations RB-01 and RB-02, 0.739 and 0.732, respectively (Table 6).

Simpson's Dominance Index measures the diversity of a sample, with a lower value indicating a more diverse community. Simpson's Dominance Index was 0.21 at both locations RB-01 and RB-02 (Table 6). The low Simpson's Dominance Index value is indicative of high species diversity.

The Shannon-Wiener Species Diversity Index takes into account both species richness and species evenness, with higher values indicating a more diverse benthic community. Both locations RB-01 and RB-02 had a Shannon-Wiener Species Diversity Index of 2.7, indicating that these areas have diverse benthic communities (Table 6).

Benthic Bioassays

Benthic bioassays with whole sediment are designed to determine whether the sediment from each sampling location is likely to produce unacceptable adverse effects on benthic organisms by exposing the organisms to the whole sediment for 10 days. A freshwater amphipod (*Hyalella azteca)* was used in the whole-sediment bioassay. Bioassay testing was only conducted at one River Beach location (RB-01), because location RB-02 was comprised almost entirely of sand (91%). *Hyalella azteca* is adapted to live in silty environments, so the toxicity tests are only applicable for fine-grained sediments comprised mostly of silts and clays. The sample from location RB-01 was primary fine-grained (70% silts and clays), therefore, sediment from this location was submitted for bioassay testing.

Results of the benthic bioassays were compared to the results in the control (Table 7). A control sediment is a non-impacted sediment sample that that is used to evaluate the results of a test. Mean survival of *Hyalella azteca* exposed for 10 days to the River Beach sediment was 94%. The survival result was not statistically different (p=0.05) from the mean survival in the control sediment (93%). Therefore, the sediment sample collected from location RB-01 was not acutely toxic to *Hyalella azteca*.

Summary

Sampling was conducted for two River Beach locations in the nearshore Elk River to evaluate existing conditions for sediment quality, surface water quality, and the benthic community. Data collected during this investigation will be compared to data collected in future events to identify trends. Additional sampling will be conducted in the fall of 2016 and the spring of 2017.

References

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FIGURES

TABLES