Former Zephyr Oil Refinery Fire Suppression Ditch Area Sediment Remediation Remedy Effectiveness

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Background/Objectives. Remediation of metals and petroleum impacted wetlands sediment adjacent to the Muskegon River was conducted in 2017-2018 under the Great Lakes Legacy Act to remove beneficial use impairments within the Muskegon Lake Area of Concern. The objectives of the removal comprised dewatering and dry excavation of 1,370 cubic yards (cy) hazardous lead wetland sediment and 30,113 cy non-hazardous sediment from the wetlands and 12,614 cy from the fire suppression ditch. Project goals were ≤ 128 milligrams per kilogram dry weight (mg/kg dw) total lead, ≤ 2000 mg/kg dw total petroleum hydrocarbons (TPH) and to stabilize and render the hazardous lead non-hazardous. The removal was conducted in a mixed-use area with residential and commercial properties nearby and along a high recreational use waterbody.

Approach/Activities. The mixed-use upland and recreational waterbody areas warranted environmental monitoring during remedial action. The remedial design recognized the need for robust air monitoring, wastewater permit compliance monitoring, and post-excavation sediment confirmation. Remediation and restoration monitoring of the Fire Suppression Ditch Area was guided by the *Final Basis of Design Report* (*Basis of Design*) (EA, 2017).

Results/Lessons Learned. The air monitoring program combined real-time continuous monitoring with 24-hour time-weighted average (TWA) monitoring at specified intervals. Air monitoring measured indicator organic compounds, particulate matter as PM10, and total lead at four stationary locations surrounding the site. No TWA exceedances were detected but real-time instruments were sensitive to humidity triggering false alarms during wet weather events or on humid days.

Wastewater permit compliance monitoring was performed weekly to monitor effectiveness of dewatering treatment operations. An initial batch test was completed prior to initiation of continuous dewatering operations. Lead, indicator organic compounds, and total suspended solids were effectively treated by the on-site treatment system.

The hazardous lead sediment was rendered non-hazardous as verified by toxicity characteristic leaching procedure testing of 51 cores collected on a 15 foot by 15 foot grid and composited over a 2-foot sample depth interval. Another fifty one 2-foot cores were collected in this area at 6-inch discrete intervals to assess attainment of remedial goals. The remainder of the dewatered wetland had 177 cores collected on a 50 foot by 50 foot grid, sampled at 6-inch discrete intervals, to verify attainment of remedial goals. Thirteen verification samples and additional samples were collected as step-outs as needed to assist with decisions regarding re-excavation of the fire suppression ditch. Confirmation sediment samples verified sediment attained remedial goals for lead and TPH and the remedy was effective.