Final Capture Zone Analysis Report

Stanton Cleaners Area
Groundwater Contamination Site
Great Neck, Nassau County, New York

Prepared for:

U.S. Environmental Protection Agency Region II
Emergency and Remedial Response Division
Removal Action Branch
Edison, New Jersey

Prepared by:

EARTH TECH

Greenville, South Carolina

April 2004

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U.S. Environmental Protection Agency Region II
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2890 Woodbridge Avenue (MS-211)
Edison, New Jersey 08837

Prepared by:
Earth Tech, Inc.
10 Patewood Drive
Building VI, Suite 500
Greenville, South Carolina 29615

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1.0 INTRODUCTION

Earth Tech, Inc. performed a capture zone analysis of the Stanton Cleaners Area (SCA) groundwater extraction and treatment system (P&T) for the United States Environmental Protection Agency (U.S. EPA) Region II, Emergency & Remedial Response Division, Removal Action Branch (RAB). This analysis was performed to evaluate the effectiveness of the SCA P&T system and the system's ability to meet the requirements stipulated in the March 1999, EPA issued Record of Decision (ROD).

This report describes the capture zone analysis performed for the groundwater extraction system operating at the Stanton Cleaners Area Groundwater Contamination Site (hereinafter, the Site) in Great Neck, Nassau County, New York. The general site location and surrounding area is shown in Figure 1. A site map is provided as Figure 2 and well construction information is provided in Table 1.

1.1 REPORT ORGANIZATION

This Capture Zone Analysis Report is organized such that the step-by-step approach to meeting the project goals may be reviewed in an orderly manner, as follows:

- Section 1.0 (Introduction).
- Section 2.0 presents the Site Conceptual Model, including Site geology, hydrogeology, historical data, and P&T system goals.
- The analytical approaches employed in the capture zone assessment are presented in Section 3.0.
- A summary of recommendations and conclusions derived from this analysis are presented in Section 4.0.

2.0 CONCEPTUAL MODEL

The Site includes an active dry-cleaning business, located at 110 Cutter Mill Road in the Town of North Hempstead, Nassau County (Figure 2). The Stanton Cleaners Property (SCP) is approximately 1/4-acre in size and includes a one-story building in which the dry-cleaning business operates and an adjacent one-story boiler/storage building. Since 1958, a dry cleaning operation has existed on the SCP. During the late 1970s and early 1980s, Nassau County Department of Health (NCDOH) identified low levels of the VOC PCE, a solvent commonly used by dry cleaners, in the public water supply wells located about 1,000 ft down-gradient of the SCP and owned by the Water Authority of Great Neck North (WAGNN). In 1983, the WAGNN solicited help from NCDOH to assist them in identifying potential sources of the PCE contamination. As a result, the SCP was inspected by the NCDOH. At that time, it was noted that a discharge pipe led from the dry cleaning fluid separator to the grassy, sloped area at the rear of the building. Shortly thereafter, the discharge was stopped.

2.1 HYDROGEOLOGY

Hydrogeology of the site includes two principle aquifers (the Upper Glacial Aquifer and the Lloyd Aquifer) and two prominent confining units (the North Shore Confining Unit and the Raritan Clay). The Upper Glacial Aquifer of unconsolidated Pleistocene deposits is the near surface aquifer. The sandy units of the Upper Glacial Aquifer are interbedded with fine-grain units (silts and clays) typical of glacial deposits, and the aquifer can be subdivided into shallow, intermediate, and deep portions for monitoring purposes.

The North Shore Confining Unit separates the shallow and intermediate portions of the Upper Glacial Aquifer from the deep Upper Glacial Aquifer below. Reports produced by the United States Geological Survey (USGS) document erosional features in the Upper Glacial Aquifer and North Shore Confining Unit beneath the Site. These geologic conditions may allow interaction between the shallow, intermediate, and deep Upper Glacial Aquifers. Concentrations of PCE detected during Site investigations (Earth Tech, June 2003) indicate that the shallow, intermediate, and deep Upper Glacial Aquifers have all been affected by surface contaminants to some degree.

The Raritan Clay separates the Upper Glacial Aquifer above from the Lloyd Aquifer below and constitutes a confining unit for the Lloyd Aquifer, preventing impact by contaminants from the overlying strata. The Lloyd Aquifer overlays the crystalline bedrock and is the major regional drinking water aquifer. There is no indication that this aquifer has been impacted by migration of surface contaminants.

2.2 WATER AUTHORITY OF GREAT NECK NORTH WATER MILL LANE WELL FIELD

As mentioned previously, a public water supply well field located at Water Mill Lane (Figure 2) and operated by WAGNN exists approximately 1,000 ft south of the SCP. Two of the WAGNN wells, PW-2A and PW-9, are screened in the deep portions of the Upper Glacial Aquifer with a total depth of approximately 145 ft below ground surface (bgs). The presence of discontinuous clays (i.e. the North Shore Confining Unit) allows for hydrogeologic inter-connection between the deep and shallow/intermediate portions of the Upper Glacial Aquifer. Thus making the deep Upper Glacial Aquifer susceptible to surface contamination migrating from the impacted shallow/intermediate Upper Glacial Aquifer.

Water level measurements were collected during the *Hydrogeologic Investigation - OU-1* (HI OU-1) (Earth Tech, June 2003) and used to approximate the radius of influence of WAGNN wells PW-2A and PW-9. As discussed in Section 4.2.5 of the HI OU-1, the radius of influence potentially extends several thousand feet, placing the SCP within the capture zone of these wells.

Concentrations of PCE have been detected in groundwater samples collected from public water supply wells PW-9 and PW-2A. Due to the location of the SCP (up-gradient and within the capture zone of the WAGNN well field), historic and present elevated concentrations of PCE contamination found at the Site, and PCE plume delineation defined by the HI OU-1, the SCP was found to be a likely source for a major portion of the PCE contamination.

2.3 GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

In an effort to mitigate the groundwater contamination resulting from past Site activities, a Record of Decision (ROD) was issued for the Stanton Cleaners Site (US EPA, March 31, 1999). The ROD described the selected remedial alternative, which included the upgrade of the existing Site extraction system. Details of the P&T system components, as required by the ROD, were as follows:

- The P&T system for the Site should include an enhanced system to capture the contaminated groundwater plume. Contaminated groundwater from high source areas should be pumped from one or two down-gradient extraction wells. The extracted groundwater should be pumped to an off-site treatment system.
- The extraction wells should be installed at the 1 ppm PCE contaminant contour, approximately 400 ft south of the SCP. These wells should be pumped at a rate of approximately 50 to 100 gpm. As a result of the strong influence of the WAGNN well pumping rates on the aquifer, which is in close proximity to these wells, it is not feasible to capture the leading edge of the groundwater VOC plume. However, the leading edge

of the plume is being captured by the WAGNN wells where it is treated to meet federal and state drinking water standards.

- Contaminated groundwater should be pumped from the aquifer and directed through an air stripping treatment system to remove VOCs. Off-gasses should be treated, if required, using a vapor phase GAC filter to federal and state ambient air quality standards. Pretreatment may be necessary to prevent fouling of the air stripper by metals, which naturally exist in the groundwater. The pretreatment process for metals removal should utilize chemical precipitation and pH adjustment combined with filtering and/or equivalent. Pre-treatment metals residuals should be disposed of off-site according to federal and state RCRA disposal standards, and the treated groundwater should be discharged to either a storm sewer/sanitary sewer and/or for re-injection, according to federal and state effluent discharge standards. The vapor phase GAC filters should be designed for regeneration and/or off-site disposal.

- The operation time for extraction and treatment is expected to be 20 years. The long-term groundwater monitoring program is assumed to remain in effect for up to 30 years.

The resulting pump and treat system was put on-line in September 2001 and is currently operational. Since the installation, EPA-EXT-02 has been pumping almost continuously at approximately 50 gallons per minute (gpm) and ST-IW-01 has been pumping intermittently at approximately 10 gpm. In May 2003, ST-IW-01 was taken off-line due to a major reduction in concentration levels and replaced with EPA-MW-24, which had been converted to an extraction well. Current long-term plans are to continue pumping extraction well EPA-EXT-02 at a rate of 50 gpm and EPA-MW-24 at a rate of 10 to 15 gpm, with the desire to capture the 1 part per million (ppm) (or 1,000 part per billion (ppb)) PCE contour.

3.0 CAPTURE ZONE ANALYSIS

The capture zone analysis described in this document was performed to 1.) to evaluate the capture zone created by the Site extraction system and 2.) to analyze the stability/transport of the plume outside the capture zone. These objectives were met using a combination of historical data analysis and groundwater modeling techniques. Groundwater modeling performed for the capture zone analysis included flow modeling utilizing MODFLOW, particle tracking using MODPATH, and contaminant transport utilizing MODFLOWT. The approach and results of the capture zone analysis are provided in the sections that follow.

3.1 ANALYSIS OF HISTORICAL SITE DATA

Historical Site chemistry data were analyzed to determine if the Site extraction system has been effective in reducing PCE concentrations in groundwater. Available analytical data include eight separate groundwater sampling events (September 1999, February 2000, April 2000, January 2001, October 2001, September 2002, April 2003, and September 2003) conducted at the Site between September 1999 and September 2003 (Tables 2 through 4). PCE concentrations from February/April 2000, collected prior to the P&T system start-up, were contoured along with PCE concentrations from recent sampling events (i.e., April 2003 and September 2003). Figures 3, 4, and 5 present PCE concentrations for the shallow, intermediate and deep Upper Glacial Aquifers, respectively.

The effects of the extraction system are most dramatic in the shallow Upper Glacial Aquifer (Figure 3), where concentrations have dropped from 20,000 ppb to 4,900 ppb and from 23,000 ppb 3,600 ppb at monitoring wells EPA-MW-21 and ST-MW-19, respectively. The 1,000 ppb PCE isoconcentration contour (the desired capture level for the P&T system) is displayed on Figure 3 for each sampling event. The decreasing area of the 1,000 ppb PCE contour indicates there has been removal of mass from the aquifer since the P&T system was activated in September 2001.

PCE concentrations also show an overall decrease in the intermediate Upper Glacial Aquifer (Figure 4), where sampling results down-gradient of the Site show PCE dropping from 93 ppb to non-detect at well CL-3 and from 54 ppb to non-detect in well CL-4S. Concentrations in ST-MW-17 increased from 170 ppb (February 2000) to 240 ppb (April 2003), but decreased to 120 ppb in September 2003.

In the deep Upper Glacial Aquifer, PCE concentrations are mostly low to non-detect values (Figure 5). At monitoring well CL-1D, PCE concentrations decreased from 840 ppb (April 2000) to 120 ppb (April 2003). However, concentrations increased between April 2003 (120 ppb) and September 2003 (1,700 ppb). This high PCE value may be the result of residual soil contamination in clay layers or migration of PCE that began before the P&T system was operational.

In addition to plotting the PCE data spatially, time series of PCE concentration data were graphed for select shallow Upper Glacial Aquifer monitoring wells (Figures 6 and 7). Decreasing trends in PCE concentration are shown for both wells in the high range of initial PCE concentration (Figure 6) and those with lower initial PCE concentration (Figure 7). The biggest decrease in PCE concentration occurred between the April 2000 sampling event (conducted before the P&T system was operational) and the October 2002 sampling event (conducted just more than a year after the P&T system start-up).

Time series of PCE concentrations were also plotted for WAGNN wells PW-2A and PW-9 (Figures 8 and 9). PCE concentrations in WAGNN wells PW-2A and PW-9 have declined since the extraction system was put on-line in September 2001. Most likely, this decline can be attributed to capture of contaminant mass by the P&T system as well as decreased pumping of the WAGNN wells in recent years.

Declining trends in PCE concentration for the majority of monitoring wells, coupled with reduced area of the 1,000 ppb PCE contour indicate that the system is effective in capturing at least part of the 1000 ppb contour. Increase in PCE concentration in the deep Upper Glacial Aquifer monitoring well CL-1D may indicate residual soil contamination is present, or it may be the result of contaminant migration pathways that began prior to P&T system start-up.

3.2 HYDRAULIC CAPTURE ZONE ANALYSIS

In October 2003, water level measurements were collected in Site monitoring wells to evaluate the radius of influence created by the P&T system. Water level measurements were collected with the P&T system on (October 29, 2003) and off (October 31, 2003). WAGNN wells PW-2A and PW-9 were not pumping for the duration of the measurement effort. Water level data sheets are provided as Appendix A.

Figure 10 shows the shallow Upper Glacial Aquifer potentiometric map for measurements taken when the system was off. Groundwater flow direction is to the west in the vicinity of the Site and is to the southwest down-gradient of the Site. This flow direction is in general agreement with past water level measurements (Earth Tech, June 2003). However, water levels vary seasonally and are expected to be lower when WAGNN wells PW-2A and PW-9 are operational.

Water levels collected on October 31, 2003 (Figure 11) show the influence of the P&T system. These water level measurements suggest a capture zone of approximately 200 feet as indicated by the concentric potentiometric contours. No previous water level measurements are available for comparison, as other measurements collected during P&T system operation are overwhelmed by the effects of intermittent pumping of WAGNN wells.

In addition to potentiometric data, the exiting groundwater flow and transport model (Earth Tech, Inc., May 2001 and May 17, 2001) was utilized for hydraulic capture zone analysis. Because the groundwater flow and transport model incorporates the complex hydrogeology beneath the Stanton Cleaners Site, it should provide a better estimate of the extraction system capture zone than a analytical model/equation that is subject to numerous assumptions (including isotropic and homogeneous aquifer properties, no recharge, no vertical flow components, and fully penetrating wells) which do not apply to the Site.

For the purpose of this analysis, the existing groundwater flow model (Earth Tech, May 2001) was updated to include extraction well EPA-EXT-02 pumping at 50 gpm and EPA-MW-24 pumping at 10 gpm. The model was also updated to include the average pumping rates for PW-2A and PW-9 between September 2000 and September 2003 (296.6 gpm and 477.6 gpm, respectively). A refined model grid was created with 10-foot grid spacing in the Site vicinity grading to 100-foot grid spacing in the model edges. Flow model properties are presented in Table 6.

Particles were inserted along and inside the 1000 ppb contour in Layers 2 and 3 of the model (Figure 12), which represent the silty and sandy portions of the Shallow Upper Glacial Aquifer, respectively. Results of forward (i.e., down-gradient) particle tracking indicate that the majority of the particles (approximately 94 %) are captured by EPA-EXT-02 and EPA-MW-24 (Figure 13). However, particle tracking indicates that some of the particles are not captured by the Site extraction system and are ultimately captured by the WAGNN wells (Figure 13).

3.3 ANALYSIS OF PLUME STABILIZATION OUTSIDE THE CAPTURE ZONE

The existing groundwater transport model (Earth Tech, May 2001) was utilized to evaluate the fate of contaminants outside the P&T capture zone. As with the groundwater flow model, the existing transport model was updated to include P&T system pumping rates and average pumping rates for PW-2A and PW-9 between September 2000 and September 2003. MODFLOWT was then used to simulate the transport of PCE in an effort to estimate the fate and stability of the uncaptured portion of the PCE plume.

The transport model utilized February/April 2000 PCE concentrations as initial concentrations. Simulations were performed with and without the inclusion of constant source terms. The transport model included the effects of pumping extraction well EPA-EXT-02 at 50 gpm, EPA-MW-24 at 10 gpm, PW-2A at 296.6 gom, and PW-9 at 477.6 gpm. Transport model parameters are summarized in Table 6.

Figures 14, 15, and 16 depict simulation results without a constant source (i.e., transport of initial concentrations only) for the shallow, intermediate, and deep portions of the Upper Glacial, respectively. As shown in these figures, contaminant mass that is not captured by the P&T system (EPA-EXT-02 and EPA-MW24) migrates south/southwest towards the WAGNN well field and the marshy area east of Little

Neck Bay. In the deep upper Glacial Aquifer (model Layer 7), PCE concentrations decrease to below 5 ppb within a year as the initial concentrations are transported quickly out of the system. Concentrations rise above 5 ppb again after 2 years, as contaminant mass from upper zones migrates down to Layer 7. This lapse in PCE concentrations in the lower layer indicates that contaminant mass in the deep Upper Glacial Aquifer may be underestimated in the model.

Simulation results (Figures 14, 15, and 16) show PCE concentrations decreasing much more rapidly than indicated by groundwater sampling results (Figures 3, 4, and 5). Furthermore, observed PCE concentrations in public supply well PW-2A (Figure 6) are much higher than modeled concentrations. Possible reasons for the discrepancy between predicted and observed groundwater PCE concentrations include 1.) the existence of residual PCE concentrations in silty and/or clayey zones (i.e., model layers 2, 5, and 6); 2.) the recharge rates in the model (which were based on regional estimates) may be higher than actual recharge rates; 3.) the modeled hydraulic conductivities may be too high (as a result of high recharge rates) and result in flushing of contaminants through the system; and 4.) the retardation of chemical species may be higher than indicated by measured Site total organic carbon values.

Model simulations with varied aquifer properties (e.g. increased retardation rates) and contaminant source terms may produce results that more closely approached observed concentrations. Recalibration and verification of the groundwater flow and transport model as data becomes available should help to refine model predictions, as well as to fill gaps in the conceptual model by providing improved estimates of aquifer properties and configuration of possible continuing source concentrations.

4.0 RECOMMENDATIONS AND CONCLUSIONS

The SCA P&T system has been operational since September 2001, running at an average flow rate of 50 gpm to 65 gpm, and has treated approximately 52 million gallons of PCE contaminated groundwater. This capture zone analysis was performed to evaluate the ability of the SCA P&T system to capture the 1,000 ppb PCE contour and to mitigate the groundwater contamination resulting from past Site activities. Several types of analysis were employed as part of this task, including analysis of historical data, hydraulic capture, and plume stabilization outside the capture zone. Although the complex hydrogeology of the Site and transient nature of pumping systems make definitive analysis difficult, several converging lines of evidence indicate that the SCA P&T system is capturing the majority of the 1,000 ppb contour. These lines of evidence include:

- With the exception of well CL-1D, declining PCE trends in monitoring wells have been observed in both the Site vicinity and down-gradient of the Site (Figures 3,4, and 5);

- The area covered by the 1,000 ppb PCE contour has decreased in size since the P&T system start-up (Figure 3);

- Water level measurements collected with EPA-EXT-02 pumping at 50 gpm and EPA-MW-24 pumping at 10 gpm indicate a capture zone of roughly 200 feet (Figure 11), which is the approximate width of the 1,000 ppb contour for the February/April 2000 groundwater sampling event; and

- Particle tracking suggests that, while a small portion of particles in the 1,000 ppb contour may escape capture due to the influence of the WAGNN wells, the P&T system captures the majority of the particles within the 1,000 ppb contour.

Although some contaminant migration pathways may escape capture by the P&T system, the ROD (US EPA, March, 31, 1999) acknowledges that it is not feasible to capture the leading edge of the plume before it reaches the WAGNN wells due to the strong influence of the WAGNN wells and their proximity to the Site extraction system. Furthermore, modeling and WAGNN well influent sampling indicate that concentrations of PCE captured by public supply wells PW-2A and PW-9 should be sufficiently low to be effectively removed by the WAGNN air stripper.

Increasing concentrations at monitoring well CL-1D may be indicative of the existence of residual PCE concentrations in silty and/or clayey zones. However, the increase may also correspond to mass transport of contaminants that began migrating before the P&T system was operational. Further trend analysis is needed once future sampling data is available.

The analyses presented in this document suggest that the system is capable of capturing the majority of the 1,000 ppb PCE contour. Declining PCE concentrations at the Site (20,000 ppb to 4,900 ppb at EPA-MW21) and down gradient of the Site (23,000 ppb to 3,600 ppb at ST-MW19) indicate the system's capture of contaminants has reduced the threat to the public supply wells. Observed decreases in influent PCE concentration for PW-2A and PW-9 (Figures 8 and 9) can conceivably be attributed to a combination of reduced pumping rates at the Water Mill Lane Well Field and the capture of contaminants by the SCA P&T system.

Based on the analyses presented in this document, the following are recommended:

- The capture zone analysis process should be repeated periodically in the future to demonstrate that the groundwater contaminant capture zone is maintained under changing stresses (e.g., changing rates of WAGNN wells) and seasonal fluctuations in groundwater elevation.

- Future water level measurement efforts (including monthly water levels collected as part of the Long Term Removal Action (LTRA)) should be performed in cooperation with WAGNN in order to ensure steady state pumping conditions exist. Water levels should be collected when public supply wells PW-2A and PW-9 are pumping at a known rate (preferably off) for the entire duration of water level collection.

- Regular water level measurement and groundwater sampling events conducted as part of the LTRA should include, at a minimum, the following 29 wells: CL-1D, CL-1S, CL-3, CL-4S, CL-4D, EPA-MW-9A, EPA-MW-11D, EPA-MW-21, EPA-MW-22, EPA-MW-23, EPA-MW-25, EPA-MW-26, EPA-MW-27, EPA-MW-29, EPA-MW30, EPA-MW31, EPA-MW32, EPA-MW-33, ST-MW-02, ST-MW-06 (or ST-IW-01), ST-MW-11, ST-MW-12, ST-MW-13, ST-MW-14, ST-MW-15, ST-MW-16, ST-MW-17, ST-MW18, and ST-MW-20. (Note: These wells define the current plume configuration. The number of wells may be reduced in the future as the plume size is reduced).

- Natural attenuation parameters (as described in the EPA's *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*) should be collected from a subset of source area and down-gradient monitoring wells during sampling events. These parameters can be used during future analyses to help evaluate the potential for natural attenuation at the Site.

- Data recorded during recent water level and sampling events indicate some well components (i.e., bolts, covers, and/or caps) are missing from many wells. To ensure well integrity, the LTRA should include provisions for the maintenance and repair of monitoring and extraction wells.

- When additional Site water level and analytical data become available, recalibration and verification of the groundwater flow and transport model will provide a better understanding of the Site conceptual model, increase the confidence in model predictions, and make the model a more useful decision-making tool. Recalibration and verification is recommended if the model will be used as a decision making tool in the future.

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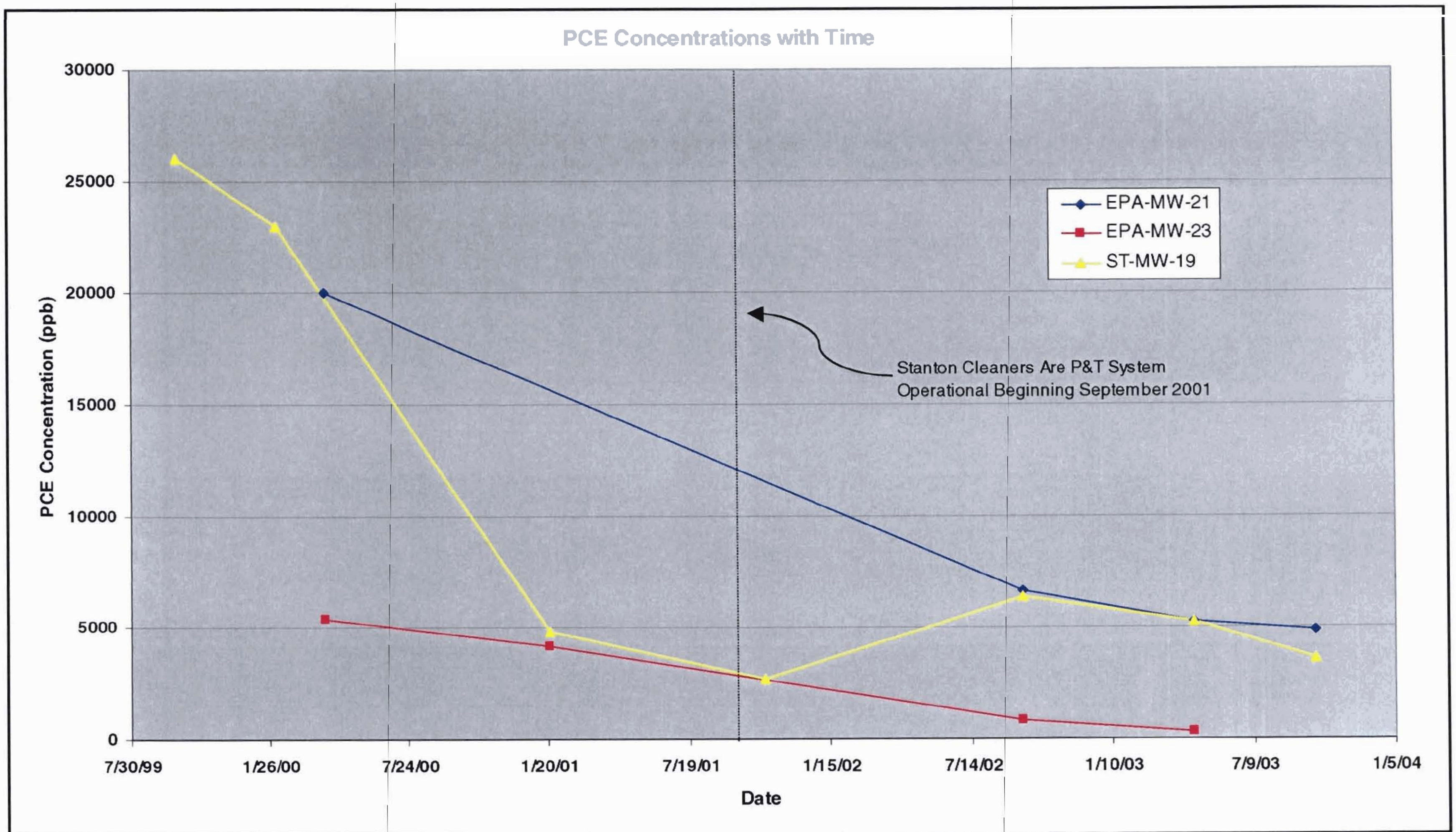

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FIGURE 6

Time Series of Observed PCE Concentrations for Select Shallow Upper Glacial Aquifer Monitoring Wells

Stanton Cleaners Area Groundwater Contamination Site
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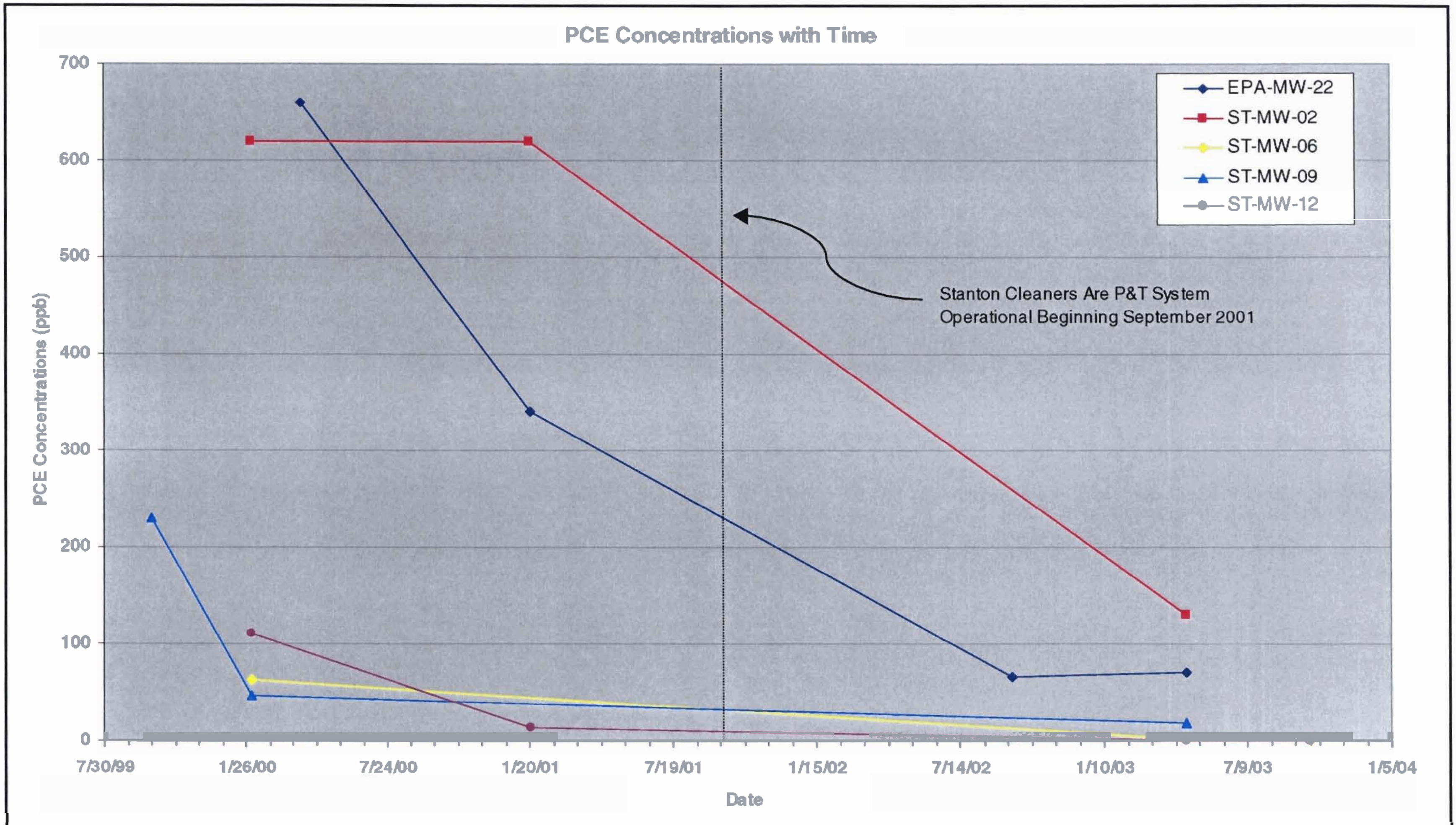

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FIGURE 7
Time Series of Observed PCE Concentrations for Select Shallow Upper Glacial Aquifer Monitoring Wells

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