High-Volume Surface Water Monitoring for Characterization of Low PCB Levels – 9131

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ABSTRACT

This paper will describe a high-volume sampling method for polychlorinated biphenyls (PCBs) in surface water as a part of a monitoring program completed to determine potential sources contributing to PCBs previously found in fish tissue samples. Because the typical surface water grab sampling method yielded non-detect results, an approach was needed to obtain much lower detection limits for PCBs. A high-volume sampling method was utilized in which approximately 1,000 liters of water were passed through a filter containing specially packed polyurethane foam (PUF). The filter was then analyzed, thereby reducing the detection limit to parts per quadrillion or picograms per liter. The monitoring results of this study were used to identify the source(s) of the low PCB contamination. The results of monitoring by this method indicated that low levels of PCBs were present in the surface water below traditional grab sample detection limits.

INTRODUCTION

The Portsmouth Gaseous Diffusion Plant (PORTS), a U.S. Department of Energy (DOE) facility in southern Ohio, is a former uranium enrichment facility that was in operation from the early 1950s until 2000. The PORTS facility used PCB oils which were common at most industrial facilities operating since the 1950s. The X-533A Switchyard at PORTS was an area of particularly high PCB use. The 17.75-acre switchyard contains electrical transformers and circuit breakers, some of which contain PCB-contaminated oil. Past practices mandated that the PCB-contaminated oils in the transformers were drained and replaced with non-PCB oil, but residual quantities of PCBs remain in the transformers.

The X-533A switchyard drains to a series of storm sewers, holding ponds with oil containment basins, ditches, and eventually into Little Beaver Creek (LBC). LBC flows through the eastern and northern portions of the PORTS reservation and is the primary surface drainage for the eastern and northern areas of the site. The switchyard is located at the northernmost part of the industrialized area of the reservation, as shown in Figure 1.

Documented spills at the X-533A Switchyard may be sources contributing to PCB contamination in LBC. There are also, however, additional buildings and facilities within the LBC drainage area that might contribute PCBs. These potential sources include transformers, an oil biodegradation plot, PCB oil dissolved within a dense non-aqueous phase liquid trichloroethylene plume, and undocumented oil spills in the process buildings.

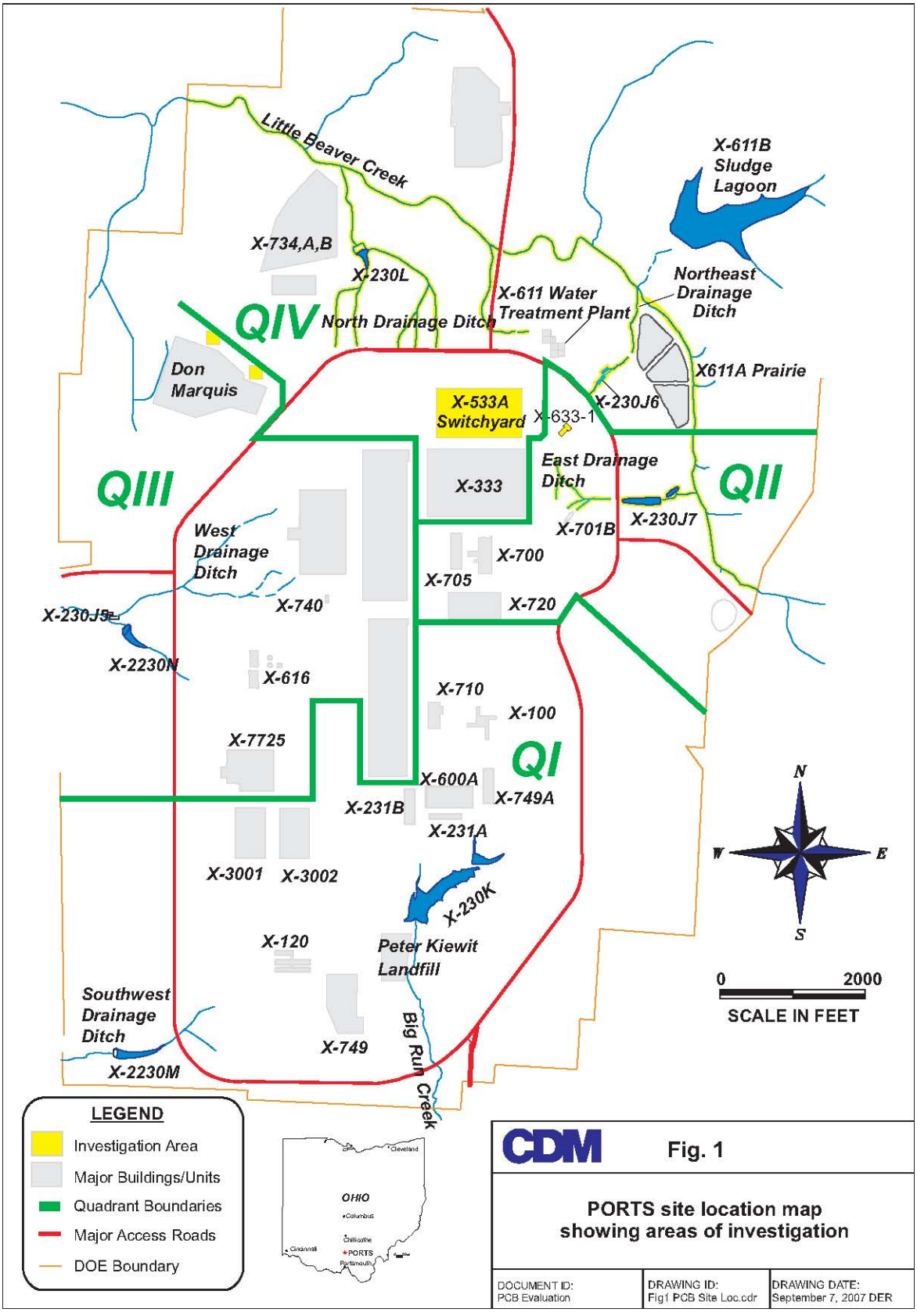

Fig. 1. PORTS site location map showing areas of investigation [1]

2005 Ohio Environmental Protection Agency (Ohio EPA) Stream Study

In 2005, Ohio EPA conducted a water resource assessment of the streams at PORTS which included collection of surface water, sediment, and fish tissue samples. In LBC, two fillet and three whole-body fish tissue samples exceeded the Ohio Consumption Advisory restriction level of one meal per week for PCBs and the Ohio Water Quality Criteria for the protection of wildlife. These fish sampling results and recent site inspections in which visible oil sheens were noted at one of the holding ponds, prompted the Ohio EPA to request that the DOE investigate the possible PCB sources in LBC.

Investigation of Potential Sources of PCB Contamination in Little Beaver Creek

Although many sampling events have taken place at or near the switchyard since the early 1990s, this investigation was intended to evaluate sampling results to more accurately delineate the potential source area and possible contamination that may be contributing to PCBs identified in fish sampled within LBC. Historically, standard grab sampling methods for surface water did not indicate PCBs present in LBC because the analytical detection limits were not low enough for grab sampling methods. Therefore, the high-volume surface water sampling technique was used to determine whether PCBs are being discharged at low concentrations into LBC. This technique also yielded information on PCBs in the dissolved/soluble phase and PCBs associated with suspended particles in LBC water samples which would account for the bio-accumulation of PCBs in the fish tissue.

Surface water grab samples (non-high-volume water samples) were collected from each tributary to LBC discharging from PORTS. Surface water grab samples were collected from 31 locations during two separate sampling events. Locations included drainage ditches, discharge from the X-533A Switchyard, holding ponds, and LBC. Surface water grab sampling events included one round of sampling during a non-rainfall period and one round within 24 hours of a precipitation event to detect PCB transport by surface runoff/flow.

High-volume water samples were collected during a non-rainfall sampling period from the discharge of three ditches that drain into LBC, the North Drainage Ditch, Northeast Drainage Ditch, and East Drainage Ditch, and directly from LBC at the DOE property boundary. The high-volume samples were each collected over 8 to 10 hours using a high-volume water sampling method for the detection of PCBs at very low levels (i.e., picograms/liter or parts per quadrillion range). The high-volume sampler collected approximately 800 liters of surface water that was passed through a 1 micrometer glass-fiber filter. The water was then passed through a specially packed PUF filter at a rate of up to 2.2 liters per minute. This rate allowed the water sample to be in contact with the PUF filter long enough for the PCBs (if present) to adsorb to the filter, which is specifically designed to extract PCBs from the water. The PUF filter and the glass-fiber filters were then submitted to the laboratory for analysis. The glass-fiber filter analysis provided particle-associated PCB concentrations, and the PUF-filter analysis provided the dissolved PCB concentration.

RESULTS

Grab Samples

PCBs were detected in only 1 of 62 surface water grab-samples collected from LBC, the drainage ditches, ponds, and storm sewers. Aroclor-1260 was detected at 0.31 µg/L. This sample was collected during the non-rainfall sampling event from standing water with visible oil sheen in the drainage basin near the southeast corner of the X-533A Switchyard. PCBs were not detected in any other surface water grab samples collected during the non-rainfall sampling event. Post-rainfall surface water samples were

collected after 1.1 inches of precipitation were measured. PCBs were not detected in any water samples collected during the post-rainfall sampling event.

High-Volume Samples

PCBs were detected in all four of the high-volume water samples collected. The results are summarized in Table 1.

Table I. High-Volume Surface Water Total PCB Results

Sample Location	Suspended Solids (pg/L)	Dissolved Solids (pg/L)	Total PCB Concentration (pg/L)
North Drainage Ditch	970	451	1421
Little Beaver Creek	1240	1510	2750
Northeast Drainage Ditch	1340	1320	2660
East Drainage Ditch	6710	1510	8220

Note: pg/L = picograms per liter (or parts per quadrillion)

The high-volume surface water sample results indicate that PCBs are being transported by the surface water in LBC and by each of the three ditches that drain into LBC. The total PCBs detected in LBC and the Northeast Drainage Ditch are divided almost equally between the suspended particulate matter and dissolved phase. The total PCBs detected in the East Drainage Ditch are mostly adhered to the suspended particulate matter. Turbidity measurements were not collected during the high-volume sampling, but the pump pressure did increase more during sampling at the East Drainage Ditch than it did at the other high-volume sample locations. This phenomenon suggests that there were more suspended solids in the East Drainage Ditch during sampling than at the other sample locations. In the North Drainage Ditch sample, total PCBs from the suspended particulate matter were more than double the PCBs detected in the dissolved phase.

Method Detection Limits – Grab Sampling versus High-Volume Sampling

The standard method for analyzing PCB grab samples is EPA SW846-8082; the method detection limits are typically 0.054 to 0.9 µg/L. By combining the high-volume sampling technique and EPA Method 1668A for analysis of PCBs, significantly lower detection limits can be achieved: a range of 0.001 to 0.003 pg/L. Note that 0.054 µg/L equals 54,000 pg/L.

CONCLUSIONS

Routine grab sampling methods did not detect levels of PCBs in surface water during this investigation except in one sample that was collected from standing water with a visible sheen. The associated detection limits for grab sampling are too high to evaluate slowly releasing sources which are presumed to be present due to PCBs found in fish tissue. High-volume surface water sampling has shown that low levels of PCBs are present in the east, northeast, and north drainage ditch tributaries of LBC. These drainage ditch tributaries drain industrial areas of PORTS. The high-volume surface water sample results indicate that PCBs are present in the drainage ditch tributaries and that each contributes to PCB contamination in LBC.

REFERENCES

1. DOE (U.S. Department of Energy), “Work Plan for the Investigation of Potential Sources of PCB Contamination in Little Beaver Creek at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,” DOE/PPPO/03-0040&D1, Piketon, Ohio (2007).

2. DOE, “Investigation of Potential Sources of PCB Contamination in Little Beaver Creek at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,” DOE/PPPO/03-0051&D1, Piketon, Ohio (2007).