ENVIRONMENTAL RESOURCES MANAGEMENT

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NYSDEC REGION 1

REQUEST FOR PERMANENT SHUTDOWN

Former Columbia Ribbon and Carbon
Company Disposal Site
Glen Cove, New York
NYSDEC Site Code No. 1-30-028

19 September 2000

Prepared for:

Konica Graphic Imaging International, Inc.
71 Charles Street
Glen Cove, New York 11542

Prepared by:

ENVIRONMENTAL RESOURCES MANAGEMENT, INC.
175 Froehlich Farm Boulevard
Woodbury, New York 11797

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1.0 BACKGROUND

1.1 SITE DESCRIPTION AND HISTORY

The Former Columbia Ribbon and Carbon Company Disposal Site (the "site") is located in Glen Cove, New York. The site is defined as a 0.8-acre area of concern, currently an employee parking lot that was impacted by the disposal of industrial waste from the former Columbia Ribbon and Carbon Company. The location of the site is shown in Figure 1-1 and a site map is presented in Figure 1-2.

The properties to the north and east of the site are predominantly residential. An industrial corridor that includes four other inactive hazardous waste disposal sites is located to the south and west of the site. The site was acquired by Powers Chemco, Inc. in 1979. Powers Chemco, Inc., was renamed Chemco Technologies, Inc., and the site was purchased by Konica, Inc. After purchase by Konica, Inc., the company was renamed Konica Graphic Imaging International, Inc.

A Remedial Investigation and feasibility Study (RI/FS) was finalized in January 1991. This RI/FS was the basis for the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD) for the site that was issued in March 1991.

The ROD identified a combined ground water and vapor extraction alternative as the preferred remedy but witheld confirmation of the selected remedial action until completion of a pilot study. The pilot study was intended to evaluate the preferred remedy and compare it to a conventional pump and treat remedial alternative. The basis for the comparison and ultimate selection of a final remedy would consider the ability of either remedy to meet remedial goals, their associated costs and expected time frame of operation.

Konica Graphic Imaging International, Inc., (Konica) entered into an order on consent to implement the pilot study identified in the ROD. The results of the pilot study were presented in a report that was approved by the NYSDEC in October 1992. Based on the pilot study, Konica recommended the preferred remedy of combined ground water and vapor extraction. Although this remedy came at a higher cost ($2,060,000 Net Present Value {NPV} versus $1,727,000 NPV for conventional pump and treat), it was more aggressive and hence, offered the opportunity to approach or meet the ground water remedial goals set forth in the ROD. NYSDEC concurred with Konica's recommendation, and the combined ground water and vapor extraction alternative was confirmed as the selected remedial action for the site.

The selected remedial action entailed using de-watering to lower the water table in the area of concern, while using soil vapor extraction (SVE) to remove exposed volatile organic compounds (VOCs) from the subsurface. As mentioned above, this approach was selected to accelerate the pace of the remediation. Specifically, the selected remedial action offered the opportunity to approach or meet ground water remedial goals in two to four years while a conventional pump-and-treat technology was estimated to take at least six to eight years to achieve the same goals.

Konica entered into another order on consent to construct and operate the selected remedial action (remediation system). Construction and startup/shakedown was completed in the fall of 1994 and the remediation system began operating in November 1994. The remediation system operated from November 1994 to August 1996, twenty-one (21) months, before entering a six-month period of temporary shutdown. This period of temporary shutdown commenced in accordance with Section II (G) of the order on consent and the subsequent Performance Analysis Design Modification Plan (PADMP) that was part of the approved remedial design. The remediation system was restarted in February 1997 and operated until November 1999, an additional thirty-three (33) months of operation. At that time, the remediation system entered a second period of temporary shutdown in accordance with the approved PADMP.

Based on the data collected during the second period of temporary shutdown, the remediation system has now reached a point where, in accordance with the approved PADMP, permanent shutdown is appropriate and post shutdown monitoring can commence.

1.2 *PURPOSE AND GOALS OF THE REMEDIATION SYSTEM*

As stated in the ROD, the goals of the combined ground water and vapor extraction system have been to remove contaminants from ground water by:

- Treating ground water such that, to the extent technically feasible, the concentration of contaminants is reduced to within promulgated standards;
- Ensuring that remediation activities do not increase the potential for the migration of contaminated ground water by damaging the naturally occurring confining layer; and
- Treating soil via soil vapor extraction to prevent the recontamination of ground water by the leaching of chemicals out of the soil mass.

Table 4 in the ROD summarizes applicable or relevant and appropriate requirements for ground water for the target chemical contaminants. The section in the ROD entitled <u>Compliance with State Standards, Criteria, and Guidance</u> (ROD page 14) states that New York State quality standards for ground water are the chemical specific goals for the ground water remediation. Soil cleanup will be based on preventing further ground water contamination via leaching to levels above the aforementioned ground water standards. The chemical specific goals for ground water apply to the following nine VOCs:

- Benzene
- Chloroethane
- Dichloroethane (all isomers)
- Dichloroethene (all isomers)
- Ethylbenzene
- Tetrachloroethene
- Toluene
- Trichloroethene
- Xylenes (all isomers)

The chemical specific goal for each VOC, or its isomer, is 5 μg/L. This value represents the standard contained in New York State Sanitary Code, Subpart 5-1, Public Water Supplies.

1.3 *DESCRIPTION OF THE REMEDIATION SYSTEM*

The remediation system is comprised of four main components: 1) ground water recovery, 2) ground water treatment, 3) Soil Vapor Extraction (SVE), and 4) soil vapor treatment. A process flow diagram of the treatment system is provided in Figure 1-3. Figure 1-4 indicates the location of the ground water recovery wells (WRWs), soil vapor recovery wells (VRWs), passive air inlet wells (AIWs), and ground water monitoring wells (MWs).

Ground water recovery was accomplished via thirty (30), WRWs that de-watered the area of concern. The recovered ground water was treated, typically at a total flow rate of 6 to 15 gpm, by two low profile air strippers configured for operation in series or parallel. Initially, the air strippers operated in series. However, as the ground water VOC concentrations declined, the two air strippers were operated in parallel. In June 1997, one air stripper was used to treat the ground water.

The ground water recovery treatment system included an upstream addition of polyphosphate sequestering agent that was used to prevent iron from fouling the air strippers. However, this was taken offline during the beginning of the second phase of operations in the late spring of 1997, and a more frequent air stripper cleaning schedule was utilized. During this period, it was determined that more frequent cleaning of the air strippers was more effective than the polyphosphate at preventing air stripper shutdown due to iron fouling.

After treatment by the air strippers, the ground water was pumped to on-site storm drain piping that ultimately discharged to the City of Glen Cove Storm Sewer System. The final discharge point of the storm sewer system is the Glen Cove Creek. Off-gas from the air strippers was conveyed to a thermal oxidizer that was also used to treat the extracted soil vapor gas.

The SVE system consisted of twelve (12) VRWs and eighteen (18) AIWs. Moisture in the extracted soil vapor was removed with a cyclone separator and transferred to the air stripper inlet for treatment. Dilution air was added to the soil vapor stream, when necessary, in order to reduce the percent lower explosive limit (LEL) of the soil vapor, and to meet safety requirements. Each VRW was fitted with a valve such that applied vacuum and soil vapor flow from each VRW could be regulated. The system was designed to operate at a maximum total flow rate of up to 240 cfm. Total soil vapor flow rate was typically 200 cfm. A 10-Horsepower blower conveyed the soil vapor from the VRWs to the thermal oxidizer, which was capable of treating flows of up to 1,000 cfm. The vapor was treated by the oxidizer and discharged to the atmosphere in accordance with the limits specified in 6 NYCRR Part 212 and Air Guide 1.

2.0 *ROLE OF THE PERFORMANCE ANALYSIS AND DESIGN MODIFICATION PLAN (PADMP)*

The PADMP for this site was prepared in accordance with the NYSDEC Order on Consent, Index No. W1-0547-91-07, executed on 12 May 1993. The PADMP was submitted to NYSDEC in September 1994, and was subsequently approved by the NYSDEC in a letter to Konica, dated 21 September 1994.

The PADMP was intended to achieve the following objectives:

1) evaluate the performance of the remediation system components to determine whether they are operating in accordance with the design intent of the remediation system;
2) evaluate the effectiveness of the remediation system in achieving the remedial goals established in the NYSDEC Record of Decision;
3) define monitoring requirements, methods of data analysis and decision-making processes to effect operational changes or design modifications to the system, in order to meet recovery and treatment requirements or improve the ability of the system to achieve the remedial goals; and
4) establish a mechanism to implement temporary and permanent shutdown of the remediation system.

2.1 *PERFORMANCE AND EFFECTIVENESS MONITORING*

The PADMP considers both the performance and effectiveness of the remediation system. The criteria developed to evaluate performance focused on the adjustable components and record keeping procedures for each of the recovery and treatment elements in the remediation system. Based on these, specific operational adjustments to assist in meeting the design objectives and to improve overall system effectiveness were defined. In general the remediation system's effectiveness was to be based upon ground water quality data that was also used to assess the remediation system's progress towards achieving the remedial goals. In addition, the ground water quality data was also used to make temporary and permanent shutdown decisions, as discussed in Section 2.2.

A summary of the remediation system's performance monitoring data and effectiveness monitoring data, i.e., ground water quality data, is presented in Sections 3.0 through 3.3. Section 3.3 also presents a summary of the overall effectiveness of the remedial action and provides a description of the current status of the project.

2.2 *TEMPORARY AND PERMANENT SHUTDOWN EVALUATION*

In Section 4.0 of the PADMP, a specific plan for shutdown of the remediation system is provided. Figure 2-1 presents a flow chart that summarizes the approach to determine the timing of temporary shutdowns, and the decision mechanism for progressing to a permanent/post-shutdown monitoring period. Figure 2-1 also shows the pathway that has been taken towards permanent shutdown, as indicated by the dotted line. The current status of the project is further detailed in Section 3.3.

The remediation system was designed to dewater the area of concern to expose saturated soils containing VOCs that were then removed through vapor extraction. This approach was intended to aggressively remove the contaminants that were responsible for ground water concentrations in excess of the remedial goals set forth in the ROD. Consequently, in order to assess progress toward meeting the ground water remedial goals in the ROD, the PADMP established a mechanism to determine when to temporarily shut down the system. The temporary shutdown permitted the ground water to rise and equilibrate with the soil mass impacted by VOCs. Then, samples of ground water were collected to gauge the remedial system's effectiveness.

There were two temporary shutdown criteria established in the PADMP. The first criterion for temporary shutdown approval was when the monthly toluene removal for three consecutive months was less than 10% of the maximum monthly removal in any previous month. The second criterion for temporary shutdown approval was the completion of one year of system operations.

Once the system achieved temporary shutdown, and the ground water rose, ground water samples were collected from the site monitoring wells (MW-1, MW-3R, MW-4, MW-5, MW-6, MW-8, MW-11 and MW-12), and from the treatment system influent. If the sampling results indicated that the remedial goals (see Section 1.2) were attained, the remediation system would meet the criteria for permanent shutdown. If the criteria were not achieved, then a second round of operations would occur.

Once the temporary shutdown criteria were met again, the system would be shut down, the ground water level would rise, and ground water samples would be collected. If the sampling results of site MWs and treatment system influent indicated that the remedial goals, or the Federal Maximum Contaminant Levels (MCLs) were achieved, then the system would meet the criteria for permanent shutdown. If the remedial goals and the MCLs were not achieved, then a focused risk assessment would be prepared.

The dotted line in Figure 2-1 indicates how the recent ground water sample results meet the ROD remedial goals in all site MWs but exceed the federal MCL for toluene (1,000μg/L) in the treatment system influent, and therefore, the remedial system has reached the point in the flow chart that provides for the completion of a focused risk assessment. If the conclusions of the focused risk assessment that is presented in Section 4.0 of this report indicate that the residual risks are acceptable, then permanent shutdown criteria are met. Following permanent shutdown, a period of post-shutdown monitoring would then commence.

2.3 *POST SHUTDOWN MONITORING*

Post shutdown monitoring will involve quarterly samples from the aforementioned monitoring wells for the VOCs with remedial goals. The average specific VOC concentration, based on the four quarters of measurement, will be reviewed to determine whether ambient ground water concentrations have increased above the levels that were present at the time of permanent shutdown.

If the average specific VOC concentrations, based on the four quarters of measurement, indicate levels at, or below, the remedial goals, the remedial action will be deemed complete.

If the average specific VOC concentrations, based on the four quarters of measurement, indicate levels at, or below, the federal MCLs (following two years of operation), the remedial action will be deemed complete.

If the average specific VOC concentrations, based on the four quarters of measurement, indicate levels above the federal MCLs, the focused risk assessment will be re-visited to determine if the residual chemical mass poses an unacceptable risk to human health and the environment. The outcome of the focused risk assessment will dictate either a re-start of the system or deem the remedial action complete. For more detailed information on the approved mechanism for shutdown, see Section 4.0 of the PADMP.

3.0 *SUMMARY OF OPERATIONS*

As previously indicated in Section 1.1, the remediation system began operations in November 1994. The remediation system operated from November 1994 to August 1996, twenty-one (21) months, before entering a six-month period of temporary shutdown. During this period of temporary shutdown, remediation system enhancements were made as outlined in Section 3.2. The remediation system was re-started in February 1997 and operated until November 1999, another thirty-three (33) months of operation. At that time, the remediation system entered a second period of temporary shutdown in accordance with the PADMP.

Based on the data collected during the second period of temporary shutdown, the remediation system has now reached a point where, in accordance with the PADMP, permanent shutdown is appropriate and post shutdown monitoring can commence.

The following sections present a summary of the performance and effectiveness data collected during the first and second periods of operation and a summary of remediation system enhancements that were made during the period of temporary shutdown. A summary of the system's overall effectiveness is also provided.

3.1 *SUMMARY OF PERFORMANCE AND EFFECTIVENESS MONITORING DATA - FIRST ROUND OF OPERATIONS*

In November 1994, the ground water treatment system was brought online. Approximately two months later, in January 1995, once the remediation area was sufficiently dewatered, the SVE system was brought online. The remediation system then operated for another nineteen (19) months until August 1996. During this twenty-one (21) month period, performance monitoring data was collected monthly and used, as presented in the PADMP, to adjust the remediation system's components to ensure efficient operation of the equipment, and to ensure maximum removal of VOCs. These monthly adjustments included:

- Monitoring VOC concentrations from individual VRWs with a photoionization detector (PID). This data was used to adjust flow rates from the individual VRWs, flows were increased from wells with higher PID readings and flows were reduced from wells with lower PID readings;
- Adjusting the frequency of the recovery well pumps. The frequency controlled the flow rate of the pumps and by adjusting the frequency, it was attempted to match the well yield to the pump flow. The closer the pump flow rate is to the well yield, the less frequent the pump will cycle, which optimized the performance of the pump; and
- Adjusting the heights of the recovery well pump's, on/off level switches to ensure maximum de-watering while preventing the pump from running dry and or cycling on/off excessively.

At the end of each month of remedial system operations, a detailed monthly operations summary report was prepared and submitted to the Department. Each of these reports summarizes the adjustments that were made as operating conditions dictated.

Performance Monitoring Data Summary

During the first twenty-one (21) months of ground water recovery operations, (November 1994 to August 1996), 8.8 million gallons of ground water were recovered and treated at the site. Table 3-1 summarizes ground water and SVE performance monitoring data collected during this first period of operations. The data indicates that an estimated 1,100 pounds of toluene were removed from the recovered ground water via air stripping. The air stripper off-gases were transferred to and destroyed by the on-site thermal oxidizer.

During the operation of the remediation system, ground water samples were routinely collected from the treatment system influent and from the site MWs. The laboratory analytical data results for samples collected for the nine parameters of concern, as discussed in Section 1.2, are presented in Tables 3-2 and 3-3. The data in Table 3-2 indicates that the ground water treatment system provided sufficient VOC removal from the recovered ground water prior to discharge to the Glen Cove Storm Water System.

Table 3-1 also indicates that during the 19 months of SVE operations, an estimated 7,400 pounds of toluene were recovered from the de-watered strata beneath the site. The soil vapor gases and air stripper off-gases were conveyed and destroyed by the thermal oxidizer. Vapor samples were routinely collected from the combined gases influent header pipe to the thermal oxidizer and the oxidizer's discharge stack. The laboratory analytical data collected is summarized in Table 3-4 and indicates that the thermal oxidizer provided effective destruction of the parameters of concern prior to discharge to the atmosphere.

In summary, during this first period of operations which lasted twenty-one (21) months, it is estimated that 8,500 pounds of toluene were removed from the remediation area. In addition to the 8,500 pounds of toluene removed by the remedial system, it is also believed that a substantial amount of toluene was biologically degraded by the presence of indigenous bacteria. Although no monitoring data was collected, it is assumed that an increase in the population of indigenous VOC degrading bacteria occurred due to the increased oxygen levels in the impacted area due to the use of SVE and the passive AIWs.

Effectiveness Monitoring Data Summary

As discussed above, during the operation of the remediation system, ground water samples were routinely collected from the treatment system influent and from the site MWs. As shown in Table 3-2, the toluene concentration in the treatment system influent decreased over the 21-month operational period from an initial level of 100,000 μg/L to 310 μg/L. This trend indicates that as the SVE system removed VOCs from the subsurface, the toluene level was being reduced in the ground water recovered from the remediation area. This trend indicates that the remedial system was effectively progressing towards achieving the remedial goals.

As shown in the graph contained in Table 3-1, it is estimated that approximately 8,500 pounds of toluene were removed by the remediation system during the first operational period. During this first round of operation the maximum monthly toluene removal rate was 1,406 pounds. At the end of this period of operations and after the PADMP criteria of three consecutive months with a toluene removal rate less than 10% of the maximum monthly removal rate (i.e., <140 pounds of toluene), the monthly toluene removal rate was approximately 74 pounds of toluene per month. This data indicates that a decreasing rate of toluene removal is evident as the length of time of SVE system operation increased.

When the temporary shutdown criteria were met in August 1996, the system was shut off, as approved by the Department, and the water table was allowed to rebound. After the ground water levels rebounded to static levels (January 1997), site MWs and the treatment system influent, were sampled, in accordance with the PADMP.

Table 3-3 presents a summary of the analytical results from routine MW ground water sampling and the effectiveness monitoring results obtained in January 1997. The data indicates that once the remediation area was allowed to recharge and the ground water level rebounded, the remedial goals were met in all the MWs except MW-5. The MW-5 ground water sample, collected in January 1997, exhibited a toluene concentration of 70 μg/L. The data also indicates that during the operational period, when the remediation area was de-watered, the parameters of concern were all non-detectable in the site MWs.

In January 1997, the treatment system influent concentration of toluene was 5,000 μg/L, (See Table 3-2). When compared to the initial toluene concentration of 100,000 μg/L, observed in November 1994, it can be seen that an approximate two order of magnitude decrease in the toluene concentration was realized. This data indicates that the remedial system was effective in reducing the VOC source material, thereby reducing the amount of VOCs that could leach from site soils into the ground water.

3.2 *REMEDIATION SYSTEM ENHANCEMENTS*

Based on a review of the performance monitoring data collected during the first round of operations, it was determined that it would be beneficial if the remediation system's ground water de-watering capability could be enhanced. In addition, WRW pump end inspections conducted in the spring/summer of 1996 indicated that several of the WRW pump ends were severely worn. It was believed that by changing the pump ends to larger capacity, the units could provide additional de-watering capabilities and prevent pump end failure due to wear. Therefore, during the first temporary shutdown, the following enhancements were made to the ground water recovery system:

1) *Well redevelopment* - All thirty (30) WRW pumps and recovery piping were removed from the wells. The recovery wells were re-developed by adding solutions of mild acids (CETCO LBA and DPA) to remove

bacteria and scale deposits. Finally, each well screen was surged with a surge block and pumped clear;

2) *Pump replacement* – During the first round of operation, heavy sand and debris in the WRWs was found to limit the performance of the WRW pumps. In addition, the desire to increase the dewatering capacity of the ground water recovery well system led us to evaluate the use of replacement pumps for each well. Based on total dynamic head (TDH) and flow requirements, a new pump and motor was specified for each individual WRW, with the exception of four wells. These wells were found to provide very little yield (< 1gpm), and were considered to have little or no impact on the overall site dewatering effort. Of the remaining twenty-six (26) wells, ten recovery well pumps were upgraded with pump ends that have a maximum flow capacity of 15 gpm and the other sixteen (16) well pump ends were upgraded with pump ends that have a maximum flow capacity of 25 gpm. The original pump ends had a maximum flow capacity of 10 gpm. All twenty-six (26) recovery well pump motors were replaced with new 1.5 hp electric motors; and

3) *Electrical troubleshooting* – Repairs were made to several of the variable frequency drives (VFDs) and damaged electrical wires were replaced.

All of these activities resulted in an increase in the ground water recovery capacity of the recovery system across the remediation area. Table 3-5 presents the depth-to-water (DTW) for each AIW and VRW in June 1996, and one year later, at the start of the second round of operations in June 1997. In June 1996, the average DTW was 19.56 feet. One year later, the average depth to water was 19.82 feet. However, from June 1996 to June 1997, the regional water table elevation increased by two feet and the ground water influent volume increased from 144,000 gallons recovered in June 1996 to 343,000 gallons recovered in June 1997. Although there was a marginal decrease in the average site water level, the pump replacement and other enhancements allowed the treatment system to handle the increase in ground water present in the remediation area due to regional conditions.

3.3 SUMMARY OF PERFORMANCE AND EFFECTIVENESS MONITORING DATA - SECOND ROUND OF OPERATIONS

With the new recovery well pumps online, the ground water recovery treatment system was restarted in February 1997. In June 1997, the remediation area was sufficiently de-watered, and the SVE system was brought back online. The remediation system then operated for another twenty-nine (29) months.

Similar to the first round of operations, adjustments were continuously made to the treatment system to maximize performance of the equipment and overall effectiveness of the treatment system. As before, this was accomplished by adjusting air flow rates from the VRWs, adjusting pumping rates of the WRWs pump motors, replacing fouled WRW pump ends, and changing the height of the pump on/off level switches in each WRW. At the end of each month of remedial system operations, detailed monthly operations summary report was prepared and submitted to the Department. Each of these reports summarizes the adjustments that were made as operating conditions dictated.

Performance Monitoring Data Summary

During the thirty-three (33) months of ground water recovery operations (February 1997 to November 1999), approximately 10.8 million gallons of ground water were recovered at the site. Table 3-6 summarizes ground water and SVE performance monitoring data collected during this second period of operations. The table indicates that an estimated 37 pounds of toluene were removed from the recovered ground water via air stripping. The air stripper off-gases were transferred to and destroyed by the on-site thermal oxidizer.

During the operation of the remediation system, ground water samples were routinely collected from the treatment system influent and from the site MWs. The laboratory analytical data results for samples collected for the nine parameters of concern, as discussed in Section 1.2, are presented in Tables 3-3 and 3-7. The data in Table 3-7 indicates that the ground water treatment system provided sufficient VOC removal from the recovered ground water prior to discharge to the Glen Cove Storm Water System.

Table 3-6 also indicates that during the twenty-nine (29) months of SVE operations, an estimated 4,350 pounds of toluene were recovered from the de-watered strata beneath the site. The soil vapor gases and air stripper off-gases were conveyed and destroyed by the thermal oxidizer. Vapor samples were routinely collected from the combined gases influent header pipe to the thermal oxidizer and the oxidizer's discharge stack. The laboratory analytical data collected is summarized in Table 3-4 and indicates that the thermal oxidizer provided effective destruction of the parameters of concern prior to discharge to the atmosphere.

In summary, during the second period of operations, lasting thirty-three (33) months, it is estimated that 4,400 pounds of toluene were removed from the remediation area. In addition to the 4,400 pounds of toluene removed by the remedial system, it is also believed that a substantial amount of toluene was biologically degraded by the presence of indigenous bacteria. Although no monitoring data was collected, it is assumed that an increase in the population of indigenous VOC degrading bacteria occurred due to the increased oxygen levels in the impacted area due to the use of SVE and the passive AIWs.

After the re-starting of the SVE system in June 1997, the peak toluene removal rate was 2.6 pounds per day (lb/day) in July 1997. By December 1997, the toluene removal rate had declined to 0.039 lb/day. This low toluene removal rate was investigated by measuring the vacuum at the VRW wellhead, and at a point just upstream of the SVE piping manifold. These measurements indicated a significant loss of vacuum between the SVE blower and the SVE wellheads. Further investigation revealed that slugs of water were accumulating in the SVE piping and restricting soil vapor airflow. The cause of this problem was believed to be subsurface settling of the parking area, which resides above the system piping. It is likely that the settling caused low points in the flexible, copper SVE piping where water could accumulate.

During January 1998, changes were made to the routine maintenance regime of the remediation system that significantly improved the VOC removal effectiveness. On a regular basis, an air compressor was used to inject air into the SVE piping in order to remove any water that had accumulated in the SVE piping. Shortly after this operational modification was implemented, toluene removal rates increased to approximately 50 lb/day.

To further facilitate maximum VOC removal, the applied vacuum at the VRW wellheads was routinely monitored and utilized in conjunction with VRW water table elevation measurements. If the vacuum reading was too high, the water table would rise and limit the length of unsaturated zone through which soil vapor could flow. Also, a high vacuum could introduce droplets of water into the SVE piping, and exacerbate the water slug problem described above. Based on the applied vacuum, adjustments were made to the valve settings, which maximized the flow of air, minimized the collection of water, and ultimately, improved the removal of VOCs.

Approximately five months after the SVE clean-out process was implemented, routine performance monitoring data indicated there was a decrease in the volume of ground water extracted from the recovery wells. This problem was addressed in June 1998 as follows:

- Replacement of twelve (12) WRW pump ends;
- Clean-out of individual pipelines from the WRWs to the main plant header;
- Clean-out of pipes and pumps in the treatment building; and
- Electrical repairs were made to some WRW pumps that were not performing optimally.

These activities were effective in increasing the volume of ground water recovered from the site. In May 1998, the monthly ground water recovery total was approximately 167,000 gallons. By July 1998, after completion of the activities listed above, the total amount of ground water recovered increased three-fold and totaled 503,000 gallons. The resulting increase in the volume of water removed had a corresponding positive impact on the performance of the SVE system operation. In May 1998, the monthly toluene removal rate was 107 pounds and in July 1998, after completion of the activities listed above, the toluene removal rate increased three-fold to approximately 333 pounds.

From July 1998 onward, the monthly toluene removal steadily declined, until August 1999, when the SVE system was shutdown. As approved by the Department, the ground water recovery system was shutdown in November 1999, and the remediation system entered a second period of temporary shutdown.

Effectiveness Monitoring Data Summary

During the second round of remediation system operations, ground water samples were routinely collected from the treatment system influent and from the site MWs. As shown in Table 3-7, the toluene concentration in the treatment system influent decreased over the thirty-three (33) month operational period. The second period of operation's initial treatment system influent level, as indicated by the sample collected in January 1997, was 5,000 μg/L and the final sample collected in November 1999 was 300 μg/L. This trend indicates that as the SVE system removed VOCs from the subsurface the toluene level in the ground water recovered from the remediation area was being reduced. This trend indicates that the remedial system was effectively progressing towards achieving the remedial goals.

As shown in graph in Table 3-6, it is estimated that approximately 4,350 pounds of toluene were removed by the remediation system during the second operational period. The maximum, monthly toluene removal rate was 811 pounds and at the end of this period of operations, after the PADMP criteria of three consecutive months with a toluene removal rate less than 10% of the maximum monthly removal rate (i.e., <81 pounds of toluene), the monthly toluene removal rate was approximately 6 pounds of toluene per month. This data indicates that a decreasing rate of toluene removal is evident as the length of time of SVE system operation increases.

When the temporary shutdown criteria were again met in September 1999, the SVE system was shut off. Upon approval from the Department, the ground water recovery system was shut-off in November 1999, and similar to the first temporary shutdown, the ground water table was allowed to rebound to a static level. Ground water samples were again collected from the site MWs and the treatment system influent. The analytical results, as shown in Table 3-8, indicate that the site MWs had all achieved the ROD remedial goals. In fact, all but one of the monitoring wells had non-detectable levels of VOCs. However, the treatment system influent was 1,700 μg/L, and met neither the remedial goals, nor the MCLs for toluene.

The overall effectiveness of the remediation system can be observed by the approximate two-order of magnitude reduction in the influent toluene concentration, from an initial level of 100,000 μg/L (November 1994) to the current level of 1,700 μg/L, as indicated by the sample results of March 2000.

A further review of the treatment system influent analytical results from the March 2000 sample, indicates that the remaining parameters of concern, benzene, chloroethane, DCA (all isomers), DCE (all isomers), TCE and PCE, are all below the remedial goals and federal MCLs. The levels of ethyl benzene and xylenes (all isomers) are below the federal MCLs but exceed the remedial goals.

In total, during the two periods of operation approximately 12,900 pounds of toluene were extracted from the site. An overall summary of the recovery data is provided in table 3-9. A review of the graphical interpretation of this data, as shown in table 3-9, illustrates the decreasing trend in the overall removal efficiently of the remedial system over time.

This is now the current status of the remediation project. All of the paths taken to reach this point have been consistent with the Flow Chart in Section 4.0 of the PADMP (provided as Figure 2-1). As shown in the Flow Chart, in order to proceed toward permanent shutdown, a focused risk assessment must be prepared, and submitted to the Department. This focused risk assessment is provided in Section 4.0 and evaluates a worst-case scenario based on the potential impact from a volume of shallow ground water, exhibiting toluene levels of 1,700 μg/L, migrating towards Glen Cove Creek. A model is used to determine the toluene concentrations in ground water that may enter the creek. The toluene levels are compared to New York State Surface Water Criteria. Additionally, the focused risk assessment evaluates the potential for volatilization of VOCs (specifically toluene) to have impacts to humans while ground water migrates toward Glen Cove Creek. If the focused risk assessment shows no adverse impact from the residual toluene concentrations in the ground water, then permanent shutdown criteria will be met.

4.0 FOCUSED RISK ASSESSMENT

In accordance with the PADMP, a focused risk assessment was conducted to evaluate residual risk to human health and the environment associated with toluene in ground water following termination of the remediation system operation. The focused risk assessment is divided into four sections: (1) Background information (Section 4.1); (2) Identification of potential exposure pathways (Section 4.2); (3) quantitative evaluation of potential exposure pathways (Section 4.3); and (4) Conclusion (Section 4.4).

4.1 BACKGROUND INFORMATION

The site is defined as a 0.8-acre area of concern that is contaminated by the disposal of industrial waste from the former Columbia Ribbon and Carbon Company. The location of the site is shown in Figure 1-1 and a site map is presented in Figure 1-2. The site is paved and is currently used as a parking lot. The properties to the north and east of the site are predominantly residential. An industrial corridor that includes four other inactive hazardous waste disposal sites is located to the south and west of the site.

The shallow ground water at the site occurs at an average depth of approximately 11 feet, and is underlain by a semi-confining layer. Ground water flow is to the south-southeast across the site. Previous studies have indicated that contaminated ground water does not have the potential to move northward beyond the site boundary, and that the potential for contamination to migrate downward is extremely low. Analytical data further indicate that the contamination present is not readily migrating from the former disposal area (ERM-Northeast, 1992).

The shallow ground water at the site is not used for drinking water and is not adequate (based on volume and yield) for a community water source (ERM-Northeast, 1994). Ground water from the site could discharge to nearby streams. The nearest stream in the downgradient direction is Glen Cove Creek, located approximately 1,200 ft from the area of contamination. Between the area of contamination and Glen Cove Creek are an active manufacturing facility, a fuel depot and a cement manufacturing facility.

4.2 IDENTIFICATION OF POTENTIAL EXPOSURE PATHWAYS

Human exposure to toluene in ground water could potentially occur via two pathways: (1) inhalation of vapors; and (2) following discharge of ground water to Glen Cove Creek. Each of these pathways is discussed below.

Inhalation of Vapors: The site is currently paved and used for a parking lot for a nearby manufacturing facility. Manufacturing and commercial facilities are located between the site and Glen Cove Creek, to which site ground water may be discharging. Therefore, toluene in ground water could volatilize to ambient air and result in inhalation exposures to commercial workers. This pathway is quantitatively evaluated in Section 4.3.1.

Discharge of Site Ground Water to Glen Cove Creek: In the vicinity of the site, Glen Cove Creek is classified as Class SC (6 NYCRR 885.6 – Table 1, Item No. 39). The best usage of Class SC saline surface waters is fishing, and these waters are suitable for fish propagation and survival (6 NYCRR 701.12). The regulations state that the water quality for Class SC waters shall be suitable for primary and secondary contact recreation, but that other factors may limit the use for these purposes. Based on this information, the most likely potential human exposure pathway for toluene in site ground water discharging to Glen Cove Creek is ingestion of fish from the creek. This potential exposure pathway is quantitatively evaluated in Section 4.3.2.

Exposure to toluene in ground water by ecological receptors could occur following discharge of ground water to Glen Cove Creek. As noted above, Class SC waters are suitable for fish propagation and survival. Therefore, the exposed population would include aquatic life associated with the creek. This pathway is quantitatively evaluated in Section 4.3.3.

4.3 QUANTITATIVE EVALUATION OF POTENTIAL EXPOSURE PATHWAYS

As discussed in the previous section, potential exposure pathways for toluene in ground water at the site include: (1) inhalation of toluene from ground water by commercial workers; (2) ingestion of fish from Glen Cove Creek; and (3) impacts to aquatic life in Glen Cove Creek. Each of these potential exposure pathways is evaluated in the following sections.

4.3.1 *Inhalation of Toluene Vapors from Ground Water*

Inhalation exposures can occur through indoor air or outdoor air. In general, exposures via indoor air will be higher than for outdoor air. Therefore, although the site is currently used for a parking lot and is paved, it was assumed that a hypothetical industrial/commercial facility is present in the area of contamination in order to provide a more conservative (protective) evaluation. Thus, potential exposures to on-site commercial workers via inhalation of indoor air was evaluated.

In order to evaluate this pathway, a maximum allowable concentration of toluene in ground water was calculated based on inhalation of indoor air by commercial workers. In this approach, a maximum allowable concentration of toluene in indoor air is first developed. Then, using volatilization equations, the maximum concentration of toluene in ground water that would not result in the maximum allowable concentration in air being exceeded is calculated. This acceptable ground water concentration is then compared to actual concentrations detected in ground water at the site.

The following equation is used to determine the maximum allowable concentration in ground water for protection of enclosed space (indoor) air vapor inhalation. This equation and the equations that follow are taken from the attachment to NYSDEC's memorandum of February 23, 1998 regarding Petroleum Site Inactivation and Closure. Although it is recognized that this site is not part of the NYSDEC Spills Program, for which the above guidance was developed, the equations are applicable to the chemical of concern at this site (toluene).

$$C_{max\text{-}gw} = \frac{C_{max\text{-}air}}{VF_{wesp}}$$

where:

$C_{max\text{-}gw}$ = Maximum allowable contaminant concentration in ground water, mg/l - water

$C_{max\text{-}air}$ = Maximum allowable contaminant concentration in air, mg/m^3 - air

VF_{wesp} = Volatilization factor from ground water to air, (mg/m^3 - air)/(mg/l - water)

The maximum allowable contaminant concentration in air for non-carcinogenic effects (toluene is not considered to be carcinogenic) is given by:

$$C_{max\text{-}air} = \frac{THI \times BW \times AT_{nc} \times 365 \times RfD}{IR \times ED \times EF}$$

The definition of these variables and values assigned to each are provided in Table 4-1.

The volatilization factor from ground water to indoor air is calculated by:

$$VF_{wesp} = \frac{H \times ((D_{ws}^{eff}/L_{GW})/(ER \times L_B)) \times 10^3}{1 + (D_{ws}^{eff}/L_{GW})/(ER \times L_B) + ((D_{ws}^{eff}/L_{GW})/((D_{crack}^{eff}/L_{crack})\eta))}$$

where:

D_{ws}^{eff} = effective soil diffusion coefficient between ground water and soil surface, cm^2/sec, and is given by:

$$D_{ws}^{eff} = (h_{cap} + h_v) \times ((h_{cap}/D_{cap}^{eff}) + (h_v/D_s^{eff}))^{-1}$$

D_{cap}^{eff} = effective diffusion through capillary fringe, cm^2/s, and is given by:

$$D_{cap}^{eff} = (D^a \times (\theta_{acap}^{3.33}/\theta_T^{2.0})) + (D^w \times 1/H \times (\theta_{wcap}^{3.33}/\theta_T^{2.0}))$$

D_s^{eff} = effective diffusion coefficient in soil based on vapor-phase concentration, cm^2/s, and is given by:

$$D_s^{eff} = (D^a \times (\theta_{as}^{3.33}/\theta_T^{2.0})) + (D^w \times 1/H \times (\theta_{ws}^{3.33}/\theta_T^{2.0}))$$

D_{crack}^{eff} =effective diffusion coefficient through foundation cracks, cm^2/s, and is given by:

$$D_{crack}^{eff} = (D^a \times (\theta_{acrack}^{3.33}/\theta_T^{2.0})) + (D^w \times 1/H \times (\theta_{wcrack}^{3.33}/\theta_T^{2.0}))$$

The definition of all of the variables used in the above equations and values assigned to each are provided in Table 4-1.

Using the above equations and variables listed in Table 4-1, the maximum allowable concentration of toluene in ground water for a commercial worker at the site is 81,800 μg/L. Following the most recent temporary shutdown, toluene concentrations were measured at all monitoring wells at the site as well as at the influent to the treatment system. The maximum detected concentration was at the treatment system influent, with a concentration of 1,700 μg/L. Since the maximum detected concentration is well below the allowable concentration for this pathway, no adverse impacts to human health are expected to result from the presence of toluene in ground water due to inhalation.

4.3.2 *Ingestion of Fish from Glen Cove Creek*

As discussed in Section 4.3.1, following the most recent temporary shutdown of the remediation system, the maximum detected concentration of toluene at the site was 1,700 μg/L. The actual concentration of toluene in Glen Cove Creek (the exposure point for this pathway) following migration of ground water off-site and dilution in Glen Cove Creek would be lower still (see Section 4.3.3). NYSDEC has established a Surface Water Quality Standard (SWQS) for toluene in Class SC waters based on the ingestion of fish. The applicable SWQS for toluene is 6,000 μg/L (6 NYCRR 703.5(f) – Table 1). Since the maximum detected concentration of toluene at the site itself is lower than the applicable SWQS for ingestion of fish, and the concentration in Glen Cove Creek will be lower than the on-site concentration, no adverse impacts to human health via ingestion of fish are expected.

4.3.3 *Evaluation of Impacts to Aquatic Life in Glen Cove Creek*

NYSDEC has not established a Surface Water Quality Standard for toluene for the protection of aquatic life (6 NYCRR 703.5(f) —Table 1). However, NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 (dated June 1998) includes a guidance value for toluene for the protection of aquatic life. For Class SC waters, the acute and chronic criteria for the protection of aquatic life for toluene are 430 μg/L and 92 μg/L, respectively. The maximum detected concentration of toluene at the site following the most recent temporary shutdown is 1,700 μg/L. Therefore, a solute transport model was used to predict concentrations of toluene in Glen Cove Creek due to discharge of site ground water to the creek following termination of remediation system operation.

The modeling approach used assumes that there is a continuous aquifer between the site and Glen Cove Creek. There is significant evidence suggesting that the ground water at the site is an isolated lens (i.e., perched). If this is the case, the hydraulic gradient used in the analysis is much higher than reality. The continuous aquifer assumption is therefore conservative (i.e., it will overestimate the concentration at the receptor) because a higher gradient would result in a higher solute flow velocity and less decay. The model is used to predict the concentration in ground water that reaches the receptor and does not consider the dilution that will occur when this water discharges to the creek. This adds an additional element of conservatism to the general approach.

The model used for the evaluation was the Domenico Model (Domenico and Schwartz, 1990). The Domenico model utilizes the following assumptions:

- Uniform flow field;
- Homogeneous, isotropic aquifer; and
- Continuous contaminant source.

Domenico is a one-dimensional model but can account for three-dimensional dispersion, as well as retardation and first order decay. A number of input parameters are required which are presented and discussed below.

Input Parameter Discussion

Distance To Compliance Point Along Centerline Of Plume: The distance from the center of the North Lot to Glen Cove Creek is approximately 1,200 feet.

Average Ground Water Concentration in Source Area: A sample of the influent to the treatment system was recently collected after a planned shutdown. Toluene was present in this sample at 1,700 μg/l.

Longitudinal Dispersivity: A value of 20 feet was used, which is a typical value for the Upper Glacial aquifer on Long Island.

Transverse Dispersivity: A value of 1.5 feet was used, which is a typical value for the Upper Glacial aquifer on Long Island.

Vertical Dispersivity: A value of 1.5 feet was used, which is a typical value for the Upper Glacial aquifer on Long Island. In general, it should be noted that the values used for dispersivity are low, and will result in less plume dispersion than higher values. Less dispersion results in a higher predicted concentration at the receptor.

Hydraulic Conductivity: A value of 18.5 feet/day was used which corresponds to the average result of slug tests performed as part of the North Lot Remedial Investigation (McLaren/Hart, 1991). This value is higher than those determined by a pumping test performed at the site in May 1992 (ERM, 1992). This test found that most of the North Lot area had lower hydraulic conductivity (i.e., less than 10 feet/day). Only in the outlying portions of the study area did the values exceed 15 feet/day. It is therefore concluded that the hydraulic conductivity value used in this modeling exercise may be higher than reality. A higher value for this parameter increases ground water flow velocity, which decreases the time it takes the solute to reach the receptor. This decreases decay, thus resulting in an overestimation of the predicted concentration at the receptor.

Hydraulic Gradient: A value of 0.042 was determined from site data. The water table elevation underlying the North Lot is approximately 50 feet MSL (McLaren-Hart, 1991). The gradient was determined assuming a head difference of 50 feet over the distance to Glen Cove Creek (1200 feet).

Effective Porosity: A value of 0.35 is assumed.

Toluene First Order Decay Constant: The value of 0.0033 days^{-1} was determined by dividing 0.693 by a half-life of 30 weeks (210 days). This half-life is the upper end of the range reported in "Handbook of Environmental Degradation Rates" (Howard, et. al., 1991) for aerobic and anaerobic decay of toluene in ground water. A longer half-life represents slower decay and will result in a higher predicted concentration at the receptor.

Source Width Perpendicular to Ground Water Flow Direction: The width of the North Lot remediation area perpendicular to ground water flow is 200 feet.

Source Vertical Thickness: The plume in the North Lot area is known to be limited to the shallow ground water. The plume thickness is therefore estimated to be twenty (20) feet.

Ground Water Flow Velocity: 6.6 feet/day is calculated using Darcy's Law.

Aquifer Organic Carbon Content (*Foc*): Soil samples at the site collected in 1992 were analyzed for *Foc* - the average value of these samples being 0.12% (ERM, 1992). This is the value used in this modeling exercise.

Toluene/*Foc* Partition Coefficient (*Koc*): The utilized value of 227 (dimensionless) is the average of a range of values reported in EPA, 1998.

Distribution Coefficient (*Kd*): The utilized value of 1.135 (dimensionless) is determined using the following relationship (Freeze and Cherry, 1979, page 403):

$Kd = Foc \times Koc.$

Aquifer Bulk Density: The utilized value of 1.75 g/cc was chosen such that bulk density/effective porosity equals 5.0 as prescribed for "most soils" in (Brubaker, et al., 1993).

Retardation Coefficient (*Rf*): The utilized value of 4.63 (dimensionless) is determined using the following relationship (Freeze and Cherry, 1979, page 404):

$Rf = 1 + ((\text{Bulk Density}/ \text{ Porosity}) \times Kd)$

Solute Flow Velocity: The retarded solute flow velocity (0.99 feet/day) was determined as follows (Freeze and Cherry, 1979, page 404):

$V_{solute} = V_{gw}/Rf$

Model Results

The input parameters presented above were utilized in the Domenico model equation which is presented in Table 4-2 (ASTM, 1995). The only difference between the equation shown in Table 4-2 and the version used in this exercise was that the retarded solute flow velocity was used in place of ground water seepage velocity. The model equation was programmed to run on an Excel spreadsheet. To simplify the model computations, the Domenico equation was subdivided into five separate calculations.

The results of the model run are presented in Table 4-3. The results indicate a predicted toluene ground water concentration discharging to Glen Cove Creek of less than 5.0 µg/l. This value is within the New York State Ambient Ground Water Quality Standard (for Class GA water) and far less than the NYSDEC chronic surface water quality guidance value for Class SC waters for protection of aquatic life (92 µg/l). Recalling the multiple levels of conservatism built into this modeling exercise, it can be concluded that terminating the remediation system operation will not represent an unacceptable risk to aquatic life in Glen Cove Creek.

4.4 *CONCLUSION*

A focused risk assessment of residual toluene in ground water at the North Lot remediation site was conducted to evaluate risks to human health and the environment following termination of the remediation system. Three potential exposure pathways were identified: (1) inhalation of toluene following volatilization from ground water for a commercial worker; (2) ingestion of fish from Glen Cove Creek following discharge of site ground water to the creek; and (3) impacts to aquatic life in Glen Cove Creek following discharge of site ground water to the creek. For all three pathways, the predicted exposure point concentrations are well below acceptable levels. Thus, the presence of residual toluene in ground water following termination of the remediation system operation at the site is not expected to pose any unacceptable risk to either human health or the environment.

5.0 EVALUATION OF HISTORIC AND CURRENT REMEDIATION COSTS

The focused risk assessment has shown that, by entering permanent shutdown, the residual toluene mass would not pose an unacceptable risk to human health and the environment. Moreover, a review of the toluene removal rates shows that significantly lower amounts of chemical mass are being removed under the same operating scenario. Hence, continued operation of the remediation system has reached a point of depreciating returns. In fact, as demonstrated below, continued operation would consume more hydrocarbons then would be removed.

Figure 5-1 presents, on a logarithmic scale, the utility costs to remove one pound of toluene throughout the duration of remedial activities. The utility costs include the cost of electric power to operate the remediation system equipment, and the cost of propane needed to operate the thermal oxidizer. A best-fit line was plotted for the data in the first and second round of operations. As shown in Figure 5-1, the utility costs at the start of the first and second round of operations were approximately $2 per pound of toluene removed.

During the first round of operation, utility costs had increased to approximately $20 per pound of toluene removed after one year. When the system met the criteria for the first temporary shutdown, utility costs had increased to approximately $50 per pound of toluene removed. These costs increased significantly during the second round of operation. After one year of operation in the second round, utility costs had risen to approximately $50 per pound of toluene. By the time the criteria were met for the second temporary shutdown, the utility costs had increased by over two orders of magnitude to approximately $400 per pound of toluene removed.

These data illustrate the trend of increasing costs for power and propane needed to operate the remediation system. From the end of the first round of operations to the end of the second round of operations, the remediation system costs increased by an order of magnitude. Any further system operations would most likely be conducted at excessively high utility costs that may increase to over $1,000 per pound of toluene removed.

6.0 SUMMARY AND CONCLUSIONS

An aggressive remedial approach, site de-watering and SVE, was confirmed as the selected remedial action and installed at the site. It was selected to accomplish a greater removal of VOCs, in a shorter time frame, from the unsaturated and saturated zones beneath the site than conventional ground water pump and treat.

The remediation system has been online from November 1994 to November 1999. During this time, the concentration of toluene in the recovered ground water has decreased from 100,000 μg/L to 1,700 μg/L. This reduction in toluene concentration has been achieved by removing a total of 12,900 pounds of toluene from the subsurface.

The operation of the remediation system has been conducted in accordance with the approved PADMP. This included numerous enhancements to the remediation system, including pump replacements, and continuous adjustments to the remediation system equipment. These enhancements and adjustments were successful in optimizing the performance of the selected remediation.

Now after a second period of temporary shutdown, the effectiveness monitoring data indicates that ambient ground water quality in the perimeter monitoring wells meet the ROD remedial goals. However, the influent water quality to the ground water treatment system shows a toluene level above the federal MCL.

Pursuant to the approved PADMP, a focused risk assessment, which considered three potential exposure pathways was performed. The three pathways were: (1) inhalation of toluene following volatilization from ground water for a commercial worker; (2) ingestion of fish from Glen Cove Creek following discharge of site ground water to the creek; and (3) impacts to aquatic life in Glen Cove Creek following discharge of site ground water to the creek. For all three pathways, there was no unacceptable risk, resulting from the residual amount of toluene, posed to human health and the environment.

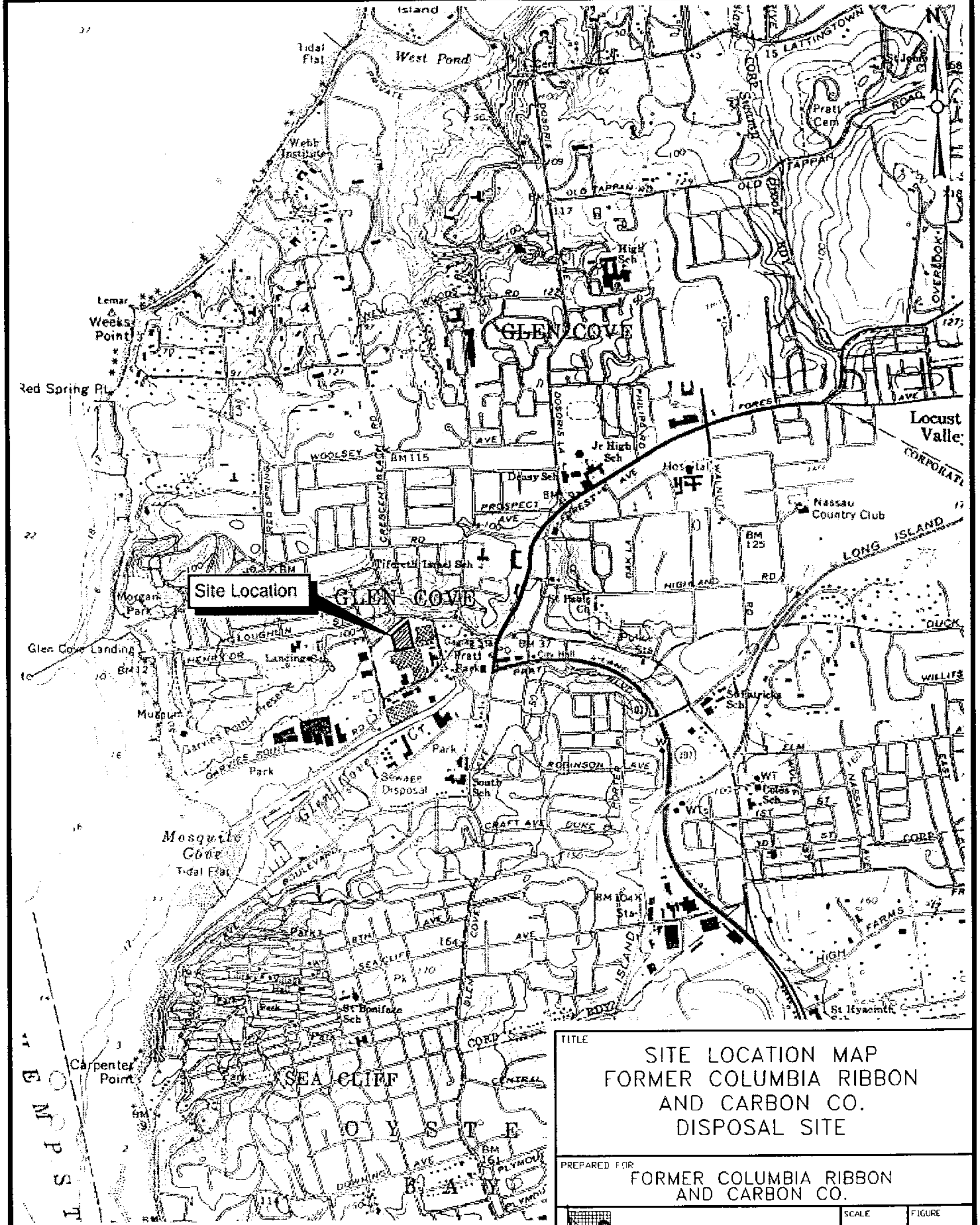
In light of the findings of the focused risk assessment and the diminishing returns realized from continued remediation system operation, this document is a formal request for NYSDEC approval for the remediation system to enter permanent shutdown. This request is made in accordance with the PADMP and is further supported by the analysis of ever increasing power use costs and hydrocarbon consumption. Once approved by the Department, a period of post-shutdown monitoring, as described in the PADMP, will commence.

Post shutdown monitoring will involve quarterly samples from the aforementioned monitoring wells for the VOCs with remedial goals. The average specific VOC concentration, based on the four quarters of measurement, will be reviewed to determine whether ambient ground water concentrations have increased above the levels that were present at the time of permanent shutdown.

If the average specific VOC concentrations, based on the four quarters of measurement, indicate levels at, or below, the remedial goals, the remedial action will be deemed complete.

If the average specific VOC concentrations, based on the four quarters of measurement, indicate levels at, or below, the federal MCLs (following two years of operation), the remedial action will be deemed complete.

If the average specific VOC concentrations, based on the four quarters of measurement, indicate levels above the federal MCLs, the focused risk assessment will be re-visited to determine if the residual chemical mass poses an unacceptable risk to human health and the environment. The outcome of the focused risk assessment will dictate either a re-start of the system or deem the remedial action complete. For more detailed information on the approved mechanism for shutdown, see Section 4.0 of the PADMP.



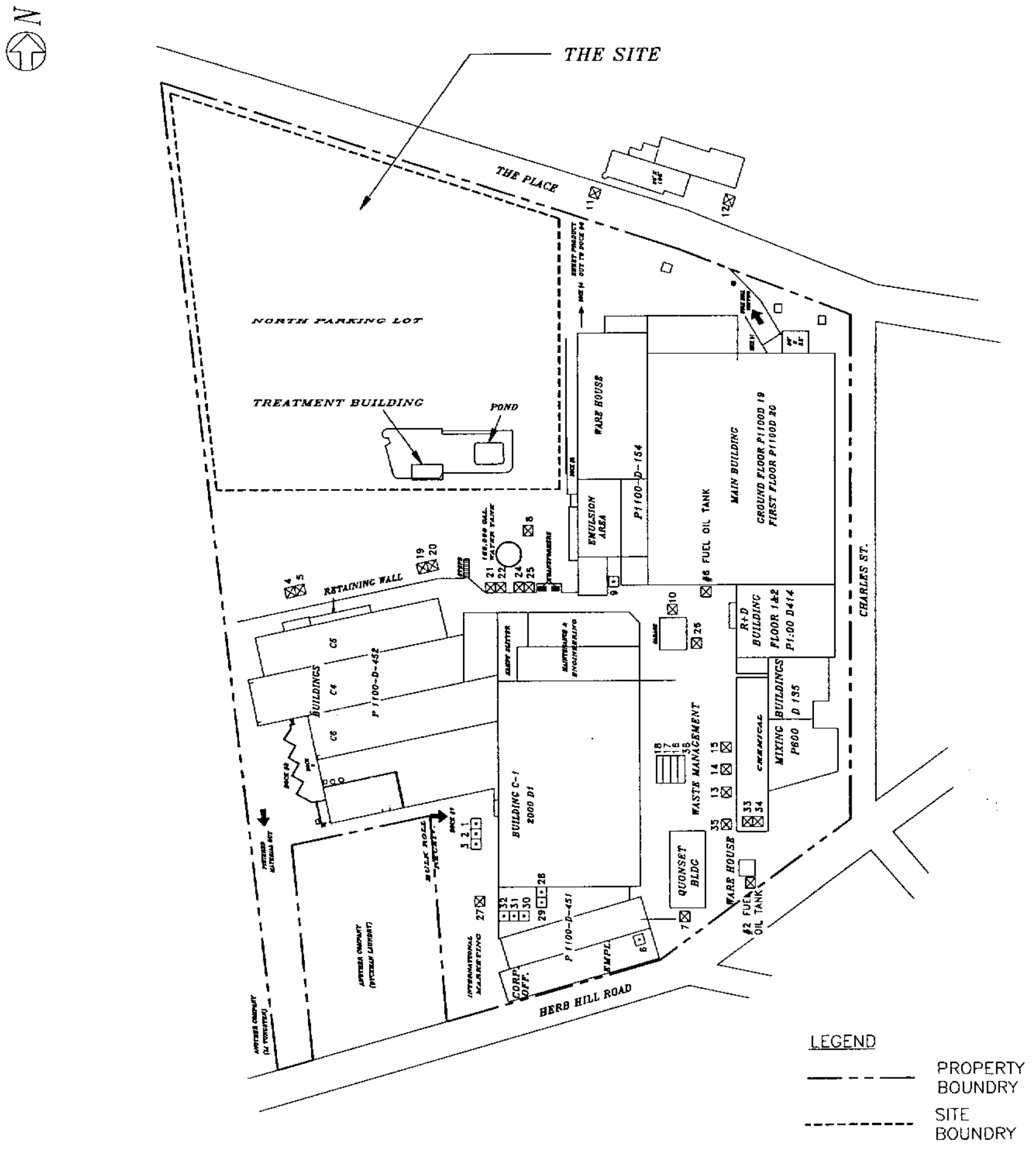
SOURCE: U.S.G.S. QUADRANGLE MAPS, BAYVILLE, HICKSVILLE MAMARONECK & SEA CLIFF, NY

TITLE

SITE LOCATION MAP
FORMER COLUMBIA RIBBON AND CARBON CO. DISPOSAL SITE

PREPARED FOR
FORMER COLUMBIA RIBBON AND CARBON CO.

ERM Environmental Resources Management		SCALE 1"=2000'	FIGURE 1—1
DRAWN Y.S.	JOB NO. 68904.00	FILE NAME: 68904021	DATE 8/18/00



TITLE

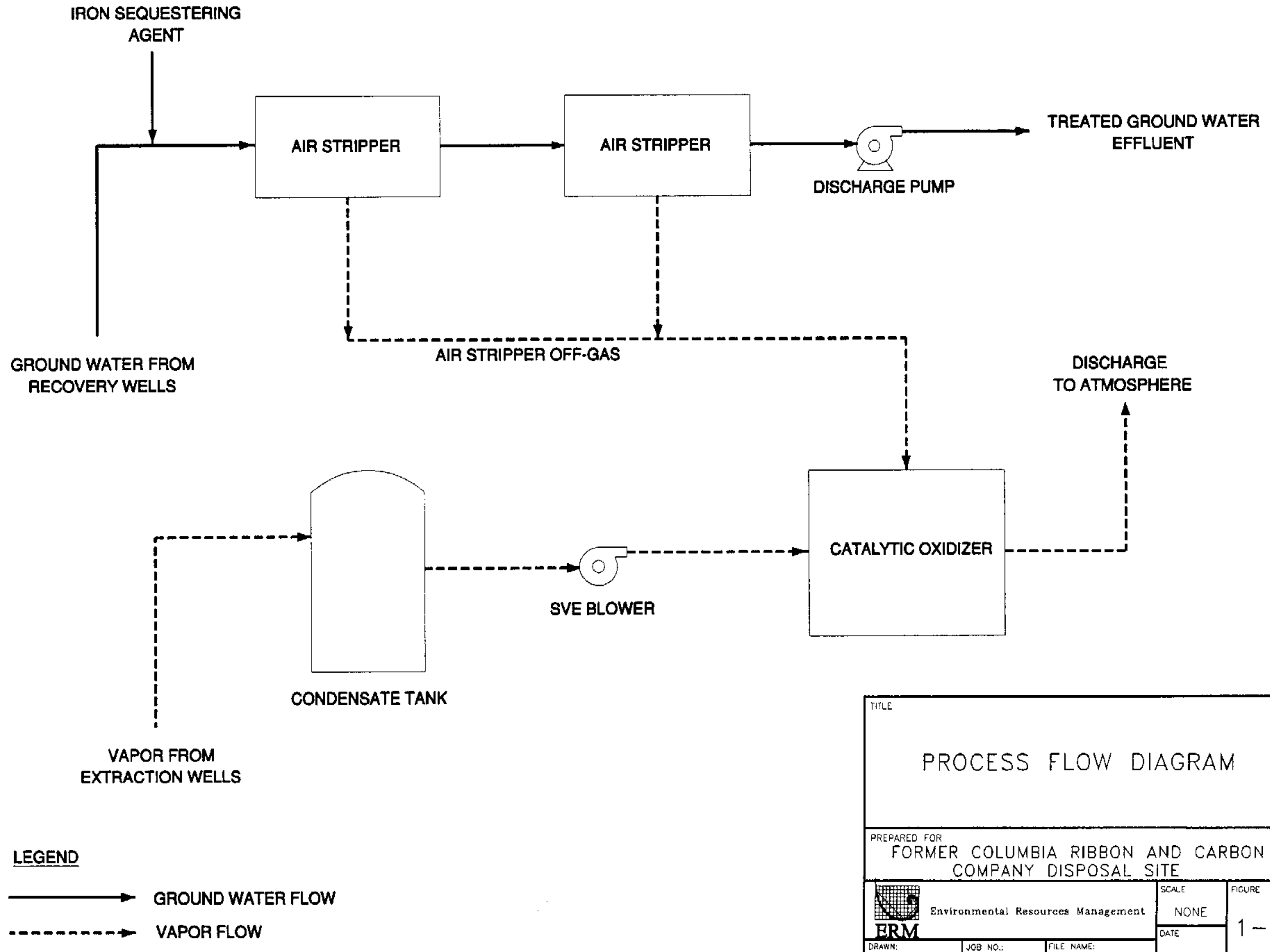
SITE MAP

FORMER COLUMBIA RIBBON
AND CARBON CO.
DISPOSAL SITE

PREPARED FOR

KONICA GRAPHIC IMAGING INTERNATIONAL, INC.

ERM Environmental Resources Management			SCALE N.T.S.	FIGURE 1–2
DRAWN: A.M.	JOB NO.: 68904.00.01	FILE NAME: 68904020	DATE 8/17/00	



TITLE

PROCESS FLOW DIAGRAM

PREPARED FOR
FORMER COLUMBIA RIBBON AND CARBON
COMPANY DISPOSAL SITE

ERM Environmental Resources Management

SCALE NONE

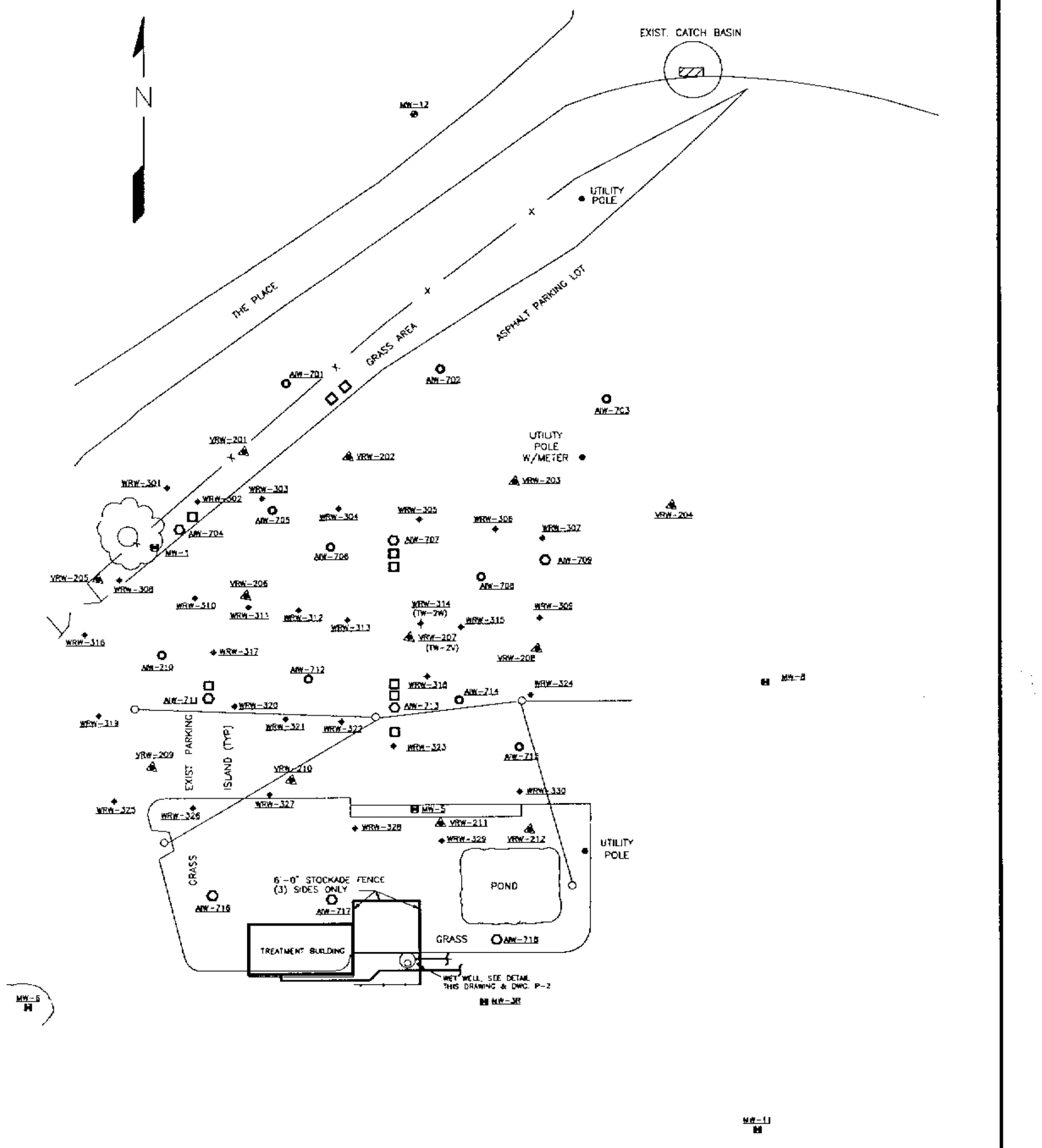
FIGURE 1-3

DATE 8/04/00

DRAWN: Y.S.

JOB NO.: 68901.00

FILE NAME: 68901001



LEGEND

- ☐ ABOVE GROUND VENT FOR PASSIVE AIR INJECTION WELL
- ○ PASSIVE AIR INJECTION WELL
- ○ COMBINATION PASSIVE AIR INJECTION WELL AND AG VENT
- ▲ VAPOR RECOVERY WELL
- ◆ WATER RECOVERY WELL
- ▣ MONITORING WELL
- ● UTILITY POLE

TITLE
MONITORING WELLS AND
RECOVERY SYSTEM

PREPARED FOR
FORMER COLUMBIA RIBBON AND
CARBON COMPANY

ERM Environmental Resources Management

DRAWN: Y.S.	JOB NO.: 68904.00	FILE NAME: 68904023	SCALE 1"=40' DATE 8/18/00	FIGURE 1-4

Figure 2-1
Flow Chart Showing Plans to Achieve Permanent Shutdown and Current Status
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

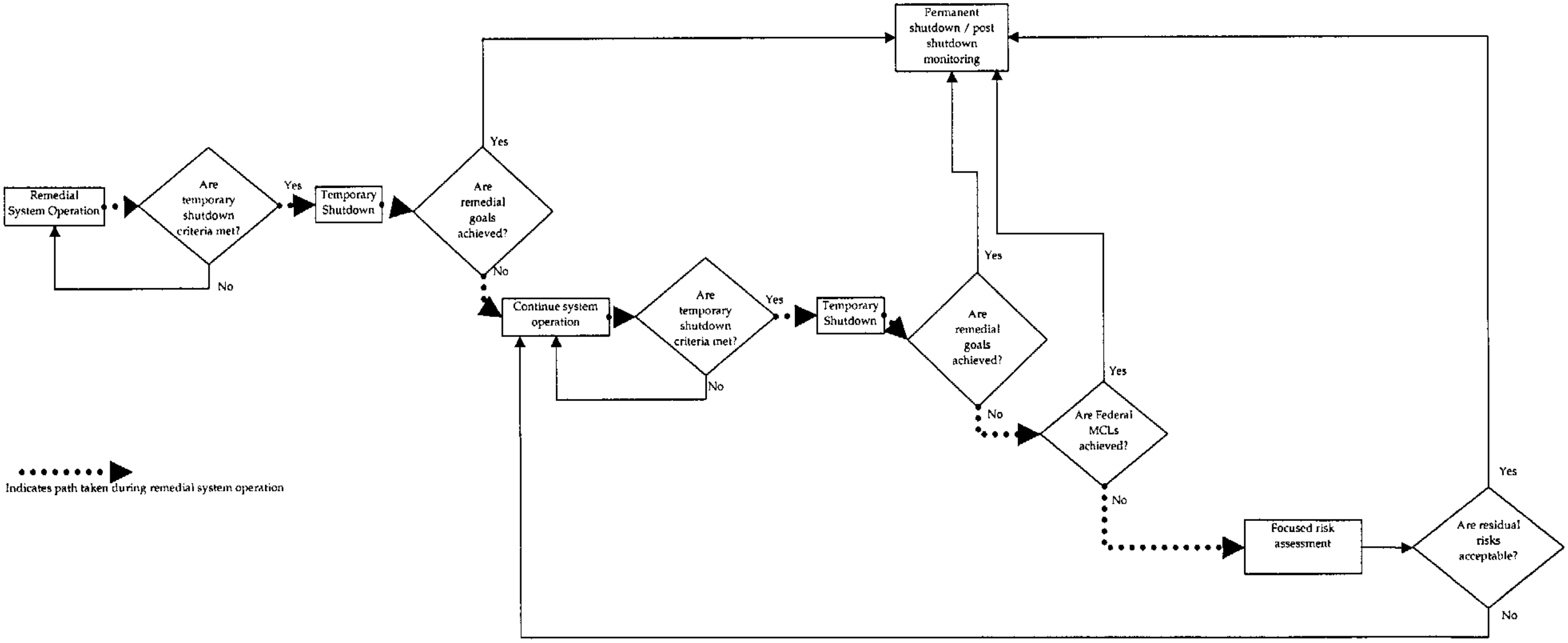
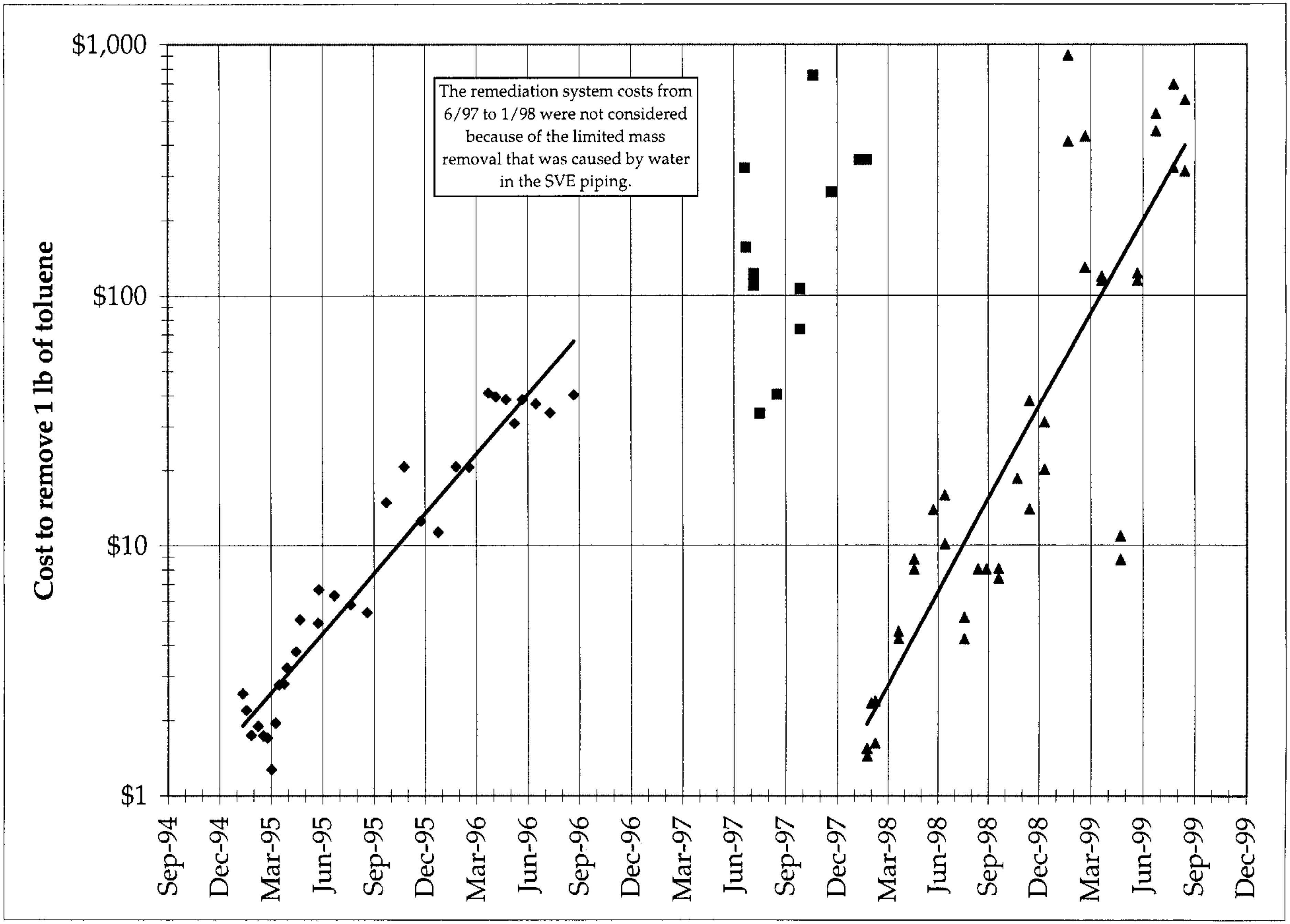


Figure 5-1

Historic Utility Costs for Operation of the Remediation System

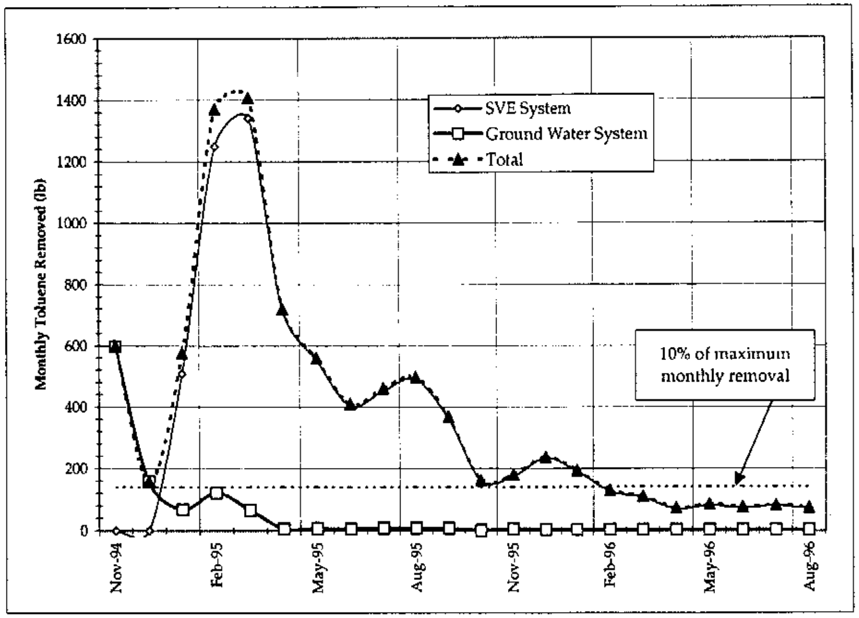
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York



The remediation system costs from 6/97 to 1/98 were not considered because of the limited mass removal that was caused by water in the SVE piping.

Table 3-1
Summary of Toluene Mass Removal During First Round of Operations
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Month	Monthly Toluene Removed (lb): SVE System	Monthly Toluene Removed (lb): Ground Water System	Monthly Toluene Removed (lb): Total	Cumulative Toluene Removed (lb): SVE System	Cumulative Toluene Removed (lb): Ground Water System	Cumulative Toluene Removed (lb): Total
Oct-94	0.00	0.00	0.00	0.00	0.00	0.00
Nov-94	0.00	597.40	597.40	0.00	597.40	597.40
Dec-94	0.00	157.30	157.30	0.00	754.70	754.70
Jan-95	507.97	67.90	575.87	507.97	822.60	1330.57
Feb-95	1248.45	121.43	1369.87	1756.41	944.03	2700.44
Mar-95	1340.44	65.99	1406.43	3096.85	1010.01	4106.87
Apr-95	712.71	6.56	719.27	3809.56	1016.58	4826.14
May-95	553.07	6.78	559.85	4362.63	1023.36	5385.99
Jun-95	403.21	6.56	409.77	4765.84	1029.92	5795.76
Jul-95	453.16	8.21	461.37	5219.00	1038.14	6257.14
Aug-95	489.08	8.21	497.29	5708.08	1046.35	6754.43
Sep-95	360.80	7.95	368.75	6068.88	1054.30	7123.18
Oct-95	161.58	0.88	162.46	6230.46	1055.18	7285.64
Nov-95	173.76	6.32	180.08	6404.21	1061.50	7465.72
Dec-95	233.24	3.26	236.50	6637.45	1064.76	7702.21
Jan-96	190.77	3.26	194.03	6828.22	1068.02	7896.24
Feb-96	126.21	3.05	129.26	6954.43	1071.07	8025.50
Mar-96	106.00	3.26	109.26	7060.43	1074.32	8134.75
Apr-96	68.45	3.15	71.60	7128.88	1077.48	8206.36
May-96	80.57	3.26	83.83	7209.45	1080.73	8290.18
Jun-96	71.82	3.15	74.97	7281.27	1083.89	8365.15
Jul-96	79.23	3.26	82.49	7360.50	1087.15	8447.64
Aug-96	71.01	3.26	74.26	7431.50	1090.40	8521.90



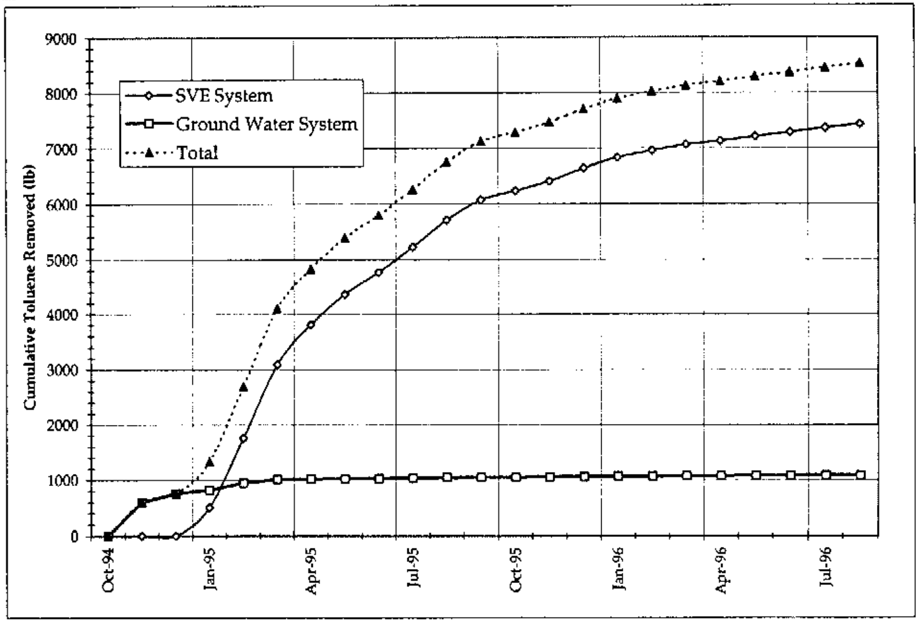


Table 3-2
Historic VOC Concentrations at Treatment Plant Influent and Effluent
1st Round of Operations
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Sampling Date ⇒	9/29/94			11/8/94		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)
Benzene	50	< 1	> 99.00	< 50	< 1	NA
Toluene	130000	2	99.998	100000	5	99.995
m Xylene	1300	< 2	> 99.92	460	< 1	> 99.89
o&p Xylene	560	< 4	> 99.64	1800	< 2	> 99.94
Chloroethane	20	< 1	> 97.50	800	< 4	> 99.75
1,1 Dichloroethene	< 20	< 1	NA	< 50	< 1	NA
1,1 Dichloroethane	84	< 1	> 99.40	< 50	< 1	NA
1,2 Dichloroethene	52	< 1	> 99.04	< 50	< 1	NA
1,2 Dichloroethane	< 20	< 1	NA	< 50	< 1	NA
Ethyl Benzene	320	< 1	> 99.84	< 50	< 1	NA
Tetrachloroethene	< 20	< 1	NA	< 50	< 1	NA
Trichloroethylene	< 20	< 1	NA	< 50	< 1	NA

Sampling Date ⇒	12/21/94			1/25/95		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)
Benzene	26	< 1	> 98.08	< 20	< 1	NA
Toluene	29000	< 2	> 99.997	9500	< 2	> 99.99
m Xylene	130	< 1	> 99.62	20	< 1	> 97.50
o&p Xylene	660	14	97.88	280	< 2	> 99.64
Chloroethane	320	7	97.81	100	< 4	> 98.00
1,1 Dichloroethene	< 2	< 1	NA	< 20	< 1	NA
1,1 Dichloroethane	21	< 1	> 97.62	< 20	< 1	NA
1,2 Dichloroethene	< 2	< 1	NA	< 20	< 1	NA
1,2 Dichloroethane	< 2	< 1	NA	< 20	< 1	NA
Ethyl Benzene	11	< 1	> 95.45	< 20	< 1	NA
Tetrachloroethene	< 2	< 1	NA	< 20	< 1	NA
Trichloroethylene	< 2	< 1	NA	< 20	< 1	NA

* Between influent and final effluent concentrations.
For removal calculations all values reported as"<"are
considered to be 50% of the values shown as "<".

Table 3-2
Historic VOC Concentrations at Treatment Plant Influent and Effluent
1st Round of Operations
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Sampling Date ⇒	2/16/95			3/13/95		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)
Benzene	20	< 1	> 95.00	19	< 1	> 97.37
Toluene	23000	< 2	> 99.996	12000	< 2	> 99.99
m Xylene	360	< 2	> 99.72	280	< 2	> 99.64
o&p Xylene	140	< 4	> 98.57	120	< 4	> 98.33
Chloroethane	< 20	< 1	NA	15	< 1	> 96.67
1,1 Dichloroethene	< 20	< 1	NA	11	< 1	> 90.91
1,1 Dichloroethane	< 20	< 1	NA	< 1	< 1	NA
1,2 Dichloroethene	< 20	< 1	NA	< 1	< 1	NA
1,2 Dichloroethane	< 20	< 1	NA	4	< 1	> 75.00
Ethyl Benzene	80	< 1	> 98.75	50	< 1	> 98.00
Tetrachloroethene	< 20	< 1	NA	< 1	< 1	NA
Trichloroethylene	< 20	< 1	NA	< 1	< 1	NA

Sampling Date ⇒	4/18/95			7/28/95		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)
Benzene	4	< 1	> 75.00	11	< 1	> 95.45
Toluene	1400	< 2	> 99.93	2000	< 2	> 99.95
m Xylene	85	< 2	> 98.82	100	< 2	> 99.00
o&p Xylene	48	< 4	> 95.83	42	< 4	> 95.24
Chloroethane	3	< 1	> 83.33	3	< 1	> 83.33
1,1 Dichloroethene	< 1	< 1	NA	2	< 1	> 75.00
1,1 Dichloroethane	4	< 1	> 75.00	4	< 1	> 87.50
1,2 Dichloroethene	< 1	< 1	NA	< 1	< 1	NA
1,2 Dichloroethane	< 1	< 1	NA	< 1	< 1	NA
Ethyl Benzene	3	< 1	> 66.67	< 1	< 1	NA
Tetrachloroethene	< 1	< 1	> 0.00	< 1	< 1	NA
Trichloroethylene	< 1	< 1	> 95.00	< 1	< 1	NA

* Between influent and final effluent concentrations.
For removal calculations all values reported as"<"are
considered to be 50% of the values shown as "<".

Table 3-2
Historic VOC Concentrations at Treatment Plant Influent and Effluent
1st Round of Operations
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Sampling Date ⇒	10/31/95			11/28/95		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)
Benzene	5	< 1	> 90.00	26	< 1	> 98.08
Toluene	300	< 2	> 99.67	2700	< 2	> 99.96
m Xylene	9	< 2	> 88.89	100	< 2	> 99.00
o&p Xylene	6	< 4	> 66.67	21	< 4	> 90.48
Chloroethane	4	< 1	> 87.50	13	< 1	> 96.15
1,1 Dichloroethene	<1	< 1	NA	< 1	< 1	NA
1,1 Dichloroethane	1	< 1	> 50.00	7	< 1	NA
1,2 Dichloroethene	<1	< 1	NA	3	< 1	NA
1,2 Dichloroethane	<1	< 1	NA	< 1	< 1	NA
Ethyl Benzene	3	< 1	> 83.33	< 1	< 1	NA
Tetrachloroethene	<1	< 1	NA	< 1	< 1	NA
Trichloroethylene	<1	< 1	NA	< 1	< 1	NA

Sampling Date ⇒	2/1/96		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total* Removal (%)
Benzene	5	< 1	> 90.00
Toluene	310	< 1	> 99.84
m Xylene	29	< 2	> 96.55
o&p Xylene	7	< 1	> 92.86
Chloroethane	5	< 1	> 90.00
1,1 Dichloroethene	< 1	< 1	NA
1,1 Dichloroethane	< 1	< 1	NA
1,2 Dichloroethene	< 2	< 2	NA
1,2 Dichloroethane	< 1	< 1	NA
Ethyl Benzene	5	< 1	> 90.00
Tetrachloroethene	< 1	< 1	NA
Trichloroethylene	< 1	< 1	NA

Sampling Date ⇒	1/17/97
Analytical Parameters	Influent Conc. (ug/L)
Benzene	8
Toluene	5000
m + p Xylene	230
o Xylene	66
Chloroethane	NA
1,1 Dichloroethene	< 1
1,1 Dichloroethane	19
1,2 Dichloroethene	3
1,2 Dichloroethane	4
Ethyl Benzene	67
Tetrachloroethene	2
Trichloroethylene	3

* Between influent and final effluent concentrations.
For removal calculations all values reported as"<"are
considered to be 50% of the values shown as "<".

Table 3-3
GROUND WATER QUALITY IN MONITORING WELLS
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Date	Well MW-1	Well MW-3R	Well MW-4	Well MW-5	Well MW-6	Well MW-8	Well MW-11	Well MW-12	
Sample Collected	TVOCs (ppb)	TVOCs (ppb)	TVOCs (ppb)	TVOCs (ppb)	TVOCs (ppb)	TVOCs (ppb)	TVOCs (ppb)	TVOCs (ppb)	Comments
2/27/95	NA	NA	NA	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
3/31/95	NA	NA	NA	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
4/28/95	NA	NA	NA	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
9/28/95	NA	NA	NA	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
2/12/96	NA	NA	NA	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
1/10/97	4	NA	ND	70	ND	ND	ND	NA	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
6/30/97	NA	NA	ND	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
10/1/97	NA	NA	ND	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
12/22/97	NA	NA	ND	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
3/26/98	NA	NA	ND	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
6/19/98	NA	NA	ND	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
9/30/98	NA	NA	ND	NA	NA	ND	1	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
12/23/98	NA	NA	ND	NA	NA	ND	ND	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
3/23/99	NA	NA	ND	NA	NA	ND	3	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
6/17/99	NA	NA	ND	NA	NA	ND	4	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
9/21/99	NA	NA	ND	NA	NA	ND	7	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.
3/16/00	ND	NA	ND	ND	ND	ND	3	ND	NA-Not analyzed, since no water in MW. ND-All compounds less than detection limits.

Table 3-4
Oxidizer Removal Efficiency
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

First Round of Operations

Parameter	1/17/95 (1)				2/13/95 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Freon 113	< 1.00	3.60	0.05	98.61%	< 1.00	< 1.00	< 1.00	N/A
Methylene Chloride	< 1.00	2.40	0.21	91.25%	< 1.00	< 1.00	< 1.00	N/A
1,1,1-Trichloroethane	2.40	1.20	0.05	95.83%	3.7	< 1.00	< 1.00	N/A
Toluene	600.00	300.00	7.7	97.43%	1000	250	1.4	99.44%
Tetrachloroethene	< 1.00	3.10	0.05	98.39%	< 1.00	< 1.00	< 1.00	N/A
Ethylbenzene	1.90	1.20	0.05	95.83%	4.3	1.1	0.006	99.45%
Xylenes	8.20	4.20	0.48	88.57%	18.7	4.2	0.023	99.45%
Benzene	< 1.00	< 1.00	< 0.1	N/A	< 1.00	< 1.00	< 1.00	N/A
1,1-Dichloroethane	< 1.00	< 1.00	< 0.1	N/A	< 1.00	< 1.00	< 1.00	N/A
Trichloroethene	< 1.00	< 1.00	< 0.1	N/A	< 1.00	< 1.00	< 1.00	N/A
4-Ethyltoluene	NR	NR	NR	N/A	NR	NR	NR	N/A
1,3,5-Trimethylbenzene	NR	NR	NR	N/A	NR	NR	NR	N/A
1,2,4-Trimethylbenzene	NR	NR	NR	N/A	NR	NR	NR	N/A
TPH (C2-C10) as hexane	1400.00	580.00	32	94.48%	2000	610	10	98.36%
Methane	7500.00	2800.00	1300	53.57%	1600	500	340	32.00%

Parameter	5/31/95 (2)				9/29/95 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Freon 113	1.40	< 0.01	< 0.001	N/A	0.058	0.021	< 0.001	N/A
Methylene Chloride	1.20	< 0.01	< 0.001	N/A	0.021	0.011	< 0.001	N/A
1,1,1-Trichloroethane	1.40	0.65	0.001	99.85%	1.2	0.19	< 0.001	N/A
Toluene	350.00	72.00	0.36	99.50%	350	48	0.15	99.69%
Tetrachloroethene	< 0.10	0.017	0.002	88.24%	0.033	< 0.01	0.002	N/A
Ethylbenzene	2.60	0.78	0.004	99.49%	2.6	0.48	< 0.001	N/A
Xylenes	11.00	3.69	0.022	99.40%	16	2.47	0.004	99.84%
Benzene	0.52	0.085	0.004	95.29%	0.059	< 0.01	< 0.001	N/A
1,1-Dichloroethane	0.15	0.074	0.001	98.65%	0.078	0.011	< 0.001	N/A
Trichloroethene	0.43	0.014	0.003	78.57%	< 0.01	< 0.01	< 0.001	N/A
4-Ethyltoluene	0.27	0.21	0.001	99.52%	NR	NR	NR	N/A
1,3,5-Trimethylbenzene	0.14	0.12	0.001	99.17%	NR	NR	NR	N/A
1,2,4-Trimethylbenzene	0.32	0.29	0.001	99.66%	NR	NR	NR	N/A
TPH (C2-C10) as hexane	400.00	110.00	10.00	90.91%	480	64	< 20	N/A
Methane	120.00	45.00	5.00	88.89%	140	20	20	0.00%

Parameter	1/31/96 (2)				4/11/96 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Freon 113	< 0.001	< 0.001	< 0.001	N/A	< 0.001	< 0.001	< 0.001	N/A
Methylene Chloride	< 0.001	0.00	< 0.001	N/A	< 0.001	< 0.001	< 0.001	N/A
1,1,1-Trichloroethane	0.43	0.06	< 0.001	N/A	0.24	0.56	< 0.001	N/A
Toluene	140.00	16.00	0.07	99.56%	54	16	0.08	99.50%
Tetrachloroethene	0.011	0.011	< 0.001	N/A	0.004	< 0.001	< 0.001	N/A
Ethylbenzene	0.34	0.09	< 0.001	N/A	0.27	0.067	< 0.001	N/A
Xylenes	2.36	0.78	0.004	99.49%	2.21	1.098	0.01	99.09%
Benzene	0.04	0.013	< 0.001	N/A	0.026	0.007	< 0.001	N/A
1,1-Dichloroethane	0.049	0.009	< 0.001	N/A	0.028	0.009	< 0.001	N/A
Trichloroethene	0.008	0.002	< 0.001	N/A	0.001	< 0.001	< 0.001	N/A
4-Ethyltoluene	NR	NR	NR	N/A	0.026	0.007	< 0.001	N/A
1,3,5-Trimethylbenzene	NR	NR	NR	N/A	0.021	0.006	< 0.001	N/A
1,2,4-Trimethylbenzene	NR	NR	NR	N/A	0.04	0.012	< 0.001	N/A
TPH (C2-C10) as hexane	79.00	13.00	< 10	N/A	65	< 10	10	N/A
Methane	57.00	25.00	20.00	20.00%	60	6	25	-316.67% (5)

Parameter	7/16/1996 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Freon 113	0.016	0.002	0.002	0.00%
Methylene Chloride	< 0.010	< 0.002	< 0.001	NA
1,1,1-Trichloroethane	0.41	0.068	< 0.001	NA
Toluene	73.00	12.00	0.019	99.84%
Tetrachloroethene	0.015	0.003	0.001	66.67%
Ethylbenzene	0.22	0.038	< 0.001	NA
Xylenes	2.33	0.415	< 0.001	NA
Benzene	0.014	0.003	< 0.001	NA
1,1-Dichloroethane	0.053	0.009	< 0.001	NA
Trichloroethene	< 0.010	< 0.002	< 0.001	NA
4-Ethyltoluene	0.038	0.007	< 0.001	NA
1,3,5-Trimethylbenzene	0.027	0.005	< 0.001	NA
1,2,4-Trimethylbenzene	0.051	0.009	< 0.001	NA
TPH (C2-C10) as hexane	58.00	10.00	< 10	NA
Methane	130.00	28.00	22.00	21.43%

Notes:

(1) Sample was collected in tedlar bags.
(2) Sample was collected in Summa canisters.
(3) NR - no reading
(4) N/A - not applicable
(5) This high value may be caused by a sampling error or analytical error. Also, methane may be produced by the incomplete combustion of the supplemental fuel supply.

Table 3-4
Oxidizer Removal Efficiency
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Second Round of Operations

Parameter	6/25/1997 (2)				7/22/1997 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Chloroethane	0.041	0.002	< 0.001	100.00%	< 0.1	< 0.005	< 0.001	NA
Freon 113	0.025	< 0.001	< 0.001	NA	< 0.1	< 0.005	< 0.001	NA
1,1-Dichloroethane	0.050	0.003	< 0.001	100.00%	< 0.1	< 0.005	< 0.001	NA
1,1,1-Trichloroethane	0.170	0.012	< 0.001	100.00%	< 0.1	< 0.005	< 0.001	NA
Benzene	0.012	< 0.001	< 0.001	NA	< 0.1	< 0.005	< 0.001	NA
Toluene	4.100	0.320	0.002	99.38%	46	3.9	0.002	99.95%
Tetrachloroethene	0.013	0.001	< 0.001	100.00%	< 0.1	< 0.005	< 0.001	NA
Ethylbenzene	0.140	0.009	< 0.001	100.00%	0.14	0.012	< 0.001	100.00%
Xylenes	0.890	0.064	< 0.001	100.00%	2.01	0.167	< 0.001	100.00%
4-Ethyltoluene	0.013	0.001	< 0.001	100.00%	< 0.1	< 0.005	< 0.001	NA
1,3,5-Trimethylbenzene	0.013	0.001	< 0.001	100.00%	< 0.1	< 0.005	< 0.001	NA
1,2,4-Trimethylbenzene	0.022	< 0.001	< 0.001	NA	< 0.1	< 0.005	< 0.001	NA
TPH (C2-C10) as hexane	< 20	< 20	< 20	NA	57	< 20	< 20	NA
Methane	7400	460	340.00	26.09%	140	10	10	0.00%

Parameter	10/1/1997 (2)				12/30/1997 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Chloroethane	< 0.05	< 0.001	< 0.001	NA	0.002	< 0.001	< 0.001	NA
Freon 113	< 0.05	< 0.001	< 0.001	NA	0.001	< 0.001	< 0.001	NA
Dichlorodifluoromethane	< 0.05	0.001	< 0.001	100.00%	< 0.001	< 0.001	< 0.001	NA
1,1-Dichloroethane	< 0.05	0.002	< 0.001	100.00%	0.02	0.002	< 0.001	100.00%
1,1,1-Trichloroethane	0.093	0.008	< 0.001	100.00%	0.086	0.01	< 0.001	100.00%
Benzene	< 0.05	< 0.001	< 0.001	NA	0.001	0.001	0.002	NA
Toluene	18.000	1.700	0.002	99.88%	0.55	0.06	0.003	95.00%
Tetrachloroethene	< 0.05	< 0.001	< 0.001	NA	0.005	< 0.001	< 0.001	NA
Ethylbenzene	0.064	0.005	< 0.001	100.00%	0.002	< 0.001	< 0.001	NA
Xylenes	0.960	0.083	< 0.001	100.00%	0.055	0.007	< 0.001	100.00%
4-Ethyltoluene	< 0.05	0.001	< 0.001	100.00%	< 0.001	< 0.001	< 0.001	NA
1,3,5-Trimethylbenzene	< 0.05	0.002	< 0.001	100.00%	< 0.001	< 0.001	< 0.001	NA
1,2,4-Trimethylbenzene	< 0.05	0.002	< 0.001	100.00%	< 0.001	< 0.001	< 0.001	NA
TPH (C2-C10) as hexane	22	< 20	< 20	NA	< 20	< 20	< 20	NA
Methane	50	< 10	< 10	NA	150	20	15	25.00%

Parameter	2/4/1998 (2)				5/29/1998 (1)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Chloroethane	< 1	< 1	< 0.005	NA	< 0.003	< 0.003	< 0.001	NA
Chloromethane	< 1	< 1	< 0.005	NA	< 0.003	< 0.003	0.002	NA
Methylene Chloride	< 1	< 1	< 0.005	NA	< 0.003	< 0.003	0.002	NA
Freon 113	< 1	< 1	< 0.005	NA	< 0.003	< 0.003	< 0.001	NA
1,1-Dichloroethane	< 1	< 1	< 0.005	NA	0.038	0.036	< 0.001	100.00%
1,1,1-Trichloroethane	1.3	1.9	< 0.005	100.00%	0.26	0.26	< 0.001	100.00%
Carbon Tetrachloride	< 1	< 1	< 0.005	NA	< 0.003	< 0.003	< 0.001	NA
cis-1,2-Dichloroethene	< 1	< 1	< 0.005	NA	0.009	0.008	< 0.001	100.00%
Benzene	< 1	< 1	0.008	NA	0.022	0.015	0.003	80.00%
Toluene	560	640	2.600	99.59%	76	89	0.280	99.69%
Tetrachloroethene	< 1	< 1	< 0.005	NA	0.011	0.011	0.002	81.82%
Trichloroethene	< 1	< 1	< 0.005	NA	0.013	0.009	< 0.001	100.00%
Ethylbenzene	2.4	3.3	0.013	99.61%	0.32	0.32	0.012	96.25%
Xylenes	12.0	16.8	0.065	99.61%	2.47	2.38	0.059	97.52%
4-Ethyltoluene	< 1	< 1	< 0.005	NA	0.035	0.034	0.002	94.12%
1,3,5-Trimethylbenzene	< 1	< 1	< 0.005	NA	0.033	0.031	0.002	93.55%
1,2,4-Trimethylbenzene	< 1	< 1	< 0.005	NA	0.049	0.045	0.005	88.89%
Benzyl Chloride	< 1	< 1	< 0.005	NA	< 0.003	< 0.003	0.002	NA
TPH (C2-C10) as hexane	790	810	< 20	100.00%	< 10	< 10	< 10	NA
Methane	150	120	81.00	32.50%	7	7	6	14.29%

Parameter	9/2/1998 (2)				11/19/1998 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Chloroethane	< 0.2	< 0.2	< 0.001	NA	< 0.033	< 0.033	< 0.05	NA
Chloromethane	< 0.2	< 0.2	0.004	NA	< 0.033	< 0.033	< 0.05	NA
Methylene Chloride	< 0.2	< 0.2	0.002	NA	< 0.033	< 0.033	< 0.05	NA
Freon 113	< 0.2	< 0.2	< 0.001	NA	< 0.033	< 0.033	< 0.05	NA
1,1-Dichloroethane	< 0.2	< 0.2	0.001	NA	0.033	< 0.033	< 0.05	NA
1,1-Dichloroethene	< 0.2	< 0.2	0.002	NA	< 0.033	< 0.033	< 0.05	NA
1,1,1-Trichloroethane	0.490	0.400	0.002	99.50%	0.23	0.069	< 0.05	100.00%
Carbon Tetrachloride	< 0.2	< 0.2	< 0.2	NA	0.19	< 0.033	< 0.05	NA
cis-1,2-Dichloroethene	< 0.2	< 0.2	0.002	NA	< 0.033	< 0.033	< 0.05	NA
1,2-Dichloroethane	< 0.2	< 0.2	0.006	NA	< 0.033	< 0.033	< 0.05	NA
Benzene	< 0.2	< 0.2	0.018	NA	< 0.033	< 0.033	< 0.05	NA
Toluene	130.0	98.0	0.085	99.91%	39	12	< 0.05	100.00%
Tetrachloroethene	< 0.2	< 0.2	0.005	NA	< 0.033	0.041	< 0.05	100.00%
Trichloroethene	< 0.2	< 0.2	0.002	NA	< 0.033	< 0.033	< 0.05	NA
Ethylbenzene	0.640	0.490	0.020	95.92%	0.098	< 0.033	< 0.05	NA
Xylenes	7.2	5.42	0.066	98.78%	1.55	0.522	< 0.05	100.00%
4-Ethyltoluene	< 0.2	< 0.2	< 0.001	NA	< 0.033	< 0.033	< 0.05	NA
1,3,5-Trimethylbenzene	< 0.2	< 0.2	< 0.001	NA	< 0.033	< 0.033	< 0.05	NA
1,2,4-Trimethylbenzene	< 0.2	< 0.2	< 0.001	NA	< 0.033	< 0.033	< 0.05	NA
1,2-Dibromoethane	< 0.2	< 0.2	0.005	NA	0.11	0.12	< 0.05	100.00%
Chlorobenzene	< 0.2	< 0.2	0.004	NA	0.081	0.082	< 0.05	100.00%
Benzyl Chloride	< 0.2	< 0.2	< 0.001	NA	< 0.033	< 0.033	< 0.05	NA
TPH (C2-C10) as hexane	240	200	< 20	100.00%	34	< 20	< 20	NA
Methane	120	91	42.00	53.85%	16	< 10	< 10	NA

Notes:

(1) Sample was collected in tedlar bags.

(2) Sample was collected in Summa canisters.

(3) NR - no reading

(4) N/A - not applicable

(5) This high value may be caused by a sampling error or analytical error. Also, methane may be produced by the incomplete combustion of the supplemental fuel supply.

Table 3-4
Oxidizer Removal Efficiency
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Second Round of Operations

Parameter	2/25/1999 (2)				5/28/1999 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Chloroethane	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
Chloromethane	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
Methylene Chloride	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
Freon 113	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
1,1-Dichloroethane	0.015	0.009	< 0.001	100.00%	< 0.050	0.009	< 0.001	100.00%
1,1-Dichloroethene	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
1,1,1-Trichloroethane	0.095	0.059	< 0.001	100.00%	0.11	0.077	< 0.001	100.00%
Carbon Tetrachloride	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
cis-1,2-Dichloroethene	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
1,2-Dichloroethane	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
Benzene	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
Toluene	3.400	1.800	0.002	99.89%	11	9.1	0.013	99.86%
Tetrachloroethene	0.008	0.005	< 0.001	100.00%	0.18	0.008	< 0.001	100.00%
Trichloroethene	< 0.002	0.001	< 0.001	100.00%	< 0.050	< 0.007	< 0.001	NA
Ethylbenzene	0.016	0.009	< 0.001	100.00%	0.068	0.052	< 0.001	100.00%
Xylenes	0.201	0.124	0.003	97.58%	1.01	0.77	0.002	99.74%
4-Ethyltoluene	0.005	0.003	< 0.001	100.00%	< 0.050	0.012	< 0.001	100.00%
1,3,5-Trimethylbenzene	0.004	0.002	< 0.001	100.00%	< 0.050	0.019	< 0.001	100.00%
1,2,4-Trimethylbenzene	0.006	0.004	< 0.001	100.00%	< 0.050	0.022	< 0.001	100.00%
1,2-Dibromoethane	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
Chlorobenzene	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
Benzyl Chloride	< 0.002	< 0.001	< 0.001	NA	< 0.050	< 0.007	< 0.001	NA
TPH (C2-C10) as hexane	< 20	< 20	< 20	NA	< 20	< 20	< 20	NA
Methane	13	10	< 10	100.00%	20	16	14	12.50%

Parameter	8/19/1999 (2)			
	Raw Soil Vapor Conc. (ppmv)	Combined Influent Conc. (ppmv)	Combined Effluent Conc. (ppmv)	Removal Efficiency
Chloroethane	< 0.007	< 0.007	< 0.001	NA
Chloromethane	< 0.007	< 0.007	< 0.001	NA
Methylene Chloride	< 0.007	< 0.007	< 0.001	NA
Freon 113	< 0.007	< 0.007	< 0.001	NA
1,1-Dichloroethane	0.020	0.016	< 0.001	100.00%
1,1-Dichloroethene	< 0.007	< 0.007	< 0.001	NA
1,1,1-Trichloroethane	0.072	0.057	< 0.001	100.00%
Carbon Tetrachloride	< 0.007	< 0.007	< 0.001	NA
cis-1,2-Dichloroethene	< 0.007	< 0.007	< 0.001	NA
1,2-Dichloroethane	< 0.007	< 0.007	< 0.001	NA
Benzene	0.018	< 0.007	0.003	NA
Toluene	2.200	2.000	0.011	99.45%
Tetrachloroethene	0.007	< 0.007	0.002	NA
Trichloroethene	< 0.007	< 0.007	< 0.001	NA
Ethylbenzene	0.035	0.024	0.004	83.33%
Xylenes	0.590	0.530	0.018	96.60%
4-Ethyltoluene	0.004	0.008	< 0.001	100.00%
1,3,5-Trimethylbenzene	0.012	0.013	< 0.001	100.00%
1,2,4-Trimethylbenzene	0.012	0.012	< 0.001	100.00%
1,2-Dibromoethane	< 0.007	< 0.007	< 0.001	NA
Chlorobenzene	< 0.007	< 0.007	< 0.001	NA
Benzyl Chloride	< 0.007	< 0.007	< 0.001	NA
TPH (C2-C10) as hexane	< 20	< 20	< 20	NA
Methane	100	84	44.00	47.62%

Notes:

(1) Sample was collected in tedlar bags.
(2) Sample was collected in Summa canisters.
(3) NR - no reading
(4) N/A - not applicable
(5) This high value may be caused by a sampling error or analytical error. Also, methane may be produced by the incomplete combustion of the supplemental fuel supply.

Table 3-5
Comparison of Water Levels Before and After Pump Replacement
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

End of First Round of Operations

Date/time	Well	DTW (ft)
6/21/96 10:40	VRW-201	23.48
6/21/96 10:40	VRW-202	ND
6/21/96 10:40	VRW-203	ND
6/21/96 10:40	VRW-204	11.88
6/21/96 10:40	VRW-205	22.60
6/21/96 10:40	VRW-206	23.64
6/21/96 10:40	VRW-207	12.16
6/21/96 10:40	VRW-208	ND
6/21/96 10:40	VRW-209	24.36
6/21/96 10:40	VRW-210	23.11
6/21/96 10:40	VRW-211	13.19
6/21/96 10:40	VRW-212	16.51
6/21/96 10:40	AIW-701	14.92
6/21/96 10:40	AIW-702	12.91
6/21/96 10:40	AIW-703	ND
6/21/96 10:40	AIW-704	27.76
6/21/96 10:40	AIW-705	ND
6/21/96 10:40	AIW-706	ND
6/21/96 10:40	AIW-707	26.78
6/21/96 10:40	AIW-708	ND
6/21/96 10:40	AIW-709	12.34
6/21/96 10:40	AIW-710	ND
6/21/96 10:40	AIW-711	16.39
6/21/96 10:40	AIW-712	24.50
6/21/96 10:40	AIW-713	27.90
6/21/96 10:40	AIW-714	18.76
6/21/96 10:40	AIW-715	17.75
6/21/96 10:40	AIW-716	23.35
6/21/96 10:40	AIW-717	16.43
	Average =	*19.56*

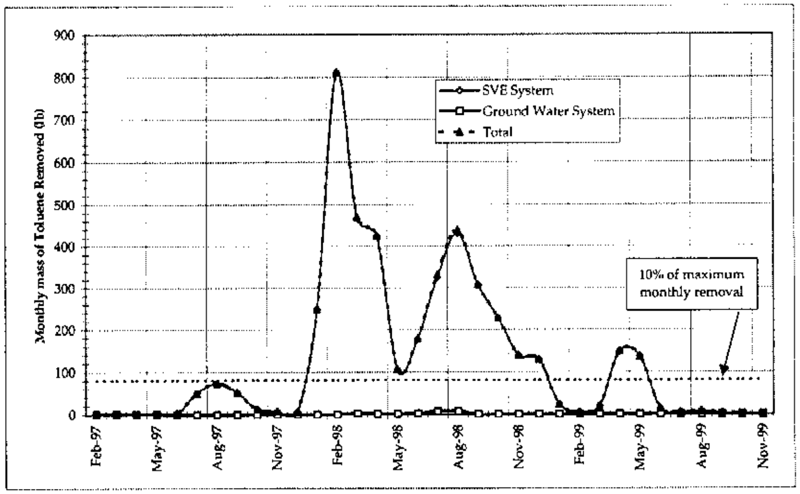
Start of Second Round of Operations

Date/time	Well	DTW (ft)	Regional Increase in Water Table Elevation from 6/96 to 6/97 (ft)	Adjusted DTW (ft)
6/25/97 10:00	VRW-201	15.20	2.00	17.20
6/25/97 10:00	VRW-202	12.09	2.00	14.09
6/25/97 10:00	VRW-203	10.72	2.00	12.72
6/25/97 10:00	VRW-204	10.62	2.00	12.62
6/25/97 10:00	VRW-205	22.40	2.00	24.40
6/25/97 10:00	VRW-206	22.96	2.00	24.96
6/25/97 10:00	VRW-207	21.25	2.00	23.25
6/25/97 10:00	VRW-208	17.44	2.00	19.44
6/25/97 10:00	VRW-209	25.14	2.00	27.14
6/25/97 10:00	VRW-210	24.42	2.00	26.42
6/25/97 10:00	VRW-211	13.65	2.00	15.65
6/25/97 10:00	VRW-212	16.48	2.00	18.48
6/25/97 10:00	AIW-701	13.80	2.00	15.80
6/25/97 10:00	AIW-702	12.10	2.00	14.10
6/25/97 10:00	AIW-703	ND	2.00	ND
6/25/97 10:00	AIW-704	27.14	2.00	29.14
6/25/97 10:00	AIW-705	21.76	2.00	23.76
6/25/97 10:00	AIW-706	21.70	2.00	23.70
6/25/97 10:00	AIW-707	25.64	2.00	27.64
6/25/97 10:00	AIW-708	20.80	2.00	22.80
6/25/97 10:00	AIW-709	17.76	2.00	19.76
6/25/97 10:00	AIW-710	25.96	2.00	27.96
6/25/97 10:00	AIW-711	29.94	2.00	31.94
6/25/97 10:00	AIW-712	23.80	2.00	25.80
6/25/97 10:00	AIW-713	27.75	2.00	29.75
6/25/97 10:00	AIW-714	17.75	2.00	19.75
6/25/97 10:00	AIW-715	17.00	2.00	19.00
6/25/97 10:00	AIW-716	23.04	2.00	25.04
6/25/97 10:00	AIW-717	16.68	2.00	18.68
	Average =	*19.82*		*21.82*

DTW - depth to water

Table 3-6
Summary of Toluene Mass Removal During Second Round of Operations
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, NewYork

Month	Monthly Toluene Removed (lb):			Cumulative Toluene Removed (lb):		
	SVE System	Ground Water System	Total	SVE System	Ground Water System	Total
Feb-97	0.00	1.51	1.51	0.00	1.51	1.51
Mar-97	0.00	2.13	2.13	0.00	3.64	3.64
Apr-97	0.00	1.07	1.07	0.00	4.71	4.71
May-97	0.00	1.15	1.15	0.00	5.86	5.86
Jun-97	3.29	0.00	3.29	3.29	5.86	9.15
Jul-97	51.26	0.00	51.26	54.55	5.86	60.41
Aug-97	73.76	0.00	73.76	128.31	5.86	134.17
Sep-97	52.36	0.29	52.65	180.68	6.15	186.82
Oct-97	12.92	0.32	13.24	193.60	6.47	200.07
Nov-97	7.67	0.24	7.91	201.27	6.71	207.98
Dec-97	5.78	0.00	5.78	207.04	6.71	213.75
Jan-98	249.07	0.00	249.07	456.12	6.71	462.83
Feb-98	810.81	0.00	810.81	1266.93	6.71	1273.64
Mar-98	467.26	2.61	469.87	1734.20	9.32	1743.51
Apr-98	423.79	1.37	425.16	2157.99	10.68	2168.67
May-98	105.19	1.81	107.00	2263.18	12.49	2275.68
Jun-98	177.37	1.95	179.32	2440.55	14.44	2454.99
Jul-98	324.80	7.97	332.77	2765.36	22.41	2787.77
Aug-98	431.01	7.65	438.66	3196.37	30.07	3226.43
Sep-98	307.08	0.21	307.29	3503.45	30.28	3533.73
Oct-98	227.68	0.22	227.90	3731.13	30.49	3761.63
Nov-98	139.32	0.12	139.44	3870.45	30.62	3901.07
Dec-98	129.66	0.00	129.66	4000.11	30.62	4030.73
Jan-99	24.31	0.00	24.31	4024.42	30.62	4055.04
Feb-99	5.69	0.00	5.69	4030.11	30.62	4060.73
Mar-99	20.42	0.72	21.13	4050.53	31.33	4081.86
Apr-99	147.84	0.66	148.50	4198.36	31.99	4230.36
May-99	136.94	0.47	137.41	4335.30	32.47	4367.77
Jun-99	13.25	0.83	14.08	4348.55	33.30	4381.85
Jul-99	4.88	0.68	5.56	4353.43	33.97	4387.41
Aug-99	7.22	0.70	7.92	4360.66	34.67	4395.33
Sep-99	2.65	0.80	3.45	4363.31	35.47	4398.78
Oct-99	0.00	0.82	0.82	4363.31	36.30	4399.61
Nov-99	0.00	0.38	0.38	4363.31	36.68	4399.99



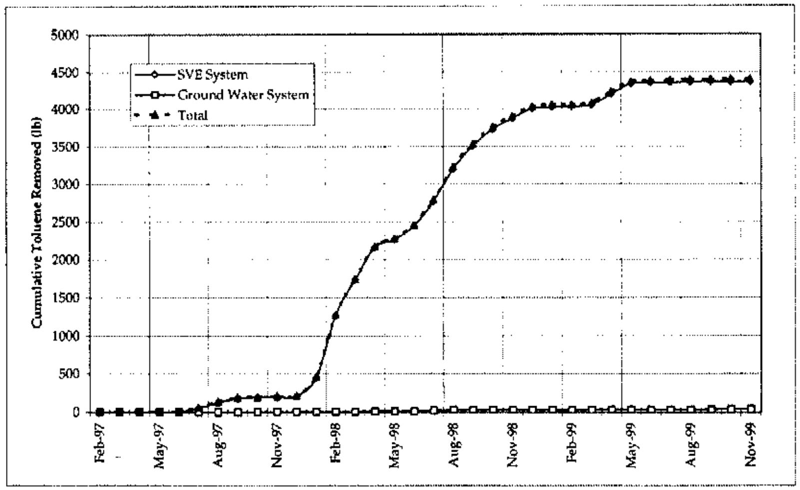


Table 3-7
Historic VOC Concentrations at Treatment Plant Influent and Effluent
2nd Round of Operations
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Sampling Date ⇒	2/10/97			6/27/97			10/1/97		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)
Benzene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Toluene	350	< 2	> 99.43%	< 2	< 2	NA	160	< 2	> 98.75%
m Xylene	7	< 2	> 71.43%	3	2	33.33%	35	< 2	> 94.29%
o&p Xylene	11	< 4	> 63.64%	< 4	< 4	NA	17	< 4	> 76.47%
Chloroethane	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,1 Dichloroethene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,1 Dichloroethane	1	< 1	NA	< 1	< 1	NA	2	< 1	> 50.00%
1,2 Dichloroethene	1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,2 Dichloroethane	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Ethyl Benzene	8	< 1	> 87.50%	< 1	< 1	NA	2	< 1	> 50.00%
Tetrachloroethene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Trichloroethylene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA

	12/22/97			3/26/98			4/7/98		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)
Benzene	< 1	< 1	NA	< 10	< 5	NA	< 1	< 1	NA
Toluene	< 2	< 2	NA	2900	1200	58.62%	1300	< 2	> 99.85%
m Xylene	17	< 2	> 88.24%	110	70	36.36%	57	< 2	> 96.49%
o&p Xylene	< 4	< 4	NA	60	40	33.33%	33	< 4	> 87.88%
Chloroethane	< 1	< 1	NA	< 10	< 5	NA	< 1	< 1	NA
1,1 Dichloroethene	< 1	< 1	NA	< 10	< 5	NA	< 1	< 1	NA
1,1 Dichloroethane	< 1	< 1	NA	< 10	< 5	NA	1	< 1	NA
1,2 Dichloroethene	< 1	< 1	NA	< 10	< 5	NA	< 1	< 1	NA
1,2 Dichloroethane	< 1	< 1	NA	< 10	< 5	NA	< 1	< 1	NA
Ethyl Benzene	< 1	< 1	NA	10	< 5	> 50.00%	5	< 1	> 80.00%
Tetrachloroethene	< 1	< 1	NA	< 10	< 5	NA	< 1	< 1	NA
Trichloroethylene	< 1	< 1	NA	< 10	< 5	NA	< 1	< 1	NA

Table 3-7
Historic VOC Concentrations at Treatment Plant Influent and Effluent
2nd Round of Operations
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

	6/19/98			9/24/98			11/5/98		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)
Benzene	< 10	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Toluene	1900	< 2	> 99.89%	160	97	39.38%	42	< 2	> 95.24%
m Xylene	80	< 2	> 97.50%	30	18	40.00%	36	< 2	> 94.44%
o&p Xylene	< 40	< 4	NA	17	10	41.18%	21	< 4	> 80.95%
Chloroethane	< 10	< 1	NA	< 1	< 1	NA	2	< 1	> 50.00%
1,1 Dichloroethene	< 10	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,1 Dichloroethane	< 10	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,2 Dichloroethene	< 10	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,2 Dichloroethane	< 10	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Ethyl Benzene	20	< 1	> 95.00%	< 1	< 1	NA	< 1	< 1	NA
Tetrachloroethene	< 10	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Trichloroethylene	< 10	< 1	NA	< 1	< 1	NA	< 1	< 1	NA

	12/16/98			3/26/99			6/29/99		
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)
Benzene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Toluene	< 2	< 2	NA	150	< 2	> 98.67%	380	< 2	> 99.47%
m Xylene	14	< 2	> 85.71%	38	< 2	> 94.74%	40	< 2	> 95.00%
o&p Xylene	7	< 4	> 42.86%	19	< 4	> 78.95%	19	< 4	> 78.95%
Chloroethane	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,1 Dichloroethene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,1 Dichloroethane	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,2 Dichloroethene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
1,2 Dichloroethane	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Ethyl Benzene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Tetrachloroethene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA
Trichloroethylene	< 1	< 1	NA	< 1	< 1	NA	< 1	< 1	NA

	11/4/99			3/16/00
Analytical Parameters	Influent Conc. (ug/L)	Final Effluent Conc. (ug/L)	Effective Total Removal (%)	Influent Conc. (ug/L)
Benzene	< 1	< 1	NA	< 1
Toluene	300	< 2	> 99.33%	1700
m-Xylene	17	< 2	> 88.24%	56
o&p-Xylene	9	< 4	> 55.56%	24
Chloroethane	< 1	< 1	NA	< 1
1,1 Dichloroethene	< 1	< 1	NA	< 1
1,1 Dichloroethane	< 1	< 1	NA	1
1,2 Dichloroethene	< 1	< 1	NA	< 1
1,2 Dichloroethane	< 1	< 1	NA	< 1
Ethyl Benzene	< 1	< 1	NA	16
Tetrachloroethene	< 1	< 1	NA	< 1
Trichloroethylene	< 1	< 1	NA	< 1

Table 3-8
Results of Sampling During Second Temporary Shutdown
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

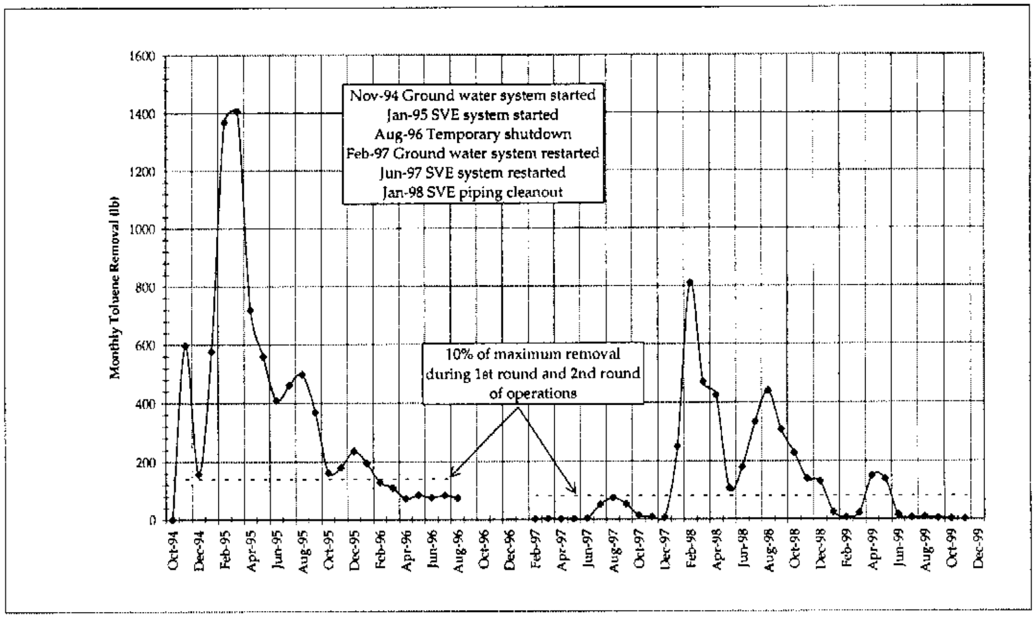
Sampling Date ⇒ 3/16/00

Parameter	Remedial Goal (µg/L)	Maximum Contaminant Level (µg/L)	Concentration in µg/L at:							
			MW-1	MW-4	MW-5	MW-6	MW-8	MW-11	MW-12	Treatment Plant Influent
Benzene	5	5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Toluene	5	1,000	< 2	< 2	< 2	< 2	< 2	< 2	< 2	1,700
Ethylbenzene	5	700	< 1	< 1	< 1	< 1	< 1	< 1	< 1	16
m-Xylene	5	Not applicable	< 2	< 2	< 2	< 2	< 2	< 2	< 2	56
o&p-Xylene	5 (for each isomer)	Not applicable	< 4	< 4	< 4	< 4	< 4	< 4	< 4	24
Xylenes (total)	5 (for each isomer)	10,000	NA	NA	NA	NA	NA	NA	NA	80
Chloroethane	5	None	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1 Dichloroethene	5	7	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1 Dichloroethane	5	None	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1
1,2 Dichloroethene (total)	5	70 for cis- / 100 for trans-	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,2 Dichloroethane	5	5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tetrachloroethene	5	5	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1
Trichloroethene	5	5	< 1	< 1	< 1	< 1	< 1	2	< 1	< 1
Calcium	None	None	26,000	17,000	120,000	55,000	210,000	33,000	32,000	52,000
Iron	None	None	5,700	20,000	48,000	6,400	5,900	470	7,600	21,000
Magnesium	None	None	7,800	4,100	24,000	22,000	24,000	12,000	12,000	12,000
Manganese	None	None	140	200	3,300	330	11,000	1,600	1,600	3,500

Table 3-9
Estimated Monthly Toluene Removal
Former Columbia Ribbon and Carbon Co. Disposal Site, Glen Cove, New York

Toluene removed by the SVE system is based upon monthly lab analyses of the combined soil vapor.

Month	SVE System Toluene Removed (lb)	Ground Water System Toluene Removed (lb)	Total Monthly Toluene Removed (lb)	Cumulative Total Toluene Removed (lb)
Oct-94	0.00	0.00	0.00	0.00
Nov-94	0.00	597.40	597.40	597.40
Dec-94	0.00	157.30	157.30	754.70
Jan-95	507.97	67.90	575.87	1330.57
Feb-95	1248.45	121.43	1369.87	2700.44
Mar-95	1340.44	65.99	1406.43	4106.87
Apr-95	712.71	6.56	719.27	4826.14
May-95	553.07	6.78	559.85	5385.99
Jun-95	403.21	6.56	409.77	5795.76
Jul-95	453.16	8.21	461.37	6257.14
Aug-95	489.08	8.21	497.29	6754.43
Sep-95	360.80	7.95	368.75	7123.18
Oct-95	161.58	0.88	162.46	7285.64
Nov-95	173.76	6.32	180.08	7465.72
Dec-95	233.24	3.26	236.50	7702.21
Jan-96	190.77	3.26	194.03	7896.24
Feb-96	126.21	3.05	129.26	8025.50
Mar-96	106.00	3.26	109.26	8134.75
Apr-96	68.45	3.15	71.60	8206.36
May-96	80.57	3.26	83.83	8290.18
Jun-96	71.82	3.15	74.97	8365.15
Jul-96	79.23	3.26	82.49	8447.64
Aug-96	71.01	3.26	74.26	8521.90
Sep-96	Remediation system was off-line due to temporary shutdown			8521.90
Oct-96	Remediation system was off-line due to temporary shutdown			8521.90
Nov-96	Remediation system was off-line due to temporary shutdown			8521.90
Dec-96	Remediation system was off-line due to temporary shutdown			8521.90
Jan-97	Remediation system was off-line due to temporary shutdown			8521.90
Feb-97	0.00	1.51	1.51	8523.41
Mar-97	0.00	2.13	2.13	8525.54
Apr-97	0.00	1.07	1.07	8526.61
May-97	0.00	1.15	1.15	8527.76
Jun-97	3.29	0.00	3.29	8531.06
Jul-97	51.26	0.00	51.26	8582.31
Aug-97	73.76	0.00	73.76	8656.08
Sep-97	52.36	0.29	52.65	8708.73
Oct-97	12.92	0.32	13.24	8721.97
Nov-97	7.67	0.24	7.91	8729.88
Dec-97	5.78	0.00	5.78	8735.66
Jan-98	249.07	0.00	249.07	8984.73
Feb-98	810.81	0.00	810.81	9795.55
Mar-98	467.26	2.61	469.87	10265.42
Apr-98	423.79	1.37	425.16	10690.58
May-98	105.19	1.81	107.00	10797.58
Jun-98	177.37	1.95	179.32	10976.90
Jul-98	324.80	7.97	332.77	11309.67
Aug-98	431.01	7.65	438.66	11748.34
Sep-98	307.08	0.21	307.29	12055.63
Oct-98	227.68	0.22	227.90	12283.53
Nov-98	139.32	0.12	139.44	12422.97
Dec-98	129.66	0.00	129.66	12552.64
Jan-99	24.31	0.00	24.31	12576.94
Feb-99	5.69	0.00	5.69	12582.63
Mar-99	20.42	0.72	21.13	12603.76
Apr-99	147.84	0.66	148.50	12752.26
May-99	136.94	0.47	137.41	12889.67
Jun-99	13.25	0.83	14.08	12903.75
Jul-99	4.88	0.68	5.56	12909.31
Aug-99	7.22	0.70	7.92	12917.24
Sep-99	2.65	0.80	3.45	12920.69
Oct-99	0.00	0.82	0.82	12921.51
Nov-99	0.00	0.38	0.38	12921.89



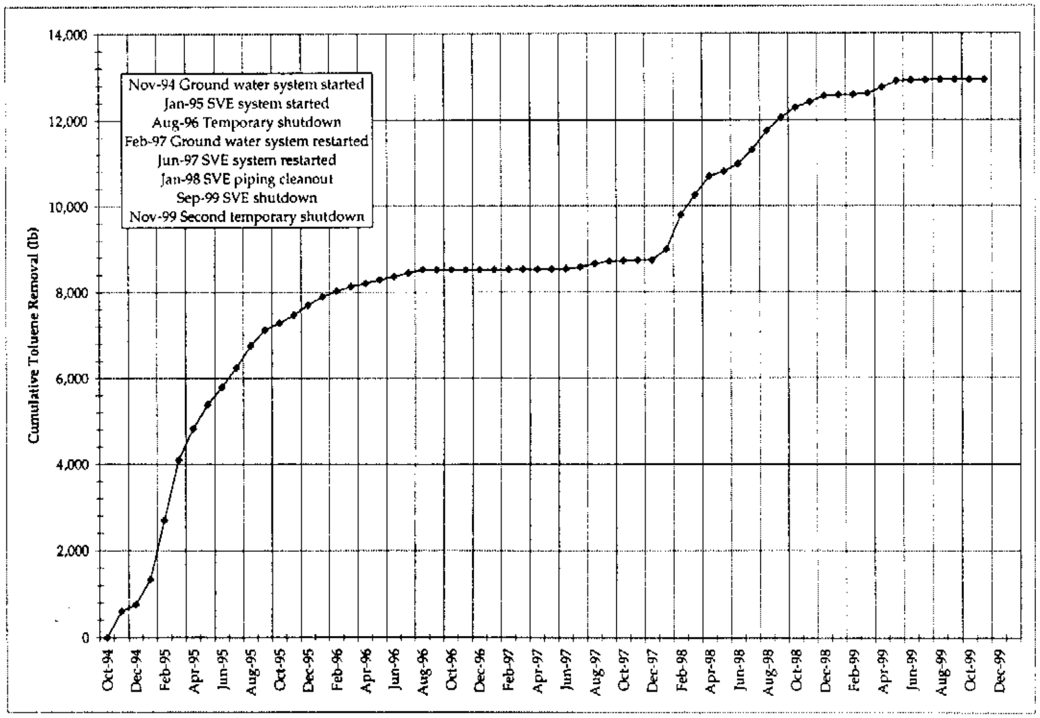


Table 4-1

Assumed Values for Exposure Parameters and Fate and Transport Parameters used in Evaluating Inhalation Exposures

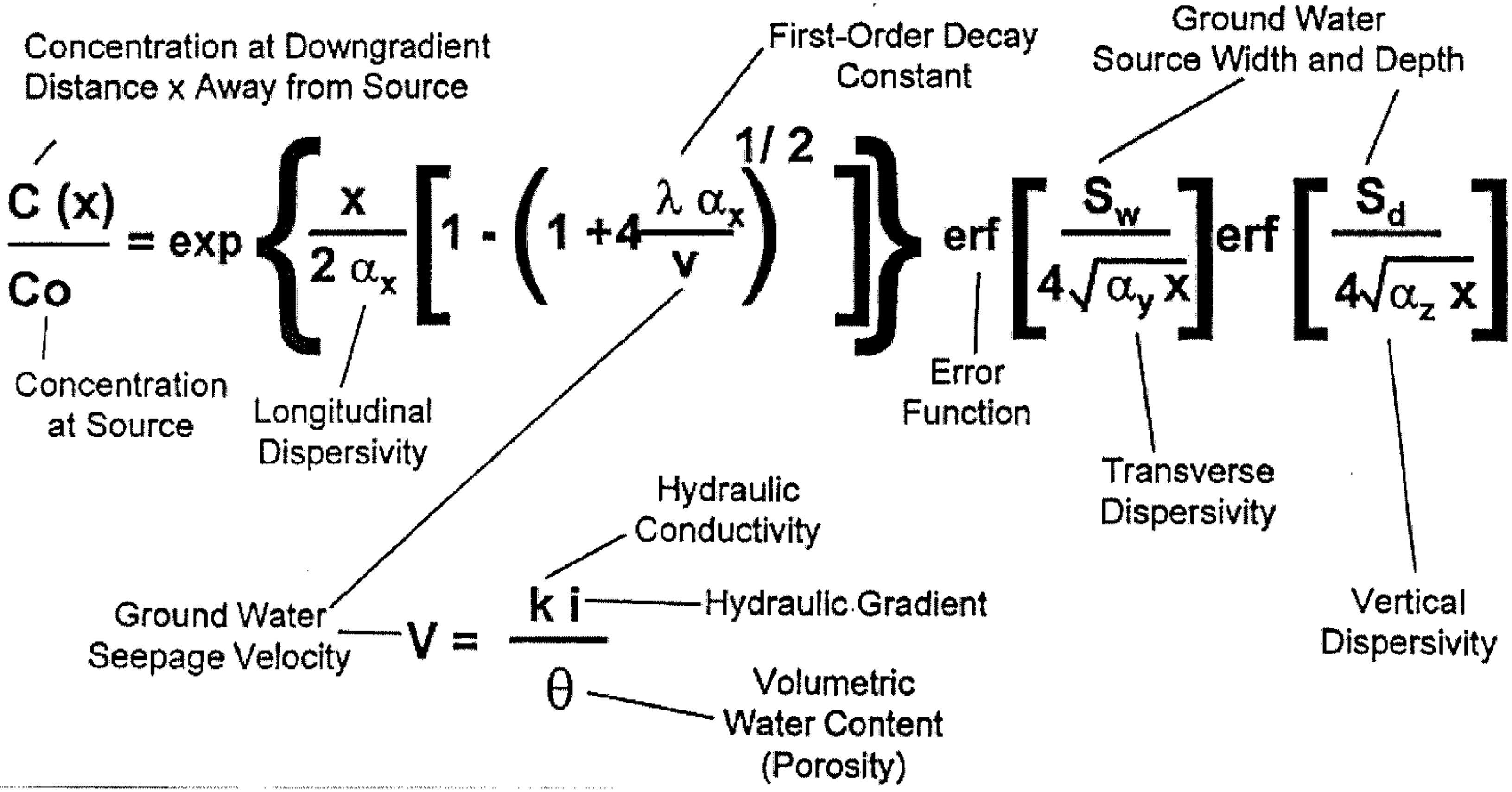
	Value
Exposure Parameters	
THI, target hazard index	1
BW, body weight, kg	70
AT_{nc}, averaging time for noncarcinogens, years	25
RfD, chemical-specific inhalation reference dose, mg/kg-d)	0.11
IR, Inhalation rate, m^3/day	20
ED, exposure duration, years	25
EF, exposure frequency, days/year	250
Fate and Transport Parameters	
H, chemical-specific Henry's Law Constant, cm^3-water/cm^3-air	0.260
L_{GW}, depth to ground water, cm	300
ER, enclosed space air exchange rate (changes/s)	0.00023
L_B, enclosed space volume/infiltration area ratio, cm	300
L_{crack}, enclosed space foundation or wall thickness, cm	15
η, areal fraction of cracks in foundation walls, cm^2–cracks/cm^2–total area	0.01
h_{cap}, thickness of capillary fringe, cm	5
h_v, thickness of vadose zone, cm	295
D^a, diffusion coefficient in air, cm^2/sec	0.085
θ_{acap}, volumetric air content in capillary fringe soils, cm^3-air/cm^3-soil	0.038
θ_T, total soil porosity, cm^3/cm^3-soil	0.38
D^w, diffusion coefficient in water, cm^2/sec	9.40×10^{-6}
θ_{wcap}, volumetric water content in capillary fringe soils, cm^3-water/cm^3-soil	0.342
θ_{as}, volumetric air content in vadose zone soils, cm^3-air/cm^3-soil	0.26
θ_{ws}, volumetric water content in vadose zone soils, cm^3-water/cm^3-soil	0.12
θ_{acrack}, volumetric air content in foundation/wall cracks, cm^3-air/cm^3-total volume	0.26
θ_{wcrack}, volumetric water content in foundation/wall cracks, cm^3-water/cm^3-total volume	0.12

TABLE 4-2

Ground Water in Source Zone → Ground Water at Receptor

Multidimensional transport equation involving dispersion, advection, and one kinetic term can be expressed as:
$D_x(\delta^2C/\delta x^2) + D_y(\delta^2C/\delta y^2) + D_z(\delta^2C/\delta z^2) - V_x(\delta C/\delta x) - (r/\theta) = \delta C/\delta t$
where r = mathematical rate law (decay rate)

The steady state concentration along the centerline is expressed as:



$$\frac{C(x)}{Co} = \exp\left\{\frac{x}{2\,\alpha_x}\left[1 - \left(1 + 4\frac{\lambda\,\alpha_x}{v}\right)^{1/2}\right]\right\} \operatorname{erf}\left[\frac{S_w}{4\sqrt{\alpha_y\,x}}\right] \operatorname{erf}\left[\frac{S_d}{4\sqrt{\alpha_z\,x}}\right]$$

$$V = \frac{k\,i}{\theta}$$

Table 4-3. DOMENICO SOLUTE TRANSPORT MODEL

Site: Former Columbia Ribbon and Carbon Co. Disposal Site - Glen Cove, NY - Toluene Simulation

Input Parameters:
(Shaded cells are input manually; non-shaded cells are calculated.)

		Conversion to Domenico units
Distance to Compliance Point along centerline of plume (feet):	1200	36576 cm
Average Ground Water Concentration in Source Area (ug/l):	1700	1.7E-06 g/ml
Longitudinal Dispersivity (feet):	20	609.6 cm
Transverse Dispersivity (feet):	5	152.4 cm
Vertical Dispersivity (feet):	1.5	45.72 cm
Hydraulic Conductivity (feet/day):	18.5	563.88 cm/day
Hydraulic Gradient (dimensionless):	0.042	0.042
Porosity (dimensionless):	0.35	0.35
First Order Decay Constant or 0.693/H_L (day^{-1}):	3.30E-03	0.0033 day^{-1}
Source Width Perpendicular to Ground Water Flow (feet):	400	12192 cm
Source Vertical Thickness (feet):	20	609.6 cm
GW Flow Velocity - Calculated from Darcy's Law (feet/day):	2.22	67.6656 cm/day
Contaminant Octanol/Water Partition Coefficient (K_{ow}):	NA	N/A
Contaminant Water/Foc Partition Coefficient - K_{oc} (L/kg):	227	N/A
Aquifer Organic Carbon Content - F_{oc} (dimensionless):	0.0012	N/A
Distribution Coefficient - K_d (L/kg):	0.2724	N/A
Aquifer Bulk Density (kg/L)	1.75	N/A
Retardation Coefficient - R_f (dimensionless)	2.362	N/A
Solute Flow Velocity (feet/day)	0.9398815	28.6476 cm/day

Domenico Calculation:

Part 1:	-0.1317626
Part 2:	0.0191994
Part 3:	0.9321108
Part 4:	0.1323677
Part 5:	4.027E-09

Predicted Contaminant Concentration at Compliance Point (ug/l):	4.027039
New York State Ambient Ground Water Quality Standard (ug/l):	5
New York State Class SC Surface Water Standard [1] (ug/l):	92