SECTION 6

Summary and Conclusions

The findings of the DMT sediment and surface water study regarding the nature and extent of chromium at DMT, the fate and transport of chromium, and refinements to the CSM based on the results of this study are summarized in Section 6.1. Conclusions are provided in Section 6.2.

6.1 Summary

The major findings of the DMT sediment and surface water study are as follows:

Nature and Extent of Chromium at DMT

- Cr(VI) was not detected in pore water in any of the samples taken from DMT in any of the four quarterly sampling events. The detection limit of 5 µg/L is well below the USEPA's saltwater acute and chronic NRWQC for Cr(VI) of 1,100 and 50 µg/L, respectively. According to USEPA and published scientific studies, if Cr(VI) were present in sediment and biologically available, it would be detected in pore water (USEPA, 2005a; Berry et al., 2004; Besser et al., 2004).
- Cr(VI) was not detected in 97 percent of the surface water samples analyzed[1], and in those limited locations where it was detected, concentrations were well below the USEPA's NRWQC. Detected concentrations were consistently identified in areas adjacent to stormwater discharge outfalls, and with limited exception detections followed wet weather events.
- Dissolved total chromium was detected at very low concentrations in pore water and surface water during the four quarterly sampling events. Detected concentrations were well below the USEPA's NRWQC for Cr(III) and similar to those seen at the reference locations. The presence of organic ligands in pore water and surface water may increase the solubility of Cr(III), resulting in the observed detections.
- Total chromium concentrations in sediment were consistent with those found at the reference locations except near Area 1501/1602 at the southeast part of the study area, and in Colgate Creek in the northwest part of the study area. In Area 1501/1602, concentrations were highest in the surficial (0 to 6 inches in depth) and mid-depth samples (approximately 12 to 18 inches in depth), and decreased with increasing distance from the shoreline and with increasing depth in the sediment column. Chromium concentrations in Colgate Creek sediments at the northwest edge of DMT also were higher than reference concentrations, with the highest levels occurring at depth at the location farthest away from DMT.

[11] Sample count excludes duplicate samples.

- Concentrations of other COPR constituents (aluminum, calcium, iron, magnesium, manganese, and vanadium) in surficial sediment have been delineated relative to reference concentrations.

Fate and Transport of Chromium

- Measurements of geochemical parameters in pore water, surface water, and sediment (e.g. Fe(II)) demonstrate conditions favorable to the presence of chromium as Cr(III) rather than Cr(VI). Sediments at DMT contained consistent measurable concentrations of these geochemical constituents despite fluctuations that naturally occur with the change of season.

- A statistically significant relationship was observed between total dissolved chromium and Cr(VI) concentrations in surface water samples where Cr(VI) was detected. These results demonstrate that Cr(VI) is rapidly reduced to Cr(III) in the water column, where it most likely precipitates to the sediment.

- Based on the results of this study and other related studies with respect to chromium geochemistry, total chromium in sediment is unlikely to oxidize to Cr(VI) in the future because the geochemical conditions necessary for this process do not naturally occur in the estuarine environment.

Refinements to the CSM

In the preliminary CSM, potential migration pathways for the transport of chromium from DMT to the Patapsco River were identified as 1) direct discharge of groundwater to the river; 2) groundwater seepage into storm drains that discharge directly to the river via outfalls; and 3) tidal inundation of storm drains. This CSM can be refined based on the results of this study as follows:

- Areas of groundwater upwelling were identified in the near shore environment near Area 1501/1602 where sediment chromium concentrations higher than reference location values are present; however, analytical results for groundwater samples from the waterfront perimeter monitoring wells installed in Area 1501/1602 indicate that Cr(VI) is not present at concentrations above the NRWQC. Therefore, groundwater does not appear to be a significant pathway for the transport of Cr(VI) from DMT to the Patapsco River in this area.

- The absence of Cr(VI) in pore water also indicates that Cr(VI) is not being transported from DMT to the river via groundwater upwelling. The data from the pore water samples also demonstrate that historical releases from DMT via storm drain outfalls has not resulted in the accumulation of Cr(VI) in sediment.

- These results are consistent with the CSM which shows that during wet weather stormwater discharges, the influence of Cr(VI) on the adjacent water body is minimal, even in the area where the least mixing/dilution occurs. Furthermore, there is considerable evidence that the Cr(VI) released to the Patapsco is rapidly reduced to Cr(III).

- The presence of total chromium in sediment adjacent to the shoreline of Area 1501/1602 is likely related to the historical runoff of Cr(VI)-contaminated surface water from uncovered COPR stockpiles in the southeast part of DMT and other filling operations

prior to the installation of pavement. Total chromium in sediment in the vicinity of the 14th and 15th Street outfalls and associated transects may also be related to historical releases of Cr(VI) via the storm drain outfalls that precipitated to Cr(III) and accumulated in sediment.

- Additional information regarding potential chromium transport to the river from DMT in dry and wet weather conditions is being collected as part of the Chromium Transport Study.
- The findings of the DMT sediment and surface water investigation are consistent with those seen by the USEPA and other researchers in other estuarine environments, and those seen by JHU researchers at other locations in Baltimore Harbor.

6.2 Conclusions

The DMT data are sufficient to support the conclusion that the nature and extent of chromium in the Patapsco River and Colgate Creek are delineated, in accordance to the approach defined in the Work Plan, and as such, meets the requirements as stipulated in the Consent Decree. Furthermore, the data provided herein are of sufficient quality for use in subsequent human health and ecological risk assessment activities.