GROUNDWATER PLUME MIGRATION
TECHNICAL EVALUATION
NORWOOD PCB SUPERFUND SITE
Norwood, Massachusetts

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1.0 INTRODUCTION

Foster Wheeler Environmental Corporation (Foster Wheeler) is under contract to the United States Army Corps of Engineers (USACE) for the Total Environmental Restoration Contract (TERC) (Contract No. DACW33-94-D-0002) at the Norwood PCB Superfund Site. Under the TERC, the purpose of Delivery Order No. 7 included the construction of a groundwater treatment plant (GWTP) and the installation of nine extraction wells. In conjunction with treatment plant start-up, a groundwater monitoring program consisting of hydrogeologic analysis and groundwater chemical analysis was implemented. The treatment plant was shut down in June 2000. In August 2001, Nobis Engineering, Inc. (Nobis) assumed primary responsibility of the Norwood groundwater monitoring program and initiated sampling under contract DACW33-01-C-0023.

The overall groundwater monitoring program has been implemented to provide hydrogeological and chemical data necessary to evaluate the effectiveness of the management of migration and groundwater remediation efforts at the Norwood Site. Specific objectives of the quarterly monitoring program have included the following:

- Characterization of site groundwater quality and hydrogeology including groundwater flow directions following the construction of the treatment unit;
- Monitoring of site groundwater contamination to identify any evidence of off-site migration;
- Development of a hydrogeological and chemical database with which to evaluate the effectiveness of treatment plant operations; and
- Monitoring groundwater quality and migration following the cessation of treatment plant operations.

The groundwater treatment plant was operated from early 1996 until June 2000 at which time it was shut down. The treatment plant has been shut down for approximately 31 months.

1.1 Technical Evaluation

This technical memorandum summarizes the results of an evaluation of groundwater plume migration since the cessation of treatment plant operations. In particular, this memo considers chemical data collected from the 18th through the 26th groundwater sampling rounds. This evaluation has also been developed in conjunction with the groundwater plume video presentation requested by the USACE and is intended to provide technical support for the presentation.

2.0 SITE BACKGROUND

As noted above, the groundwater treatment plant (GWTP) at the Norwood Site commenced operation in early 1996. The primary purpose of the plant was to extract and treat groundwater contaminated with volatile organic compounds (VOCs), in particular chlorinated ethenes such as trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride prior to discharge to Meadow Brook. Concentrations of PCBs in site groundwater were also reduced prior to discharge to the Brook.

Groundwater monitoring program results showed the overall treatment plant operations to be effective. VOCs were extracted from both overburden and shallow bedrock aquifers at the Norwood Site. Over time, groundwater monitoring program results showed evidence of gradual decreases in chlorinated ethene concentrations in the primary VOC plume at the Site. Since the construction of the GWTP, the
Massachusetts Department of Environmental Protection (MADEP) reclassified the groundwater in the vicinity of the Norwood Site. Based upon the revised groundwater classification for the Site area, a decision was reached by EPA and the USACE that treatment of the groundwater plume was no longer required. The GWTP was taken off-line in June 2000. Subsequent to this, monitoring of the groundwater plume has continued on a quarterly basis, to determine whether the treatment plant may be permanently shut down.

3.0 GROUNDWATER PLUME MIGRATION

Detailed changes in the overall groundwater plume at the Norwood Site, since the cessation of treatment plant operations, have been discussed in the 18th through the 26th Quarterly Reports. The purpose of this evaluation is to provide an overall assessment of the broader multi-year changes in key groundwater plume components and possible implications for future plume behavior. For discussion purposes, this evaluation has focused on four key plume components: the shallow bedrock and lower overburden total chlorinated volatile (TCV) plume, the upper overburden TCV plume, and the overburden polychlorinated biphenyl (PCB) plume and the overburden 1,2,4-trichlorobenzene (TCB) plume. This discussion is consistent with the technical elements of the video presentation.

To support this evaluation, quarterly TCV, PCB, and TCB contaminant concentration plume contours, have been compiled and summarized, to facilitate evaluation of multi-year trends. It should be noted that these concentration contours have been compiled from the quarterly reports and were originally developed using a computer software program (Surfer), to provide a two dimensional representation of plume shape and concentration profiles. The computer program mathematically estimates concentration contours based on interpolation between measured data points. In some instances, certain portions of the computer-generated contours have been manually modified for this evaluation, where the contours are deemed to be highly uncertain. This has primarily been done in areas where an insufficient number of monitoring wells exist, to appropriately bound the plume contours. Also, to facilitate data comparison between quarters, some minor manual adjustments have been made in certain individual quarterly contours.

3.1 Overall Site Groundwater Flow

Since the cessation of GWTP operations, groundwater flow directions have been relatively consistent. In the overburden, groundwater flow has been observed to be predominantly to the east toward Route 1 and Meadow Brook. A north to northeast component has also been observed flowing toward Meadow Brook, in the northern portion of the Site. In addition, some evidence of a localized groundwater mound, in the vicinity of well ME-10 has also been observed. Groundwater in bedrock has generally been observed to flow to the east, with a secondary component to the southeast, in the southern portion of the site.

It should be noted that the basic groundwater flow trends noted above, are generally similar to those observed during monitoring rounds while the treatment plant was operating. Hence, while the extraction well system had some localized influence on groundwater flow, overall site-wide flow trends have not dramatically changed.

3.2 Shallow Bedrock and Lower Overburden Plume

Figures 3-1 through 3-9 summarize the shallow bedrock and lower overburden total chlorinated volatile contours for the 18th through the 26th quarterly sampling rounds. In these figures, total chlorinated
volatile (TCV) contaminant concentration contours have been based upon the wells shown in bold. The overall plume contours for this time period display a number of the most pertinent features of the plume.

The core (TCV > 1,000 ug/L) of the shallow bedrock and lower overburden plume extends from the vicinity of well MW-1BR to extraction wells EW-9 and EW-10 in the east and monitoring well ME-11A, in the northeast. Due to the absence of monitoring wells beneath the former Grant Gear foundation, there exists some uncertainty regarding the width of the core of the plume in this area. Elements of the shallow bedrock and lower overburden plume have reached Meadow Brook.

A comparison of the changes in TCV contours between the 18th and 26th Quarters suggests several significant points regarding ongoing plume migration. Of particular importance, the more recent contours suggest that the core of the plume appears to have contracted slightly and migration has shifted more to the north and northeast. During the 18th quarter, some of the most contaminated groundwater was in the vicinity of well EW-11, to the east of the former Grant Gear Building foundation. Maximum TCV concentrations, in this area, exceeded 5,000 ug/L. More recently, during the 23rd to the 26th quarters, the most contaminated portion of the plume appears to have shifted north around wells EW-8 and EW-9 in the vicinity of the treatment plant. Maximum concentrations in this area, are typically observed at well EW-9 and generally range between 2,500 ug/L and 3,600 ug/L.

As noted above, the groundwater TCV plume has reached Meadow Brook. As indicated in Figures 3-1 to 3-9, there is no evidence that the plume is migrating beneath the Brook to the north. Based upon the overall shape of the plume contours and the northerly shift in the core of the plume, noted above, it appears that the bulk of the residual plume is in the process of slowly discharging to Meadow Brook. It should be noted that there are no shallow bedrock or lower overburden monitoring wells to the north of the treatment plant between wells ME-11A and EW-16. Therefore, some uncertainty exists in the exact shape of the plume contours along Meadow Brook and the maximum concentrations in groundwater in the immediate vicinity of the Brook.

Figure 3-10 presents the TCV concentration trends, between the 18th and 24th Quarters, for three shallow bedrock and/or lower overburden wells (ME-11B, ME-11A and MW-2B) located along Meadow Brook. At well ME-11B, located in the northwestern area of the Site, TCV concentrations show some evidence of a very gradual decline over time. During the 18th Quarter, TCV levels slightly exceeded 100 ug/L, while more recent results have consistently been below 100 ug/L. At well ME-11A, in the north-central portion of the Site, TCV concentrations have shown considerable quarterly variability but no clear evidence of consistent decline. At well MW-2B, which is down gradient of the main line of extraction wells, evidence suggests a slow gradual increase in TCV concentrations over time. This may reflect down gradient migration past the extraction wells that are no longer operational.

It should be noted that recent surface water sampling results generally support the hypothesis that site groundwater is migrating toward Meadow Brook. Recently, trace levels of chlorinated ethenes (primarily dichloroethene) have been detected, in several samples from the Brook, usually, at sampling station STS-3, on the eastern downgradient end of the Site. These results suggest chlorinated volatiles are discharging to the Brook and are being diluted by surface water flow from areas up gradient of the Site.

**Future Implications**

Based on the trends in groundwater migration observed between the 18th and 26th sampling rounds, it appears likely that, going forward, Meadow Brook will continue to be the primary discharge area for the shallow bedrock and lower overburden TCV plume. The available data suggests that maximum concentrations in the plume may remain similar to current levels or very slowly decrease. Recent results do not suggest that persistent sharp increases in the maximum TCV concentrations are likely to be
observed. However, very sharp transitory increases in TCV concentration may occur at certain wells. (Preliminary data indicates such an increase occurred in well EW-11 in the 27th Quarter.)

While total TCV concentrations may remain static in the future, the overall composition of the TCV plume may also change somewhat over time. Evidence suggests that some TCE is being microbially degraded to by-products, including DCE and vinyl chloride. Therefore, DCE concentrations are likely to continue to comprise a high and possibly increasing percentage of the total TCV concentration. In addition, it appears quite possible that some increases in the frequency of detection and/or maximum concentrations of vinyl chloride may be observed. Recent evidence does not show dramatic increases in vinyl chloride but it is possible that degradation rates might increase in the future, should changes in groundwater geochemical conditions occur.

3.3 Upper Overburden TCV Plume

As is indicated in Figures 3-11 to 3-19, the Upper Overburden TCV plume differs significantly from the shallow bedrock and lower overburden plume. The Upper Overburden plume covers a much smaller surface area and is at generally lower concentration, as compared to the deeper plume. Results from the 18th to the 26th Quarterly Sampling rounds indicate the primary area of upper overburden TCV contamination lies in the vicinity of well MW-1A. As has been discussed in quarterly monitoring reports, this area is believed to represent a primary source term for site groundwater contamination. TCV contours suggest upper overburden TCV contamination principally extends to the north-northeast toward wells B-4 and ME-10. In addition, an isolated pocket of upper overburden TCV contamination continues to exist in the vicinity of well MW-7A, although contamination was not observed at this location during the 26th Quarter. It should also be noted that there does not appear to be consistent interaction between the upper overburden TCV plume and Meadow Brook. TCV is frequently absent from several upper overburden wells along the Brook, including EW-4 and EW-5.

Overall, between the 18th and 26th quarters, no consistent trend is observed in the upper overburden TCV contours. From quarter to quarter some variations in the contours are noted. These variations may reflect, in part, seasonal changes in water levels in the upper overburden. However, there does not appear to be any clear evidence of consistent decrease or increase in the overall direction or shape of the plume. The plume does not show clear evidence of contracting. Throughout the time period, the highest TCV concentrations continue to be noted around well MW-1A.

Future Implications

Based upon the available data, little near term future change in the upper overburden TCV plume is expected. If, the MW-1A area is, in fact, the primary source for the upper overburden plume, then this plume will likely continue as long as this area continues to release contaminated source material. The relationship of the more dilute contamination around well MW-7A to the main plume remains uncertain. It appears possible that this plume component might reflect the presence of a small and localized source term in this area.

3.4 Overburden PCB Migration

Figures 3-20 to 3-29 present the concentration contours for PCBs in the overburden aquifer, for the 18th to 26th Quarter Sampling rounds. Overall, the overburden contours indicate relatively widespread detection of PCBs across the western portion of the Site. Detected concentrations generally range from approximately 0.01 ug/L to 10 ug/L. As indicated by the contours, the PCB plume is oriented in a north-northeasterly direction from well MW-4A in the southern portion of the Site to wells B-19R and ME-11B in the north. PCB concentrations between 1.0 and 10.0 ug/L are frequently detected between wells B-10
and B-4. Somewhat isolated PCB contaminated groundwater areas are also observed in the vicinity of wells EW-4 and MW-2A, in the northeastern portion of the Site.

An examination of the 18th to 26th Quarterly PCB contours indicates relatively little change in the overall orientation of the PCB plume contours over this time frame, particularly in northern and eastern portions of the site. This is not surprising given the relatively strong PCB adsorption to soils and the generally limited mobility in groundwater-soil systems. However, this does not necessarily mean that no PCB migration is occurring at the Site. It should be noted that the more recent Quarterly data suggests some southward expansion of the area of PCB contaminated groundwater. This is primarily due to the recent detection of varying levels of PCBs in groundwater at well MW-4A, particularly since the 20th Sampling Round. The detection of PCBs in groundwater at well MW-4A might indicate the downward migration of PCBs from shallow subsurface soils, in this area. It should be noted that due to the elevated PCB levels detected at well MW-4A during the 25th and 26th quarters, combined with the lack of neighboring monitoring wells, the extent of the dilute PCB contours in this area are considered highly uncertain. Therefore, the most dilute PCB contour (blue > 0.01 ug/L) has been omitted from the 25th and 26th Quarter data (Figures 3-27 and 3-28).

The potential impact of the PCB plume on Meadow Brook is not completely certain. As noted above, little change has been observed in the overall orientation of the PCB plume between the 18th and the 26th Quarters. However, the plume contours also clearly indicate that the northern edge of the plume abuts the edge of Meadow Brook. In addition, very recent surface water sampling (26th and 27th Quarter Sampling Round) has detected trace PCBs in the Brook.

Figure 3-29 presents the PCB concentration trends between the 18th and 24th Quarters for three wells (ME-11B, EW-4, and MW-2A) located along Meadow Brook. At shallow bedrock/lower overburden well ME-11B, low levels of PCBs have been consistently detected over the entire time frame. There is no obvious indication of a consistent decrease or increase in the concentration levels. Further to the east at well EW-4, there appears to be some evidence of a slight gradual decrease in levels over time. Further to the southeast, at well MW-2A, PCB levels appear to have decreased between the 18th and 26th sampling rounds with relatively consistent levels having been reported since then.

Future Implications

Overall, the shape of the groundwater plume, the proximity of the northern edge of the plume and the number of wells near the Brook in which PCBs have been detected, all suggest that some PCB migration into the Brook or the sediments beneath the Brook may be occurring and continue to occur over time. The rate at which this may occur is uncertain and would require more detailed technical evaluation.

3.5 Trichlorobenzene Migration

1,2,4-Trichlorobenzene (TCB) has been consistently detected in wells MW-1A and MW-1BR over recent sampling rounds, including the 18th to the 26th Quarterly rounds. The concentrations detected at these locations frequently exceed the ROD specified cleanup standard as well as Massachusetts Department of Environmental Protection GW-3 standard. During the 18th to 26th Quarterly rounds, TCB concentrations at these locations have ranged from approximately 250 ug/L to 1400 ug/L. TCB concentrations at these two wells are somewhat erratic, with quarterly concentration changes in the two wells often behaving inversely to each other.

As indicated in Figures 3-30 to 3-38, TCB has also been detected above 10 ug/L in several additional overburden wells in the western portion of the Site and at certain locations immediately down gradient of the former Grant Gear Building foundation. TCB concentrations in these wells have been lower
(<175 ug/L) than the levels observed in wells MW-1A and MW-1BR. As indicated by the plume contours, TCB has been detected in a couple of overburden wells (B-9 and B-18) to the west and northwest of MW-1A. These wells are up gradient or cross gradient to the groundwater flow at well MW-1A. TCB has also been detected in down gradient wells EW-11, EW-16, ME-10 and B-4. Overall, the contours suggest a relatively limited overburden TCB plume. The primary source of the majority of the plume appears to be located around well MW-1A. TCB has generally not been detected in most wells further down gradient on the Site or at wells proximate to Meadow Brook.

Future Implications

Based upon the results of the 18th to the 26th Quarterly Sampling rounds, TCB migration at the Site appears, to date, to be relatively limited. It does appear that some low-level northward migration of TCB may be occurring in central portions of the Site, in the vicinity of wells B-4 and ME-10. This migration may continue to occur over the near future. It does not appear that TCB migration will reach Meadow Brook in the near future, although this is not completely certain. The available data suggests that concentrations in wells down gradient of wells MW-1A and MW-1BR appear likely to remain below the ROD cleanup standard and the MADEP GW-3 standard.

4.0 SUMMARY

The results of the 18th to the 26th Quarterly Groundwater Sampling rounds at the Norwood Site have been evaluated to assess ongoing migration trends in the groundwater plume and their potential implications for future migration. The overall results indicate that the majority of the shallow bedrock and lower overburden TCV plume appears to be migrating to the north and northeast, and slowly discharging to Meadow Brook. While localized changes in concentrations continue to occur within the plume, no persistent significant site-wide increases in the maximum plume TCV concentrations have been observed since the GWTP was taken off-line. Rather, the evidence supports a rather static plume with some decline in overall TCV levels, at a number of well locations. The relative concentrations of the primary plume components are, however, continuing to change. Evidence indicates slow general decreases in the TCE concentrations with steady or increasing DCE and vinyl chloride concentrations. It appears possible that some additional increases in vinyl chloride concentrations may occur in the future.

The upper overburden TCV plume has not shown dramatic changes over the time period under review. TCV concentrations are lower than in the shallow bedrock and lower overburden. In addition, the core of this plume is further removed from Meadow Brook and shows less evidence of discharge to the Brook.

The groundwater PCB plume shape and orientation shows little evidence of significant change from the 18th to the 26th Quarters although there is some indication of expansion of this plume toward southwestern portions of the Site. The consistent detection of PCBs in several wells near Meadow Brook raises the likelihood that some discharge of trace to low levels of PCBs to the Brook might currently be occurring and may continue to occur in the future. Recent detection of trace PCB levels in surface water in the Brook adds some support to this hypothesis.

The TCB plume at the Site is relatively limited in extent and continues to be focused around well MW-1A. There is some evidence to suggest that dilute elements of this plume are slowly migrating to the north of the former Grant Gear building foundation. However, to date, no significant elements of this plume have approached Meadow Brook. It is uncertain to what extent, if any, elements of this plume may continue to migrate further to the north in the future.
QUARTER 23

ESTIMATED CONTAMINATION

BOUNDARIES

GRANT SCAN FOUNDATION

TREATMENT AND REUSE WELLS IN INTERACTION

NOTE: This map includes color coding for contamination boundaries.