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Engineering Evaluation / Cost Analysis
North Chicago, Illinois Facility

Prepared For:

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May 2005

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Executive Summary

Penn Environmental and Remediation, Inc. (Penn E&R), on behalf of North Chicago, Inc. (NCI) [a wholly-owned, special purpose subsidiary of Fansteel Inc. (Fansteel)], has prepared this May 2005 Engineering Evaluation/Cost Analysis (EE/CA) Report for the North Chicago, Illinois facility (Figure 1). The development and submittal of this EE/CA Report was performed in compliance with the September 21, 2000 Administrative Order (AO) issued by the U.S. Environmental Protection Agency (USEPA) Region V. As specified in the AO, the contents and format of the North Chicago facility EE/CA Report adhere to the reporting guidelines that are outlined in the USEPA document, Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (USEPA, August 1993).

The intent of this report is to provide an evaluation of the site characterization data for the North Chicago facility and adjacent areas in order to identify an appropriate remedial strategy for the North Chicago facility. Additionally, as required by the Illinois Environmental Protection Agency (IEPA), the EE/CA Report also provides a Resource Conservation and Recovery Act (RCRA) contingent closure plan modification for the facility's former Hazardous Waste Management Unit (HWMU). The successful completion of the CERCLA cleanup will provide for completion of, and financing for, the equivalent of an RCRA closure of the two RCRA-regulated units

Fieldwork associated with the EE/CA Work Plan was completed on June 11, 2001. A draft EE/CA Report was submitted to the USEPA on July 11, 2001. Fansteel received comments on the draft report from the IEPA dated September 17, 2001 and from the USEPA dated August 16, 2001 and September 19, 2001 (TN & Associates, Inc. on behalf of USEPA). A meeting with the USEPA was held on October 30, 2001 to discuss the comments received. As a result of this meeting, Earth Sciences Consultants, Inc. (Earth Sciences), on behalf of Fansteel, issued a letter dated November 20, 2001 that presented a revised approach for performing the streamlined risk evaluation (SRE) and developing the remedial objectives (RO). Fansteel later received comments from the USEPA regarding the revised approach dated December 10, 2001.

As set forth in Fansteel's Monthly Written Reports to the USEPA, Fansteel's past financial difficulties leading to the Fansteel bankruptcy delayed further work on the project until June 2002. Data validation activities, development of responses to the December 10, 2001 comment letter, and the development of information regarding the proposed analysis of remedial alternatives were completed in preparation for a

meeting with the USEPA on September 10, 2002. Prior to the meeting, Earth Sciences submitted, on behalf of Fansteel, a letter dated August 30, 2002 documenting data validation efforts and a letter dated September 3, 2002 responding to the December 10, 2001 USEPA comment letter regarding the SRE.

During the September 10, 2002 meeting with USEPA, several agreements were reached concerning the nature of the risk evaluation to be performed, the screening levels employed, and the use of the validated data. These agreements were documented in final meeting minutes dated September 25, 2002. An agreement was also reached that a formal written response to the comments previously received by Fansteel regarding the July 11, 2001 draft EE/CA Report would not be submitted. Rather, Fansteel agreed to acknowledge, as it does now, that the comments were reviewed and considered in the creation of the February 2003 EE/CA Report. The parties originally agreed that the revised EE/CA Report would be submitted in January 2003. This date was later changed to February 2003, per agreement with the USEPA as documented in the Monthly Written Report for December 2002, to allow for the completion of additional groundwater modeling. On September 27, 2002, TN & Associates, Inc. generated a report discussing their review of the data validation information provided in the August 30, 2002 transmittal referenced above. Based on the results of the report, Fansteel has used the data as qualified in the validation reports.

Fansteel received TN & Associates, Inc. comments on the February 2003 EE/CA Report from the USEPA on June 4, 2003. The comments were dated May 23, 2003. A Response to Comments letter dated June, 10, 2003 was generated by Earth Sciences and submitted to the USEPA on behalf of Fansteel. Fansteel received additional comments on the February 2003 EE/CA Report from the USEPA on June 17, 2003. The comments were generated directly by USEPA risk assessment staff and were dated June 4, 2003. A meeting was held on June 19, 2003 between Fansteel, USEPA and their representatives to resolve the June 4, 2003 comments. On that day, Fansteel received additional comments on the February 2003 EE/CA Report from USEPA legal staff via e-mail.

Earth Sciences, on behalf of Fansteel, prepared and transmitted a Response to Comments letter dated August 26, 2003. The letter addressed the June 19, 2003 USEPA comments and provided redline comments on draft meeting minutes prepared by USEPA to document the June 19, 2003 meeting. Later, Earth Sciences also transmitted a technical memo to TN & Associates, Inc. on October 20, 2003 regarding vapor intrusion.

A site meeting between NCI, USEPA and their consultants took place on August 25, 2004. (At this time, Penn E&R was now the project consultant for NCI.) At the meeting, Brenda Jones introduced herself as the new project manager for USEPA. For informational purposes only, Ms. Jones also presented NCI with USEPA comments dated August 24, 2004 on the February 2003 EE/CA Report. A subsequent meeting took place in Chicago, Illinois at USEPA's Region V offices on October 7, 2004. The intent of the October 7, 2004 meeting was to resolve outstanding issues so the EE/CA Report could be revised and submitted for final approval by USEPA. Draft minutes from the meeting were distributed by Penn E&R via e-mail on November 3, 2004. In addition, position papers by Penn E&R regarding six remaining issues (requested by USEPA at the October 7, 2004 meeting) were distributed via e-mail on November 10, 2004. USEPA later transmitted a letter to NCI dated January 19, 2005 accepting the minutes from the October 7, 2004 meeting.

USEPA commented on the position papers via a letter to NCI dated December 16, 2004 and with a memo from TN & Associates, Inc. dated January 7, 2005. A final conference call was scheduled between the parties for January 19, 2005. During the call, outstanding issues between NCI and USEPA were resolved. Minutes from the conference call were generated by Penn E&R and circulated for approval. The minutes, as modified by USEPA, were approved by USEPA via letter to NCI dated February 1, 2005. This approval allowed for NCI and Penn E&R to prepare this May 2005 EE/CA Report, which is intended to address the sum total of comments and responses since the last EE/CA Report dated February 2003.

As a final informational note, the City of North Chicago acquired the North Chicago property on March 7, 2005. In accordance with the NCI Consent Decree, dated November 17, 2003, and the recently completed Stipulation and Order Clarifying and/or Modifying the Consent Decree (executed on March 4, 2005 by Judge Farnon who was the presiding judge in the Fansteel bankruptcy) and other closing conditions:

- The City of North Chicago payment of $1.4 million was transferred to the USEPA. Upon USEPA's receipt of payment, NCI has no further obligation to implement the North Chicago facility Response Action.
- Fansteel cancelled the $2.17 million note issued to NCI as part of the bankruptcy.
- Fansteel issued the Eminent Domain Note to USEPA in the amount of $677,232.
- Fansteel transferred $65,000 to NCI to cover remaining expenses to complete the EE/CA Report (EE/CA-related expenses will be deducted from the semi-annual payments to the Eminent Domain Note). After USEPA Region V approves the May 2005 EE/CA Report, NCI shall be free to dissolve.
- Fansteel executed a 6-month lease agreement with the City of North Chicago for continued use of the North Chicago property as their corporate administrative offices.

Therefore as of May 2005, NCI remains in existence but the City of North Chicago owns the subject property. However under the terms of the March 4, 2005 document, NCI is obligated to complete the EE/CA Report (until the document is approved by USEPA). This May 2005 EE/CA Report submittal is intended to fulfill that obligation, dependent upon the need for further comment from USEPA.

The supplemental site characterization work associated with this EE/CA Report included an assessment of groundwater conditions at several on-site locations since groundwater quality data for the facility was limited. The work also included additional groundwater characterization beneath the Vacant Lot Site to allow a refined definition of the contaminant plumes in this area. A signed access agreement was obtained from EMCO Chemical Distributors, Inc. (current owner of the Vacant Lot Site) prior to initiating the field activities on this property. Additionally, the collection of groundwater samples on the R. Lavin & Sons property was proposed by the EE/CA Work Plan to further define the horizontal extent of contaminants in groundwater and to determine the possibility for contribution from an off-site source(s). However, access to the property and additional site characterization data regarding the property could not be obtained from R. Lavin & Sons. Groundwater analytical data from facility monitoring wells and test borings located near the eastern property boundary with R. Lavin & Sons were evaluated.

In addition to the on- and off-site groundwater sampling activities, soil samples were obtained and submitted for laboratory analysis and aquifer characterization tests were performed. The following list provides an overview of the supplemental site characterization field program:

- Drilling and continuous soil screening was performed at 37 Geoprobe® locations (24 on site and 13 off site [Vacant Lot Site]). Two proposed Geoprobe® borings on the R. Lavin & Sons property were not completed, as discussed above.
- Continuous soil samples were collected from 10 Geoprobe® borings and submitted for laboratory analysis of constituents of potential concern (COPC).
- Three samples of the slag/fly ash material were obtained and submitted for laboratory analysis of COPCs.
- Soil samples were collected from 7 Geoprobe® borings and analyzed for parameters related to modeling and removal alternative evaluation.
- Nine soil samples were obtained from 5 hollow-stem auger borings and subjected to laboratory geotechnical evaluation.

- Groundwater samples were collected from 36 Geoprobe® borings and submitted for laboratory analysis of COPCs.
- Groundwater samples were obtained from the 9 existing monitoring wells and submitted for laboratory analysis of COPCs.
- Aquifer characterization testing was performed in 5 facility monitoring wells to assist in quantifying hydraulic parameters for the shallow aquifer beneath Fansteel property.
- A quality assurance/quality control (QA/QC) program for soil and groundwater samples was instituted for the duration of the field activities.

Fieldwork was initiated on May 30, 2001 and was completed on June 11, 2001.

The analytical results from the supplemental site characterization program, along with results presented in the Carlson Site Investigation Report, were evaluated to determine the prevalence of COPCs in soils at the North Chicago facility. Both sets of data were subject to data validation. The evaluation revealed that, in comparison with appropriate screening levels (USEPA; Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft March 2001 and Blood Lead Concentrations of U.S. Adult Females; Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey, Technical Review Workshop for Lead March 2002), the COPCs in soils that most frequently approached or exceeded applicable screening criteria were:

- Lead
- Trichloroethene
- Benzo(a)pyrene

Each of these COPCs were detected at varying concentrations and frequencies in soils within the identified areas of concern. For this EE/CA, the areas of concern are: 1) the HWMU and aboveground storage tank (AST) area; 2) the Metallurgical Buildings A and B area; 3) the Former Drum Storage area; and 4) the Chemical Building A and B area. The most elevated concentrations of trichloroethene in soil were located within the HWMU and AST area; specifically, south of the former HWMU, in subsurface samples. Based on an evaluation of the analytical data for both soils and groundwater, this area is considered to be a potential source area.

An evaluation was performed of groundwater data from both the Carlson Environmental, Inc. Site Investigation and the supplemental site characterization for the EE/CA. The analytical data represented

groundwater samples taken from both wells and geoprobes. The COPCs in groundwater that were most frequently detected were:

- Total Cadmium
- Total Lead
- Dissolved Lead
- Trichloroethene
- Cis-1,2-Dichloroethene
- Vinyl Chloride

Based on an evaluation of the analytical data, a trichloroethene groundwater plume (northern plume) exists beneath the former HWMU and AST area. This supports the conclusion stated above that a source area may be present. A relatively smaller trichloroethene plume (in both aerial extent and intensity) is also present beneath the Former Drum Storage area (southeastern plume). A separate and distinct trichloroethene plume was also noted along the western boundary of the Vacant Lot Site near Pettibone Creek. NCI believes this plume is not associated with Fansteel operations for three reasons. First. based on data from groundwater samples taken from TB-20, 21, and 23, the plume near the creek is isolated from the plume identified under the HWMU and AST area. Second, given the relatively slow linear groundwater velocity in the area, a plume originating within the North Chicago facility could not have traveled the corresponding distance from the property line in the timeframe since Fansteel operations began. Finally, there are no data or information indicating the North Chicago facility contributed to any surficial contamination on the Vacant Lot Site that could be the source of this plume.

Groundwater samples from some facility monitoring points have contained metals concentrations including lead. Adjacent properties to the east (R. Lavin & Sons property) and west (Vacant Lot Site) have also identified lead in soils and/or groundwater. NCI's (and Fantseel's) historical knowledge of facility activities supports NCI's belief that lead was never used in or generated from site operations, beyond common maintenance applications. The historical knowledge is based on anecdotal reports obtained from a past company employee. As a result, NCI believes the presence of lead throughout these three properties represents a regional/fill contamination source related to the Vulcan Louisville Smelting Company historical operations.

A baseline risk assessment was performed to provide a quantitative analyses, in a conservative and health-protective manner, of the likelihood that adverse health effects may be associated with potential exposures to constituents in environmental media at the North Chicago facility. In providing health-related information on potential contact with site-associated constituents, the risk assessment is designed to pro-

vide a sound basis for risk management decisions so that further evaluation of the site, if warranted, may be focused.

Based on the results of the baseline risk assessment, risk based remediation goals (RBRGs) were developed for those constituents with a risk greater than the carcinogenic point of departure of 1 x 10-6 and the noncarcinogenic acceptable benchmark of 1 per media and receptor. This resulted in the following RBRGs:

Receptor	**Media**	**Parameter**
Construction Worker	Groundwater - Ambient Air	Trichloroethene
On-site Trespasser	Groundwater - Ambient Air	Trichloroethene
Outdoor Worker	Groundwater - Ambient Air	Trichloroethene
	Soil - Direct Contact	Tetrachloroethene Benzo(a)pyrene
Indoor Worker	Groundwater - Indoor Air	Trichloroethene Vinyl chloride cis-1,2-Dichloroethene
	Soil - Indoor Air	Trichloroethene Vinyl chloride cis-1,2-Dichloroethene Chloroform Tetrachloroethene trans-1,2-Dichloroethene
	Soil - Direct Contact	Tetrachloroethene

Tables 47A through 47F present the equations and exposure input parameters used to develop the RBRGs. The exposure input parameters were the same as those used in the baseline risk assessment. The indoor air RBRGs were developed using the Johnson and Ettinger GW-SCREEN Version 3.0 model and the SL-SCREEN Version 3.0 model. The exposure input parameters for the model are presented on Table 47F. It should be noted that for carcinogenic parameters, RBRGs were developed for target risk levels of 1×10^{-6}, 1×10^{-5} and 1×10^{-4}. The calculations are presented in Appendix N. Tables 47G through 47J present the RBRGs per receptor and media.

RBRGs for total lead were derived and are presented in Table 47K. These goals were derived in accordance with the guidance presented in the USEPA's Recommendations of the Technical Review Workgroup for Lead for an Approach for Assessing Risks Associated with Adult Exposures to Lead in Soil (USEPA 2003). Some of the input parameters (i.e., GSD and GM - Midwest Region) for this assessment approach were provided in the USEPA document entitled Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III) (USEPA 2002b). Input parameters and calculation of these remediation goals are presented in Appendix N.

Based on the USEPA 2003 guidance, receptors for the adult lead model are defined as contact intensive and contact nonintensive. The contact intensive RBRG is 538 milligrams per kilogram. This would be representative of the construction worker for the entire soil column. The contact nonintensive RBRG is 1,079 milligrams per kilogram representative of surface soils. This is most representative of the Indoor and Outdoor Worker and On-Site Trespasser.

The potential migration of trichloroethene over time (as a solute in groundwater) was predicted using Visual Modflow/MT3D v3.0.0 (Modflow). The modeling effort was conducted based on the contaminant distributions, groundwater flow, and geologic data collected during the site investigations. In addition, the contribution of trichloroethene contamination from shallow soils was determined using the 2-Dimensional program VLEACH and incorporated into Visual Modflow. These model runs provide a range of what can be expected of the plume's migration and overall concentration reduction over time.

None of the modeling scenarios indicate that the northern plume will reach Pettibone Creek within the next 100 years. (As stated in Item 12 of Section 4.1: Synopsis of Groundwater Flow, "…a deliberately conservative range of degradation rates were selected for modeling purposes. The values used ranged from 1.4 percent (50 year half life) to 3.5 percent per year (20 year half life)." NCI believes that the modeling scenarios provide reasonable predictions of plume dissipation over time.) Only the scenario with the greater hydraulic conductivity and slowest biodegradation rate ever reaches Pettibone Creek. In fact, the other three scenarios with the slower hydraulic conductivity indicate that the extent of the plume is not anticipated to be much greater than what is depicted for existing conditions. In the northern plume area, relatively high concentrations of trichloroethene and degradation products (10 to 50 milligrams per liter [mg/l]) still remain within the plume area after 50 years in any of the scenarios. In addition, after 100 years, concentrations in the center of the northern plume still remain in the 1 to 10 mg/l range. In summary, except for the one scenario, the overall extent of the plume is not anticipated to extend much

beyond current conditions. However, concentrations within the plume will remain relatively high for the foreseeable future within the immediate source area.

The southeastern and southwestern area plumes are much more limited in size and concentration compared to the northern plume area. Similar to the northern plume, the southwestern plume (MW-8 area) does reach Pettibone Creek for the one scenario only. In all scenarios, concentrations are at relatively low levels beyond the 50-year time period and concentrations are at or just above detection limits in 100 years.

Based on these results, it was determined that source removal/treatment alternatives should be evaluated further for the northern plume area in order to ensure control of plume migration and to meet applicable trichloroethene water quality standards within a more reasonable time frame. Another reason for evaluating the reduction of contaminant concentrations within the plume area is to address potential future risks due to indoor vapor intrusion from groundwater as identified in the baseline risk assessment. However, this risk could also be managed by restricting the area for future building construction and/or installing vapor removal systems within existing buildings.

To evaluate the overall impact on source reduction, it was assumed that the total concentration of trichloroethene and degradation products within the highest portion of the plume would be reduced to an average concentration of 10 mg/l. As expected, the northern plume concentrations in the future are reduced significantly and only one scenario suggests concentrations may be slightly above 1 mg/l beyond 100 years. In addition, for the scenario with the greater hydraulic conductivity and slowest biodegradation rate, the extent of the plume is more limited and at lower concentrations.

The removal action objectives are based on an evaluation of the identified removal action goals and the possible means by which the goals can be achieved. When practicable, an attempt was made to provide the reader with definable objectives to achieve the goals, without prejudice to the possible removal alternatives that may be employed. The removal action goals, followed by the associated removal action objectives, are listed below.

<u>Goal No. 1:</u> Manage the potential for risks due to the inhalation of indoor air by indoor workers, current and future.

Objective No. 1: Mitigate the exposure pathway primarily through confirmation monitoring and/or the application of institutional and engineering controls.

Goal No. 2: Reduce the potential risk of exposure to lead in soils via direct contact/ingestion/inhalation.

Objective No. 2: Isolate, treat, or remove soils impacted by lead within exposed areas in the HWMU and AST area and the Former Drum Storage Area. Areas of the facility covered by structures or pavement fulfill this objective, but must be maintained.

Goal No. 3: Control and manage the groundwater plume associated with the HWMU and AST area through source area reduction.

Objective No. 3: Isolate, treat, or remove contaminants within the potential source area associated with the HWMU and AST area to assist in the natural dissipation of the plume over time to acceptable levels.

NCI considers the use of the presumptive remedy (containment) for lead in soils at the North Chicago facility to be applicable to address the Removal Objective No. 2. Based on the evaluation of the presumptive remedies, and the limitations associated with each, other remedial alternatives were considered to address Removal Objective No. 3 concerning groundwater. The following technologies were selected for alternative analyses based on potential applicability to site circumstances and judgements made as to the probability of meeting both remedial objectives. The No Action Alternative is traditionally included as a baseline alternative.

Alternative 1: No Action
Alternative 2: Surface Capping with Excavation, Transportation, and Disposal
Alternative 3: Surface Capping with Enhanced In-Situ Bioremediation
Alternative 4: Surface Capping with Permeable Reactive Barrier

Each of the four alternatives includes provisions for groundwater monitoring. Alternatives 2, 3, and 4 also include the establishment of institutional controls (i.e. deed restrictions regarding subsurface intrusion and notifications regarding vapor intrusion) and possible engineering controls to address Removal Objective No. 1. Indoor air sampling for COCs is also anticipated to confirm the results of vapor intrusion modeling. Specifics regarding the sampling and analyses program will be developed as part of the Removal Action Work Plan.

The four removal alternatives were compared based on effectiveness, implementability, and cost. A summary of the comparison is presented in Table 54. Considering effectiveness, Alternative 1 would not be effective in protecting human health and the environment since the remedial objectives would not be met. Alternative 1 would also not be effective in the short or long term and would not reduce toxicity, mobility, or volume of the contaminants. Alternatives 2, 3 and 4 would be effective since each is protective of human health and the environment once implemented and maintained. These three alternatives would also reduce toxicity, mobility, and volume and would be effective in the long term. Alternative 3 is effective in the short term based on the relatively minor level of disturbance involved with the application of the HRC material. However, Alternatives 2 and 4 present concerns regarding short-term effectiveness. (As stated in the Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA, PB93-963402, EPA540R-93-057, "The short-term effectiveness criterion addresses the effects of the alternative during implementation before the removal objectives have been met.") Alternatives 2 and 3 involve potential risks from the logistics associated with excavation and material handling, although Alternative 3 less so given a limited excavation scope. Alternative 4 involves the same risks associated with the installation of the PRB, in addition to the fact that impacted groundwater will take an extended period of time to reach the PRB. Therefore, comparatively, Alternative 3 is the most effective.

Regarding implementability, Alternative 1 is clearly the most easily implemented. Alternatives 2, 3, and 4 are feasible to varying degrees. Alternatives 2 and 3 (Alternative 3 to a lesser degree) involve excavation, transportation, and disposal, which are commonly performed. However, difficulties related to these activities, such as excavation stability, water management, and materials management demand particular attention. Alternative 4 also presents similar concerns, in addition to administrative coordination with the Vacant Lot Site property owner and potential agency acceptance issues considering the passive nature of the PRB. Alternative 3 can be implemented fairly easily considering the relatively simplistic method of HRC application. Therefore, comparatively, Alternative 1 is the most easily implemented, Alternative 3 being the next most feasible.

Lastly, the costs for each alternative have been compared. Alternative 1 is the least costly followed by Alternative 3. Alternatives 2 and 4 are the most costly.

The recommended removal action alternative is Alternative 3, Surface Capping with Enhanced Bioremediation. This alternative fulfills the removal action objectives of: 1) mitigating the exposure

pathway primarily through confirmation monitoring and/or the application of institutional and engineering controls; 2) isolating, treating, and/or removing soils impacted by lead within exposed areas of the HWMU and AST area and the Former Drum Storage Area; and 3) isolating, treating, or removing the potential source area (affected soil and groundwater) associated with the HWMU and AST area to assist in the natural dissipation of the plume over time to acceptable levels. This alternative would be effective, implementable, and the most cost effective (aside from the No Action alternative) option. This alternative will address all remaining issues relative to completing the EE/CA for the North Chicago facility.

The Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA, PB93-963402, EPA540R-93-057, states that, "The EE/CA should identify the action that best satisfies the evaluation criteria based on the comparative analysis in the previous section." NCI has appropriately provided a recommendation. NCI acknowledges that USEPA must select which removal alternative will be implemented.

Engineering Evaluation/Cost Analysis
North Chicago, Inc.
North Chicago, Illinois Facility

1.0 Introduction

Penn Environmental and Remediation, Inc. (Penn E&R), on behalf of North Chicago, Inc. (NCI) [a wholly-owned, special purpose subsidiary of Fansteel Inc. (Fansteel)], has prepared this May 2005 Engineering Evaluation/Cost Analysis (EE/CA) Report for the North Chicago, Illinois facility (Figure 1). The development and submittal of this EE/CA Report was performed in compliance with the September 21, 2000 Administrative Order (AO) issued by the U.S. Environmental Protection Agency (USEPA) Region V. As specified in the AO, the contents and format of the North Chicago facility EE/CA Report adhere to the reporting guidelines that are outlined in the USEPA document, Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA (USEPA, August 1993).

The intent of this report is to provide an evaluation of the site characterization data for the North Chicago facility and adjacent areas in order to identify an appropriate remedial strategy for the North Chicago facility. Additionally, as required by the Illinois Environmental Protection Agency (IEPA), the EE/CA Report also provides a Resource Conservation and Recovery Act (RCRA) contingent closure plan modification for the facility's former Hazardous Waste Management Unit (HWMU). The successful completion of the CERCLA cleanup will provide for completion of, and financing for, the equivalent of an RCRA closure of the two RCRA-regulated units

A proposed scope of work for completing the North Chicago facility EE/CA, as well as implementing a supplemental site characterization program, was detailed in the EE/CA Work Plan, prepared by Earth Sciences Consultants, Inc. (Earth Sciences), that was submitted to the USEPA for review and approval on March 28, 2001. The EE/CA Work Plan was developed based on the following: 1) requirements of the AO; 2) USEPA comments regarding Carlson Environmental, Inc.'s (Carlson) draft Site Investigation Report; 3) results contained in Carlson's January 26, 2001 Site Investigation Report (final version); 4) Ecology and Environment, Inc.'s (E&E) October 30, 1997 EE/CA Report for the Vacant Lot Site (a site located contiguous to and west of the North Chicago facility); 5) information provided from miscellaneous investigations previously conducted for the North Chicago facility and the Vacant Lot Site; and 6) relevant USEPA regulations and guidance. A Quality Assurance Project Plan (QAPP) and a

Health and Safety Plan (HSP) were developed in association with the supplemental site characterization program and were submitted for USEPA approval along with the EE/CA Work Plan.

The USEPA provided comments on the EE/CA Work Plan in its May 8, 2001 facsimile transmittal. The USEPA's May 14, 2001 follow-up letter (EE/CA Work Plan Approval Letter with Comments) approved the EE/CA Work Plan contingent upon the incorporation of USEPA's comments into the plan. USEPA comments regarding the EE/CA Work Plan were subsequently addressed in a Response to Comments letter that was prepared by Earth Sciences and submitted to the USEPA on May 18, 2001. In addition to the USEPA's comments regarding the EE/CA Work Plan, the Response to Comments letter also considered the USEPA's May 1, 2001 correspondence that provided comments for Carlson's final Site Investigation Report. As stipulated in the USEPA's May 14, 2001 conditional approval letter, the Response to Comments letter was included as an addendum to the EE/CA Work Plan and the fieldwork was initiated on May 30, 2001. Comments were also received from the USEPA on June 5 and June 11, 2001 regarding the QAPP and HSP submittals respectively. A response to these comments was prepared and submitted to the USEPA on August 16, 2001, after the field activities had been completed. The August 16, 2001 response was also incorporated as an addendum to the approved EE/CA Work Plan.

Fieldwork associated with the EE/CA Work Plan was completed on June 11, 2001. A draft EE/CA Report was submitted to the USEPA on July 11, 2001. Fansteel received comments on the draft report from the IEPA dated September 17, 2001 and from the USEPA dated August 16, 2001 and September 19, 2001 (TN & Associates, Inc. on behalf of USEPA). A meeting with the USEPA was held on October 30, 2001 to discuss the comments received. As a result of this meeting, Earth Sciences, on behalf of Fansteel, issued a letter dated November 20, 2001 that presented a revised approach for performing the streamlined risk evaluation (SRE) and developing the remedial objectives (RO). Fansteel later received comments from the USEPA regarding the revised approach dated December 10, 2001.

As set forth in Fansteel's Monthly Written Reports to the USEPA, Fansteel's past financial difficulties leading to the Fansteel bankruptcy, delayed further work on the project until June 2002. Data validation activities, development of responses to the December 10, 2001 comment letter, and the development of information regarding the proposed analysis of remedial alternatives were completed in preparation for a meeting with the USEPA on September 10, 2002. Prior to the meeting, Earth Sciences submitted, on behalf of Fansteel, a letter dated August 30, 2002 documenting data validation efforts and a letter dated September 3, 2002 responding to the December 10, 2001 USEPA comment letter regarding the SRE.

During the September 10, 2002 meeting with USEPA, several agreements were reached concerning the nature of the risk evaluation to be performed, the screening levels employed, and the use of the validated data. These agreements were documented in final meeting minutes dated September 25, 2002. An agreement was also reached that a formal written response to the comments previously received by Fansteel regarding the July 11, 2001 draft EE/CA Report would not be submitted. Rather, Fansteel agreed to acknowledge, as it does now, that the comments were reviewed and considered in the creation of the February 2003 EE/CA Report. The parties originally agreed that the revised EE/CA Report would be submitted in January 2003. This date was later changed to February 2003, per agreement with the USEPA as documented in the Monthly Written Report for December 2002, to allow for the completion of additional groundwater modeling. On September 27, 2002, TN & Associates, Inc. generated a report discussing their review of the data validation information provided in the August 30, 2002 transmittal referenced above. Based on the results of the report, Fansteel has used the data as qualified in the validation reports.

Fansteel received TN & Associates, Inc. comments on the February 2003 EE/CA Report from the USEPA on June 4, 2003. The comments were dated May 23, 2003. A Response to Comments letter dated June, 10, 2003 was generated by Earth Sciences and submitted to the USEPA on behalf of Fansteel. Fansteel received additional comments on the February 2003 EE/CA Report from the USEPA on June 17, 2003. The comments were generated directly by USEPA risk assessment staff and were dated June 4, 2003. A meeting was held on June 19, 2003 between Fansteel, USEPA and their consultants to resolve the June 4, 2003 comments. On that day, Fansteel received additional comments on the February 2003 EE/CA Report from USEPA legal staff via e-mail.

Earth Sciences, on behalf of Fansteel, prepared and transmitted a Response to Comments letter dated August 26, 2003. The letter addressed the June 19, 2003 USEPA comments and provided redline comments on draft meeting minutes prepared by USEPA to document the June 19, 2003 meeting. Later, Earth Sciences also transmitted a technical memo to TN & Associates, Inc. on October 20, 2003 regarding vapor intrusion.

A site meeting between NCI, USEPA and their consultants took place on August 25, 2004. (At this time, Penn E&R was now the project consultant for NCI.) At the meeting, Brenda Jones introduced herself as the new project manager for USEPA. For informational purposes only, Ms. Jones also presented NCI with USEPA comments dated August 24, 2004 on the February 2003 EE/CA Report. A subsequent meeting took place in Chicago, Illinois at USEPA's Region V offices on October 7, 2004. The intent of

the October 7, 2004 meeting was to resolve outstanding issues so the EE/CA Report could be revised and submitted for final approval by USEPA. Draft minutes from the meeting were distributed by Penn E&R via e-mail on November 3, 2004. In addition, position papers by Penn E&R regarding six remaining issues (requested by USEPA at the October 7, 2004 meeting) were distributed via e-mail on November 10, 2004. USEPA later transmitted a letter to NCI dated January 19, 2005 accepting the minutes from the October 7, 2004 meeting.

USEPA commented on the position papers via a letter to NCI dated December 16, 2004 and with a memo from TN & Associates, Inc. dated January 7, 2005. A final conference call was scheduled between the parties for January 19, 2005. During the call, outstanding issues between NCI and USEPA were resolved. Minutes from the conference call were generated by Penn E&R and circulated for approval. The minutes, as modified by USEPA, were approved by USEPA via letter to NCI dated February 1, 2005. This approval allowed for NCI and Penn E&R to prepare this May 2005 EE/CA Report, which is intended to address the sum total of comments and responses since the last EE/CA Report dated February 2003.

[As a final informational note, the City of North Chicago acquired the North Chicago property on March 7, 2005. In accordance with the NCI Consent Decree, dated November 17, 2003, and the recently completed Stipulation and Order Clarifying and/or Modifying the Consent Decree (executed on March 4, 2005 by Judge Farnon who was the presiding judge in the Fansteel bankruptcy) and other closing conditions:

- The City of North Chicago payment of $1.4 million was transferred to the USEPA. Upon USEPA's receipt of the payment, NCI has no further obligation to implement the North Chicago facility Response Action.
- Fansteel cancelled the $2.17 million note issued to NCI as part of the bankruptcy.
- Fansteel issued the Eminent Domain Note to USEPA in the amount of $677,232.
- Fansteel transferred $65,000 to NCI to cover remaining expenses to complete the EE/CA Report (EE/CA-related expenses will be deducted from the semi-annual payments to the Eminent Domain Note). After USEPA Region V approves the May 2005 EE/CA Report, NCI shall be free to dissolve.
- Fansteel executed a 6-month lease agreement with the City of North Chicago for continued use of the North Chicago property as their corporate administrative offices.

Therefore as of May 2005, NCI remains in existence but the City of North Chicago owns the subject property. However under the terms of the March 4, 2005 document, NCI is obligated to complete the EE/CA Report (until the document is approved by USEPA). This May 2005 EE/CA Report submittal is intended to fulfill that obligation, dependent upon the need for further comment from USEPA.]

This May 2005 EE/CA Report is formatted as follows. Chapter 2.0 presents a discussion of site characterization information that includes an overview of site features and history, a summary of previous investigations and removal actions, and detailed discussions regarding the field methods and results associated with the supplemental site characterization program. Chapter 2.0 also provides detailed information regarding the source, nature, and extent of contamination. Chapter 3.0 is the baseline risk assessment. Chapter 4.0 presents the results of groundwater modeling performed to evaluate the site. The identification of removal action objectives and the identification and analysis of removal action alternatives are addressed in Chapters 5.0 and 6.0 respectively. A comparative analysis of removal action alternatives is contained in Chapter 7.0, and Chapter 8.0 presents the recommended removal action alternative. [Per agreement with USEPA, detailed information regarding the removal of PCBs from the Transformer Courtyard is provided as a separate appendix (Appendix P) of this document.]

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2.0 Site Characterization

2.1 Site Description and Background

2.1.1 Site Description

The North Chicago facility is located at Number One Tantalum Place, approximately 2 miles east of the intersection of Martin Luther King Jr. Street (22nd Street) and U.S. Highway 41 in North Chicago, Lake County, Illinois (Figure 1). The site is bounded by the R. Lavin & Sons facility to the east, 22nd Street to the south, the Vacant Lot Site (currently owned by EMCO Chemical Distributors, Inc.) to the west, and the Elgin, Joliet & Eastern Railroad to the north. Relevant facility features and contiguous properties are depicted in Figure 2.

Specifically, the site consists of a former industrial facility located on an approximate 8-acre parcel. There are two brick buildings on the site, a boiler house, and a main production building that is comprised of multi-story and multi-use inner buildings. In addition, a transite building and some aluminum buildings are present on the site. The reported total gross floor space is 325,500 square feet. The entire site is enclosed by security fencing.

Portions of the property not covered by buildings are generally paved with asphalt or concrete, and are used as parking areas or access ways. Two large empty aboveground storage tanks (AST) are located at the northern end of the property. A railroad spur is situated in proximity to the eastern edge of the site and an elevated siding is located south of the ASTs. Some vegetation, consisting of grass and bushes, exists between the office area and 22nd Street.

Site topography is essentially flat, although within the eastern portion of the property, the ground surface is elevated near the fence line and slopes downward into the parking lot. The main building is elevated in comparison to the parking lot, and the eastern railroad spur is several feet below the site grade. The railroad property north of the site slopes steeply downward toward the site.

2.1.2 Site History

Between approximately 1910 and 1942, Vulcan Louisville Smelting Company (VLS) and North Chicago Refiners and Smelters (NCRS) operated on the areas that currently comprise the Vacant Lot Site, the North Chicago facility, and the R. Lavin & Sons plant. VLS was a primary property owner during this time period. Based on a review of Sanborn Fire Insurance maps, VLS is shown to occupy areas of the

North Chicago facility during 1912, 1917, 1924, and 1929. Prior to VLS, previous site owners of Lanyon Zinc Oxide Smelting Company and the Mineral Point Zinc Company operated on the areas that are currently occupied by the Vacant Lot Site, the North Chicago facility, and the R. Lavin & Sons property.

The federal government purchased a portion of the VLS property in 1942 through its Defense Plant Corporation, and authorized and financed the construction of the North Chicago facility. A Fansteel subsidiary, the Tantalum Defense Corporation, was formed and leased the site from the federal government. The Tantalum Defense Corporation supplied the government with various materials needed during World War II. The federal government owned the facility from 1942 to 1947. The facility was subsequently sold by the federal government to Fansteel in 1947. The Fansteel Metals Division and Fansteel VR/Wesson Division operated at the site between 1954 and 1990. The main facility operations included the production of specialty metals and related products in addition to powder metallurgy operations. Production activities at the North Chicago facility ceased in 1990.

2.1.3 Current Site Operations

The facility is currently used by Fansteel as office space for its corporate headquarters. The former site buildings are primarily vacant and are maintained, as necessary. As stated in Chapter 1.0, the City of North Chicago acquired the North Chicago property on March 7, 2005. Fansteel executed a 6-month lease agreement with the City of North Chicago for continued use of the North Chicago property as their corporate administrative offices. Therefore as of May 2005, NCI remains in existence (as a wholly-owned subsidiary of Fansteel) but the City of North Chicago owns the subject property.

2.2 Previous Investigations and Removal Actions

2.2.1 Vacant Lot Site and Pettibone Creek

The Vacant Lot Site is situated adjacent to and west of the North Chicago facility (Figure 2). Several investigations have previously been conducted for the Vacant Lot Site. Specifically, Geraghty & Miller, Inc. (Geraghty & Miller) implemented a subsurface investigation at the Vacant Lot Site during November 1993 that focused on shallow groundwater to a depth of approximately 14 feet. That investigation was described in a report entitled, [redacted] Additionally, Ecology and Environment, Inc. (E&E) performed a site assessment at the Vacant Lot Site in 1994. The results of these investigations indicated the presence of elevated concentrations of heavy metals, trichloroethene, and polychlorinated biphenyls (PCB) on the site. Subsequently, an EE/CA was performed for the Vacant Lot Site by E&E in 1997 under contract with the

USEPA. The EE/CA included an historic review of the Vacant Lot Site; additional soil, groundwater, and sediment sampling at the site; a feasibility type analysis of potential remedial alternatives; and a cost analysis for various remediation strategies. The EE/CA indicated elevated levels of lead and PCBs in surface soils. A plume of chlorinated solvents in groundwater was also identified in the Vacant Lot Site EE/CA. The EE/CA for the Vacant Lot Site reported that the site had been used for waste disposal by local industrial properties and that on-site groundwater contamination is impacted by on-site source/fill area contaminant leaching. Additionally, the USEPA has contended that potential contamination at the North Chicago facility may have impacted groundwater at the Vacant Lot Site and Fansteel was identified as a potential source for the chlorinated solvent plume. Following the EE/CA that was performed for the Vacant Lot Site, the USEPA conducted a site-wide soil and sediment removal action that was completed in May 1999.

Pettibone Creek runs in a generally north-south direction, transecting the Vacant Lot Site that lies adjacent to, and to the west of, the North Chicago facility. Pettibone Creek eventually flows east into Lake Michigan approximately 1.5 miles away. Two recent investigations of Pettibone Creek have been performed, including an evaluation performed for the USEPA. The following discussion summarizes the results of the investigations.

Carlson performed a Site Investigation of the North Chicago facility, on behalf of Fansteel, in April and September 2000. Carlson's investigation of Pettibone Creek as part of this effort focused on the portion of Pettibone Creek immediately down gradient or south of the Vacant Lot Site. Carlson collected sediment samples from Pettibone Creek at three locations approximately 300, 600, and 900 feet south of 22nd street. (According to Fansteel personnel, the only known potentially active discharge from the North Chicago facility to Pettibone Creek is located immediately up gradient or north of the 22nd Street culvert.) At each location, sediment samples were taken at depths of 0 to 6 inches and 6 to 12 inches below Pettibone Creek bottom and analyzed for potential contaminants of concern.

Based on an evaluation of the analytical results for the sediment samples, Carlson concluded that other sources separate from Fansteel appear to have contributed or may continue to be contributing to the impacts detected in Pettibone Creek, based on the nature and relative location of the constituents detected. Therefore, Carlson concluded that it would be inappropriate for Fansteel to conduct an EE/CA addressing Pettibone Creek since the EE/CA would include an evaluation of contaminants (such as polynuclear aromatic hydrocarbons [PNA] and PCBs) that are unrelated to the contaminants of concern at the North Chicago facility.

TN & Associates, Inc. performed an investigation of Pettibone Creek in October 2000 for the USEPA. The investigation focused on the section of Pettibone Creek located between 22nd Street and Sheridan Road, and the section of the Elgin, Joliet & Eastern Railroad ditch discharging at the origin of Pettibone Creek. After obtaining sediment samples from Pettibone Creek and the northern most drainage ditch feeding Pettibone Creek (Elgin, Joliet & Eastern Railroad ditch), TN & Associates, Inc. submitted the samples for Target Analyte List and Target Compound List analysis. The results of the analysis indicated that the most elevated contaminant concentrations were present at the NCRS/City of North Chicago storm water discharge location (SED 1003) and east of the storm water pipe located in the Elgin, Joliet & Eastern Railroad ditch (SED 1008). The location of SED 1003 is significantly down gradient of the North Chicago facility discharge and the location of SED 1008 is actually located up gradient. Therefore, based on the results of TN & Associates, Inc.'s investigation, it is probable that the primary sources of contamination in Pettibone Creek are either up gradient or down gradient of the North Chicago facility discharge location.

2.2.2 Fansteel Property

In a letter to Fansteel dated June 17, 1997, the USEPA requested that an investigation of the North Chicago facility be conducted to identify any contamination that may be contributing to the groundwater contaminants at the Vacant Lot Site and to collect sediment samples from Pettibone Creek. Fansteel then retained Carlson to prepare a Site Investigation Work Plan (July 1999) that proposed soil, groundwater, and sediment sampling consistent with USEPA's requests. Following USEPA approval of the work plan, field investigations were initiated and completed by Carlson during the period from April through September 2000. The site investigation included the advancement and sampling of 37 soil borings and the installation, development, and sampling of 9 groundwater monitoring wells. In addition, sediment samples were collected from Pettibone Creek and the drainage ditch located north of the Vacant Lot Site.

The investigative work completed by Carlson was conducted in accordance with the July 1999 USEPA approved Site Investigation Work Plan. The results of that investigation culminated in a Site Investigation Report that was submitted by Carlson in final form to the USEPA on January 26, 2001.

As a result of the information provided by the previous on- and off-site environmental investigations, the USEPA Region V issued an AO dated September 21, 2000 that ordered Fansteel to conduct an EE/CA for its property in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements.

2.2.3 RCRA Closure Activities for the Former HWMU

The NCI facility has operated as an interim status facility (ILD005130786) under RCRA. As such, NCI's predecessor (Fansteel) submitted both RCRA Part A and Part B applications (with subsequent revisions) in accordance with applicable regulatory requirements, but never received a formal operating permit. On January 8, 1991, NCI's predecessor formally withdrew its RCRA Part B application for the NCI facility. The RCRA Part A application remains on file. On January 23, 2004, NCI submitted to IEPA a request for Change of Ownership of the RCRA Part A interim status when the property was transferred to NCI in accordance with the Plan of Reorganization under the Chapter 11 bankruptcy proceedings for Fansteel Inc.

In 1987, NCI's predecessor successfully closed all but one of the HWMUs present at the site (IEPA approval May 14, 1987). The remaining HWMU tanks (Tanks S02 – 27,000 gallons; 2 tanks @ 13,500 gallons) were removed from the site in 1990, but formal RCRA closure of the unit was never completed. The original closure plan for this unit, dated December 18, 1987, was approved by the IEPA on March 15, 1988 with subsequent plan modifications approved on November 4, 1988, June 30, 1989, February 13, 1990, February 5, 1991, August 9, 1991, and February 13, 1992. (Final closure soil sampling was conducted by Carlson during August and September 1992. During the RCRA-related investigations, elevated concentrations of trichloroethene, lead, and cadmium were detected in soil. The investigation results were submitted by Fansteel to the IEPA RCRA Section.)

The September 21, 2000 AO required that an EE/CA be completed for the NCI facility. Because the USEPA and IEPA had previously agreed that the closure of the remaining HWMU should be considered in subsequent USEPA site action under CERCLA (Letter IEPA to USEPA December 11, 1996), the completion of the remaining HWMU closure was included within the scope of the EE/CA. This was accomplished through narrative references and, in the February 2003 version of the EE/CA, the inclusion of Appendix I. Appendix I was a proposed Contingent Closure/Post Closure Plan for the HWMU. The plan was intended to modify the current closure plan by closing the HWMU in conjunction with the recommended remedy proposed for the entire site in the EE/CA. Appendix I was also intended to address comments in the IEPA letter dated September 17, 2001 regarding the initial submittal of the EE/CA Report, dated July 2001. In the IEPA comment letter, IEPA requested that in-situ bioremediation for groundwater be considered (which was done) and directed that that HWMU be closed in accordance with landfill closure requirements.

Since the submittal of the February 2003 version of the EE/CA Report, no formal comments have been received from IEPA concerning the document. However, in a letter from USEPA to IEPA dated October 31, 2003, USEPA states, "It is our understanding that Illinois EPA concurs that the successful completion of CERCLA cleanup as described in the pending draft of the EE/CA Report will provide for completion of, and financing for, the equivalent of RCRA closure of the two RCRA-regulated units." Please note that Section 33 of the North Chicago Consent Decree, describing the treatment of the North Chicago property in accordance with the Plan of Reorganization under the Chapter 11 bankruptcy proceedings for Fansteel also provides that the implementation and completion of the removal action per the revised EE/CA Report shall satisfy the RCRA closure requirements.

This May 2005 EE/CA Report also incorporates a Contingent Closure/Postclosure Plan (Appendix I) to modify the currently approved closure plan for the HWMU. Once proper closure of the HWMU has been achieved, a certification of closure and an associated closure documentation report (as required by 35 IAC 725.215) will be submitted, by others. These documents will be submitted to USEPA and IEPA for review and/or approval. Once the remedy is completed (i.e. when the removal action field activities are complete, operation and maintenance period not included) IEPA will terminate NCI's interim status as a TSD facility.

The costs for long-term operation and maintenance at the facility have been included in the cost estimates provided in the EE/CA Report. These costs are all inclusive for the implementation of the removal action under CERCLA and for the closure and subsequent postclosure care of the HWMU under IEPA hazardous waste requirements. The funding of these remediation activities was discussed in the Fansteel Plan of Reorganization (POR) filed on July 24, 2003 with the U.S. District Bankruptcy Court in the District of Delaware and consists of financial notes and other funding obligations. The funding mechanism described in the POR is intended to satisfy, and shall be in lieu of, any RCRA financial assurance requirements that could be imposed by the IEPA for the closure/postclosure of the HWMU.

2.3 Supplemental Site Characterization Field Program

Typically, an EE/CA is performed once all characterization information for a particular facility has been gathered. However, because data gaps were identified by the USEPA relative to Carlson's 2000 Site Investigation, additional site characterization work was required to address these deficiencies. The supplemental site characterization program completed by Earth Sciences, as described in the EE/CA Work Plan and associated addenda, was designed to eliminate the data gaps identified in USEPA's December 21, 2000 letter (comments regarding Carlson's draft Site Investigation Report), and USEPA's

May 1, 2001 correspondence (comments related to Carlson's final Site Investigation Report). As previously indicated in Chapter 1.0, the EE/CA Work Plan was conditionally approved in the USEPA's May 14, 2001 correspondence.

The supplemental site characterization work primarily included an assessment of groundwater conditions at several on-site locations since groundwater quality data for the facility was limited. The work also included additional groundwater characterization beneath the Vacant Lot Site to allow a refined definition of the contaminant plumes in this area. A signed access agreement was obtained from EMCO Chemical Distributors, Inc. (current owner of the Vacant Lot Site) prior to initiating the field activities on this property. Additionally, the collection of groundwater samples on the R. Lavin & Sons property was proposed by the EE/CA Work Plan to further define the horizontal extent of contaminants in groundwater and to determine the possibility for contribution from an off-site source(s). However, access to the property and additional site characterization data regarding the property could not be obtained from R. Lavin & Sons. Groundwater analytical data from facility monitoring wells and test borings located near the eastern property boundary with R. Lavin & Sons were evaluated.

In addition to the on- and off-site groundwater sampling activities, soil samples were obtained and submitted for laboratory analysis and aquifer characterization tests were performed. The following list provides an overview of the supplemental site characterization field program:

- Drilling and continuous soil screening was performed at 37 Geoprobe® locations (24 on site and 13 off site [Vacant Lot Site]). Two proposed Geoprobe® borings on the R. Lavin & Sons property were not completed, as discussed above.
- Continuous soil samples were collected from 10 Geoprobe® borings and submitted for laboratory analysis of constituents of potential concern (COPC).
- Three samples of the slag/fly ash material were obtained and submitted for laboratory analysis of COPCs.
- Soil samples were collected from 7 Geoprobe® borings and analyzed for parameters related to modeling and removal alternative evaluation.
- Nine soil samples were obtained from 5 hollow-stem auger borings and subjected to laboratory geotechnical evaluation.
- Groundwater samples were collected from 36 Geoprobe® borings and submitted for laboratory analysis of COPCs.
- Groundwater samples were obtained from the 9 existing monitoring wells and submitted for laboratory analysis of COPCs.

- Aquifer characterization testing was performed in 5 facility monitoring wells to assist in quantifying hydraulic parameters for the shallow aquifer beneath Fansteel property.
- A quality assurance/quality control (QA/QC) program for soil and groundwater samples was instituted for the duration of the field activities.

Soil and groundwater sampling locations for the supplemental site characterization work are depicted in Figure 3.

Fieldwork was initiated on May 30, 2001 and was completed on June 11, 2001. A notification letter regarding the commencement of field activities was submitted to the USEPA on May 23, 2001. Earth Sciences retained Rock & Soil Drilling Corporation (Rock & Soil) of St. Charles, Illinois to perform the subsurface work. The USEPA was provided with a notification letter regarding the selection of Rock & Soil along with Rock & Soil's Statement of Qualifications prior to the initiation of fieldwork.

All work was conducted according to the March 28, 2001 EE/CA Work Plan and associated addenda. Also, all investigative fieldwork was performed in accordance with USEPA guidance and the provisions of the AO. Fieldwork was supervised on a full-time basis by an Earth Sciences' geologist under the supervision of a licensed professional geologist. The field geologist maintained detailed written and photographic documentation for all aspects of the investigative procedures. Methods and protocol for the field activities described in this chapter are detailed in the Standard Operating Procedures that are contained in the associated QAPP. All individuals performing fieldwork had completed an approved Occupational Safety and Health Administration 40-hour training course and had a current 8-hour continuing instruction certificate. Also, an HSP specific to the supplemental site characterization activities was developed by Earth Sciences. That plan was reviewed by all personnel performing the field activities and was maintained in the field by the supervising geologist.

2.3.1 Preparatory Work

Prior to initiating the subsurface investigation, the Illinois One Call System was contacted to locate potential underground utilities in the vicinity of the North Chicago facility. Available facility schematics were also reviewed and knowledgeable facility personnel were contacted to assist in identifying site-specific subsurface features. In addition, a site map indicating the proposed test boring locations was supplied to facility personnel who marked the locations within the facility property boundary prior to beginning the fieldwork.

2.3.2 Subsurface Assessment

This section provides a detailed description of the field activities and methods that were implemented to complete the supplemental site characterization program. Sampling locations are indicated in Figure 3. Boring logs, including logs from the 2000 Carlson Site Investigation, and field logbook records are contained in Appendices A and B respectively. Photographs depicting pertinent aspects of the field activities are provided in Appendix C. Appendix D contains Well Evacuation/Groundwater Sampling Reports.

2.3.2.1 Drilling Program

A total of 37 Geoprobe® borings (13 off site and 24 on site) and 5 on- and off-site hollow-stem auger borings were advanced to provide subsurface characterization data. The location for each boring, as depicted in Figure 3, was determined by measuring the location relative to established site features. Slight modifications to some of the proposed boring locations were necessary due to underground utilities, concrete footers, or rough terrain/ponded water (vacant lot). Drilling was completed using Geoprobe® direct-push technology (truck and track mounted rigs) and hollow-stem auger methods (all terrain vehicle mounted rig).

2.3.2.1.1 Geoprobe® Borings

To further characterize soil and groundwater in areas of concern, a total of 37 borings (TB-1 through TB-11, TB-11a, TB-12 through TB-30, and TB-33 through TB-38) were advanced using Geoprobe® direct-push technology. Boring placement was based on groundwater flow direction, available soils and groundwater analytical data, site production history, and field observations/discussions conducted with Fansteel's personnel. Specifically, these borings were completed at the following locations:

Off site:

- Eight borings within the Vacant Lot Site hydraulically down gradient of the HWMU/AST source area (Borings TB-20 through 25, TB-35, and TB-36).
- Five borings within the Vacant Lot Site hydraulically down gradient of the Metallurgical A and B buildings (Borings TB-26 through TB-30).

On site:

- Four borings within Metallurgical Buildings A and B for confirmation of the groundwater plume estimated in this area by Carlson and for soil data (Borings TB-1, TB-2, TB-37, and TB-38).

- Nine borings adjacent to and in the vicinity of the Warehouse Building for the evaluation of possible groundwater and soil impacts associated with the Former Drum Storage area (Borings TB-3 through TB-9, TB-33, and TB-34).

- Three borings associated with Chemical Building A and the Maintenance Shop to characterize groundwater and soil conditions in this area (Borings TB-10, TB-11, and TB-11a).

- Seven borings within and adjacent to the HWMU and AST area for confirmation of the groundwater plume estimated by Carlson, an evaluation of possible groundwater impacts from the ASTs, and soil data (Borings TB-12 through TB-18).

- One boring along the eastern property boundary associated with determining potential contributions from off site (Boring TB-19).

Two borings (TB-31 and TB-32) were proposed to be located on the R. Lavin & Sons property (hydraulically up gradient of the North Chicago facility), but were not completed due to the inability to gain access. These borings, therefore, were removed from the field program.

Based on field observations during drilling, groundwater within the Geoprobe® borings was encountered at depths ranging from 3.0 feet (TB-23) to 13.6 feet (TB-30) below ground surface (bgs). To facilitate groundwater sample collection, each boring was extended to a depth of approximately 3 feet below the level groundwater was first encountered. Soil samples were initially collected along a 4-foot interval within each boring (e.g., 0.0 foot to 4.0 feet) and at 3-foot intervals thereafter. Borings located within areas overlain by concrete or asphalt were initially advanced using a masonry tip.

During drilling procedures on the North Chicago facility and Vacant Lot Site property, soils from continuous sampling intervals were subjected to screening using a photoionization device (PID) in conjunction with standard heated headspace methods. Visual and olfactory screening was also performed for each soil sample retrieved.

2.3.2.1.2 Hollow-Stem Auger Drilling

Soil samples were obtained for geotechnical evaluation to further characterize subsurface conditions. Soil samples for geotechnical characterization were collected from a total of five borings (GT-1, GT-2, GT-3, GT-4, and GT-5) that were advanced using 4-1/4-inch inside diameter continuous-flight hollow-stem augers. Locations of the geotechnical borings are indicated in Figure 3.

2.3.2.1.3 Soil Sampling

Soil samples for chemical and geotechnical analyses were respectively obtained from the Geoprobe® and hollow-stem auger borings as discussed in the EE/CA Work Plan and associated addenda. Soil samples collected for chemical analysis were subject to visual and olfactory field screening as well as quantitative headspace analysis. Soil samples were collected from selected test borings for the following reasons: to provide additional data regarding the levels of COPCs in areas of concern, to obtain chemical and physical data to assist with the modeling and removal alternative evaluation activities, and to characterize the slag/fly ash-type fill material.

2.3.2.1.4 Soil Sampling for Chemical Analysis

Each test boring was advanced to a depth of approximately 3 feet below the level groundwater was initially encountered using standard Geoprobe® direct-push methods. Although continuous soil samples were retrieved from each of the test borings and field screened, only samples obtained from ten of the borings were submitted for laboratory analysis as specified in the Work Plan Addenda. Samples collected from above the depth of groundwater saturation were submitted for analysis.

Specifically, continuous soil samples obtained from Test Borings (TB-2, TB-4, TB-7, TB-11, TB-11a, TB-14, TB-26, TB-35, TB-37, and TB-38) were submitted for chemical analysis of COPCs. The purpose of these soil samples was to provide additional data regarding the vertical and horizontal extent of contaminants in both on- and off-site soils for future removal considerations. The soil samples were analyzed for volatile organic compounds (VOC), total metals (cadmium, lead, and tantalum), and semivolatile organic compounds (SVOC), PNA only. One soil sample was collected from each depth interval (0.0 foot to 4.0 feet, 4.0 feet to 7.0 feet, etc.) until groundwater saturation was encountered. Soil samples for VOC analysis were obtained utilizing Encore sampling devices (USEPA Method 5035). Encore samples were collected from the area within each sample interval that displayed the highest PID field screening result. The remaining soil within each sampling interval was composited for metals and SVOC analysis. Soil samples were composited using a stainless steel pail and soil scoop prior to placement into the laboratory container. Soil sample identification and analytical results are presented in Section 2.4.5.2.

Samples of the slag/fly ash–type material were collected from Test Borings TB-13, TB-14, and TB-16. These samples were submitted for laboratory analysis of VOCs, total metals, and semivolatile organic compounds – polynuclear aromatic hydrocarbons (SVOC – PNA). Samples of the slag/fly ash material

were collected using the methods previously discussed for the soil samples. Slag/fly ash sample identification and analytical results are presented in Section 2.4.5.3.

Soil samples were collected from seven test borings (TB-1, TB-5, TB-12, TB-13, TB-18, TB-19, and TB-33) for chemical analysis associated with the modeling and removal alternative evaluation activities. Specifically, two composite soil samples were collected from each test boring with the exception of Borings TB-5 and TB-13 from which only one composite was obtained. Excluding Borings TB-5 and TB-13, one composite soil sample was collected from the 0- to 6-foot interval and one sample was obtained from the 6- to 12-foot interval (one above and below groundwater saturation). Only the sample from the 0- to 6-foot interval was collected from Test Borings TB-5 and TB-13. The borings were advanced at locations that indicated relatively slight subsurface impacts (near areas of concern) so that analytical results would approximate intrinsic soil conditions. Samples were obtained and analyzed for organic carbon content, moisture content, and cation exchange capacity. The soil samples were composited using a stainless steel pail and dedicated plastic soil scoops prior to placement into laboratory containers. Soil sample identification and analytical results are presented in Section 2.4.5.4.

2.3.2.1.5 Geotechnical Soil Sampling

Soil samples were obtained for geotechnical characterization. These samples were collected from a total of five borings (GT-1, GT-2, GT-3, GT-4, and GT-5) that were advanced using continuous flight hollow-stem augers and a 3-inch-by-2-1/2-foot thin-walled metal sampling tube (Shelby tube). Locations of the geotechnical borings are depicted in Figure 3. The boring locations were selected to provide a representation of the varied subsurface materials while also considering the areas of concern. Two samples were retrieved from each boring with the exception of Boring GT-5 from which only one sample was obtained. The samples were evaluated for permeability, specific gravity, grain size analysis, and Atterberg limits. The Shelby tube sampler was attached to the end of a series of drill rods and was pushed into the underlying soil ahead of the auger string. Each Shelby tube was advanced along a 2-foot sampling interval. Samples were obtained from the 0- to 6-foot and from the 6- to 12-foot depth intervals within Borings GT-1 through GT-4 (one above and one below groundwater saturation). A sample was obtained from the 6- to 12-foot depth interval only within Boring GT-5. A sample from the 0- to 6-foot interval within Boring GT-5 could not be obtained because of the loose (e.g., uncompacted) quality of the near surface material in the area of this boring. Immediately after sample collection, the Shelby tubes were sealed with wax and capped on both ends. Sample identification and geotechnical analytical results are presented in Section 2.4.6.

2.3.2.2 Groundwater Sampling

To assist in evaluating the remedial alternatives for the NCI property, it was necessary to determine the extent of impacts to groundwater at both on- and off-site locations. Therefore, the groundwater sampling program included the collection of samples from the North Chicago facility and the Vacant Lot Site. As previously indicated, Borings TB-31 and TB-32 proposed on the R. Lavin & Sons property were not completed. The following list provides an overview of the groundwater sampling conducted during the supplemental investigation:

- Thirteen groundwater samples were collected from the Vacant Lot Site (Borings TB-20 through TB-30, TB-35, and TB-36) to evaluate the extent of groundwater impacts hydraulically down gradient of the North Chicago facility. These borings provided additional groundwater characterization data for two areas associated with trichloroethene plumes previously identified by Carlson: the area down gradient of the HWMU, and the area down gradient of Wells MW-8 and MW-9.

- Twenty-three groundwater samples were obtained from Borings TB-1 through TB-10, TB-11a, TB-12 through TB-19, TB-33, TB-34, TB-37, and TB-38 to characterize facility groundwater associated with areas of concern and to assess possible contributions from an off-site source(s).

In addition, groundwater samples were collected from the nine existing groundwater monitoring wells (MW-1 through MW-9) located on, or adjacent to, the North Chicago facility. The facility wells were sampled in conjunction with the test borings to provide comparative data for fate and transport modeling related to the baseline risk assessment.

2.3.2.2.1 Groundwater Sampling from Geoprobe® Borings

Following the advancement of each test boring to total depth, a groundwater sample was collected for laboratory analysis. Upon the completion of each boring, temporary 1-inch diameter polyvinylchloride (PVC) pipe and a well screen/bottom cap set (dedicated to each test boring) was placed into the borehole to allow for the accumulation of sufficient sample volume. The PVC pipe and well screen was pre-wrapped by the manufacturer, steam cleaned prior to use as a precaution, and handled with a new pair of latex surgical gloves per boring following steam cleaning. Samples from the temporary wells were collected using a peristaltic pump and dedicated polyethylene tubing (metals analysis) or a Teflon bailer (VOC analysis) immediately following the determination of sufficient sample volume. In most instances, the rate of groundwater recharge allowed for the collection of samples following placement of the PVC pipe. One exception is that groundwater recharge within Boring TB-2 was extremely slow. As a result, the temporary well was left within Boring TB-2 for approximately 6 days. During this period, the volume

of groundwater that had accumulated was only sufficient to collect VOC samples (approximately 1-1/2 feet of water). These samples were obtained on the final day of field activities and, therefore, metals samples were not collected.

Groundwater samples were placed into appropriate bottles containing preservative, as applicable, that was preadded by the laboratory. Immediately following collection, the sample bottles were transferred into an iced cooler and transported to the laboratory. Samples were shipped to the laboratory on a daily basis along with appropriate custody seals and chain of custody information. Samples for dissolved metals analysis were either field filtered using a 0.45-micron filter, or were unfiltered and placed directly into an unpreserved container for laboratory filtration. Only samples that exhibited extremely high levels of turbidity were submitted for laboratory filtration. Disposable filters were dedicated for each sample.

2.3.2.2.2 Monitoring Well Sampling

Groundwater sample collection from the nine existing monitoring wells (Figure 3) was conducted using low-flow purging/sampling techniques. Use of these techniques generally results in the least amount of groundwater agitation/aeration during sample collection. To obtain the groundwater samples, an adjustable rate Grundfos RediFlo-2® electric submersible pump was used in conjunction with an YSI Model 600XL® flow-through cell and dedicated Teflon-lined polyethylene tubing. The flow cell used was capable of continuously monitoring pH, specific conductance, temperature, dissolved oxygen, and oxidation-reduction potential.

Prior to initiating low-flow purging and sampling activities, static groundwater levels were measured within each of the nine monitoring wells using an electronic water level indicator. All measurements were obtained from the north side of the inner PVC casing, and were recorded to the nearest 0.01 foot. These data were used to calculate the volume of fluids standing in the monitoring wells and to determine groundwater flow conditions. Each well was then purged with the submersible pump until the parameters pH, specific conductance, temperature, dissolved oxygen, and oxidation-reduction potential had stabilized and turbidity was visually reduced to an acceptable level. Values that were within 10 percent of the previous three measurements were considered stabilized. A pump flow rate of between 100 to 200 milliliters per minute was maintained during purging and sampling. Locations of Monitoring Wells MW-1 through MW-9 are presented in Figure 3.

Immediately following stabilization, samples were collected directly from the pump discharge. Samples were contained in 40-milliliter glass vials (VOCs) and 500-milliliter plastic bottles (metals) that were

preserved, as applicable, by the laboratory. The portion of the sample to be analyzed for dissolved metals was filtered immediately at each well site through a disposable 0.45-micron filter and then chemically preserved on site prior to shipment to the laboratory. One disposable filter was dedicated for each sample to be filtered. Purging and sampling procedures were documented on the Groundwater Evacuation and Sampling Forms contained in Appendix D.

2.3.2.3 QA/QC Sample Collection for Soil and Groundwater

Soil and groundwater QA/QC samples and results are discussed in Sections 2.4.8.1 and 2.4.8.2 respectively.

2.3.2.4 Post Drilling Activities

Following the collection of groundwater samples, the PVC pipe was removed from applicable borings, and all borings were completely sealed with hydrated bentonite hole plugs. Borings located in areas overlain by asphalt or concrete were finished at the surface with concrete to grade. For future reference, the location of each Geoprobe® and auger boring was marked with a wooden stake or high visibility paint, as appropriate, following abandonment. Boring locations were also measured from known facility features (e.g., building corners, existing monitoring wells, etc.) for inclusion on facility drawings.

2.3.2.5 Aquifer Characterization Testing

Single well aquifer characterization tests (slug tests) were conducted to quantify hydraulic conductivities and other relevant aquifer properties to supplement the baseline risk assessment, groundwater modeling, and removal alternative evaluation. Rising and falling head tests were performed dependant upon the position of the groundwater surface relative to the top of the communication zone.

Tests were performed using an In-situ® electronic data logger and pressure transducer. At each monitoring well location, a pressure transducer was lowered approximately 10 feet into the water column, secured to the surface casing, and connected to a Hermit Model SE1000C data logger. The data logger was programmed to record readings on a logarithmic scale to ensure that a sufficient number of data points were collected early in the test. Once the data logger was set up, a slug designed to displace a known volume of water was initially lowered to a point slightly above the water surface. The data logger was then started in conjunction with the rapid insertion of the slug into the water column, which caused the water level to rise. Falling head test data were then collected as the water level returned to equilibrium. After the water level returned to equilibrium, the data logger was reset in conjunction with the removal of the slug from the water column which caused the water level to fall. Rising head test data

were then collected as the water level recovered to equilibrium. Both the falling head and rising head test data were evaluated by the Bouwer and Rice (1979, updated 1989) method for completely or partially penetrating wells in unconfined or confined aquifers. The data evaluation was completed using Aqtesolv software developed by Geraghty & Miller. Field data sheets, calculations, and data plots are presented in Appendix E.

Aquifer testing was performed within five of the nine site groundwater monitoring wells (MW-1, MW-3, MW-4, MW-6, and MW-8) to provide representative information from both an aerial and stratigraphic perspective. A slug test was not performed within Monitoring Well MW-2 as proposed in the Work Plan because this well was submerged below water during the time the tests were performed. Monitoring Well MW-4 was selected to replace MW-2 to provide data hydraulically down gradient of the former HWMU area.

2.3.2.6 Decontamination Procedures

Sample integrity was maintained during the field investigation program through specific and systematic equipment decontamination methods. Drilling equipment was decontaminated with a high-pressure steam wash upon arrival at the site, between boring locations, and prior to departing from the site. The PVC pipe used in the construction of the temporary wells was also steamed cleaned prior to use. Decontamination was performed on a temporary plastic lined containment pad that was constructed within the Warehouse Building located within the North Chicago facility. All nondedicated sampling equipment (e.g., groundwater filtering equipment, bailer, stainless steel compositing pail and trowel, submersible pump, low-flow equipment) was decontaminated by scrubbing with potable water and a phosphate-free laboratory grade detergent followed by misting with hexanes, methanol, and nitric acid and rinsing with deionized water. Also, new Geoprobe® sampling sleeves were used for each sampling interval, each sample for laboratory analysis was placed into new laboratory-supplied sample containers, and a new pair of protective gloves was used prior to collecting each sample.

2.3.2.7 Investigation Derived Wastes Management Procedures

During the field investigations, various investigation derived wastes (IDW) were generated. The procedures for managing IDWs are listed below:

- Excess drill cuttings produced during the subsurface investigation work were containerized in 55-gallon steel drums.
- Purge water or excess sample volume from the groundwater monitoring wells and Geoprobe® borings was containerized in 55-gallon steel drums.

- All used Geoprobe® sampling sleeves were placed in 55-gallon steel drums.
- All decontamination water generated from the steam-cleaning process was containerized and transferred to 55-gallon steel drums at the end of each workday.
- Personal protective equipment that required disposal (i.e., sampling gloves, tyvek, etc.) was placed in 55-gallon steel drums.
- Broken sample containers and expendable sampling materials were placed in 55-gallon steel drums.

All drums were labeled by Earth Sciences' field personnel who marked the contents and date(s) of generation on each 55-gallon drum using an indelible marker. Upon completion of the field investigation, the drums were temporarily staged on a plastic lined containment pad that was constructed within the Warehouse Building pending implementation of the approved removal action. Treatment/transportation and disposal of the drum contents will then be addressed concurrently with wastes generated during site remediation. The handling and disposal of investigation-derived wastes is subject to RCRA waste identification, transportation, and disposal requirements, assuming the waste is identified as a hazardous waste. However, in accordance with the USEPA approved EE/CA Work Plan and in accordance with applicable USEPA guidance, "Consistent with established practice, investigation-derived materials may remain on-site until the remedial action commences," (CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, pg. 1-9).

2.4 Results from the Supplemental Site Characterization Program

The supplemental site characterization program provided original or additional data for the following samples and field measurements/tests:

- Lithologic properties of subsurface materials
- Groundwater flow characteristics for the shallow aquifer
- Hydraulic characteristics for the shallow aquifer
- Field screening of on- and off-site soils
- Soil analyses for COPCs
- Slag/fly ash material analyses for COPCs
- Soil analyses for constituents associated with modeling and remedial alternative evaluation
- Soil evaluation for geotechnical characteristics
- Groundwater field parameter measurements
- Groundwater analyses for COPCs

The chemical analysis of groundwater and soil samples was performed by Great Lakes Analytical (GLA) located in Buffalo Grove, Illinois. Soil samples for geotechnical evaluation were transported to Geotech-

nics located in Pittsburgh, Pennsylvania. Before beginning the fieldwork, a notice was provided to the USEPA regarding Earth Sciences' intent to select these laboratories. Also during this time, a Statement of Qualifications for Geotechnics was forwarded to the USEPA. A preselection submittal of GLA's QA Program was not necessary because the USEPA had previously received and approved this document in association with Carlson's 2000 Site Investigation work. Laboratory procedures and QA/QC protocol associated with the analytical methods are detailed in the GLA and Geotechnics QA programs contained in Appendices D and E of the QAPP respectively.

2.4.1 Site Geology

The geological information obtained from this investigation is generally consistent with the information reported for the previous Site Investigation that was conducted by Carlson during the period from April through September 2000.

Regional geologic information indicates that unconsolidated materials in the vicinity of the site consist of glacial lake deposits underlain by glacial till deposits. The deposits consist of clay, silt, sand, and gravel that accumulated on the bottoms of glacial lakes. These strata are reportedly underlain by glacial till. Generally, the glacial lake deposits range from 10 to 25 feet in thickness with the underlying glacial till ranging from 50 to 100 feet in thickness.

Additional subsurface information was provided from the 37 test borings (13 off site and 24 on site) and 5 on- and off-site hollow-stem auger borings that were completed as part of the supplemental investigation. The locations of these borings are depicted in Figure 3 and copies of the boring logs are contained in Appendix A.

Unconsolidated materials encountered in the soil borings were similar at all locations across the properties. The ground surface in the area of most of the test borings located in the North Chicago facility, except Test Borings TB-13, TB-15, and TB-16, is covered with asphalt and/or concrete. The ground surface in the area of Test Borings TB-13, TB-15, and TB-16 is earthen. Underlying the surficial asphalt and/or concrete and vegetation is fill material that ranges in thickness from 0.5 foot to 7.0 feet. The fill material for most of the test borings, except for Test Borings TB-13 through TB-18, consists of clay, silt, and sand with some rock and brick fragments, and a slag/fly ash-type material that is dry to damp, and dense. The fill material in the areas of Test Borings TB-13 through TB-18 consists of a black/reddish-brown, dry to moist, slag/fly ash-type material that ranges in thickness from 4.4 feet (TB-16) to 7.0 feet (TB-17 and TB-18). The fill material in the area of Test Borings TB-21 and TB-22

consists of dry to damp, clay, silt, and sand with some rock fragments and gravel. The fill material in Test Boring TB-35 is comprised of 7.0 feet of slag/fly ash-type material.

Underlying the fill material are typical glacial lacustrine deposits comprised of finer grained materials including brown and gray silty and sandy clay, clayey silt containing laterally discontinuous silt lenses, and sand/gravel deposits to depths ranging from approximately 10.0 feet to 13.0 feet bgs. Grayish silty clay with several laterally discontinuous silt, sand, and gravel layers is present from a depth of approximately 10 to 20 feet. Also at a depth below 10.0 feet is a laterally impersistent layer of very stiff to hard, dry to damp clay. With the exception of the TB-2 location, this clay layer ranges from approximately 1.5 to 3.0 feet in thickness when fully penetrated. Within Test Boring TB-2, however, the clay layer was encountered at a depth of approximately 10.0 feet bgs and extends to a depth below 22.0 feet (total depth of TB-2).

2.4.2 Site Hydrogeology and Evaluation of Groundwater Flow Characteristics

This study has focused on groundwater associated with the shallow/unconfined aquifer underlying the North Chicago facility and the Vacant Lot Site. The shallow aquifer exists within the near surface glacial lacustrine deposits and, to a lesser extent, within the surficial fill materials. With the exception of Boring TB-2, groundwater saturation was encountered beneath the North Chicago facility and the Vacant Lot Site at depths ranging from 3.0 feet (TB-23) and 13.6 feet (TB-30) bgs. No water was encountered within Test Boring TB-2 following its completion, although 1-1/2 feet of water was measured in this boring approximately 6 days afterward. Groundwater levels within the nine facility monitoring wells indicated depths equivalent to ground surface (MW-2) to 8.5 feet (MW-9) bgs. Groundwater level measurements obtained from the facility monitoring wells were converted to elevations in feet relative to a site-specific datum. The elevations indicate that groundwater within the shallow aquifer generally mimics the local topography and flows in a westerly direction toward Pettibone Creek. A summary of groundwater elevation data is provided in Table 1. In addition, Figure 4 presents a groundwater elevation map for the shallow aquifer.

2.4.3 Aquifer Characterization Results

Slug tests were performed within Monitoring Wells MW-1, MW-3, MW-4, MW-6, and MW-8 to evaluate aquifer characteristics within the shallow/unconfined aquifer beneath the North Chicago facility. Calculations performed from the raw slug test data indicate values for average hydraulic conductivity that range from 2.85×10^{-07} centimeter per second within Monitoring Well MW-1 to 2.99×10^{-05} centimeter per second within Well MW-3. These calculations also indicate that transmissivity values range from

1.56×10^{-04} centimeters squared per second within Well MW-1 to 1.40×10^{-02} centimeter squared per second at Well MW-2.

The calculated average hydraulic gradient across the North Chicago facility is 0.010 foot/foot and the calculated average linear groundwater velocity is $6.1 \times 10^{(-07)}$ centimeter per second (0.00173 feet/day or 0.63 feet per year).

A summary of aquifer test results is provided in Table 2. Slug test calculations and drawdown plots are contained in Appendix E.

2.4.4 Soil and Groundwater Analytical Programs

2.4.4.1 Soil

Soil samples collected from Test Borings TB-1 through TB-11, TB-11a, TB-12 through TB-30, and TB-33 through TB-38, as well as samples of the slag/fly ash material obtained from Borings TB-13, TB-14, and TB-16 were submitted for laboratory analysis of COPCs that included the following parameters:

- VOCs by USEPA Method 8260B
- total metals including cadmium and lead by USEPA Method 6010B and tantalum by USEPA Method 1620
- SVOCs, PNAs only, according to USEPA Method 8310
- dry weight (USEPA SW-846)

The analytical program indicated above was developed based on a review of the results from Carlson's 2000 Site Investigation and knowledge of previous facility operations.

Soil samples were collected from Test Borings TB-1, TB-5, TB-12, TB-13, TB-18, TB-19, and TB-33 for chemical analysis associated with the modeling and removal alternative evaluation activities. These samples were analyzed for the following parameters:

- organic carbon according to American Society for Testing and Materials (ASTM) Method D2974-87

- moisture content by USEPA Method SW-846
- cation exchange capacity by Method ASA/ASSA

Samples of soil obtained from Borings GT-1 through GT-5 were submitted to the laboratory for geotechnical evaluation. The soil properties quantified through geotechnical testing included the following:

- permeability (also included moist bulk density, dry bulk density, and moisture content) according to ASTM Method D 5084-97
- specific gravity by ASTM Method D 854-00
- grain size analysis by ASTM Method D 422-63
- Atterburg limits according to ASTM Method D 4318-00

2.4.4.2 Groundwater

Groundwater samples obtained from 36 Geoprobe® borings and the nine facility monitoring wells were analyzed for the following constituents:

- VOCs by USEPA Method 8260B
- total metals including cadmium according to USEPA Method 7131A, lead by USEPA Method 7421, and tantalum by USEPA Method 1620
- dissolved metals including cadmium by USEPA Method 7131A, lead by USEPA Method 7421, and tantalum by USEPA Method 1620

Groundwater samples were analyzed for cadmium and lead because of their pervasiveness in site soils (especially lead) and because of the presence of lead and cadmium in facility groundwater as indicated in Carlson's 2000 Site Investigation Report. Tantalum, although not detected in site groundwater during Carlson's work, was included in the analytical program because of its previous use in manufacturing at the facility and because facility groundwater quality data were limited. According to Carlson's 2000 Site Investigation Report, VOCs of potential concern for groundwater beneath the facility were identified as cis-1,2-dichloroethene, trans-1,2-dichloroethene, hexachlorobutadiene, n-propylbenzene, 1,1,2-trichloroethane, 1,2,4-trichlorobenzene, trichloroethene, and vinyl chloride. These compounds were detected for one or more of the groundwater samples collected from the facility monitoring wells during

the 2000 Site Investigation. The comprehensive suite of VOCs analyzed for the supplemental site characterization program included these compounds.

2.4.5 Soil Chemical Analytical Results

2.4.5.1 Soil Field Screening Results

Field screening results for soil samples retrieved from Test Borings TB-1 through TB-11, TB-11a, TB-12 through TB-30, and TB-33 through TB-38 indicated total VOC concentrations ranging from 0.0 part per million (several borings at various depth intervals) to >2,000 parts per million (TB-18, 7 to 10 feet bgs). As previously indicated, field screening was performed using a PID according to the heated headspace method. Results from soils field screening are indicated on the boring logs contained in Appendix A.

2.4.5.2 Soil Results for COPC Analyses

Laboratory analytical results were provided for soil samples collected from ten test borings located within suspected areas of concern. Areas of concern include: 1) the HWMU and AST area; 2) the Metallurgical Buildings A and B area; 3) the Former Drum Storage area; and 4) the Chemical Building A and Maintenance Shop area. Soil analytical data (including Carlson Site Investigation data) for these areas are summarized in Tables 3A through 3H and in Figure 5. Laboratory reports issued by GLA, including field and laboratory QA/QC sample results and chain-of-custody information, are provided in Appendix F.

The following subsections provide a summary of the COPCs concentrations in soils that approach or exceed industrial screening criteria agreed to by the USEPA. The purpose of the comparisons is to provide the reader with a general indication of the prevalent constituents present within particular areas of the facility. In this context, screening criteria are not used to select constituents of concern (COC) or to limit the evaluation of the analytical data obtained. Selection of COCs is performed in the baseline risk assessment presented in Chapter 3.0.

(For consistency, the referenced industrial screening criteria are the same as those used in the baseline risk assessment presented in Chapter 3.0. The industrial screening criteria included, per agreement with the USEPA; Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft March 2001 and Blood Lead Concentrations of U.S. Adult Females; Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey, Technical Review Workshop for Lead; March 2002. The screening levels focus on the potential exposure pathways of

ingestion, dermal contact, and inhalation. Screening criteria associated with soil to groundwater migration were not included. See Chapter 3.0 for further information.)

2.4.5.2.1 HWMU and AST Area

Test borings sampled within this area included TB-14 and TB-35. The following list provides a summary of COPC concentrations that approached or exceeded established screening criteria.

- Lead – Concentrations of lead were detected in Borings TB-14 at 1,760 milligrams per kilogram (0.0 foot to 4.0 feet); TB-14DUP at 2,850 milligrams per kilogram (0.0 foot to 4.0 feet) and TB-35 at 7,820 milligrams per kilogram (0.0 foot to 4.0 feet) and at 573 milligrams per kilogram (4.0 feet to 7.0 feet). Detected concentrations of lead in subsurface samples were below screening levels.

- Trichloroethene – Trichloroethene was identified in soil samples collected from Boring TB-14 at concentrations of 63,100 micrograms per kilogram (0.0 foot to 4.0 feet) and 80,600 micrograms per kilogram (0.0 foot to 4.0 feet, duplicate). Detected concentrations of trichloroethene in remaining samples were below screening levels.

- Benzo (a) pyrene – Benzo (a) pyrene was identified in a soil sample collected from Boring TB-35 at a concentration of 273 micrograms per kilogram (0.0 foot to 4.0 feet). Concentrations of benzo (a) pyrene in remaining samples were not detected.

2.4.5.2.2 Metallurgical Buildings A and B Area

Test borings sampled within this area included TB-2, TB-26, TB-37, and TB-38. The proceeding list provides a summary of COPC concentrations that approached or exceeded established screening criteria.

- Lead – Lead was identified in a soil sample collected from Boring TB-37 at a concentration of 813 milligrams per kilogram (0.0 foot to 4.0 feet). Detected concentrations of lead in remaining samples were below screening levels.

- Trichloroethene – Trichloroethene was identified in a soil sample collected from Boring TB -2DUP at 5,460 micrograms per kilogram (7.0 feet to 10.0 feet). Detected concentrations of trichloroethene in remaining samples were below screening levels.

- Tetrachloroethene – Tetrachloroethene was identified in a soil sample collected from Boring TB-38 at 55,900 micrograms per kilogram (0.0 foot to 4.0 feet). Detected concentrations of tetrachloroethene in remaining samples were below screening levels.

2.4.5.2.3 Former Drum Storage Area

Test borings sampled within this area included TB-4 and TB-7. Trichloroethene was the only COPC that approached or exceeded its established screening criteria. Trichloroethene was identified in soil samples

collected from Borings TB-4 at 64,800 micrograms per kilogram (0.0 foot to 4.0 feet) and TB-7 at 413,000 micrograms per kilogram (0.0 foot to 4.0 feet) and at 5,530 micrograms per kilogram (4.0 feet to 7.0 feet).

2.4.5.2.4 Chemical Building A and Maintenance Shop Area

Within this area, soil samples were collected from Borings TB-11 and TB-11a. The following list provides a summary of COPC concentrations that approached or exceeded established screening criteria.

- Lead – Lead was identified in a soil sample collected from Boring TB-11 at a concentration of 1,660 milligrams per kilogram (0.0 foot to 4.0 feet). Detected concentrations of lead in remaining samples were below screening levels.

- Trichloroethene – Trichloroethene was identified in a soil sample collected from Boring TB-11a at 4,660 micrograms per kilogram (0.0 foot to 4.0 feet). Concentrations of trichloroethene in remaining samples were not detected.

- Benzo (a) pyrene – Benzo (a) pyrene was identified in a soil sample collected from Boring TB-11 at a concentration of 117 micrograms per kilogram (0.0 foot to 4.0 feet). Concentrations of benzo (a) pyrene in remaining samples were not detected.

2.4.5.3 Slag/Fly Ash Material Results for COPC Analyses

The proceeding list provides a summary and concentration range for COPCs identified in the slag/fly ash material collected from Test Borings TB-13, TB-14, and TB-16:

- Cadmium – Cadmium was present in each of the slag/fly ash material samples and ranged in concentration from 8.8 milligrams per kilogram. (TB-16; 0.0 foot to 4.0 feet) to 21.4 milligrams per kilogram (TB-13; 0.0 foot to 4.0 feet). These cadmium concentrations were below screening levels.

- Lead – Lead was detected in each of the slag/fly ash material samples and ranged in concentration from 1,760 milligrams per kilogram (TB-14; 0.0 foot to 4.0 feet) to 13,100 milligrams per kilogram (TB-16; 0.0 foot to 4.0 feet). Lead concentrations exceeded screening levels for each sample.

- Trichloroethene – Trichloroethene was identified in samples of the slag/fly ash material collected from Borings TB-13 (3.0 feet to 4.0 feet) and TB-14 (1.0 foot to 2.0 feet) at concentrations of 716 and 63,100 micrograms per kilogram respectively. The trichloroethene concentration of 63,100 micrograms per kilogram exceeded screening levels.

- PNAs – Low concentrations of PNAs were present in the slag/fly ash material obtained from Borings TB-13 and TB-14. These compounds included acenaphthene (TB-13 and TB-14) and benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, chrysene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, and

pyrene (TB-13). The benzo (a) pyrene concentration of 288 micrograms per kilogram approached screening levels.

Tantalum was not detected in the slag/fly ash samples. A summary of identified constituents for the samples of slag/fly ash material is provided in Tables 3A and 4. Laboratory reports issued by GLA, including field and laboratory QA/QC sample results and chain of custody information, are contained in Appendix F.

2.4.5.4 Soil Results for Modeling and Removal Alternative Evaluation

The following list provides an analyte summary and reported ranges for the soil samples analyzed from Borings TB-1, TB-5, TB-12, TB-13, TB-18, TB-19, and TB-33 in association with the modeling and removal alternative evaluation activities:

- Organic carbon – Organic carbon was present within the samples collected from Borings TB-12 (0.0 foot to 6.0 feet), TB-13 (0.0 foot to 6.0 feet), and TB-33 (0.0 foot to 6.0 feet and 6.0 feet to 12.0 feet). The percent organic carbon ranged from 1.02 (TB-33; 6.0 feet to 12.0 feet) to 2.06 (TB-12; 0.0 foot to 6.0 feet).
- Cation exchange capacity – Cation exchange capacity was reported for each of the borings previously identified and ranged from 6.58 milliequivalents (meq)/100 grams (g) (TB-18; 6.0 feet to 12.0 feet) to 23.2 meq/100 g (TB-13; 0.0 foot to 6.0 feet).
- Moisture content – The percent moisture content within each of the subject borings ranged from 12.8 (TB-19; 0.0 foot to 6.0 feet) to 31.9 (TB-13; 0.0 foot to 6.0 feet).

Soil analytical results related to the modeling and removal alternative evaluation activities are provided in Table 5. Laboratory reports issued by GLA, including field and laboratory QA/QC sample results and chain of custody information, are contained in Appendix F.

2.4.6 Soil Geotechnical Analytical Results

Results provided from the geotechnical testing of soil samples collected from Borings GT-1 through GT-5 are provided in Table 6. In part, Table 6 indicates that soil permeability ranged from 2.8×10^{-08} (GT-3; 8.0 feet to 10.0 feet) to 1.0×10^{-04} (GT-4; 2.0 feet to 4.0 feet). The laboratory report issued by Geotechnics is provided in Appendix G.

2.4.7 Groundwater Analytical Results

2.4.7.1 Field Parameters

During the low-flow purging of facility groundwater Monitoring Wells MW-1 through MW-9, field parameters were periodically measured until groundwater chemistry had stabilized. A summary of the ranges for these parameters following stabilization and prior to sample collection is presented in the following list:

- pH (standard units) – 6.93 (Well MW-4) to 7.63 (Well MW-1)
- Specific conductance (micromhos per centimeter) – 708.3 (Well MW-1) to 4,468 (Well MW-2)
- Temperature (degrees centigrade) – 14.88 (Well MW-1) to 21.60 (Well MW-2)
- Oxidation/reduction potential (millivolts) – (-) 2,450.4 (Well MW-4) to (-) 102.8 (Well MW-8)
- Dissolved oxygen (milligrams per liter) – 0.00 (Wells MW-1, MW-3, MW-4, MW-6, MW-8, and MW-9) to 0.58 (Well MW-7)
- Turbidity (visual) – Although slight to moderate turbidity was noted for groundwater removed from some wells prior to stabilization, no turbidity was visually observed for any of the samples obtained from the facility monitoring wells during sample collection.

In addition, no odor or immiscible layers were associated with groundwater at the locations of facility Monitoring Wells MW-1 through MW-9. Complete low-flow purging and sampling information is contained in Appendix D. Related information is also indicated in the field logbook records provided in Appendix B.

2.4.7.2 Groundwater Analytical Results, Test Borings

Analytical results for metals and VOCs detected in groundwater samples collected from Test Borings TB-1 through TB-10, TB-11a, TB-12 through TB-30, and TB-33 through TB-38 are summarized in the following list:

- Total cadmium – Total cadmium was identified in groundwater samples collected from test borings TB-3, TB-4, TB-5, TB-6, TB-7, TB-8, TB-9, TB-10, TB-13, TB-14, TB-15, TB-16, TB-17, TB-18, TB-34, TB-37, and TB-38 (17 of 36). Total cadmium ranged in concentration from 0.000576 milligram per liter (TB-22) to 1.34 milligrams per liter (TB-15).

- Dissolved cadmium – Concentrations of dissolved cadmium were detected in groundwater samples obtained from Borings TB-8, TB-14, TB-15, TB-16, TB-17, and TB-18 (6 of 36). Dissolved cadmium ranged in concentration from 0.000630 milligram per liter (TB-8) to 0.0678 milligram per liter (TB-17).

- Total lead – Total lead was identified in groundwater samples collected from several test borings including TB-5, TB-7, TB-9, TB-10, TB-13, TB-14, TB-15, TB-16, TB-17, TB-18, TB-20, TB-22, TB-23, TB-24, TB-25, TB-29, TB-34, TB-35, and TB-38 (19 of 36). Total lead ranged in concentration from 0.0105 milligram per liter (TB-10) to 9.85 milligrams per liter (TB-18).

- Dissolved lead – Concentrations of dissolved lead were detected in groundwater samples obtained from Test Borings TB-8, TB-13, TB-14, TB-15, TB-16, TB-17, TB-18, TB-26, TB-33, and TB-35 (10 of 36). Dissolved lead ranged in concentration from 0.0113 milligram per liter (TB-33) to 0.437 milligrams per liter (TB-15).

- 1,1,1-trichloroethane – Levels of 1,1,1-trichloroethane were present in samples collected from Test Borings TB-11a, TB-12, TB-24, TB-33, and TB-38 (5 of 36). Concentrations of this compound ranged from 2.25 micrograms per liter (TB-12) to 157 micrograms per liter (TB-11a).

- 1,1-dichloroethene – Concentrations of 1,1-dichloroethene were identified in groundwater at boring locations TB-4, TB-9, TB-11a, TB-15, TB-22, TB-24, and TB-25 (7 of 36). Levels of this compound ranged from 4.27 (TB-25) to 339 micrograms per liter (TB-24).

- 1,1-dichloroethane – The compound 1,1-dichloroethane was detected in samples collected from Test Borings TB-11a (145 micrograms per liter), TB-33 (6.83 micrograms per liter), and TB-38 (22.5 micrograms per liter) (3 of 36).

- Chloroethane – Chloroethane was present in Boring TB-11a only, at a concentration of 3.83 micrograms per liter (1 of 36).

- Chloroform –Chloroform was identified in samples collected from Test Borings TB-11a (2.14 micrograms per liter), and TB-33 (2.21 micrograms per liter) (2 of 36).

- 1,2-dichloroethane – The compound 1,2-dichloroethane was detected in Boring TB-11a at a concentration of 9.68 micrograms per liter (1 of 36).

- 1,2,4-trimethylbenzene – This compound was identified in Boring TB-15 at a concentration of 3.37 micrograms per liter (1 of 36).

- 1,3,5-trimethylbenzene – This compound was detected in Boring TB-15 at a concentration of 6.33 micrograms per liter (1 of 36).

- Cis-1,2-dichloroethene – Cis-1,2-dichloroethene was present in samples collected from Test Borings TB-4, TB-9, TB-10, TB11a, TB-12, TB-14, TB-15, TB-18, TB-19, TB-22, TB-24, TB-25, TB-29, TB-35, and TB-36 (15 of 36). Concentrations of this compound ranged from 3.30 micrograms per liter (TB-19) to 66,500 micrograms per liter (TB-18).

- Methylene chloride – Methylene chloride was identified in Boring TB-24 at a concentration of 103 micrograms per liter and in Boring TB-14 at 125 micrograms per liter (2 of 36).

- Sec-butylbenzene – This compound was detected in Boring TB-15 at a concentration of 2.29 micrograms per liter (1 of 36).

- Tetrachloroethene – Tetrachloroethene was present in groundwater samples collected from Borings TB-4, TB-9, TB-11a, TB-33, TB-34, TB-36, and TB-38 (7 of 36). Concentrations of this compound ranged from 2.24 micrograms per liter (TB-36) to 858 micrograms per liter (TB-38).

- Toluene - This compound was identified in Boring TB-4 at a concentration of 2.01 micrograms per liter (1 of 36).

- Trans-1,2-dichloroethene – Levels of trans-1,2-dichloroethene were present in samples collected from several test borings including TB-4, TB-9, TB-11a, TB-15, TB-22, TB-24, TB-25, and TB-38 (8 of 36). Concentrations of this compound ranged from 4.78 micrograms per liter (TB-11a) to 389 micrograms per liter (TB-24).

- Trichloroethene – Trichloroethene was detected in Borings TB-1, TB-2, TB-4, TB-5, TB-7, TB-9, TB11a, TB-12, TB-14, TB-15, TB-16, TB-18, TB-19, TB-22, TB-24, TB-25, TB-29, TB-33, TB-34, TB-35, and TB-36 (21 of 36). Concentrations of this compound ranged from 2.82 micrograms per liter (TB-1) to 1,190,000 micrograms per liter (TB-18).

- Vinyl chloride – This compound was identified in Borings TB-4, TB-9, TB-11a, TB-18, TB-21, TB-22, TB-24, TB-25, TB-35, and TB-36 (10 of 36). Concentrations of vinyl chloride ranged from 2.32 micrograms per liter (TB-36) to 59,900 micrograms per liter (TB-18).

Groundwater analytical results for samples obtained from the test borings are presented in Tables 7A through 7C and in Figure 6. Laboratory reports issued by GLA, including field and laboratory QA/QC sample results and chain of custody information, are contained in Appendix F.

2.4.7.3 Groundwater Analytical Results, Facility Monitoring Wells

Analytical results for metals and VOCs detected in groundwater samples collected from facility Monitoring Wells MW-1 through MW-9 (June 10, 2001 event) are summarized in the following list:

- Total cadmium – Total cadmium was identified in groundwater samples collected from Monitoring Wells MW-2 (0.000543 milligram per liter), MW-4 (0.00329 milligram per liter), and MW-9 (0.00178 milligram per liter).

- Total lead – Total lead was detected in samples obtained from Monitoring Wells MW-2 (0.112 milligram per liter), MW-4 (0.361 milligram per liter), and MW-9 (0.240 milligram per liter).

- Dissolved lead – Dissolved lead was detected in the groundwater sample collected from Monitoring Well MW-9 (0.0443 milligram per liter).

- Cis-1,2-dichloroethene – Levels of cis-1,2-dichloroethene were present in samples collected from Monitoring Wells MW-4 (145 micrograms per liter) and MW-8 (2.62 micrograms per liter).

- Trichloroethene – Concentrations of trichloroethene were detected in Monitoring Wells MW-2 (2.97 micrograms per liter), MW-4 (2,290 micrograms per liter), and MW-8 (825 micrograms per liter).

- Vinyl chloride – Vinyl chloride was identified in the groundwater sample collected from Well MW-4 (43.4 micrograms per liter).

Groundwater analytical results for samples obtained from the facility monitoring wells (including Carlson Site Investigation data) are presented in Tables 7A and through 7C and in Figure 6. Laboratory reports issued by GLA, including field and laboratory QA/QC sample results and chain of custody information, are contained in Appendix F.

2.4.8 Soil and Groundwater Sample QA/QC Programs and Analytical Results

2.4.8.1 Soil QA/QC

Various types of QA/QC samples were collected in the field to ensure the validity of the soil characterization program. Soil QA/QC samples included the following:

- Field duplicate samples - One duplicate sample was collected per every 10 soil samples submitted for analysis. Duplicate samples were analyzed for organic carbon, moisture content, cation exchange capacity, VOCs, total metals, and PNAs.

- Equipment blank samples - One equipment blank sample was obtained per every 20 soil samples submitted for analysis. Equipment blank samples were analyzed for organic carbon, VOCs, total metals, and PNAs.

- Field blank samples - Groundwater field blank samples also served for the soil samples (see Section 2.4.8.2).

- Trip blank samples - Groundwater trip blank samples also served for the soil samples (see Section 2.4.8.2).

- Matrix spike samples - One matrix spike sample was collected per every 20 soil samples submitted for analysis. Matrix spike samples were analyzed for VOCs, total metals, and PNAs.

No constituents were identified in the equipment blank sample. As detailed in Section 2.4.8.2, chloroform was present in some groundwater field and trip blank samples. Only one date for these affected QA/QC samples coincides with the collection of a soil sample containing chloroform. Specifically, Boring TB-11a (20.8 micrograms per kilogram of chloroform) was collected on May 31, 2001 and was shipped with trip blank sample TB-0531-01 (2.67 micrograms per liter of chloroform). It is uncertain whether the chloroform is related to the laboratory or field environment.

Field duplicate sample results for Borings TB-14A, TB-2, and TB-12 were in general agreement with the associated normal samples. Analytical results for the matrix spike sample obtained from Boring TB-2 were also consistent with concentrations reported for the associated normal sample.

A summary of the QA/QC analytical results for soil samples is provided in Table 8. Additional QA/QC results (field duplicate and matrix spike samples) are indicated in Tables 3A through 3H. Table 9 presents results for groundwater field and trip blank results which also apply to the soil samples. Comprehensive program QA/QC data are provided in the GLA laboratory report contained in Appendix F.

2.4.8.2 Groundwater QA/QC

To certify the validity of the groundwater quality results, several types of QA/QC samples were collected in the field. Groundwater QA/QC samples consisted of the following:

- Duplicate samples - One duplicate sample was obtained per every 10 groundwater samples submitted for analysis. Duplicate samples were analyzed for VOCs and total/dissolved metals.
- Equipment blank samples - One equipment blank sample was collected per every 20 groundwater samples submitted for analysis. Equipment blank samples were analyzed for VOCs and dissolved metals.
- Field blank samples - One field blank sample was collected per each day of field activities. Field blank samples were analyzed for VOCs, PNAs, and total/dissolved metals.
- Trip blank samples - One trip blank sample was included with each sample shipment. Trip blank samples were analyzed for VOCs.

- Matrix spike/matrix spike duplicate samples - One matrix spike/matrix spike duplicate sample set was obtained per every 20 groundwater samples submitted for analysis. Matrix spike/matrix spike duplicate samples were analyzed for VOCs and total/dissolved metals.

No constituents were detected in the field blank, trip blank, or equipment blank samples with the exception of the following:

- Chloroform was present at low concentrations in field blank samples FB-0530-01 (3.39 micrograms per liter), FB-0608-01 (2.04 micrograms per liter), and FB-0609-01 (2.51 micrograms per liter); and trip blank samples TB-0530-01 (2.73 micrograms per liter), TB-0531-01 (2.67 micrograms per liter); TB-0605-01 (2.19 micrograms per liter), and TB-0606-01 (2.70 micrograms per liter).

- Trichloroethene was identified in equipment blank sample EB-0604-01 (116 micrograms per liter).

It is uncertain whether the chloroform is related to the laboratory or field environment. Similar concentrations of chloroform were detected in groundwater samples collected from Test Borings TB-11a (2.14 micrograms per liter) and TB-33 (2.21 micrograms per liter). These samples were obtained on June 4 and June 5, 2001 respectively.

As indicated below, low to substantial concentrations of trichloroethene were identified in laboratory method blanks associated with some groundwater samples. It is likely, therefore, that the trichloroethene present within sample EB-0604-01 can be attributed to a laboratory artifact.

Field duplicate samples collected from Borings TB-22, TB-35, TB-34, and Monitoring Well MW-3 reflected concentrations that were compatible with the associated normal samples. The analytical results for matrix spike/matrix spike duplicate sample sets obtained from Borings TB-22 and TB-35 were also consistent with concentrations reported for the associated normal samples.

The laboratory method blank associated with groundwater samples collected from Borings TB-13 and TB-15 contained 13.2 micrograms per liter of trichloroethene. Also, the method blank associated with the groundwater sample obtained from Boring TB-14 contained 660 micrograms per liter of trichloroethene. It is possible that this laboratory artifact contributed to the concentrations reported for the samples collected from these borings.

A summary of the QA/QC analytical results for groundwater samples is provided in Table 9. Additional QA/QC results (field duplicate and matrix spike/matrix spike duplicate samples) are indicated in Tables 7A through 7C. Comprehensive program QA/QC data are provided in the GLA laboratory report contained in Appendix F.

2.5 Source, Nature, and Extent of Contamination

2.5.1 Soil

Analytical data from both the 2000 Carlson Site Investigation and the supplemental site characterization program performed for the EE/CA were evaluated to determine which COPCs approached or exceeded the established screening criteria for soils, for the purposes discussed in Section 2.4.5.2. The following is a listing of those COPCs.

HWMU and AST Area

- Lead
- Trichloroethene
- Benzo (a) pyrene
- Dibenzo (a,h) anthracene
- Vinyl Choride
- Cis-1,2-dichloroethene
- Tetrachloroethene
- Benzo (a) anthracene
- Benzo (b) fluoranthene

Metallurgical Buildings A and B Area

- Lead
- Trichloroethene
- Benzo (a) pyrene
- Dibenzo (a,h) anthracene
- Tetrachloroethene

Former Drum Storage Area

- Lead
- Trichloroethene
- Benzo (a) pyrene
- Dibenzo (a,h) anthracene
- Tetrachloroethene
- Benzo (a) anthracene

Chemical Building A and Maintenance Shop Area

- Lead
- Trichloroethene
- Benzo (a) pyrene
- Dibenzo (a,h) anthracene
- Benzo (b) fluoranthene
- 1,1-Dichloroethene

The COPCs which most frequently approached or exceeded applicable screening criteria for both surficial and subsurface soil samples were lead, trichloroethene, and benzo (a) pyrene. Soil analytical data from the supplemental site characterization program, along with historical soil analytical data from Carlson's Site Investigation, are presented in Tables 3A through 3H. Also, historical analytical data for soils that incorporate results from Carlson's Site Investigation as well as the supplemental site characterization program are depicted in Figure 5.

The horizontal extent of contamination in soils for trichloroethene is indicated in Figure 7. Figure 7 illustrates the presence of trichloroethene soil plumes beneath each of the areas of concern indicated above. In addition, both lead and benzo (a) pyrene were also detected beneath each of the areas of concern.

The approximate vertical extent of COPCs that approached or exceeded the established screening criteria for soils, based on analysis of soil samples obtained from each area of concern, is provided in the following list. (It should be noted that based on the depth to groundwater measurements at monitoring wells, several soil samples are below the water table. Because of the presence of low permeability soils, it was not always possible to identify the exact location of the groundwater table during drilling activities. Based on the groundwater contour map depicted in Figure 4, the average depth to groundwater across the site was approximated at 5 feet below ground surface.)

HWMU and AST Area

- Lead (6-8 feet; GP-27E)
- Trichloroethene (10-12 feet; GP-13G)
- Benzo (a) pyrene (1-2 feet; GP-29B)
- Dibenzo (a,h) anthracene (1-2 feet; GP-29B)
- Vinyl Choride (12-14 feet GP-15H)
- Cis-1,2-dichloroethene (8-10 feet GP-14F)
- Tetrachloroethene (8-10 feet GP-14F)
- Benzo (a) anthracene (1-2 feet; GP-29B)
- Benzo (b) fluoranthene (1-2 feet; GP-29B)

Metallurgical Buildings A and B Area

- Lead (2-4 feet; GP-21C)
- Trichloroethene (8-10 feet GP-21F, GP-32F, GP-37F, and TB-2Cdup)
- Benzo (a) pyrene (0-1 foot; GP-20A, GP-33B)
- Dibenzo (a,h) anthracene (0-1 foot; GP-20A)
- Tetrachloroethene (1-1.5 feet; TB-38A)

Former Drum Storage Area

- Lead (2-4 feet; GP-2CDup)
- Trichloroethene (6-8 feet; GP-6E)
- Benzo (a) pyrene (2-4 feet; GP-2CDup)
- Dibenzo (a,h) anthracene (0-1 foot; GP-3A, GP-7A)
- Tetrachloroethene (0-1 foot; GP-3A)
- Benzo (a) anthracene (0-1 foot; GP-3A)

Chemical Building A and Maintenance Shop Area

- Lead (4-6 feet; GP-24D)
- Trichloroethene (4-6 feet; GP-8D)
- Benzo (a) pyrene (4-6 feet GP-24D)
- Dibenzo (a,h) anthracene (1-2 feet; GP-9B)
- Benzo (b) fluoranthene (0-1 foot GP-8A)
- 1,1-Dichloroethene (4-6 feet; GP-8D)

2.5.2 Groundwater

An agreement was reached between Fansteel and the USEPA that the only potential groundwater exposure pathway of interest for this EE/CA was the exposure due to potential indoor vapor intrusion. Exposure pathways associated with groundwater ingestion and dermal contact have not been evaluated. As a consequence, the applicable screening criteria listed in the groundwater data tables are taken from the draft USEPA Subsurface Vapor Intrusion Guidance, November 2002. The screening values listed are only pertinent to indoor exposures.

Again, as with the soils data, the purpose of the comparisons against screening criteria is to provide the reader with a general indication of the prevalent constituents present within particular areas of the facility. In this context, screening criteria are not used to select COCs or to limit the evaluation of the analytical data obtained. Selection of COCs is performed in the baseline risk assessment presented in Chapter 3.0.

An evaluation was performed of groundwater data from both the Carlson Site Investigation and the supplemental site characterization for the EE/CA. The analytical data represented groundwater samples

taken from both wells and Geoprobes®. The COPCs in groundwater that approached or exceeded applicable indoor vapor intrusion screening criteria at least once were:

- Trichloroethene
- Cis-1,2-Dichloroethene
- Vinyl Chloride
- Trans-1,2-Dichloroethene
- Tetrachloroethene
- Methylene Chloride
- 1,1-Dichloroethene
- 1,2-Dichloroethane

Indoor vapor intrusion screening criteria are not applicable to inorganics (metals) since volatilization is not a concern. The COPCs in groundwater that were most frequently detected were limited to the following:

- Total Cadmium
- Total Lead
- Dissolved Lead
- Trichloroethene
- Cis-1,2-Dichloroethene
- Vinyl Chloride

Pertinent groundwater analytical data from the supplemental site characterization program are indicated in Tables 7A through 7C. Historical groundwater analytical data provided from Carlson's Site Investigation are also presented in Tables 7A through 7C. Historical analytical data for groundwater that incorporate results from Carlson's Site Investigation as well as the supplemental site characterization program is depicted in Figure 6. These data were used to develop the isoconcentration maps for trichloroethene, vinyl chloride, and cis-1,2-dichlorethene that are provided in Figures 8, 9, and 10 respectively.

The horizontal extent of contamination in groundwater for trichloroethene, cis-1,2-dichlorethene and vinyl chloride is indicated in Figures 8, 9, and 10 respectively. Figure 8 indicates a trichloroethene groundwater plume (northern plume) beneath the former HWMU and AST area. A relatively smaller trichloroethene plume is also present beneath the Former Drum Storage area (southeastern plume). Localized trichloroethene concentrations are also noted at MW-8 and TB-29 (southwestern plume). NCI believes the separate and distinct trichloroethene plume shown along the western boundary of the Vacant Lot Site near Pettibone Creek is not associated with Fansteel operations for three reasons. First, based on data from groundwater samples taken from TB-20, 21, and 23, the plume near the creek is isolated from

the plume identified under the HWMU and AST area. Second, given the relatively slow linear groundwater velocity in the area, a plume originating within the North Chicago facility could not have traveled the corresponding distance from the property line, in the timeframe since Fansteel operations began. Finally, there are no data or information indicating the North Chicago facility contributed to any surficial contamination on the Vacant Lot Site that could be the source of this plume. Similar conclusions can be made regarding the cis-1,2-dichlorethene and vinyl chloride groundwater plumes indicated in Figures 9 and 10 respectively. The presence of cis-1,2-dichlorethene, vinyl chloride and other degradation products of trichloroethene in groundwater substantiate the effects of natural attenuation processes.

Groundwater samples from some facility monitoring points have contained metals concentrations including lead. Adjacent properties to the east (R. Lavin & Sons property) and west (Vacant Lot Site) have also identified lead in soils and/or groundwater. NCI's (and previously Fantseel's) historical knowledge of facility activities supports NCI's belief that lead was never used in or generated from site operations, beyond common maintenance applications. The historical knowledge is based on anecdotal reports obtained from a past company employee. As a result, NCI believes the presence of lead throughout these three properties represents a regional/fill contamination source related to the Vulcan Louisville Smelting Company historical operations.

3.0 Baseline Risk Assessment

3.1 Ecological Evaluation

The North Chicago facility is located in an industrialized area. The facility is bounded by the R. Lavin & Sons facility to the east, 22nd Street to the south, the Vacant Lot Site (currently owned by EMCO Chemical Distributors, Inc.) to the west, and the Elgin, Joliet & Eastern Railroad to the north.

Specifically, the site consists of an older industrial complex located on an approximate 8-acre parcel. There are two brick buildings, a boiler house, and a main production building that is comprised of a multi-story and multi-use inner buildings. In addition, a transite building and some aluminum buildings are present. The entire site is enclosed by security fencing.

Portions of the property that are not covered by buildings are generally paved with asphalt or concrete and are used as parking areas or access ways. Two large empty ASTs are located at the northern end of the property. A railroad spur is situated in proximity to the eastern edge of the site and an elevated siding is located south of the ASTs. Some vegetation, consisting of grass and bushes, exists between the office area and 22nd Street.

Based on the industrialized nature of the site and the lack of vegetative area, it is not supportive of habitats for ecological receptors. As agreed upon during the September 2002 meeting between USEPA and Fansteel, Pettibone Creek is excluded from the scope of the EE/CA.

3.2 Human Health Baseline Risk Assessment

This baseline human health risk assessment has been prepared for the North Chicago facility. The risk assessment consists of a quantitative analysis of the potential for adverse effects to human health that may be associated with constituents present at the site.

Human health risk assessment is defined as the scientific evaluation of potential health effects posed by a particular substance or combination of substances. The purpose of this risk assessment is to provide quantitative analyses, in a conservative and health-protective manner, of the likelihood that adverse health effects may be associated with potential exposures to constituents in environmental media at the North Chicago facility. In providing health-related information on potential contact with site-associated constituents, this risk assessment is designed to provide a sound basis for risk management decisions so that further evaluation of the site, if warranted, may be focused.

This risk assessment generally follows the guidelines presented in the Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2001), Soil Screening Guidance: Technical Background Document (USEPA 1996), and Risk Assessment Guidance for Superfund (USEPA 1989). The scientific basis and validity of values used in this assessment are considered and explained in order to provide a frame of reference for the conclusions. However, due to the custom of adherence to conservative regulatory policies, the actual levels of human exposure and the potential health risks associated with exposure to constituents at the North Chicago facility are likely to be significantly lower than the quantitative estimates described in this assessment.

The organization of this human health risk assessment follows the guidelines published in the Risk Assessment Guidance for Superfund (USEPA 1989). This risk assessment contains the following four major steps:

- Hazard Identification. An evaluation of site investigation data and identification of constituents of concern (COCs) with regard to potential health effects.
- Exposure Assessment. Identification of the human receptors likely to be exposed to site originated constituents and the likely extent of their exposure under defined exposure scenarios.
- Dose-Response Evaluation (Toxicity Assessment). A description of the relationship between the magnitude of exposure (dose) and the probability of occurrence of adverse health effects (response) associated with the constituents of interest.
- Risk Characterization. A description of the nature and magnitude of potential human health risks and a comparison to Federal criteria regarding health risks at hazardous waste sites.

Each of these steps is described in more detail below.

3.2.1 Hazard Identification

This section presents the Hazard Identification step of the risk assessment. The purpose of this step is to identify the constituents detected at the North Chicago facility that will be evaluated quantitatively in the human health risk assessment. Several steps are involved in the hazard identification. The first step is the data usability and segregation of the data set into categories that are representative of the exposure potential for the defined receptor. Next, a receptor-specific constituent concentration representative of a specified media is developed. This is often referred to as the exposure point concentration (EPC). The

final step is to identify appropriate screening criteria and compare the representative concentration to the corresponding criterion. Details for each of these steps is presented below.

3.2.1.1 Data Usability and Calculation of Exposure Point Concentrations

Data for this project are a combination of analytical results from two studies. The first investigation was the site investigation performed by Carlson in 2000. The second field program was the supplemental characterization program for the EE/CA performed by Earth Sciences in 2001. Details of these studies are provided in Sections 2.2, 2.3 and 2.4 of this report. The data set referred to throughout this baseline risk assessment will be the combination of the data from both of these studies.

Twenty percent of the data for this site was validated in accordance with the National Functional Guidelines for Organic and Inorganic Data Validation. The remaining data were evaluated in a false positive/false negative assessment. The conclusions of these evaluations are presented in Appendix H. In general, the data may be used quantitatively; however, in some instances, the numerical result is estimated. Raw soils data from the Carlson Site Investigation were reported on a wet-weight basis. A conversion based on average moisture content obtained during the supplemental characterization program was applied to convert the results to dry-weight basis for use.

Tables 3A through 3H present the soil analytical results for the data set. Tables 7A through 7C present the groundwater analytical results. These tables present only those constituents that were detected at least once. Those constituents that were never detected in any sample are not presented in these tables. The analytical numerical result is presented in these tables, as well as the data qualifier resulting from the data validation process.

Data also were statistically evaluated. To perform the statistical evaluation, the data were segregated into categories that correspond with the identified potential receptors for this site. Section 3.2.2 presents the exposure assessment and the applicable receptors and exposure pathways. The Conceptual Site Model (CSM) presented in Figure 11 summarizes the assessment. The CSM for the site was developed in conjunction with the USEPA. The CSM addresses exposure pathways considered by both parties to be legitimate, viable and complete.

Tables 10 and 11 present the samples that were included in each category. In general, the following presents the segregation of the data by receptor and exposure pathway:

Outdoor Worker:

- Inhalation of ambient air - surface soil, subsurface soil, and groundwater not located under structures
- Ingestion of/Dermal contact with - surface soil not located under structures

Indoor Worker:

- Inhalation of indoor air – surface soil, subsurface soil, and groundwater over the entire site
- Ingestion of soil - surface soil that is not located under structures

Construction Worker:

- Inhalation of ambient air - surface soil, subsurface soil, and groundwater over the entire site
- Ingestion of/Dermal contact with - surface and subsurface soil above the water table over the entire site

On-Site Trespasser:

- Inhalation of ambient air - surface soil, subsurface soil, and groundwater not located under structures
- Ingestion of/Dermal contact with - surface soil not located under structures

Surface soil is defined as soil ranging in depth from 0 foot to a maximum of 4 feet. Subsurface soil is defined as soil ranging in depth from greater than 1 foot. The overlap in the sample depth is due to the combination of samples from different field investigations. Further details on these investigations are located in Sections 2.2 and 2.3. See Section 3.4 for a discussion of possible impacts to the risk assessment uncertainty.

It should be noted that for the Outdoor Worker, Construction Worker and On-Site Trespasser, screening for the particulate emissions was performed on the applicable inhalation soil data set. It is recognized, however, that for the Outdoor Worker and On-site Trespasser, only shallow uncovered soil is applicable

because the receptor would only be exposed via particulate emissions adhered to particles from shallow uncovered soil. For the Construction Worker, the soil data used to develop the ingestion exposure concentration are applicable to determine the particulate emissions because dust would not be generated from soil below the water table. Also, in accordance with USEPA guidance (USEPA 2001), SVOCs are not evaluated via fugitive dust because the dermal/ingestion soil screening levels (SSL) are often several orders of magnitude lower (i.e., more stringent) than the corresponding default fugitive dust SSLs. Therefore, evaluation of the SVOC via ingestion/dermal contact would provide sufficient evaluation of the constituent.

For all receptors, volatile constituent statistics for inhalation are based on only constituents applicable for volatilization from soil into air. This includes constituents with a molecular weight less than 200 and Henry's Law Constant greater than 1×10^{-5} atm m^3/mol.

The statistical evaluation includes the following:

- minimum and maximum detected concentrations
- location of maximum detected concentration
- arithmetic and lognormal 95 percent upper confidence limit (UCL)
- test of the distribution of the data
- frequency of detection
- minimum and maximum nondetected concentrations

To generate the 95 percent UCL, the following procedures were applied to the validated data set:

- Samples qualified as estimated "J" were used as real numbers.

- For constituents detected in at least one sample, samples that did not detect the constituent of interest ("U" qualifier) were incorporated into the statistical calculations at one-half the laboratory-reporting limit. This value is assigned because the actual value can range between zero and just below the reporting limit.

- Samples qualified as unusable "R" were not used in calculating the 95 percent UCL or in any other evaluation of the data.

- For field duplicate samples, only the original sample result was used. It should be noted that the field duplicate results were evaluated separately for the frequency of detection. As shown on the statistical summary tables (Table 12 through 23), the maximum detected concentration was used as the EPC in the majority of the exposure pathways. In selecting the maximum concentration, both the original and duplicate sample concentrations were evaluated. Therefore, a conservative approach was used. In the few situations where the 95 percent upper confidence limit was used as the EPC, the maximum concentration was so

great that a small change in one data point (e.g., average of duplicates) would not have a significant impact on the exposure point concentration. This in turn would not change the risk assessment conclusions.

The following equation was used to calculate the arithmetic 95 percent UCL (USEPA, 1992b):

$$95 \text{ percent UCL} = X_{avg} + t_{(1-\alpha)}(s/\sqrt{N})$$

where,

95 percent UCL	=	95 percent Upper confidence limit
X_{avg}	=	Arithmetic average
$t_{(1-\alpha)}$	=	Student's t statistic at a 95 percent level with degree of freedom (n-1)
s	=	Standard deviation
N	=	Number of samples

The lognormal 95 percent UCL was calculated using the following equation (USEPA, 1992b):

$$95 \text{ percent UCL} = \exp(\ddot{y} + 0.5\, s_y^2 + (s_y * H)/\sqrt{(n-1)})$$

where,

95 percent UCL	=	95 percent upper confidence limit
$\ddot{Y}$	=	Mean of the ln-transformed data set
s_y	=	Standard deviation of the ln-transformed data set
H	=	H- statistic for the one-sided (upper) confidence limit
N	=	Number of samples

The W-test was performed to determine if each data set approximates either a normal or log normal distribution. In the instance where the data set contained more than 50 data points, the D'Agostino test was performed. The W-test and D'Agostino statistical tests are used by USEPA. A description of these tests may be found in, Statistical Method for Environmental Pollution Monitoring, Richard O. Gilbert, 1987 (ISBN 0-442-23050-8).

As shown in Tables 12 through 23, in some cases, the data fit neither a normal nor a log normal distribution to the $W_{.05}$ level. In these cases, if the distribution test shows a potential for fitting the data distribution ($W_{calculated}$ is within - 0.1 of $W_{.05}$ level) and the UCL is less than the maximum detected concentration, the UCL is used to represent the constituent concentration. In cases where there is a high

degree of variability in a data set (i.e., distribution test does not approximate a tested distribution); there are only a small number of samples in the data set (i.e., less than 10 data points); or the calculated 95 percent UCL exceeds the maximum detected concentration of a constituent, the maximum detected concentration is used as the representative concentration for the constituent. Therefore, the representative concentration is either the maximum detected concentration or the appropriate 95 percent UCL. As shown on Tables 12 through 23, the lognormal 95 percent UCL was used as the EPC in the following situations:

Receptor/Exposure Pathway	Constituent	W_{value} (calculated)	$W_{0.05}$ (acceptable)
Onsite Trespasser - Ingestion	Lead	0.9	0.9
	Trichloroethene	0.9	0.9
	Benzo(a)pyrene	0.9	0.9
	Benzo(a)anthracene	0.96	0.91
	Benzo(b)fluoranthene	0.9	0.9
	Diben(a,h)anthracene	0.95	0.91
	Indeno(1,2,3-cd)pyrene	0.97	0.91
Onsite Trespasser - Inhalation	Lead	0.9	0.9
Indoor Worker - Ingestion	Lead	0.9	0.9
	Benzo(a)pyrene	0.9	0.9
	Dibenz(a,h)anthracene	0.95	0.91
Indoor Worker - Inhalation	Tetrachloroethene	0.8	0.9
	Trichloroethene	1	0.93
Outdoor Worker - Ingestion	Lead	0.9	0.9
	Trichloroethene	0.9	0.9
	Benzo(a)pyrene	0.9	0.9
	Benzo(a)anthracene	0.96	0.91
	Diben(a,h)anthracene	0.95	0.91
Outdoor Worker - Inhalation	Lead	0.9	0.9
Construction Worker -	Lead	0.5	-2.8 - 0.9
Ingestion	Benzo(a)pyrene	-2.6	-2.8 - 0.9

	Diben(a,h)anthracene	-1.8	-2.8 - 0.9
Construction Worker - Inhalation	Lead	0.5	-2.8 - 0.9

As shown by this summary table, the data approximated the lognormal distribution in each instance the lognormal 95% UCL was used. Also, the data set in generating these 95% UCLs was greater than 10 data points.

To ensure that all appropriate COPCs were selected as COCs, a review of the reporting limits (i.e., nondetected concentrations) was performed. As shown in Tables 12 through 23, the maximum reporting limit for the soils - ingestion/dermal contact for each receptor was less than the corresponding screening criterion. For soils - inhalation, the maximum reporting limit for tetrachloroethene was greater than the screening criterion for the outdoor worker, construction worker, and on-site trespasser. In these instances, the constituent was identified as a COC. For groundwater, there are several constituents for which the maximum reporting limit is elevated due to dilution of the sample. Because there are no screening criteria for groundwater (other than indoor air), all detected constituents were retained as COCs.

For those constituents that were not detected at least once, a review of the typical reporting limits was performed. There were some instances where dilution of a sample was required. In these instances, the reporting limit was elevated. In general, the analytical program for both field investigations was sensitive enough to allow conclusions to be drawn on the absence or presence of a constituent with respect to the screening criteria (see Table 24).

3.2.1.2 Selection of COCs

An important step in the risk assessment is to identify the COCs at the site. Although many different constituents have been detected in media of the North Chicago facility, most of these pose a negligible concern by customary risk assessment standards, as explained below, and may be eliminated from further consideration in this preliminary step. USEPA soil screening guidance (USEPA 2001) presents a methodology for identifying which detected constituents should be included in a quantitative risk evaluation. These COCs are defined by the USEPA as constituents potentially related to the site whose data are of sufficient quality for use in a quantitative risk assessment.

It is important to recognize that the selection of a constituent as a COC does not necessarily indicate that it poses a significant health risk. The selection of a constituent only indicates that there is a need to evaluate it quantitatively in the risk assessment to determine if that constituent may be associated with potential health risks. Furthermore, because the approach to select constituents is conservative (as described below), there is a possibility that a constituent selected for detailed analysis is not site related.

Constituents were eliminated from further evaluation in the risk assessment by comparing detected values to health-based screening criteria. These criteria are derived using standard conservative exposure assumptions, and therefore, provide a useful mechanism to identify constituents that may be associated with potential health risks. USEPA directed NCI as to the screening criteria to use for the risk assessment. These screening criteria are listed below. The current values in use when the risk assessment was prepared were used. If a screening criterion was not available for a constituent, the parameter was eliminated as a constituent of concern for the associated exposure pathway. The screening criteria used for each medium is as follows:

<u>Soil</u>

- EPA Generic Soil Screening Levels (SSLs) (USEPA, 2001) - Outdoor Worker - Ingestion/Dermal; Inhalation of Volatiles/Fugitive Dust
- EPA Generic Soil Screening Levels (SSLs) (USEPA, 2001) - Indoor Worker - Ingestion/Dermal
- EPA Generic Soil Screening Levels (SSLs) (USEPA, 2001) - Residential - Ingestion/Dermal; Inhalation of Volatiles/Fugitive Dust (On-Site Trespasser only)

It should be noted that if an SSL was not available for a constituent, the USEPA Region IX preliminary remediation goal (PRG) was used, if available.

<u>Groundwater</u>

- EPA Vapor Intrusion Generic Screening Levels (1×10^{-6})(USEPA, 2002)

There are no soil or groundwater screening criterion for tantalum. The USEPA Office of Research and Development provided information indicating that tantalum is not toxic and that no suitable toxicity studies have been performed to develop a reference dose factor. It was agreed upon by USEPA and

Fansteel during the September 2002 meeting that tantalum would not be considered a constituent of concern and that risk could not be quantitated for tantalum. Specific details and references on the use of these screening criteria are presented below.

3.2.1.2.1 Soil COCs

For constituents in surface and subsurface soil, the representative concentration of each constituent was compared to established health-based screening criteria as noted above. There were several instances where a soil inhalation criterion was not available for a constituent. For most of these constituents, there are no inhalation toxicity data to quantitatively evaluate the constituent. Therefore, these constituents were screened from further evaluation for the inhalation pathway. A listing of the soil constituents without inhalation screening criteria that were screened from further evaluation are as follows:

Acetone	2-Butanone	Chloroethane	Chloromethane
cis-1,2,-Dichloroethene	trans-1,2-Dichloroethene	Xylenes, total	p-Isopropyltoluene
n-Propylbenzene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	

The uncertainty analysis provides a qualitative evaluation of the absence of these constituents from the baseline risk assessment. (At the initiation of the risk assessment, the Integrated Risk Information System (IRIS) was reviewed for the most current toxicity data. This information was used in the risk assessment. If toxicity data were not available in IRIS, information from the National Center for Environmental Assessment (NCEA) was used. Due to the conservatism built into the toxicity information, route-to-route extrapolation was not used. The use of route-to-route extrapolation introduces uncertainties into the risk calculations. If toxicity information was not available for a constituent via the exposure pathway, it was not assessed. It should be noted that the toxicity information for the risk drivers was available and used in the risk assessment.)

For PNAs, the following surrogates were used to evaluate constituents without a criterion:

- acenaphthene was used as a surrogate for acenaphthylene
- pyrene was used as a surrogate for benzo(g,h,i)perylene
- anthracene was used as a surrogate for phenanthrene

Use of the surrogates was taken from the West Virginia Department of Environmental Protection Voluntary Remediation and Redevelopment Act Guidance.

As agreed upon by USEPA and NCI, for this site, PNAs as a group will be not evaluated. The PNAs are evaluated individually. Any PNA that exceeds the associated screening criteria is retained as a constituent of concern.

The construction worker is a potential receptor for this site. There are no screening criteria specific to a construction worker. The data group for the construction worker was screened against the outdoor worker criteria. It is recognized that the outdoor worker SSLs are based upon exposure assumptions and toxicity data that differ from the construction worker; however, it was agreed upon by USEPA and Fansteel that data will be screened with industrial screening numbers.

Surface, subsurface, and total soils are evaluated as separate media because of their different exposure potentials. For example, while all potential receptors may be exposed to surface soil, only a receptor involved in intrusive activities would contact subsurface soil. In addition, soil of all depths should be evaluated for volatilization to ambient air, but the deeper soils would not be available for direct contact exposure pathways. Therefore, soil samples are screened for COCs as follows:

- Outdoor Worker and On-Site Trespasser
  - surficial samples not located under a structure - (for direct contact pathways)
  - total soils not located under a structure - (all available depths - for volatilization from soil into ambient air and inhalation of fugitive dust).
- Indoor Worker
  - surficial samples not located under a structure - (for incidental ingestion)
  - total soils over the entire site - (all available depths - for volatilization from soil into indoor air).
- Construction Worker
  - Soil samples above the water table located over the entire site - (for direct contact pathways). Exposure to soil at or below the water table is not considered applicable for the construction worker. Subsurface excavations at or below the water table involves additional constraints (dewatering, confined space entry, etc.) that are not envisioned as part of the more mundane construction-related activities expected (minor maintenance

activities, utility work, etc.). It should be noted that if environmental or construction activities are conducted at or below the water table, the work should be performed by trained personnel under the terms and conditions of a site-specific health and safety plan.

– total soils located over the entire site - (all available depths - for volatilization from soil into ambient air and inhalation of fugitive dust).

To screen the soil data, the representative concentration was compared to the soil criterion. The results of the screening by receptor are presented below. It should be noted that a constituent may be identified as a COC for one pathway and eliminated from another exposure pathway. For example, a constituent may be screened for both direct contact and inhalation. The direct contact EPC may be greater than the screening criterion and the constituent would be retained as a COC. However, the same constituent may be less than the inhalation screening criterion and not retained as a COC for the inhalation pathway.

Outdoor Worker

Tables 12 and 13 present the screening for COCs for the Outdoor Worker. The COCs for this receptor were obtained by comparing the exposure point concentration for each constituent to the associated SSL for the Outdoor Worker (ingestion/dermal and inhalation of volatiles/fugitive dust). The following constituents were identified as COCs:

Inhalation: tetrachloroethene, trichloroethene, and vinyl chloride
Ingestion/Direct Contact: lead, tetrachloroethene, and benzo(a)pyrene

Indoor Worker

Tables 14 and 15 present the screening for COCs for the Indoor Worker. The COCs for this receptor were obtained by comparing the exposure point concentration for each constituent to the associated SSL for the Indoor Worker (ingestion). The following constituents were identified as COCs:

Inhalation: Because there are no soil screening criteria for indoor air, all volatile constituents detected in soil were considered to be COCs.
Ingestion: lead and tetrachloroethene

Construction Worker

Tables 16 and 17 present the screening for COCs for the Construction Worker. As stated previously, there are no screening levels for the construction worker. Based on an agreement between USEPA and Fansteel, the COCs for the construction worker were obtained by comparing the exposure point concentrations for each constituent to the associated SSL for the Outdoor Worker (ingestion/dermal and inhalation of volatiles/fugitive dust). The following constituents were identified as COCs:

Inhalation: tetrachloroethene, trichloroethene, and vinyl chloride
Ingestion/Direct Contact: tetrachloroethene, trichloroethene, benzo(a)pyrene, and benzo(a)anthracene

On-Site Trespasser

Tables 18 and 19 present the screening for COCs for the On-Site Trespasser. The COCs for this receptor were obtained by comparing the exposure point concentration for each constituent to the associated SSL for the Residential Receptor (ingestion/dermal and inhalation of volatiles/fugitive dust). Although it is recognized that screening for this project was to be to industrial criteria, it was deemed that the residential SSLs were most appropriate for the On-Site Trespasser. The following constituents were identified as COCs:

Inhalation: 1,1-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride
Ingestion/Direct Contact: lead, tetrachloroethene, dibenz(a,h)anthracene, and benzo(a)pyrene

3.2.1.2.2 Groundwater COCs

As described in Section 3.2.2.1.1, the only complete exposure pathway to groundwater is via inhalation to both ambient and indoor air. The only relevant groundwater screening criteria are the draft vapor intrusion levels. The representative concentration of each constituent for the Indoor Worker was compared to established health-based screening criteria. Groundwater data for the other receptors were not screened. Volatile constituents detected in groundwater for each receptor other than the Indoor Worker were retained as COCs.

Groundwater data were segregated because of their different exposure potentials. For example, groundwater samples collected under a structure are appropriate for indoor air but not applicable for ambient air. Therefore, groundwater samples were screened for COCs as follows:

- Outdoor Worker and On-Site Trespasser
  - groundwater samples collected from areas not located under a structure
- Construction Worker
  - groundwater samples collected from all areas of the site
- Indoor Worker
  - groundwater samples collected from all areas of the site

To screen the groundwater data for the Indoor Worker, the representative concentration was compared to the draft vapor intrusion levels. As directed by USEPA, the screening levels based on a 1×10^{-6} cancer risk and 0.1 noncancer risk were used for screening. This is conservative for an industrial screening but is used to ensure that additive risks do not pose a concern. The results of the screening by receptor are presented below.

Outdoor Worker

Table 20 presents the screening for COCs for the Outdoor Worker. The following constituents were identified as COCs:

Inhalation: Because there are no groundwater screening criteria for ambient air, all volatile constituents detected in groundwater were considered to be COCs.

Indoor Worker

Table 21 presents the screening for COCs for the Indoor Worker. The COCs for this receptor were obtained by comparing the exposure point concentration for each constituent to the associated vapor intrusion screening level. The following constituents were identified as COCs:

Inhalation: 1,2-Dichloroethane, Chloroform, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene, cis-1,2-Dichloroethene, Methylene chloride, Tetrachloroethene, trans-1,2-Dichloroethene, Trichloroethene and Vinyl chloride

Construction Worker

Table 22 presents the screening for COCs for the Construction Worker. The following constituents were identified as COCs:

Inhalation: Because there are no groundwater screening criteria for ambient air, all volatile constituents detected in groundwater were considered to be COCs.

On-Site Trespasser

Table 23 presents the screening for COCs for the On-Site Trespasser. The following constituents were identified as COCs:

Inhalation: Because there are no groundwater screening criteria for ambient air, all volatile constituents detected in groundwater were considered to be COCs.

3.2.2 Exposure Assessment

Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to an agent in the environment. This section of the human health risk assessment presents the mechanisms by which people might come in contact with constituents of interest and the approximate magnitude, frequency, and duration of contact between potential human receptors and the constituents. The quantitative assessment of exposure, based on constituent concentrations and the degree of absorption of each constituent, provides the basis for estimating constituent uptake (dose) and associated health risks.

The exposure assessment follows, as much as possible, the recommendations for conducting an exposure assessment provided in the USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2001), USEPA's Risk Assessment Guidance for Superfund (USEPA 1989), and the Guidelines for Exposure Assessment (USEPA 1992a). In cases where guidance was not available, exposure assumptions were based on professional judgment, and noted as such.

In accordance with USEPA 1989, an exposure assessment consists of three basic steps:

- Characterization of the exposure setting (physical environment and potential receptors).
- Identification of exposure pathways (constituent sources, points of release, and exposure routes).
- Quantification of pathway-specific exposures [exposure point concentrations and intake (dose) assumptions].

The first step characterizes the salient features of the site environment that might influence human exposure. Potential pathways of human exposure are identified in the second step by characterizing the constituent sources, points of release, and potential exposure routes. In the third step, the qualitative information from the first two steps is integrated with the estimates of exposure concentrations and intake assumptions to quantitatively estimate exposure (dose). These components are described in greater detail in the following subsections.

3.2.2.1 Identification of Exposure Pathways

This section describes the potential pathways by which the receptors could be exposed to constituents located at the North Chicago facility. An exposure pathway is a description of the mechanism by which an individual may come into contact with constituents in the environment. In accordance with USEPA 1989 risk assessment guidance, all potential exposure pathways applicable to the site have been identified and addressed.

An exposure pathway is defined by four elements (USEPA 1989):

- A source and mechanism of constituent release to the environment (e.g., leaking tank)
- An environmental receiving or transport medium (e.g., soil, groundwater) for the released constituent
- A point of potential contact with the medium of interest (e.g., exposed surface soil)
- An exposure route (e.g., ingestion) at the contact point

An exposure pathway is considered "complete" if all elements are present. The characterization of the potential exposure pathways at the North Chicago facility, and whether each pathway is complete, is presented in the following sections.

3.2.2.1.1 Exposure Media and Potential Routes of Exposure

The identification of potential human receptors and complete exposure pathways is based on the characteristics of the site, the surrounding land uses, and the probable future land uses. As shown in Figure 11, the following potential exposure pathways were evaluated for reasonable future and current scenarios:

- Groundwater ingestion and dermal contact as a potable water source (tap water)
- Inhalation of outdoor vapors originating from volatile constituents in groundwater
- Inhalation of indoor vapors originating from volatile constituents in groundwater
- Ingestion and dermal contact of surficial soils
- Inhalation of outdoor vapors and particulates from surficial soils
- Inhalation of outdoor vapors from volatile constituents in subsurface soils
- Inhalation of indoor vapors from volatile constituents in surficial and subsurface soils
- Inhalation of particulates from subsurface soil during construction activities
- Incidental ingestion and dermal contact with groundwater during construction activities
- Ingestion of groundwater impacted by leaching of organic constituents from subsurface soil
- Incidental ingestion and dermal contact with surface water/sediment
- Inhalation of constituents originating from surface water/sediment

Based on land use in the area, it was determined that the following potential receptors were appropriate for this site:

- Indoor worker - There are structures on the site, and in the future there is a potential for structures to be present. The indoor worker will be exposure to indoor air vapors originating from both soil and groundwater as well as to incidental ingestion of surface soil from limited outdoor exposure. The indoor worker is a reasonable current and future receptor.
- Outdoor worker - The outdoor worker in both the current and future scenarios has the potential to be present anywhere on the site. The outdoor worker would do light maintenance work around the facility. The outdoor worker will be exposed to ambient air vapors originating from groundwater and soil as well as to incidental ingestion and dermal contact with surface soil. The outdoor worker will not come into contact with the groundwater. The outdoor worker is a reasonable current and future receptor.
- Construction worker - The construction worker in both the current and future scenarios has the potential to be present anywhere on the site. The construction worker will be exposed to ambient air vapors originating from groundwater and soil as well as incidental ingestion and dermal contact with soil above the water table. For this site, subsurface excavation at or below the water table will involve additional constraints (e.g., dewatering, confined space entry, etc.) that are not envisioned as part of the more mundane construction-related activities expected. The site will be under deed restrictions limiting subsurface activities of all types (above and below the water table) to environmental monitoring activities, ancillary environmental work and work performed by trained personnel under the terms and conditions of a site-specific health and safety plan.
- On-site trespasser - The on-site trespasser in both the current and future scenarios has the potential to be present anywhere on the site. The on-site trespasser is expected to range in

age from 10-17 years. The on-site trespasser will be exposed to ambient air vapors originating from groundwater and soil as well as to incidental ingestion and dermal contact with surface soil. The on-site trespasser will not come into contact with the groundwater. The on-site trespasser is a reasonable current and future receptor.

Each receptor-exposure pathway combination was evaluated to determine whether a current and/or reasonable future complete exposure pathway existed for the site. Results of the evaluation are summarized in Figure 11, Conceptual Site Model**.** The evaluation identified the following complete exposure pathways and receptors based on sources identified at the site:

- Inhalation of indoor vapors from groundwater and soil for an indoor worker
- Incidental ingestion of surficial soil for the indoor worker
- Incidental ingestion, dermal contact, and inhalation of outdoor vapors and particulates from surface soils for an outdoor worker
- Inhalation of outdoor vapors from groundwater and subsurface soils for an outdoor worker
- Incidental ingestion, dermal contact, and inhalation of outdoor vapors and particulates from surface and subsurface soils for a construction worker
- Inhalation of outdoor vapors from groundwater and subsurface soils for a construction worker
- Incidental ingestion, dermal contact, and inhalation of outdoor vapors and particulates from surface soils for an on-site trespasser
- Inhalation of outdoor vapors from groundwater and subsurface soils for an on-site trespasser

Because of the following factors, all other potential receptor-exposure pathway combinations represented an incomplete exposure pathway:

- The North Chicago facility is located in an industrial setting and is bordered on the north and east by railroad tracks, the south by a major roadway and the west by a vacant lot previously used for industrial purposes and remediated by the Federal Government for only industrial use. No residential properties are located within approximately 2,600 feet (0.5 mile) of the site, except to the north/northwest. However, a substantial railroad embankment north/northwest of the site separates the facility from local residents. Due to the location of the site relative to residential areas and the highly industrialized nature in the vicinity of the site, there is not a complete exposure pathway for residential receptors.
- Groundwater at the site is shallow, ranging in depth from 0 to 13.6 feet. Currently, groundwater at the site is not used for potable purposes. Potable water is supplied by a

public water supply district. In the future, potable water will continue to be supplied by the public water supply district. Therefore, direct contact and ingestion of groundwater is not a reasonably complete pathway for either current or future exposure scenarios. This conclusion was agreed upon during a September 2002 meeting with USEPA and Fansteel.

- As agreed upon between USEPA and Fansteel during the September 2002 meeting, inhalation of volatiles from groundwater is the only complete groundwater pathway. Therefore, incidental ingestion and dermal contact with groundwater is not considered to be complete for the construction worker.

- As agreed upon during a September 2002 meeting between USEPA and Fansteel, there are no complete exposure pathways with nearby surface water or sediment.

- As stated previously, the site is bounded on the south by a roadway and the north and east by railroad tracks. A vacant lot is located to the west of the site. This site has been remediated by the Federal Government, and currently, the lot is not used. Based on the surrounding areas of the North Chicago facility, there are no current or reasonably foreseeable future off-site industrial receptors. This conclusion was agreed upon during a September 2002 meeting with USEPA and Fansteel.

3.2.2.1.2 Quantification of Exposures

Potential exposure to constituents in the environment is directly proportional to the concentration of constituents in environmental media (e.g., soil and water) and characteristics of exposure (e.g., frequency and duration). The concentrations at exposure points generally are referred to as EPCs. The analytical results for samples from a given area are combined to derive a single EPC for each constituent that represents the level of that constituent to which potential receptors may be exposed. For constituents in soil and water, EPCs were statistically calculated from sampling data. EPCs of constituents in ambient air were modeled using standard USEPA methodologies.

Derivation of the soil and groundwater EPCs are presented in Section 3.2.1.1 of this report. The EPC for constituents in soil are listed in Tables 12 through 19. EPCs for groundwater are listed in Tables 20 through 23.

Inhalation of both ambient and indoor air is a potential exposure pathway. Air concentrations of nonvolatile constituents resulting from fugitive dust emissions (i.e., particulates generated by wind erosion, vehicular traffic, or intrusive activities) are to be estimated using a particulate emission factor (PEF). PEFs relate the concentration of a constituent in soil to the estimated concentration in respirable airborne particulates. As stated previously, SVOCs are not evaluated via fugitive dust because the dermal/ingestion SSLs are often several orders of magnitude lower (i.e., more stringent) than the corresponding default fugitive dust SSLs. Therefore, evaluation of the SVOCs via ingestion/dermal

contact would be sufficient to assess risk. Lead was the only inorganic element identified as a COC. Assessment of lead risk is done qualitatively and does not rely on the use of the PEF. Consequently, no COCs with the route of exposure via inhalation of fugitive dust were identified. Therefore, PEF is not applicable for this site.

To assess risk of inhalation of volatiles from soil and groundwater, a volatilization factor (VF) was used. The VF relates the concentration of a constituent in soil or groundwater to the flux of the volatilized constituent to air. The VF used in this assessment was calculated based on the guidance presented in the Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (March 2001). The VF was applied to soils and groundwater to estimate volatile air concentrations that might be inhaled by potential receptors.

The equation for calculating the VF, as well as factors incorporated into the equation, is presented in Table 25. As agreed upon between USEPA and NCI, the USEPA VLEACH model was used in developing the VFs. As shown on Table 25, the USEPA VLEACH model was used to calculate the average release rate (J_t) of each COC per receptor. The flux (J_t) is divided into the dispersion factor (Q/C_{vol}). The dispersion factor was calculated in accordance with the Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (March 2001). Constants used to calculate the dispersion factor are based on information for the Chicago area. Calculation of the VF for each receptor is provided in Appendix J. Information on the VLEACH model is provided in Appendix K. Soil and groundwater concentrations are converted to air concentrations by dividing the soil and groundwater concentrations by the VF to obtain an air concentration (Ca) in units of mg/m^3.

3.2.2.1.3 <u>The Concept of "Dose"</u>

The term "dose" can be defined in a variety of ways; however, for the purpose of quantitative risk assessment, dose is defined as the amount of a constituent in an environmental medium which is absorbed by a receptor. This is differentiated from exposure, which may be defined as the amount of a constituent which contacts the receptor. The difference between exposure and dose is that the portion of constituent which contacts the receptor is the exposure, while the portion of the constituent which is absorbed is the dose. In the case of ingestion of constituents, the amount ingested is the exposure, while the amount absorbed through the gastrointestinal tract is the dose. The difference is the unabsorbed portion which is excreted in the waste. Similarly, in the case of dermal contact with constituents, the amount in contact with the skin is the exposure, while the amount absorbed through the skin is the dose. The difference is the unabsorbed portion which is ultimately removed from the surface of the skin by washing. In the case

of inhalation of constituents, the amount of the constituent inhaled in air is the exposure, while the amount absorbed through the deep lung alveoli is the dose. The difference is the unabsorbed portion which is exhaled back into the ambient air and not absorbed.

The "Average Daily Dose" (ADD) or "Lifetime Average Daily Dose" (LADD) are the general parameters used to quantify exposure doses in site risk assessments. The ADD is used as a standard measure for characterizing long-term noncarcinogenic effects. The LADD addresses exposures that may occur over varying durations from a single event to an average 70-year human lifetime and are used to estimate potential carcinogenic risks. These equations, and the factors used in each, apply to all constituents with the exception of lead. Lead is evaluated separately, as will be explained in the toxicity assessment. Tables 26 through 32 present the equations for calculating soil and groundwater ADD and LADD.

3.2.2.1.4 Absorption Adjustments to Dose

For the purpose of quantitative regulatory risk assessment, dose is defined as the amount of a constituent in an environmental medium which is absorbed by a receptor. In many cases, the absorption is less than the degree of contact. In order to account for the differential absorption as compared to contact, the following exposure-route specific modifications have been employed in this risk assessment.

Ingestion: Based on the Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (March 2001), for all constituents in soil, it was conservatively assumed that the absorptions from ingestion were all equivalent to the absorptions in the applicable toxicity studies. Thus, a default oral absorption factor of 100 percent was assumed.

Dermal Contact with Soil: For a constituent to be absorbed by the skin from contacted soil, it must be released from the soil matrix and pass through the stratum corneum, the epidermis, and the dermis before it can be absorbed into the systemic circulation. Only a small fraction of the administered dose of a constituent will actually penetrate the skin and enter the body of the receptor. Dermal exposure calculations are always calculated as an absorbed dose and require the inclusion of a dermal absorption factor.

Dermal absorption factors for the COCs in soil were obtained from Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (March 2001). These factors are listed in Tables 26 through 29. In accordance with the Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (March 2001), dermal absorption from volatiles is not assumed to occur. It is

assumed that VOCs volatilize before they are absorbed through the skin. For PNAs, it was assumed that only 13 percent is absorbed dermally.

Inhalation: Based on the Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (March 2001), for all organic and inorganic constituents in soil and groundwater, it was conservatively assumed that a relative inhalation absorption factor of 1 (i.e., 100 percent absorbed) was used in the dose calculations.

3.2.2.1.5 Exposure Parameters

The quantitative estimation of constituent intake involves the incorporation of numerical assumptions for a variety of exposure parameters. Where guidance was available, exposure parameters used in these dose calculations are based on values recommended by Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (March 2001). Some exposure values are not addressed in the available guidance, and in these cases, values were derived based on site characteristics or best professional judgment. For example, the on-site trespasser exposure assumptions are based solely on a child receptor (ages approximately 10 to 17). The exposure frequency of 54 days (approximately 1 day/week during the school year; 2-3 days per week during the summer and vacations) and the exposure duration (7 years) was agreed upon during the September 2002 meeting between USEPA and Fansteel. The exposure parameters for each receptor are presented in Tables 26 through 32.

3.2.3 Toxicity Assessment

The toxicity assessment provides a description of the relationship between a dose of a chemical and the anticipated incidence of an adverse health effect (Preuss and Ehrlich, 1987). Most of the understanding of the dose-response relationship is based on data collected from studies of animals (usually rodents), studies of human occupational exposures, and theories about how humans respond to environmental doses of chemicals.

The USEPA has developed dose-response assessment techniques to set “acceptable” levels of human exposure to chemicals in the environment. These USEPA-derived risk criteria address both subchronic and chronic noncarcinogenic health effects and potential carcinogenic health risks.

3.2.3.1 Criteria for Carcinogenic Responses

USEPA uses a two-step approach for evaluating potential carcinogenic effects of chemicals. First, the substance is assigned a weight-of-evidence classification reflecting the likelihood that the chemical is a

human carcinogen. Second, a cancer slope factor (CSF) is calculated for known or probable human carcinogens.

The USEPA weight-of-evidence classification system for carcinogenicity has the following categories.

- Group A chemicals (human carcinogens) are agents for which there is sufficient evidence of carcinogenicity from human studies.
- Groups B1 and B2 chemicals (probable human carcinogens) are agents for which there is limited evidence of carcinogenicity from human studies (B1) or sufficient evidence in animal studies and inadequate evidence from human studies (B2).
- Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals.
- Group D chemicals (not classifiable as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.
- Group E chemicals (evidence of noncarcinogenicity) are agents for which there is no evidence of carcinogenicity in adequate human or animal studies.

CSFs are typically calculated for potential carcinogens in classes A, B1, and B2. The slope factor is used to estimate an upperbound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. To derive the CSF, data from animal studies (or occasionally from human epidemiology) are fit to the linearized multistage model, and the upper 95th percent confidence limit on the slope of the resulting dose-response curve is calculated. This slope factor, therefore, reflects an upperbound estimate of the probability of carcinogenic response per unit dose of a chemical. The CSF is expressed in units of reciprocal dose (milligrams per kilogram-day)$^{-1}$. CSFs are derived separately for oral and inhalation exposure, as appropriate.

This risk assessment evaluates theoretical excess lifetime cancer risks for the COCs selected in this risk assessment. The relevant dose-response values (i.e., toxicity data) for these chemicals are summarized in Table 33. When available, toxicity data were obtained from the Integrated Risk Information System (IRIS). If toxicity data were not available from IRIS, toxicity data developed by the National Center for Environmental Assessment (NCEA) were used. It should be noted that IRIS has currently withdrawn information for trichloroethene for further review. The toxicity information used for trichloroethene is published from NCEA. Route to route extrapolations were not used in this risk assessment. For example, if a toxicity value was provided for the oral route and no toxicity data were available for the inhalation

route, oral toxicity data were not used to evaluate the inhalation exposures. It should be noted that for the primary COCs, toxicity data for both the oral and inhalation exposure routes were available.

3.2.3.1.1 Estimating the Likelihood of Carcinogenic Response

For carcinogenic chemicals, a risk assessment evaluates the degree to which a receptor may have an increased likelihood of developing cancer over a lifetime due to exposure to site-associated chemicals. At environmental dosage levels, the CSF is assumed to be constant and potential carcinogenic risk to be directly related to intake. In order to estimate the theoretical excess lifetime cancer risk, the LADD of a chemical is multiplied by the CSF as shown.

LADD x CSF = Risk

This calculation is carried out for each chemical applicable to a particular exposure pathway, and the potential risks are summed to obtain the total potential risk due to that pathway. The total theoretical excess lifetime cancer risk for a particular receptor is then calculated as the sum of the potential risks from all exposure pathways for that receptor. Tables 34 through 39 present the risk by receptor, media and constituent. The calculation of these risks is presented in Appendix L.

3.2.3.2 Criteria for Noncarcinogenic Responses

It is widely accepted that noncarcinogenic biological effects of chemical substances occur only after a threshold dose is achieved (Klaasen et al., 1986). USEPA uses the no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) estimates of threshold dose to establish reference doses (RfD) for human exposure. An RfD is an estimate of a daily exposure level (dose) that is unlikely to present an appreciable risk of deleterious effects during a lifetime. USEPA has derived both chronic and subchronic RfDs: subchronic RfDs are appropriate for evaluating exposure periods of less than 7 years, while chronic RfDs are intended for evaluating long-term exposure. RfDs are expressed in units of dose (milligrams per kilogram-day) and incorporate uncertainty factors to account for limitations in the quality or quantity of available data. Separate RfDs are derived for oral and inhalation exposure. For this site, subchronic toxicity data were used to assess risk for the construction worker. The subchronic data are Minimal Risk Levels (MRL) published by the Agency for Toxic Substances and Disease Registry (ATSDR). When available, chronic MRLs were used. These represent exposure from 365 days or greater. If chronic MRLs were not available, intermediate values were used. The intermediate value represents exposure from greater than 14 days to 364 days. Finally, if neither chronic nor intermediate values were available, the acute MRL was used. The acute MRL represents exposure

from 1 to 14 days. The inhalation MRLs were converted from a Unit Risk Factor (parts per million) to a reference concentration (milligrams per kilogram-day). When no MRL was available, the CSF and/or RfD was used.

This risk assessment evaluates potential noncarcinogenic health effects caused by the COCs selected in this risk assessment. The relevant dose-response values (i.e., toxicity data) for these chemicals are summarized in Table 33. When available, toxicity data were obtained from the IRIS. If toxicity data were not available from IRIS, toxicity data developed by NCEA were used. It should be noted that IRIS has currently withdrawn information for trichloroethene for further review. The toxicity information used for trichloroethene is published from NCEA. Route to route extrapolations were not used in this risk assessment. For example, if a toxicity value was provided for the oral route and no toxicity data were available for the inhalation route, oral toxicity data were not used to evaluate the inhalation exposures. It should be noted that for the primary COCs, toxicity data for both the oral and inhalation exposure routes were available.

3.2.3.2.1 Estimating the Likelihood of Adverse Noncarcinogenic Response

The likelihood of occurrence of adverse noncarcinogenic effects depends on the relationship between the RfD and the estimated average chemical dose received by the receptor. Received doses less than the RfD are not likely to be associated with any adverse health effects and are, generally, not of regulatory concern. Doses that exceed the RfD are considered to present the potential for adverse effects.

Noncarcinogenic responses are evaluated numerically using parameters known as the hazard quotient (HQ) and hazard index (HI). The HQ is obtained by dividing the ADD by the RfD as presented below. The ADD is the estimated daily dose of a chemical averaged over the specific duration of exposure, which may not necessarily be an entire lifetime.

$$ADD / RfD = HQ$$

Each dose calculation with a specific combination of chemical, receptor, and exposure pathway will have a distinct ADD and calculated HQ. In a screening-level assessment, values associated with all chemicals for a particular pathway are summed to yield the HI, as indicated:

$$HQ_i+HQ_{ii}+HQ_{iii}+ ....=HI$$

If a receptor is subject to exposure through more than one pathway, the hazard indices for all pathways are summed. A calculated HI of less than one indicates that an adverse effect would not be anticipated. Tables 34 through 39 present the risk by receptor, media, and constituent. The calculation of these risks is presented in Appendix L.

3.2.3.3 Indoor Worker

Both carcinogenic and noncarcinogenic risk posed to the indoor worker via inhalation of volatilized organics from soil and groundwater over the entire site was assessed. The indoor air risk was evaluated using the Johnson and Ettinger Model (USEPA 2003). For soils, the SL-SCREEN Version 3.0 was used. GW-SCREEN Version 3.0 was used to assess indoor air risk originating from groundwater. A copy of the data input sheet and result sheet for each constituent is provided in Appendix M. The groundwater and soil input parameters are summarized in Table 27. Soil risks were based on the assumption that existing and future structures do not have basements. Also, it is assumed that the existing and future structures would be constructed directly in soil that contains COCs. Based on site-specific information, the soil texture throughout the soil column was characterized as silty clay. For groundwater, the site average depth to groundwater was conservatively assumed to be 8.5 feet for use in the model. Risks to the indoor worker by media and constituent are presented in Tables 40 through 42.

3.2.3.4 Risk Characterization

Risk characterization is the final step of the baseline health risk assessment process. It includes a description of the nature and magnitude of the potential for occurrence of adverse health effects under a specific set of conditions. In this step, the site-specific exposure assessment and the dose-response assessment are integrated into quantitative and qualitative estimates of potential health risks.

3.2.3.4.1 Approach

In this section, potential carcinogenic risks and noncarcinogenic health effects are calculated and summarized individually for each identified receptor at the North Chicago facility. Potential carcinogenic risks are characterized by using projected doses and constituent-specific dose-response information to estimate probabilities that an individual will develop cancer over a lifetime. Theoretical excess lifetime cancer risks were calculated for the COCs that are considered carcinogens by the USEPA. In order to estimate the theoretical upper-bound excess lifetime carcinogenic risk associated with exposure to a constituent, the product of the medium-specific CSF and the LADD estimated for the exposure pathway of concern is determined. The calculation of the theoretical excess lifetime cancer risk is shown below:

$Risk_i = LADD_i \times CSF_i$

where:

$Risk_i$ = theoretical excess lifetime cancer for constituent i

$LADD_i$ = lifetime average daily dose for constituent i

CSF_i = cancer slope factor for constituent i

This approach to estimating carcinogenic risk assumes that the increased risk of cancer resulting from exposure to a constituent is linearly proportional to the amount of constituent intake averaged over a lifetime. The potential carcinogenic risks associated with the exposures to constituents were estimated by summing the constituent-specific risks to yield exposure pathways potential risks. Implicit in this approach is the assumption that potential carcinogenic risks from multiple constituent exposures are additive such that the total pathway-specific risk is equal to the sum of the individual constituent-specific risks.

Similarly, the theoretical excess lifetime cancer risks for each carcinogenic constituent were also summed from each exposure pathway. The resulting total constituent-specific potential risks represent the upperbound potential risk of developing cancer from that constituent upon exposure to that medium (i.e., the risk may be lower, but is unlikely to be greater).

Various demarcations of acceptable risk have been established by regulatory agencies. USEPA has established an acceptable range for lifetime excess cancer risks of 1×10^{-6} to 1×10^{-4}. USEPA uses the 1×10^{-6} level as the point of departure for the baseline risk assessment that evaluates cancer risks from contaminated sites. Risk-based remediation goals will be developed for cancer risks ranging from 1×10^{-6} to 1×10^{-4}. The risk management step of the process will identify the appropriate site-specific risk based cleanup standard for this site.

Potential noncarcinogenic effects are estimated by comparing projected intakes with constituent-specific toxicity values. HQs were calculated for the constituents which could potentially pose chronic or subchronic noncarcinogenic hazards. The HQs for these constituents were calculated as follows:

$HQ_i = ADD_i/RfD_i$

where:

HQ_i = hazard quotient for constituent i

ADD_i = average daily dose for constituent i

RfD_i = reference dose for constituent i

Noncancer HIs were calculated by summing all HQs. An HI value equal to or less than one indicates that an adverse effect would not be anticipated. Conversely, an HI greater than one indicates that there is a potential for a noncarcinogenic health effect to occur as a result of exposure to constituents released from the site. All constituent-specific HQs are summed at the initial exposure screening level, regardless of the actual toxic endpoint.

3.2.3.4.2 Summary of Potential Health Effects

Tables 43 through 46 present a summary of the potential carcinogenic risks and noncarcinogenic HIs associated with each of the potential receptors for the North Chicago facility. Risk calculation spreadsheets for each receptor are presented in Appendix L. These results are compared with USEPA criteria. USEPA has identified the point of departure for cancer risk at 10^{-6} . Noncarcinogenic hazard indices less than or equal to one are considered acceptable by USEPA (1989). A summary of the risk characterization for each receptor is presented below.

Outdoor Worker

The calculated risks for the Outdoor Worker are summarized in Table 43.

The summed theoretical excess lifetime cancer risks over all pathways for the Outdoor Worker is 9.2 x 10^{-5}. For the soil pathways, tetrachloroethene (PCE) for incidental ingestion poses a risk of 1.9 x 10^{-6}. For benzo(a)pyrene the individual exposure pathway risks are less than 1 x 10-6; however, the cumulative risk for this constituent is 1.4 x 10^{-6}. For the groundwater inhalation pathway, the risk posed by TCE is 8.8 x 10^{-5}.

The estimated noncarcinogenic HI for the Outdoor Worker is 0.07. The HI for this receptor is less than the acceptable benchmark of 1.

Indoor Worker

The calculated risks for the Indoor Worker are summarized in Table 44.

The summed theoretical excess lifetime cancer risks over all pathways for the Indoor Worker is 4.6×10^{-1}. The carcinogenic risk is primarily driven by the inhalation of trichloroethene in indoor air originating from both soil and groundwater.

The estimated noncarcinogenic HI for the Indoor Worker is 350.94. The noncarcinogenic risk is primarily driven by the inhalation of trichloroethene in indoor air originating from both soil and groundwater.

Construction Worker

The calculated risks for the Construction Worker are summarized in Table 45.

The summed theoretical excess lifetime cancer risks over all pathways for the Construction Worker is 4.4×10^{-6}. This risk is driven by trichloroethene (TCE) 3.9×10^{-6} in the groundwater inhalation pathway.

The estimated noncarcinogenic HI for the Construction Worker is 0.03. The HI for this receptor is less than the acceptable benchmark of 1.

On-Site Trespasser

The calculated risks for the On-Site Trespasser are summarized in Table 46.

The summed theoretical excess lifetime cancer risks over all pathways for the On-Site Trespasser is 4.8×10^{-6}. This risk is driven by TCE 4.1×10^{-6} in groundwater inhalation pathway.

The estimated noncarcinogenic HI for the On-Site Trespasser is 0.02. The HI for this receptor is less than the acceptable benchmark of 1.

3.2.3.4.3 Qualitative Lead Risk Evaluation

The risk from lead is evaluated differently than other constituents. USEPA has several screening values that may be used to determine if lead is a potential concern at a site. The following values were used to assess lead as of potential concern at the North Chicago facility:

- Outdoor Worker and Construction Worker - 750 milligrams per kilogram (USEPA 2001)
- On-Site Trespasser - 400 milligrams per kilogram (USEPA 2001)
- Indoor Worker – 1,079 milligrams per kilogram (USEPA 2002b)

As shown in Tables 12 through 19, the exposure point concentration for the Outdoor Worker, Indoor Worker, and On-Site Trespasser was greater than the corresponding screening criterion. Therefore, lead may be of potential concern at the site for these receptors.

3.3 Remediation Target Concentrations

This section presents human health remediation target concentrations where warranted for soils and groundwater at the North Chicago facility. The risk based remediation goals (RBRGs) were developed for only those constituents with a risk greater than the carcinogenic point of departure of 1 x 10-6 and the noncarcinogenic acceptable benchmark of 1 per media and receptor. This results in the following RBRGs:

Receptor	**Media**	**Parameter**
Construction Worker	Groundwater - Ambient Air	Trichloroethene
On-site Trespasser	Groundwater - Ambient Air	Trichloroethene
Outdoor Worker	Groundwater - Ambient Air	Trichloroethene
	Soil - Direct Contact	Tetrachloroethene Benzo(a)pyrene
Indoor Worker	Groundwater - Indoor Air	Trichloroethene Vinyl chloride cis-1,2-Dichloroethene
	Soil - Indoor Air	Trichloroethene Vinyl chloride cis-1,2-Dichloroethene Chloroform Tetrachloroethene trans-1,2-Dichloroethene
	Soil - Direct Contact	Tetrachloroethene

Tables 47A through 47F present the equations and exposure input parameters used to develop the RBRGs. The exposure input parameters were the same as those used in the baseline risk assessment. The indoor air RBRGs were developed using the Johnson and Ettinger GW-SCREEN Version 3.0 model and

the SL-SCREEN Version 3.0 model. The exposure input parameters for the model are presented on Table 47F. It should be noted that for carcinogenic parameters, a RBRG was developed at a target risk level of 1×10^{-6}, 1×10^{-5} and 1×10^{-4}. The calculations are presented in Appendix N. Tables 47G through 47J present the RBRGs per receptor and media.

RBRGs for total lead were derived and are presented in Table 47K. These goals were derived in accordance with the guidance presented in the USEPA's Recommendations of the Technical Review Workgroup for Lead for an Approach for Assessing Risks Associated with Adult Exposures to Lead in Soil (USEPA 2003). Some of the input parameters (i.e., GSD and GM - Midwest Region) for this assessment approach were provided in the USEPA document entitled Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III) (USEPA 2002b). Input parameters and calculation of these remediation goals are presented in Appendix N.

Based on the USEPA 2003 guidance, receptors for the adult lead model are defined as contact intensive and contact nonintensive. The contact intensive RBRG is 538 milligrams per kilogram. This would be representative of the construction worker for the entire soil column. The contact nonintensive RBRG is 1,079 milligrams per kilogram representative of surface soils. This is most representative of the Indoor and Outdoor Worker and On-Site Trespasser.

3.4 Uncertainties

Uncertainties are inherent in every aspect of a quantitative risk assessment. The inclusion of site-specific factors can decrease uncertainty, although significant uncertainty persists in even the most site-specific and accurate risk assessments. A careful and comprehensive analysis of the critical areas of uncertainty in a risk assessment is an important part of the risk assessment process. The uncertainty analysis provides a context for better understanding the assessment conclusions by identifying the uncertainties that have most significantly affected the assessment results.

Examples of uncertainties associated with this baseline risk assessment for this site are as follow:

- Focused vs. Random Sampling. The environmental sampling used in this assessment included biased samples - samples collected intentionally to locate the highest likely concentrations of constituents. Random sampling would have been more likely to provide a representative set of values to be incorporated into the risk assessment for consistency with the other exposure considerations. This directed sampling effort tends to lead to an

overestimation of constituent presence and the concentrations to which receptors will contact.

- Sample Depth. Surface soil for this site was defined as 0-4 feet. Subsurface soil is defined as soil ranging in depth from greater than 1 foot. The overlap in the sample depth is due to the combination of samples from different field investigations. Therefore, to evaluate potential risk impact from exposure to surface soils, data collected from 0-4 feet were used. It is not likely that exposure to soils greater than 6 inches would occur; however, this risk assessment assumes that exposure would occur up to 4 feet. This was a conservative approach and would overestimate potential risk.

- Quality of the Data: As described in Appendix H, there is some uncertainty associated with the data. The analytical deliverable package from the laboratory for the first field investigation did not provide sufficient quality control (QC) information to perform complete data validation. The data were validated with the QC information provided. Also, the solid samples were not presented as dry weight for the first field investigation. Therefore, an average percent moisture per boring was calculated for the EE/CA supplemental characterization program. This average percent moisture was applied to the solid samples from the first investigation to obtain dry weight results. The uncertainty associated with the analytical data may lead to an under-or-over estimation of the risks.

- Selection of COCs. COCs at the site have been selected by comparing the representative constituent concentration to conservative risk-based screening criteria. Factors such as background and anthropogenic sources were not evaluated in the screening process. This may lead to an overestimation of the risk.

- Selection of COCs. As noted in Section 3.2.1.2.1, there were several volatile organic compounds for which no soil inhalation screening criteria were available. These constituents are as follow:

Acetone	2-Butanone	Chloroethane	Chloromethane
cis-1,2,-Dichloroethene	trans-1,2-Dichloroethene	Xylenes, total	p-Isopropyltoluene
n-Propylbenzene	Trichlorofluoromethane	1,2,4-Trimethylbenzene	

In most instances, there are no inhalation toxicity data for these constituents. It was agreed upon between NCI and USEPA that route-route extrapolations would not be used for this project. The exclusion of these constituents from the inhalation exposure pathway may underestimate the risk. However, the driving risk constituents at this site are tetrachloroethene and trichloroethene. Although, the exclusion of these constituents from the inhalation exposure pathway may lead to an underestimation of the risk, it would most likely be inconsequential due to the overall risk posed at the site.

It should be noted that there were several soil constituents for indoor air that were not included in the Johnson and Ettinger model. These constituents were PAHs are not highly volatile. The exclusion of these constituents from the risk assessment would lead to an underestimation of risk; however, the overall impact on the indoor air risk would be minimal. It is clearly evident that trichloroethene is the leading cause of indoor air risk posed at the site.

- Use of Maximum Detected Concentrations. For most soil results and all groundwater results, the maximum detected concentration of a constituent is incorporated as the EPC. Relying on the maximum values is a very conservative estimate of exposure which overestimates potential risk.

  It should be noted that for field duplicate samples, the maximum detected value was used in determining the EPC. Again, this would overestimate potential risks. In the few instances where the 95% UCL was used as the EPC, the maximum concentration was so great that the small change in one data point (e.g., average of duplicates) would not have a significant impact on the EPC.

  For indoor air, the maximum detected concentration from data collected site wide was used as the EPC. By using the maximum detected concentration, it appears that the maximum concentrations in groundwater and soil are not within the RBRGs. Using the maximum detected concentration is an overestimation of risk at the site. The uncertainty of using the maximum detected value is compounded by the uncertainties inherent in the Johnson and Ettinger Model. In conclusion, the indoor risk presented in this risk assessment are highly conservative and greatly overestimate the risk posed by soil and groundwater to indoor air.

- Lead Particle Size. For this site, information on the soil particle size for lead samples is not available. Therefore, the fraction of soil containing lead that is less than 250 microns is not known. The lead risk assessed for this site was based on all soil fractions. This may lead to an over- or under- estimation of the site risks. Personnel on site should take precautions when dust is generated at the site.

- Use of Default Exposure Factors. Use of the default exposure values in lieu of site-specific information may lead to an over- or under estimation of risk.

- Use of Toxicity Data. Toxicity assessments almost never incorporate direct data about the effects of environmental constituents on human receptors. Very little useful epidemiological data are available for most constituents for human populations near waste sites. The epidemiological studies on exposures in the workplace are largely inapplicable to an evaluation of a hazardous waste site because the exposure concentrations, frequencies, and durations are very different. In all, there is almost no direct data on the toxicity of chemicals to residential, recreational, or industrial receptors subject to environmental exposure levels. Therefore, toxicity assessments for nearly all constituents involve the extrapolation of results from studies on animals. Primary concern of toxicity data is the uncertainty involved in the extrapolation of results obtained in animal research to humans and the shortcomings in extrapolating responses obtained from high-dose research studies to estimate responses at very low doses. For example, humans are typically exposed to environmental chemicals at levels that are less than a thousandth of the lowest dose tested in animals. Such doses may be easily degraded or eliminated by physiological internal mechanisms that are present in humans. Use of highly conservative toxicity data may lead to an overestimation of risk.

- Risk Characterization. The typical approach to risk assessment involves conservatively multiplying the upper bound exposure assumptions together to evaluate exposure. USEPA risk assessment guidance specifies that numerous factors in the exposure equation should each be represented by the 95th percentile value for that variable. These factors include the representative concentration, the contact rate with the environmental medium, and the

exposure frequency and duration. Multiplying all of these upper bound values may result in an overestimation of risk.

In summary, the baseline risk assessment is a conservative estimation of risks to designated receptors.

3.5 Baseline Risk Assessment References

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USEPA (2002b). Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases I and 2 of the National Health and Nutrition Evaluation Survey. March 2002.

USEPA (2003) Recommendations of the Technical Review Workgroup for Lead for an Approach for Assessing Risks Associated with Adult Exposures to Lead in Soil. January 2003.

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4.0 Fate and Transport Evaluation and Modeling

As discussed previously, groundwater related exposure pathways (ingestion, direct contact, soil to groundwater) were not considered due to the lack of current and anticipated future receptors in the area (see Section 3.2.2.1.1). Nevertheless, NCI recognizes the need to evaluate groundwater further to ensure that the groundwater plume (primarily consisting of TCE and degradation products) is reasonably controlled in the future and that ultimately, through natural attenuation processes, the plume concentrations will be reduced to meet applicable state water standards. To assist in this evaluation, fate and transport modeling was used as a method for determining the anticipated future conditions of the plume. The model used provided an evaluation of TCE transport mechanisms that control soil to groundwater transfer, migration of TCE as a solute in groundwater, and conditions that limit the migration of TCE and promote natural attenuation of the TCE plume(s) in groundwater.

The potential migration of TCE over time (as a solute in groundwater) was predicted using Visual Modflow/MT3D v3.0.0 (Modflow). The modeling effort was conducted based on the contaminant distributions, groundwater flow, and geologic data collected during the site investigations. In addition, the contribution of TCE contamination from shallow soils was determined using the 2-Dimensional program VLEACH and incorporated into Visual Modflow. A synopsis of the groundwater flow and transport model and a summary of the results are provided below.

4.1 Synopsis of the Groundwater Flow Model

(1) The selected model area is 1,200 feet north-south by 1,800 feet east-west as depicted in Appendix O-1 which provides for an area that is centered on and surrounds the North Chicago facility and includes the adjoining Vacant Lot property to the west. This area was divided into a grid of 24 by 36 cells. The dimension of each cell was 50 feet by 50 feet.

(2) The flow model was integrated into a coherent regional picture by balancing net recharge onto the site with inflow and outflow from the boundaries of the site. Recharge was set at 3 inches per year over most of the site, 2 inches per year for areas beneath the larger buildings, and 4 inches per year with an extinction depth of 5 feet. The balance between recharge and evapotranspiration results in the water table mimicking topography.

(3) Inflow from hydraulically upgradient areas was modeled with a line of general head boundary cells along the entire east side of the model area. These boundaries were established with an elevation of

672 feet mean sea level (msl) and a conductance of 0.2 square foot per day (ft/day). Discharge to Pettibone Creek was simulated by placing stream boundary cells at the creek. The stage elevation of the creek boundary ranged from 658 feet msl at the northern (upstream) end to 655 feet msl at the southern (downstream) end. Conductance at the creek boundary ranged from 8 square feet per day at the upstream end to 10 square feet per day at the downstream end.

(4) The aquifer was divided into three layers to allow for the evaluation of vertical groundwater movement and contaminant migration within the subsurface soils. The total aquifer thickness modeled was about 30 feet. Layer 1 represents the upper approximate 15-foot zone and includes about a 5-foot unsaturated horizon. Layers 2 and 3 are about 10 feet in thickness each. The ground surface across the site was estimated from topographic maps and from the ground surface elevations surveyed at the monitoring wells.

(5) The hydraulic conductivity was based on site-specific information. Modeling efforts indicate that this parameter is sensitive to predicting the future contaminant plume configuration and concentration levels. Therefore, a lower and upper bound value was used for hydraulic conductivity. The lower bound value used was the approximate average of most single well hydraulic conductivity tests performed at the site (1.50×10^{-5} centimeters per second [cm/sec] or 0.042 ft/day). Because of secondary porosity and preferential migration pathways such as sand/silt stringers, it is possible that a greater value than the one determined by the single well testing will influence contaminant migration. Therefore, a second hydraulic conductivity value of 0.28 ft/day (about one order of magnitude greater) was also used.

(6) Existing groundwater quality data indicated that TCE was the primary plume contaminant. Degradation products of TCE, especially cis-1,2-dichloroethene, were also present but at concentrations typically an order of magnitude less than that of TCE. For this reason, TCE was selected as the constituent for modeling.

(7) Retardation of TCE was modeled as linear adsorption onto organic carbon. Organic carbon to water distribution coefficient for each compound of concern was found in the *Groundwater Chemicals Desk Reference* (Montgomery and Welkom, 1992). The fraction of organic carbon was analyzed in ten soil samples, five from depths above the water table and five from below. The organic carbon content of four of the five saturated zone samples was less than the reporting limit of 1.0 percent, and that of the fifth sample was 1.02 percent. Accordingly, an average organic carbon content was computed at 0.6 percent, assigning a value of half the detection limit to each of the nondetect samples.

(8) The soil-water distribution coefficient for TCE was used in the fate and transport model. This was determined by taking the organic carbon to water distribution coefficient of TCE (126 milliliters per gram) times the average organic carbon content of the soil (0.6 percent). This yields a soil-water distribution coefficient of 0.756 milliliter per gram for TCE.

(9) The measured concentrations of TCE were inserted into the model cells as slugs of contaminated water, available to move downgradient and be dispersed. The sum of all TCE-related compounds (chlorinated ethenes) in groundwater samples from all the wells and test borings sampled in 2001 were interpolated log-normally. These values were then contoured using the Surfer grid feature of the model. For areas known to be outside the plume (i.e., stream edges and edges of the map), "dummy" points were inputted and given the value of 1 microgram per liter. In addition, several "dummy" points were included in specific areas within the site to ensure the most accurate interpretation by the Surfer feature. A plot of these initial conditions is shown in Appendix O-2.

(10) The contribution of TCE from shallow soils, as a potential ongoing source, was also incorporated into the model. The magnitude of the recharge concentration in each cell was estimated using VLEACH. The diffusional and advective flux (mass flux) to groundwater was computed at three specified concentrations found in their respective area (413 milligrams per kilogram, 38.5 milligrams per kilogram, and 13.7 milligrams per kilogram). The mass flux was then divided by the water infiltration rate to determine an effective recharge concentration. Subsequently, the average effective concentration was computed for the periods 0-5 years, 5-10 years, and 10-15 years. These average effective concentrations were assigned to applicable groundwater cells in the model.

(11) Dispersion was assumed using a longitudinal dispersivity of 30 feet, transverse dispersivity of 6 feet, and vertical dispersivity of 3 feet for all cells in the model grid. These values are consistent with the ranges provided within literature sources.

(12) Loss of TCE (and degradation products) from the aquifer can occur from chemical degradation, biological degradation, and volatilization from the aquifer through the vadose zone to the surface. These losses in whole represent the attenuation rate of TCE over time. Natural biological degradation of TCE and its daughter products will occur in the subsurface. However, this degradation rate is variable from site to site and difficult to measure. The duration of groundwater sampling at the North Chicago facility is insufficient for defining the actual aquifer-specific degradation rates for these compounds. Nevertheless, the significant concentrations of cis-1,2-dichloroethene and the presence

of vinyl chloride indicate that chemical/biological degradation is occurring at the site. Because of the uncertainty at this time and the relatively significant sensitivity of this parameter, a deliberately conservative range of degradation rates were selected for modeling purposes. The values used ranged from 1.4 percent per year (50 year half life) to 3.5 percent per year (20 year half life).

4.2 Modeling Scenarios and Results

As presented above, the different groundwater modeling scenarios run were based on using ranges of both the hydraulic conductivity and biodegradation rates. Specifically, the model scenarios included:

- Hydraulic conductivity value of 0.042 ft/day and attenuation half-life of 50 years
- Hydraulic conductivity value of 0.28 ft/day and attenuation half-life of 50 years
- Hydraulic conductivity value of 0.042 ft/day and attenuation half-life of 20 years
- Hydraulic conductivity value of 0.28 ft/day and attenuation half-life of 20 years

These model runs provide a range of what can be expected of the plume's migration and overall concentration reduction over time. The models were run starting at time 0 year to 200 years. The baseline condition at time 0 year is presented in Appendix O-2. The results of these models are presented in Appendix O-3 through O-6.

None of the modeling scenarios indicate that the northern plume will reach Pettibone Creek within the next 100 years. (As stated in Item 12 of Section 4.1: Synopsis of the Groundwater Flow Model, "…a deliberately conservative range of degradation rates were selected for modeling purposes. The values used ranged from 1.4 percent (50 year half life) to 3.5 percent per year (20 year half life)." NCI believes that the modeling scenarios provide reasonable predictions of plume dissipation over time.) Only the scenario with the greater hydraulic conductivity and slowest biodegradation rate ever reaches Pettibone Creek. In fact, the other three scenarios with the slower hydraulic conductivity indicate that the extent of the plume is not anticipated to be much greater than what is depicted for existing conditions. In the northern plume area, relatively high concentrations of TCE and degradation products (10 to 50 milligrams per liter) still remain within the plume area after 50 years in any of the scenarios. In addition, after 100 years, concentrations in the center of the northern plume still remain in the 1 to 10 milligrams per liter range. In summary, except for the one scenario, the overall extent of the plume is not anticipated to extend much beyond current conditions. However, concentrations within the plume will remain relatively high for the foreseeable future within the immediate source area.

The southeastern and southwestern area plumes are much more limited in size and concentration compared to the northern plume area. Similar to the northern plume, the southwestern plume (MW-8 area) does reach Pettibone Creek for the one scenario only. In all scenarios, concentrations are at relatively low levels beyond the 50-year time period and concentrations are at or just above detection limits in 100 years.

4.3 Effects of Abatement in Source Areas

Based on these results, it was determined that source removal/treatment alternatives (for affected soil and groundwater) should be evaluated further for the northern plume area in order to ensure control of plume migration and to meet applicable TCE water quality standards within a more reasonable time frame. Another reason for evaluating the reduction of contaminant concentrations within the plume area is to address potential risks due to indoor vapor intrusion from groundwater as identified in the baseline risk assessment. However, this risk could also be managed by restricting the area for future building construction and/or installing vapor removal systems within existing buildings.

To evaluate the overall impact on source reduction, it was assumed that the total concentration of TCE and degradation products within the highest portion of the plume would be reduced to an average concentration of 10 milligrams per liter (accounting for residual soil concentrations). The area of reduction was assumed to be about 3,750 square feet (50 feet by 75 feet) within the TB-18 location. Baseline conditions at time 0 year following this assumed abatement are presented in Appendix O-7.

Appendix O-8 through O-11 present the same four modeling scenarios discussed in Section 4.1. As expected, the northern plume concentrations in the future are reduced significantly and only one scenario suggests concentrations may be slightly above 1 milligram per liter beyond 100 years. (Again, the models account for contamination associated with both soil and groundwater in the affected areas.) In addition, for the scenario with the greater hydraulic conductivity and slowest biodegradation rate, the extent of the plume is more limiting and at lower concentrations.

5.0 Identification of Removal Action Scope, Goals, and Objectives

5.1 Removal Action Scope

As stated in the September 21, 2000 AO for the North Chicago facility, the conditions at the site that constitute a potential threat to public health, welfare, or the environment based upon the following factors (as set forth in Section 300.415(b)(2) of the National Oil and Hazardous Substances Pollution Contingency Act):

- Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants or contaminants;
- Actual or potential contamination of drinking water supplies or sensitive ecosystems;
- High levels of hazardous substances or pollutants or contaminants in soils largely at the surface, that may migrate.

The scope of the removal action for the North Chicago facility is to address the factors noted above, as confirmed by the results of the baseline risk assessment presented in Chapter 3.0. Further discussion concerning the exposure pathways of concern is also presented in Chapter 3.0. The intent is to complete the subject removal action to address currently identified potential risk such that no further actions (removal or remedial) will be required in the future.

5.2 Removal Action Goals

The risk assessment presented in Chapter 3.0 resulted in the characterization of risk to the potential identified receptors. The consideration of these identified risks and the associated remediation target concentrations (RBRGs), relative to the management of risk and the development of removal action goals, is discussed below.

As stated in the Risk Assessment Guidance for Superfund, Part B (USEPA 1989), "When the current or future baseline cancer risk is within the range of 10^{-4} to $10^{-6,}$ a decision about whether or not to take action is a site specific determination." That is why, per agreement with USEPA, RBRGs were calculated for risks at 10^{-4}, 10^{-5} and 10^{-6}, although a point of departure of 10^{-6} excess cancer risk was used to quantify risk in the risk assessment. NCI believes the circumstances present for the North Chicago facility warrant the use of RBRGs calculated for risks between 10^{-4} and 10^{-6}. These circumstances include, but are not limited to:

- The site is zoned an industrial property. (Industrial/commercial usage limits occupancy and therefore exposure, relative to residential usage.)
- The site is currently used for industrial purposes and has a very low occupancy.
- Potential future uses of the property will most likely remain industrial or commercial.
- Sensitive populations are not present, nor will likely be present in the future.
- In many instances, the EPCs driving the calculated risks are localized and are not representative of large portions of the site.
- The uncertainty analysis of the risk assessment indicates that, for a variety of reasons, the assessment of risk is conservative.

(It should be noted again that NCI has recently transferred ownership of the North Chicago facility property to the City of North Chicago. As such, NCI no longer directs the ultimate usage of the property. Future land use at the site must be evaluated by others, relative to this EE/CA Report and the information contained herein, in order to determine whether or not the parameters regarding risk assessment and management and potential future land usage remain applicable.)

Construction Worker

Summed theoretical excess cancer risk over all pathways:	4.4×10^{-6} (Table 45)
Soil pathways:	5.3×10^{-7} (Table 36)
Groundwater inhalation:	3.9×10^{-6} (Table 37)
Estimated non-carcinogenic HI:	0.03 (Table 45)

The estimated non-carcinogenic HI is less than one, indicating even sensitive populations would not likely experience adverse health impacts from non-carcinogenic effects.

The summed excess cancer risk over all pathways for this receptor is between 10^{-5} and $10^{-6.}$ Based on the justification provided above, NCI believes this level of excess cancer risk is acceptable for this circumstance. Therefore, no removal or remedial action is required to address the identified exposure pathways for the construction worker; the calculated RBRG for 1×10^{-5} excess cancer risk is already satisfied (see Table 47H). However, it is recommended that institutional controls (deed restriction, etc.) be used as a risk management tool to restrict potential subsurface intrusion, particularly below the water table.

On-Site Trespasser

Summed theoretical excess cancer risks over all pathways:	4.8×10^{-6} (Table 46)
Soil pathways:	6.7×10^{-7} (Table 38)
Groundwater inhalation:	4.1×10^{-6} (Table 39)
Estimated non-carcinogenic HI:	0.02 (Table 46)

The estimated non-carcinogenic HI is less than one, indicating even sensitive populations would not likely experience adverse health impacts from non-carcinogenic effects. The summed excess cancer risk over all pathways for this receptor is between 10^{-5} and $10^{-6.}$ Based on the justification provided above, NCI believes this level of excess cancer risk is acceptable for this circumstance. Therefore, no removal or remedial action is required to address the identified exposure pathways for the on-site trespasser; the calculated RBRG for 1×10^{-5} excess cancer risk is satisfied (see Table 47I).

Outdoor Worker

Summed theoretical excess cancer risks over all pathways:	9.2×10^{-5} (Table 43)
Soil pathways:	4.0×10^{-6} (Table 34)
Groundwater inhalation:	8.8×10^{-5} (Table 35)
Estimated non-carcinogenic HI:	0.07 (Table 43)

The estimated non-carcinogenic HI is less than one, indicating even sensitive populations would not likely experience adverse health impacts from non-carcinogenic effects.

The summed excess cancer risk over all pathways for this receptor is between 10^{-4} and 10^{-5}. While potentially acceptable for the circumstance at hand, the excess cancer risk is in the less conservative portion of the target range. The primary cause for the increased cancer risk above 10^{-5} is the inhalation of volatiles from groundwater in ambient air. Specifically, the EPC for TCE relative to the subject pathway represents the highest TCE concentration in groundwater recorded at the site and contributes essentially all of the increased risk (Tables 35 and 43). In addition, the next highest TCE concentration in groundwater at the site is three orders of magnitude less than the EPC value. In light of this review, it is apparent that the elevated increased cancer risk is localized to one particular area (one sampling location, TB-18 – HWMU area) and to one COC, namely TCE. Because of this, NCI believes a removal action directed specifically toward this isolated excess cancer risk is not warranted. However, this action will be incorporated with other removal action goals, as appropriate (see Section 5.3, Goal No. 3) .

Indoor Worker

Summed theoretical excess cancer risks over all pathways:	4.6×10^{-1} (Table 44)
Soil pathways:	4.3×10^{-1} (Tables 40, 41)
Groundwater inhalation:	2.6×10^{-2} (Table 42)
Estimated non-carcinogenic HI:	351 (Table 44)

The estimated non-carcinogenic HI is greater than one, indicating likely adverse health impacts from non-carcinogenic effects. The primary contributors to the elevated HI are:

- cis-1,2-Dichloroethene, trichloroethene, trans-1,2-Dichloroethene, and vinyl chloride in soils (inhalation), and
- cis-1,2-Dichloroethene, trichloroethene, and vinyl chloride in groundwater (inhalation).

The EPCs for these contaminants represent detected concentrations in soils and groundwater not under structures (GP-14 and GP-15 for soils, TB-18 for groundwater). Per agreement with USEPA, data obtained from both inside and outside the building footprints were used to assess risk for this potential receptor.

The summed excess cancer risk over all pathways for this receptor is greater than $10^{-4,}$ indicating a need for removal action. The primary cause for the increased cancer risk above 10^{-4} is the inhalation of volatiles from soils and groundwater in indoor air. The COCs of particular interest are:

- trichloroethene, tetrachloroethene, and vinyl chloride in soils (inhalation), and
- trichloroethene and vinyl chloride in groundwater (inhalation).

Again, the EPCs for these contaminants represent detected concentrations in soils and groundwater not under structures (GP-3, GP-14 and GP-15 for soils, TB-18 for groundwater). Per agreement with USEPA, data obtained from both inside and outside the building footprints were used to assess risk for this potential receptor.

NCI recognizes that calculated RBRGs for the inhalation of indoor air by an indoor worker are exceeded at the site (Table 47J). The goals are exceeded both inside and outside the footprints of existing buildings. It particular, the concentrations of COCs in and around the HWMU and AST area are typically

the highest concentrations found at the site, and merit particular attention as a potential source area. However, as stated in the uncertainty section of the risk assessment, the assessment of risk due to the inhalation of indoor air is highly conservative and likely reflects an overestimation of actual risk to indoor workers. Regardless, a removal action goal will be to manage the potential for risks due to the inhalation of indoor air by indoor workers, current and future.

Lead is fairly pervasive in soils throughout the facility, as well as adjacent properties to the east and west. Concentrations of lead in soils throughout the site exceed calculated RBRGs as presented in the risk assessment. To address lead, one removal action goal will be to reduce the potential risk of exposure to lead in soils via direct contact/ingestion/inhalation.

The only groundwater exposure pathway of concern evaluated in the baseline risk assessment was the inhalation pathway. Other groundwater related exposure pathways (ingestion, direct contact, soil to groundwater) were not considered due to the lack of current and future receptors in the area (see Section 3.2.2.1.1). However, based on the groundwater modeling results in Chapter 4.0, it was determined that source removal/treatment alternatives should be evaluated for the northern plume area (HWMU and AST area) to ensure control of plume migration and to meet applicable water quality standards within a more reasonable time frame.

Other areas of concern at the facility do not merit further consideration for removal actions to address groundwater. For example, the groundwater plume identified in the Former Drum Storage Area has contaminant concentrations several orders of magnitude lower than the plume associated with the HWMU and AST area. Also, the results of the groundwater modeling presented in Chapter 4.0 indicate that the groundwater plume in the Former Drum Storage Area will dissipate over time without further removal action in the area (see Chapter 4.0). The area west of the Metallurgical Buildings does not merit further consideration for removal action since groundwater contamination in the area is limited and isolated.

5.3 Removal Action Objectives

The removal action objectives are based on an evaluation of the identified removal action goals and the possible means by which the goals can be achieved. When practicable, an attempt has been made to provide the reader with definable objectives to achieve the goals, without prejudice to the possible removal alternatives that may be employed. The removal action goals, followed by the associated removal action objectives, are listed below.

Goal No. 1: Manage the potential for risks due to the inhalation of indoor air by indoor workers, current and future.

Objective No. 1: Mitigate the exposure pathway primarily through confirmation monitoring and/or the application of institutional and engineering controls.

Goal No. 2: Reduce the potential risk of exposure to lead in soils via direct contact/ingestion/inhalation.

Objective No. 2: Isolate, treat, or remove soils impacted by lead within exposed areas in the HWMU and AST area and the Former Drum Storage Area. Areas of the facility covered by structures or pavement fulfill this objective, but must be maintained.

Goal No. 3: Control and manage the groundwater plume associated with the HWMU and AST area through source area reduction.

Objective No. 3: Isolate, treat, or remove contaminants within the potential source area associated with the HWMU and AST area to assist in the natural dissipation of the plume over time to acceptable levels.

6.0 Identification and Analysis of Removal Action Alternatives

6.1 Presumptive Remedies

The USEPA has published presumptive remedies to address the types of contamination present at the North Chicago facility. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and USEPA's scientific and engineering evaluation of performance data on technology implementation (USEPA, September 1993a). Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

The following presumptive remedies were evaluated for the North Chicago facility.

- Soil Vapor Extraction (SVE): Soils with VOCs
- Multiphase Extraction (MPE): Soils and Groundwater with VOCs
- Pump and Treat: Groundwater with VOCs
- Containment: Soils with Metals

Subsurface conditions within the HWMU and AST area were reviewed to determine the applicability of the first three presumptive remedies involving active extraction techniques. Subsurface conditions in the plume area indicate that maximum VOC contamination in the subsurface (indicative of a source) is generally contained within low permeability clays at depth, at or below the water table. For example, at GP-14, silty clay was encountered between 5 and 20 feet below ground surface with soil contamination at a maximum concentration (1,310 milligrams per kilogram trichloroethene) at a depth of 8 to 10 feet. Contamination was also present at elevated concentrations at depths of 6 to 8 feet and 10 to 12 feet in the same boring. Groundwater is estimated at between 6 and 8 feet below grade in the area based on boring logs for TP-14 and TP-18, although the presence of the clay at depth makes exact determinations of depth difficult. Clay was also encountered at depth in borings GP-10, GP-13, GP-15, GP-25, GP-26, TB-18, and TB-14, with similar contaminant profiles in GP-13, GP-15, and GP-25. In TB-18, although no soil sample was obtained below the water table, maximum PID readings were coincidental with the presence of clay. A qualitative evaluation of the 1993 Carlson study of the HWMU area also indicates similar subsurface conditions.

Aquifer characterization testing and geotechnical analytical results indicate very limited subsurface permeability in the area. Slug tests at facility wells estimate hydraulic conductivity between 2.99×10^{-5} cm/sec and 2.85×10^{-7} cm/sec, depending upon location (Table 2). Geotechnical samples of material in the area classified as clays demonstrate vertical permeabilities in the range of 1×10^{-6} to 1×10^{-8} cm/sec (Table 6).

The use of active extraction technologies is not recommended for the conditions described. The presence of low permeability soils suggests that extraction methods (vacuum and pumping) cannot overcome the capillary forces retaining contaminants and water within the soil. Minimum permeabilities in the range of 1×10^{-3} cm/sec to 1×10^{-5} cm/sec are recommended for the use of MPE (U.S. Army Corps of Engineers [USACE], June 1999). Similar permeabilities are required for the use of SVE, although the use of SVE is generally limited to unsaturated soils which are not identified as the significant source in this circumstance (USEPA, September 1993b). Groundwater pumping becomes increasingly difficult approaching a permeability of 1×10^{-4} cm/sec (USEPA, October 1996) and, as a matter of practice, cannot be considered practicable given site circumstances. Consideration could be given to attempts at exploiting the presence of discontinuous stingers and lenses of silt, sand, and gravel within the target area in order to apply active extraction methods. However, as stated previously, indications are that the maximum contamination in the source area resides within the lower permeability soils present. Also, the application of extraction technologies to layered strata tends to concentrate flow through preferential (more permeable) layers and further prolong already limited extraction through lower permeable soils. Therefore, increased effectiveness is not realized (USACE, June 1999). As a result of this analysis, presumptive remedies using SVE, MPE and pump and treat were not considered further.

A presumptive remedy for metals in soils is containment (USEPA, September 1999). This remedy usually takes the form of engineered barriers, such as caps, to provide sustained isolation and prevent mobilization of contaminants to potential receptors. Caps can also reduce surface infiltration, control fugitive dust emissions, provide a stable surface over contaminated materials, limit direct contact, and improve aesthetics. NCI considers the use of the presumptive remedy for lead in soils at the North Chicago facility to be applicable to address the Removal Objective No. 2.

Institutional controls are generally used in conjunction with containment to limit the potential for unintended access to the affected materials. A deed restriction is anticipated to limit subsurface activities of all types (above and below the water table) to environmental monitoring activities, ancillary environmental work, and work performed by trained personnel under the terms and conditions of a site specific health and safety plan. This type of control is a projected component of the remedial alternative to be selected by USEPA.

6.2 Preliminary Screening and Identification of Alternatives

Based on the evaluation of the presumptive remedies, other remedial alternatives were considered to

address Removal Objective No. 3 concerning groundwater. A review of potential removal technologies was performed using the Remediation Technologies Screening Matrix and Reference Guide (Federal Remediation Technologies Roundtable [FRTR], 2001). This guide lists potential remedial technologies that may be applied depending on site-specific circumstances. For the reasons specified in Section 6.1, many technologies were screened out based on the reliance of extraction techniques. The following technologies were selected for alternative analyses based on potential applicability to site circumstances and judgements made as to the probability of meeting both remedial objectives. The No Action Alternative is traditionally included as a baseline alternative.

Alternative 1: No Action
Alternative 2: Surface Capping with Excavation, Transportation, and Disposal
Alternative 3: Surface Capping with Enhanced In-Situ Bioremediation
Alternative 4: Surface Capping with Permeable Reactive Barrier

Each of the four alternatives includes provisions for groundwater monitoring. Alternatives 2, 3, and 4 also include the establishment of institutional controls (i.e. deed restrictions regarding subsurface intrusion and notifications regarding vapor intrusion) and possible engineering controls to address Removal Objective No. 1. Indoor air sampling for COCs is also anticipated to confirm the results of vapor intrusion modeling. Specifics regarding the sampling and analyses program will be developed as part of the Removal Action Work Plan.

6.3 Identification of and Compliance with ARARs

Section 300.415(I) of the National Contingency Plan states that fund-financed removal actions under CERCLA Section 104 shall, to the extent practicable considering the exigencies of the situation, attain ARARs under federal or state environmental laws. Other advisories, criteria, or guidance may be considered for a particular site, and are referred to as To-Be-Considered requirements.

Under CERCLA, a requirement may be either “applicable” or “relevant and appropriate” to a specific removal action, but not both. The definition of the components of Applicable or Relevant and Appropriate Requirements (ARAR) are listed below:

- Applicable Requirements: Defined as those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.

- Relevant and Appropriate Requirements: Defined as those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site, that their use is well suited to the particular site.

Several potential state ARARs have been identified for the various removal actions and are identified in Table 52 and potential federal ARARs are identified in Table 53.

6.4 Analysis of Alternatives

Each alternative is discussed in the following sections. The alternatives are then evaluated based on effectiveness, implementability, and cost in accordance with applicable USEPA guidance (USEPA, August 1993).

Specific evaluation criteria for evaluating the effectiveness of each alternative include:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Specific evaluation criteria for evaluating the implementability of each alternative include:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Specific evaluation criteria for evaluating the cost of each alternative include:

- Capital costs
- Annual operation and maintenance costs
- Present worth

6.4.1 Alternative 1 - No Action

The No Action alternative is included as a basis for comparison with the remaining alternatives. Under Alternative 1, No Action, the site would be left in its present condition. Exposed (unpaved or uncovered) areas would remain in the HWMU and AST area and in the Former Drum Storage Area. In addition, no effort would be made to address the source area within the groundwater plume present in the HWMU and AST area. Groundwater monitoring (existing wells plus four additional) would be implemented with this alternative; institutional and possible engineering controls are not included. This removal action alternative will require no time to implement since removal activities are not performed. Groundwater monitoring is projected for 30 years.

Effectiveness

Overall Protection of Human Health and the Environment

This alternative is not protective of public health and the environment beyond that which is currently occurring. Risks associated with vapor intrusion into buildings (Removal Objective No. 1) would not be addressed. Exposure to surface soils containing lead (Removal Objective No. 2) would not be mitigated and the elevated risk to identified potential receptors would remain. In addition, source area control to limit future expansion of the HWMU and AST plume and to promote the dissipation of the plume over time (Removal Objective No. 3) would not be performed. Based on the fact that direct contact and ingestion of groundwater is not a reasonably completed pathway for either current or future exposure scenarios, and that groundwater contamination is projected to dissipate over time through natural processes, this alternative may be protective of human health and the environment. In addition, groundwater monitoring would be performed to evaluate subsurface conditions over time. However, concerns regarding potential indoor vapor intrusion in the area and concerns regarding the presence of relatively high contaminant concentrations long term and controlling plume migration limit this alternative's protectiveness.

Compliance with ARARs

This alternative does not comply with relevant ARARs; in particular, regulations regarding the closure of RCRA facilities.

Long-Term Effectiveness and Permanence

The ability for the No Action alternative to achieve the removal action objectives is limited. Vapor intrusion concerns are not addressed. Since no level of containment is expected, the residuals left in

exposed site soil may affect potential receptors. Also, as stated above, concerns regarding the groundwater plume remain. Therefore, this alternative would not be effective in the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative does not reduce toxicity, mobility, or volume of contaminants, although groundwater contaminants are projected to dissipate over time through natural processes.

Short-Term Effectiveness

The ability for the No Action alternative to achieve the removal action objectives is limited. Vapor intrusion concerns are not addressed. Since no level of containment is expected, the residuals left in site soil may affect potential receptors. Also, as stated above, concerns regarding the groundwater plume remain. Overall, this alternative would not be effective in the short term, although potential exposures to removal action workers and the community are limited (installation of additional groundwater monitoring wells).

Implementability

Technical Feasibility

The technical feasibility of this alternative is considered high. Construction and/or operational considerations are of no concern, since no removal action is proposed. The installation of additional monitoring wells is not a concern.

Administrative Feasibility

The administrative feasibility of this alternative is considered high, since no removal action is proposed. Permission will be required to install additional groundwater monitoring wells in off-site locations.

Availability of Services and Materials

Resources for implementing the No Action alternative are minimal (installation of additional groundwater monitoring wells and groundwater monitoring).

State Acceptance

State acceptance of this alternative is not anticipated.

Community Acceptance

Community acceptance of this alternative is not anticipated.

Cost

There would be minimal capital costs for this alternative (installation of additional monitoring wells). Operation and maintenance costs associated with groundwater monitoring (30 years) are applicable. A detailed cost estimate for Alternative 1, No Action, is provided in Table 48.

6.4.2 Alternative 2 - Surface Capping with Excavation, Transportation, and Disposal

This alternative includes surface capping and limited excavation to address the source area present within the HWMU and AST area. Cap maintenance, establishment of institutional controls, groundwater monitoring, indoor air monitoring, and possible engineering controls for vapor intrusion are also included.

Source area reduction to facilitate groundwater plume control (Removal Objective No. 2) will be addressed through targeted excavation and removal of contamination. Based on an evaluation of site characterization information, the excavation will be approximately 75 feet by 75 feet by 15 feet deep, centered near the location of GP-14 and TB-18. The anticipated aerial extent of this excavation is illustrated in Figure 12. The intent of this approach is to physically remove the source area, contained primarily within the subsurface clays, that otherwise could not be removed using previously discussed extraction techniques. It was assumed that this excavation would reduce groundwater VOC concentrations in the source area to about 10 mg/l consistent with Section 4.2.

Prior to excavation, subsurface samples will be obtained through the use of Geoprobes or other intrusive techniques to obtain representative samples of the material to be excavated. The samples will be analyzed for waste characterization to determine whether all or portions of the material should be classified as hazardous, and to determine what constituents may be of particular concern with regard to disposal. Samples for waste characterization are typically obtained at a frequency of one per 500 to 1,000 tons, dependent upon the disposal facility. The purpose of pre-excavation sampling is to allow for the direct placement of excavated material into trucks for off-site transportation and disposal, which is more cost effective than material staging or stockpiling. Samples from individual loads may also be obtained and analyzed as a contingency measure to verify the expected waste characterization profile.

The quantity of material to be excavated is estimated at 3,200 cubic yards or approximately 5,800 tons. In order to complete the anticipated excavation, one or more remnant concrete foundations will require demolition and removal. Commonly available equipment (hoe-ram) will be used to complete the task. Excavation will then proceed in a controlled manner to identify the excavated material with one or several pre-excavation waste characterization samples. This will ensure that material loaded for transport is not misrepresented. Each load, accompanied by a manifest, will be transported to a permitted solid waste management facility for proper treatment, if required, and disposal.

Additional ancillary activities are associated with the excavation work. For example, erosion and sedimentation controls will be established prior to excavation to prevent sediment loss and the possible spread of contamination. Utilities in the area will be identified and marked to prevent contact and disruption. Access will be planned to allow for the movement of heavy equipment and transport vehicles. Also, decontamination procedures will be implemented to clean equipment that may contact contaminated materials. Appropriate health and safety procedures must be implemented during all removal activities, including excavation. Therefore, a site-specific health and safety plan will be written and implemented in conjunction with the Removal Action Work Plan for removal.

If groundwater collects within the excavation, it will most likely be limited in quantity due to the significant amount of clays present in the subsurface. The possibility does exist, however, for significant quantities of groundwater to be encountered during the excavation if, for example, a water-bearing sand/silt lens is breached. In any case, an allowance will be made to pump this water from the excavation, store the water in a temporary tank on the site, characterize the water, and then transport the water off-site for proper treatment and disposal. Treatment of groundwater in the source area in this manner (dewatering) is considered an associated benefit to the excavation, treatment, and disposal alternative, but not a primary removal action in and of itself. Once excavation activities are complete and the targeted area has been removed, then the excavation will be backfilled and compacted with clean fill in preparation for capping.

The primary objective of surface capping is to contain and isolate exposed soils affected with lead to prevent exposure to potential surface receptors (Removal Objective No. 2). The cap will also serve to:

- prevent sediment loss and erosion,
- promote storm water run-off,
- limit infiltration and percolation, and
- create a land surface that can support continued industrial use.

Approximately 75,000 square feet of surface area will be capped, as shown in Figure 12. The cap will be placed to cover exposed areas within the facility and contain and isolate soils impacted by lead. The cap will consist of a prepared subbase of compacted stone topped with commercially available asphalt pavement. Provisions in the site design will accommodate storm water management through engineered controls (i.e., appropriate grading, catch basins, and conveyances, as required). This alternative also includes long-term maintenance of the asphalt cap and appurtenances. These activities will include regular cap inspections and the completion of necessary repairs and replacement to the cap and storm water management system, as required.

Institutional controls will include placing deed restrictions on the use of the property to limit intrusive operations and to address future construction of buildings. Groundwater monitoring will be performed for a period of 30 years to monitor the condition of groundwater in the area. The installation of four additional monitoring wells is anticipated. Finally, engineering controls to improve building ventilation, vent subsurface vapors, or restricting building access will be reviewed based on possible concerns regarding indoor vapor intrusion. Indoor air sampling for COCs is also anticipated to confirm the results of vapor intrusion modeling. Specifics regarding the sampling and analyses program will be developed as part of the Removal Action Work Plan.

The field activities required to implement this removal action alternative could be completed in a short period of time. Once the Removal Action Work Plan and associated plans were written and approved, contractor procurement activities completed, disposal contracts arranged, utility clearances obtained, etc., actual field activities for the surface capping; the excavation, transportation, and disposal; and the monitoring well placement would most likely be completed within one month. Groundwater monitoring is projected for 30 years.

Effectiveness

Overall Protection of Human Health and the Environment

Surface capping effectively contains the lead in soils and prevents exposure via ingestion, direct contact, and fugitive dust inhalation to potential receptors, which is protective of human heath and the environment. Excavation, transportation, and disposal are also protective since actions performed to target the source area facilitate the control and management of the groundwater plume in the HWMU and AST area and further protect human health and the environment.

Compliance with ARARS

Based upon the modeling presented in Chapter 4.0, it is expected that this intensive source removal activity will assist in the control and management of the groundwater plume in the HWMU and AST area and the natural dissipation over time.

Long-Term Effectiveness and Permanence

Excavation, transportation, and disposal of the source area provide long-term effectiveness and permanence. Groundwater monitoring will be implemented to provide an ongoing evaluation of its effectiveness. Use of a surface cap, coupled with routine maintenance and inspections to ensure the integrity of the cap, also provides long-term effectiveness and permanence for this alternative.

Reduction of Toxicity, Mobility, or Volume through Treatment

Excavation, transportation, and disposal of the source area reduce the toxicity, mobility, and volume of the impacted soil. Surface capping does not reduce the toxicity or volume of the remaining impacted soil on site, although the mobility of constituents to the air or to groundwater will be eliminated or greatly reduced.

Short-Term Effectiveness

The short-term effectiveness of this alternative is moderate, provided that proper health and safety protocols are employed during capping and excavation, transportation, and disposal activities. Operations required to excavate material at depth carry risks. These risks include: potential contact with contaminated media, construction hazards associated with relatively deep excavations, decontamination concerns, water management, material handling logistics, traffic management, etc. In addition, the potential exists for contaminant migration if proper erosion and sedimentation controls are breached or not properly installed. Disturbance of soils within the groundwater table may also enhance the mobilization of contaminants.

Implementability

Technical Feasibility

Excavation, transportation, and disposal of the source area are technically feasible since excavation, transportation, and disposal activities are routinely performed every day. However, trained professionals should be employed to execute this alternative, since excavations of potentially hazardous materials, at

depths of 4 feet or greater, present unique difficulties related to health and safety and excavation techniques. For example, shoring or over excavation may be required to maintain the open excavation or to reach additional impacted material. Groundwater encountered may result in the implementation being more difficult. In addition, concerns regarding subsurface utilities, site access, material management in limited areas, and traffic flow require attention. The use of surface capping is also technically feasible since it is a presumptive remedy and is routinely performed.

Administrative Feasibility

The administrative feasibility of this alternative is considered high. Considerations for highway occupancy permits, utility clearances, erosion and sedimentation control plans, and similar instruments are relatively minor. Permission will be required to install additional groundwater monitoring wells in off-site locations. Finally, the ability to impose institutional controls to supplement this alternative is also feasible.

Availability of Services and Materials

Remediation, transportation, and disposal companies are available to execute the removal action as described for the North Chicago facility. These services are available separately or in combination. Paving services required for placement of the surface cap are readily available locally. The installation of additional monitoring wells and groundwater monitoring is not a concern.

State Acceptance

State acceptance of this alternative is anticipated. The alternative addresses both removal of the source area in the former HWMU area and exposure to the remaining impacted soil left on site.

Community Acceptance

Community acceptance of this alternative is anticipated. The alternative addresses both removal of the source area in the former HWMU area and exposure to the remaining impacted soil left on site. In addition, this alternative would allow operations at the site to potentially resume, including use as a light industrial area, subject to the restrictions imposed by the institutional controls specified.

Cost

The capital costs for this alternative would be relatively high since excavation, transportation, disposal, backfilling, and surface capping are included. However, most activities could be accomplished in a relatively short time frame. There would be minimal surface cap maintenance and routine groundwater

monitoring required, which is assumed to occur for a period of 30 years. A detailed cost estimate for Alternative 2, Surface Capping with Excavation, Transportation, and Disposal is provided in Table 49.

6.4.3 Alternative 3 – Surface Capping with Enhanced In-Situ Bioremediation

This alternative includes surface capping and Enhanced In-Situ Bioremediation to address the source area present within the HWMU and AST area. (Preparatory site investigation activities along with the possible use of targeted excavation, removal and off-site disposal are also considered.) Cap maintenance, establishment of institutional controls, groundwater monitoring, and considerations for improved building ventilation in the area of the HWMU are included.

The Enhanced In-Situ Bioremediation alternative is the in-situ oxidation of COCs through the injection of a biological activity enhancing material (e.g., hydrogen release compound [HRC] or Biodrain system) via direct push technology into the contaminated zone of the groundwater. Once this material is injected, it enhances microbial reactions in the groundwater that are highly anaerobic and increases the reaction potential for halorespiration to occur. The halorespiration reaction causes the COCs present in the contaminated zone to be biologically degraded into daughter products and, ultimately, mineralized. The application of the biological enhancing material is performed through the use of injection points. The injection points are spaced according to the expected radius of influence for the quantity of material to be injected at each location and the concentration of COCs within the treatment grid area. Enhanced In-Situ Bioremediation has been effectively used at numerous sites for the chemical degradation of chlorinated organics, as present at this site.

Enhanced In-Situ Bioremediation is a remediation system that employs the use of engineered in-situ systems to heighten the effects of naturally occurring biodegradation processes. Enhanced bioremediation technologies include bioaugmentation, nutrient addition, electron donor addition, and electron acceptor addition. In order to evaluate the Enhanced In-Situ Bioremediation alternative, the selected remediation system is anticipated to include electron donor addition (HRC) utilizing direct injection (via direct push technology).

Based on existing data, the primary source area is estimated at 75 feet by 75 feet, or 5,625 square feet (Figure 13). Generally, it has been found that the area of influence of the treatment grid will be twice the area of the grid. For instance, if a treatment grid is 400 square feet, the area of influence for this grid is assumed to be 800 square feet. Therefore, the area of influence for the HRC injection area is estimated to be about 10,000 square feet, which will result in the treatment of a large portion of the significant plume

concentrations. Based on the characterization data, the majority of contamination is within the 5 to 15 foot depth zone and injection of the HRC will be completed within this zone.

REGENESIS, the licensee of the HRC, was contacted to determine the amount of HRC needed and a recommendation on the spacing of injection points across the treatment area. Because of the relatively low permeability soils, injection point spacing was assumed to be on 5-foot centers. Consequently, a total of 120 injection points will be placed within the treatment area. (Less-permeable site soils limit the aerial extent of HRC at each injection point. For this reason, the grid spacing between the injection points was decreased.) The amount of HRC was determined based on reducing an average TCE concentration of 200 milligrams per liter throughout the treatment area to an average TCE concentration of about 10 milligrams per liter. Based on this information, an average HRC injection rate of 9 pounds per foot of boring will be utilized or a total of 90 pounds per boring. This would result in the injection of about 10,800 pounds of HRC within the treatment area. (Given the available information regarding subsurface conditions at the site, HRC is considered a viable alternative and a bench-scale treatability was not considered necessary for further consideration of the alternative.)

Several items should be noted when discussing the application of HRC in this circumstance. First, the highest trichloroethene (TCE) concentrations present at the site are located at or below the water table in and around the Hazardous Waste Management Unit (HWMU) area. The TCE source in this area is not limited by media; both soil and groundwater are affected and both should be considered contributors to contamination in the area.

Second, the application of HRC to saturated soils (soils at or below the water table) promotes enhanced bioremediation and the accelerated reduction of chlorinated solvents. HRC is applied within the saturated zone to allow the compound to mobilize to the extent practicable and be carried throughout the target area. However, reductive dechlorination is not limited by media. Through continued desorption and dissolution based on Fick's Law, contaminants present throughout the saturated soils, both dissolved in groundwater and absorbed on particles, are targeted for remediation.

Third, Regenesis considered both soil and groundwater concentration data determine the appropriate amount of HRC to be applied. The application as is intended to address the contamination present within the saturated zone, regardless of media. It should be noted that the fate and transport evaluation and modeling (Chapter 4.0) also considered concentrations of TCE in both soil and groundwater by accounting for the appropriate soil-water distribution coefficient for TCE.

It is anticipated that a preparatory site investigation in and around the HWMU area will be valuable prior to the implementation of this alternative. One goal of this proposed investigation is to characterize the immediate HWMU target area for the potential excavation, removal and off-site disposal of more significantly contaminated material (possible "hot spot," removal). This action, if practicable, may significantly reduce the mass of contaminated material identified for treatment with HRC. In turn, the excavation, removal, and off-site disposal of the material may reduce the amount of HRC material required and the time necessary to achieve reductions in contaminant concentrations. This action may also aid in the application of HRC material by allowing for direct application (placement in the excavation) rather than application with Geoprobe technology. The criteria for implementing potential excavation, removal, and off-site disposal activities will be the identification of a definable, subsurface contaminant mass with concentrations significant enough to warrant the action. For example, localized areas with concentrations above 1,000 mg/kg TCE, dry weight basis, and/or 1,000 mg/l in groundwater may be targeted. However, unbound or undefined zones of contamination would not necessarily justify the action. It should be noted that the complete excavation, removal, and off-site disposal of the HWMU target area (75 feet by 75 feet) is not contemplated in this alternative; that option is presented as Alternative 2.

A second goal of the preparatory site investigation activities is to provide analytical data directly representative of the proposed HRC application area. This will enable an HRC application specifically tailored to the subsurface conditions in the immediate area of concern. Specifically, the preparatory site investigation would involve a targeted Geoprobe investigation of the application area (75 feet by 75 feet) to obtain samples of the subsurface media. Geoprobe locations would be spaced on a grid (say 20 to 30 foot spacing) in the application area and samples would be obtained from the target depth of approximately 5 to 15 feet below grade. Selected samples would be analyzed for contaminant concentrations (TCE, cis 1,2-DCE, VC) in addition to other potential parameters of interest such as; pH, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO), Total Organic Compounds (TOC), metabolic acids, dissolved manganese and iron, nitrate, sulfides/sulfates and methane.

A description of the cap installation is presented in the description of Alternative 2 in Section 6.4.2.

Institutional controls will include placing deed restrictions on the use of the property to limit intrusive operations and to address future construction of buildings. Groundwater monitoring will be performed for a period of 30 years to monitor the condition of groundwater in the area. The installation of four

additional monitoring wells is anticipated. Finally, engineering controls to improve building ventilation, vent subsurface vapors, or restricting building access will be reviewed based on possible concerns regarding indoor vapor intrusion. Indoor air sampling for COCs is also anticipated to confirm the results of vapor intrusion modeling. Specifics regarding the sampling and analyses program will be developed as part of the Removal Action Work Plan.

Based on available information regarding the use and effectiveness of the HRC technology in similar site circumstances, contaminant concentrations in groundwater in and around the point of application have decreased dramatically in a relatively short period of time. For the purpose of establishing quantifiable benchmarks for remedy effectiveness, both a post-application timeframe and a target reduction level should be proposed. The time period that enhanced bioremediation is expected to occur is in the range of 3-5 years. However, USEPA has requested that an evaluation of remedy effectiveness be performed at 2-3 years after HRC application..

In terms of groundwater contaminant concentrations, TCE is the primary COC and is proposed as the primary evaluation parameter relate to effectiveness. It is proposed to establish a 25-50 percent reduction in average groundwater concentration in the application area as a target reduction level. Assuming the average concentration in the proposed application area is approximately 150-250 mg/l (say 200 mg/l), this would mean that the target reduction level would be approximately 100-150 mg/l, 2-3 years after HRC application. However, more significant reductions percentages are likely. (It is anticipated that groundwater will be monitored with a well/wells installed in the application area.)

As stated above, it is proposed to monitor the progress of the enhanced in-situ biodegradation through the regular (minimum quarterly) sampling and analysis of groundwater in the application area. One (possibly two) monitoring wells will be placed within the application area to obtain the samples required. The samples will be analyzed for COCs and possibly other parameters, as recommended by Regenesis. Non-detections will be considered at one-half the PQL for data reduction purposes. Concentration averages, as applicable, will be computed as the arithmetic mean. The data will be tracked over time and evaluated by USEPA during the third year after initial application to determine remedy effectiveness versus the benchmark established above, and other factors as judged to be appropriate. USEPA will then determine if the remedy has been sufficiently effective and decide on a course of action. That course of action may involve the continued monitoring of the application area to track progress, reapplication of HRC material, implementation of an alternate removal action alternative, or some additional variation.

The field activities required to implement this removal action alternative could be completed in short period of time, assuming preparatory activities (work plan development and approval, contractor procurement, site investigation, etc.) have already been completed. Potential excavation, removal, and off-site disposal, HRC application, capping, and monitoring well placement would most likely be completed within one month. Enhanced bioremediation activity is anticipated for 3-5 years after the initial HRC application with mass reductions noted with the first year. Groundwater monitoring is projected for 30 years.

Effectiveness

Overall Protection of Human Health and the Environment

Surface capping effectively contains the lead in soils and prevents exposure via ingestion, direct contact, and fugitive dust inhalation to potential receptors, which is protective of human heath and the environment. Enhanced In-Situ Bioremediation is also protective since actions performed to target the source area, and beyond, facilitate the control and management of the groundwater plume in the HWMU and AST area and further protect human health and the environment.

Compliance with ARARs

Based upon the modeling presented in Chapter 4.0, it is expected that this intensive source removal activity will assist in the control and management of the groundwater plume in the HWMU and AST area and the natural dissipation over time to meet applicable standards.

Long-Term Effectiveness and Permanence

Enhanced In-Situ Bioremediation provides long-term effectiveness and permanence. Once implementation of this alternative is complete, historical information for various enhanced bioremediation injection systems indicate that the time period that enhanced bioremediation will occur is 3 to 5 years. After this period of time, conditions in the affected groundwater equilibrate in and around the source area and natural degradation will continue to occur. Use of a surface cap, coupled with routine maintenance and inspections to ensure the integrity of the cap, also provides long-term effectiveness and permanence for this alternative.

Reduction of Toxicity, Mobility, or Volume through Treatment

If properly designed, this alternative will be effective in reducing the toxicity (concentration), mobility, and volume of the contaminant plume during its operation. Surface capping does not reduce the toxicity

or volume of the remaining impacted soil on site, although the mobility of constituents to the air or to groundwater will be eliminated or greatly reduced.

Short-Term Effectiveness

During installation of this alternative, minimal impacts to the public health and the environment would occur. Workers could be exposed to the contaminants during the implementation of the alternative via contact with soil or groundwater and inhalation of vapors although the work would be completed according to the requirements of the site-specific health and safety plan. Upon installation and startup of this alternative, pilot studies have indicted that the constituent mass will relatively quickly (within 1 year) begin to be reduced within the injection grid and will migrate downgradient according to concentration and groundwater flow.

Implementability

Technical Feasibility

This alternative is technically feasible for implementation. The HRC material has been shown to reduce the concentration and mass at similar sites. The use of direct-push technology is routinely used and presents minimal technical challenges and the extent of the application grid is manageable. The use of surface capping is also technically feasible since it is a presumptive remedy and is routinely performed.

Administrative Feasibility

The administrative feasibility of this alternative requires no special consideration, other than the need to check for subsurface utilities in the area. Based on site-specific discussions with Regenesis representatives, there are no substantive issues or requirements associated with the subsurface injection of HRC material at the subject site. Permission will be required to install additional groundwater monitoring wells in off-site locations. Finally, the ability to impose institutional controls to supplement this alternative is also feasible.

Availability of Services and Materials

Resources required for the implementation of this alternative, such as direct push units and HRC material, are readily available. Paving services required for placement of the surface cap are readily available locally. The installation of additional monitoring wells and groundwater monitoring is not a concern.

State Acceptance

State acceptance of this alternative is anticipated. The alternative addresses both removal of the source area in and around the former HWMU area and exposure to the remaining impacted soil left on site.

Community Acceptance

Community acceptance of this alternative is anticipated. The alternative addresses both removal of the source area in and around the former HWMU and exposure to the remaining impacted soil left on site. In addition, this alternative would allow operations at the site to potentially resume, including use as a light industrial area, subject to the restrictions imposed by the institutional controls specified.

Cost

The capital costs associated with this alternative are relatively moderate, considering the amount of injection borings, the quantity of injection material, and the long-term monitoring requirements. There would be minimal surface cap maintenance and routine groundwater monitoring required, which is assumed to occur for a period of 30 years. A detailed cost estimate for Alternative 3, Surface Capping with Enhanced In-Situ Bioremediation is provided in Table 50. Consideration has been made for preparatory site investigation, limited excavation, removal, and off-site disposal and routine monitoring of HRC application effectiveness for two years.

6.4.4 Alternative 4 – Surface Capping with Permeable Reactive Barrier

This alternative includes surface capping and the installation of a Permeable Reactive Barrier (PRB) to address the groundwater plume present within the HWMU and AST area. Cap maintenance, establishment of institutional controls, groundwater monitoring, and considerations for improved building ventilation in the area of the HWMU are also included.

PRBs are treatment walls installed in the saturated soil to treat impacted groundwater. PRBs can be installed by constructing a trench across the flow path of impacted groundwater and filling it with one of a variety of materials (reactive fillings) carefully selected based on their ability to treat specific types of contaminants. As the impacted groundwater passes through the PRB, the constituents are either trapped by the PRB or chemically transformed into harmless substances that flow out of the PRB.

Two types of PRBs are typically used, the funnel and gate and the iron treatment wall. The funnel and gate technology for in-situ treatment of groundwater consists of a low hydraulic conductivity cutoff wall (the funnel) with a gate that contains the reactive material. The funnel area can be constructed of a slurry

wall material or sheet piling, although deep soil mixing and jet grouting can also be used. The funnel area is typically keyed into a low permeability layer, such as clay, that prevents groundwater from passing beneath the wall. The groundwater then flows around the funnel area and through the higher permeability gates. As the water passes through the gates, contaminants react with the filling material, thereby trapping or chemically treating the constituents allowing the passage of clean treated water through the gates.

The iron treatment wall consists of iron granules or other iron-bearing minerals for the treatment of chlorinated VOCs such as trichloroethylene, dichloroethylene, or vinyl chloride. As the iron is oxidized, a chlorine atom is removed from the groundwater by one or more reductive dechlorination mechanisms, using electrons supplied by the oxidation of iron. The groundwater passing through the PRB would, therefore, contain little or no COCs, treating the groundwater and protection downgradient receptors. The iron granules are dissolved and used by the process, but the metal disappears so slowly that the iron treatment walls can be expected to remain effective for many years.

In this application, a PRB would be installed across the groundwater flow path on the Vacant Lot Site, as shown in Figure 14. The total length of the trench would be approximately 1,150 feet and would consist of two types of construction, a slurry wall and the PRB, as shown in Figure 15. This combination of the funnel and gate and the iron treatment wall technologies would be utilized to better manage site groundwater as well as specifically address VOCs.

Based on hydrogeologic data for the site, the depth of the PRB would be approximately 14 feet. This would include the installation of slurry walls at the funnel locations shown in Figure 15 from a depth of approximately 14 feet bgs to 4 feet bgs with a width of approximately 3 feet. The actual depth may vary depending upon site conditions and the actual depth of the low permeability clay.

At the gate locations shown in Figure 15, iron fillings and limestone would be used as backfill. The iron fillings would serve to address the chlorinated VOCs detected in groundwater while the limestone would address any metals that may be mobilized in the site groundwater. The depth of the gates would also be from approximately 14 feet bgs to 4 feet bgs with a width of approximately 3 feet. Upon installation of both the slurry wall and the PRB, the trench would be backfilled to grade using soil and compacted. The portion of the site where the slurry wall and PRB exists could then be made available for use.

A description of the cap installation is presented in the description of Alternative 1 in Section 6.4.2.

Institutional controls will include placing deed restrictions on the use of the property to limit intrusive operations and to address future construction of buildings. Groundwater monitoring will be performed for a period of 30 years to monitor the condition of groundwater in the area. The installation of four additional monitoring wells is anticipated. Finally, engineering controls to improve building ventilation, vent subsurface vapors, or restricting building access will be reviewed based on possible concerns regarding indoor vapor intrusion. Indoor air sampling for COCs is also anticipated to confirm the results of vapor intrusion modeling. Specifics regarding the sampling and analyses program will be developed as part of the Removal Action Work Plan.

The field activities required to implement this removal action alternative could be completed in a relatively short period of time, assuming preparatory activities (plan development and approval, contractor procurement, etc.) have already been completed. Surface capping, PRB installation, and monitoring well placement would most likely be completed within one to two months. Groundwater treatment via the PRB would require decades, if not longer, given the relatively slow groundwater velocity in the area. Groundwater monitoring is projected for 30 years.

Effectiveness

Overall Protection of Human Health and the Environment

Surface capping effectively contains the lead in soils and prevents exposure via ingestion, direct contact, and fugitive dust inhalation to potential receptors, which is protective of human health and the environment. In general, installation of the PRB would be also be protective of human heath and the environment, although the time required for the groundwater plumes to reach the PRB may be excessive given the relatively slow groundwater velocity at the site. Source area reduction (Removal Objective No. 3) would not be performed with the understanding that all contaminated groundwater would eventually pass through the PRB.

Compliance with ARARs

This alternative is expected to comply relevant ARARs, although source removal is not performed.

Long-Term Effectiveness and Permanence

Through management and subsequent treatment of groundwater, this alternative would provide for both long-term effectiveness and permanence once installed. However, the existing groundwater condition will persist for an extended period until groundwater reaches the PRB. Use of a surface cap, coupled with routine maintenance and inspections to ensure the integrity of the cap, also provides long-term effectiveness and permanence for this alternative.

Reduction of Toxicity, Mobility, or Volume through Treatment

Based on the reactive chemistry involved with this technology, no residual effects due to the dechlorination process would occur using this alternative. The constituents that are exposed to the PRB would be chemically modified to innocuous compounds. Surface capping does not reduce the toxicity or volume of the remaining impacted soil on site, although the mobility of constituents to the air or to groundwater will be eliminated or greatly reduced.

Short-Term Effectiveness

The short-term effectiveness of this alternative is low. Operations required to excavate material at depth carry risks. These risks include: potential contact with contaminated media, construction hazards associated with relatively deep excavations, decontamination concerns, water management, material handling logistics, traffic management, etc. In addition, the potential exists for contaminant migration if proper erosion and sedimentation controls are not properly installed. The PRB will not be effective for an extended period of time given the velocity of groundwater in the area.

Implementability

Technical Feasibility

This alternative is technically feasible based on existing site conditions. Construction of the PRB system can easily be implemented on the west side of the facility on the Vacant Lot. However, site soil characteristics and hydrogeology may limit the feasibility of this alternative given the relatively slow linear groundwater velocity in the area. The PRB technology has been demonstrated at numerous sites to be effective on the constituents and under the conditions present at this site. The use of surface capping is technically feasible, since it is a presumptive remedy and is consistent with the future use of the site.

Administrative Feasibility

The administrative feasibility of this alternative requires coordination with the Vacant Lot Site owner to permit installation. Difficulties may arise during negotiations since future site development on the Vacant Lot Site may be affected. The installation of the asphalt cap is administratively feasible.

Availability of Services and Materials

Resources required to implement this alternative, such as standard earth moving and construction equipment, are readily available. Trenching activities would occur to a depth of approximately 14 feet and dewatering capabilities would be necessary. However, these are standard construction techniques and the personnel and equipment are readily available. Installation of the slurry for the funnels is a proven technique and backfilling of the iron fillings is also considered a routine construction activity. Disposal of the excavated material and groundwater can also be arranged. Paving services required for placement of the surface cap are readily available locally.

State Acceptance

PRB technology is relatively new compared to other more proven technologies such as groundwater pump and treat. However, it has been used recently on numerous federal sites and has been documented by both federal and state agencies. Due to the relatively standard construction techniques, this approach should gain state acceptance as a removal alternative. It should be noted that the passive nature of this alternative may present difficulties with regard to acceptance.

Community Acceptance

Since the PRB alternative employs standard construction techniques and would minimize any long-term site disruptions, it is expected to be accepted by the community.

Cost

The capital costs for this alternative would be relatively high but design, procurement, and installation can be completed in a relatively short time frame. There would be minimal surface cap maintenance and routine groundwater monitoring required, which is assumed to occur for a period of up to 30 years. A detailed cost estimate for Alternative 4, PRB is provided in Table 51.

6.4.5 Removal Action Alternatives References

USEPA (August 1993) Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA, PB93-963402, EPA540-R-93-057

USEPA (September 1993a) Presumptive Remedies: Policy and Procedures, Directive: 9355.0-47S, EPA540-F-93-047

USEPA (September 1993b) Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils, Directive: 9355.0-48FS, EPA540-F-93-048

USEPA (October 1996) Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites, Final Guidance, Directive: 9283.1-12, EPA540/R-96/-023

USACE (June 1999) Engineering and Design, Multi-Phase Extraction, On-Line

USACE (September 1999) Presumptive Remedy for Metals-in-Soils Sites, PB99-963301, EPA540-F-98-054

FRTR (2001) Remediation Technologies Screening Matrix, Version 4.0, On-Line

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7.0 Comparative Analysis of Removal Action Alternatives

The four removal alternatives were compared based on effectiveness, implementability, and cost. A summary of the comparison is presented in Table 54. Considering effectiveness, Alternative 1 would not be effective in protecting human health and the environment since the remedial objectives would not be met. Alternative 1 would also not be effective in the short or long term and would not reduce toxicity, mobility, or volume of the contaminants. Alternatives 2, 3 and 4 would be effective since each is protective of human health and the environment once implemented and maintained. These three alternatives would also reduce toxicity, mobility, and volume and would be effective in the long term. Alternative 3 is effective in the short term based on the relatively minor level of disturbance involved with the application of the HRC material. However, Alternatives 2 and 4 present concerns regarding short-term effectiveness. (As stated in the Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA, PB93-963402, EPA540R-93-057, "The short-term effectiveness criterion addresses the effects of the alternative during implementation before the removal objectives have been met.") Alternatives 2 and 3 involve potential risks from the logistics associated with excavation and material handling, although Alternative 3 less so given a limited excavation scope. Alternative 4 involves the same risks associated with the installation of the PRB, in addition to the fact that impacted groundwater will take an extended period of time to reach the PRB. Therefore, comparatively, Alternative 3 is the most effective.

Regarding implementability, Alternative 1 is clearly the most easily implemented. Alternatives 2, 3, and 4 are feasible to varying degrees. Alternatives 2 and 3 (Alternative 3 to a lesser degree) involve excavation, transportation, and disposal, which are commonly performed. However, difficulties related to these activities, such as excavation stability, water management, and materials management demand particular attention. Alternative 4 also presents similar concerns, in addition to administrative coordination with the Vacant Lot Site property owner and potential agency acceptance issues considering the passive nature of the PRB. Alternative 3 can be implemented fairly easily considering the relatively simplistic method of HRC application. Therefore, comparatively, Alternative 1 is the most easily implemented, Alternative 3 being the next most feasible.

Lastly, the costs for each alternative have been compared. Alternative 1 is the least costly followed by Alternative 3. Alternatives 2 and 4 are the most costly.

8.0 Recommended Removal Action Alternative

The recommended removal action alternative is Alternative 3, Surface Capping with Enhanced Bioremediation. This alternative fulfills the removal action objectives of: 1) mitigating the exposure pathway primarily through confirmation monitoring and/or the application of institutional and engineering controls; 2) isolating, treating, and/or removing soils impacted by lead within exposed areas of the HWMU and AST area and the Former Drum Storage Area; and 3) isolating, treating, or removing the potential source area (affected soil and groundwater) associated with the HWMU and AST area to assist in the natural dissipation of the plume over time to acceptable levels. This alternative would be effective, implementable, and the most cost effective (aside from the No Action alternative) option. This alternative will address all remaining issues relative to completing the EE/CA for the North Chicago facility.

The Guidance for Conducting Non-Time-Critical Removal Actions under CERCLA, PB93-963402, EPA540R-93-057, states that, "The EE/CA should identify the action that best satisfies the evaluation criteria based on the comparative analysis in the previous section." NCI has appropriately provided a recommendation. NCI acknowledges that USEPA must select which removal alternative will be implemented.

Table 19
Statistical Analysis
On-Site Trespasser - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Residential (outdoor)	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Metals [5]														
Cadmium	mg/kg	1,800.0	1.6	47.1	GP-33A	15.4	9.8	0.8	0.9	0.9	0.9	0.6	0.6	21 / 24
Lead	mg/kg	NE[1]	5.8	28,200.0	GP-12A	7,322.6	2,466.8	0.7	0.9	0.9	0.9	NA	NA	24 / 24
Tantalum	mg/kg	NE	6.2	398.7	GP-10A	80.3	14.8	0.3	0.9	0.6	0.9	6.0	6.2	10 / 19
VOCs [6]														
Acetone	µg/kg	NE	31.3	118.0	TB-35B	25.9	21.6	-74.2	DT	-47.1	DT	3.1	3080.0	9 / 105
Benzene	µg/kg	800.0	6.1	10.5	GP-8D	4.8	4.2	-51.5	DT	105.6	DT	6.0	6.8	6 / 62
2-Butanone	µg/kg	NE	21.6	21.6	TB-35B	50.0	959.0	NA[2]	NA	NA	NA	12.8	12.8	1 / 2
Carbon disulfide	µg/kg	720,000.0	6.2	688.2	GP-12I	51.4	11.9	-47.0	DT	-17.8	DT	5.9	615.0	49 / 117
Chloroethane	µg/kg	NE	11.0	11.0	TB-11A	17.1	34.4	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
Chloroform	µg/kg	300.0	11.3	24.8	TB-11A	6.5	4.2	0.2	0.9	0.3	0.9	6.1	615.0	2 / 36
Chloromethane	µg/kg	NE	7.3	7.3	GP-32D	4.7	4.1	-48.5	DT	241.5	DT	6.1	6.8	1 / 65
1,1-Dichloroethane	µg/kg	1,200,000.0	26.6	57.8	TB-11A	15.8	7.2	0.4	0.9	0.4	0.9	6.0	6.1	2 / 17
1,2-Dichloroethane	µg/kg	400.0	10.3	10.3	TB-11A	16.5	32.6	0.8	0.8	0.8	0.8	6.0	6.1	1 / 4
1,1-Dichloroethene	µg/kg	70.0	7.3	86.1	GP-8D	9.3	4.6	-76.4	DT	-51.9	DT	5.9	615.0	14 / 120
Cis-1,2-Dichloroethene	µg/kg	NE	6.5	185000.0	GP-14F	7390.1	27.4	-71.2	DT	-19.5	DT	5.9	615.0	38 / 122
Trans-1,2-Dichloroethene	µg/kg	NE	6.8	6230.0	GP-15G	240.2	8.1	-70.0	DT	-32.8	DT	5.9	615.0	21 / 120
Ethylbenzene	µg/kg	400,000.0	7.1	166.0	GP-3D	5.0	4.4	0.3	0.9	0.3	0.9	6.1	6.8	5 / 62
Methylene Chloride	µg/kg	13,000.0	6.4	353.3	GP-30I	17.1	4.3	-67.0	DT	-58.8	DT	6.0	6.2	8 / 89
p-Isopropyltoluene	µg/kg	NE	18.8	18.8	GP-14F	5.4	4.5	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
n-Propylbenzene	µg/kg	NE	9.3	9.3	GP-14F	5.1	4.4	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
Styrene	µg/kg	1,500,000.0	29.8	29.8	GP-36C	12.7	9.4	0.4	0.8	0.4	0.8	6.1	6.1	1 / 12
Tetrachloroethene	µg/kg	10,000.0	6.2	116000.0	GP-3	3311.4	8.2	-82.1	DT	-45.6	DT	5.9	21600.0	23 / 122
Toluene	µg/kg	650,000.0	7.0	95.2	GP-14E	8.2	4.2	-58.8	DT	-52.7	DT	6.1	6.8	7 / 89
1,2,4-Trichlorobenzene	µg/kg	3,200,000.0	8.3	494.4	GP-32F	31.2	4.4	-55.0	DT	-52.2	DT	6.1	6.8	3 / 63
1,1,1-Trichloroethane	µg/kg	1,200,000.0	8.9	1630.0	GP-8D	49.5	4.4	-78.8	DT	-62.8	DT	5.9	615.0	7 / 122
1,1,2-Trichloroethane	µg/kg	1,000.0	31.4	44.3	GP-37F	9.4	4.9	0.2	0.9	0.2	0.9	6.0	6.1	2 / 33
Trichloroethene	µg/kg	5,000.0	6.8	1310000.0	GP-14F	45152.2	85.2	-74.7	DT	-10.7	DT	6.0	247.8	50 / 121
1,2,4-Trimethylbenzene	µg/kg	NE	30.3	70.4	GP-14F	9.2	4.3	0.2	0.9	0.2	0.9	6.1	6.8	2 / 47
Trichlorofluoromethane	µg/kg	NE	74.4	74.4	TB-35A	20.5	8.9	0.2	0.9	0.2	0.9	6.1	615.0	1 / 14

Table 19
Statistical Analysis
On-Site Trespasser - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Residential (outdoor)	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Vinyl Chloride	µg/kg	600.0	6.8	1210.0	GP-15H	59.2	6.3	-61.0	DT	-41.0	DT	5.9	615.0	21 / 122
Total Xylenes	µg/kg	NE	18.0	18.0	GP-14E	10.1	10.9	0.5	0.9	0.4	0.9	6.1	13.6	1 / 47
SVOCs (PAHs)[6,7]														
Acenaphthene	µg/kg	NE	11.2	72000.0	GP-3	4028.5	106.8	-52.1	DT	-3.4	DT	10.7	128.0	33 / 63
Acenapthylene	µg/kg	NE	533.0	72000.0	GP-3	38922.9	74410.9	0.2	0.9	0.5	0.9	246.0	1230.0	2 / 7
Anthracene	µg/kg	NE	15.7	8450.0	GP-3	509.7	31.8	-48.5	DT	-4.8	DT	10.7	156.0	22 / 63
Fluorene	µg/kg	NE	36.1	9089.8	GP-3	543.6	23.2	-49.5	DT	-1.0	DT	0.0	156.0	15 / 58
Naphthalene	µg/kg	170,000.0	13.2	233.1	GP-29B	26.3	12.2	-9.5	DT	-3.0	DT	10.7	213.4	12 / 58
Phenanthrene	µg/kg	NE	19.4	48900.0	GP-3	2809.2	92.8	-51.1	DT	-3.0	DT	10.7	128.0	31 / 63

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Notes:

(1) NE denotes that no screening criteria was established.

(2) NA = Not Applicable due to insufficient data to calculate statistics

(3) For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied.
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.

(4) DT = D'Agostino's Test; acceptable value must fall within the lower bound (-2.8) and upper bound (0.9) values

(5) Statistics are based on only shallow exposed soil because the receptor would only be exposed via fugitive emissions of the constituent adhered to particles from shallow exposed soil.

(6) Only constituents applicable for volatilization from soil into air are listed. That includes constituents with a molecular weight less than 200 and Henry's Law Constant greater than 1×10^{-5} atm m^3/mol.

(7) SVOCs are not evaluated via fugitive dust because the dermal/ingestion soil screening levels (SSLs) are often several orders of magnitude lower (i.e., more stringent) than the corresponding default fugitive dust SSLs.

Table 16
Statistical Analysis
Construction Worker - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[4]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Metals														
Cadmium	mg/kg	900.0	1.0	47.1	GP-33A	10.7	4.7	-10.7	DT[5]	3.8	DT	0.6	0.6	47 / 63
Lead	mg/kg	750.0	4.5	28,200.0	GP-12A	3,895.4	468.7	-22.1	DT	0.5	DT	3.1	3.1	73 / 74
Tantalum	mg/kg	NE[1]	6.2	398.7	GP-10A	34.6	10.1	0.2	0.9	0.6	0.9	5.9	6.4	26 / 48
VOCs														
Acetone	µg/kg	110,000,000.0	31.3	182.8	GP-23C	31.6	25.7	-54.0	DT	-33.1	DT	27.6	3,080.0	10 / 75
Benzene	µg/kg	58,000.0	6.1	10.5	GP-8D	6.4	5.6	0.3	0.9	0.4	0.9	6.0	6.8	2 / 19
2-Butanone	µg/kg	27,000,000.0 [2]	21.6	21.6	TB-35B	50.0	959.0	0.6	0.9	0.6	0.9	12.8	12.8	1 / 2
Carbon disulfide	µg/kg	110,000,000.0	6.2	159.5	GP-26E	13.5	5.8	-46.9	DT	-30.3	DT	5.5	615.0	15 / 73
Chloroethane	µg/kg	6,500.0 [2]	11.0	11.0	TB-11A	17.1	34.4	0.4	0.8	0.4	0.8	6.0	6.1	1 / 4
Chloroform	µg/kg	520,000.0	8.5	24.8	TB-11A	6.3	4.4	0.3	0.9	1.2	0.9	5.5	615.0	4 / 46
Chloromethane	µg/kg	2,600.0 [2]	7.3	7.3	GP-32D	5.3	4.7	0.3	0.9	0.3	0.9	5.5	287.0	1 / 33
1,1-Dichloroethane	µg/kg	110,000,000.0	26.6	57.8	TB-11A	19.6	9.4	0.3	0.9	0.4	0.9	6.0	6.1	2 / 12
1,2-Dichloroethane	µg/kg	35,000.0	10.3	10.3	TB-11A	5.7	4.9	0.3	0.9	0.3	0.9	6.0	6.1	1 / 4
1,1-Dichloroethene	µg/kg	5,000.0	7.3	86.1	GP-8D	11.0	5.5	0.1	0.9	1.8	0.9	5.5	615.0	8 / 77
Cis-1,2-Dichloroethene	µg/kg	11,000,000.0	6.5	71,500.0	GP-14E	2,983.4	21.6	-62.6	DT	-13.7	DT	5.5	615.0	26 / 82
Trans-1,2-Dichloroethene	µg/kg	23,000,000.0	6.8	1,960.0	GP-15D	105.8	7.0	-48.6	DT	-23.6	DT	5.5	615.0	11 / 77
Ethylbenzene	µg/kg	110,000,000.0	7.1	166.0	GP-3D	7.7	7.2	0.5	0.9	43.2	0.9	5.9	6.8	4 / 16
Methylene Chloride	µg/kg	420,000.0	6.4	179.1	GP-17C	15.9	6.0	-37.9	DT	-27.1	DT	5.5	287.0	11 / 54
Styrene	µg/kg	230,000,000.0	29.8	29.8	GP-36C	8.3	6.0	0.4	0.9	0.5	0.9	5.5	287.0	1 / 20
Tetrachloroethene	µg/kg	61,000.0	6.2	116,000.0	GP-3A	5,593.2	14.8	-60.1	DT	-23.4	DT	5.5	615.0	26 / 83
Toluene	µg/kg	230,000,000.0	7.0	95.2	GP-14E	9.3	4.5	-42.1	DT	-36.2	DT	5.5	287.0	6 / 53
1,2,4-Trichlorobenzene	µg/kg	6,800,000.0	9.6	9.6	GP-36C	5.6	4.8	0.3	0.9	0.3	0.9	5.5	287.0	1 / 30
1,1,1-Trichloroethane	µg/kg	1,200,000.0 [2]	13.0	1,630.0	GP-8D	69.1	5.1	-53.0	DT	-37.6	DT	5.5	615.0	7 / 82
1,1,2-Trichloroethane	µg/kg	56,000.0	31.4	31.4	GP-8D	6.9	5.1	0.3	0.9	0.4	0.9	5.5	287.0	1 / 31
Trichloroethene	µg/kg	290,000.0	6.8	413,000.0	TB-7A	22,457.4	193.9	-51.7	DT	-4.2	DT	5.5	242.9	48 / 83
1,2,4-Trimethylbenzene	µg/kg	170,000.0 [2]	30.3	30.3	GP-14E	12.9	9.4	0.5	0.9	0.6	0.9	6.1	6.8	1 / 10
Trichlorofluoromethane	µg/kg	2,000,000.0 [2]	74.4	74.4	TB-35A	21.7	8.2	0.3	0.9	0.5	0.9	6.1	615.0	1 / 14
Vinyl Chloride	µg/kg	4,000.0	6.8	981.4	GP-15D	41.6	5.8	-48.1	DT	-30.9	DT	5.5	615.0	14 / 82
Total Xylenes	µg/kg	1,000,000,000.0	18.0	18.0	GP-14E	15.9	23.5	0.5	0.9	0.6	0.9	12.3	13.6	1 / 10
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000.0	14.2	72,000.0	GP-3A	3,383.0	333.8	-58.9	DT	-4.3	DT	10.7	128.0	43 / 73

Table 16
Statistical Analysis
Construction Worker - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[4]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Acenapthylene [3]	µg/kg	37,000,000.0	533.0	72,000.0	GP-3A	38,922.9	74,410.9	0.2	0.9	0.7	0.9	246.0	1,230.0	2 / 7
Anthracene	µg/kg	180,000,000.0	15.7	8,450.0	GP-3A	467.8	142.5	-53.7	DT	-3.7	DT	10.7	156.0	30 / 71
Benzo (a) anthracene	µg/kg	2,000.0	12.3	2,400.0	GP-3A	297.2	200.7	-29.9	DT	-3.3	DT	10.7	136.0	33 / 72
Benzo (a) pyrene	µg/kg	200.0	30.4	2,180.0	GP-29B	311.5	216.5	-24.8	DT	-2.6	DT	10.7	123.0	34 / 72
Benzo (b) fluoranthene	µg/kg	2,000.0	13.2	1,750.0	GP-29B	282.9	221.2	-21.5	DT	-2.7	DT	10.7	136.0	33 / 72
Benzo (ghi) perylene [3]	µg/kg	18,000,000.0	23.3	1,660.0	GP-29B	275.2	241.4	-20.8	DT	-2.9	DT	10.7	136.0	34 / 68
Benzo (k) fluoranthene	µg/kg	23,000.0	12.4	886.0	GP-29B	147.1	118.0	-18.9	DT	-1.7	DT	10.7	156.0	28 / 71
Chrysene	µg/kg	230,000.0	15.7	5,310.0	GP-3A	463.8	238.1	-37.3	DT	-3.5	DT	10.7	136.0	34 / 72
Dibenzo (a,h) anthracene	µg/kg	200.0	11.0	824.0	GP-9B	147.8	121.4	-23.1	DT	-1.8	DT	10.7	156.0	25 / 64
Fluoranthene	µg/kg	24,000,000.0	15.0	29,900.0	GP-3A	1,758.9	397.3	-50.1	DT	-3.4	DT	10.7	128.0	39 / 73
Fluorene	µg/kg	24,000,000.0	11.1	9,089.8	GP-3A	517.1	127.8	-53.1	DT	1.1	DT	0.0	156.0	21 / 64
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000.0	18.2	767.9	GP-3A	102.2	73.4	-21.5	DT	-1.7	DT	10.7	136.0	26 / 72
Naphthalene	µg/kg	12,000,000.0	11.6	233.1	GP-29B	45.7	44.4	-4.2	DT	-1.4	DT	10.7	213.4	15 / 64
Phenanthrene [3]	µg/kg	180,000,000.0	11.0	48,900.0	GP-3A	2,367.6	308.8	-57.9	DT	-4.7	DT	10.7	128.0	40 / 73
Pyrene	µg/kg	18,000,000.0	15.7	15,000.0	GP-3A	943.9	316.6	-48.2	DT	-3.4	DT	10.7	128.0	41 / 73

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Notes:

[1] NE denotes that no screening criteria was established.

[2] Value is the USEPA Region IX Residential Soil Preliminary Remediation Goal.

[3] Acenpathene was used as a surrogate for Acenaphthylene.
Pyrene was used as a surrogate for Benzo(g,h,I)perylene.
Anthracene was used as a surrogate for Phenanthrene.

[4] For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied.
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.

[5] DT = D'Agostino's Test; acceptable value must fall within the lower bound (-2.8) and upper bound (0.9) values

Table 14
Statistical Analysis
Indoor Worker - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Indoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[5]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Metals														
Cadmium	mg/kg	2,000.0	1.6	47.1	GP-33A	15.4	9.8	0.8	0.9	0.9	0.9	0.6	0.6	21 / 24
Lead	mg/kg	1,079.0	5.8	28,200.0	GP-12A	7,322.6	2,466.8	0.7	0.9	0.9	0.9	NA	NA	24 / 24
Tantalum	mg/kg	NE[1]	6.2	398.7	GP-10A	80.3	14.8	0.3	0.9	0.6	0.9	6.0	6.2	10 / 19
VOCs														
Acetone	µg/kg	200,000,000.0	31.3	74.2	TB-7A	249.6	28.0	0.2	0.9	0.4	0.9	29.7	3,080.0	5 / 22
Carbon disulfide	µg/kg	200,000,000.0	8.8	45.8	GP-5A	53.0	5.9	0.3	0.9	0.4	0.9	6.1	615.0	3 / 21
Chloroethane	µg/kg	6500.0 (2)	11.0	11.0	TB-11A	14.1	18.3	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
Chloroform	µg/kg	940,000.0	11.3	24.8	TB-11A	57.1	5.3	0.3	0.9	0.4	0.9	6.1	615.0	2 / 19
1,1-Dichloroethane	µg/kg	200,000,000.0	57.8	57.8	TB-11A	79.4	185.0	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
1,2-Dichloroethane	µg/kg	63,000.0	10.3	10.3	TB-11A	13.2	16.7	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
1,1-Dichloroethene	µg/kg	10,000.0	7.8	23.9	TB-4A	47.3	5.0	0.2	0.9	0.4	0.9	6.0	615.0	3 / 22
Cis-1,2-Dichloroethene	µg/kg	20,000,000.0	6.5	6,930.0	TB-4A	1,392.8	56.8	0.4	0.9	0.8	0.9	6.0	615.0	11 / 26
Trans-1,2-Dichloroethene	µg/kg	41,000,000.0	19.0	99.8	TB-4A	54.7	9.2	0.3	0.9	0.7	0.9	6.0	615.0	4 / 24
Methylene Chloride	µg/kg	760,000.0	6.4	7.0	GP-3A	5.1	4.7	0.6	0.8	0.6	0.8	6.1	6.2	2 / 9
Tetrachloroethene	µg/kg	110,000.0	6.2	116,000.0	GP-3A	14,393.1	38.9	0.2	0.9	0.6	0.9	6.0	615.0	10 / 26
Toluene	µg/kg	410,000,000.0	7.3	12.2	TB-4A	4.8	4.4	0.3	0.9	0.3	0.9	6.1	6.2	2 / 20
1,1,1-Trichloroethane	µg/kg	1,200,000.0 (2)	13.0	132.5	GP-26A	51.4	6.5	0.3	0.9	0.4	0.9	6.0	615.0	3 / 26
Trichloroethene	µg/kg	520,000.0	6.8	413,000.0	TB-7A	62,001.1	1,598.4	0.4	0.9	0.9	0.9	6.0	108.8	19 / 26
Trichlorofluoromethane	µg/kg	2,000,000.0 (2)	74.4	74.4	TB-35A	692.4	14,165.2	NA[4]	NA	NA	NA	615.0	615.0	1 / 3
Vinyl Chloride	µg/kg	8,000.0	7.4	21.6	GP-3A	43.0	5.7	0.2	0.9	0.4	0.9	6.0	615.0	5 / 26
SVOCs (PAHs)														
Acenaphthene	µg/kg	120,000,000.0	67.8	72,000.0	GP-3A	10,247.9	904.9	0.3	0.9	0.9	0.9	10.7	125.0	20 / 24
Acenapthylene [3]	µg/kg	120,000,000.0	533.0	72,000.0	GP-3A	34,845.8	5,991.1	0.5	0.8	0.8	0.8	246.0	1,230.0	2 / 7
Anthracene	µg/kg	610,000,000.0	24.8	8,450.0	GP-3A	1,269.2	217.0	0.3	0.9	0.9	0.9	10.7	246.0	13 / 24
Benzo (a) anthracene	µg/kg	8,000.0	41.5	2,400.0	GP-3A	617.8	297.1	0.7	0.9	1.0	0.9	10.7	125.0	15 / 24
Benzo (a) pyrene	µg/kg	800.0	47.1	1,470.0	GP-3A	588.7	331.0	0.8	0.9	0.9	0.9	10.7	113.0	16 / 24
Benzo (b) fluoranthene	µg/kg	8,000.0	46.1	1,160.0	GP-3A	526.2	322.9	0.8	0.9	0.9	0.9	10.7	125.0	15 / 24
Benzo (ghi) perylene [3]	µg/kg	61,000,000.0	46.5	910.2	GP-8A	459.7	297.6	0.8	0.9	0.9	0.9	10.7	125.0	17 / 24
Benzo (k) fluoranthene	µg/kg	78,000.0	21.3	606.0	GP-3A	266.2	176.9	0.8	0.9	0.9	0.9	10.7	156.0	12 / 24
Chrysene	µg/kg	780,000.0	49.2	5,310.0	GP-3A	1,103.7	408.4	0.5	0.9	1.0	0.9	10.7	125.0	16 / 24
Dibenzo (a,h) anthracene	µg/kg	800.0	28.7	819.4	GP-14A	221.5	128.5	0.6	0.9	1.0	0.9	10.7	140.0	12 / 24
Fluoranthene	µg/kg	82,000,000.0	93.8	29,900.0	GP-3A	4,856.3	1,012.7	0.4	0.9	1.0	0.9	10.7	125.0	18 / 24
Fluorene	µg/kg	82,000,000.0	36.1	9,089.8	GP-3A	1,290.8	159.9	0.2	0.9	0.8	0.9	10.7	156.0	12 / 24

Table 14
Statistical Analysis
Indoor Worker - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Indoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[5]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Indeno (1,2,3-c,d) pyrene	µg/kg	8,000.0	37.9	767.9	GP-3A	235.1	153.2	0.7	0.9	1.0	0.9	10.7	125.0	14 / 24
Naphthalene	µg/kg	41,000,000.0	21.7	91.8	GP-26A	56.2	43.8	0.9	0.9	0.9	0.9	10.7	213.4	7 / 24
Phenanthrene [3]	µg/kg	610,000,000.0	62.7	48,900.0	GP-3A	7,046.8	763.6	0.3	0.9	0.9	0.9	10.7	125.0	18 / 24
Pyrene	µg/kg	61,000,000.0	82.8	15,000.0	GP-3A	2,518.0	614.4	0.4	0.9	1.0	0.9	10.7	125.0	18 / 24

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Notes:

[1] NE denotes that no screening criteria was established.

[2] Value is the USEPA Region IX Residential Soil Preliminary Remediation Goal.

[3] Acenpathene was used as a surrogate for Acenaphthylene.
Pyrene was used as a surrogate for Benzo(g,h,I)perylene.
Anthracene was used as a surrogate for Phenanthrene.

[4] NA = Not Applicable due to insufficient data to calculate statistics

[5] For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied.
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.

Table 13
Statistical Analysis
Outdoor Worker - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Metals [5]														
Cadmium	mg/kg	3,400.0	1.6	47.1	GP-33A	15.4	9.8	0.8	0.9	0.9	0.9	0.6	0.6	21 / 24
Lead	mg/kg	NE[1]	5.8	28,200.0	GP-12A	7,322.6	2,466.8	0.7	0.9	0.9	0.9	NA	NA	24 / 24
Tantalum	mg/kg	NE	6.2	398.7	GP-10A	80.3	14.8	0.3	0.9	0.6	0.9	6.0	6.2	10 / 19
VOCs [6]														
Acetone	µg/kg	NE	31.3	118.0	TB-35B	25.9	21.6	-74.2	DT	-47.1	DT	3.1	3080.0	9 / 105
Benzene	µg/kg	1,000.0	6.1	10.5	GP-8D	4.8	4.2	-51.5	DT	105.6	DT	6.0	6.8	6 / 62
2-Butanone	µg/kg	NE	21.6	21.6	TB-35B	50.0	959.0	NA[2]	NA	NA	NA	12.8	12.8	1 / 2
Carbon disulfide	µg/kg	720,000.0	6.2	688.2	GP-12I	51.4	11.9	-47.0	DT	-17.8	DT	5.9	615.0	49 / 117
Chloroethane	µg/kg	NE	11.0	11.0	TB-11A	17.1	34.4	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
Chloroform	µg/kg	500.0	11.3	24.8	TB-11A	6.5	4.2	0.2	0.9	0.3	0.9	6.1	615.0	2 / 36
Chloromethane	µg/kg	NE	7.3	7.3	GP-32D	4.7	4.1	-48.5	DT	241.5	DT	6.1	6.8	1 / 65
1,1-Dichloroethane	µg/kg	1,700,000.0	26.6	57.8	TB-11A	15.8	7.2	0.4	0.9	0.4	0.9	6.0	6.1	2 / 17
1,2-Dichloroethane	µg/kg	600.0	10.3	10.3	TB-11A	16.5	32.6	0.8	0.8	0.8	0.8	6.0	6.1	1 / 4
1,1-Dichloroethene	µg/kg	100.0	7.3	86.1	GP-8D	9.3	4.6	-76.4	DT	-51.9	DT	5.9	615.0	14 / 120
Cis-1,2-Dichloroethene	µg/kg	NE	6.5	185000.0	GP-14F	7390.1	27.4	-71.2	DT	-19.5	DT	5.9	615.0	38 / 122
Trans-1,2-Dichloroethene	µg/kg	NE	6.8	6230.0	GP-15G	240.2	8.1	-70.0	DT	-32.8	DT	5.9	615.0	21 / 120
Ethylbenzene	µg/kg	400,000.0	7.1	166.0	GP-3D	5.0	4.4	0.3	0.9	0.3	0.9	6.1	6.8	5 / 62
Methylene Chloride	µg/kg	22,000.0	6.4	353.3	GP-30I	17.1	4.3	-67.0	DT	-58.8	DT	6.0	6.2	8 / 89
p-Isopropyltoluene	µg/kg	NE	18.8	18.8	GP-14F	5.4	4.5	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
n-Propylbenzene	µg/kg	NE	9.3	9.3	GP-14F	5.1	4.4	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
Styrene	µg/kg	1,500,000.0	29.8	29.8	GP-36C	12.7	9.4	0.4	0.8	0.4	0.8	6.1	6.1	1 / 12
Tetrachloroethene	µg/kg	18,000.0	6.2	116000.0	GP-3	3311.4	8.2	-82.1	DT	-45.6	DT	5.9	21600.0	23 / 122
Toluene	µg/kg	650,000.0	7.0	95.2	GP-14E	8.2	4.2	-58.8	DT	-52.7	DT	6.1	6.8	7 / 89
1,2,4-Trichlorobenzene	µg/kg	3,200,000.0	8.3	494.4	GP-32F	31.2	4.4	-55.0	DT	-52.2	DT	6.1	6.8	3 / 63
1,1,1-Trichloroethane	µg/kg	1,200,000.0	8.9	1630.0	GP-8D	49.5	4.4	-78.8	DT	-62.8	DT	5.9	615.0	7 / 122
1,1,2-Trichloroethane	µg/kg	2,000.0	31.4	44.3	GP-37F	9.4	4.9	0.2	0.9	0.2	0.9	6.0	6.1	2 / 33
Trichloroethene	µg/kg	8,000.0	6.8	1310000.0	GP-14F	45152.2	85.2	-74.7	DT	-10.7	DT	6.0	247.8	50 / 121
1,2,4-Trimethylbenzene	µg/kg	NE	30.3	70.4	GP-14F	9.2	4.3	0.2	0.9	0.2	0.9	6.1	6.8	2 / 47
Trichlorofluoromethane	µg/kg	NE	74.4	74.4	TB-35A	20.5	8.9	0.2	0.9	0.2	0.9	6.1	615.0	1 / 14

Table 13
Statistical Analysis
Outdoor Worker - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Vinyl Chloride	µg/kg	1,000.0	6.8	1210.0	GP-15H	59.2	6.3	-61.0	DT	-41.0	DT	5.9	615.0	21 / 122
Total Xylenes	µg/kg	NE	18.0	18.0	GP-14E	10.1	10.9	0.5	0.9	0.4	0.9	6.1	13.6	1 / 47
SVOCs (PAHs) [6,7]														
Acenaphthene	µg/kg	NE	11.2	72000.0	GP-3	4028.5	106.8	-52.1	DT	-3.4	DT	10.7	128.0	33 / 63
Acenapthylene	µg/kg	NE	533.0	72000.0	GP-3	38922.9	74410.9	0.2	0.9	0.5	0.9	246.0	1230.0	2 / 7
Anthracene	µg/kg	NE	15.7	8450.0	GP-3	509.7	31.8	-48.5	DT	-4.8	DT	10.7	156.0	22 / 63
Fluorene	µg/kg	NE	36.1	9089.8	GP-3	543.6	23.2	-49.5	DT	-1.0	DT	0.0	156.0	15 / 58
Naphthalene	µg/kg	240,000.0	13.2	233.1	GP-29B	26.3	12.2	-9.5	DT	-3.0	DT	10.7	213.4	12 / 58
Phenanthrene	µg/kg	NE	19.4	48900.0	GP-3	2809.2	92.8	-51.1	DT	-3.0	DT	10.7	128.0	31 / 63

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Notes:

(1) NE denotes that no screening criteria was established.

(2) NA = Not Applicable due to insufficient data to calculate statistics

(3) For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied.
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.

(4) DT = D'Agostino's Test; acceptable value must fall within the lower bound (-2.8) and upper bound (0.9) values

(5) Statistics are based on only shallow exposed soil because the receptor would only be exposed via fugitive emissions of the constituent adhered to particles from shallow exposed soil.

(6) Only constituents applicable for volatilization from soil into air are listed. That includes constituents with a molecular weight less than 200 and Henry's Law Constant greater than 1×10^{-5} atm m^3/mol.

(7) SVOCs are not evaluated via fugitive dust because the dermal/ingestion soil screening levels (SSLs) are often several orders of magnitude lower (i.e., more stringent) than the corresponding default fugitive dust SSLs.

Table 23
Statistical Analysis
Onsite Tresspasser - Inhalation/Groundwater
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Units	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmatic mean)	95% UCL (log normal)	Distribution Test		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
							W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
VOCs													
1,1,1-Trichloroethane	µg/l	2.3	157.0	TB-11A	676.3	2.0	0.2	0.9	0.4	0.9	2.0	10,000.0	2 / 25
1,1-Dichloroethane	µg/l	145.0	145.0	TB-11A	675.8	1.9	0.2	0.9	0.4	0.9	2.0	10,000.0	1 / 25
1,1-Dichloroethene	µg/l	5.3	13.2	TB-9	671.3	2.1	0.2	0.9	0.5	0.9	2.0	10,000.0	4 / 25
1,2-Dichloroethane	µg/l	9.7	9.7	TB-11A	670.3	1.4	0.2	0.9	0.4	0.9	2.0	10,000.0	1 / 25
Chloroethane	µg/l	3.8	3.8	TB-11A	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Chloroform	µg/l	2.1	2.1	TB-11A	670.0	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
1,2,4-Trimethylbenzene	µg/l	3.4	3.4	TB-15	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
1,3,5-Trimethylbenzene	µg/l	6.3	6.3	TB-15	670.1	1.3	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Cis-1,2-Dichloroethene	µg/l	2.6	66,500.0	TB-18	9,082.8	43.7	0.2	0.9	0.7	0.9	2.0	2.0	10 / 25
Methylene chloride	µg/l	125.0	125.0	TB-14	673.0	1.9	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Sec-Butylbenzene	µg/l	2.3	2.3	TB-15	670.0	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Tetrachloroethene	µg/l	10.4	133.0	TB-9	677.5	2.9	0.2	0.9	0.5	0.9	2.0	10,000.0	3 / 25
Toluene	µg/l	2.0	2.0	TB-4	670.0	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Trans-1,2-Dichloroethene	µg/l	4.8	65.3	TB-4	674.2	2.7	0.2	0.9	0.5	0.9	2.0	10,000.0	4 / 24
Trichloroethene	µg/l	3.0	1,190,000.0	TB-18	159,249.8	139.0	0.2	0.9	0.8	0.9	2.0	51.3	12 / 25
Vinyl Chloride	µg/l	9.9	59,900.0	TB-18	8,005.7	9.2	0.2	0.9	0.5	0.9	2.0	100.0	5 / 24

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Note:
NA = Not Applicable due to insufficient data to calculate statistics

Table 22
Statistical Analysis
Construction Worker - Inhalation/Groundwater
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Units	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
							W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
VOCs													
1,1,1-Trichloroethane	µg/l	2.3	157.0	TB-11A	469.1	2.2	0.2	0.9	0.4	0.9	2.0	10,000.0	4 / 35
1,1-Dichloroethane	µg/l	6.8	145.0	TB-11A	465.7	2.0	0.2	0.9	0.5	0.9	2.0	10,000.0	3 / 35
1,1-Dichloroethene	µg/l	5.3	13.2	TB-9	463.1	1.7	0.2	0.9	0.5	0.9	2.0	10,000.0	4 / 35
1,2-Dichloroethane	µg/l	9.7	9.7	TB-11A	462.3	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 35
Chloroethane	µg/l	3.8	3.8	TB-11A	462.2	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 35
Chloroform	µg/l	2.1	2.2	TB-33	462.2	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	2 / 35
1,2,4-Trimethylbenzene	µg/l	3.4	3.4	TB-15	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
1,3,5-Trimethylbenzene	µg/l	6.3	6.3	TB-15	670.1	1.3	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
Cis-1,2-Dichloroethene	µg/l	2.6	66,500.0	TB-18	6,266.8	15.1	0.2	0.9	0.7	0.9	2.0	2.0	11 / 35
Methylene chloride	µg/l	125.0	125.0	TB-14	673.0	2.0	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
Sec-Butylbenzene	µg/l	2.3	2.3	TB-15	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
Tetrachloroethene	µg/l	5.6	858.0	TB-38	497.2	3.7	0.2	0.9	0.6	0.9	2.0	10,000.0	7 / 35
Toluene	µg/l	2.0	2.0	TB-4	462.1	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 35
Trans-1,2-Dichloroethene	µg/l	4.8	65.3	TB-4	480.2	2.2	0.2	0.9	0.5	0.9	2.0	10,000.0	5 / 34
Trichloroethene	µg/l	2.8	1,190,000.0	TB-18	109,774.7	47.0	0.2	0.9	0.8	0.9	2.0	51.3	19 / 35
Vinyl Chloride	µg/l	9.9	59,900.0	TB-18	5,695.3	4.8	0.2	0.9	0.5	0.9	2.0	100.0	5 / 34

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Table 20
Statistical Analysis
Outdoor Worker - Inhalation/Groundwater
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Units	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmatic mean)	95% UCL (log normal)	Distribution Test		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
							W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
VOCs													
1,1,1-Trichloroethane	µg/l	2.3	157.0	TB-11A	676.3	2.0	0.2	0.9	0.4	0.9	2.0	10,000.0	2 / 25
1,1-Dichloroethane	µg/l	145.0	145.0	TB-11A	675.8	1.9	0.2	0.9	0.4	0.9	2.0	10,000.0	1 / 25
1,1-Dichloroethene	µg/l	5.3	13.2	TB-9	671.3	2.1	0.2	0.9	0.5	0.9	2.0	10,000.0	4 / 25
1,2-Dichloroethane	µg/l	9.7	9.7	TB-11A	670.3	1.4	0.2	0.9	0.4	0.9	2.0	10,000.0	1 / 25
Chloroethane	µg/l	3.8	3.8	TB-11A	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Chloroform	µg/l	2.1	2.1	TB-11A	670.0	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
1,2,4-Trimethylbenzene	µg/l	3.4	3.4	TB-15	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
1,3,5-Trimethylbenzene	µg/l	6.3	6.3	TB-15	670.1	1.3	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Cis-1,2-Dichloroethene	µg/l	2.6	66,500.0	TB-18	9,082.8	43.7	0.2	0.9	0.7	0.9	2.0	2.0	10 / 25
Methylene chloride	µg/l	125.0	125.0	TB-14	673.0	1.9	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Sec-Butylbenzene	µg/l	2.3	2.3	TB-15	670.0	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Tetrachloroethene	µg/l	10.4	133.0	TB-9	677.5	2.9	0.2	0.9	0.5	0.9	2.0	10,000.0	3 / 25
Toluene	µg/l	2.0	2.0	TB-4	670.0	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 25
Trans-1,2-Dichloroethene	µg/l	4.8	65.3	TB-4	674.2	2.7	0.2	0.9	0.5	0.9	2.0	10,000.0	4 / 24
Trichloroethene	µg/l	3.0	1,190,000.0	TB-18	159,249.8	139.0	0.2	0.9	0.8	0.9	2.0	51.3	12 / 25
Vinyl Chloride	µg/l	9.9	59,900.0	TB-18	8,005.7	9.2	0.2	0.9	0.5	0.9	2.0	100.0	5 / 24

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).
Note:
NA = Not Applicable due to insufficient data to calculate statistics

Table 18
Statistical Analysis
Onsite Tresspasser - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Residential (outdoor)	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[5]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Metals														
Cadmium	mg/kg	70.0	1.6	47.1	GP-33A	15.4	9.8	0.8	0.9	0.9	0.9	0.6	0.6	21 / 24
Lead	mg/kg	400.0	5.8	28,200.0	GP-12A	7,322.6	2,466.8	0.7	0.9	0.9	0.9	NA	NA	24 / 24
Tantalum	mg/kg	NE[1]	6.2	398.7	GP-10A	80.3	14.8	0.3	0.9	0.6	0.9	6.0	6.2	10 / 19
VOCs														
Acetone	µg/kg	7,800,000.0	31.3	74.2	TB-7A	249.6	28.0	0.2	0.9	0.4	0.9	29.7	3,080.0	5 / 22
Carbon disulfide	µg/kg	7,800,000.0	8.8	45.8	GP-5A	53.0	5.9	0.3	0.9	0.4	0.9	6.1	615.0	3 / 21
Chloroethane	µg/kg	3,000.0 [2]	11.0	11.0	TB-11A	14.1	18.3	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
Chloroform	µg/kg	100,000.0	11.3	24.8	TB-11A	57.1	5.3	0.3	0.9	0.4	0.9	6.1	615.0	2 / 19
1,1-Dichloroethane	µg/kg	7,800,000.0	57.8	57.8	TB-11A	79.4	185.0	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
1,2-Dichloroethane	µg/kg	7,000.0	10.3	10.3	TB-11A	13.2	16.7	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
1,1-Dichloroethene	µg/kg	1,000.0	7.8	23.9	TB-4A	47.3	5.0	0.2	0.9	0.4	0.9	6.0	615.0	3 / 22
Cis-1,2-Dichloroethene	µg/kg	780,000.0	6.5	6,930.0	TB-4A	1,392.8	56.8	0.4	0.9	0.8	0.9	6.0	615.0	11 / 26
Trans-1,2-Dichloroethene	µg/kg	1,600,000.0	19.0	99.8	TB-4A	54.7	9.2	0.3	0.9	0.7	0.9	6.0	615.0	4 / 24
Methylene Chloride	µg/kg	85,000.0	6.4	7.0	GP-3A	5.1	4.7	0.6	0.8	0.6	0.8	6.1	6.2	2 / 9
Tetrachloroethene	µg/kg	12,000.0	6.2	116,000.0	GP-3A	14,393.1	38.9	0.2	0.9	0.6	0.9	6.0	615.0	10 / 26
Toluene	µg/kg	16,000,000.0	7.3	12.2	TB-4A	4.8	4.4	0.3	0.9	0.3	0.9	6.1	6.2	2 / 20
1,1,1-Trichloroethane	µg/kg	1,200,000.0 [2]	13.0	132.5	GP-26A	51.4	6.5	0.3	0.9	0.4	0.9	6.0	615.0	3 / 26
Trichloroethene	µg/kg	58,000.0	6.8	413,000.0	TB-7A	62,001.1	1,598.4	0.4	0.9	0.9	0.9	6.0	108.8	19 / 26
Trichlorofluoromethane	µg/kg	390,000.0 [2]	74.4	74.4	TB-35A	692.4	14,165.2	NA[4]	NA	NA	NA	615.0	615.0	1 / 3
Vinyl Chloride	µg/kg	900.0	7.4	21.6	GP-3A	43.0	5.7	0.2	0.9	0.4	0.9	6.0	615.0	5 / 26
SVOCs (PAHs)														
Acenaphthene	µg/kg	3,400,000.0	67.8	72,000.0	GP-3A	10,247.9	904.9	0.3	0.9	0.9	0.9	10.7	125.0	20 / 24
Acenapthylene [3]	µg/kg	3,400,000.0	533.0	72,000.0	GP-3A	34,845.8	5,991.1	0.5	0.8	0.8	0.8	246.0	1,230.0	2 / 7
Anthracene	µg/kg	17,000,000.0	24.8	8,450.0	GP-3A	1,269.2	217.0	0.3	0.9	0.9	0.9	10.7	246.0	13 / 24
Benzo (a) anthracene	µg/kg	600.0	41.5	2,400.0	GP-3A	617.8	297.1	0.7	0.9	1.0	0.9	10.7	125.0	15 / 24
Benzo (a) pyrene	µg/kg	60.0	47.1	1,470.0	GP-3A	588.7	331.0	0.8	0.9	0.9	0.9	10.7	113.0	16 / 24
Benzo (b) fluoranthene	µg/kg	600.0	46.1	1,160.0	GP-3A	526.2	322.9	0.8	0.9	0.9	0.9	10.7	125.0	15 / 24
Benzo (ghi) perylene [3]	µg/kg	1,700,000.0	46.5	910.2	GP-8A	459.7	297.6	0.8	0.9	0.9	0.9	10.7	125.0	17 / 24
Benzo (k) fluoranthene	µg/kg	6,000.0	21.3	606.0	GP-3A	266.2	176.9	0.8	0.9	0.9	0.9	10.7	156.0	12 / 24
Chrysene	µg/kg	62,000.0	49.2	5,310.0	GP-3A	1,103.7	408.4	0.5	0.9	1.0	0.9	10.7	125.0	16 / 24
Dibenzo (a,h) anthracene	µg/kg	60.0	28.7	819.4	GP-14A	221.5	128.5	0.6	0.9	1.0	0.9	10.7	140.0	12 / 24
Fluoranthene	µg/kg	2,300,000.0	93.8	29,900.0	GP-3A	4,856.3	1,012.7	0.4	0.9	1.0	0.9	10.7	125.0	18 / 24

Table 18
Statistical Analysis
Onsite Tresspasser - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Residential (outdoor)	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[5]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Fluorene	µg/kg	2,300,000.0	36.1	9,089.8	GP-3A	1,290.8	159.9	0.2	0.9	0.8	0.9	10.7	156.0	12 / 24
Indeno (1,2,3-c,d) pyrene	µg/kg	600.0	37.9	767.9	GP-3A	235.1	153.2	0.7	0.9	1.0	0.9	10.7	125.0	14 / 24
Naphthalene	µg/kg	1,100,000.0	21.7	91.8	GP-26A	56.2	43.8	0.9	0.9	0.9	0.9	10.7	213.4	7 / 24
Phenanthrene [3]	µg/kg	17,000,000.0	62.7	48,900.0	GP-3A	7,046.8	763.6	0.3	0.9	0.9	0.9	10.7	125.0	18 / 24
Pyrene	µg/kg	1,700,000.0	82.8	15,000.0	GP-3A	2,518.0	614.4	0.4	0.9	1.0	0.9	10.7	125.0	18 / 24

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Notes:

[1] NE denotes that no screening criteria was established.

[2] Value is the USEPA Region IX Residential Soil Preliminary Remediation Goal

[3] Acenpathene was used as a surrogate for Acenaphthylene.
Pyrene was used as a surrogate for Benzo(g,h,I)perylene.
Anthracene was used as a surrogate for Phenanthrene.

[4] NA = Not Applicable due to insufficient data to calculate statistics

[5] For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.

Table 12
Statistical Analysis
Outdoor Worker - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[5]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Metals														
Cadmium	mg/kg	900.0	1.6	47.1	GP-33A	15.4	9.8	0.8	0.9	0.9	0.9	0.6	0.6	21 / 24
Lead	mg/kg	750.0	5.8	28,200.0	GP-12A	7,322.6	2,466.8	0.7	0.9	0.9	0.9	NA	NA	24 / 24
Tantalum	mg/kg	NE[1]	6.2	398.7	GP-10A	80.3	14.8	0.3	0.9	0.6	0.9	6.0	6.2	10 / 19
VOCs														
Acetone	µg/kg	110,000,000.0	31.3	74.2	TB-7A	249.6	28.0	0.2	0.9	0.4	0.9	29.7	3,080.0	5 / 22
Carbon disulfide	µg/kg	110,000,000.0	8.8	45.8	GP-5A	53.0	5.9	0.3	0.9	0.4	0.9	6.1	615.0	3 / 21
Chloroethane	µg/kg	6500.0 [2]	11.0	11.0	TB-11A	14.1	18.3	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
Chloroform	µg/kg	520,000.0	11.3	24.8	TB-11A	57.1	5.3	0.3	0.9	0.4	0.9	6.1	615.0	2 / 19
1,1-Dichloroethane	µg/kg	110,000,000.0	57.8	57.8	TB-11A	79.4	185.0	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
1,2-Dichloroethane	µg/kg	35,000.0	10.3	10.3	TB-11A	13.2	16.7	0.8	0.8	0.8	0.8	6.0	6.1	1 / 3
1,1-Dichloroethene	µg/kg	5,000.0	7.8	23.9	TB-4A	47.3	5.0	0.2	0.9	0.4	0.9	6.0	615.0	3 / 22
Cis-1,2-Dichloroethene	µg/kg	11,000,000.0	6.5	6,930.0	TB-4A	1,392.8	56.8	0.4	0.9	0.8	0.9	6.0	615.0	11 / 26
Trans-1,2-Dichloroethene	µg/kg	23,000,000.0	19.0	99.8	TB-4A	54.7	9.2	0.3	0.9	0.7	0.9	6.0	615.0	4 / 24
Methylene Chloride	µg/kg	420,000.0	6.4	7.0	GP-3A	5.1	4.7	0.6	0.8	0.6	0.8	6.1	6.2	2 / 9
Tetrachloroethene	µg/kg	61,000.0	6.2	116,000.0	GP-3A	14,393.1	38.9	0.2	0.9	0.6	0.9	6.0	615.0	10 / 26
Toluene	µg/kg	230,000,000.0	7.3	12.2	TB-4A	4.8	4.4	0.3	0.9	0.3	0.9	6.1	6.2	2 / 20
1,1,1-Trichloroethane	µg/kg	1,200,000.0 (2)	13.0	132.5	GP-26A	51.4	6.5	0.3	0.9	0.4	0.9	6.0	615.0	3 / 26
Trichloroethene	µg/kg	290,000.0	6.8	413,000.0	TB-7A	62,001.1	1,598.4	0.4	0.9	0.9	0.9	6.0	108.8	19 / 26
Trichlorofluoromethane	µg/kg	2,000,000.0 (2)	74.4	74.4	TB-35A	692.4	14,165.2	NA[4]	NA	NA	NA	615.0	615.0	1 / 3
Vinyl Chloride	µg/kg	4,000.0	7.4	21.6	GP-3A	43.0	5.7	0.2	0.9	0.4	0.9	6.0	615.0	5 / 26
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000.0	67.8	72,000.0	GP-3A	10,247.9	904.9	0.3	0.9	0.9	0.9	10.7	125.0	20 / 24
Acenapthylene [3]	µg/kg	37,000,000.0	533.0	72,000.0	GP-3A	34,845.8	5,991.1	0.5	0.8	0.8	0.8	246.0	1,230.0	2 / 7
Anthracene	µg/kg	180,000,000.0	24.8	8,450.0	GP-3A	1,269.2	217.0	0.3	0.9	0.9	0.9	10.7	246.0	13 / 24
Benzo (a) anthracene	µg/kg	2,000.0	41.5	2,400.0	GP-3A	617.8	297.1	0.7	0.9	1.0	0.9	10.7	125.0	15 / 24
Benzo (a) pyrene	µg/kg	200.0	47.1	1,470.0	GP-3A	588.7	331.0	0.8	0.9	0.9	0.9	10.7	113.0	16 / 24
Benzo (b) fluoranthene	µg/kg	2,000.0	46.1	1,160.0	GP-3A	526.2	322.9	0.8	0.9	0.9	0.9	10.7	125.0	15 / 24
Benzo (ghi) perylene [3]	µg/kg	18,000,000.0	46.5	910.2	GP-8A	459.7	297.6	0.8	0.9	0.9	0.9	10.7	125.0	17 / 24
Benzo (k) fluoranthene	µg/kg	23,000.0	21.3	606.0	GP-3A	266.2	176.9	0.8	0.9	0.9	0.9	10.7	156.0	12 / 24
Chrysene	µg/kg	230,000.0	49.2	5,310.0	GP-3A	1,103.7	408.4	0.5	0.9	1.0	0.9	10.7	125.0	16 / 24
Dibenzo (a,h) anthracene	µg/kg	200.0	28.7	819.4	GP-14A	221.5	128.5	0.6	0.9	1.0	0.9	10.7	140.0	12 / 24
Fluoranthene	µg/kg	24,000,000.0	93.8	29,900.0	GP-3A	4,856.3	1,012.7	0.4	0.9	1.0	0.9	10.7	125.0	18 / 24

Table 12
Statistical Analysis
Outdoor Worker - Soil Ingestion
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[5]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Fluorene	µg/kg	24,000,000.0	36.1	9,089.8	GP-3A	1,290.8	159.9	0.2	0.9	0.8	0.9	10.7	156.0	12 / 24
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000.0	37.9	767.9	GP-3A	235.1	153.2	0.7	0.9	1.0	0.9	10.7	125.0	14 / 24
Naphthalene	µg/kg	12,000,000.0	21.7	91.8	GP-26A	56.2	43.8	0.9	0.9	0.9	0.9	10.7	213.4	7 / 24
Phenanthrene [3]	µg/kg	180,000,000.0	62.7	48,900.0	GP-3A	7,046.8	763.6	0.3	0.9	0.9	0.9	10.7	125.0	18 / 24
Pyrene	µg/kg	18,000,000.0	82.8	15,000.0	GP-3A	2,518.0	614.4	0.4	0.9	1.0	0.9	10.7	125.0	18 / 24

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Notes:

[1] NE denotes that no screening criteria was established.

[2] Value is the USEPA Region IX Residential Soil Preliminary Remediation Goal.

[3] Acenpathene was used as a surrogate for Acenaphthylene.
Pyrene was used as a surrogate for Benzo(g,h,I)perylene.
Anthracene was used as a surrogate for Phenanthrene.

[4] NA = Not Applicable due to insufficient data to calculate statistics

[5] For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied.
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.

Table P-1
Cost Estimate
Alternative 4
Excavation, Retrieval, and Off-site Disposal

CAPITAL COST	Unit	Quantity	Unit Cost	Total
Planning and Preparation				
Characterization of Area/Material	Lump Sum	1	$15,000	$15,000
Project Admin and Management	Lump Sum	1	$5,000	$5,000
Health and Safety Supplies and Equip.	Lump Sum	1	$5,000	$5,000
Survey (Excavation and Verifaction)	Day	2	$2,000	$4,000
Construction (Excavation, Removoal, T&D)				
CQA	Lump Sum	1	$20,000	$20,000
Mobilization/Demobilization	Lump Sum	1	$5,000	$5,000
Site Preparation	Lump Sum	1	$10,000	
Concrete Removal	Lump Sum	1	$20,000	$20,000
Soil Removal	Lump Sum	1	$5,000	$5,000
Soil T&D (Haz)	Ton	15	$150	$2,250
Confirmation Sampling and Analysis	Lump Sum	1	$15,000	$15,000
Backfill Material	Cubic Yard	10	$7	$70
Placement and Compaction	Cubic Yard	10	$7	$70
Contingency Second Round	Lump Sum	1	$30,000	$30,000
Subtotal				$126,390
Contingency (15% of Capital Costs)				$18,959
Total Capital Costs				$145,000

ANNUAL O&M COSTS	Unit	Quantity	Unit Cost	Total
TOTAL CAPITAL COST				**$145,000**
PRESENT WORTH				**$145,000**
			Interest Rate	7%
			Term (years)	30

Table 21
Statistical Analysis
Indoor Worker - Inhalation/Groundwater
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Units	EPA Vapor Intrusion	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
VOCs														
1,1,1-Trichloroethane	µg/l	310	2.3	157.0	TB-11A	469.1	2.2	0.2	0.9	0.4	0.9	2.0	10,000.0	4 / 35
1,1-Dichloroethane	µg/l	220	6.8	145.0	TB-11A	465.7	2.0	0.2	0.9	0.5	0.9	2.0	10,000.0	3 / 35
1,1-Dichloroethene	µg/l	19	5.3	13.2	TB-9	463.1	1.7	0.2	0.9	0.5	0.9	2.0	10,000.0	4 / 35
1,2-Dichloroethane	µg/l	2.3	9.7	9.7	TB-11A	462.3	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 35
Chloroethane	µg/l	2800	3.8	3.8	TB-11A	462.2	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 35
Chloroform	µg/l	0.8	2.1	2.2	TB-33	462.2	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	2 / 35
1,2,4-Trimethylbenzene	µg/l	2.4	3.4	3.4	TB-15	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
1,3,5-Trimethylbenzene	µg/l	2.5	6.3	6.3	TB-15	670.1	1.3	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
Cis-1,2-Dichloroethene	µg/l	21	2.6	66,500.0	TB-18	6,266.8	15.1	0.2	0.9	0.7	0.9	2.0	2.0	11 / 35
Methylene chloride	µg/l	58	125.0	125.0	TB-14	673.0	2.0	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
Sec-Butylbenzene	µg/l	25	2.3	2.3	TB-15	670.0	1.2	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 24
Tetrachloroethene	µg/l	1.1	5.6	858.0	TB-38	497.2	3.7	0.2	0.9	0.6	0.9	2.0	10,000.0	7 / 35
Toluene	µg/l	15	2.0	2.0	TB-4	462.1	1.1	0.2	0.9	0.3	0.9	2.0	10,000.0	1 / 35
Trans-1,2-Dichloroethene	µg/l	18	4.8	65.3	TB-4	480.2	2.2	0.2	0.9	0.5	0.9	2.0	10,000.0	5 / 34
Trichloroethene	µg/l	0.053	2.8	1,190,000.0	TB-18	109,774.7	47.0	0.2	0.9	0.8	0.9	2.0	51.3	19 / 35
Vinyl Chloride	µg/l	0.25	9.9	59,900.0	TB-18	5,695.3	4.8	0.2	0.9	0.5	0.9	2.0	100.0	5 / 34

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Table 17
Statistical Analysis
Construction Worker - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
Metals [5]														
Cadmium	mg/kg	3,400.0	1.0	47.1	GP-33A	10.7	4.7	-10.7	DT[5]	3.8	DT	0.6	0.6	47 / 63
Lead	mg/kg	NE[1]	4.5	28,200.0	GP-12A	3,895.4	468.7	-22.1	DT	0.5	DT	3.1	3.1	73 / 74
Tantalum	mg/kg	NE	6.2	398.7	GP-10A	34.6	10.1	0.2	0.9	0.6	0.9	5.9	6.4	26 / 48
VOCs [6]														
Acetone	µg/kg	NE	31.3	182.8	GP-23C	51.0	21.5	-81.6	DT	-2.6	DT	3.1	3080.0	11 / 148
Benzene	µg/kg	1,000.0	6.1	10.5	GP-8D	4.7	4.1	-55.6	DT	102.3	DT	6.0	6.8	6 / 69
2-Butanone	µg/kg	NE	21.6	21.6	TB-35B	50.0	959.0	NA[2]	NA	NA	NA	12.8	12.8	1 / 2
Carbon disulfide	µg/kg	720,000.0	6.2	688.2	GP-12I	47.1	10.5	-49.6	DT	4.5	DT	5.5	615.0	60 / 156
Chloroethane	µg/kg	NE	11.0	11.0	TB-11A	13.8	19.7	0.7	0.7	0.7	0.7	6.0	6.1	1 / 3
Chloroform	µg/kg	500.0	8.5	24.8	TB-11A	5.5	3.9	-44.0	DT	-37.1	DT	5.5	615.0	4 / 66
Chloromethane	µg/kg	NE	7.3	7.3	GP-32D	4.4	3.9	-63.9	DT	-62.3	DT	5.5	287.0	1 / 91
1,1-Dichloroethane	µg/kg	1,700,000.0	26.6	57.8	TB-11A	11.8	5.5	0.3	0.9	0.3	0.9	6.0	6.1	2 /26
1,2-Dichloroethane	µg/kg	600.0	10.3	10.3	TB-11A	5.6	4.8	0.2	0.9	0.2	0.9	6.0	6.1	1 / 4
1,1-Dichloroethene	µg/kg	100.0	7.3	86.1	GP-8D	8.8	4.5	-70.9	DT	-51.7	DT	5.5	615.0	14 / 160
Cis-1,2-Dichloroethene	µg/kg	NE	6.5	185000.0	GP-14F	5485.6	16.7	-85.6	DT	-11.6	DT	5.5	615.0	42 / 165
Trans-1,2-Dichloroethene	µg/kg	NE	6.8	6230.0	GP-15G	181.8	6.4	-82.5	DT	6.0	DT	5.5	615.0	21 / 160
Ethylbenzene	µg/kg	400,000.0	7.1	166.0	GP-3D	5.0	4.4	0.3	0.9	0.3	0.9	6.0	6.8	5 / 63
Methylene Chloride	µg/kg	22,000.0	6.4	353.3	GP-30I	23.0	5.5	-56.4	DT	-44.6	DT	5.5	287.0	20 / 125
p-Isopropyltoluene	µg/kg	NE	18.8	18.8	GP-14F	5.4	4.5	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
n-Propylbenzene	µg/kg	NE	9.3	9.3	GP-14F	5.1	4.4	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
Styrene	µg/kg	1,500,000.0	29.8	29.8	GP-36C	6.5	4.9	0.2	0.9	0.3	0.9	5.5	287.0	1 / 38
Tetrachloroethene	µg/kg	18,000.0	6.2	116000.0	GP-3	3042.5	8.3	-91.2	DT	0.5	DT	5.5	21600.0	30 / 165
Toluene	µg/kg	650,000.0	7.0	95.2	GP-14E	6.8	3.9	-68.9	DT	56.4	DT	5.5	287.0	8 / 125
1,2,4-Trichlorobenzene	µg/kg	3,200,000.0	8.3	494.4	GP-32F	23.4	4.0	-59.3	DT	-56.0	DT	5.5	287.0	3 / 87
1,1,1-Trichloroethane	µg/kg	1,200,000.0	8.9	1630.0	GP-8D	37.4	4.1	-89.3	DT	33.1	DT	5.5	615.0	8 / 165
1,1,2-Trichloroethane	µg/kg	2,000.0	31.4	44.3	GP-37F	6.4	3.8	-49.7	DT	-43.7	DT	5.5	287.0	2 / 66
Trichloroethene	µg/kg	8,000.0	6.8	1310000.0	GP-14F	33507.6	50.5	-89.4	DT	-16.6	DT	5.5	247.8	63 / 164
1,2,4-Trimethylbenzene	µg/kg	NE	30.3	70.4	GP-14F	9.2	4.3	0.2	0.9	0.2	0.9	6.1	287.0	2 / 47
Trichlorofluoromethane	µg/kg	NE	74.4	74.4	TB-35A	20.5	8.9	0.2	0.9	0.2	0.9	615.0	615.0	1 / 3
Vinyl Chloride	µg/kg	1,000.0	6.8	1210.0	GP-15H	44.7	5.3	-71.3	DT	-52.4	DT	5.5	615.0	21 / 134
Total Xylenes	µg/kg	NE	18.0	18.0	GP-14E	10.1	10.9	0.5	0.9	0.4	0.9	6.1	13.6	1 / 47

Table 17
Statistical Analysis
Construction Worker - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs Outdoor Worker	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
								W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
SVOCs (PAHs)[6,7]														
Acenaphthene	µg/kg	NE	11.2	72000.0	GP-3	2775.4	66.9	-67.1	DT	-4.2	DT	10.7	128.0	45 / 92
Acenapthylene	µg/kg	NE	533.0	72000.0	GP-3	33571.5	27342.9	0.2	0.9	0.6	0.9	246.0	1230.0	2 / 7
Anthracene	µg/kg	NE	15.7	8450.0	GP-3	361.4	22.9	-61.0	DT	-5.1	DT	10.7	136.0	30 / 89
Fluorene	µg/kg	NE	11.1	9089.8	GP-3	401.0	18.2	-59.9	DT	-1.4	DT	0.0	136.0	21 / 79
Naphthalene	µg/kg	240,000.0	11.6	233.1	GP-29B	21.2	10.4	-8.4	DT	-3.5	DT	10.7	213.4	15 / 79
Phenanthrene	µg/kg	NE	11.0	48900.0	GP-3	1936.4	58.1	-65.9	DT	-4.3	DT	10.7	128.0	43 / 92

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).
Notes:
(1) NE denotes that no screening criteria was established.
(2) NA = Not Applicable due to insufficient data to calculate statistics
(3) For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied.
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.
(4) DT = D'Agostino's Test; acceptable value must fall within the lower bound (-2.8) and upper bound (0.9) values
(5) Statistics are based on only shallow exposed soil because the receptor would only be exposed via fugitive emissions of the constituent adhered to particles from shallow exposed soil.
(6) Only constituents applicable for volatilization from soil into air are listed. That includes constituents with a molecular weight less than 200 and Henry's Law Constant greater than 1 x 10^{-5} atm m^3/mol.
(7) SVOCs are not evaluated via fugitive dust because the dermal/ingestion soil screening levels (SSLs) are often several orders of magnitude lower (i.e., more stringent) than the corresponding default fugitive dust SSLs.

Table 15
Statistical Analysis
Indoor Worker - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
							W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
VOCs [6]													
Acetone	µg/kg	31.3	182.8	GP-23C	51.0	21.5	-81.6	DT	-2.6	DT	3.1	3080.0	11 / 148
Benzene	µg/kg	6.1	10.5	GP-8D	4.7	4.1	-55.6	DT	102.3	DT	6.0	6.8	6 / 69
2-Butanone	µg/kg	21.6	21.6	TB-35B	50.0	959.0	NA[2]	NA	NA	NA	12.8	12.8	1 / 2
Carbon disulfide	µg/kg	6.2	688.2	GP-12I	47.1	10.5	-49.6	DT	4.5	DT	5.5	615.0	60 / 156
Chloroethane	µg/kg	11.0	11.0	TB-11A	13.8	19.7	0.7	0.7	0.7	0.7	6.0	6.1	1 / 3
Chloroform	µg/kg	8.5	24.8	TB-11A	5.5	3.9	-44.0	DT	-37.1	DT	5.5	615.0	4 / 66
Chloromethane	µg/kg	7.3	7.3	GP-32D	4.4	3.9	-63.9	DT	-62.3	DT	5.5	287.0	1 / 91
1,1-Dichloroethane	µg/kg	26.6	57.8	TB-11A	11.8	5.5	0.3	0.9	0.3	0.9	6.0	6.1	2 /26
1,2-Dichloroethane	µg/kg	10.3	10.3	TB-11A	5.6	4.8	0.2	0.9	0.2	0.9	6.0	6.1	1 / 4
1,1-Dichloroethene	µg/kg	7.3	86.1	GP-8D	8.8	4.5	-70.9	DT	-51.7	DT	5.5	615.0	14 / 160
Cis-1,2-Dichloroethene	µg/kg	6.5	185000.0	GP-14F	5485.6	16.7	-85.6	DT	-11.6	DT	5.5	615.0	42 / 165
Trans-1,2-Dichloroethene	µg/kg	6.8	6230.0	GP-15G	181.8	6.4	-82.5	DT	6.0	DT	5.5	615.0	21 / 160
Ethylbenzene	µg/kg	7.1	166.0	GP-3D	5.0	4.4	0.3	0.9	0.3	0.9	6.0	6.8	5 / 63
Methylene Chloride	µg/kg	6.4	353.3	GP-30I	23.0	5.5	-56.4	DT	-44.6	DT	5.5	287.0	20 / 125
p-Isopropyltoluene	µg/kg	18.8	18.8	GP-14F	5.4	4.5	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
n-Propylbenzene	µg/kg	9.3	9.3	GP-14F	5.1	4.4	0.2	0.9	0.2	0.9	6.1	6.8	1 / 47
Styrene	µg/kg	29.8	29.8	GP-36C	6.5	4.9	0.2	0.9	0.3	0.9	5.5	287.0	1 / 38
Tetrachloroethene	µg/kg	6.2	116000.0	GP-3	3042.5	8.3	-91.2	DT	0.5	DT	5.5	21600.0	30 / 165
Toluene	µg/kg	7.0	95.2	GP-14E	6.8	3.9	-68.9	DT	56.4	DT	5.5	287.0	8 / 125
1,2,4-Trichlorobenzene	µg/kg	8.3	494.4	GP-32F	23.4	4.0	-59.3	DT	-56.0	DT	5.5	287.0	3 / 87
1,1,1-Trichloroethane	µg/kg	8.9	1630.0	GP-8D	37.4	4.1	-89.3	DT	33.1	DT	5.5	615.0	8 / 165
1,1,2-Trichloroethane	µg/kg	31.4	44.3	GP-37F	6.4	3.8	-49.7	DT	-43.7	DT	5.5	287.0	2 / 66
Trichloroethene	µg/kg	6.8	1310000.0	GP-14F	33507.6	50.5	-89.4	DT	-16.6	DT	5.5	247.8	63 / 164
1,2,4-Trimethylbenzene	µg/kg	30.3	70.4	GP-14F	9.2	4.3	0.2	0.9	0.2	0.9	6.1	287.0	2 / 47
Trichlorofluoromethane	µg/kg	74.4	74.4	TB-35A	20.5	8.9	0.2	0.9	0.2	0.9	615.0	615.0	1 / 3
Vinyl Chloride	µg/kg	6.8	1210.0	GP-15H	44.7	5.3	-71.3	DT	-52.4	DT	5.5	615.0	21 / 134
Total Xylenes	µg/kg	18.0	18.0	GP-14E	10.1	10.9	0.5	0.9	0.4	0.9	6.1	13.6	1 / 47

Table 15
Statistical Analysis
Indoor Worker - Soil Inhalation
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	Minimum Detected Value	Maximum Detected Value	Location of Maximum Detected Value	95% UCL (arithmetic mean)	95% UCL (log normal)	Distribution Test[3]		Log Normal Distribution Test		Minimum Non-Detect Value	Maximum Non-Detect Value	Frequency of Detection (No. of Hits / No. of Analyses)
							W_{value} (calculated)	$W_{0.05}$ (acceptable)	W_{value} (calculated)	$W_{0.05}$ (acceptable)			
SVOCs (PAHs)[6]													
Acenaphthene	µg/kg	11.2	72000.0	GP-3	2775.4	66.9	-67.1	DT	-4.2	DT	10.7	128.0	45 / 92
Acenapthylene	µg/kg	533.0	72000.0	GP-3	33571.5	27342.9	0.2	0.9	0.6	0.9	246.0	1230.0	2 / 7
Anthracene	µg/kg	15.7	8450.0	GP-3	361.4	22.9	-61.0	DT	-5.1	DT	10.7	136.0	30 / 89
Fluorene	µg/kg	11.1	9089.8	GP-3	401.0	18.2	-59.9	DT	-1.4	DT	0.0	136.0	21 / 79
Naphthalene	µg/kg	11.6	233.1	GP-29B	21.2	10.4	-8.4	DT	-3.5	DT	10.7	213.4	15 / 79
Phenanthrene	µg/kg	11.0	48900.0	GP-3	1936.4	58.1	-65.9	DT	-4.3	DT	10.7	128.0	43 / 92

Shaded cells indicate the value used as the exposure point concentration (EPC).
Bold analyte name indicates that the parameter is a constituent of concern (COC).

Notes:

(3) For sample populations less than 50, the Shapiro-Wilk Test (distribution test) was applied.
For sample populations greater than 50, the D'Agostino's Test (distribution test) was applied.

(4) DT = D'Agostino's Test; acceptable value must fall within the lower bound (-2.8) and upper bound (0.9) values

(6) Only constituents applicable for volatilization from soil into air are listed. That includes constituents with a molecular weight less than 200 and Henry's Law Constant greater than 1×10^{-5} atm m^3/mol.

Table 3A
Summary of Detected Constituents in Shallow Soils
Hazardous Waste Management Unit and Aboveground Storage Tank Areas
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date							
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-10 GP-10A (0-1')[3,4] 4/9/2000		GP-12 GP-12A (0-1') 4/9/2000		GP-13 GP-13A (0-1') 4/9/2000		GP-14 GP-14A (0-1') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Cadmium[5]	mg/kg	900	3,400	2,000	23.8		2.9	J	15.8		12.4	
Lead	mg/kg	750[6]	NE	1079[7]	**2,850**		**28,200**	J	**1,850**		**3,560**	
Tantalum	mg/kg	NE	NE	NE	398.7	J	74.3	J	6.1	U	7.5	
VOCs												
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	30.7	U	30.7	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	6.1	U	6.1	U	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	6.1	U	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	305	J	6.1	U	6.1	U	2,770	J
Chloroform	µg/kg	520,000	500	940,000	6.1	U	6.1	U	6.1	U	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	41.2	J	6.1	U	6.1	U	39.9	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.2	J	6.1	U	6.1	U	63.4	J
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	84.3	J	6.1	U	109	U	**18,000**	J
Trichlorofluoromethane	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	6.1	U	6.1	U
SVOCs (PAHs)												
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	305		10.7	U	107		373	
Anthracene	µg/kg	180,000,000	NE	610,000,000	83		10.7	U	21.3	U	59.1	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	142		10.7	U	50.2		53.4	U
Benzo (a) pyrene	µg/kg	200	NE	800	**616**		10.7	U	49.3		53.4	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	567		10.7	U	81.9		53.4	U
Benzo (ghi) perylene	µg/kg	-	NE	NE	761		10.7	U	76.9		408	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	193		10.7	U	21.3	U	53.4	U
Chrysene	µg/kg	230,000	NE	780,000	224		10.7	U	95.7		53.4	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	140		10.7	U	21.3	U	**819**	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	486		10.7	U	380		570	
Fluorene	µg/kg	24,000,000	NE	82,000,000	36.1		10.7	U	21.3	U	53.4	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	40.1		10.7	U	62.2		106	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	21.3	U	10.7	U	31.5		53.4	U
Phenanthrene	µg/kg	NE	NE	NE	194		10.7	U	112		283	
Pyrene	µg/kg	18,000,000	NE	61,000,000	319		10.7	U	90.3		319	

See footnotes at end of table.

Table 3A
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date							
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-15 GP-15A (0-1') 4/9/2000		GP-25 GP-25A (0-1') 4/9/2000		GP-26 GP-26A (0-1') 4/9/2000		GP-27 GP-27A (0-1') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Cadmium	mg/kg	900	3,400	2,000	8.9		0.6	U	14.2		26.6	
Lead	mg/kg	750[6]	NE	1079[7]	**2,290**		17.3		**3,140**		**9,990**	
Tantalum	mg/kg	NE	NE	NE	6.1	U	6.1	U	11.9		6.1	U
VOCs												
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	31.3	J	45.3	
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	8.8		6.1	U	6.1	UJ	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	7.8	J	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	8.1	U	7.4	U	136	UJ	6.1	U
Chloroform	µg/kg	520,000	500	940,000	6.1	U	6.1	U	6.1	UJ	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	U	40.7	UJ	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	18.9		6.1	U	14.5	J	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	132	J	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	3,720		6.1	U	**38,400**		6.1	U
Trichlorofluoromethane	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	UJ	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	7.4	J	6.1	U
SVOCs (PAHs)												
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	316		124		2,800	J	81.5	
Anthracene	µg/kg	180,000,000	NE	610,000,000	110		53.4	U	683	J	24.8	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	173		78.4		1,180	J	41.5	
Benzo (a) pyrene	µg/kg	200	NE	800	171		79.7		**1,240**	J	47.1	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	147		179		1,020	J	46.1	
Benzo (ghi) perylene	µg/kg	-	NE	NE	128		96.5		891	J	46.5	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	76		53.4	U	572	J	21.3	
Chrysene	µg/kg	230,000	NE	780,000	191		177		1,530	J	49.2	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	28.7		53.4	U	**312**	J	10.7	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	442		399		3,850	J	110	
Fluorene	µg/kg	24,000,000	NE	82,000,000	55.4		53.9		435	J	10.7	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	67.1		53.4	U	594	J	37.9	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	21.7		85.7		92	J	10.7	U
Phenanthrene	µg/kg	NE	NE	NE	321		605		2,940	J	62.7	
Pyrene	µg/kg	18,000,000	NE	61,000,000	302		166		2,520	J	82.8	

See footnotes at end of table.

Table 3A
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-28/MW-4 GP-28A (0-1') 4/9/2000		GP-34 GP-34A (0-1') 4/9/2000		GP-35 GP-35A (0-1') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals										
Cadmium	mg/kg	900	3,400	2,000	23.7		-[9]		-	
Lead	mg/kg	750[6]	NE	1079[7]	**5,030**		-		-	
Tantalum	mg/kg	NE	NE	NE	11.6		-		-	
VOCs										
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U,R	30.7	U,R	30.7	U,R
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	6.1	UJ	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	UJ	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	21.6	J	6.1	U
Chloroform	µg/kg	520,000	500	940,000	6.1	U	6.1	UJ	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	UJ	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	UJ	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	13.0	J	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	29.2		**31,400**	J	6.1	U
Trichlorofluoromethane	µg/kg	NE	NE	NE	6.1	U	6.1	UJ	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	UJ	6.1	U
SVOCs (PAHs)										
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	558		-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	62.7		-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	282		-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	**313**		-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	323		-		-	
Benzo (ghi) perylene	µg/kg	-	NE	NE	251		-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	136		-		-	
Chrysene	µg/kg	230,000	NE	780,000	369		-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	42.3		-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	1,090		-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	110		-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	132		-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	21.3	U	-		-	
Phenanthrene	µg/kg	NE	NE	NE	601		-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	493		-		-	

See footnotes at end of table.

Table 3A
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	TB-14A (0.0-4.0'/1.0-2.0') 6/1/2001		TB-14A (0.0-4.0'/1.0-2.0') - DUP 6/1/2001		TB-35A (0.0-4.0'/3.0-3.4') 6/4/2001	
					Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals										
Cadmium	mg/kg	900	3,400	2,000	11.9		17.2		3.1	J
Lead	mg/kg	750[6]	NE	1079[7]	**1,760**		**2,850**		**7,820**	J
Tantalum	mg/kg	NE	NE	NE	6.2	U	6.2	U	7.8	U, R
VOCs										
Acetone	µg/kg	110,000,000	NE	200,000,000	3,080	U	7,710	U	55	J
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	615	U	1,540	U	8	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	615	U	1,540	U	8	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	615	U	1,540	U	8	U
Chloroform	µg/kg	520,000	500	940,000	615	U	1,540	U	11	J
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	615	U	1,540	U	8	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	615	U	1,540	U	8	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	615	U	1,540	U	75	J
Trichloroethene	µg/kg	290,000	8,000	520,000	**63,100**		**80,600**		49	J
Trichlorofluoromethane	µg/kg	NE	NE	NE	615	U	1,540	U	74	J
Vinyl Chloride	µg/kg	4,000	1,000	8,000	615	U	1,540	U	20	J
SVOCs (PAHs)										
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	149		123	U	609	J
Anthracene	µg/kg	180,000,000	NE	610,000,000	123	U	123	U	156	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	123	U	123	U	269	J
Benzo (a) pyrene	µg/kg	200	NE	800	111	U	111	U	**273**	J
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	123	U	123	U	283	J
Benzo (ghi) perylene	µg/kg	-	NE	NE	123	U	123	U	173	J
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	123	U	123	U	156	U
Chrysene	µg/kg	230,000	NE	780,000	123	U	123	U	285	J
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	111	U	111	U	140	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	123	U	123	U	578	J
Fluorene	µg/kg	24,000,000	NE	82,000,000	123	U	123	U	156	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	123	U	123	U	165	J
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	123	U	123	U	156	U
Phenanthrene	µg/kg	NE	NE	NE	123	U	123	U	447	J
Pyrene	µg/kg	18,000,000	NE	61,000,000	123	U	123	U	472	J

See footnotes at end of table.

Table 3A
(Continued)

Footnotes:

(1) *Footnote 1 not used.*

(2) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft, US EPA Office of Solid Waste and Emergency Response, March 2001. http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf

(3) 2000 data collected by Carlson Environmental, Inc.

(4) Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval over which metals and SVOC samples were composited. The second interval represents the depth range from which VOC samples were collected based on PID screening.

(5) Bolded and shaded results denote an exceedence of a screening criteria.

(6) The Residential level for onsite trespasser (400 mg/kg) will be used to determine if lead is a constituent of concern.

(7) Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), Technical Review Workgroup for Lead; March 2002.

(8) NE denotes that no screening criteria was established.

(9) Dash denotes not analyzed.

J - Reported value may not be accurate or precise.

U - The associated number indicates approximate sample concentration necessary to be detected.

R - Analyte may or may not be present in the sample.

UJ - Quanitation limit may be inaccurate of imprecise.

General Note: The 2000 data in this table has been adjusted to reflect concentrations based on a dry sample. The conversion factor was calculated using moisture contents from the 2001 Earth Sciences sampling event. The conversion factor used was 1.2267.

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Table 11

On-Site Trespasser and Outdoor Worker
Inhalation - Groundwater
Groundwater Samples Used to Develop Statistical Tests
(All Exposed Groundwater Samples)

MW-2 8/17/2000	MW-3 8/15/2000	MW-4 8/17/2000	MW-5 8/15/2000	MW-6 8/15/2000	MW-7 8/17/2000	MW-8 8/15/2000	MW-9 8/17/2000	MW-2 6/10/2001	MW-3 6/10/2001	MW-4 6/10/2001	MW-5 6/9/2001	MW-6 6/9/2001
MW-7 6/9/2001	MW-8 6/8/2001	MW-9 6/10/2001	TB-3 5/30/2001	TB-4 5/31/2002	TB-6 5/30/2001	TB-7 5/30/2001	TB-8 5/30/2001	TB-9 5/30/2001	TB-10 5/31/2001	TB-11a 6/04/2001	TB-12 6/4/2001	TB-13 6/01/2001
TB-14 6/1/2001	TB-15 6/01/01	TB-16 5/31/01	TB-17 6/01/2001	TB-18 6/04/2001	MW-3 DUP 8/15/2000	MW-3 - DUP 6/10/2001						

Indoor Worker and Construction Worker
Inhalation - Groundwater
Groundwater Samples Used to Develop Statistical Tests
(All Exposed and Covered Groundwater Samples)

MW-2 8/17/2000	MW-3 8/15/2000	MW-4 8/17/2000	MW-5 8/15/2000	MW-6 8/15/2000	MW-7 8/17/2000	MW-8 8/15/2000	MW-9 8/17/2000	MW-2 6/10/2001	MW-3 6/10/2001	MW-4 6/10/2001	MW-5 6/9/2001
MW-7 6/9/2001	MW-8 6/8/2001	MW-9 6/10/2001	TB-3 5/30/2001	TB-4 5/31/2002	TB-6 5/30/2001	TB-7 5/30/2001	TB-8 5/30/2001	TB-9 5/30/2001	TB-10 5/31/2001	TB-11a 6/04/2001	TB-12 6/4/2001
TB-14 6/1/2001	TB-15 6/01/01	TB-16 5/31/01	TB-17 6/01/2001	TB-18 6/04/2001	MW-1 8/17/2000	MW-1 6/10/2001	TB-1 6/06/2001	TB-2 6/11/2001	TB-5 5/31/2001	TB-19 6/04/2001	TB-33 6/05/2001
TB-37 6/01/2001	TB-38 6/01/2001	TB-34 - DUP 5/31/2001	MW-3 - DUP 6/10/2001	MW-3 DUP 8/15/2000							

Table 10E

Construction Worker
Ingestion - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed and Covered Soil Samples to Groundwater Table)

GP-10 GP-10A (0-1') 4/9/2000	GP-12 GP-12A (0-1') 4/9/2000	GP-13 GP-13A (0-1') 4/9/2000	GP-14 GP-14A (0-1') 4/9/2000	GP-15 GP-15A (0-1') 4/9/2000	GP-25 GP-25A (0-1') 4/9/2000	GP-26 GP-26A (0-1') 4/9/2000	GP-27 GP-27A (0-1') 4/9/2000	GP-28/MW-4 GP-28A (0-1') 4/9/2000	GP-34 GP-34A (0-1') 4/9/2000	GP-35 GP-35A (0-1') 4/9/2000	TB-14A (0.0-4.0'/1.0-2.0') 6/1/2001	TB-35A (0.0-4.0'/3.0-3.4') 6/4/2001
GP-3 GP-3A (0-1') 4/9/2000	GP-4 GP-4A (0-1') 4/9/2000	GP-5 GP-5A (0-1') 4/9/2000	GP-6 GP-6A (0-1') 4/9/2000	GP-7 GP-7A (0-1') 4/9/2000	TB-4A (0.0-4.0'/1.8') 5/31/2001	TB-7A (0.0-4.0'/0.5-1.0') 5/30/2001	GP-20/MW-3 GP-20A (0-1') 4/9/2000	GP-33/MW-9 GP-33A (0-1') 4/9/2000	GP-8 GP-8A (0-1') 4/9/2000	TB-11A (0.0-4.0'/1.5') 5/31/2001	TB-11A (0.0-4.0'/1.0-1.5') 6/4/2001	GP-10B (1-2') 4/9/2000
GP-10C (2-4') 4/9/2000	GP-11B (1-2') 4/9/2000	GP-11C (2-4') 4/9/2000	GP-14E (6-8') 4/9/2000	GP-15D (4-6') 4/9/2000	GP-26D (4-6") 4/9/2000	GP-26E (6-8') 4/9/2000	GP-27B (1-2') 4/9/2000	GP-29B (1-2') 4/9/2000	GP-29C (2-4') 4/9/2000	GP-35E (6-8') 4/9/2000	TB-14B (4.0-7.0'/5.0-5.4')(4) 6/1/2001	TB-35B (4.0-7.0'/5.0-5.3') 6/4/2001
GP-20B (1-2') 4/9/2000	GP-32B (1-2') 4/9/2000	GP-32D (4-6') 4/9/2000	GP-33F (8-10') 4/9/2000	GP-36C (2-4') 4/9/2000	GP-37B (1-2') 4/9/2000	GP-8B (1-2')(3,4) 4/9/2000	GP-8D (4-6') 4/9/2000	GP-9B (1-2') 4/9/2000	GP-9C (2-4') 4/9/2000	GP-9D (4-6') 4/9/2000	GP-30B (1-2') 4/9/2000	GP-30C (2-4') 4/9/2000
GP-31C (2-4') 4/9/2000	TB-11Ab (4.0-7.0'/5.0-5.5')(4) 6/4/2001	GP-3B (1-2') 4/9/2000	GP-3D (4-6') 4/9/2000	GP-4D (4-6') 4/9/2000	GP-5B (1-2') 4/9/2000	GP-5D (4-6') 4/9/2000	GP-6B (1-2') 4/9/2000	GP-6C (2-4') 4/9/2000	GP-6E (6-8') 4/9/2000	GP-7B (1-2') 4/9/2000	GP-7D (4-6') 4/9/2000	TB-7B (4.0-7.0'/4.0-4.4') 5/30/2001
GP-18E (6-8')(3,4) 4/9/2000	GP-19D (4-6') 4/9/2000	GP-21C (2-4') 4/9/2000	GP-21F (8-10') (4/9/2000	GP-22B (1-2') 4/9/2000	GP-23C (2-4') 4/9/2000	GP-23E (6-8') 4/9/2000	GP-23F (8-10') 4/9/2000	GP-23I (14'16') 4/9/2000	TB-2B (4.0-7.0'/4.6-5.0') 6/5/2001	TB-2C (7.0-10.0'/9.6-10.0') 6/5/2001	TB-2D (10.0-13.0'/12.5-13.0') 6/5/2001	TB-2E (13.0-16.0'/15.5-16.0') 6/5/2001
TB-2F (16.0-19.0'/18.5-19.0') 6/5/2001	TB-37B (4.0-7.0'/5.0-5.2') 6/1/2001	TB-37C (7.0-10.0'/8.5-9.0') 6/1/2001	TB-38B (4.0-7.0'/5.0-5.5') 6/1/2001	TB-38C (7.0-10.0'/8.0-8.2') 6/1/2001	GP-24 GP-24A (0-1') 4/9/2000	GP-1D (4-6')(3,4) 4/9/2000	GP-1F (8-10') 4/9/2000	GP-2B (1-2') 4/9/2000	GP-2C (2-4') 4/9/2000	GP-2D (4-6') 4/9/2000	GP-2F (8-10') 4/9/2000	GP-16B (1-2') 4/9/2000
GP-16C (2-4') 4/9/2000	GP-16E (6-8') 4/9/2000	GP-17B (1-2') 4/9/2000	GP-17C (2-4') 4/9/2000	GP-17E (6-8') 4/9/2000	GP-24D (4-6') 4/9/2000	TB-2A (0.0-4.0'/1.0-1.3') 6/5/2001	TB-37A (0.0-4.0'/1.0-1.4') 6/1/2001	TB-38A (0.0-4.0'/1.0-1.5') 6/1/2001	TB-2C (7.0-10.0'/9.6-10.0') - DUP 6/5/2001	GP-2C DUP (2-4') 4/9/2000	TB-14A (0.0-4.0'/1.0-2.0') - DUP 6/1/2001	

Table 10D

Construction Worker
Inhalation - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed and Covered, Shallow and Deep Soil Samples)

GP-10 GP-10A (0-1') 4/9/2000	GP-12 GP-12A (0-1') 4/9/2000	GP-13 GP-13A (0-1') 4/9/2000	GP-14 GP-14A (0-1') 4/9/2000	GP-15 GP-15A (0-1') 4/9/2000	GP-25 GP-25A (0-1') 4/9/2000	GP-26 GP-26A (0-1') 4/9/2000	GP-27 GP-27A (0-1') 4/9/2000	GP-28/MW-4 GP-28A (0-1') 4/9/2000	GP-34 GP-34A (0-1') 4/9/2000	GP-35 GP-35A (0-1') 4/9/2000	TB-14A (0.0-4.0'/1.0-2.0') 6/1/2001	TB-35A (0.0-4.0'/3.0-3.4') 6/4/2001
GP-3 GP-3A (0-1') 4/9/2000	GP-4 GP-4A (0-1') 4/9/2000	GP-5 GP-5A (0-1') 4/9/2000	GP-6 GP-6A (0-1') 4/9/2000	GP-7 GP-7A (0-1') 4/9/2000	TB-4A (0.0-4.0'/1.8') 5/31/2001	TB-7A (0.0-4.0'/0.5-1.0') 5/30/2001	GP-20/MW-3 GP-20A (0-1') 4/9/2000	GP-33/MW-9 GP-33A (0-1') 4/9/2000	GP-8 GP-8A (0-1') 4/9/2000	TB-11A (0.0-4.0'/1.5') 5/31/2001	TB-11A (0.0-4.0'/1.0-1.5') 6/4/2001	GP-10B (1-2') 4/9/2000
GP-10C (2-4') 4/9/2000	GP-10F (8-10') 4/9/2000	GP-10H (12-14') 4/9/2000	GP-11B (1-2') 4/9/2000	GP-11C (2-4') 4/9/2000	GP-11E (6-8') 4/9/2000	GP-11F (8-10') 4/9/2000	GP-11G (10-12') 4/9/2000	GP-11H (12-14') 4/9/2000	GP-12G (10-12') 4/9/2000	GP-12I (14-16') 4/9/2000	GP-13F (8-10') 4/9/2000	GP-13G (10-12') 4/9/2000
GP-13H (12-14') 4/9/2000	GP-13J (16-18') 4/9/2000	GP-13K (18-20') 4/9/2000	GP-14E (6-8') 4/9/2000	GP-14F (8-10') 4/9/2000	GP-14G (10-12') 4/9/2000	GP-14H (12-14') 4/9/2000	GP-14I (14-16') 4/9/2000	GP-15D (4-6') 4/9/2000	GP-15E (6-8') 4/9/2000	GP-15G (10-12') 4/9/2000	GP-15H (12-14') 4/9/2000	GP-15I (14-16') 4/9/2000
GP-25D (8-10') 4/9/2000	GP-25F (8-10') 4/9/2000	GP-25G (10-12') 4/9/2000	GP-26D (4-6'') 4/9/2000	GP-26E (6-8') 4/9/2000	GP-26F (8-10') 4/9/2000	GP-26H (12-14') 4/9/2000	GP-26I (12-14') 4/9/2000	GP-27B (1-2') 4/9/2000	GP-27E (6-8') 4/9/2000	GP-27H (12-14') 4/9/2000	GP-28F (8-10') 4/9/2000	GP-28J (16-18') 4/9/2000
GP-29B (1-2') 4/9/2000	GP-29C (2-4') 4/9/2000	GP-29E (6-8') 4/9/2000	GP-29J (16-18') 4/9/2000	GP-34E (6-8') 4/9/2000	GP-34F (8-10') 4/9/2000	GP-35E (6-8') 4/9/2000	GP-35F (8-10') 4/9/2000	GP-35G (10-12') 4/9/2000	TB-14B (4.0-7.0'/5.0-5.4') 6/1/2001	TB-35B (4.0-7.0'/5.0-5.3') 6/4/2001	GP-20B (1-2') 4/9/2000	GP-20E (6-8') 4/9/2000
GP-20H (12-14') 4/9/2000	GP-32B (1-2') 4/9/2000	GP-32D (4-6') 4/9/2000	GP-32F (8-10') 4/9/2000	GP-32H (12-14') 4/9/2000	GP-32I (14-16') 4/9/2000	GP-32J (16-18') 4/9/2000	GP-32K (18-20') 4/9/2000	GP-33F (8-10') 4/9/2000	GP-33I (14-16') 4/9/2000	GP-36C (2-4') 4/9/2000	GP-36F (8-10') 4/9/2000	GP-36H (12-14') 4/9/2000

Table 10D

Construction Worker
Inhalation - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed and Covered, Shallow and Deep Soil Samples)

GP-37B (1-2') 4/9/2000	GP-37F (8-10') 4/9/2000	GP-8B (1-2') 4/9/2000	GP-8D (4-6') 4/9/2000	GP-8G (10-12') 4/9/2000	GP-8K (18-20') 4/9/2000	GP-9B (1-2') 4/9/2000	GP-9C (2-4') 4/9/2000	GP-9D (4-6') 4/9/2000	GP-9E (6-8') 4/9/2000	GP-9I (14-16') 4/9/2000	GP-30B (1-2') 4/9/2000	GP-30C (2-4') 4/9/2000
GP-30F (8-10') 4/9/2000	GP-30I (14-16') 4/9/2000	GP-31C (2-4') 4/9/2000	GP-31F (8-10') 4/9/2000	GP-31G (10-12') 4/9/2000	GP-31I (14-16') 4/9/2000	TB-11Ab (4.0-7.0'/5.0-5.5') 6/4/2001	GP-3B (1-2') 4/9/2000	GP-3D (4-6') 4/9/2000	GP-3F (8-10') 4/9/2000	GP-3H (12-14') 4/9/2000	GP-4D (4-6') 4/9/2000	GP-4F (8-10') 4/9/2000
GP-4I (14-16') 4/9/2000	GP-5B (1-2') 4/9/2000	GP-5D (4-6') 4/9/2000	GP-5E (6-8') 4/9/2000	GP-5J (16-18') 4/9/2000	GP-6B (1-2') 4/9/2000	GP-6C (2-4') 4/9/2000	GP-6E (6-8') 4/9/2000	GP-6F (8-10') 4/9/2000	GP-6I (14-16') 4/9/2000	GP-7B (1-2') 4/9/2000	GP-7D (4-6') 4/9/2000	GP-7G (10-12') 4/9/2000
GP-7K (18-20') 4/9/2000	TB-7B (4.0-7.0'/4.0-4.4') 5/30/2001	TB-14A (0.0-4.0'/1.0-2.0') - DUP 6/1/2001	GP-10H DUP (12-14') 4/9/2000	GP-12G DUP (10-12') 4/9/2000	GP-25G DUP (10-12') 4/9/2000	GP-20E DUP (6-8') 4/9/2000	GP-32K DUP (18-20') 4/9/2000	GP-30I DUP (14-16') 4/9/2000				
GP-18E (6-8')[3,4] 4/9/2000	GP-18I (14-16') 4/9/2000	GP-19D (4-6') 4/9/2000	GP-19I (14-16') 4/9/2000	GP-21C (2-4') 4/9/2000	GP-21F (8-10') (4/9/2000	GP-21H (12-14') 4/9/2000	GP-21J (16-18') 4/9/2000	GP-22B (1-2') 4/9/2000	GP-22G (10-12') 4/9/2000	GP-22K (18-20') 4/9/2000	GP-23C (2-4') 4/9/2000	GP-23E (6-8') 4/9/2000
GP-23F (8-10') 4/9/2000	GP-23I (14'16') 4/9/2000	GP-23J (16-18') 4/9/2000	TB-2B (4.0-7.0'/4.6-5.0') 6/5/2001	TB-2C (7.0-10.0'/9.6-10.0') 6/5/2001	TB-2D (10.0-13.0'/12.5-13.0') 6/5/2001	TB-2E (13.0-16.0'/15.5-16.0') 6/5/2001	TB-2F (16.0-19.0'/18.5-19.0') 6/5/2001	TB-37B (4.0-7.0'/5.0-5.2') 6/1/2001	TB-37C (7.0-10.0'/8.5-9.0') 6/1/2001	TB-38B (4.0-7.0'/5.0-5.5') 6/1/2001	TB-38C (7.0-10.0'/8.0-8.2') 6/1/2001	GP-24 GP-24A (0-1') 4/9/2000
GP-1D (4-6')[3,4] 4/9/2000	GP-1F (8-10') 4/9/2000	GP-1J (16-18') 4/9/2000	GP-2B (1-2') 4/9/2000	GP-2C (2-4') 4/9/2000	GP-2D (4-6') 4/9/2000	GP-2F (8-10') 4/9/2000	GP-16B (1-2') 4/9/2000	GP-16C (2-4') 4/9/2000	GP-16E (6-8') 4/9/2000	GP-16G (10-12') 4/9/2000	GP-16I (14-16') 4/9/2000	GP-17B (1-2') 4/9/2000
GP-17C (2-4') 4/9/2000	GP-17E (6-8') 4/9/2000	GP-17H (12-14') 4/9/2000	GP-24D (4-6') 4/9/2000	GP-24F (8-10') 4/9/2000	TB-2A (0.0-4.0'/1.0-1.3') 6/5/2001	TB-37A (0.0-4.0'/1.0-1.4') 6/1/2001	TB-38A (0.0-4.0'/1.0-1.5') 6/1/2001	GP-23J DUP (16-18') 4/9/2000	TB-2C (7.0-10.0'/9.6-10.0') - DUP 6/5/2001	GP-2C DUP (2-4') 4/9/2000		

Table 10C

Indoor Worker
Inhalation - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed and Covered, Shallow and Deep Soil Samples)

GP-10 GP-10A (0-1') 4/9/2000	GP-12 GP-12A (0-1') 4/9/2000	GP-13 GP-13A (0-1') 4/9/2000	GP-14 GP-14A (0-1') 4/9/2000	GP-15 GP-15A (0-1') 4/9/2000	GP-25 GP-25A (0-1') 4/9/2000	GP-26 GP-26A (0-1') 4/9/2000	GP-27 GP-27A (0-1') 4/9/2000	GP-28/MW-4 GP-28A (0-1') 4/9/2000	GP-34 GP-34A (0-1') 4/9/2000	GP-35 GP-35A (0-1') 4/9/2000	TB-14A (0.0-4.0'/1.0-2.0') 6/1/2001	TB-35A (0.0-4.0'/3.0-3.4') 6/4/2001
GP-3 GP-3A (0-1') 4/9/2000	GP-4 GP-4A (0-1') 4/9/2000	GP-5 GP-5A (0-1') 4/9/2000	GP-6 GP-6A (0-1') 4/9/2000	GP-7 GP-7A (0-1') 4/9/2000	TB-4A (0.0-4.0'/1.8') 5/31/2001	TB-7A (0.0-4.0'/0.5-1.0') 5/30/2001	GP-20/MW-3 GP-20A (0-1') 4/9/2000	GP-33/MW-9 GP-33A (0-1') 4/9/2000	GP-8 GP-8A (0-1') 4/9/2000	TB-11A (0.0-4.0'/1.5') 5/31/2001	TB-11A (0.0-4.0'/1.0-1.5') 6/4/2001	GP-10B (1-2') 4/9/2000
GP-10C (2-4') 4/9/2000	GP-10F (8-10') 4/9/2000	GP-10H (12-14') 4/9/2000	GP-11B (1-2') 4/9/2000	GP-11C (2-4') 4/9/2000	GP-11E (6-8') 4/9/2000	GP-11F (8-10') 4/9/2000	GP-11G (10-12') 4/9/2000	GP-11H (12-14') 4/9/2000	GP-12G (10-12') 4/9/2000	GP-12I (14-16') 4/9/2000	GP-13F (8-10') 4/9/2000	GP-13G (10-12') 4/9/2000
GP-13H (12-14') 4/9/2000	GP-13J (16-18') 4/9/2000	GP-13K (18-20') 4/9/2000	GP-14E (6-8') 4/9/2000	GP-14F (8-10') 4/9/2000	GP-14G (10-12') 4/9/2000	GP-14H (12-14') 4/9/2000	GP-14I (14-16') 4/9/2000	GP-15D (4-6') 4/9/2000	GP-15E (6-8') 4/9/2000	GP-15G (10-12') 4/9/2000	GP-15H (12-14') 4/9/2000	GP-15I (14-16') 4/9/2000
GP-25D (8-10') 4/9/2000	GP-25F (8-10') 4/9/2000	GP-25G (10-12') 4/9/2000	GP-26D (4-6'') 4/9/2000	GP-26E (6-8') 4/9/2000	GP-26F (8-10') 4/9/2000	GP-26H (12-14') 4/9/2000	GP-26I (12-14') 4/9/2000	GP-27B (1-2') 4/9/2000	GP-27E (6-8') 4/9/2000	GP-27H (12-14') 4/9/2000	GP-28F (8-10') 4/9/2000	GP-28J (16-18') 4/9/2000
GP-29B (1-2') 4/9/2000	GP-29C (2-4') 4/9/2000	GP-29E (6-8') 4/9/2000	GP-29J (16-18') 4/9/2000	GP-34E (6-8') 4/9/2000	GP-34F (8-10') 4/9/2000	GP-35E (6-8') 4/9/2000	GP-35F (8-10') 4/9/2000	GP-35G (10-12') 4/9/2000	TB-14B (4.0-7.0'/5.0-5.4') 6/1/2001	TB-35B (4.0-7.0'/5.0-5.3') 6/4/2001	GP-20B (1-2') 4/9/2000	GP-20E (6-8') 4/9/2000
GP-20H (12-14') 4/9/2000	GP-32B (1-2') 4/9/2000	GP-32D (4-6') 4/9/2000	GP-32F (8-10') 4/9/2000	GP-32H (12-14') 4/9/2000	GP-32I (14-16') 4/9/2000	GP-32J (16-18') 4/9/2000	GP-32K (18-20') 4/9/2000	GP-33F (8-10') 4/9/2000	GP-33I (14-16') 4/9/2000	GP-36C (2-4') 4/9/2000	GP-36F (8-10') 4/9/2000	GP-36H (12-14') 4/9/2000

Table 10C

GP-37B (1-2') 4/9/2000	GP-37F (8-10') 4/9/2000	GP-8B (1-2') 4/9/2000	GP-8D (4-6') 4/9/2000	GP-8G (10-12') 4/9/2000	GP-8K (18-20') 4/9/2000	GP-9B (1-2') 4/9/2000	GP-9C (2-4') 4/9/2000	GP-9D (4-6') 4/9/2000	GP-9E (6-8') 4/9/2000	GP-9I (14-16') 4/9/2000	GP-30B (1-2') 4/9/2000	GP-30C (2-4') 4/9/2000
GP-30F (8-10') 4/9/2000	GP-30I (14-16') 4/9/2000	GP-31C (2-4') 4/9/2000	GP-31F (8-10') 4/9/2000	GP-31G (10-12') 4/9/2000	GP-31I (14-16') 4/9/2000	TB-11Ab (4.0-7.0'/5.0-5.5') 6/4/2001	GP-3B (1-2') 4/9/2000	GP-3D (4-6') 4/9/2000	GP-3F (8-10') 4/9/2000	GP-3H (12-14') 4/9/2000	GP-4D (4-6') 4/9/2000	GP-4F (8-10') 4/9/2000
GP-4I (14-16') 4/9/2000	GP-5B (1-2') 4/9/2000	GP-5D (4-6') 4/9/2000	GP-5E (6-8') 4/9/2000	GP-5J (16-18') 4/9/2000	GP-6B (1-2') 4/9/2000	GP-6C (2-4') 4/9/2000	GP-6E (6-8') 4/9/2000	GP-6F (8-10') 4/9/2000	GP-6I (14-16') 4/9/2000	GP-7B (1-2') 4/9/2000	GP-7D (4-6') 4/9/2000	GP-7G (10-12') 4/9/2000
GP-7K (18-20') 4/9/2000	TB-7B (4.0-7.0'/4.0-4.4') 5/30/2001	TB-14A (0.0-4.0'/1.0-2.0') - DUP 6/1/2001	GP-10H DUP (12-14') 4/9/2000	GP-12G DUP (10-12') 4/9/2000	GP-25G DUP (10-12') 4/9/2000	GP-20E DUP (6-8') 4/9/2000	GP-32K DUP (18-20') 4/9/2000	GP-30I DUP (14-16') 4/9/2000				
GP-18E (6-8')[3,4] 4/9/2000	GP-18I (14-16') 4/9/2000	GP-19D (4-6') 4/9/2000	GP-19I (14-16') 4/9/2000	GP-21C (2-4') 4/9/2000	GP-21F (8-10') (4/9/2000	GP-21H (12-14') 4/9/2000	GP-21J (16-18') 4/9/2000	GP-22B (1-2') 4/9/2000	GP-22G (10-12') 4/9/2000	GP-22K (18-20') 4/9/2000	GP-23C (2-4') 4/9/2000	GP-23E (6-8') 4/9/2000
GP-23F (8-10') 4/9/2000	GP-23I (14'16') 4/9/2000	GP-23J (16-18') 4/9/2000	TB-2B (4.0-7.0'/4.6-5.0') 6/5/2001	TB-2C (7.0-10.0'/9.6-10.0') 6/5/2001	TB-2D (10.0-13.0'/12.5-13.0') 6/5/2001	TB-2E (13.0-16.0'/15.5-16.0') 6/5/2001	TB-2F (16.0-19.0'/18.5-19.0') 6/5/2001	TB-37B (4.0-7.0'/5.0-5.2') 6/1/2001	TB-37C (7.0-10.0'/8.5-9.0') 6/1/2001	TB-38B (4.0-7.0'/5.0-5.5') 6/1/2001	TB-38C (7.0-10.0'/8.0-8.2') 6/1/2001	GP-24 GP-24A (0-1') 4/9/2000
GP-1D (4-6')[3,4] 4/9/2000	GP-1F (8-10') 4/9/2000	GP-1J (16-18') 4/9/2000	GP-2B (1-2') 4/9/2000	GP-2C (2-4') 4/9/2000	GP-2D (4-6') 4/9/2000	GP-2F (8-10') 4/9/2000	GP-16B (1-2') 4/9/2000	GP-16C (2-4') 4/9/2000	GP-16E (6-8') 4/9/2000	GP-16G (10-12') 4/9/2000	GP-16I (14-16') 4/9/2000	GP-17B (1-2') 4/9/2000
GP-17C (2-4') 4/9/2000	GP-17E (6-8') 4/9/2000	GP-17H (12-14') 4/9/2000	GP-24D (4-6') 4/9/2000	GP-24F (8-10') 4/9/2000	TB-2A (0.0-4.0'/1.0-1.3') 6/5/2001	TB-37A (0.0-4.0'/1.0-1.4') 6/1/2001	TB-38A (0.0-4.0'/1.0-1.5') 6/1/2001	GP-23J DUP (16-18') 4/9/2000	TB-2C (7.0-10.0'/9.6-10.0') - DUP 6/5/2001	GP-2C DUP (2-4') 4/9/2000		

Table 10B

Onsite Trespasser and Outdoor Worker
Inhalation - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed Shallow and Deep Soil Samples)

GP-10 GP-10A (0-1') 4/9/2000	GP-12 GP-12A (0-1') 4/9/2000	GP-13 GP-13A (0-1') 4/9/2000	GP-14 GP-14A (0-1') 4/9/2000	GP-15 GP-15A (0-1') 4/9/2000	GP-25 GP-25A (0-1') 4/9/2000	GP-26 GP-26A (0-1') 4/9/2000	GP-27 GP-27A (0-1') 4/9/2000	GP-28/MW-4 GP-28A (0-1') 4/9/2000	GP-34 GP-34A (0-1') 4/9/2000	GP-35 GP-35A (0-1') 4/9/2000	TB-14A (0.0-4.0'/1.0-2.0') 6/1/2001	TB-35A (0.0-4.0'/3.0-3.4') 6/4/2001
GP-3 GP-3A (0-1') 4/9/2000	GP-4 GP-4A (0-1') 4/9/2000	GP-5 GP-5A (0-1') 4/9/2000	GP-6 GP-6A (0-1') 4/9/2000	GP-7 GP-7A (0-1') 4/9/2000	TB-4A (0.0-4.0'/1.8') 5/31/2001	TB-7A (0.0-4.0'/0.5-1.0') 5/30/2001	GP-20/MW-3 GP-20A (0-1') 4/9/2000	GP-33/MW-9 GP-33A (0-1') 4/9/2000	GP-8 GP-8A (0-1') 4/9/2000	TB-11A (0.0-4.0'/1.5') 5/31/2001	TB-11A (0.0-4.0'/1.0-1.5') 6/4/2001	GP-10B (1-2') 4/9/2000
GP-10C (2-4') 4/9/2000	GP-10F (8-10') 4/9/2000	GP-10H (12-14') 4/9/2000	GP-11B (1-2') 4/9/2000	GP-11C (2-4') 4/9/2000	GP-11E (6-8') 4/9/2000	GP-11F (8-10') 4/9/2000	GP-11G (10-12') 4/9/2000	GP-11H (12-14') 4/9/2000	GP-12G (10-12') 4/9/2000	GP-12I (14-16') 4/9/2000	GP-13F (8-10') 4/9/2000	GP-13G (10-12') 4/9/2000
GP-13H (12-14') 4/9/2000	GP-13J (16-18') 4/9/2000	GP-13K (18-20') 4/9/2000	GP-14E (6-8') 4/9/2000	GP-14F (8-10') 4/9/2000	GP-14G (10-12') 4/9/2000	GP-14H (12-14') 4/9/2000	GP-14I (14-16') 4/9/2000	GP-15D (4-6') 4/9/2000	GP-15E (6-8') 4/9/2000	GP-15G (10-12') 4/9/2000	GP-15H (12-14') 4/9/2000	GP-15I (14-16') 4/9/2000
GP-25D (8-10') 4/9/2000	GP-25F (8-10') 4/9/2000	GP-25G (10-12') 4/9/2000	GP-26D (4-6'') 4/9/2000	GP-26E (6-8') 4/9/2000	GP-26F (8-10') 4/9/2000	GP-26H (12-14') 4/9/2000	GP-26I (12-14') 4/9/2000	GP-27B (1-2') 4/9/2000	GP-27E (6-8') 4/9/2000	GP-27H (12-14') 4/9/2000	GP-28F (8-10') 4/9/2000	GP-28J (16-18') 4/9/2000
GP-29B (1-2') 4/9/2000	GP-29C (2-4') 4/9/2000	GP-29E (6-8') 4/9/2000	GP-29J (16-18') 4/9/2000	GP-34E (6-8') 4/9/2000	GP-34F (8-10') 4/9/2000	GP-35E (6-8') 4/9/2000	GP-35F (8-10') 4/9/2000	GP-35G (10-12') 4/9/2000	TB-14B (4.0-7.0'/5.0-5.4') 6/1/2001	TB-35B (4.0-7.0'/5.0-5.3') 6/4/2001	GP-20B (1-2') 4/9/2000	GP-20E (6-8') 4/9/2000
GP-20H (12-14') 4/9/2000	GP-32B (1-2') 4/9/2000	GP-32D (4-6') 4/9/2000	GP-32F (8-10') 4/9/2000	GP-32H (12-14') 4/9/2000	GP-32I (14-16') 4/9/2000	GP-32J (16-18') 4/9/2000	GP-32K (18-20') 4/9/2000	GP-33F (8-10') 4/9/2000	GP-33I (14-16') 4/9/2000	GP-36C (2-4') 4/9/2000	GP-36F (8-10') 4/9/2000	GP-36H (12-14') 4/9/2000

Table 10B

Onsite Trespasser and Outdoor Worker
Inhalation - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed Shallow and Deep Soil Samples)

GP-37B (1-2') 4/9/2000	GP-37F (8-10') 4/9/2000	GP-8B (1-2') 4/9/2000	GP-8D (4-6') 4/9/2000	GP-8G (10-12') 4/9/2000	GP-8K (18-20') 4/9/2000	GP-9B (1-2') 4/9/2000	GP-9C (2-4') 4/9/2000	GP-9D (4-6') 4/9/2000	GP-9E (6-8') 4/9/2000	GP-9I (14-16') 4/9/2000	GP-30B (1-2') 4/9/2000	GP-30C (2-4') 4/9/2000
GP-30F (8-10') 4/9/2000	GP-30I (14-16') 4/9/2000	GP-31C (2-4') 4/9/2000	GP-31F (8-10') 4/9/2000	GP-31G (10-12') 4/9/2000	GP-31I (14-16') 4/9/2000	TB-11Ab (4.0-7.0'/5.0-5.5') 6/4/2001	GP-3B (1-2') 4/9/2000	GP-3D (4-6') 4/9/2000	GP-3F (8-10') 4/9/2000	GP-3H (12-14') 4/9/2000	GP-4D (4-6') 4/9/2000	GP-4F (8-10') 4/9/2000
GP-4I (14-16') 4/9/2000	GP-5B (1-2') 4/9/2000	GP-5D (4-6') 4/9/2000	GP-5E (6-8') 4/9/2000	GP-5J (16-18') 4/9/2000	GP-6B (1-2') 4/9/2000	GP-6C (2-4') 4/9/2000	GP-6E (6-8') 4/9/2000	GP-6F (8-10') 4/9/2000	GP-6I (14-16') 4/9/2000	GP-7B (1-2') 4/9/2000	GP-7D (4-6') 4/9/2000	GP-7G (10-12') 4/9/2000
GP-7K (18-20') 4/9/2000	TB-7B (4.0-7.0'/4.0-4.4') 5/30/2001	TB-14A (0.0-4.0'/1.0-2.0') - DUP 6/1/2001	GP-10H DUP (12-14') 4/9/2000	GP-12G DUP (10-12') 4/9/2000	GP-25G DUP (10-12') 4/9/2000	GP-20E DUP (6-8') 4/9/2000	GP-32K DUP (18-20') 4/9/2000	GP-30I DUP (14-16') 4/9/2000				

Table 10A

Onsite Trespasser, Indoor and Outdoor Worker
Ingestion - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed Shallow Soil Samples)

GP-10 GP-10A (0-1') 4/9/2000	GP-12 GP-12A (0-1') 4/9/2000	GP-13 GP-13A (0-1') 4/9/2000	GP-14 GP-14A (0-1') 4/9/2000	GP-15 GP-15A (0-1') 4/9/2000	GP-25 GP-25A (0-1') 4/9/2000	GP-26 GP-26A (0-1') 4/9/2000	GP-27 GP-27A (0-1') 4/9/2000	GP-28/MW-4 GP-28A (0-1') 4/9/2000	GP-34 GP-34A (0-1') 4/9/2000	GP-35 GP-35A (0-1') 4/9/2000	TB-14A (0.0-4.0'/1.0-2.0') 6/1/2001	TB-35A (0.0-4.0'/3.0-3.4') 6/4/2001
GP-3 GP-3A (0-1') 4/9/2000	GP-4 GP-4A (0-1') 4/9/2000	GP-5 GP-5A (0-1') 4/9/2000	GP-6 GP-6A (0-1') 4/9/2000	GP-7 GP-7A (0-1') 4/9/2000	TB-4A (0.0-4.0'/1.8') 5/31/2001	TB-7A (0.0-4.0'/0.5-1.0') 5/30/2001	GP-20/MW-3 GP-20A (0-1') 4/9/2000	GP-33/MW-9 GP-33A (0-1') 4/9/2000	GP-8 GP-8A (0-1') 4/9/2000	TB-11A (0.0-4.0'/1.5') 5/31/2001	TB-11A (0.0-4.0'/1.0-1.5') 6/4/2001	TB-14A (0.0-4.0'/1.0-2.0') - DUP 6/1/2001

Table 51
Cost Estimate
Alternative 4
Surface Capping with Permeable Reactive Barrier

CAPITAL COST	Unit	Quantity	Unit Cost	Total
Planning, Preparation and Oversight				
Engineering (Capping and PRB)	Lump Sum	1	$30,000	$30,000
Project Admin and Management	Lump Sum	1	$10,000	$10,000
Legal (Institutional Controls)	Lump Sum	1	$50,000	$50,000
Health and Safety Supplies and Equip.	Lump Sum	1	$2,000	$2,000
Permits and Fees (RCRA Closure Permit, etc.)	Lump Sum	1	$25,000	$25,000
Survey (PRB and Capping)	Day	5	$2,000	$10,000
Construction (PRB)				
CQA	Lump Sum	1	$25,000	$25,000
Treatability Study	Lump Sum	1	$20,000	$20,000
Mob/Demob	Lump Sum	1	$30,000	$30,000
Site Preparation	Lump Sum	1	$10,000	$10,000
Excavation	Cubic Yard	1,790	$10	$17,900
Transportation	Ton	3,500	$50	$175,000
Disposal	Ton	3,500	$125	$437,500
Water Management	Gallon	150,000	$1	$150,000
Slurry Wall Installation	Square Foot	8,500	$7	$59,500
PRB Installation	Each	6	$51,400	$308,400
Backfill and Compaction	Cubic Yard	510	$14	$7,140
Construction (Capping)				
Subgrade Prep	Square Foot	75000	$1	$75,000
Capping Placement	Square Foot	75000	$3	$225,000
Construction (Misc.)				
Monitoring Well Installation (30' Depth)	Each	4	$5,000	$20,000
Subtotal				$1,687,440
Contingency (15% of Capital Costs)				$253,116
Total Capital Costs				$1,941,000

ANNUAL O&M COSTS	Unit	Quantity	Unit Cost	Total
Surface Cap Maintenance	Each	1	$5,000	$5,000
Subtotal				$5,000
Contingency (15% of Annual O&M Costs)				$750
Annual O&M Costs				$5,750
Groundwater Monitoring (0-5 years)				
Labor	Semiannual	2	$4,500	$9,000
Equip., Supplies, Travel	Semiannual	2	$4,000	$8,000
Analytical (20 samples/event)	Semiannual	2	$6,000	$12,000
Reporting, Admin. and PM	Semiannual	2	$7,500	$15,000
Maintenance	Semiannual	2	$500	$1,000
Subtotal				$45,000
Contingency (15% of Annual O&M Costs)				$6,750
Annual O&M Costs (0-5 years)				$51,750
Groundwater Monitoring (6-30 years)				
Labor	Annual	1	$4,500	$4,500
Equip., Supplies, Travel	Annual	1	$4,000	$4,000
Analytical (20 samples/event)	Annual	1	$6,000	$6,000
Reporting, Admin. and PM	Annual	1	$7,500	$7,500
Maintenance	Annual	1	$500	$500
Subtotal				$22,500
Contingency (15% of Annual O&M Costs)				$3,375
Annual O&M Costs (6-30 years)				$25,875

TOTAL CAPITAL COST		**$1,941,000**
ANNUAL O&M COST (0-30 years)		**$5,750**
ANNUAL O&M COST (0-5 years)		**$51,750**
ANNUAL O&M COST (6-30 years)		**$25,875**
PRESENT WORTH		**$2,440,000**
	Interest Rate	7%
	Term (years)	30

Table 50
Cost Estimate
Alternative 3
Surface Capping with Enhanced Insitu Bioremediation

CAPITAL COST	Unit	Quantity	Unit Cost	Total
Planning and Preparation				
Engineering (Capping and Bio)	Lump Sum	1	$20,000	$20,000
Project Admin and Management	Lump Sum	1	$10,000	$10,000
Legal (Institutional Controls)	Lump Sum	1	$35,000	$35,000
Health and Safety Supplies and Equip.	Lump Sum	1	$7,500	$7,500
Permits and Fees (RCRA Closure Permit, etc.)	Lump Sum	1	$25,000	$25,000
Survey (Bio and Capping)	Day	5	$2,000	$10,000
Construction (Bio)				
Charcaterization	Lump Sum	1	$35,000	$35,000
Geoprobes	Lump Sum	1	$15,000	$15,000
HRC Application	Lump Sum	1	$120,000	$120,000
Waste Management	Lump Sum	1	$10,000	$10,000
Short-term Monitoring	Lump Sum	1	$25,000	$25,000
Construction (Capping)				
Subgrade Prep	Square Foot	75000	$1	$75,000
Capping Placement	Square Foot	75000	$3	$225,000
Construction (Misc.)				
Monitoring Well Installation (30' Depth)	Each	4	$5,000	$20,000
Subtotal				$632,500
Contingency (15% of Capital Costs)				$94,875
Total Capital Costs				$727,000

Note: Additional capital costs resulting from the potential excavation, removal and off-site disposal of contaminated soils within the HWMU target area are estimated for budgetary purposes at $300,000. This is based on removing approximately half of the material projected for excavation in Alternative 2 (2,900 tons/2) at $200/ton captital cost, inclusive. This potential cost is NOT included in the Alternative 3 estimated total.

ANNUAL O&M COSTS	Unit	Quantity	Unit Cost	Total
Surface Cap Maintenance	Each	1	$5,000	$5,000
Subtotal				$5,000
Contingency (15% of Annual O&M Costs)				$750
Annual O&M Costs				$5,750
Groundwater Monitoring (0-5 years)				
Labor	Semiannual	2	$4,500	$9,000
Equip., Supplies, Travel	Semiannual	2	$4,000	$8,000
Analytical (20 samples/event)	Semiannual	2	$6,000	$12,000
Reporting, Admin. and PM	Semiannual	2	$7,500	$15,000
Maintenance	Semiannual	2	$500	$1,000
Subtotal				$45,000
Contingency (15% of Annual O&M Costs)				$6,750
Annual O&M Costs (0-5 years)				$51,750
Groundwater Monitoring (6-30 years)				
Labor	Annual	1	$4,500	$4,500
Equip., Supplies, Travel	Annual	1	$4,000	$4,000
Analytical (20 samples/event)	Annual	1	$6,000	$6,000
Reporting, Admin. and PM	Annual	1	$7,500	$7,500
Maintenance	Annual	1	$500	$500
Subtotal				$22,500
Contingency (15% of Annual O&M Costs)				$3,375
Annual O&M Costs (6-30 years)				$25,875

TOTAL CAPITAL COST		**$727,000**
ANNUAL O&M COST (0-30 years)		**$5,750**
ANNUAL O&M COST (0-5 years)		**$51,750**
ANNUAL O&M COST (6-30 years)		**$25,875**
PRESENT WORTH		**$1,226,000**
	Interest Rate	7%
	Term (years)	30

Table 50
Cost Estimate
Alternative 3
Surface Capping with Enhanced Insitu Bioremediation

CAPITAL COST	Unit	Quantity	Unit Cost	Total
Planning and Preparation				
Engineering (Capping and Bio)	Lump Sum	1	$20,000	$20,000
Project Admin and Management	Lump Sum	1	$10,000	$10,000
Legal (Institutional Controls)	Lump Sum	1	$35,000	$35,000
Health and Safety Supplies and Equip.	Lump Sum	1	$7,500	$7,500
Permits and Fees (RCRA Closure Permit, etc.)	Lump Sum	1	$25,000	$25,000
Survey (Bio and Capping)	Day	5	$2,000	$10,000
Construction (Bio)				
Charcaterization	Lump Sum	1	$35,000	$35,000
Geoprobes	Lump Sum	1	$15,000	$15,000
HRC Application	Lump Sum	1	$120,000	$120,000
Waste Management	Lump Sum	1	$10,000	$10,000
Short-term Monitoring	Lump Sum	1	$25,000	$25,000
Construction (Capping)				
Subgrade Prep	Square Foot	75000	$1	$75,000
Capping Placement	Square Foot	75000	$3	$225,000
Construction (Misc.)				
Monitoring Well Installation (30' Depth)	Each	4	$5,000	$20,000
Subtotal				$632,500
Contingency (15% of Capital Costs)				$94,875
Total Capital Costs				$727,000

ANNUAL O&M COSTS	Unit	Quantity	Unit Cost	Total
Surface Cap Maintenance	Each	1	$5,000	$5,000
Subtotal				$5,000
Contingency (15% of Annual O&M Costs)				$750
Annual O&M Costs				$5,750
Groundwater Monitoring (0-5 years)				
Labor	Semiannual	2	$4,500	$9,000
Equip., Supplies, Travel	Semiannual	2	$4,000	$8,000
Analytical (20 samples/event)	Semiannual	2	$6,000	$12,000
Reporting, Admin. and PM	Semiannual	2	$7,500	$15,000
Maintenance	Semiannual	2	$500	$1,000
Subtotal				$45,000
Contingency (15% of Annual O&M Costs)				$6,750
Annual O&M Costs (0-5 years)				$51,750
Groundwater Monitoring (6-30 years)				
Labor	Annual	1	$4,500	$4,500
Equip., Supplies, Travel	Annual	1	$4,000	$4,000
Analytical (20 samples/event)	Annual	1	$6,000	$6,000
Reporting, Admin. and PM	Annual	1	$7,500	$7,500
Maintenance	Annual	1	$500	$500
Subtotal				$22,500
Contingency (15% of Annual O&M Costs)				$3,375
Annual O&M Costs (6-30 years)				$25,875

TOTAL CAPITAL COST		**$727,000**
ANNUAL O&M COST (0-30 years)		**$5,750**
ANNUAL O&M COST (0-5 years)		**$51,750**
ANNUAL O&M COST (6-30 years)		**$25,875**
PRESENT WORTH		**$1,226,000**
	Interest Rate	7%
	Term (years)	30

Table 49
Cost Estimate
Alternative 2
Surface Capping with Excavation, Transportation and Disposal

CAPITAL COST	Unit	Quantity	Unit Cost	Total
Planning and Preparation				
Engineering (Capping and Excavation)	Lump Sum	1	$30,000	$30,000
Project Admin and Management	Lump Sum	1	$10,000	$10,000
Legal (Institutional Controls)	Lump Sum	1	$35,000	$35,000
Health and Safety Supplies and Equip.	Lump Sum	1	$15,000	$15,000
Permits and Fees (RCRA Closure Permit, etc.)	Lump Sum	1	$25,000	$25,000
Survey (Excavation and Capping)	Day	5	$2,000	$10,000
Construction (Excavation and Backfill)				
CQA	Lump Sum	1	$25,000	$25,000
Waste Characterization and Analyses	Lump Sum	1	$40,000	$40,000
Mobilization/Demobilization	Lump Sum	1	$30,000	$30,000
Site Preparation	Lump Sum	1	$10,000	$10,000
Erosion and Sedimentation Controls	Lump Sum	1	$10,000	$10,000
Demolition of Concrete	Lump Sum	1	$10,000	$10,000
Excavation and On-Site Handling	Cubic Yard	3,200	$10	$32,000
Water Management	Gallon	150,000	$1	$150,000
Soil T&D (Haz)	Ton	2,900	$175	$507,500
Soil T&D (Non-haz)	Ton	2,900	$125	$362,500
Backfill Material	Cubic Yard	3,500	$7	$24,500
Placement and Compaction	Cubic Yard	3,500	$7	$24,500
Contingency S&A	Lump Sum	1	$25,000	$25,000
Construction (Capping)				
Subgrade Prep	Square Foot	75000	$1	$75,000
Capping Placement	Square Foot	75000	$3	$225,000
Construction (Misc.)				
Monitoring Well Installation (30' Depth)	Each	4	$5,000	$20,000
Subtotal				$1,696,000
Contingency (15% of Capital Costs)				$254,400
Total Capital Costs				$1,950,000

ANNUAL O&M COSTS	Unit	Quantity	Unit Cost	Total
Surface Cap Maintenance	Each	1	$5,000	$5,000
Subtotal				$5,000
Contingency (15% of Annual O&M Costs)				$750
Annual O&M Costs				$5,750
Groundwater Monitoring (0-5 years)				
Labor	Semiannual	2	$4,500	$9,000
Equip., Supplies, Travel	Semiannual	2	$4,000	$8,000
Analytical (20 samples/event)	Semiannual	2	$6,000	$12,000
Reporting, Admin. and PM	Semiannual	2	$7,500	$15,000
Maintenance	Semiannual	2	$500	$1,000
Subtotal				$45,000
Contingency (15% of Annual O&M Costs)				$6,750
Annual O&M Costs (0-5 years)				$51,750
Groundwater Monitoring (6-30 years)				
Labor	Annual	1	$4,500	$4,500
Equip., Supplies, Travel	Annual	1	$4,000	$4,000
Analytical (20 samples/event)	Annual	1	$6,000	$6,000
Reporting, Admin. and PM	Annual	1	$7,500	$7,500
Maintenance	Annual	1	$500	$500
Subtotal				$22,500
Contingency (15% of Annual O&M Costs)				$3,375
Annual O&M Costs (6-30 years)				$25,875

TOTAL CAPITAL COST		**$1,950,000**
ANNUAL O&M COST (0-30 years)		**$5,750**
ANNUAL O&M COST (0-5 years)		**$51,750**
ANNUAL O&M COST (6-30 years)		**$25,875**
PRESENT WORTH		**$2,449,000**
	Interest Rate	7%
	Term (years)	30

Table 48
Cost Estimate
Alternative 1
No Action

CAPITAL COST	Unit	Quantity	Unit Cost	Total
Construction (Misc.)				
Monitoring Well Installation (30' Depth)	Each	4	$5,000	$20,000
Subtotal				$20,000
Contingency (15% of Capital Costs)				$3,000
Total Capital Costs				$23,000

ANNUAL O&M COSTS	Unit	Quantity	Unit Cost	Total
Groundwater Monitoring (0-5 years)				
Labor	Semiannual	2	$4,500	$9,000
Equip., Supplies, Travel	Semiannual	2	$4,000	$8,000
Analytical (20 samples/event)	Semiannual	2	$6,000	$12,000
Reporting, Admin. and PM	Semiannual	2	$7,500	$15,000
Maintenance	Semiannual	2	$500	$1,000
Subtotal				$45,000
Contingency (15% of Annual O&M Costs)				$6,750
Annual O&M Costs (0-5 years)				$51,750
Groundwater Monitoring (6-30 years)				
Labor	Annual	1	$4,500	$4,500
Equip., Supplies, Travel	Annual	1	$4,000	$4,000
Analytical (20 samples/event)	Annual	1	$6,000	$6,000
Reporting, Admin. and PM	Annual	1	$7,500	$7,500
Maintenance	Annual	1	$500	$500
Subtotal				$22,500
Contingency (15% of Annual O&M Costs)				$3,375
Annual O&M Costs (6-30 years)				$25,875

TOTAL CAPITAL COST		**$23,000**
ANNUAL O&M COST (0-5 years)		**$51,750**
ANNUAL O&M COST (6-30 years)		**$25,875**
PRESENT WORTH		**$450,000**
	Interest Rate	7%
	Term (years)	30

TABLE 47K

LEAD RISK-BASED REMEDIATION GOAL
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Parameter	Risk-based Remediation Goal -Soil	
	Contact Intensive Receptor (mg/kg)	Contact Nonintensive Receptor (mg/kg)
Lead	539	1079

Adult Lead Model - Input Parameters

Symbol	Definition	Units	Input Parameters by Receptor		Reference
			Contact Intensive Receptor	Contact Nonintensive Receptor	
$PbB_{adult,central,goal}$	Acceptable blood lead level	ug/dL	3.08	3.08	Calculated
$PbB_{adult,0}$	Typical blood lead level	ug/dL	1.53	1.53	USEPA 2002 - Midwest Region
AT	Averaging time	days/year	365	365	USEPA 2003
ED	Exposure duration	year	1	1	USEPA 2003
BKSF	Biokinetic slope factor	ug/dL/ug/day	0.4	0.4	USEPA 2003
IR_s	Intake rate of soil	g/day	0.1	0.05	USEPA 2003
EF_s	Exposure frequency	day/year	219	219	USEPA 2003
AF_s	Absolute gastrointestional absorption factor	unitless	0.12	0.12	USEPA 2003
$PbB_{adult,central,goal}$	Acceptable blood lead level	ug/dL	Calculated	Calculated	
$GSD_{i,adult}$	Geometric standard deviation		2.18	2.18	USEPA 2002 - Midwest Region
$R_{fetal/maternal}$			0.9	0.9	USEPA 2003
$PbB_{fetal,0.95,goal}$		ug/dL	10	10	USEPA 2003

USEPA, 2002. U.S.Environmental Protection Agency. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National health and Nutrition Evaluation Survey (NHANES III). March 2002.

USEPA, 2003. U.S.Environmental Protection Agency. Recommendations of the Technical Review Workgroup for Lead for an Appraoch to Assessing Risks Associated with Adult Exposures to Lead in Soil. January 2003.

TABLE 47J
RISK BASED REMEDIATION GOALS
INDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

INDOOR AIR - GROUNDWATER

Parameter	Exposure Point Concentration (ug/L)	Indoor Exposure Carcinogenic (ug/L)			Indoor Exposure Noncarcinogenic (ug/L)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Trichloroethene	1.19E+06	4.66E+03	4.66E+02	4.66E+01	7.33E+04
Vinyl chloride	5.99E+04	4.08E+04	4.08E+03	4.08E+02	1.28E+05
cis-1,2-Dichloroethene	6.65E+04	NA	NA	NA	5.97E+04

INDOOR AIR - SOIL

Parameter	Exposure Point Concentration (ug/kg)	Indoor Exposure Carcinogenic			Indoor Exposure Noncarcinogenic (ug/kg)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Trichloroethene	1.31E+06	1.88E+02	1.88E+01	1.88E+00	2.96E+03
Vinyl chloride	1.21E+03	3.58E+02	3.58E+01	3.58E+00	1.12E+03
cis-1,2-Dichloroethene	1.85E+05	NA	NA	NA	3.08E+03
Chloroform	2.48E+01	1.20E+03	1.20E+02	1.20E+01	NA
Tetrachloroethene	1.16E+05	4.14E+03	4.14E+02	4.14E+01	NA
trans-1,2-Dichloroethene	6.23E+03	NA	NA	NA	2.95E+03

INGESTION - SOIL

Parameter	Exposure Point Concentration (ug/kg)	Indoor Exposure Carcinogenic			Indoor Exposure Noncarcinogenic (ug/kg)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Tetrachloroethene	1.16E+05	1.10E+07	1.10E+06	1.10E+05	2.04E+07

NA - Not Applicable

TABLE 47I
RISK BASED REMEDIATION GOALS
ON-SITE TRESPASSER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

AMBIENT AIR - GROUNDWATER

Parameter	Exposure Point Concentration (ug/L)	Ambient Air Exposure Carcinogenic (ug/L)			Ambient Air Exposure Noncarcinogenic (ug/L)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Trichloroethene	1.19E+06	2.87E+07	2.87E+06	2.87E+05	1.15E+08

TABLE 47H
RISK BASED REMEDIATION GOALS
CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

AMBIENT AIR - GROUNDWATER

Parameter	Exposure Point Concentration (ug/L)	Ambient Air Exposure Carcinogenic (ug/L)			Ambient Air Exposure Noncarcinogenic (ug/L)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Trichloroethene	1.19E+06	3.04E+07	3.04E+06	3.04E+05	1.74E+07

TABLE 47G
RISK BASED REMEDIATION GOALS
OUTDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

AMBIENT AIR - GROUNDWATER

Parameter	Exposure Point Concentration (ug/L)	Ambient Air Exposure Carcinogenic (ug/L)			Ambient Air Exposure Noncarcinogenic (ug/L)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Trichloroethene	1.19E+06	1.35E+06	1.35E+05	1.35E+04	1.93E+07

INGESTION/INHALATION/DERMAL CONTACT - SOIL

Parameter	Exposure Point Concentration (ug/kg)	Soil Exposure Carcinogenic (ug/kg)			Soil Exposure Noncarcinogenic (ug/kg)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Tetrachloroethene	1.16E+05	6.11E+06	6.11E+05	6.11E+04	5.68E+07
Benzo(a)pyrene	3.30E+02	2.34E+04	2.34E+03	2.34E+02	NA

NA - Not Applicable

TABLE 47F
SOIL AND GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
FOR THE JOHNSON AND ETTINGER MODEL
INDOOR WORKER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Symbol	Definition	Units	Indoor Worker	Reference
L_f	Depth below grade to bottom of enclosed space	cm	15	J&E 2003
L_t	Depth below grade to top of contamination	cm	15	Site-specifi
L_{wt}	Depth below grade to water table	cm	259.08	Site-specifi
SCS	Soil type directly above water table	unitless	SIC - Silty Clay	Site-specifi
T_s	Average soil/groundwater temperature	C	10	J&E 2003
Vadose Zone SCS	Soil type used to estimate soil vapor permeability	unitless	SIC - Silty Clay	Site-specifi
f_{oc}^{V}	Vadose zone soil organic carbon fraction	unitless	0.002	J&E 2003
r_b^v	Vadose zone soil dry bulk density	g/cm^3	1.5	J&E 2003
n^v	Vaodse zone soil total porosity	unitless	0.43	J&E 2003
O_w^v	Vadose zone soil water-filled porosity	cm^3/cm^3	0.3	J&E 2003
AT_c	Averaging time for carcinogens	yrs	70	J&E 2003
AT_{nc}	Averaging time for noncarcinogens	yrs	25	USEPA 20
ED	Exposure duration	yrs	25	USEPA 20
EF	Exposure frequency	days/yr	250	USEPA 20

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TABLE 47E
SOIL CONCENTRATION EQUATIONS AN
EXPOSURE PARAMETER INPUT VALUE
INDOOR WORKER - INGESTION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FAC

Ingestion Exposure Soil - Carcinogens

$$Cs = \frac{BWa \times ATc \times Risk\ Level}{CSFo \times IRSo \times CF \times EFo \times EDo}$$

Ingestion Exposure Soi

$$Cs = \frac{RfDo \times BWa \times A}{IRSo \times CF \times}$$

Symbol	Definition (units)	Default
CSFo	Cancer slope factor oral $(mg/kg*day)^{-1}$	Chemical-specific
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific
RfDo	Reference dose factor oral (mg/kg*day)	Chemical-specific
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific
TRi	Target cancer risk level - Indoor Worker	10^{-6}; 10^{-5}; 10^{-4}
THQs	Target hazard quotient risk level - Indoor Worker	1
BWa	Body weight - adult (kg)	70
ATc	Averaging time - carcinogens (days)	25550
ATn	Averaging time - noncarcinogens (days)	ED*365
IRSo	Soil ingestion - adult (mg/day)	50
EFo	Exposure frequency - indoor worker (day/year)	250
EDo	Exposure duration - indoor worker (year)	25
CF	Conversion factor (kg/mg)	1.00E-06

D
S

ILITY

l - Noncarcinogens

Tn x Risk Level
EFo x EDc

Reference

USEPA 2003
USEPA 2003
USEPA 2003
USEPA 2003
USEPA 2001
USEPA 2001
USEPA 2001
USEPA 2001
USEPA 2001
USEPA 2001
USEPA 2001
USEPA 2001

TABLE 47D
GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
ON-SITE TRESPASSER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Symbol	Definition (units)	Default	Reference
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2002
Risk Level	Target cancer risk - On-site trespasser	10^{-6}; 10^{-5}; 10^{-4}	
Risk Level	Target hazard quotient	1	USEPA 2001
BWa	Body weight - adolesence (kg)	50	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adolesence(m^3/day)	10	USEPA 2001
EFo	Exposure frequency - On-site trespasser (day/year)	54	
EDo	Exposure duration - On-site trespasser (year)	7	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cgw	Groundwater concentration (mg/L)	Maximum detection concentration	

(1) The body weight for the following ranges is provided in the USEPA Exposure Factors Handbook:

	Boys and Girls
Age	Mean Weight
9<12	36
12<15	50.6
15<18	61.2

The on-site trespasser for this site ranges in age from 10 to 17. The average of these body weights was used at the body weight for the site receptor.

TABLE 47C
GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
CONSTRUCTION WORKER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Symbol	Definition (units)	Default	Reference
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2002
Risk Level	Target cancer risk - Construction Worker	10^{-6}; 10^{-5}; 10^{-4}	
Risk Level	Target hazard quotient	1	USEPA 2001
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
EFo	Exposure frequency - Construction worker (day/year)	250	
EDo	Exposure duration - Construction worker (year)	1	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cgw	Groundwater concentration (mg/L)	Maximum detection concentration	

TABLE 47 B
GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
OUTDOOR WORKER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Symbol	Definition (units)	Default	Reference
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2002
Risk Level	Target cancer risk - Outdoor Worker	10^{-6}; 10^{-5}; 10^{-4}	
Risk Level	Target hazard quotient	1	USEPA 2001
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
EFo	Exposure frequency - outdoor worker (day/year)	225	
EDo	Exposure duration - outdoor worker (year)	25	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cgw	Groundwater concentration (mg/L)	Maximum detection concentration	

TABLE 47A
EXPOSURE PARAMETER INPUT VALUES
OUTDOOR WORKER - INGESTION, INHALATION AND DERMAL CONTACT
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Combined Soil Exposures to Carcinogens in Industrial Soil

$$Cs = \frac{BWa \times ATc \times Risk\ Level}{EFo \times EDo \times [(CSFo \times IRSo \times CF)+((CSFi \times IRAa)/VF\ or\ PEF)+(CSFo \times SA \times AF \times ABS \times CF)]}$$

Combined Soil Exposures to Noncarcinogens in Industrial Soil

$$Cs = \frac{BWa \times ATc \times Risk\ Level}{EFo \times EDo \times [((IRSo \times CF)/RfDo)+((IRAa)/(VF\ or\ PEF \times RfDi)+((SA \times AF \times ABS \times CF)/RfDo)]}$$

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2003
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2003
RfDo	Reference dose factor oral (mg/kg*day)	Chemical-specific	USEPA 2003
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2003
Risk Level	Target cancer risk - Outdoor Worker	10^{-6}; 10^{-5}; 10^{-4}	
Risk Level	Target hazard quotient - Outdoor Worker	1	USEPA 2001
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATn	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
IRSo	Soil ingestion - adult (mg/day)	100	USEPA 2001
EFo	Exposure frequency - outdoor worker (day/year)	225	USEPA 2001
EDo	Exposure duration - outdoor worker (year)	25	USEPA 2001
PEF	Particulate emission factor (m^3/kg)	Site - specific	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
CF	Conversion factor (kg/mg)	1.00E-06	USEPA 2001
SA	Skin surface area (cm^2/event)	3300	USEPA 2001
ABS	Chemical specific absorption factor	chemical-specific	USEPA 2001
AF	Soil to skin adherence factor (mg/cm^2)	0.2	USEPA 2001
ABS Factors:			
	Cadmium	0.001	
	PAHs	0.13	
	VOCs	Not included for dermal exposure	

Table 46

SUMMARY OF TOTAL RISK
ON-SITE TRESPASSER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to ambient air	4.1E-06	1.0E-02
Soil		
Inhalation to ambient air	3.4E-08	8.6E-05
Incidential Ingestion	5.6E-07	6.9E-03
Dermal Contact	7.2E-08	0.0E+00
	4.8E-06	**0.02**

Table 45

SUMMARY OF TOTAL RISK
CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to ambient air	3.9E-06	2.5E-02
Soil		
Inhalation to ambient air	3.2E-08	2.0E-04
Incidential Ingestion	4.3E-07	7.5E-03
Dermal Contact	6.0E-08	0.0E+00
	4.4E-06	**0.03**

Table 44

SUMMARY OF TOTAL RISK
INDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to indoor air	2.6E-02	1.8E+01
Soil		
Inhalation to indoor air	4.3E-01	3.3E+02
Incidential Ingestion	1.1E-06	5.7E-03
	4.6E-01	**350.94**

Table 43

SUMMARY OF TOTAL RISK
OUTDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to ambient air	8.8E-05	6.2E-02
Soil		
Inhalation to ambient air	7.3E-07	5.1E-04
Incidential Ingestion	2.7E-06	1.0E-02
Dermal Contact	6.5E-07	0.0E+00
	9.2E-05	**0.07**

Table 42

SUMMARY OF RECEPTOR RISKS AND HAZARDS - GROUNDWATER
INDOOR WORKER - INDOOR AIR INHALATION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (ug/L)	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
1,2-Dichloroethane	9.7	2.9E-08	NA
Chloroform	2.2	9.5E-09	NA
1,2,4-Trimethylbenzene	3.4	NA	2.5E-04
1,3,5-Trimethylbenzene	6.3	NA	5.0E-04
cis-1,2-Dichloroethene	66500	NA	1.1E+00
Methylene chloride	125	1.1E-08	2.2E-05
Tetrachloroethene	858	4.7E-07	NA
trans-1,2-Dichloroethene	65.3	NA	6.5E-04
Trichloroethene	11900000	2.6E-02	1.6E+01
Vinyl chloride	59900	1.5E-04	4.7E-01
		Total Carcinogenic Risk	**Total Hazard Quotient**
		2.6E-02	1.8E+01

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

2.9E-08	NA
9.5E-09	NA
NA	2.5E-04
NA	5.0E-04
NA	
1.1E-08	2.2E-05
4.7E-07	NA
NA	6.5E-04
Total Carc	**Hazard Quotient**
5.2E-07	1.4E-03

Table 41

SUMMARY OF RECEPTOR RISKS AND HAZARDS - SOIL
INDOOR WORKER - INDOOR AIR INHALATION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (ug/kg)	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
1,1,1-Trichloroethane	1630	NA	2.20E-02
1,1,2-Trichloroethane	44.3	5.10E-07	6.30E-03
1,1-Dichloroethane	57.8	NA	1.90E-03
1,1-Dichloroethene	86.1	NA	2.60E-02
1,2,4-Trichlorobenzene	494.4	NA	4.40E-04
1,2,4-Trimethylbenzene	70.4	NA	1.40E-02
1,2-Dichloroethane	10.3	2.90E-07	NA
2-Butanone	21.6	NA	4.30E-06
Acenapthene	72000	NA	9.70E-04
Acetone	182.8	NA	8.00E-05
Benzene	10.5	3.70E-07	NA
Carbon disulfide	688.2	NA	7.20E-02
Chloroethane	11	1.20E-07	3.90E-05
Chloroform	24.8	2.10E-06	NA
Chloromethane	7.3	1.00E-07	3.20E-03
cis-1,2-Dichloroethene	185000	NA	6.00E+01
Ethylbenzene	166	3.40E-07	8.70E-04
Fluorene	9089.8	NA	5.40E-05
Methylene chloride	353.3	4.70E-07	9.30E-04
Naphthalene	233.1	NA	4.40E-03
p-Isopropyltoluene (2)	18.8	NA	NA
n-Propylbenzene	9.3	NA	3.00E-04
Styrene	29.8	NA	2.80E-05
Trichloroethene	1310000	4.30E-01	2.70E+02
Tetrachloroethene	116000	2.60E-03	NA
Toluene	95.2	NA	1.90E-03
trans-1,2-Dichloroethene	6230	NA	2.10E+00
Trichlorofluoromethane	74.4	NA	6.60E-03
Vinyl chloride	1210.00	3.4E-04	1.1E+00
Xylenes, total (1)	18.00	NA	1.2E-05
Acenaphthylene (2)	72,000.00	NA	NA
Anthracene (2)	8450.00	NA	NA
Phenanthrene (2)	48900.00	NA	NA
		Total Carcinogenic Risk	**Total Hazard Quotient**
		4.3E-01	3.3E+02

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

(1) Xylenes, total is based on p-xylene.

(2) These constituents were not included in the Johnson and Ettinger Model.

NA	2.20E-02
5.10E-07	6.30E-03
NA	1.90E-03
NA	2.60E-02
NA	4.40E-04
NA	1.40E-02
2.90E-07	NA
NA	4.30E-06
NA	9.70E-04
NA	8.00E-05
3.70E-07	NA
NA	7.20E-02
1.20E-07	3.90E-05
2.10E-06	NA
1.00E-07	3.20E-03
NA	
3.40E-07	8.70E-04
NA	5.40E-05
4.70E-07	9.30E-04
NA	4.40E-03
NA	NA
NA	3.00E-04
NA	2.80E-05
	NA
NA	1.90E-03
NA	
NA	6.60E-03
NA	1.2E-05
NA	NA
NA	NA
NA	NA
Total Carcinogen	**Hazard Quotient**
4.3E-06	1.6E-01

Table 40

SUMMARY OF RECEPTOR RISKS AND HAZARDS - SOIL
INDOOR WORKER - INCIDENTAL INGESTION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/kg) Ingestion	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Lead (1)	2,466.80	NA	NA
Tetrachloroethene	116.00	1.1E-06	5.7E-03
		Total Carcinogenic Risk	**Total Hazard Quotient**
		1.1E-06	0.01

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

(1) The ingestion exposure concentration is the log normal 95% UCL.

Table 39

SUMMARY OF RECEPTOR RISKS AND HAZARDS - GROUNDWATER
ON-SITE TRESPASSER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/L)	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
1,1,1-Trichloroethane	0.157	NA	4.7E-12
1,1-Dichloroethane	0.145	NA	NA
1,1-Dichloroethene	0.0132	NA	1.2E-14
1,2-Dichloroethane	0.0097	7.2E-18	NA
Chloroethane	0.0038	NA	5.4E-16
Chloroform	0.0021	1.4e=18	NA
1,1,2-Trichloroethane	0.0443	3.1E-21	NA
1,2,4-Trimethylbenzene	0.0034	NA	2.3E-13
1,3,5-Trimethylbenzene	0.0063	NA	NA
Cis-1,2-Dichloroethene	66.5	NA	NA
Methylene chloride	0.125	5.1E-17	NA
Sec-Butylbenzene	0.0023	NA	NA
Tetrachloroethene	0.133	2.1E-15	1.2E-11
Toluene	0.002	NA	1.7E-15
Trans-1,2-Dichloroethene	0.0653	NA	NA
Trichloroethene	1190	4.1E-06	1.0E-02
Vinyl Chloride	59.9	2.9E-09	3.3E-05
		Total Carcinogenic Risk	**Total Hazard Quotient**
		4.1E-06	0.01

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical.

Table 38

SUMMARY OF RECEPTOR RISKS AND HAZARDS - SOIL
ON-SITE TRESPASSER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/kg)		Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
	Ingestion	Inhalation		
Lead (1)	2466.80	NC	NA	NA
1,1-Dichloroethene	NC	0.09	NA	7.9E-14
Tetrachloroethene	116.00	116.00	3.6E-07	6.9E-03
Trichloroethene	NC	1310.00	3.4E-08	8.6E-05
Vinyl Chloride	NC	1.21	2.5E-15	2.8E-11
Benzo (a) pyrene (1)	0.37	ND	2.0E-07	NA
Dibenzo (a,h) anthracene (1)	0.14	ND	7.6E-08	NA
			Total Carcinogenic Risk	**Total Hazard Quotient**
			6.7E-07	0.01

(1) The ingestion exposure concentration is the log normal 95% UCL.
NC - This is not a constituent of concern for the exposure pathway.
ND - Not Detected
NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

Table 37

SUMMARY OF RECEPTOR RISKS AND HAZARDS - GROUNDWATER
CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/L)	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
1,1,1-Trichloroethane	0.157	NA	9.9E-11
1,1-Dichloroethane	0.145	NA	NA
1,1-Dichloroethene	0.0132	NA	4.2E-11
1,2-Dichloroethane	0.0097	6.8E-18	3.1E-14
Chloroethane	0.0038	NA	2.4E-15
Chloroform	0.0022	1.4E-18	2.1E-13
1,2,4-Trimethylbenzene	0.0034	NA	NA
1,3,5-Trimethylbenzene	0.0063	NA	NA
Cis-1,2-Dichloroethene	66.5	NA	NA
Methylene chloride	0.125	4.8E-17	2.4E-11
Sec-Butylbenzene	0.0023	NA	NA
Tetrachloroethene	0.858	1.3E-14	7.9E-09
Toluene	0.002	NA	5.7E-14
Trans-1,2-Dichloroethene	0.0653	NA	3.0E-11
Trichloroethene	1190	3.9E-06	2.4E-02
Vinyl Chloride	59.9	2.7E-09	7.2E-04
		Total Carcinogenic Risk	**Total Hazard Quotient**
		3.9E-06	0.02

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

Table 36

SUMMARY OF RECEPTOR RISKS AND HAZARDS - SOIL
CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/kg)		Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
	Ingestion	Inhalation		
Tetrachloroethene	116.00	116.00	2.8E-07	7.5E-03
Trichloroethene	413.00	1310.00	3.2E-08	2.0E-04
Vinyl chloride	NC	1.20	2.3E-15	6.0E-10
Benzo(a)anthracene	2.40	ND	1.1E-07	0.0E+00
Benzo(a)pyrene	0.22	ND	1.0E-07	0.0E+00
			Total Carcinogenic Risk	**Total Hazard Quotient**
			5.3E-07	0.01

NC - This is not a constituent of concern for the exposure pathway.
ND - Not Detected

Table 35

SUMMARY OF RECEPTOR RISKS AND HAZARDS - GROUNDWATER
OUTDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/L)	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
1,1,1-Trichloroethane	0.157	NA	2.8E-11
1,1-Dichloroethane	0.145	NA	NA
1,1-Dichloroethene	0.0132	NA	7.2E-14
1,2-Dichloroethane	0.0097	1.5E-16	NA
Chloroethane	0.0038	NA	3.2E-15
Chloroform	0.0021	2.9E-17	NA
1,2,4-Trimethylbenzene	0.0034	NA	1.4E-12
1,3,5-Trimethylbenzene	0.0063	NA	NA
Cis-1,2-Dichloroethene	66.5	NA	NA
Methylene chloride	0.125	1.1E-15	NA
Sec-Butylbenzene	0.0023	NA	NA
Tetrachloroethene	0.133	4.5E-14	7.4E-11
Toluene	0.002	NA	1.0E-14
Trans-1,2-Dichloroethene	0.0653	NA	NA
Trichloroethene	1190	8.8E-05	6.2E-02
Vinyl Chloride	59.9	6.2E-08	1.9E-04
		Total Carcinogenic Risk	**Total Hazard Quotient**
		8.8E-05	0.06

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical.

Table 34

SUMMARY OF RECEPTOR RISKS AND HAZARDS - SOIL
OUTDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/kg)		Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
	Ingestion	Inhalation		
Lead (1)	2,466.80	NC	NA	NA
Tetrachloroethene	116.00	116.00	1.9E-06	1.0E-02
Trichloroethene	NC	1,310.00	7.3E-07	5.1E-04
Vinyl chloride	NC	1.20	5.2E-14	NA
Benzo (a) pyrene (1)	0.33	NC	1.4E-06	NA
			Total Carcinogenic Risk	**Total Hazard Quotient**
			4.0E-06	0.01

(1) The ingestion exposure point concentration is the log normal 95% UCL.
NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical.
NC - This is not a constituent of concern for the exposure pathway.

Table 46

SUMMARY OF TOTAL RISK
ON-SITE TRESPASSER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to ambient air	4.1E-06	1.0E-02
Soil		
Inhalation to ambient air	3.4E-08	8.6E-05
Incidential Ingestion	5.6E-07	6.9E-03
Dermal Contact	7.2E-08	0.0E+00
	4.8E-06	**0.02**

Table 45

SUMMARY OF TOTAL RISK
CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to ambient air	3.9E-06	2.5E-02
Soil		
Inhalation to ambient air	3.2E-08	2.0E-04
Incidential Ingestion	4.3E-07	7.5E-03
Dermal Contact	6.0E-08	0.0E+00
	4.4E-06	**0.03**

Table 44

SUMMARY OF TOTAL RISK
INDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to indoor air	2.6E-02	1.8E+01
Soil		
Inhalation to indoor air	4.3E-01	3.3E+02
Incidential Ingestion	1.1E-06	5.7E-03
	4.6E-01	**350.94**

Table 43

SUMMARY OF TOTAL RISK
OUTDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to ambient air	8.8E-05	6.2E-02
Soil		
Inhalation to ambient air	7.3E-07	5.1E-04
Incidential Ingestion	2.7E-06	1.0E-02
Dermal Contact	6.5E-07	0.0E+00
	9.2E-05	**0.07**

Table 42

SUMMARY OF RECEPTOR RISKS AND HAZARDS - GROUNDWATER
INDOOR WORKER - INDOOR AIR INHALATION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (ug/L)	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
1,2-Dichloroethane	9.7	2.9E-08	NA
Chloroform	2.2	9.5E-09	NA
1,2,4-Trimethylbenzene	3.4	NA	2.5E-04
1,3,5-Trimethylbenzene	6.3	NA	5.0E-04
cis-1,2-Dichloroethene	66500	NA	1.1E+00
Methylene chloride	125	1.1E-08	2.2E-05
Tetrachloroethene	858	4.7E-07	NA
trans-1,2-Dichloroethene	65.3	NA	6.5E-04
Trichloroethene	11900000	2.6E-02	1.6E+01
Vinyl chloride	59900	1.5E-04	4.7E-01
		Total Carcinogenic Risk	**Total Hazard Quotient**
		2.6E-02	1.8E+01

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

2.9E-08	NA
9.5E-09	NA
NA	2.5E-04
NA	5.0E-04
NA	
1.1E-08	2.2E-05
4.7E-07	NA
NA	6.5E-04
Total Carc	**Hazard Quotient**
5.2E-07	1.4E-03

Table 41

SUMMARY OF RECEPTOR RISKS AND HAZARDS - SOIL
INDOOR WORKER - INDOOR AIR INHALATION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (ug/kg)	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
1,1,1-Trichloroethane	1630	NA	2.20E-02
1,1,2-Trichloroethane	44.3	5.10E-07	6.30E-03
1,1-Dichloroethane	57.8	NA	1.90E-03
1,1-Dichloroethene	86.1	NA	2.60E-02
1,2,4-Trichlorobenzene	494.4	NA	4.40E-04
1,2,4-Trimethylbenzene	70.4	NA	1.40E-02
1,2-Dichloroethane	10.3	2.90E-07	NA
2-Butanone	21.6	NA	4.30E-06
Acenapthene	72000	NA	9.70E-04
Acetone	182.8	NA	8.00E-05
Benzene	10.5	3.70E-07	NA
Carbon disulfide	688.2	NA	7.20E-02
Chloroethane	11	1.20E-07	3.90E-05
Chloroform	24.8	2.10E-06	NA
Chloromethane	7.3	1.00E-07	3.20E-03
cis-1,2-Dichloroethene	185000	NA	6.00E+01
Ethylbenzene	166	3.40E-07	8.70E-04
Fluorene	9089.8	NA	5.40E-05
Methylene chloride	353.3	4.70E-07	9.30E-04
Naphthalene	233.1	NA	4.40E-03
p-Isopropyltoluene (2)	18.8	NA	NA
n-Propylbenzene	9.3	NA	3.00E-04
Styrene	29.8	NA	2.80E-05
Trichloroethene	1310000	4.30E-01	2.70E+02
Tetrachloroethene	116000	2.60E-03	NA
Toluene	95.2	NA	1.90E-03
trans-1,2-Dichloroethene	6230	NA	2.10E+00
Trichlorofluoromethane	74.4	NA	6.60E-03
Vinyl chloride	1210.00	3.4E-04	1.1E+00
Xylenes, total (1)	18.00	NA	1.2E-05
Acenaphthylene (2)	72,000.00	NA	NA
Anthracene (2)	8450.00	NA	NA
Phenanthrene (2)	48900.00	NA	NA
		Total Carcinogenic Risk	**Total Hazard Quotient**
		4.3E-01	3.3E+02

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

(1) Xylenes, total is based on p-xylene.
(2) These constituents were not included in the Johnson and Ettinger Model.

NA	2.20E-02
5.10E-07	6.30E-03
NA	1.90E-03
NA	2.60E-02
NA	4.40E-04
NA	1.40E-02
2.90E-07	NA
NA	4.30E-06
NA	9.70E-04
NA	8.00E-05
3.70E-07	NA
NA	7.20E-02
1.20E-07	3.90E-05
2.10E-06	NA
1.00E-07	3.20E-03
NA	
3.40E-07	8.70E-04
NA	5.40E-05
4.70E-07	9.30E-04
NA	4.40E-03
NA	NA
NA	3.00E-04
NA	2.80E-05
	NA
NA	1.90E-03
NA	
NA	6.60E-03
NA	1.2E-05
NA	NA
NA	NA
NA	NA
Total Carcinogen	**Hazard Quotient**
4.3E-06	1.6E-01

Table 40

SUMMARY OF RECEPTOR RISKS AND HAZARDS - SOIL
INDOOR WORKER - INCIDENTAL INGESTION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Exposure Concentration (mg/kg) Ingestion	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Lead (1)	2,466.80	NA	NA
Tetrachloroethene	116.00	1.1E-06	5.7E-03
		Total Carcinogenic Risk	**Total Hazard Quotient**
		1.1E-06	0.01

NA - Not applicable. The USEPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD) for this chemical

(1) The ingestion exposure concentration is the log normal 95% UCL.

Table 33

TOXICITY DATA
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Cancer Slope Factor Oral (CSFo) $(mg/kg/day)^{-1}$	Cancer Slope Factor Inhalation (CSFi) $(mg/kg/day)^{-1}$	Cancer Weight of Evidence	Reference Dose Oral (RfDo) (mg/kg/day)	Reference Dose Inhalation (RfDi) (mg/kg/day)	Minimal Risk Level Oral (MRLo) (mg/kg/day)	Minimal Risk Level Inhalation (MRLi) (mg/kg/day)
Cadmium	NA	6.30E+00 i	B1	5.00E-04 i	NA	2.00E-04 c	NA
Lead	NA	NA	B2	NA	NA	NA	NA
Tantalum	NA	NA	NR	NA	NA	NA	NA
Acetone	NA	NA	D	1.00E-01 i	NA	2.00E+00 in	3.71E+00 c
Benzene	5.50E-02 i	2.70E-02 i	A	NA	NA	NA	1.14E-03 in
2-Butanone	NA	NA	D	6.00E-01 i	2.86E-01 i	NA	NA
Carbon disulfide	NA	NA	NR	1.00E-01 i	2.00E-01 i	1.00E-02 a	8.57E-02 c
Chloroethane	NA	NA	NR	NA	2.90E+00 i	NA	4.29E+00 a
Chloroform	NA	8.05E-02 i	B2	1.00E-02 i	NA	1.00E-02 c	5.70E-03 c
Chloromethane	NA	NA	D	NA	2.57E-02 i	NA	1.43E-02 c
1,1-Dichloroethane	NA	NA	C	NA	NA	NA	NA
1,2-Dichloroethane	9.10E-02 i	9.10E-02 i	B2	NA	NA	2.00E-01 in	1.71E-01 c
1,1-Dichloroethene	NA	NA	C	5.00E-02 i	5.70E-02 i	9.00E-03 c	5.71E-03 in
Cis-1,2-Dichloroethene	NA	NA	D	NA	NA	3.00E-01 in	NA
Trans-1,2-Dichloroethene	NA	NA	NR	2.00E-02 i	NA	2.00E-01 in	5.71E-02 in
Ethylbenzene	NA	NA	D	1.00E-01 i	2.86E-01 i	NA	2.86E-01 in
Hexachlorobutadiene	7.80E-02 i	7.70E-02 i	C	NA	NA	2.00E-05 c	NA
Methylene Chloride	7.50E-03 i	1.65E-03 i	B2	6.00E-02 i	NA	6.00E-02 c	8.57E-02 c
p-Isopropyltoluene	NA	NA	NR	NA	NA	NA	NA
n-Propylbenzene	NA	NA	NR	NA	NA	NA	NA
sec-Butylbenzene	NA	NA	NR	NA	NA	NA	NA
Styrene	NA	NA	NR	2.00E-01 i	2.86E-01 i	2.00E-01 in	1.71E-02 c
Tetrachloroethene	5.20E-02 n	1.00E-02 n	NR	1.00E-02 i	1.70E-01 n	5.00E-02 a	1.14E-02 c
Toluene	NA	NA	D	2.00E-01 i	1.14E-01 i	2.00E-02 in	2.29E-02 c
1,2,3-Trichlorobenzene	NA	NA	NR	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	D	1.00E-02 i	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	D	2.80E-01 n	6.30E-01 n	NA	2.00E-01 in
1,1,2-Trichloroethane	5.70E-02 i	5.60E-02 i	C	4.00E-03 i	NA	4.00E-02 in	NA
Trichloroethene	4.00E-01 n	4.00E-01 n	NR	3.00E-04 n	1.00E-02 n	2.00E-01 a	2.86E-02 in

Table 33

TOXICITY DATA
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Cancer Slope Factor Oral (CSFo)	Cancer Slope Factor Inhalation (CSFi)	Cancer Weight of Evidence	Reference Dose Oral (RfDo)	Reference Dose Inhalation (RfDi)	Minimal Risk Level Oral (MRLo)	Minimal Risk Level Inhalation (MRLi)
1,2,4-Trimethylbenzene	NA	NA	NR	5.00E-02 n	1.70E-03 n	NA	NA
1,3,5-Trimethylbenzene	NA	NA	NR	NA	NA	NA	NA
Trichlorofluoromethane	NA	NA	NR	3.00E-01 i	NA	NA	NA
Vinyl Chloride	1.50E+00 i	3.10E-02 i	A	3.00E-03 i	2.86E-02 i	2.00E-05 c	8.60E-03 in
Total Xylenes	NA	NA	NR	2.00E+00 i	NA	2.00E-01 in	2.86E-02 c
Acenaphthene	NA	NA	NR	6.00E-02 i	NA	NA	NA
Acenapthylene (1)	NA	NA	D	6.00E-02 i	NA	NA	NA
Anthracene	NA	NA	D	3.00E-01 i	NA	1.00E+01 in	NA
Benzo (a) anthracene	7.30E-01 n	NA	NR	NA	NA	NA	NA
Benzo (a) pyrene	7.30E+00 i	NA	B2	NA	NA	NA	NA
Benzo (b) fluoranthene	7.30E-01 n	NA	B2	NA	NA	NA	NA
Benzo (ghi) perylene (1)	NA	NA	D	3.00E-02 i	NA	NA	NA
Benzo (k) fluoranthene	7.30E-02 n	NA	B2	NA	NA	NA	NA
Chrysene	7.30E-03 n	NA	B2	NA	NA	NA	NA
Dibenzo (a,h) anthracene	7.30E+00 n	NA	B2	NA	NA	NA	NA
Fluoranthene	NA	NA	D	4.00E-02 i	NA	4.00E-01 in	NA
Fluorene	NA	NA	D	4.00E-02 i	NA	4.00E-01 in	NA
Indeno (1,2,3-c,d) pyrene	7.30E-01 n	NA	B2	NA	NA	NA	NA
Naphthalene	NA	NA	C	2.00E-02 i	8.60E-04 i	2.00E-02 in	5.71E-04 c
Phenanthrene (1)	NA	NA	D	3.00E-01 i	NA	NA	NA
Pyrene	NA	NA	D	3.00E-02 i	NA	NA	NA

Table 33

TOXICITY DATA
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS FACILITY

Chemical	Cancer Slope Factor Oral (CSFo)	Cancer Slope Factor Inhalation (CSFi)	Cancer Weight of Evidence	Reference Dose Oral (RfDo)	Reference Dose Inhalation (RfDi)	Minimal Risk Level Oral (MRLo)	Minimal Risk Level Inhalation (MRLi)

(1) Acenpathene was used as a surrogate for Acenaphthylene.
Pyrene was used as a surrogate for Benzo(g,h,I)perylene.
Anthracene was used as a surrogate for Phenanthrene.
These surrogates were taken from the West Virginia Department of Environmental Protection Voluntary Remediation and Redevelopment Act Guidance.

i - value is from IRIS (Integrated Risk Information System)
n - value is from NCEA (National Center for Environmental Assessment)
a - acute value based on exposure for 1-14 days
in - intermediate value based on exposure for >14 - 364 days
c - chronic value based on exposure for 365 days and longer

NA - No Data Available
NR - Not assessed under the IRIS Program.

a) Toxicity information used was taken at the time the risk assessment was being conducted (2003). It was agreeded upon by USEPA and NCI that the toxicity information present at the time of preparing the risk assessment would be used and not updated . during subsequent revisions to the risk assessment.
b) CSFs were obtained from current IRIS information. If information was not availble from IRIS, NCEA values listed in the current USEPA Region IX PRG table were used. Although a value from IRIS was available for tetrachloroethene, the NCEA values also were used because this is a primary constituent of concern.
c) MRL is a subchronic exposure value published by the Agency for Toxic Substances and Disease Registry (ATSDR). The MRL is used only for assessing noncarcinogenic risk for the construction worker.
d) Inhalation values expressed in mg/m^3 (ppm for MRLs) were converted to mg/kg-day.

Cancer Weight of Evidence

A - Know human carcinogen
B1 - Probable human carcinogen, based on limited evidence of carcinogenicity in humans
B2 - Probable human carcinogen, based on sufficient evidence of carcinogenicity in animals
C - Possible human carcinogen
D - Not classifiable as to human carcinogenicity

Table 32

GROUNDWATER ADD AND LADD EQUATIONS
EXPOSURE PARAMETER INPUT VALUES
ON-SITE TRESPASSER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Exposure to Carcinogens in Ambient Air

Inhalation

$$LADD = \frac{Cw \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Exposure to Noncarcinogens in Ambient Air

Inhalation

$$ADD = \frac{Cw \times IRAo \times EFo \times EDo}{VF \text{ for } PEF \times BWa \times ATn}$$

Symbol	**Definition (units)**	**Default**	**Reference**
BWa	Body weight - adult (kg)	50	USEPA 1989
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - on-site trespasser (m^3/day)	10	USEPA 2001
EFo	Exposure frequency - on-site trespasser (day/year)	54	
EDo	Exposure duration - ons-ite trespasser (year)	7	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cw	groundwater concentration (mg/L)	Maximum detection concentration	

(1) The body weight for the following ranges is provided in the USEPA Exposure Factors Handbook:

	Boys and Girls
Age	Mean Weight
9<12	36
12<15	50.6
15<18	61.2

The on-site trespasser for this site ranges in age from 10 to 17. The average of these body weights was used at the body weight for the site receptor.

Table 31

GROUNDWATER ADD AND LADD EQUATIONS
EXPOSURE PARAMETER INPUT VALUES
CONSTRUCTION SCENARIO - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Exposure to Carcinogens in Ambient Air

Inhalation

$$LADD = \frac{Cw \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Exposure to Noncarcinogens in Ambient Air

Inhalation

$$ADD = \frac{Cw \times IRAo \times EFo \times EDo}{VF \text{ for } PEF \times BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
EFo	Exposure frequency - construction (day/year)	250	USEPA 2001
EDo	Exposure duration - construction (year)	1	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cw	groundwater concentration (mg/L)	Maximum detection concentration	

Table 30

GROUNDWATER ADD AND LADD EQUATIONS
EXPOSURE PARAMETER INPUT VALUES
OUTDOOR WORKER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Exposure to Carcinogens in Ambient Air

Inhalation

$$LADD = \frac{Cw \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Exposure to Noncarcinogens in Ambient Air

Inhalation

$$ADD = \frac{Cw \times IRAo \times EFo \times EDo}{VF \text{ for } PEF \times BWa \times ATn}$$

Symbol	**Definition (units)**	**Default**	**Reference**
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
EFo	Exposure frequency - outdoor worker (day/year)	225	
EDo	Exposure duration - outdoor worker (year)	25	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cw	groundwater concentration (mg/L)	Maximum detection concentration	

Table 29

SOIL ADD AND LADD EQUATIONS
EXPOSURE PARAMETER INPUT VALUES
ON-SITE TRESPASSER - INGESTION, INHALATION AND DERMAL CONTACT
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Combined Exposures to Carcinogens in Soil

Ingestion

$$LADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATc}$$

Inhalation

$$LADD = \frac{Cs \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Dermal Contact

$$LADD = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATc}$$

Combined Exposures to Noncarcinogens in Soil

Ingestion

$$ADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATn}$$

Inhalation

$$ADD = \frac{Cs \times IRAo \times EFo \times EDo}{VF \text{ for } PEF \times BWa \times ATn}$$

Dermal Contact

$$ADD = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
LADD	Lifetime Average Daily Dose	Chemical-specific	
ADD	Average Daily Dose	Chemical-specific	
BWa	Body weight - child (kg)	50	USEPA 1989
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATn	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
Cs	Soil exposure point concentration (mg/kg)	Chemical-specific	
IRAa	Inhalation rate - child (m^3/day)	10	USEPA 2001
IRSo	Soil ingestion - child (mg/day)	200	USEPA 2001
EFo	Exposure frequency - on-site trespasser (day/year)	54	
EDo	Exposure duration - on-site trespasser (year)	7	
PEF	Particulate emission factor (m^3/kg)	Site-specific	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
CF	Conversion factor (kg/mg)	1.00E-06	
SA	Skin surface area (cm^2/event)	2800	USEPA 2001
ABS	Chemical specific absorption factor	chemical-specific	USEPA 2001
AF	Soil to skin adherence factor (mg/cm^2)	0.2	USEPA 2001
ABS Dermal Factors:			
	Cadmium	0.001	
	PAHs	0.13	

(1) The body weight for the following ranges is provided in the USEPA Exposure Factors Handbook:

	Boys and Girls
Age	Mean Weight
9<12	36
12<15	50.6
15<18	61.2

The on-site trespasser for this site ranges in age from 10 to 17. The average of these body weights was used at the body weight for the site receptor.

Table 28

SOIL ADD AND LADD EQUATIONS
EXPOSURE PARAMETER INPUT VALUES
CONSTRUCTION WORKER - INGESTION, INHALATION AND DERMAL CONTACT
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Combined Exposures to Carcinogens in Soil

Ingestion

$$LADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATc}$$

Inhalation

$$LADD = \frac{Cs \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Dermal Contact

$$LADD = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATc}$$

Combined Exposures to Noncarcinogens in Soil

Ingestion

$$ADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATn}$$

Inhalation

$$ADD = \frac{Cs \times IRAo \times EFo \times EDo}{VF \text{ for } PEF \times BWa \times ATn}$$

Dermal Contact

$$ADD = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
LADD	Lifetime Average Daily Dose	Chemical-specific	
ADD	Average Daily Dose	Chemical-specific	
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATn	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
IRSo	Soil ingestion - occupational (mg/day)	330	USEPA 2001
Cs	Soil exposure point concentration (mg/kg)	Chemical-specific	
EFo	Exposure frequency - contruction (day/year)	250	USEPA 2001
EDo	Exposure duration - construction (year)	1	USEPA 2001
PEF	Particulate emission factor (m^3/kg)	Site-specific	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
CF	Conversion factor (kg/mg)	1.00E-06	
SA	Skin surface area (cm^2/event)	3300	USEPA 2001
ABS	Chemical specific absorption factor	chemical-specific	USEPA 2001
AF	Soil to skin adherence factor (mg/cm^2)	0.3	USEPA 2001
ABS Deraml Factors:			
	Cadmium	0.001	
	PAHs	0.13	

Table 27

SOIL ADD AND LADD EQUATIONS
EXPOSURE PARAMETER INPUT VALUES
INDOOR WORKER - INGESTION AND INHALATION
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Combined Exposures to Carcinogens in Soil Ingestion

$$LADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATc}$$

Combined Exposures to Noncarcinogens in Soil Ingestion

$$ADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
LADD	Lifetime Average Daily Dose	Chemical-specific	
ADD	Average Daily Dose	Chemical-specific	
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATn	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
Cs	Soil exposure point concentration (mg/kg)	Chemical-specific	
IRSo	Soil ingestion - adult (mg/day)	50	USEPA 2001
EFo	Exposure frequency - indoor worker (day/year)	250	USEPA 2001
EDo	Exposure duration - indoor worker (year)	25	USEPA 2001
CF	Conversion factor (kg/mg)	1.00E-06	USEPA 2001

INDOOR INHALATION - J & E MODEL INPUT PARAMETERS SOIL AND GROUNDWATER

SL-SCREEN Version 3.0: 04/03 and GW-SCREEN Version 3.0: 04/03

Symbol	Definition (units)	Default	Reference
L_f	Depth below grade to bottom of enclosed space floor (assume slab construction) (cm)	15	J & E Model 2003
L_t	Depth below grade to top of contamination (assume slab is located in contamination) (cm)	15	J & E Model 2003
SCS	Soil type directly above water table	SIC - Silty Clay	Site-specific
Vadose Zone SCS	Soil type used to estimate soil vapor permeability	SIC - Silty Clay	Site-specific
ATc	Averaging time for carcinogens (years)	70	USEPA 2001
ATn	Averaging time - noncarcinogens (years)	25	USEPA 2001
EFo	Exposure frequency - indoor worker (day/year)	250	USEPA 2001
EDo	Exposure duration - indoor worker (year)	25	USEPA 2001
L_{wt}	Depth below grade to water table (cm)	259.08	Site-specific
T_s	Average soil/groundwater temperature (C)	10	J & E Model 2003
r_b^v	Vadose zone soil dry bulk density (g/cm^3)	1.5	J & E Model 2003
n^v	Vaodse zone soil total porosity	0.43	J & E Model 2003
O_w^v	Vadose zone soil water-filled porosity (cm^3/cm^3)	0.3	J & E Model 2003
f_{oc}^V	Vadose zone soil organic carbon fraction (unitless)	0.002	J & E Model 2003

Table 26

SOIL ADD AND LADD EQUATIONS
EXPOSURE PARAMETER INPUT VALUES
OUTDOOR WORKER - INGESTION, INHALATION AND DERMAL CONTACT
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Combined Exposures to Carcinogens in Soil

Ingestion

$$LADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATc}$$

Inhalation

$$LADD = \frac{Cs \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Dermal Contact

$$LADD = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATc}$$

Combined Exposures to Noncarcinogens in Soil

Ingestion

$$ADD = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATn}$$

Inhalation

$$ADD = \frac{Cs \times IRAo \times EFo \times EDo}{VF \text{ for } PEF \times BWa \times ATn}$$

Dermal Contact

$$ADD = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
LADD	Lifetime Average Daily Dose	Chemical-specific	
ADD	Average Daily Dose	Chemical-specific	
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATn	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
IRSo	Soil ingestion - adult (mg/day)	100	USEPA 2001
Cs	Soil exposure point concentration (mg/kg)	Chemical-specific	
EFo	Exposure frequency - outdoor worker (day/year)	225	USEPA 2001
EDo	Exposure duration - outdoor worker (year)	25	USEPA 2001
PEF	Particulate emission factor (m^3/kg)	Site-specific	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
CF	Conversion factor (kg/mg)	1.00E-06	
SA	Skin surface area (cm^2/event)	3300	USEPA 2001
ABS	Chemical specific absorption factor	chemical-specific	USEPA 2001
AF	Soil to skin adherence factor (mg/cm^2)	0.2	USEPA 2001
ABS Dermal Factors:			
	Cadmium	0.001	
	PAHs	0.13	

Table 25

DERIVATION OF THE VOLATILIZATION FACTOR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

$$VF = \frac{Q/C_{vol}}{J_t \times 1/CFT \times CF}$$

Symbol	Definition (units)	Default	Reference
VF	Volatilization Factor (m^3/kg)	Chemical Specific	
Q/C_{vol}	Inverse of the mean conc. at center of square source (g/m^2*s per kg/m^3) Chicago Area	61.73660321	USEPA 2001
J_t	Average release flux (g/ft^2*yr)	Chemical-specific	VLEACH (Details of the VLEACH Model are presented in Appendix K).
CFT	Conversion factor for time (yr to s)	31536000	
CF	Conversion factor (ft^2 to m^2)	0.0929	

Q/C_{vol} Calculation

$$Q/C_{vol} = A \times \exp((\ln A_{site} - B)^2/C)$$

A	Constant (unitless) - Chicago	16.8653	USEPA 2001
B	Constant (unitless) - Chicago	18.7848	USEPA 2001
C	Constant (unitless) - Chicago	215.0624	USEPA 2001
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific

Table 10A

Onsite Trespasser, Indoor and Outdoor Worker
Ingestion - Soil
Soil Samples Used to Develop Statistical Tests
(All Exposed Shallow Soil Samples)

GP-10 GP-10A (0-1') 4/9/2000	GP-12 GP-12A (0-1') 4/9/2000	GP-13 GP-13A (0-1') 4/9/2000	GP-14 GP-14A (0-1’) 4/9/2000	GP-15 GP-15A (0-1’) 4/9/2000	GP-25 GP-25A (0-1') 4/9/2000	GP-26 GP-26A (0-1') 4/9/2000	GP-27 GP-27A (0-1') 4/9/2000	GP-28/MW-4 GP-28A (0-1') 4/9/2000	GP-34 GP-34A (0-1') 4/9/2000	GP-35 GP-35A (0-1') 4/9/2000	TB-14A (0.0-4.0’/1.0-2.0’) 6/1/2001	TB-35A (0.0-4.0’/3.0-3.4’) 6/4/2001
GP-3 GP-3A (0-1') 4/9/2000	GP-4 GP-4A (0-1') 4/9/2000	GP-5 GP-5A (0-1') 4/9/2000	GP-6 GP-6A (0-1') 4/9/2000	GP-7 GP-7A (0-1') 4/9/2000	TB-4A (0.0-4.0’/1.8’) 5/31/2001	TB-7A (0.0-4.0’/0.5-1.0’) 5/30/2001	GP-20/MW-3 GP-20A (0-1') 4/9/2000	GP-33/MW-9 GP-33A (0-1') 4/9/2000	GP-8 GP-8A (0-1') 4/9/2000	TB-11A (0.0-4.0’/1.5’) 5/31/2001	TB-11A (0.0-4.0’/1.0-1.5’) 6/4/2001	TB-14A (0.0-4.0’/1.0-2.0’) - DUP 6/1/2001

Table 7C
Summary of Detected Constituents in Groundwater
Vacant Lot
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	EPA Vapor Intrusion[1,2]	Sample Location and Collection Date									
			TB-20 6/11/2001		TB-21 6/11/2001		TB-22 6/11/2001		TB-22 - DUP 6/11/2001		TB-22 - MS 6/11/2001	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Total Cadmium	mg/l	NE[4]	0.00766	U	0.00202	U	0.000576	U	0.0005	U	0.0005	U
Dissolved Cadmium	mg/l	NE	0.0005	UJ	0.0005	UJ	0.0005	UJ	0.0005	UJ	-	U
Total Lead	mg/l	NE	0.328		0.0075	U	0.0323		0.011		0.0075	U
Dissolved Lead	mg/l	NE	0.0075	U	0.0075	U	0.0075	U	0.0075	U	-	U
Total Tantalum	mg/l	NE	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	NE	0.5	U	0.5	U	0.5	U	0.5	U	-	U
VOCs												
1,1,1-Trichloroethane	µg/l	3,100	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethane	µg/l	2,200	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethene	µg/l	190	2	U	2	U	9.49		9.75		7.85	
1,2-Dichloroethane	µg/l	5	2	U	2	U	2	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/l	24	2	U	2	U	2	U	2	U	2	U
1,3,5-Trimethylbenzene	µg/l	25	2	U	2	U	2	U	2	U	2	U
Chloroethane	µg/l	28,000	2	U	2	U	2	U	2	U	2	U
Chloroform	µg/l	80	2	U	2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	210	2	U	2	U	140		147		121	
Methylene chloride	µg/l	58	2	U	2	U	2	U	2	U	2	U
Sec-Butylbenzene	µg/l	250	2	U	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/l	5	2	U	2	U	2	U	2	U	2	U
Toluene	µg/l	1,500	2	U	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	180	2	U	2	U	7.02		7.28		5.95	
Trichloroethene	µg/l	5	2	U	2	U	**1830**		**2020**		**1360**	
Vinyl Chloride	µg/l	2	2	U	**3.11**	J	**5.36**		**5.34**		**6.74**	

See footnotes at end of table.

Table 7C
(Continued)

Analyte	Unit	EPA Vapor Intrusion	Sample Location and Collection Date									
			TB-22 - MSD 6/11/2001		TB-23 6/11/2001		TB-24 6/11/2001		TB-25 6/11/2001		TB-35 6/04/2001	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Total Cadmium	mg/l	NE	0.0005	U	0.0011	U	0.000661	U	0.00356	U	0.0361	U
Dissolved Cadmium	mg/l	NE	-	U	0.0005	UJ	0.0005	UJ	0.0005	UJ	0.0005	U
Total Lead	mg/l	NE	0.0116		0.0236		0.358		0.154		3.69	
Dissolved Lead	mg/l	NE	-	U	0.0075	U	0.0075	U	0.0075	U	0.0121	
Total Tantalum	mg/l	NE	0.0075	U	0.5	U	0.5	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	NE	-	U	0.5	U	0.5	U	0.5	U	0.5	U
VOCs												
1,1,1-Trichloroethane	µg/l	3,100	2	U	2	U	122		2	U	40	U
1,1-Dichloroethane	µg/l	2,200	2	U	2	U	100	U	2	U	40	U
1,1-Dichloroethene	µg/l	190	5.58		2	U	**339**		4.27		40	U
1,2-Dichloroethane	µg/l	5	2	U	2	U	100	U	2	U	40	U
1,2,4-Trimethylbenzene	µg/l	24	2	U	2	U	100	U	2	U	40	U
1,3,5-Trimethylbenzene	µg/l	25	2	U	2	U	100	U	2	U	40	U
Chloroethane	µg/l	28,000	2	U	2	U	100	U	2	U	40	U
Chloroform	µg/l	80	2	U	2	U	100	U	2	U	40	U
Cis-1,2-Dichloroethene	µg/l	210	95.3		2	U	**33300**		**1080**		**312**	
Methylene chloride	µg/l	58	2	U	2	U	**103**		2	U	40	U
Sec-Butylbenzene	µg/l	250	2	U	2	U	100	U	2	U	40	U
Tetrachloroethene	µg/l	5	2	U	2	U	100	U	2	U	40	U
Toluene	µg/l	1,500	2	U	2	U	100	U	2	U	40	U
Trans-1,2-Dichloroethene	µg/l	180	4.34		2	U	**389**		26.9		40	U
Trichloroethene	µg/l	5	1670		2	U	**96200**		**368**		**459**	
Vinyl Chloride	µg/l	2	7.33		2	U	**603**		**2.63**		**46.6**	

See footnotes at end of table.

Table 7C
(Continued)

Analyte	Unit	EPA Vapor Intrusion	Sample Location and Collection Date									
			TB-35 - DUP 6/04/2001		TB-35 - MS 6/04/2001		TB-35 - MSD 6/04/2001		TB-36 6/04/2001		TB-26 6/06/2001	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Total Cadmium	mg/l	NE	0.0695	U	0.0111	U	0.0126	U	0.00222	UJ	0.00148	U
Dissolved Cadmium	mg/l	NE	0.0005	U	0.0005	U	0.000799		0.0005	UJ	0.0005	U
Total Lead	mg/l	NE	1.17		1.53		1.73		0.0075	U	0.0075	U
Dissolved Lead	mg/l	NE	0.0005	U	0.0075	U	0.0075	U	0.0075	U	0.0231	
Total Tantalum	mg/l	NE	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	NE	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
VOCs												
1,1,1-Trichloroethane	µg/l	3,100	20	U	-	U	-	U	2	U	2	U
1,1-Dichloroethane	µg/l	2,200	20	U	-		-		2	U	2	U
1,1-Dichloroethene	µg/l	190	20	U	-	U	-	U	2	U	2	U
1,2-Dichloroethane	µg/l	5	20	U	-		-		2	U	2	U
1,2,4-Trimethylbenzene	µg/l	24	20	U	-	U	-	U	2	U	2	U
1,3,5-Trimethylbenzene	µg/l	25	20	U	-	U	-	U	2	U	2	U
Chloroethane	µg/l	28,000	20	U	-		-		2	U	2	U
Chloroform	µg/l	80	20	U	-		-		2	U	2	U
Cis-1,2-Dichloroethene	µg/l	210	**302**		**310**		**291**		12.7		2	U
Methylene chloride	µg/l	58	20	U	-	U	-	U	2	U	2	U
Sec-Butylbenzene	µg/l	250	20	U	-	U	-	U	2	U	2	U
Tetrachloroethene	µg/l	5	**20**	U	-	U	-	U	2.24		2	U
Toluene	µg/l	1,500	20	U	-		-		2	U	2	U
Trans-1,2-Dichloroethene	µg/l	180	20	U	-	U	-	U	2	U	2	U
Trichloroethene	µg/l	5	**409**		**426**		**433**		**227**		2	U
Vinyl Chloride	µg/l	2	**25.8**		**17.6**		**16.9**		**2.32**		2	U

See footnotes at end of table.

Table 7C
(Continued)

Analyte	Unit	EPA Vapor Intrusion	Sample Location and Collection Date							
			TB-27 6/06/2001		TB-28 6/05/2001		TB-29 6/11/2001		TB-30 6/05/2001	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals										
Total Cadmium	mg/l	NE	0.0005	U	0.00351	U	0.0005	U	0.0113	U
Dissolved Cadmium	mg/l	NE	0.0005	U	0.0005	U	-		0.0005	U
Total Lead	mg/l	NE	0.0075	U	0.0075	U	0.0146		0.0075	U
Dissolved Lead	mg/l	NE	0.0075	U	0.0075	U	-		0.0075	U
Total Tantalum	mg/l	NE	0.5	U	0.5	R	0.5	U	0.5	R
Dissolved Tantalum	mg/l	NE	0.5	U	0.5	U	-		0.5	U
VOCs										
1,1,1-Trichloroethane	µg/l	3,100	2	U	2	U	2	U	2	U
1,1-Dichloroethane	µg/l	2,200	2	U	2	U	2	U	2	U
1,1-Dichloroethene	µg/l	190	2	U	2	U	2	U	2	U
1,2-Dichloroethane	µg/l	5	2	U	2	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/l	24	2	U	2	U	2	U	2	U
1,3,5-Trimethylbenzene	µg/l	25	2	U	2	U	2	U	2	U
Chloroethane	µg/l	28,000	2	U	2	U	2	U	2	U
Chloroform	µg/l	80	2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	210	2	U	2	U	10.2		2	U
Methylene chloride	µg/l	58	2	U	2	U	2	U	2	U
Sec-Butylbenzene	µg/l	250	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/l	5	2	U	2	U	2	U	2	U
Toluene	µg/l	1,500	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	180	2	U	2	U	2	U	2	U
Trichloroethene	µg/l	5	2	U	2	U	**23.3**		2	U
Vinyl Chloride	µg/l	2	2	U	2	U	2	U	2	U

See footnotes at end of table.

Table 7C
(Continued)

Footnotes:

(1) USEPA, OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), Table 2C, November 2002. http://www.epa.gov/correctiveaction/eis/vapor.htm

(2) Table 2C is based on a 10^{-6} Risk. This is conservative for an industrial exposure but is used to ensure that additive risks do not pose a concern.
(3) Bolded and shaded results denote an exceedence of screening criteria.
(4) NE denotes that no screening criteria was established.
(5) Dashes denote the analyte was analyzed for but not detected and the detection limit is unknown.
U - The associated number indicates approximate sample concentration necessary to be detected.
J - Reported value may not be accurate or precise.
UJ - Quantitation limit may be inaccurate or imprecise.

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Table 7B
Summary of Detected Constituents in Groundwater
Inside Buildings
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	EPA Vapor Intrusion[1,2]	Sample Location and Collection Date											
			MW-1 8/17/2000[3]		MW-1 6/10/2001		TB-1 6/06/2001		TB-2 6/11/2001		TB-5 5/31/2001		TB-19 6/04/2001	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Total Cadmium[4]	mg/l	NE[5]	0.0005	U	0.0005	U	0.00257	U	--		0.0275		0.00523	UJ
Dissolved Cadmium	mg/l	NE	--[6]		0.0005	U	0.0005	U	--		0.0005	U	0.00005	UJ
Total Lead	mg/l	NE	0.0075	U	0.0075	U	0.012	U	--		0.0285		0.0075	U
Dissolved Lead	mg/l	NE	--		0.0075	U	0.0075	U	--		0.0075	U	0.0075	U
Total Tantalum	mg/l	NE	0.5	U	0.5	U	0.5	U	--		0.5	U	0.5	U
Dissolved Tantalum	mg/l	NE	--		0.5	U	0.5	U	--		0.5	U	0.5	U
VOCs														
1,1,1-Trichloroethane	µg/l	3,100	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethane	µg/l	2,200	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethene	µg/l	190	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dichloroethane	µg/l	5	2	U	2	U	2	U	2	U	2	U	2	U
Chloroethane	µg/l	28,000	2	U	2	U	2	U	2	U	2	U	2	U
Chloroform	µg/l	80	2	U	2	U	2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	210	2	U	2	U	2	U	2	U	2	U	3.3	
Tetrachloroethene	µg/l	5	2	U	2	U	2	U	2	U	2	U	2	U
Toluene	µg/l	1,500	2	U	2	U	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	180	2	U	2	U	2	U	2	U	2	U	2	U
Trichloroethene	µg/l	5	2	U	2	U	2.82		**4.55**		**5.08**		**5.24**	
Vinyl Chloride	µg/l	2	2	U	2	U	2	U	2	U	2	U	2	U

See footnotes at end of table.

Table 7B
(Continued)

Analyte	Unit	EPA Vapor Intrusion	Sample Location and Collection Date									
			TB-33 6/05/2001		TB-34 5/31/2001		TB-34 - DUP 5/31/2001		TB-37 6/01/2001		TB-38 6/01/2001	
			Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Total Cadmium	mg/l	NE	0.0353	U	0.0187		0.015	J	0.0113		0.0277	
Dissolved Cadmium	mg/l	NE	0.0005	U	0.0005	U	0.0005	UJ	0.0005	U	0.0005	U
Total Lead	mg/l	NE	0.248	U	0.582		0.666		0.0075	U	0.432	
Dissolved Lead	mg/l	NE	0.0113		0.0075	U	0.0075	U	0.0075	U	0.0075	U
Total Tantalum	mg/l	NE	0.5	R	0.5	U	0.5	UJ	0.5	U	0.5	U
Dissolved Tantalum	mg/l	NE	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
VOCs												
1,1,1-Trichloroethane	µg/l	3,100	6.99		2	U	2	U	2	U	79	
1,1-Dichloroethane	µg/l	2,200	6.83		2	U	2	U	2	U	22.5	
1,1-Dichloroethene	µg/l	190	2	U	2	U	2	U	2	U	2	U
1,2-Dichloroethane	µg/l	5	2	U	2	U	2	U	2	U	2	U
Chloroethane	µg/l	28,000	2	U	2	U	2	U	2	U	2	U
Chloroform	µg/l	80	2.21		2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	210	2	U	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/l	5	**27.2**		**5.63**		**5.53**	J	2	U	**858**	
Toluene	µg/l	1,500	2	U	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	180	2	U	2	U	2	U	2	U	8.2	
Trichloroethene	µg/l	5	**42.3**		**13.4**		**10.3**	J	2	U	2	U
Vinyl Chloride	µg/l	2	2	U	2	U	2	U	2	U	2	U

See footnotes at end of table.

Table 7B
(Continued)

Footnotes:
(1) USEPA, OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), Table 2C, November 2002. http://www.epa.gov/correctiveaction/eis/vapor.htm
(2) Table 2C is based on a 10^{-6} Risk. This is conservative for an industrial exposure but is used to ensure that additive risks do not pose a concern.
(3) 2000 data collected by Carlson Environmental, Inc.
(4) Bolded and shaded results denote an exceedence of screening criteria.
(5) NE denotes that no screening criteria was established.
(6) Dashes denote the analyte was analyzed for but not detected and the detection limit is unknown.
U - The associated number indicates approximate sample concentration necessary to be detected.
J - Reported value may not be accurate or precise.
UJ - Quantitation limit may be inaccurate or imprecise.

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Table 7A
Summary of Detected Constituents in Groundwater
Open Land Areas
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

		Sample Location and Collection Date											
		MW-2 8/17/2000[1]		MW-3 8/15/2000		MW-3 DUP 8/15/2000		MW-4 8/17/2000		MW-5 8/15/2000		MW-6 8/15/2000	
Analyte	**Unit**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**
Metals													
Total Cadmium	mg/l	0.0005	U	0.0005	U	0.0005	U	0.00125		0.0005	U	0.0005	U
Dissolved Cadmium	mg/l	--[2]		--		--		--		--		--	
Total Lead	mg/l	0.0282		0.0075	U	0.0075	U	0.021		0.00991		0.0315	
Dissolved Lead	mg/l	--		--		--		--		--		--	
Total Tantalum	mg/l	0.5	U	0.5	U	0.5	U	--	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	--		--		--		--					
VOCs													
1,1,1-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroform	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Hexachlorobutadiene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
n-Propylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1,2-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2,4-Trichlorobenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,3,5-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	2	U	2	U	2	U	183		3.31		2	U
Methylene chloride	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Sec-Butylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Toluene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	2	U	2	U	2	U	3.87		2	U	2	U
Trichloroethene	µg/l	42.2		2	U	2	U	3500		2	U	2	U
Vinyl Chloride	µg/l	2	U	2	U	2	U	43.5		2	U	2	U

See footnotes at end of table.

Table 7A
(Continued)

Analyte	Unit	Sample Location and Collection Date											
		MW-7 8/17/2000		MW-8 8/15/2000		MW-9 8/17/2000		MW-2 6/10/2001		MW-3 6/10/2001		MW-3 - DUP 6/10/2001	
		Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals													
Total Cadmium	mg/l	0.0005	U	0.0005	U	0.00149		0.000543		0.0005	U	0.0005	U
Dissolved Cadmium	mg/l	--		--		--		0.0005	U	0.0005	U	0.0005	U
Total Lead	mg/l	0.0075	U	0.0078		0.0302		0.112		0.0075	U	0.0075	U
Dissolved Lead	mg/l	--		--		--		0.0075	U	0.0075	U	0.0075	U
Total Tantalum	mg/l	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	--		--		--		0.5	U	0.5	U	0.5	U
VOCs													
1,1,1-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroform	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Hexachlorobutadiene	µg/l	2	U	2	U	3.14		2	U	2	U	2	U
n-Propylbenzene	µg/l	2	U	2	U	2.3		2	U	2	U	2	U
1,1,2-Trichloroethane	µg/l	2	U	2.11		2	U	2	U	2	U	2	U
1,2,4-Trichlorobenzene	µg/l	2	U	2	U	2.58		2	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,3,5-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Methylene chloride	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Sec-Butylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Toluene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Trichloroethene	µg/l	2	U	723		15		2.97		2	U	2	U
Vinyl Chloride	µg/l	2	U	2	U	2	U	2	U	2	U	2	U

See footnotes at end of table.

Table 7A
(Continued)

Analyte	Unit	Sample Location and Collection Date											
		MW-4 6/10/2001		MW-5 6/9/2001		MW-6 6/9/2001		MW-7 6/9/2001		MW-8 6/8/2001		MW-9 6/10/2001	
		Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals													
Total Cadmium[4,5]	mg/l	0.00329		0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.00178	
Dissolved Cadmium	mg/l	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	UJ	0.0005	UJ
Total Lead	mg/l	0.361		0.0075	U	0.0075	U	0.0075	U	0.0075	U	0.24	J
Dissolved Lead	mg/l	0.0075	U	0.0075	U	0.0075	U	0.0075	U	0.0075	U	0.0443	
Total Tantalum	mg/l	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
VOCs													
1,1,1-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroform	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Hexachlorobutadiene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
n-Propylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1,2-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2,4-Trichlorobenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,3,5-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	198		2	U	2	U	2	U	2.62	J	2	U
Methylene chloride	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Sec-Butylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Toluene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Trichloroethene	µg/l	2290		2	U	2	U	2	U	825	J	2	U
Vinyl Chloride	µg/l	43.4		2	U	2	U	2	U	2	U	2	U

See footnotes at end of table.

Table 7A
(Continued)

Analyte	Unit	Sample Location and Collection Date											
		TB-3 5/30/2001		TB-4 5/31/2002		TB-6 5/30/2001		TB-7 5/30/2001		TB-8 5/30/2001		TB-9 5/30/2001	
		Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals													
Total Cadmium	mg/l	0.0198		0.00115	J	0.00211		0.0106		0.00161		0.00382	J
Dissolved Cadmium	mg/l	0.0005	U	0.0005	UJ	0.0005	U	0.0005	U	0.00063		0.0005	UJ
Total Lead	mg/l	0.0075	U	0.0075	U	0.0075	U	0.859		0.0075	U	0.729	
Dissolved Lead	mg/l	0.0075	U	0.0075	U	0.0075	U	0.0075	U	0.189		0.0075	U
Total Tantalum	mg/l	0.5	U	0.5	U,R	0.5	U	0.5	U	0.5	U	0.5	UJ
Dissolved Tantalum	mg/l	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
VOCs													
1,1,1-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1-Dichloroethene	µg/l	2	U	8.28	J	2	U	2	U	2	U	13.2	J
1,2-Dichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Chloroform	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Hexachlorobutadiene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
n-Propylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,1,2-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2,4-Trichlorobenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,2,4-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
1,3,5-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Cis-1,2-Dichloroethene	µg/l	2	U	2550	J	2	U	2	U	2	U	1790	J
Methylene chloride	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Sec-Butylbenzene	µg/l	2	U	2	U	2	U	2	U	2	U	2	U
Tetrachloroethene	µg/l	2	U	10.4	J	2	U	2	U	2	U	133	J
Toluene	µg/l	2	U	2.01	J	2	U	2	U	2	U	2	U
Trans-1,2-Dichloroethene	µg/l	2	U	65.3	J	2	U	2	U	2	U	34	J
Trichloroethene	µg/l	2	U	3170	J	2	U	888		2	U	911	J
Vinyl Chloride	µg/l	2	U	15.6	J	2	U	2	U	2	U	216	J

See footnotes at end of table.

Table 7A
(Continued)

Analyte	Unit	Sample Location and Collection Date											
		TB-10 5/31/2001		TB-11a 6/04/2001		TB-12 6/4/2001		TB-13 6/01/2001		TB-14 6/1/2001		TB-15 6/01/01	
		Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals													
Total Cadmium[4,5]	mg/l	0.013		0.0515	U	0.0118	U	0.951		0.828	J	1.34	J
Dissolved Cadmium	mg/l	0.0005	U	0.00005	U	0.00005	U	0.0005	U	0.00848	J	0.0151	J
Total Lead	mg/l	0.0105		0.0075	U	0.0882	U	0.575		0.722		8.65	
Dissolved Lead	mg/l	0.0075	U	0.0075	U	0.0075	U	0.0262		0.0561		0.437	
Total Tantalum	mg/l	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
VOCs													
1,1,1-Trichloroethane	µg/l	2	U	157		2.25		2	U	100	U	2	U
1,1-Dichloroethane	µg/l	2	U	145		2	U	2	U	100	U	2	U
1,1-Dichloroethene	µg/l	2	U	5.26		2	U	2	U	100	U	11.5	
1,2-Dichloroethane	µg/l	2	U	9.68		2	U	2	U	100	U	2	U
Chloroethane	µg/l	2	U	3.83		2	U	2	U	100	U	2	U
Chloroform	µg/l	2	U	2.14		2	U	2	U	100	U	2	U
Hexachlorobutadiene	µg/l	2	U	2	U	2	U	2	U	100	U	2	U
n-Propylbenzene	µg/l	2	U	2	U	2	U	2	U	100	U	2	U
1,1,2-Trichloroethane	µg/l	2	U	2	U	2	U	2	U	100	U	2	U
1,2,4-Trichlorobenzene	µg/l	2	U	2	U	2	U	2	U	100	U	2	U
1,2,4-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	100	U	3.37	
1,3,5-Trimethylbenzene	µg/l	2	U	2	U	2	U	2	U	100	U	6.33	
Cis-1,2-Dichloroethene	µg/l	46.9		85.7		14.1		2	U	395		88.9	
Methylene chloride	µg/l	2	U	2	U	2	U	2	U	125		2	U
Sec-Butylbenzene	µg/l	2	U	2	U	2	U	2	U	100	U	2.29	
Tetrachloroethene	µg/l	2	U	48.8		2	U	2	U	100	U	2	U
Toluene	µg/l	2	U	2	U	2	U	2	U	100	U	2	U
Trans-1,2-Dichloroethene	µg/l	2	U	4.78		2	U	2	U	100	U	7.04	
Trichloroethene	µg/l	2	U	59.8		26.7		51.3	U	3810		129	
Vinyl Chloride	µg/l	2	U	9.94		2	U	2	U	100	U	2	U

See footnotes at end of table.

Table 7A
(Continued)

Analyte	Unit	Sample Location and Collection Date					
		TB-16 5/31/01		TB-17 6/01/2001		TB-18 6/04/2001	
		Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals							
Total Cadmium	mg/l	0.138		0.33		0.777	
Dissolved Cadmium	mg/l	0.00064		0.0678		0.0333	
Total Lead	mg/l	0.865		8.55		9.85	
Dissolved Lead	mg/l	0.0934		0.0491		0.02	
Total Tantalum	mg/l	0.5	U	0.5	U	0.5	U
Dissolved Tantalum	mg/l	0.5	U	0.5	U	0.5	U
VOCs							
1,1,1-Trichloroethane	µg/l	2	U	2	U	10,000	U
1,1-Dichloroethane	µg/l	2	U	2	U	10,000	U
1,1-Dichloroethene	µg/l	2	U	2	U	10,000	U
1,2-Dichloroethane	µg/l	2	U	2	U	10,000	U
Chloroethane	µg/l	2	U	2	U	10,000	U
Chloroform	µg/l	2	U	2	U	10,000	U
Hexachlorobutadiene	µg/l	2	U	2	U	10,000	U
n-Propylbenzene	µg/l	2	U	2	U	10,000	U
1,1,2-Trichloroethane	µg/l	2	U	2	U	10,000	U
1,2,4-Trichlorobenzene	µg/l	2	U	2	U	10,000	U
1,2,4-Trimethylbenzene	µg/l	2	U	2	U	10,000	U
1,3,5-Trimethylbenzene	µg/l	2	U	2	U	10,000	U
Cis-1,2-Dichloroethene	µg/l	2	U	2	U	66,500	
Methylene chloride	µg/l	2	U	2	U	10,000	U
Sec-Butylbenzene	µg/l	2	U	2	U	10,000	U
Tetrachloroethene	µg/l	2	U	2	U	10,000	U
Toluene	µg/l	2	U	2	U	10,000	U
Trans-1,2-Dichloroethene	µg/l	2	U	2	U	10,000	U
Trichloroethene	µg/l	12.1		17	U	1,190,000	
Vinyl Chloride	µg/l	2	U	2	U	59,900	

See footnotes at end of table.

Table 7A
(Continued)

Footnotes:

(1) 2000 data collected by Carlson Environmental, Inc.
(2) Dashes denote the analyte was analyzed for but not detected and the detection limit is unknown.
U - The associated number indicates approximate sample concentration necessary to be detected.
J - Reported value may not be accurate or precise.
UJ - Quantitation limit may be inaccurate or imprecise.

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Table 4
Summary of Detected Constituents in Slag/Fly Ash Material
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	TB-13A (SLAG/FLY ASH) (0.0-4.0'/3.0-4.0')[3] 6/1/2001		TB-16A (SLAG/FLY ASH) (0.0-4.0'/3.0-4.0') 5/31/2001	
					Result	Qualifier	Result	Qualifier
Metals								
Cadmium[4]	mg/kg	900	3,400	2,000	21.4		8.8	
Lead	mg/kg	750[5]	NE	1079[6]	**6,270**		**13,100**	
Tantalum	mg/kg	NE	NE	NE	6.76	U	5.19	U
VOCs								
Trichloroethene	µg/kg	290,000	8,000	520,000	716		5.19	U
SVOCs (PAHs)								
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	678		104	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	213		104	U
Benzo (a) pyrene	µg/kg	200	NE	800	288		93.4	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	270		104	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	183		104	U
Chrysene	µg/kg	230,000	NE	780,000	246		104	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	419		104	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	170		104	U
Phenanthrene	µg/kg	NE	NE	NE	564		104	U
Pyrene	µg/kg	18,000,000	NE	61,000,000	588		104	U

Footnotes:
(1) *Footnote 1 not used.*
(2) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft, US EPA Office of Solid Waste and Emergency Response, March 2001. http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf
(3) Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval over which metals and SVOC samples were composited. The second interval represents the depth range from which VOC samples were collected based on PID
(4) Bolded and shaded results denote an exceedence of a screening criteria.
(5) The Residential level for onsite trespasser (400 mg/kg) will be used to determine if lead is a constituent of concern.
(6) Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), Technical Review Workgroup for Lead; March 2002.
(7) NE denotes that no screening criteria was established.
J - Reported value may not be accurate or precise.
U - The associated number indicates approximate sample concentration necessary to be detected.
R - Analyte may or may not be present in the sample.
UJ - Quanitation limit may be inaccurate of imprecise.

General Note: The 2000 data in this table has been adjusted to reflect concentrations based on a dry sample. The conversion factor was calculated using moisture contents from the 2001 Earth Sciences sampling event. The conversion factor used was 1.2267.

Table 3H
Summary of Detected Constituents in Deep Soils
Building A and Maintenance Shop
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

		USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-8								GP-9	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-8B (1-2')[3,4] 4/9/2000		GP-8D (4-6') 4/9/2000		GP-8G (10-12') 4/9/2000		GP-8K (18-20') 4/9/2000		GP-9B (1-2') 4/9/2000	
Analyte	Unit				Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium[5]	mg/kg	900	3,400	2,000	-[9]		-		0.6	U	-		5.2	J
Lead	mg/kg	750[6]	NE	1079[7]	14.0		-		16.9		-		**781**	J
Tantalum	mg/kg	NE	NE	NE	6.2	J	-		6.1	U,R	-		8.2	J
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	-		30.7	UJ	31.0	U	30.7	U	30.7	U
Benzene	µg/kg	58,000	1,000	100,000	-		10.5	J	6.1	U	6.1	U	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	-		6.1	UJ	168		157		6.1	U
1,1-Dichloroethane	µg/kg	110,000,000	1,700,000	200,000,000	-		6.1	UJ	6.1	U	6.1	U	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	-		86.1	J	6.1	U	6.1	U	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	-		588	J	6.1	U	6.1	U	75.8	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	-		33.9	UJ	6.1	U	6.1	U	17.7	
Methylene chloride	µg/kg	420,000	22,000	760,000	-		6.1	UJ	6.1	U	6.1	U	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	-		9.6	J	6.1	U	6.1	U	22.0	
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	-		1,630	J	6.1	U	6.1	U	6.1	U
1,1,2-Trichloroethane	µg/kg	56,000	2,000	100,000	-		31.4	J	6.1	U	6.1	U	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	-		6.1	UJ	6.1	U	6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	-		**12,200**	J	6.1	U	6.1	U	24.2	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	-		37.3	J	6.1	U	6.1	U	36.9	
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		10.7	U	-		151	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		10.7	U	-		26.3	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		114	
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		10.7	U	-		**470**	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		402	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		10.7	U	-		564	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		10.7	U	-		153	
Chrysene	µg/kg	230,000	NE	780,000	-		-		10.7	U	-		185	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		10.7	U	-		**824**	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		10.7	U	-		210	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		10.7	U	-		10.7	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		35.6	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		10.7	U	-		28.6	
Phenanthrene	µg/kg	NE	NE	NE	-		-		10.7	U	-		150	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		10.7	U	-		162	

See footnotes at end of table.

Table 3H
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date									
					GP-9								GP-16	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-9C (2-4') 4/9/2000		GP-9D (4-6') 4/9/2000		GP-9E (6-8') 4/9/2000		GP-9I (14-16') 4/9/2000		GP-16B (1-2') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		-		0.6	U	-		2.7	
Lead	mg/kg	750[6]	NE	1079[7]	7.5		-		23.3		-		92.4	
Tantalum	mg/kg	NE	NE	NE	-		-		6.1	U,R	-		16.3	J
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	-		30.7	UJ	30.7	U	31.0	UJ	30.7	U
Benzene	µg/kg	58,000	1,000	100,000	-		6.1	UJ	6.1	U	6.1	UJ	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	-		7.3	J	22.9		6.1	UJ	6.1	U
1,1-Dichloroethane	µg/kg	110,000,000	1,700,000	200,000,000	-		6.1	UJ	6.1	U	6.1	UJ	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	-		6.1	UJ	6.1	U	6.1	UJ	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	-		57.0	U	6.1	U	6.1	UJ	17.5	J
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	-		16.7	U	6.1	U	6.1	UJ	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	-		6.1	UJ	6.1	U	6.1	UJ	24.0	J
Tetrachloroethene	µg/kg	61,000	18,000	110,000	-		21.2	J	6.1	U	6.1	UJ	36.3	J
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	-		15.6	J	6.1	U	6.1	UJ	6.1	U
1,1,2-Trichloroethane	µg/kg	56,000	2,000	100,000	-		6.1	UJ	6.1	U	6.1	UJ	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	-		6.1	UJ	6.1	U	6.1	UJ	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	-		243	U	6.1	U	6.1	UJ	33.1	J
Vinyl Chloride	µg/kg	4,000	1,000	8,000	-		6.1	U	6.1	U	6.1	UJ	6.1	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		10.7	U	-		156	J
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		10.7	U	-		15.8	J
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		73.2	J
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		10.7	U	-		70.2	J
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		79.4	J
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		10.7	U	-		62.2	J
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		10.7	U	-		32.5	J
Chrysene	µg/kg	230,000	NE	780,000	-		-		10.7	U	-		88.7	J
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		10.7	U	-		11.0	J
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		10.7	U	-		174	J
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		10.7	U	-		11.1	J
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		10.7	UJ
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		10.7	U	-		11.6	J
Phenanthrene	µg/kg	NE	NE	NE	-		-		10.7	U	-		96.7	J
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		10.7	U	-		123	J

See footnotes at end of table.

Table 3H
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date									
					GP-16								GP-17	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-16C (2-4') 4/9/2000		GP-16E (6-8') 4/9/2000		GP-16G (10-12') 4/9/2000		GP-16I (14-16') 4/9/2000		GP-17B (1-2') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		0.978		-		-		-	
Lead	mg/kg	750[6]	NE	1079[7]	-		20.6		-		-		-	
Tantalum	mg/kg	NE	NE	NE	-		14.8	J	-		-		-	
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	-		-		30.7	U	30.7	U	-	
Benzene	µg/kg	58,000	1,000	100,000	-		-		6.1	U	6.1	U	-	
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	-		-		106		9.5		-	
1,1-Dichloroethane	µg/kg	110,000,000	1,700,000	200,000,000	-		-		6.1	U	6.1	U	-	
1,1-Dichloroethene	µg/kg	5,000	100	10,000	-		-		6.1	U	6.1	U	-	
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	-		-		17.4		6.1	U	-	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	-		-		6.1	U	6.1	U	-	
Methylene chloride	µg/kg	420,000	22,000	760,000	-		-		62.1		236		-	
Tetrachloroethene	µg/kg	61,000	18,000	110,000	-		-		6.1	U	6.1	U	-	
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	-		-		6.1	U	6.1	U	-	
1,1,2-Trichloroethane	µg/kg	56,000	2,000	100,000	-		-		6.1	U	6.1	U	-	
Toluene	µg/kg	230,000,000	650,000	410,000,000	-		-		6.1	U	6.1	U	-	
Trichloroethene	µg/kg	290,000	8,000	520,000	-		-		50.5		6.1	U	-	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	-		-		6.1	U	6.1	U	-	
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	275	J	10.7	UJ	-		-		226	J
Anthracene	µg/kg	180,000,000	NE	610,000,000	65.3	J	10.7	UJ	-		-		31.6	J
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	178	J	10.7	UJ	-		-		124	J
Benzo (a) pyrene	µg/kg	200	NE	800	**177**	J	10.7	UJ	-		-		**153**	J
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	163	J	10.7	UJ	-		-		139	J
Benzo (ghi) perylene	µg/kg	NE	NE	NE	145	J	10.7	UJ	-		-		136	J
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	80.6	J	10.7	UJ	-		-		68.3	J
Chrysene	µg/kg	230,000	NE	780,000	185	J	10.7	UJ	-		-		142	J
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	24.8	J	10.7	UJ	-		-		23.6	J
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	378	J	10.7	UJ	-		-		271	J
Fluorene	µg/kg	24,000,000	NE	82,000,000	242	J	10.7	UJ	-		-		16.3	J
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	52.6	J	10.7	UJ	-		-		94.6	J
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	10.7	UJ	10.7	UJ	-		-		11.8	J
Phenanthrene	µg/kg	NE	NE	NE	200	J	10.7	UJ	-		-		112	J
Pyrene	µg/kg	18,000,000	NE	61,000,000	329	J	10.7	UJ	-		-		232	J

See footnotes at end of table.

Table 3H
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date									
					GP-17						GP-24			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-17C (2-4') 4/9/2000		GP-17E (6-8') 4/9/2000		GP-17H (12-14') 4/9/2000		GP-24D (4-6') 4/9/2000		GP-24F (8-10') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	19.1		-		-		21.1		-	
Lead	mg/kg	750[6]	NE	1079[7]	**6,180**		-		-		**6,060**		-	
Tantalum	mg/kg	NE	NE	NE	6.1	U,R	-		-		6.1	U	-	
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	50.3	U	-		30.7	U	30.7	U	30.7	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	-		6.1	U	6.1	U	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	-		17.5		6.1	U	6.1	U
1,1-Dichloroethane	µg/kg	110,000,000	1,700,000	200,000,000	6.1	U			6.1	U	6.1	U	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	-		6.1	U	6.1	U	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	-		6.1	U	6.1	U	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	-		6.1	U	6.1	U	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	179	J	-		267		6.1	U	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	-		6.1	U	6.1	U	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	-		6.1	U	18.8		6.1	U
1,1,2-Trichloroethane	µg/kg	56,000	2,000	100,000	6.1	U	-		6.1	U	6.1	U	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	-		6.1	U	6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	-		6.1	U	6.1	U	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	-		6.1	U	6.1	U	6.1	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	97.0	J	10.7	UJ	-		236	J	-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	75.3	J	10.7	UJ	-		37.9	J	-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	155	J	10.7	UJ	-		118	J	-	
Benzo (a) pyrene	µg/kg	200	NE	800	**179**	J	10.7	UJ	-		**141**	J	-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	144	J	10.7	UJ	-		115	J	-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	135	J	10.7	UJ	-		119	J	-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	74.1	J	10.7	UJ	-		61.2	J	-	
Chrysene	µg/kg	230,000	NE	780,000	173	J	10.7	UJ	-		145	J	-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	28.6	J	10.7	UJ	-		18.0	J	-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	385	J	10.7	UJ	-		234	J	-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	15.9	J	10.7	UJ	-		14.0	J	-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	21.8	J	10.7	UJ	-		44.3	J	-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	18.8	J	10.7	UJ	-		10.7	UJ	-	
Phenanthrene	µg/kg	NE	NE	NE	125	J	10.7	UJ	-		136	J	-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	280	J	10.7	UJ	-		238	J	-	

See footnotes at end of table.

Table 3H
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-30									
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-30B (1-2') 4/9/2000		GP-30C (2-4') 4/9/2000		GP-30F (8-10') 4/9/2000		GP-30I (14-16') 4/9/2000		GP-30I DUP (14-16') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	22.4		-		0.6	U	-		-	
Lead	mg/kg	750[6]	NE	1079[7]	**6,280**		**6,400**		10.6		-		-	
Tantalum	mg/kg	NE	NE	NE	6.1	U,R	-		6.1	U,R	-		-	
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	39.1	U	-		3.1	UJ	30.7	U	6.1	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	-		297	J	6.1	U	6.1	U
1,1-Dichloroethane	µg/kg	110,000,000	1,700,000	200,000,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	-		6.1	UJ	353		510	
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	-		6.1	UJ	6.1	U	6.1	U
1,1,2-Trichloroethane	µg/kg	56,000	2,000	100,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	-		6.1	UJ	6.1	U	6.1	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	627		-		10.7	U	-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	146		-		10.7	U	-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	335		-		10.7	U	-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	**385**		-		10.7	U	-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	336		-		10.7	U	-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	308		-		10.7	U	-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	161		-		10.7	U	-		-	
Chrysene	µg/kg	230,000	NE	780,000	386		-		10.7	U	-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	39.0		-		10.7	U	-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	861		-		10.7	U	-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	43.9		-		10.7	U	-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	21.3	U	-		10.7	U	-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	28.1		-		10.7	U	-		-	
Phenanthrene	µg/kg	NE	NE	NE	481		-		10.7	U	-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	638		-		10.7	U	-		-	

See footnotes at end of table.

Table 3H
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-31/MW-7								TB-11	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-31C (2-4') 4/9/2000		GP-31F (8-10') 4/9/2000		GP-31G (10-12') 4/9/2000		GP-31I (14-16') 4/9/2000		TB-11Ab (4.0-7.0'/5.0-5.5')[4] 6/4/2001	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	3.2	J	-		-		-		0.596	U
Lead	mg/kg	750[6]	NE	1079[7]	**370**	J	-		-		-		7.94	
Tantalum	mg/kg	NE	NE	NE	8.3	J	-		-		-		5.96	U,R
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	-		3.1	U	29.8	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	6.1	U	-		6.1	U	6.0	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	29.7		-		310		6.0	U
1,1-Dichloroethane	µg/kg	110,000,000	1,700,000	200,000,000	6.1	U	6.1	U	-		6.1	U	26.6	
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	-		6.1	U	6.0	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	6.1	U	-		6.1	U	21.9	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	U	-		6.1	U	6.0	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	6.1	U	-		6.1	U	6.0	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	U	-		6.1	U	67.4	
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	-		6.1	U	50.4	
1,1,2-Trichloroethane	µg/kg	56,000	2,000	100,000	6.1	U	6.1	U	-		6.1	U	6.0	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	6.1	U	-		6.1	U	8.36	
Trichloroethene	µg/kg	290,000	8,000	520,000	7.6		6.1	U	-		6.1	U	27.5	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	-		6.1	U	6.0	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	14.2		-		10.7	U	-		119	U
Anthracene	µg/kg	180,000,000	NE	610,000,000	10.7	U	-		10.7	U	-		119	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	10.7	U	-		10.7	U	-		119	U
Benzo (a) pyrene	µg/kg	200	NE	800	10.7	U	-		10.7	U	-		107	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	10.7	U	-		10.7	U	-		119	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	10.7	U	-		10.7	U	-		119	U
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	10.7	U	-		10.7	U	-		119	U
Chrysene	µg/kg	230,000	NE	780,000	10.7	U	-		10.7	U	-		119	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	10.7	U	-		10.7	U	-		107	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	10.7	U	-		10.7	U	-		119	U
Fluorene	µg/kg	24,000,000	NE	82,000,000	10.7	U	-		10.7	U	-		119	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	10.7	U	-		10.7	U	-		119	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	10.7	U	-		10.7	U	-		119	U
Phenanthrene	µg/kg	NE	NE	NE	10.7	U	-		10.7	U	-		119	U
Pyrene	µg/kg	18,000,000	NE	61,000,000	10.7	U	-		10.7	U	-		119	U

See footnotes at end of table.

Table 3H
(Continued)

Footnotes:

(1) *Footnote 1 not used.*

(2) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft, US EPA Office of Solid Waste and Emergency Response, March 2001. http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf

(3) 2000 data collected by Carlson Environmental, Inc.

(4) Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval over which metals and SVOC samples were composited. The second interval represents the depth range from which VOC samples were collected based on PID screening.

(5) Bolded and shaded results denote an exceedence of a screening criteria.

(6) The Residential level for onsite trespasser (400 mg/kg) will be used to determine if lead is a constituent of concern.

(7) Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), Technical Review Workgroup for Lead; March 2002.

(8) NE denotes that no screening criteria was established.

(9) Dash denotes not analyzed.

J - Reported value may not be accurate or precise.

U - The associated number indicates approximate sample concentration necessary to be detected.

R - Analyte may or may not be present in the sample.

UJ - Quanitation limit may be inaccurate of imprecise.

General Note: The 2000 data in this table has been adjusted to reflect concentrations based on a dry sample. The conversion factor was calculated using moisture contents from the 2001 Earth Sciences sampling event. The conversion factor used was 1.2267.

Table 11G
Detected Constituents of Concern in Shallow S
Building A and Maintenance Shop
Carlson Environmental, Inc.
2000 Site Investigation
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	IEPA TACO				USE
		Ind./Com. Properties		Res. Properties Remediation		Ind. Soil PRG
		IN/ING	MTG	IN/ING	MTG	
Metals						
Cadmium[5]	mg/kg	2,000	0.005	78	0.005	810
Lead	mg/kg	400	0.0075	400	0.0075	750
Tantalum	mg/kg	NE[5]	NE	NE	NE	NE
VOCs						
Acetone	mg/kg	########	16,000	7,800,000	16,000	6,200,000
Cis-1,2-Dichloroethene	mg/kg	1,200,000	400	780,000	400	150,000
Tetrachloroethene	mg/kg	20,000	60	11,000	60	19,000
1,1,1-Trichloroethane	mg/kg	1,200,000	2,000	1,200,000	2,000	1,400,000
Trichloroethene	mg/kg	8,900	60	5,000	60	6,100
Vinyl Chloride	mg/kg	1,100	10	280	10	830
SVOCs (PAHs)						
Acenaphthene	mg/kg	########	570,000	4,700,000	570,000	38,000,000
Anthracene	mg/kg	########	#######	########	#######	#########
Benzo (a) anthracene	mg/kg	8,000	2,000	900	2,000	2,900
Benzo (a) pyrene	mg/kg	800	8,000	90	8,000	290
Benzo (b) fluoranthene	mg/kg	8,000	5,000	900	5,000	2,900
Benzo (ghi) perylene	mg/kg	#VALUE!	#######	########	#######	#VALUE!
Benzo (k) fluoranthene	mg/kg	78,000	49,000	9,000	49,000	29,000
Chrysene	mg/kg	780,000	160,000	88,000	160,000	290,000
Dibenzo (a,h) anthracene	mg/kg	800	2,000	90	2,000	290
Fluoranthene	mg/kg	########	#######	3,100,000	#######	30,000,000
Fluorene	mg/kg	########	560,000	3,100,000	560,000	33,000,000
Indeno (1,2,3-c,d) pyrene	mg/kg	8,000	14,000	900	14,000	2,900
Naphthalene	mg/kg	270,000	12,000	170,000	12,000	190,000
Phenanthrene	mg/kg	#VALUE!	#######	########	#######	#VALUE!
Pyrene	mg/kg	########	#######	2,300,000	#######	54,000,000

See footnotes at end of table.

Footnotes:
(1)IEPA, 35 Illinois Administrative Code 742, Tiered Approach to Corrective Action Objectives; Industrial/Commerci
(2)IEPA, 35 Illinois Administrative Code 742, Tiered Approach to Corrective Action Objectives; Residential Properties

[3]USEPA Region 9, Preliminary Remediation Goals (PRGs) for Planning Purposes. November, 1, 2000.
[4]Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval ov
[5]Dash denotes not analyzed.
[6]Bolded and shaded results denote an exceedence of TACO Remediation Objectives and/or USEPA Region 9 PRG.
[7]NE denotes no TACO Remediation Objective established.
U - The Associated number indicated approximate sample concentration necessary to be detected.
J - Reported value may not be accurate or precise.
R - Analyte may or may not be present in the sample.
UJ-Quantitation limit may be inaccurate or imprecise.

oils

EPA Region 9		Sample Location and Collection Date			
Res. Soil PRG	MTG (DAF	GP-8 GP-8A		GP-24 GP-24A	
		Result	Qualifier	Result	Qualifier
37	8	6.526044	J	19.74987	
400	NE(6)	19259.19	J	12242.466	
NE	NE	52.01208	J	11.175237	
1,600,000	16,000	30.6675	U	30.6675	UJ
43,000	400	6.538311	J	19.38186	UJ
5,700	60	193.8186	J	7.666875	J
630,000	2,000	6.1335	U	6.1335	UJ
2,800	60	95.6826	J	6.1335	UJ
150	10	6.1335	U	6.1335	UJ
3,700,000	570,000	2244.861	J	163.1511	
########	#######	301.7682	J	49.80402	
620	2,000	933.5187	J	114.45111	
62	8,000	1091.763	J	126.3501	
620	5,000	1016.9343	J	113.46975	
#VALUE!	#######	910.2114	J	101.44809	
6,200	49,000	525.0276	J	57.6549	
62,000	160,000	1422.972	J	130.0302	
62	2,000	168.0579	J	17.1738	
2,300,000	#######	2882.745	J	283.3677	
2,600,000	560,000	185.2317	J	13.4937	
620	14,000	210.9924	J	18.15516	
56,000	84,000	21.83526	J	10.67229	U
#VALUE!	#######	1300.302	J	123.8967	
2,300,000	#######	1840.05	J	229.3929	

ial Properties – Inhalation/Ingestion (IN/ING) and Migration to Groundwater (MTG)
s – Inhalation/Ingestion (IN/ING) and Migration to Groundwater (MTG) Remediation

er which metals and SVOC samples were composited. The second interval represents the depth

Table 11G
Detected Constituents of Concern in Shallow S
Building A and Maintenance Shop
Carlson Environmental, Inc.
2000 Site Investigation
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	IEPA TACO				USE
		Ind./Com. Properties Remediation		Res. Properties Remediation Objectives(2)		Ind. Soil PRG
		IN/ING	MTG	IN/ING	MTG	
Metals						
Cadmium(5)	mg/kg	2,000	0.005	78	0.005	810
Lead	mg/kg	400	0.0075	400	0.0075	750
Tantalum	mg/kg	NE(5)	NE	NE	NE	NE
VOCs						
Acetone	mg/kg	########	16,000	7,800,000	16,000	6,200,000
Cis-1,2-Dichloroethene	mg/kg	1,200,000	400	780,000	400	150,000
Tetrachloroethene	mg/kg	20,000	60	11,000	60	19,000
1,1,1-Trichloroethane	mg/kg	1,200,000	2,000	1,200,000	2,000	1,400,000
Trichloroethene	mg/kg	8,900	60	5,000	60	6,100
Vinyl Chloride	mg/kg	1,100	10	280	10	830
SVOCs (PAHs)						
Acenaphthene	mg/kg	########	570,000	4,700,000	570,000	38,000,000
Anthracene	mg/kg	########	#######	########	#######	#########
Benzo (a) anthracene	mg/kg	8,000	2,000	900	2,000	2,900
Benzo (a) pyrene	mg/kg	800	8,000	90	8,000	290
Benzo (b) fluoranthene	mg/kg	8,000	5,000	900	5,000	2,900
Benzo (ghi) perylene	mg/kg	#VALUE!	#######	########	#######	#VALUE!
Benzo (k) fluoranthene	mg/kg	78,000	49,000	9,000	49,000	29,000
Chrysene	mg/kg	780,000	160,000	88,000	160,000	290,000
Dibenzo (a,h) anthracene	mg/kg	800	2,000	90	2,000	290
Fluoranthene	mg/kg	########	#######	3,100,000	#######	30,000,000
Fluorene	mg/kg	########	560,000	3,100,000	560,000	33,000,000
Indeno (1,2,3-c,d) pyrene	mg/kg	8,000	14,000	900	14,000	2,900
Naphthalene	mg/kg	270,000	12,000	170,000	12,000	190,000
Phenanthrene	mg/kg	#VALUE!	#######	########	#######	#VALUE!
Pyrene	mg/kg	########	#######	2,300,000	#######	54,000,000

See footnotes at end of table.

Footnotes:
(1)IEPA, 35 Illinois Administrative Code 742, Tiered Approach to Corrective Action Objectives; Industrial/Commerci

[2]IEPA, 35 Illinois Administrative Code 742, Tiered Approach to Corrective Action Objectives; Residential Properties
[3]USEPA Region 9, Preliminary Remediation Goals (PRGs) for Planning Purposes. November, 1, 2000.
[4]Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval ov
[5]Dash denotes not analyzed.
[6]Bolded and shaded results denote an exceedence of TACO Remediation Objectives and/or USEPA Region 9 PRG.
[7]NE denotes no TACO Remediation Objective established.
U - The Associated number indicated approximate sample concentration necessary to be detected.
J - Reported value may not be accurate or precise.
R - Analyte may or may not be present in the sample.
UJ-Quantitation limit may be inaccurate or imprecise.

oils

EPA Region 9		Sample Location and Collection Date			
Res. Soil PRG	MTG (DAF 20)	GP-8 GP-8A (0-1')[4]		GP-24 GP-24A (0-1')	
		Result	Qualifier	Result	Qualifier
37	8	5.32	J	16.1	
400	NE[6]	15700	J	9980	
NE	NE	42.4	J	9.11	
1,600,000	16,000	25	U	25	UJ
43,000	400	5	J	16	UJ
5,700	60	158	J	6	J
630,000	2,000	5	U	5	UJ
2,800	60	78	J	5	UJ
150	10	5	U	5	UJ
3,700,000	570,000	1,830	J	133	
########	#######	246	J	41	
620	2,000	761	J	93	
62	8,000	890	J	103	
620	5,000	829	J	93	
#VALUE!	#######	742	J	83	
6,200	49,000	428	J	47	
62,000	160,000	1,160	J	106	
62	2,000	137	J	14	
2,300,000	#######	2,350	J	231	
2,600,000	560,000	151	J	11	
620	14,000	172	J	15	
56,000	84,000	18	J	9	U
#VALUE!	#######	1,060	J	101	
2,300,000	#######	1,500	J	187	

ial Properties – Inhalation/Ingestion (IN/ING) and Migration to Groundwater (MTG)

s – Inhalation/Ingestion (IN/ING) and Migration to Groundwater (MTG) Remediation

er which metals and SVOC samples were composited. The second interval represents the depth

Table 3F
Summary of Detected Constituents in Deep Soils
Former Drum Storage Area
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-1						GP-2/MW-1			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-1D (4-6')[3,4] 4/9/2000		GP-1F (8-10') 4/9/2000		GP-1J (16-18') 4/9/2000		GP-2B (1-2') 4/9/2000		GP-2C (2-4') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium[5]	mg/kg	900	3,400	2,000	0.6	U	-[9]		-		-		0.6	U
Lead	mg/kg	750[6]	NE	1079[7]	12.0		-		-		8.6		137	J
Tantalum	mg/kg	NE	NE	NE	6.1	U,R	-		-		-		6.1	U,R
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	31.4	U	-		56.2	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	38.9		469		-		6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	6.1	U	-		6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	6.1	U	6.1	U	-		6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	U	6.1	U	-		6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	U	6.1	U	-		6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.1	U	-		6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	6.1	U	6.1	U	-		6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	6.1	U	-		6.1	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	10.7	U	-		-		-		26.5	
Anthracene	µg/kg	180,000,000	NE	610,000,000	10.7	U	-		-		-		10.7	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	10.7	U	-		-		-		23.8	
Benzo (a) pyrene	µg/kg	200	NE	800	10.7	U	-		-		-		30.4	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	10.7	U	-		-		-		32.3	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	10.7	U,R	-		-		-		23.3	J
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	10.7	U	-		-		-		12.4	
Chrysene	µg/kg	230,000	NE	780,000	10.7	U	-		-		-		26.6	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	10.7	U	-		-		-		10.7	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	10.7	U	-		-		-		41.7	
Fluorene	µg/kg	24,000,000	NE	82,000,000	10.7	U	-		-		-		10.7	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	10.7	U	-		-		-		10.7	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	10.7	U	-		-		-		10.7	U
Phenanthrene	µg/kg	NE	NE	NE	10.7	U	-		-		-		30.9	
Pyrene	µg/kg	18,000,000	NE	61,000,000	10.7	U	-		-		-		35.2	

See footnotes at end of table.

Table 3F
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date									
					GP-2/MW-1						GP-3			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-2C DUP (2-4') 4/9/2000		GP-2D (4-6') 4/9/2000		GP-2F (8-10') 4/9/2000		GP-3B (1-2') 4/9/2000		GP-3D (4-6') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium[5]	mg/kg	900	3,400	2,000	4.0	J	-		-		-		0.6	U
Lead	mg/kg	750[6]	NE	1079[7]	**1,120**	J	48.2		-		110		6.7	
Tantalum	mg/kg	NE	NE	NE	6.1	U,R	-		-		-		6.1	U,R
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	63.8	U	-		30.7	U	-		34.2	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	-		6.1	U	-		6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	-		6.1	U	-		6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	-		6.1	U	-		119	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	-		6.1	U	-		6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	-		6.1	U	-		166	
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	-		6.1	U	-		6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	-		6.1	U	-		156	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	-		6.1	U	-		20.0	
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	217	J	-		-		-		10.7	U
Anthracene	µg/kg	180,000,000	NE	610,000,000	132	J	-		-		-		10.7	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	177	J	-		-		-		10.7	U
Benzo (a) pyrene	µg/kg	200	NE	800	**236**	J	-		-		-		10.7	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	211	J	-		-		-		10.7	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	209	J	-		-		-		10.7	U,R
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	107	J	-		-		-		10.7	U
Chrysene	µg/kg	230,000	NE	780,000	229	J	-		-		-		10.7	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	48.0	J	-		-		-		10.7	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	372	J	-		-		-		10.7	U
Fluorene	µg/kg	24,000,000	NE	82,000,000	10.7	UJ	-		-		-		10.7	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	83.7	J	-		-		-		10.7	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	10.7	UJ	-		-		-		10.7	U
Phenanthrene	µg/kg	NE	NE	NE	221	J	-		-		-		10.7	U
Pyrene	µg/kg	18,000,000	NE	61,000,000	353	J	-		-		-		10.7	U

See footnotes at end of table.

Table 3F
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date									
					GP-3				GP-4					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-3F (8-10') 4/9/2000		GP-3H (12-14') 4/9/2000		GP-4D (4-6') 4/9/2000		GP-4F (8-10') 4/9/2000		GP-4I (14-16') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		-		0.6	U	-		-	
Lead	mg/kg	750[6]	NE	1079[7]	-		-		8.6		-		-	
Tantalum	mg/kg	NE	NE	NE	-		-		6.1	U,R	-			
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	35.5	U	30.7	U	30.7	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	25.1		6.2	J	6.1	U	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	39.5	U	6.8		278	J	6.1	U	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	U	15.1	J	6.1	U	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	7.5		30	J	6.1	U	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	11.9	U	7.0		153	J	248	U	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	24.2	J	6.1	U	6.1	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		10.7	U	-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		10.7	U	-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		10.7	U	-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		10.7	U,R	-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		10.7	U	-		-	
Chrysene	µg/kg	230,000	NE	780,000	-		-		10.7	U	-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		10.7	U	-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		10.7	U	-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		10.7	U	-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		10.7	U	-		-	
Phenanthrene	µg/kg	NE	NE	NE	-		-		10.7	U	-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		10.7	U	-		-	

See footnotes at end of table.

Table 3F
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date									
					GP-5								GP-6	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-5B (1-2') 4/9/2000		GP-5D (4-6') 4/9/2000		GP-5E (6-8') 4/9/2000		GP-5J (16-18') 4/9/2000		GP-6B (1-2') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		0.6	U	-		-		-	
Lead	mg/kg	750[6]	NE	1079[7]	18.3		13.7		-		-		-	
Tantalum	mg/kg	NE	NE	NE	-		6.7	J	6.1		-		-	
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	-		30.7	U	30.7	U	30.7	U	-	
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	-		6.1	U	9.5		226.9		-	
1,1-Dichloroethene	µg/kg	5,000	100	10,000	-		6.1	U	6.1	U	6.1	U	-	
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	-		6.1	U	6	U	6.1	U	-	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	-		6.1	U	6.1	U	6.1	U	-	
Tetrachloroethene	µg/kg	61,000	18,000	110,000	-		6.1	U	6	U	6.1	U	-	
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	-		6.1	U	6.1	U	6.1	U	-	
Trichloroethene	µg/kg	290,000	8,000	520,000	-		274.8		14	U	6	U	-	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	-		6.1	U	6.1	U	6.1	U	-	
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		10.7	U	-		-		150.9	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		10.7	U	-		-		26.3	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		10.7	U	-		-		114.3	
Benzo (a) pyrene	µg/kg	200	NE	800	-		10.7	U	-		-		**469.8**	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		10.7	U	-		-		402.4	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		10.7	U	-		-		564.3	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		10.7	U	-		-		153.3	
Chrysene	µg/kg	230,000	NE	780,000	-		10.7	U	-		-		185.2	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		10.7	U	-		-		82.4	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		10.7	U	-		-		209.8	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		10.7	U	-		-		0.0	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		10.7	U	-		-		35.6	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		10.7	U	-		-		28.6	
Phenanthrene	µg/kg	NE	NE	NE	-		10.7	U	-		-		149.7	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		10.7	U	-		-		161.9	

See footnotes at end of table.

Table 3F
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date									
					GP-6								GP-7	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-6C (2-4') 4/9/2000		GP-6E (6-8') 4/9/2000		GP-6F (8-10') 4/9/2000		GP-6I (14-16') 4/9/2000		GP-7B (1-2') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		0.6	U	-		-		-	
Lead	mg/kg	750[6]	NE	1079[7]	-		8.6		-		-		**1,390.0**	
Tantalum	mg/kg	NE	NE	NE	-		6.1	U,R	-		-		-	
VOCs														
Acetone	µg/kg	110,000,000	NE	200,000,000	-		30.7	U	30.7	U	33.5	UJ	-	
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	-		6.1	U	6.1	U	35.3	J	-	
1,1-Dichloroethene	µg/kg	5,000	100	10,000	-		6.1	U	7.3		6.1	UJ	-	
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	-		196.3		171		6.1	UJ	-	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	-		6.1	U	7.1	U	6.1	UJ	-	
Tetrachloroethene	µg/kg	61,000	18,000	110,000	-		22.1		6	U	6.1	UJ	-	
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	-		6.1	U	6.1	U	6.1	UJ	-	
Trichloroethene	µg/kg	290,000	8,000	520,000	-		**9,960.0**		2,650		28	J	-	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	-		6.1	U	6.1	U	6.1	UJ	-	
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	19.1	J	10.7	U	-		-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	29.7	J	10.7	U	-		-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	12.3	J	10.7	U	-		-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	10.7	UJ	10.7	U	-		-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	13.2	J	10.7	U	-		-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	10.7	UJ	10.7	U,R	-		-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	10.7	UJ	10.7	U	-		-		-	
Chrysene	µg/kg	230,000	NE	780,000	15.7	J	10.7	U	-		-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	10.7	UJ	10.7	U	-		-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	98.9	J	10.7	U	-		-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	10.7	UJ	10.7	U	-		-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	10.7	UJ	10.7	U	-		-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	13.2	J	10.7	U	-		-		-	
Phenanthrene	µg/kg	NE	NE	NE	46.7	J	10.7	U	-		-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	28.7	J	10.7	U	-		-		-	

See footnotes at end of table.

Table 3F
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date							
					GP-7						TB-7	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-7D (4-6') 4/9/2000		GP-7G (10-12') 4/9/2000		GP-7K (18-20') 4/9/2000		TB-7B (4.0-7.0'/4.0-4.4') 5/30/2001	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Cadmium	mg/kg	900	3,400	2,000	-		0.6	U	-		1.7	J
Lead	mg/kg	750[6]	NE	1079[7]	-		8.0		-		4.5	J
Tantalum	mg/kg	NE	NE	NE	-		6.1	U,R	-		5.9	UJ
VOCs												
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	30.7	U	29.5	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	168.1		88.7		5.9	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	7.3	J	6.1	U	6.1	U	5.9	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	3,750.0		6.1	U	6	U	5.9	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	53.1	U	6.1	U	6.1	U	5.9	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	U	6	U	5.9	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.1	U	5.9	U
Trichloroethene	µg/kg	290,000	8,000	520,000	4,450.0	J	6.1	U	6	U	**5,530**	J
Vinyl Chloride	µg/kg	4,000	1,000	8,000	14.1	J	6.1	U	6.1	U	5.9	U
SVOCs (PAHs)												
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		10.7	U	-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		10.7	U	-			
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		10.7	U	-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	-		10.7	U	-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		10.7	U	-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		10.7	J	-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		10.7	U	-		-	
Chrysene	µg/kg	230,000	NE	780,000	-		10.7	U	-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		10.7	U	-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		10.7	U	-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		10.7	U	-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		10.7	U	-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		10.7	U	-		-	
Phenanthrene	µg/kg	NE	NE	NE	-		10.7	U	-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		10.7	U	-		-	

See footnotes at end of table.

Table 3F
(Continued)

Footnotes:

(1) *Footnote 1 not used.*

(2) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft, US EPA Office of Solid Waste and Emergency Response, March 2001. http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf

(3) 2000 data collected by Carlson Environmental, Inc.

(4) Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval over which metals and SVOC samples were composited. The second interval represents the depth range from which VOC samples were collected based on PID screening.

(5) Bolded and shaded results denote an exceedence of a screening criteria.

(6) The Residential level for onsite trespasser (400 mg/kg) will be used to determine if lead is a constituent of concern.

(7) Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), Technical Review Workgroup for Lead; March 2002.

(8) NE denotes that no screening criteria was established.

(9) Dash denotes not analyzed.

J - Reported value may not be accurate or precise.

U - The associated number indicates approximate sample concentration necessary to be detected.

R - Analyte may or may not be present in the sample.

UJ - Quanitation limit may be inaccurate of imprecise.

General Note: The 2000 data in this table has been adjusted to reflect concentrations based on a dry sample. The conversion factor was calculated using moisture contents from the 2001 Earth Sciences sampling event. The conversion factor used was 1.2267.

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Table 3E
Summary of Detected Constituents in Shallow Soils
Former Drum Storage Area
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

		USEPA Draft SSLs[2]			Sample Location and Collection Date							
					GP-3 GP-3A (0-1')[3,4] 4/9/2000		GP-4 GP-4A (0-1') 4/9/2000		GP-5 GP-5A (0-1') 4/9/2000		GP-6 GP-6A (0-1') 4/9/2000	
Analyte	Unit	(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals												
Cadmium[5]	mg/kg	900	3,400	2,000	2.8	J	0.6	U	8.4		1.7	
Lead	mg/kg	750[6]	NE	1079[7]	**563**	J	104		**589**		79.0	
Tantalum	mg/kg	NE	NE	NE	6.1	U,R	11.8	J	6.1	U,R	6.1	U,R
VOCs												
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	6.1	U	6.1	U
Acetone	µg/kg	110,000,000	NE	200,000,000	43.9	U	30.7	U	37.7	U	35.2	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	6.1	U	45.8		12.2	J
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	5,460	J	6.1	U	6.1	U	41.8	J
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	52.4	J	6.1	U	6.1	U	6.1	U
Methylene Chloride	µg/kg	420,000	22,000	760,000	7.0	J	6.1	U	6.1	U	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	**116,000**	J	6.1	U	6.1	U	10.4	J
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	6.1	U	6.1	U	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	**53,700**	J	24.9		6.1	U	3,720	J
Vinyl Chloride	µg/kg	4,000	1,000	8,000	21.6	J	6.1	U	6.1	U	6.1	U
SVOCs (PAHs)												
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	72,000	J	1,280		2,020		67.8	
Acenaphthylene	µg/kg	NE	NE	NE	72,000	J	491	U	1,230	U	1,227	U
Anthracene	µg/kg	180,000,000	NE	610,000,000	8,450	J	527		315		53.4	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	**2,400**	J	141		788		53.4	U
Benzo (a) pyrene	µg/kg	200	NE	800	**1,470**	J	144		**850**		53.4	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	1,160	J	115		748		53.4	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	394	J	101	J	651		74.7	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	606	J	86.2		386		53.4	U
Chrysene	µg/kg	230,000	NE	780,000	5,310	J	216		1,040		61.0	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	**615**	J	30.9		110		53.4	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	29,900	J	806		2,940		93.8	
Fluorene	µg/kg	24,000,000	NE	82,000,000	9,090	J	55.2		130		53.4	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	768	J	21.3	U	190		193	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	213	UJ	64.4		53.4	U	53.4	U
Phenanthrene	µg/kg	NE	NE	NE	48,900	J	762		1,420		388	
Pyrene	µg/kg	18,000,000	NE	61,000,000	15,000	J	489		1,400		84.3	

See footnotes at end of table.

Table 3E
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-7 GP-7A (0-1') 4/9/2000		TB-4A (0.0-4.0'/1.8') 5/31/2001		TB-7A (0.0-4.0'/0.5-1.0') 5/30/2001	
					Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals										
Cadmium	mg/kg	900	3,400	2,000	10.1		1.61		1.56	
Lead	mg/kg	750[6]	NE	1079[7]	**990**		5.82		7.36	
Tantalum	mg/kg	NE	NE	NE	6.2	J	6.14	U	6.17	U
VOCs										
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	23.9		6.17	U
Acetone	µg/kg	110,000,000	NE	200,000,000	58.5	U	30.7	U	74.2	
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	6.1	U	6.17	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	16.6		6,930		13.7	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	99.8		6.17	U
Methylene Chloride	µg/kg	420,000	22,000	760,000	6.1	U	6.35		6.17	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	42.4		4,420		6.17	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	12.2		6.17	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.17	U
Trichloroethene	µg/kg	290,000	8,000	520,000	110		**64,800**		**413,000**	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	11.2		6.17	U
SVOCs (PAHs)										
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	1,680		123	U	196	
Acenaphthylene	µg/kg	NE	NE	NE	1,230	U	246	U	533	
Anthracene	µg/kg	180,000,000	NE	610,000,000	207		123	U	123	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	568		123	U	123	U
Benzo (a) pyrene	µg/kg	200	NE	800	**808**		111	U	111	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	887		123	U	123	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	882	J	123	U	123	U
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	423		123	U	123	U
Chrysene	µg/kg	230,000	NE	780,000	886		123	U	123	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	**172**		111	U	111	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	1,840		123	U	123	U
Fluorene	µg/kg	24,000,000	NE	82,000,000	140		123	U	123	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	368		123	U	123	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	53.4	U	123	U	123	U
Phenanthrene	µg/kg	NE	NE	NE	1,040		123	U	123	U
Pyrene	µg/kg	18,000,000	NE	61,000,000	1,000		123	U	123	U

See footnotes at end of table.

Table 3E
(Continued)

Footnotes:

(1) *Footnote 1 not used.*

(2) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft, US EPA Office of Solid Waste and Emergency Response, March 2001. http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf

(3) 2000 data collected by Carlson Environmental, Inc.

(4) Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval over which metals and SVOC samples were composited. The second interval represents the depth range from which VOC samples were collected based on PID screening.

(5) Bolded and shaded results denote an exceedence of a screening criteria.

(6) The Residential level for onsite trespasser (400 mg/kg) will be used to determine if lead is a constituent of concern.

(7) Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), Technical Review Workgroup for Lead; March 2002.

(8) NE denotes that no screening criteria was established.

(9) Dash denotes not analyzed.

J - Reported value may not be accurate or precise.

U - The associated number indicates approximate sample concentration necessary to be detected.

R - Analyte may or may not be present in the sample.

UJ - Quanitation limit may be inaccurate or imprecise.

General Note: The 2000 data in this table has been adjusted to reflect concentrations based on a dry sample. The conversion factor was calculated using moisture contents from the 2001 Earth Sciences sampling event. The conversion factor used was 1.2267.

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Table 3C
Summary of Detected Constituents in Shallow Soils
Metallurgical Building A and B
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-20/MW-3 GP-20A (0-1')[3,4] 4/9/2000		GP-33/MW-9 GP-33A (0-1') 4/9/2000		TB-2A (0.0-4.0'/ 1.0-1.3') 6/5/2001	
					Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals										
Cadmium[5]	mg/kg	900	3,400	2,000	7.3	J	47.1		0.574	U,R
Lead	mg/kg	750[6]	NE	1079[7]	290	J	**9,430**		83.1	R
Tantalum	mg/kg	NE	NE	NE	7.0	J	12.2		5.74	U,R
VOCs										
Acetone	µg/kg	110,000,000	NE	200,000,000	66.9	U	30.7	R	28.7	U
Chloroform	µg/kg	520,000	500	940,000	6.1	U	6.1	U	5.74	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	26.4		5.74	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	6.1	U	5.74	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	U	20.8	
Toluene	µg/kg	230,000,000	650,000	410,000,000	7.3	J	6.1	U	5.74	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	5.74	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	5.74	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.8	J	970		87.5	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	5.74	U
SVOCs (PAHs)										
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	2,010	J	710		115	U
Anthracene	µg/kg	180,000,000	NE	610,000,000	427	J	122		115	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	871	J	388		103	U
Benzo (a) pyrene	µg/kg	200	NE	800	**1,000**	J	**461**		103	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	846	J	471		115	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	797	J	391		115	U
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	440	J	193		115	U
Chrysene	µg/kg	230,000	NE	780,000	1,420	J	492		115	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	**173**	J	82.7		103	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	2,700	J	1,330		115	U
Fluorene	µg/kg	24,000,000	NE	82,000,000	217	J	78.5		115	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	53.4	UJ	218		115	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	53.4	UJ	24.3		115	U
Phenanthrene	µg/kg	NE	NE	NE	1,560	J	547		115	U
Pyrene	µg/kg	18,000,000	NE	61,000,000	1,730	J	550		115	U

See footnotes at end of table.

Table 3C
(Continued)

Analyte	Unit	USEPA Draft SSLs			Sample Location and Collection Date			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	TB-37A (0.0-4.0'/ 1.0-1.4') 6/1/2001		TB-38A (0.0-4.0'/ 1.0-1.5') 6/1/2001	
					Result	Qualifier	Result	Qualifier
Metals								
Cadmium[5]	mg/kg	900	3,400	2,000	6.07	J	1.83	J
Lead	mg/kg	750[6]	NE	1079[7]	**813**	J	332	J
Tantalum	mg/kg	NE	NE	NE	6.37	UJ	5.9	UJ
VOCs								
Acetone	µg/kg	110,000,000	NE	200,000,000	32.7	J	29.5	UJ
Chloroform	µg/kg	520,000	500	940,000	6.37	U	11.5	J
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.37	U	11.9	J
Methylene chloride	µg/kg	420,000	22,000	760,000	10.5	J	5.9	UJ
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.37	U	**55,900**	J
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.37	U	5.9	UJ
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.37	U	5.9	UJ
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.37	U	5.9	UJ
Trichloroethene	µg/kg	290,000	8,000	520,000	15	J	161	J
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.37	U	5.9	UJ
SVOCs (PAHs)								
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	127	U	248	J
Anthracene	µg/kg	180,000,000	NE	610,000,000	127	U	118.0	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	127	U	118.0	U
Benzo (a) pyrene	µg/kg	200	NE	800	115	U	119	J
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	127	U	118.0	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	127	U	118.0	U
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	127	U	118.0	U
Chrysene	µg/kg	230,000	NE	780,000	127	U	118.0	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	115	U	106.0	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	127	U	118.0	U
Fluorene	µg/kg	24,000,000	NE	82,000,000	127	U	118.0	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	127	U	118.0	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	127	U	118.0	U
Phenanthrene	µg/kg	NE	NE	NE	127	U	131	J
Pyrene	µg/kg	18,000,000	NE	61,000,000	127	U	134	J

See footnotes at end of table.

Table 3C
(Continued)

Footnotes:

(1) *Footnote 1 not used.*

(2) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft, US EPA Office of Solid Waste and Emergency Response, March 2001. http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf

(3) 2000 data collected by Carlson Environmental, Inc.

(4) Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval over which metals and SVOC samples were composited. The second interval represents the depth range from which VOC samples were collected based on PID screening.

(5) Bolded and shaded results denote an exceedence of a screening criteria.

(6) The Residential level for onsite trespasser (400 mg/kg) will be used to determine if lead is a constituent of concern.

(7) Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), Technical Review Workgroup for Lead; March 2002.

(8) NE denotes that no screening criteria was established.

(9) Dash denotes not analyzed.

J - Reported value may not be accurate or precise.

U - The associated number indicates approximate sample concentration necessary to be detected.

R - Analyte may or may not be present in the sample.
UJ - Quanitation limit may be inaccurate of imprecise.
General Note: The 2000 data in this table has been adjusted to reflect concentrations based on a dry sample. The conversion factor was calculated using moisture contents from the 2001 Earth Sciences sampling event. The conversion factor used was 1.2267.

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Table 3B
Summary of Detected Constituents in Deep Soils
Hazardous Waste Management Unit and Aboveground Storage Tank Areas
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

		USEPA Draft SSLs[2]			Sample Location and Collection Date											
					GP-10										GP-11/MW-2	
Analyte	Unit	(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-10B (1-2')[3,4] 4/9/2000		GP-10C (2-4') 4/9/2000		GP-10F (8-10') 4/9/2000		GP-10H (12-14') 4/9/2000		GP-10H DUP (12-14') 4/9/2000		GP-11B (1-2') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals																
Cadmium	mg/kg	900	3,400	2,000	-[9]		-		0.613[6]	U	-		-		43.9	
Lead	mg/kg	750[6]	NE	1079[7]	**498**	J	-		20.5		-		-		**6,500**	
Tantalum	mg/kg	NE	NE	NE	12.4	J	-		6.5	J	-		-		12.0	J
VOCs																
2-Butanone	µg/kg	NE	NE	NE	-		12.3	R	12.3	R	12.3	R	12.3	R	12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	-		30.7	U	30.7	U	30.7	U	30.7	U	94.6	U
Benzene	µg/kg	58,000	1,000	100,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	-		44.3		6.6		42.3		68.4		6.1	U
Chloromethane	µg/kg	NE	NE	NE	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
p-Isopropyltoluene	µg/kg	NE	NE	NE	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
n-Propylbenzene	µg/kg	NE	NE	NE	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	-		11.4	U	6.1	U	6.1	U	6.1	U	12.6	
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	-		6.1	U	6.1	U	6.1	U	6.1	U	6.1	U
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	-		12.3	U	12.3	U	12.3	U	12.3	U	12.3	U
SVOCs (PAHs)																
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		11.2		-		-		49.7	J
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		10.7	U	-		-		25.3	J
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		-		53.7	J
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		10.7	U	-		-		101	J
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		-		111	J
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		10.7	U	-		-		103	J
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		10.7	U	-		-		44.3	J
Chrysene	µg/kg	230,000	NE	780,000	-		-		10.7	U	-		-		75.4	J
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		10.7	U	-		-		13.6	J
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		18.2		-		-		125	J
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		10.7	U	-		-		10.7	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		10.7	U	-		-		10.7	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		10.7	U	-		-		10.7	U
Phenanthrene	µg/kg	NE	NE	NE	-		-		19.4		-		-		48.2	J
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		10.7	U	-		-		69.2	J

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-11/MW-2									
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-11C (2-4') 4/9/2000		GP-11E (6-8') 4/9/2000		GP-11F (8-10') 4/9/2000		GP-11G (10-12') 4/9/2000		GP-11H (12-14') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		-		0.7		-		-	
Lead	mg/kg	750[6]	NE	1079[7]	**5,200**		-		29.8		-		-	
Tantalum	mg/kg	NE	NE	NE	-		-		6.1	U,R	-		-	
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	-		12.3	R	-		12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	35	U	-		30.7	U	-		32.5	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	-		6.1	U	-		6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	9.7		-		6.1	U	-		275	
Chloromethane	µg/kg	NE	NE	NE	6.1	U	-		6.1	U	-		6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	-		6.1	U	-		6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	-		6.1	U	-		6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	-		6.1	U	-		6.1	U
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	U	-		6.1	U	-		6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	-		6.1	U	-		6.1	U
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	U	-		6.1	U	-		6.1	U
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	U	-		6.1	U	-		6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	-		6.1	U	-		6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	-		6.1	U	-		6.1	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	U	-		6.1	U	-		6.1	U
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	U	-		6.1	U	-		6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	-		6.1	U	-		6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	-		6.1	U	-		6.1	U
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	U	-		6.1	U	-		6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	-		6.1	U	-		6.1	U
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	U	-		12.3	U	-		12.3	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	147		-		10.7	U	-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	130		-		10.7	U	-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	332		-		10.7	U	-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	122		-		10.7	U	-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	243		-		10.7	U	-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	158		-		10.7	U	-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	53.4	U	-		10.7	U	-		-	
Chrysene	µg/kg	230,000	NE	780,000	524		-		10.7	U	-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	53.4	U	-		10.7	U	-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	458		-		10.7	U	-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	53.4		-		10.7	U	-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	53.4	U	-		10.7	U	-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	53.4	U	-		10.7	U	-		-	
Phenanthrene	µg/kg	NE	NE	NE	342		-		10.7	U	-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	640		-		10.7	U	-		-	

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-12						GP-13			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-12G (10-12') 4/9/2000		GP-12G DUP (10-12') 4/9/2000		GP-12I (14-16') 4/9/2000		GP-13F (8-10') 4/9/2000		GP-13G (10-12') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	0.6	U	0.6	U	-		0.6	U	-	
Lead	mg/kg	750[6]	NE	1079[7]	12.8		11.5		-		9.0		-	
Tantalum	mg/kg	NE	NE	NE	6.1	U,R	6.1	U,R	-		6.8		-	
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	12.3	R	12.3	R	12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	30.7	U	30.7	UJ	30.7	UJ
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	73.7		113		688		6.1	UJ	6.1	UJ
Chloromethane	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	6.1	U	72.3	J	42.4	J
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	6.1	U	6.1	U	6,860	J	3,630	J
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	U	6.1	U	2,050	J	856	J
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	6.1	U	6.1	U	**13,250**	J	**7,560**	J
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	UJ
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	6.1	U	383	J	213	J
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	U	12.3	U	12.3	U	12.3	UJ	12.3	UJ
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	10.7	U	10.7	U	-		10.7	U	-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	10.7	U	10.7	U	-		10.7	U	-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	10.7	U	10.7	U	-		10.7	U	-	
Benzo (a) pyrene	µg/kg	200	NE	800	10.7	U	10.7	U	-		10.7	U	-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	10.7	U	10.7	U	-		10.7	U	-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	10.7	U	10.7	U	-		10.7	U	-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	10.7	U	10.7	U	-		10.7	U	-	
Chrysene	µg/kg	230,000	NE	780,000	10.7	U	10.7	U	-		10.7	U	-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	10.7	U	10.7	U	-		10.7	U	-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	10.7	U	10.7	U	-		10.7	U	-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	10.7	U	10.7	U	-		10.7	U	-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	10.7	U	10.7	U	-		10.7	U	-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	10.7	U	10.7	U	-		10.7	U	-	
Phenanthrene	µg/kg	NE	NE	NE	10.7	U	13.1		-		10.7	U	-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	10.7	U	10.7	U	-		10.7	U	-	

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-13						GP-14			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-13H (12-14') 4/9/2000		GP-13J (16-18') 4/9/2000		GP-13K (18-20') 4/9/2000		GP-14E (6-8') 4/9/2000		GP-14F (8-10') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		-		-		0.6	U	-	
Lead	mg/kg	750[6]	NE	1079[7]	-		-		-		13.5		-	
Tantalum	mg/kg	NE	NE	NE	-		-		-		6.1	U	-	
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	12.3	R	12.3	R	12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	UJ	30.7	UJ	39.4	J	30.7	UJ	30.7	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	26.6	J	75.7	J	16.9	J	6.1	UJ	6.1	U
Chloromethane	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	UJ	6.1	UJ	6.1	UJ	41.6	J	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	UJ	6.1	UJ	6.1	UJ	71,500	J	**185,000**	J
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	UJ	6.1	UJ	6.1	UJ	770	J	44.7	U
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	UJ	6.1	UJ	6.1	UJ	7.1	J	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	6.1	U
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	18.8	
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	9.3	
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	UJ	6.1	UJ	6.1	UJ	339	J	**21,600**	J
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	UJ	6.1	UJ	6.1	UJ	95.2	J	42.3	
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	6.1	U
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	UJ	6.1	UJ	6.1	UJ	6.1	UJ	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	UJ	6.1	UJ	6.1	UJ	**92,600**	J	**1,310,000**	
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	UJ	30.3	J	70.4	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	UJ	6.1	UJ	6.1	UJ	**903**	J	13	
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	6.1	UJ	6.1	UJ	12.3	UJ	18.0	J	12.3	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		-		10.7	U	-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		-		10.7	U	-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		-		10.7	U	-	
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		-		10.7	U	-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		-		10.7	U	-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		-		10.7	U	-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		-		10.7	U	-	
Chrysene	µg/kg	230,000	NE	780,000	-		-		-		10.7	U	-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		-		10.7	U	-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		-		10.7	U	-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		-		10.7	U	-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		-		10.7	U	-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		-		10.7	U	-	
Phenanthrene	µg/kg	NE	NE	NE	-		-		-		10.7	U	-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		-		10.7	U	-	

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-14						GP-15			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-14G (10-12') 4/9/2000		GP-14H (12-14') 4/9/2000		GP-14I (14-16') 4/9/2000		GP-15D (4-6') 4/9/2000		GP-15E (6-8') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		-		-		-		0.6	U
Lead	mg/kg	750[6]	NE	1079[7]	-		-		-		-		8.1	
Tantalum	mg/kg	NE	NE	NE	-		-		-		-		6.9	
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	12.3	R	12.3	R	-	
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	UJ	30.7	UJ	30.7	U	30.7	UJ	-	
Benzene	µg/kg	58,000	1,000	100,000	6.1	UJ	6.1	UJ	6.1	U	6.1	UJ	-	
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	UJ	42.2	J	10.7		8.6	J	-	
Chloromethane	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	U	6.1	UJ	-	
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	UJ	6.1	UJ	6.1	U	19.5	J	-	
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	74,500	J	6.1	UJ	6.1	U	3,020	J	-	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	171	J	6.1	UJ	6.1	U	1,960	J	-	
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	UJ	6.1	UJ	6.1	U	6.1	UJ	-	
Methylene chloride	µg/kg	420,000	22,000	760,000	41.7	J	6.1	UJ	6.1	U	6.1	UJ	-	
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	U	6.1	UJ	-	
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	U	6.1	UJ	-	
Tetrachloroethene	µg/kg	61,000	18,000	110,000	16.9	J	6.1	UJ	6.1	U	6.1	UJ	-	
Toluene	µg/kg	230,000,000	650,000	410,000,000	35.8	J	6.1	UJ	6.1	U	6.1	UJ	-	
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	8.9	J	6.1	UJ	6.1	U	6.1	UJ	-	
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	8.3	J	6.1	UJ	6.1	U	6.1	UJ	-	
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	UJ	6.1	UJ	6.1	U	6.1	UJ	-	
Trichloroethene	µg/kg	290,000	8,000	520,000	**116,000**	J	10.2	UJ	6.1	U	**8,970**	J	-	
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	UJ	6.1	U	6.1	UJ	-	
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	UJ	6.1	UJ	6.1	U	**981**	J	-	
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	UJ	12.3	UJ	12.3	U	12.3	UJ	-	
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		-		-		10.7	U
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		-		-		10.7	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		-		-		10.7	U
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		-		-		10.7	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		-		-		10.7	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		-		-		10.7	U
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		-		-		10.7	U
Chrysene	µg/kg	230,000	NE	780,000	-		-		-		-		10.7	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		-		-		10.7	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		-		-		10.7	U
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		-		-		10.7	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		-		-		10.7	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		-		-		10.7	U
Phenanthrene	µg/kg	NE	NE	NE	-		-		-		-		10.7	U
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		-		-		10.7	U

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-15						GP-25			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-15G (10-12') 4/9/2000		GP-15H (12-14') 4/9/2000		GP-15I (14-16') 4/9/2000		GP-25D (4-6') 4/9/2000		GP-25F (8-10') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		-		-		0.6	U	-	
Lead	mg/kg	750[6]	NE	1079[7]	-		-		-		12.5		-	
Tantalum	mg/kg	NE	NE	NE	-		-		-		7.8		-	
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	12.3	R	12.3	R	12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	UJ	30.7	U	30.7	UJ	30.7	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	132	J	15.8		6.1	UJ	6.1	U
Chloromethane	µg/kg	NE	NE	NE	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	81.0		6.1	UJ	6.1	U	6.1	UJ	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	43,200		14.4	UJ	93.8		6,670	J	4,640	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6,230		9.4	J	15.2		33.6	J	212	
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	U,R	6.1	UJ	6.1	U	6.1	UJ	6.1	U,R
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	U,R	6.1	UJ	6.1	U	6.1	UJ	6.1	U,R
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	10.9		6.3	UJ	6.1	U	**7,890**	J	58.6	
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	UJ	6.1	U	6.1	UJ	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	613	U	**1,210**	J	10.2		6.1	UJ	238	
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	U	12.3	UJ	12.3	U	6.1	UJ	12.3	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		-		-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		-		-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		-		-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		-		-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		-		-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		-		-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		-		-		-	
Chrysene	µg/kg	230,000	NE	780,000	-		-		-		-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		-		-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		-		-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		-		-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		-		-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		-		-		-	
Phenanthrene	µg/kg	NE	NE	NE	-		-		-		-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		-		-		-	

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-25						GP-26			
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-25G (10-12') 4/9/2000		GP-25G DUP (10-12') 4/9/2000		GP-26D (4-6') 4/9/2000		GP-26E (6-8') 4/9/2000		GP-26F (8-10') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	0.6	U	0.6	U	19.4	J	-		-	
Lead	mg/kg	750[6]	NE	1079[7]	9.0		7.6		**2,490**	J	-		-	
Tantalum	mg/kg	NE	NE	NE	8.6		6.1	U	18.5	J	-		-	
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	-		12.3	R	12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U	-		30.7	UJ	30.7	UJ
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	U	6.1	U	-		159	J	6.1	UJ
Chloromethane	µg/kg	NE	NE	NE	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	-		7.3	J	6.1	UJ
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	6.1	U	-		580	J	62.4	J
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	U	-		324	J	11.0	J
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	6.1	U	-		7.0	J	6.1	UJ
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	6.1	U	-		3,470	J	100	J
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	-		6.1	UJ	6.1	UJ
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	U	12.3	U	-		12.3	UJ	12.3	UJ
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	10.7	U	10.7	U	32.6	J	-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	10.7	U	10.7	U	21.3	J	-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	10.7	U	10.7	U	40.1	J	-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	10.7	U	10.7	U	53.6	J	-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	10.7	U	10.7	U	60.7	J	-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	10.7	U	10.7	U	47.5	J	-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	10.7	U	10.7	U	24.2	J	-		-	
Chrysene	µg/kg	230,000	NE	780,000	10.7	U	10.7	U	52.7	J	-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	10.7	U	10.7	U	11.6	J	-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	10.7	U	10.7	U	110.8	J	-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	10.7	U	10.7	U	10.7	UJ	-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	10.7	U	10.7	U	33.0	J	-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	10.7	U	10.7	U	10.7	UJ	-		-	
Phenanthrene	µg/kg	NE	NE	NE	10.7	U	10.7	U	49.9	J	-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	10.7	U	10.7	U	64.3	J	-		-	

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-26				GP-27					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-26H (12-14') 4/9/2000		GP-26I (12-14') 4/9/2000		GP-27B (1-2') 4/9/2000		GP-27E (6-8') 4/9/2000		GP-27H (12-14') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	-		-		39.5	J	10.7		-	
Lead	mg/kg	750[6]	NE	1079[7]	-		-		**17,200**	J	**7,180**		-	
Tantalum	mg/kg	NE	NE	NE	-		-		6.1	UJ	6.2		-	
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	-		12.3	R	12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	UJ	30.7	U	-		30.7	U	30.7	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	8.9	J	26.0		-		6.1	U	6.1	U
Chloromethane	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	-		6.1	U	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	22.1	UJ	6.1	U	-		6.1	U	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	-		6.1	U	6.1	U
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	-		6.1	U	6.1	U
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	20.2	UJ	6.1	U	-		6.1	U	6.1	U
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	UJ	6.1	U	-		6.1	U	6.1	U
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	UJ	12.3	U	-		12.3	U	12.3	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		-		39.7		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		-		10.7	U	-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		-		19.9		-	
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		-		20.1		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		-		20.9		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		-		16.1		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		-		10.7	U	-	
Chrysene	µg/kg	230,000	NE	780,000	-		-		-		22.9		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		-		10.7	U	-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		-		52.3		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		-		10.7	U	-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		-		18.6		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		-		10.7	U	-	
Phenanthrene	µg/kg	NE	NE	NE	-		-		-		31.4		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		-		33.5		-	

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date									
					GP-28				GP-29					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-28F (8-10') 4/9/2000		GP-28J (16-18') 4/9/2000		GP-29B (1-2') 4/9/2000		GP-29C (2-4') 4/9/2000		GP-29E (6-8') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals														
Cadmium	mg/kg	900	3,400	2,000	0.061	U	-		24.5	J	-		0.6	U
Lead	mg/kg	750[6]	NE	1079[7]	12.2		-		**6,460**	J	**12,800**		17.4	
Tantalum	mg/kg	NE	NE	NE	7.6		6.1	U	8.0	J	-		6.1	U,R
VOCs														
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	12.3	R	-		12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U,R	30.7	U,R	30.7	U	-		30.7	U
Benzene	µg/kg	58,000	1,000	100,000	6.1	UJ	6.1	U	6.1	U	-		6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.1	UJ	6.1	U	6.1	U	-		20.4	
Chloromethane	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	6.1	U	-		6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	9.1	J	6.1	U	6.1	U	-		6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	197	J	12.3		6.1	U	-		44.0	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	UJ	6.1	U	6.1	U	-		6.1	U
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	UJ	6.1	U	6.1	U	-		6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	8.8	J	6.1	U	6.1	U	-		6.1	U
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	6.1	U	-		6.1	U
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	6.1	U	-		6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	UJ	6.1	U	6.1	U	-		6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	UJ	6.1	U	6.1	U	-		6.1	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	6.1	U	-		6.1	U
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	UJ	6.1	U	6.1	U	-		6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	UJ	6.1	U	6.1	U	-		6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	**18,400**	R	6.1	U	6.1	U	-		40.7	
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	UJ	6.1	U	6.1	U	-		6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	13.7	J	6.1	U	6.1	U	-		6.1	U
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	UJ	12.3	U	12.3	U	-		12.3	U
SVOCs (PAHs)														
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	10.7	U	-		3,350	J	-		10.7	U
Anthracene	µg/kg	180,000,000	NE	610,000,000	10.7	U	-		892	J	-		10.7	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	10.7	U	-		**1,730**	J	-		10.7	U
Benzo (a) pyrene	µg/kg	200	NE	800	10.7	U	-		**2,180**	J	-		10.7	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	10.7	U	-		**1,750**	J	-		10.7	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	10.7	U	-		1,660	J	-		10.7	U
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	10.7	U	-		886	J	-		10.7	U
Chrysene	µg/kg	230,000	NE	780,000	10.7	U	-		2,000	J	-		10.7	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	10.7	U	-		**336**	J	-		10.7	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	10.7	U	-		5,230	J	-		10.7	U
Fluorene	µg/kg	24,000,000	NE	82,000,000	10.7	U	-		397	J	-		10.7	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	10.7	U	-		130	J	-		10.7	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	10.7	U	-		233	J	-		10.7	U
Phenanthrene	µg/kg	NE	NE	NE	10.7	U	-		3,860	J	-		10.7	U
Pyrene	µg/kg	18,000,000	NE	61,000,000	10.7	U	-		3,250	J	-		10.7	U

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date											
					GP-29/MW-5		GP-34				GP-35					
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	GP-29J (16-18') 4/9/2000		GP-34E (6-8') 4/9/2000		GP-34F (8-10') 4/9/2000		GP-35E (6-8') 4/9/2000		GP-35F (8-10') 4/9/2000		GP-35G (10-12') 4/9/2000	
					Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Metals																
Cadmium	mg/kg	900	3,400	2,000	-		-		-		-		-		-	
Lead	mg/kg	750[6]	NE	1079[7]	-		-		-		-		-		-	
Tantalum	mg/kg	NE	NE	NE	-		-		-		-		-		-	
VOCs																
2-Butanone	µg/kg	NE	NE	NE	12.3	R	12.3	R	12.3	R	12.3	R	12.3	R	12.3	R
Acetone	µg/kg	110,000,000	NE	200,000,000	30.7	U	30.7	U,R	30.7	U,R	30.7	U,R	30.7	U,R	30.7	U,R
Benzene	µg/kg	58,000	1,000	100,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	19.4		6.1	U	29.4		6.1	U	80.7	J	7.8	
Chloromethane	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Methylene chloride	µg/kg	420,000	22,000	760,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
n-Propylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U,R	6.1	U,R	6.1	U,R	6.1	U,R
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Trichloroethene	µg/kg	290,000	8,000	520,000	6.1	U	6.1	U	6.1	U	6.1	U	25.0	J	6.1	U
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	6.1	U	6.1	U	6.1	U	6.1	U	6.1	UJ	6.1	U
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.3	U	12.3	U	12.3	U	12.3	U	12.3	UJ	12.3	U
SVOCs (PAHs)																
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	-		-		-		-		-		-	
Anthracene	µg/kg	180,000,000	NE	610,000,000	-		-		-		-		-		-	
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	-		-		-		-		-		-	
Benzo (a) pyrene	µg/kg	200	NE	800	-		-		-		-		-		-	
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	-		-		-		-		-		-	
Benzo (ghi) perylene	µg/kg	NE	NE	NE	-		-		-		-		-		-	
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	-		-		-		-		-		-	
Chrysene	µg/kg	230,000	NE	780,000	-		-		-		-		-		-	
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	-		-		-		-		-		-	
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	-		-		-		-		-		-	
Fluorene	µg/kg	24,000,000	NE	82,000,000	-		-		-		-		-		-	
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	-		-		-		-		-		-	
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	-		-		-		-		-		-	
Phenanthrene	µg/kg	NE	NE	NE	-		-		-		-		-		-	
Pyrene	µg/kg	18,000,000	NE	61,000,000	-		-		-		-		-		-	

See footnotes at end of table.

Table 3B
(Continued)

Analyte	Unit	USEPA Draft SSLs[2]			Sample Location and Collection Date			
					TB-14		TB-35B	
		(Outdoor) Ingestion-Dermal	(Outdoor) Inhalation	(Indoor) Ingestion-Dermal	TB-14B (4.0-7.0'/5.0-5.4')[4] 6/1/2001		TB-35B (4.0-7.0'/5.0-5.3') 6/4/2001	
					Result	Qualifier	Result	Qualifier
Metals								
Cadmium	mg/kg	900	3,400	2,000	2.0		3.5	
Lead	mg/kg	750[6]	NE	1079[7]	68.4		**573.0**	
Tantalum	mg/kg	NE	NE	NE	6.4	U	6.8	U,R
VOCs								
2-Butanone	µg/kg	NE	NE	NE	12.8	U	21.6	J
Acetone	µg/kg	110,000,000	NE	200,000,000	53.0		118.0	
Benzene	µg/kg	58,000	1,000	100,000	6.4	U	6.8	U
Carbon disulfide	µg/kg	110,000,000	720,000	200,000,000	6.4	U	14.2	
Chloromethane	µg/kg	NE	NE	NE	6.4	U	6.8	U
1,1-Dichloroethene	µg/kg	5,000	100	10,000	6.4	U	6.8	U
Cis-1,2-Dichloroethene	µg/kg	11,000,000	NE	20,000,000	172.0		30.1	
Trans-1,2-Dichloroethene	µg/kg	23,000,000	NE	41,000,000	93.9		6.8	
Ethylbenzene	µg/kg	110,000,000	400,000	200,000,000	6.4	U	6.8	U
Methylene chloride	µg/kg	420,000	22,000	760,000	15.9		6.8	
p-Isopropyltoluene	µg/kg	NE	NE	NE	6.4	U	6.8	U
n-Propylbenzene	µg/kg	NE	NE	NE	6.4	U	6.8	U
Tetrachloroethene	µg/kg	61,000	18,000	110,000	6.4	U	6.8	U
Toluene	µg/kg	230,000,000	650,000	410,000,000	6.4	U	6.8	U
1,2,3-Trichlorobenzene	µg/kg	NE	NE	NE	6.4	U	6.8	U
1,2,4-Trichlorobenzene	µg/kg	6,800,000	3,200,000	20,000,000	6.4	U	6.8	U
1,1,1-Trichloroethane	µg/kg	NE	1,200,000	NE	6.4	U	6.8	U
Trichloroethene	µg/kg	290,000	8,000	520,000	200.0		103.0	
1,2,4-Trimethylbenzene	µg/kg	NE	NE	NE	6.4	U	6.8	U
Vinyl Chloride	µg/kg	4,000	1,000	8,000	105.0		6.8	
Total Xylenes	µg/kg	1,000,000,000	NE	1,000,000,000	12.8	U	13.6	U
SVOCs (PAHs)								
Acenaphthene	µg/kg	37,000,000	NE	120,000,000	128.0	U	259.0	
Anthracene	µg/kg	180,000,000	NE	610,000,000	128.0	U	136.0	U
Benzo (a) anthracene	µg/kg	2,000	NE	8,000	128.0	U	136.0	U
Benzo (a) pyrene	µg/kg	200	NE	800	115.0	U	123.0	U
Benzo (b) fluoranthene	µg/kg	2,000	NE	8,000	128.0	U	136.0	U
Benzo (ghi) perylene	µg/kg	NE	NE	NE	128.0	U	136.0	U
Benzo (k) fluoranthene	µg/kg	23,000	NE	78,000	128.0	U	136.0	U
Chrysene	µg/kg	230,000	NE	780,000	128.0	U	136.0	U
Dibenzo (a,h) anthracene	µg/kg	200	NE	800	115.0	U	123.0	U
Fluoranthene	µg/kg	24,000,000	NE	82,000,000	128.0	U	193.0	
Fluorene	µg/kg	24,000,000	NE	82,000,000	128.0	U	136.0	U
Indeno (1,2,3-c,d) pyrene	µg/kg	2,000	NE	8,000	128.0	U	136.0	U
Naphthalene	µg/kg	12,000,000	240,000	41,000,000	128.0	U	136.0	U
Phenanthrene	µg/kg	NE	NE	NE	128.0	U	150.0	
Pyrene	µg/kg	18,000,000	NE	61,000,000	128.0	U	184.0	

See footnotes at end of table.

Table 3B
(Continued)

Footnotes:

(1) *Footnote 1 not used.*

(2) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites; Peer Review Draft, US EPA Office of Solid Waste and Emergency Response, March 2001.
http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf
(3) 2000 data collected by Carlson Environmental, Inc.
(4) Sample depth intervals are in feet below ground surface. The first interval represents the entire sampling interval over which metals and SVOC samples were composited. The second interval represents the depth range from which VOC samples were collected based on PID screening.
(5) Bolded and shaded results denote an exceedence of a screening criteria.
(6) The Residential level for onsite trespasser (400 mg/kg) will be used to determine if lead is a constituent of concern.
(7) Blood Lead Concentrations of US Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III), Technical Review Workgroup for Lead; March 2002.
(8) NE denotes that no screening criteria was established.
(9) Dash denotes not analyzed.
J - Reported value may not be accurate or precise.
U - The associated number indicates approximate sample concentration necessary to be detected.
R - Analyte may or may not be present in the sample.
UJ - Quanitation limit may be inaccurate of imprecise.
General Note: The 2000 data in this table has been adjusted to reflect concentrations based on a dry sample. The conversion factor was calculated using moisture contents from the 2001 Earth Sciences sampling event. The conversion factor used was 1.2267.

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Table 6
Summary of Soils Geotechnical Results
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Parameter	Unit	Sample Location and Collection Date					
		GT-1 (2.0-4.0')[1]	GT-1 (8.0-10.0')	GT-2 (2.0-4.0')	GT-2 (7.0-9.0')	GT-3 (2.0-4.0')	GT-3 (8.0-10.0')
		6/07/01	6/07/01	6/07/01	6/07/01	6/07/01	6/07/01
Permeability	cm/sec @ 20°C	1.1×10^{-06}	6.4×10^{-07}	1.2×10^{-07}	2.5×10^{-06}	3.1×10^{-07}	2.8×10^{-08}
Wet Unit Weight	lb/ft^3	127.6	129.3	127.6	126.1	122.5	131.0
Dry Unit Weight	lb/ft^3	108.7	109.9	103.5	103.6	100.3	115.9
Moisture Content	%	15.1	20.9	23.0	22.2	16.9	13.1
Specific Gravity @ 20°C		2.70	2.72	2.74	2.71	2.69	2.72
Grain-Size Analysis							
Gravel	%	1.86	0.78	0.00	0.00	8.79	8.19
Sand	%	69.00	16.06	0.40	1.81	22.35	18.40
Silt and Clay	%	29.14	83.16	99.60	98.19	68.85	73.41
USCS Symbol		SC-SM	CL-ML	CL	ML	CL	CL
USCS Classification		Silty, Clayey Sand	Silty Clay with Sand	Lean Clay	Silt	Sandy Lean Clay	Lean Clay with Sand
Atterberg Limits							
Liquid Limit	%	18	20	33	[2]	30	24
Plastic Limit	%	13	14	21	[2]	19	13
Plasticity Index	%	5	6	12	[2]	11	11

See footnotes at end of table.

Table 6
(Continued)

Parameter	Unit	Sample Location and Collection Date		
		GT-4 (2.0-4.0')	GT-4 (8.0-10.0')	GT-5 (10.0-12.0')
		6/07/01	6/07/01	6/07/01
Permeability	cm/sec @ 20°C	1.0×10^{-04}	1.0×10^{-05}	4.8×10^{-08} (3)
Wet Unit Weight	lb/ft^3	112.9	130.7	- (4)
Dry Unit Weight	lb/ft^3	85.15	110.9	-
Moisture Content	%	33.7	18.1	17.1
Specific Gravity @ 20°C		2.57	2.73	2.72
Grain-Size Analysis				
Gravel	%	1.89	0.00	2.12
Sand	%	43.12	25.45	17.08
Silt and Clay	%	54.98	74.55	80.81
USCS Symbol		ML	ML	ML
USCS Classification		Sandy Silt	Silt with Sand	Silt with Sand
Atterberg Limits				
Liquid Limit	%	34	(2)	(2)
Plastic Limit	%	24	(2)	(2)
Plasticity Index	%	10	(2)	(2)

(1) Sample depth intervals are in feet below ground surface.

(2) Not analyzed; nonplastic material.

(3) Remolded sample.

(4) Dash denotes not analyzed.

Table 5
Summary of Soils Analytical Results
Supplementary Program for the Streamlined Risk Evaluation
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	Sample Location and Collection Date						
		TB-1 (0-6')[1]	TB-1 (6-12')	TB-5A (0-6')	TB-12 (0-6')	TB-12 (0-6')-DUP	TB-12 (6-12')	TB-13A (0-6')
		6/05/01	6/05/01	5/31/01	6/04/01	6/04/01	6/04/01	6/01/01
Organic Carbon	%	ND[2]	ND	ND	2.06	ND	ND	1.62
Cation Exchange Capacity	meq/100g	13.7	14.6	15.1	12.7	12.7	14.6	23.2
Moisture Content	%	13.3	14.5	19.6	20.1	100	16.4	31.9

See footnote at end of table

Table 5
(Continued)

Analyte	Unit	Sample Location and Collection Date					
		TB-18 (0-6')	TB-18 (6-12')	TB-19 (0-6')	TB-19 (6-12')	TB-33 (0-6')	TB-33 (6-12')
		6/04/01	6/04/01	6/04/01	6/04/01	6/05/01	6/05/01
Organic Carbon	%	ND	ND	ND	ND	1.79	1.02
Cation Exchange Capacity	meq/100g	11.1	6.58	12.7	21.1	13.8	21.8
Moisture Content	%	17.9	17.6	12.8	18.2	18.5	15.8

(1)Sample depth intervals are in feet below ground surface.

(2)ND denotes not detected at or above laboratory detection limits.

Table 24B
Typical Reporting Limits versus Screening Criteria - Groundwater
Fansteel Inc.
North Chicago, Illinois

All concentrations are expressed in micrograms per liter (ug/l), except where noted

Analyte	Reporting Limit(1)	Reporting Limit(2)	Screening Criteria(3)
Cadmium (mg/l)	0.00050	0.00050	NA
Lead (mg/l)	0.00750	0.00750	NA
Tantalum (mg/l)	0.5	0.5	NA
Acetone	10.0	10.0	220,000
Benzene	2.0	2.0	5
Bromobenzene	2.0	2.0	NA
Bromochloromethane	2.0	2.0	NA
Bromodichloromethane	2.0	2.0	2.1
Bromoform	2.0	2.0	0.0083
Bromomethane	2.0	2.0	NA
2-Butanone	10.0	10.0	NA
n-Butylbenzene	2.0	2.0	NA
sec-Butylbenzene	2.0	2.0	250
tert-Butylbenzene	2.0	2.0	NA
Carbon disulfide	2.0	2.0	560
Carbon tetrachloride	2.0	2.0	5
Chlorobenzene	2.0	2.0	390
Chloroethane	2.0	2.0	28,000
Chloroform	2.0	2.0	80
Chloromethane	2.0	2.0	NA
2-Chlorotoluene	2.0	2.0	NA
4-Chlorotoluene	2.0	2.0	NA
Dibromochloromethane	2.0	2.0	NA
1,2-Dibromo-3-chloropropane	2.0	2.0	33
1,2-Dibromoethane	2.0	2.0	0.36
Dibromomethane	2.0	2.0	NA
1,2-Dichlorobenzene	2.0	2.0	2,600
1,3-Dichlorobenzene	2.0	2.0	830
1,4-Dichlorobenzene	2.0	2.0	8,200
Dichlorodifluoromethane	2.0	2.0	14
1,1-Dichloroethane	2.0	2.0	2,200
1,2-Dichloroethane	2.0	2.0	5
1,1-Dichloroethene	2.0	2.0	190
cis-1,2-Dichloroethene	2.0	2.0	210
trans-1,2-Dichloroethene	2.0	2.0	180
1,2-Dichloropropane	2.0	2.0	35
1,3-Dichloropropane	2.0	2.0	NA
2,2-Dichloropropane	2.0	2.0	NA
1,1-Dichloropropene	2.0	2.0	NA
cis-1,3-Dichloropropene	2.0	2.0	NA
trans-1,3-Dichloropropene	2.0	2.0	NA
Di-isopropyl ether	2.0	2.0	NA
Ethylbenzene	2.0	2.0	700

Table 24B
Typical Reporting Limits versus Screening Criteria - Groundwater
Fansteel Inc.
North Chicago, Illinois

All concentrations are expressed in milligrams per liter (ug/kg), except where noted

Analyte	Reporting Limit[1]	Reporting Limit[2]	Screening Criteria[3]
Hexachlorobutadiene	2.0	2.0	0.33
2-Hexanone	10.0	10.0	NA
Isopropylbenzene	2.0	2.0	NA
p-Isopropyltoluene	2.0	2.0	NA
Methyl iodide	2.0	2.0	NA
Methylene chloride	2.0	2.0	58
4-Methyl-2-pentanone	10.0	10.0	NA
Methyl tert-butyl ether	2.0	2.0	NA
Naphthalene	2.0	2.0	150
n-Propylbenzene	2.0	2.0	320
Styrene	2.0	2.0	8,900
1,1,1,2-Tetrachloroethane	2.0	2.0	3.3
1,1,2,2-Tetrachloroethane	2.0	2.0	3
Tetrachloroethene	2.0	2.0	5
Toluene	2.0	2.0	1,500
1,2,3-Trichlorobenzene	2.0	2.0	NA
1,2,4-Trichlorobenzene	2.0	2.0	3,400
1,1,1-Trichloroethane	2.0	2.0	3,100
1,1,2-Trichloroethane	2.0	2.0	5
Trichloroethene	2.0	2.0	5
Trichlorofluoromethane	2.0	2.0	180
1,2,3-Trichloropropane	2.0	2.0	290
1,1,2-Trichloro-1,2,2-trifluoroethane	2.0	2.0	1,500
1,2,4-Trimethylbenzene	2.0	2.0	24
1,3,5-Trimethylbenzene	2.0	2.0	25
Vinyl acetate	2.0	2.0	9,600
Vinyl chloride	2.0	2.0	2
Total xylenes	10.0	10.0	NA

[1] Reporting limits indicated on analytical report, Sample TB-20, SDG No. B106161, Great Lakes Analytical, Earth Sciences Supplemental Characterization Program.

[2] Reporting limits indicated on analytical report, Sample MW-6, SDG No. B106162, Great Lakes Analytical, Earth Sciences Supplemental Characterization Program.

[3] Screening Criteria from OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), Table 2C, November 2002

Table 24A
Typical Reporting Limits versus Screening Criteria - Soils
Fansteel Inc.
North Chicago, Illinois

All concentrations are expressed in micrograms per kilogram (ug/kg), except where noted

Analyte	Reporting Limit(1)	Reporting Limit(2)	Screening Criteria(3)
Cadmium (mg/kg)	0.6	0.562	900
Lead (mg/kg)	3.1	2.81	400/750/1079
Tantalum (mg/kg)	6.1	5.62	NA
Acetone	30.7	28.1	110,000,000
Benzene	6.1	5.62	1,000
Bromobenzene	6.1	5.62	NA
Bromochloromethane	6.1	5.62	NA
Bromodichloromethane	6.1	5.62	51,000
Bromoform	6.1	5.62	88,000
Bromomethane	6.1	5.62	NA
2-Butanone	12.3	11.2	NA
n-Butylbenzene	6.1	5.62	NA
sec-Butylbenzene	6.1	5.62	NA
tert-Butylbenzene	6.1	5.62	NA
Carbon disulfide	6.1	5.62	720,000
Carbon tetrachloride	6.1	5.62	600
Chlorobenzene	6.1	5.62	180,000
Chloroethane	6.1	5.62	NA
Chloroform	6.1	5.62	500
Chloromethane	6.1	5.62	NA
2-Chlorotoluene	6.1	5.62	NA
4-Chlorotoluene	6.1	5.62	NA
Dibromochloromethane	6.1	5.62	NA
1,2-Dibromo-3-chloropropane	6.1	5.62	NA
1,2-Dibromoethane	6.1	5.62	NA
Dibromomethane	6.1	5.62	NA
1,2-Dichlorobenzene	6.1	5.62	600,000
1,3-Dichlorobenzene	6.1	5.62	NA
1,4-Dichlorobenzene	6.1	5.62	80,000
Dichlorodifluoromethane	6.1	5.62	NA
1,1-Dichloroethane	6.1	5.62	1,700,000
1,2-Dichloroethane	6.1	5.62	600
1,1-Dichloroethene	6.1	5.62	100
cis-1,2-Dichloroethene	6.1	5.62	11,000,000
trans-1,2-Dichloroethene	6.1	5.62	23,000,000
1,2-Dichloropropane	6.1	5.62	21,000
1,3-Dichloropropane	6.1	5.62	NA
2,2-Dichloropropane	6.1	5.62	NA
1,1-Dichloropropene	6.1	5.62	NA
cis-1,3-Dichloropropene	6.1	5.62	NA
trans-1,3-Dichloropropene	6.1	5.62	NA
Di-isopropyl ether	6.1	5.62	NA
Ethylbenzene	6.1	5.62	400,000

Table 24A
Typical Reporting Limits versus Screening Criteria - Soils
Fansteel Inc.
North Chicago, Illinois

All concentrations are expressed in milligrams per liter (ug/kg), except where noted

Analyte	Reporting Limit(1)	Reporting Limit(2)	Screening Criteria(3)
Hexachlorobutadiene	6.1	5.62	13,000
2-Hexanone	12.3	11.2	NA
Isopropylbenzene	6.1	5.62	NA
p-Isopropyltoluene	6.1	5.62	NA
Methyl iodide	6.1	5.62	NA
Methylene chloride	6.1	5.62	22,000
4-Methyl-2-pentanone	12.3	11.2	NA
Methyl tert-butyl ether	6.1	5.62	NA
Naphthalene	6.1	5.62	240,000
n-Propylbenzene	6.1	5.62	NA
Styrene	6.1	5.62	1,500,000
1,1,1,2-Tetrachloroethane	6.1	5.62	NA
1,1,2,2-Tetrachloroethane	6.1	5.62	1,000
Tetrachloroethene	6.1	5.62	18,000
Toluene	6.1	5.62	650,000
1,2,3-Trichlorobenzene	6.1	5.62	NA
1,2,4-Trichlorobenzene	6.1	5.62	3,200,000
1,1,1-Trichloroethane	6.1	5.62	1,200,000
1,1,2-Trichloroethane	6.1	5.62	2,000
Trichloroethene	6.1	5.62	8,000
Trichlorofluoromethane	6.1	5.62	NA
1,2,3-Trichloropropane	6.1	5.62	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	6.1	5.62	NA
1,2,4-Trimethylbenzene	6.1	5.62	NA
1,3,5-Trimethylbenzene	6.1	5.62	NA
Vinyl acetate	6.1	5.62	1,400,000
Vinyl chloride	6.1	5.62	1,000
Total xylenes	12.3	11.2	1,000,000,000
Acenaphthene	10.7	112	37,000,000
Acenaphthylene	245	225	NA
Anthracene	10.7	112	180,000,000
Benzo (a) anthracene	10.7	112	2,000
Benzo (a) pyrene	10.7	101	200
Benzo (b) fluoranthene	10.7	112	2,000
Benzo (ghi) perylene	10.7	112	NA
Benzo (k) fluoranthene	10.7	112	23,000
Chrysene	10.7	112	230,000
Dibenzo (a,h) anthracene	10.7	101	200
Fluoranthene	10.7	112	24,000,000
Fluorene	10.7	112	24,000,000
Indeno (1,2,3-c,d) pyrene	10.7	112	2,000
Naphthalene	10.7	112	240,000
Phenanthrene	10.7	112	NA
Pyrene	10.7	112	18,000,000

Table 24A
Typical Reporting Limits versus Screening Criteria - Soils
Fansteel Inc.
North Chicago, Illinois

(1) Reporting limits indicated on analytical report, Sample GP-12G, SDG No. B004296, Great Lakes Analytical, Carlson Site Investigation.

(2) Reporting limits indicated on analytical report, Sample TB-2D, SDG No. B106088, Great Lakes Analytical, Earth Sciences Supplemental Characterization Program.

(3) Screening Criteria from Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Peer Review Draft, USEPA Office of Solid Waste and Emergency Response, March 2001, Commercial/Industrial Scenario

Table 54
Comparative Analyses of Alternatives
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Alternative	Pros	Cons	Estimated Costs
Alternative 1 – No Action	• Easily implemented • Cost relatively low	• Not protective of human health and the environment • Not effective	• Capital cost: $23,000 • O&M cost (0-5 yr.): $51,800 • O&M cost (6-30 yr.): $25,900 • Present worth: $450,000
Alternative 2 – Surface Capping with Excavation, Transportation and Disposal	• Overall protective of human health and the environment • Long-term effectiveness • Common technology	• Short-term effectiveness concerns • Implementation concerns • Cost relatively high	• Capital cost: $1,950,000 • O&M cost (0-30 yr.): $5,750 • O&M cost (0-5 yr.): $51,800 • O&M cost (6-30 yr.): $25,900 • Present worth: $2,449,000
Alternative 3 – Surface Capping with Enhanced In-situ Bioremediation	• Overall protective of human health and the environment • Long-term effectiveness • Short term effectiveness • Costs relatively moderate • Larger area of impact	• Monitoring requires additional parameters related to bioremediation	• Capital cost: $727,000 • O&M cost (0-30 yr.): $5,750 • O&M cost (0-5 yr.): $51,800 • O&M cost (6-30 yr.): $25,900 • Present worth: $1,226,000
Alternative 4 – Surface Capping with Permeable Reactive Barrier	• Overall protective of human health and the environment • Long-term effectiveness • Comprehensive groundwater remediation	• Short-term effectiveness concerns • Implementation concerns • Cost relatively high	• Capital cost: $1,941,000 • O&M cost (0-30 yr.): $5,750 • O&M cost (0-5 yr.): $51,800 • O&M cost (6-30 yr.): $25,900 • Present worth: $2,440,000

Table 53
Applicable Federal ARARs and Compliance of Alternatives
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Code and Section	Abbreviated Title	Description of Regulation	Target	Meets Requirements
40 Code of Federal Regulations (CFR) §50	Ambient Air Quality Standards.	Clean Air Act, Ambient Air Quality Standards.	Air emissions from excavation and construction activities.	Dust control measures are to be implemented during construction/excavation activities.
40 CFR §61	Emissions Standard for Hazardous Air Pollutants.	National Emissions Standards for Hazardous Air Pollutants.	Air emissions from excavation and construction activities.	Dust control measures are to be implemented during construction/excavation activities.
40 CFR §264, Subparts AA and BB	Substantive Resource Conservation and Recovery Act (RCRA) standards for air strippers.	Substantive RCRA standards applicable to air stripper operations.	NA	NA
40 CFR §262	Standards for hazardous waste generators.	Establishes standards for hazardous waste generators.	Pertains to any site where hazardous waste is generated.	Proper identification of generators shall be made prior to commencement of work.
40 CFR §261	Hazardous waste identification.	Establishes standards for identification of hazardous wastes.	Pertains to any site where hazardous waste is present.	Hazardous waste constituents will be identified prior to remediation of disposal.
40 CFR §263	Standards for hazardous waste transporters.	Establishes standards for hazardous waste transporters.	Pertains to any site from where hazardous waste will be transported.	License hazardous waste transporters will be used for transporting hazardous wastes.
40 CFR §268	Standards for soil excavation and treatment residuals.	Establishes standards for soil excavation and treatment residuals.	Pertains to excavation and treatment of site soil.	Excavation and treatment work shall be performed in accordance with work plan to address identified risk.
40 CFR §112	Clean Air Act.	Regulates the concentration of air pollutants.	Pertains to emissions of all air pollutants.	Dust control measures are to be implemented during construction/excavation activities..
40 CFR §268.7	RCRA.	Regulates identification of hazardous wastes.	Pertains to identification of hazardous waste during treatment, transportation, and disposal	Hazardous material shall be properly identified prior to treatment, transportation, and disposal.
40 CFR §141.61	MCLs for organic chemicals.	Presents MCLs for organics.	Pertains to any site that has contaminated groundwater or surface water that is either being used or has the potential for use as a drinking water source.	Removal action will focus on plume control and management.
40 CFR §141.61	MCLs for inorganic chemicals.	Presents MCLs for inorganics.	Pertains to any site that has contaminated groundwater or surface water that is either being used or has the potential for use as drinking water source.	Removal action will focus on plume control and management.
40 CFR §122.26	Storm water discharges.	Presents requirements and conditions for storm water discharges.	Pertains to treated water from treatment alternative.	A general NPDES Storm water Discharge permit may be required.

Table 9
Summary of QA/QC Sample Results for Groundwater[1]
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	Sample Identification and Collection Date						
		FB-0530-01	**TB-0530-01**	**FB-0531-01**	**TB-0531-01**	**FB-0601-01**	**TB-0601-01**	**EB-0604-01**
		5/30/01	**5/30/01**	**5/31/01**	**5/31/01**	**6/01/01**	**6/01/01**	**6/04/01**
Metals								
Total Cadmium	mg/l	ND[2] G15,G2	-[3]	ND G15,G2	-	ND G15,G2	-	ND
Dissolved Cadmium	mg/l	ND	-	ND	-	ND	-	ND
Total Lead	mg/l	ND G15,G2	-	ND G15,G2	-	ND G15,G2	-	ND
Dissolved Lead	mg/l	ND	-	ND	-	ND	-	ND
Total Tantalum	mg/l	ND	-	ND	-	ND	-	ND
Dissolved Tantalum	mg/l	ND	-	ND	-	ND	-	ND
VOCs								
Chloroform	µg/l	3.39 G15	2.73 G15	ND	2.67 G15	ND	ND	ND
Trichloroethene	µg/l	ND	ND	ND	ND	ND	ND	116 G1
SVOCs (Polynuclear Aromatic Hydrocarbons)	µg/l	-	-	-	-	-	-	-

See footnotes at end of table.

Table 9
(Continued)

Analyte	Unit	Sample Identification and Collection Date						
		FB-0604-01	**TB-0604-01**	**FB-0605-01**	**TB-0605-01**	**FB-0606-01**	**TB-0606-01**	**FB-0608-01**
		6/04/01	**6/04/01**	**06/05/01**	**06/05/01**	**06/06/01**	**06/06/01**	**6/08/01**
Metals								
Total Cadmium	mg/l	ND	-	ND	-	ND	-	ND
Dissolved Cadmium	mg/l	ND	-	ND	-	ND	-	ND
Total Lead	mg/l	ND	-	ND	-	ND	-	ND
Dissolved Lead	mg/l	ND	-	ND	-	ND	-	ND
Total Tantalum	mg/l	ND	-	ND	-	ND	-	ND
Dissolved Tantalum	mg/l	ND	-	ND	-	ND	-	ND
VOCs								
Chloroform	µg/l	ND	ND	ND	2.19	ND	2.70	2.04
Trichloroethene	µg/l	ND	ND	ND	ND	ND	ND	ND
SVOCs (Polynuclear Aromatic Hydrocarbons)	µg/l	ND	-	ND	-	ND	-	-

See footnotes at end of table.

Table 9
(Continued)

Analyte	Unit	Sample Identification and Collection Date				
		FB-0609-01	**FB-0610-01**	**EB-0611-01**	**FB-0611-01**	**TB-0611-01**
		6/09/01	**6/10/01**	**6/11/01**	**6/11/01**	**6/11/01**
Metals						
Total Cadmium	mg/l	ND	ND	ND	ND	-
Dissolved Cadmium	mg/l	ND	ND	ND	ND	-
Total Lead	mg/l	ND	ND	ND	ND	-
Dissolved Lead	mg/l	ND	ND	ND	ND	-
Total Tantalum	mg/l	ND	ND	ND	ND	-
Dissolved Tantalum	mg/l	ND	ND	ND	ND	-
VOCs						
Chloroform	µg/l	2.51	ND	ND	ND	ND
Trichloroethene	µg/l	ND	ND	ND	ND	ND
SVOCs (Polynuclear Aromatic Hydrocarbons)	µg/l	-	-	-	-	-

(1) Field duplicate samples are indicated in Tables 3 and 7. Matrix spike and matrix spike duplicate sample results are provided in Tables 3 and 7.

(2) ND denotes not detected at or above laboratory detection limits.

(3) Dash denotes not analyzed.

G1 The recovery of one or more analytes in the matrix QC (MS/MSD) associated with this sample is above the laboratory's established acceptance criteria.

G2 Denotes the recovery of one or more analytes in the matrix QC (MS/MSD) associated with this sample is below the laboratory's established acceptance criteria.

G15 Denotes the relative percent difference (RPD) of one or more analytes in the matrix QC (MS/MSD) associated with this sample is above the laboratory's established acceptance limits.

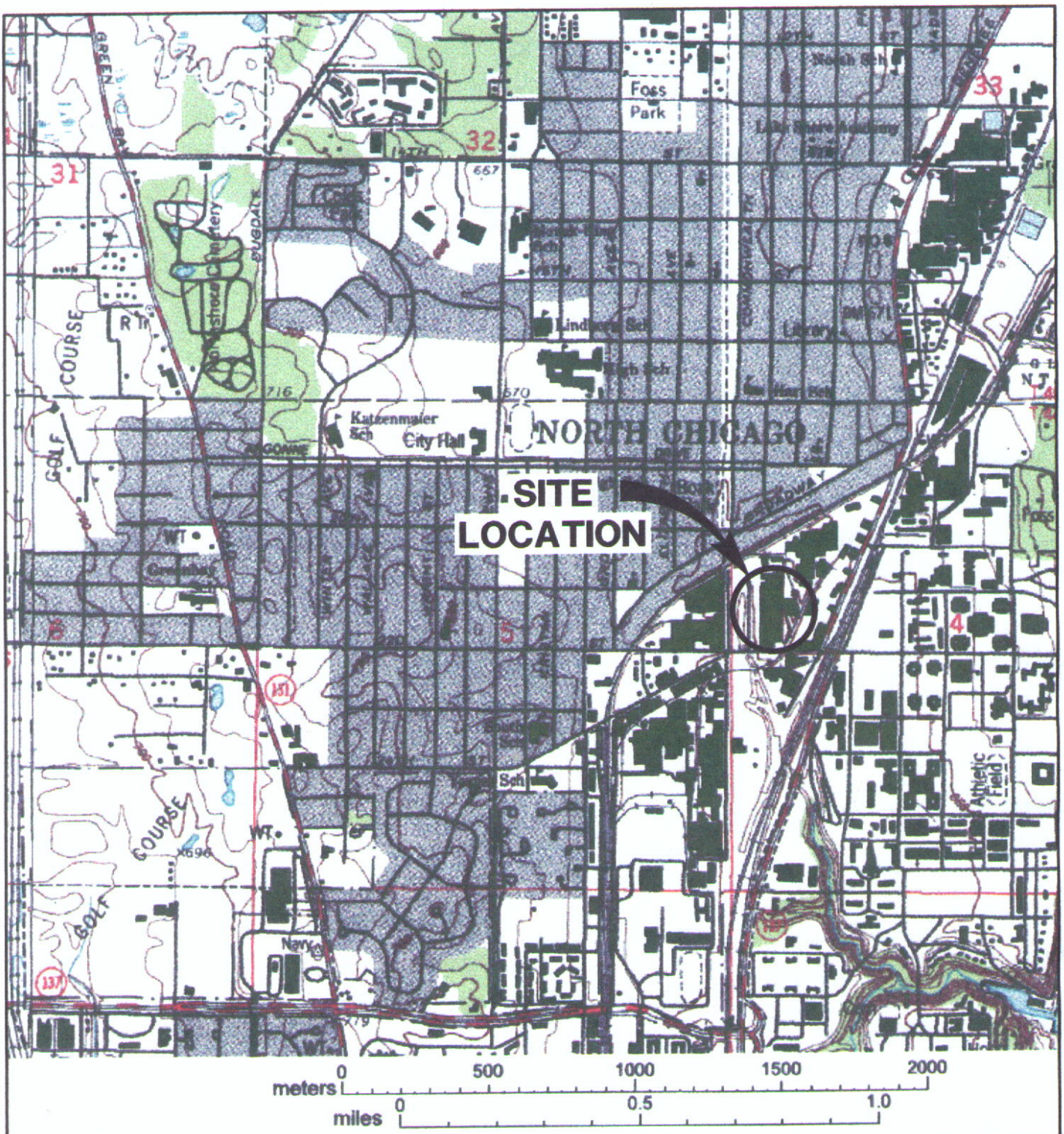
Table 8
Summary of QA/QC Sample Results for Soils[1]
Engineering Evaluation/Cost Analysis
Fansteel Inc.
North Chicago, Illinois Facility

Analyte	Unit	Sample Identification and Collection Date EB-0605-01 06/05/01
Metals		
Total Cadmium	mg/l	ND[2]
Total Lead	mg/l	ND
Total Tantalum	mg/l	ND
VOCs		
	µg/l	ND
SVOCs (Polynuclear Aromatic Hydrocarbons)		
	µg/l	ND
Organic Carbon	%	ND

[1]Field duplicate samples are indicated in Tables 3 and 7. Reference Table 9 for groundwater field blank and trip blank results which also apply to the soil samples. Matrix spike sample results are provided in Tables 3 and 7.

[2]ND denotes not detected at or above laboratory detection limits.

FIGURES



N

FIGURE 1

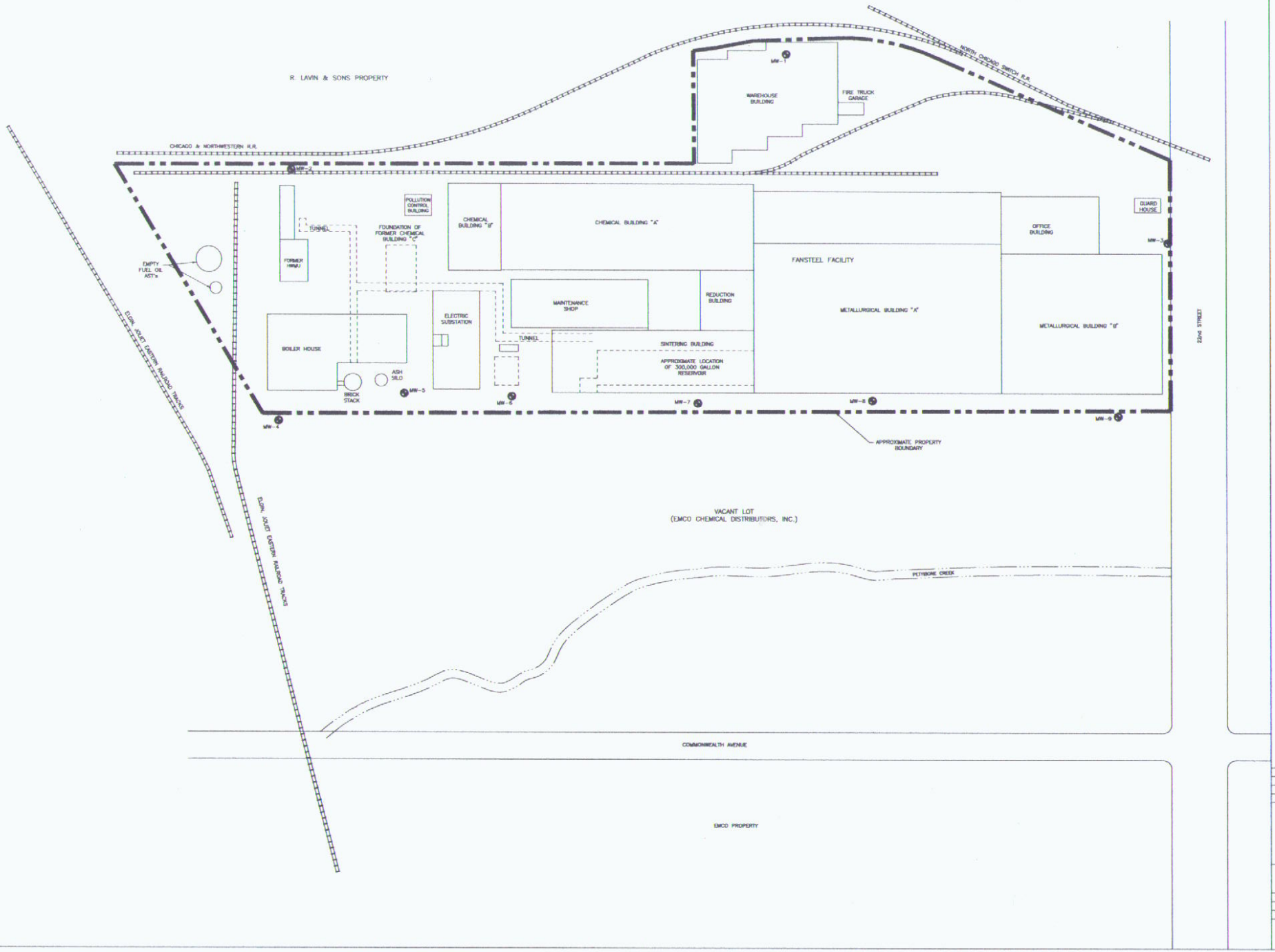
SITE LOCATION MAP
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS FACILITY

PREPARED FOR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS

APPROVED	
CHECKED	
DRAWN	GJA 3/12/01
DRAWING NUMBER	
6109001	

Earth Sciences Consultants, Inc.

REFERENCE
USGS TOPOGRAPHIC QUADRANGLE
WAUKEGAN, ILLINOIS



NOTES

1. THIS FIGURE IS BASED ON A DRAWING PREPARED BY FACTORY INSURANCE ASSOCIATION AND DATED 2/9/80; ON FIGURE C-7 FROM THE VACANT LOT SITE EE/CA DATED 10/30/87; AND ON FIGURE 6 FROM THE JANUARY 2001 SITE INVESTIGATION REPORT PREPARED BY CARLSON ENVIRONMENTAL, INC.

LEGEND

MW-1 FACILITY GROUNDWATER MONITORING WELL

APPROXIMATE PROPERTY BOUNDARY

SCALE - FEET

0 50 100

REVISION	DATE	DESCRIPTION

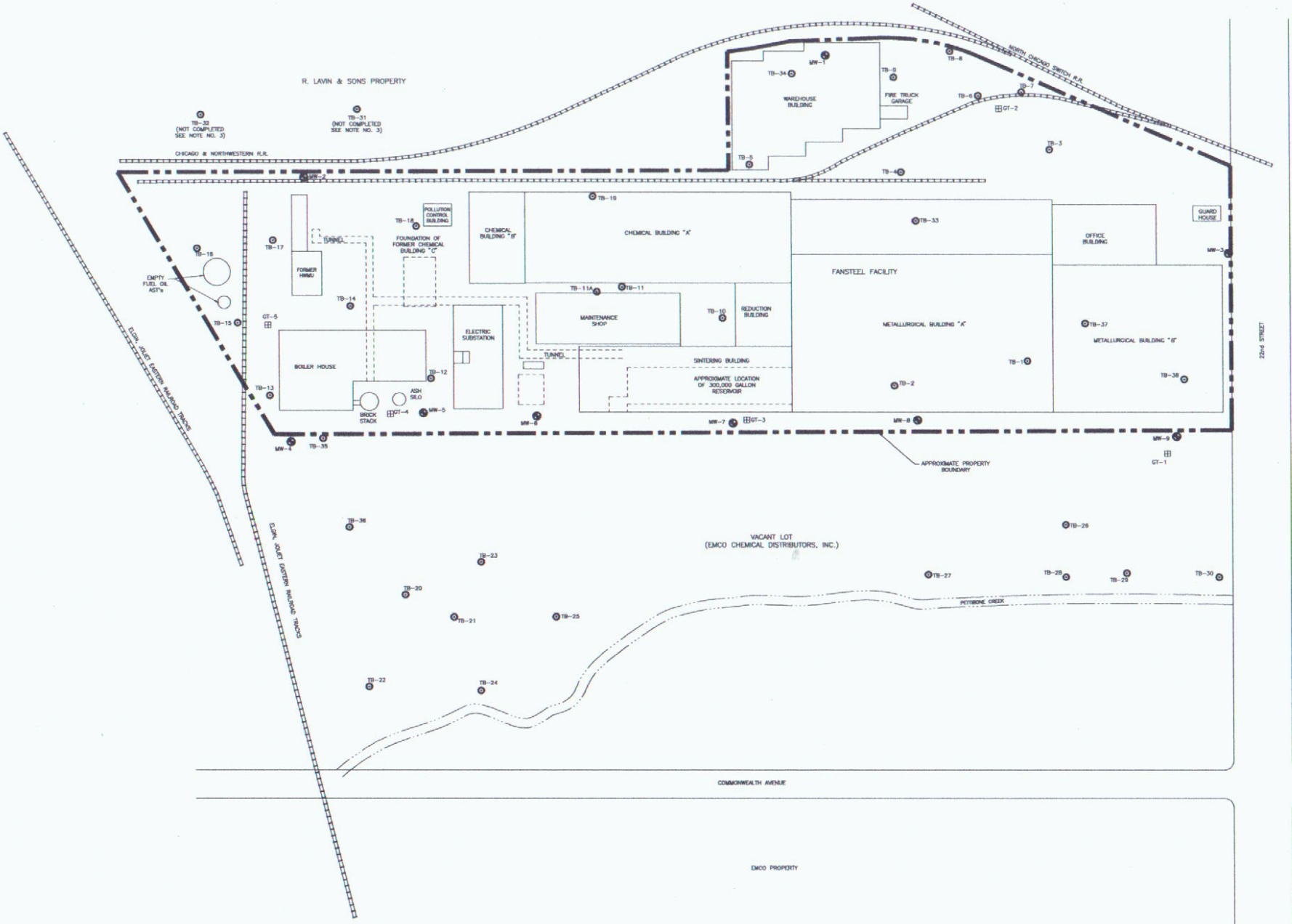
FIGURE 2
SITE FEATURES MAP

FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN GJA 6/13/01
DRAWING NUMBER
6109401

Earth Sciences Consultants, Inc.



NOTES

1. THIS FIGURE IS BASED ON A DRAWING PREPARED BY FACTORY INSURANCE ASSOCIATION AND DATED 2/9/80; ON FIGURE C-7 FROM THE VACANT LOT SITE EE/CA DATED 10/30/97; AND ON FIGURE 6 FROM THE JANUARY 2001 SITE INVESTIGATION REPORT PREPARED BY CARLSON ENVIRONMENTAL, INC.
2. LOCATIONS OF TEST BORINGS AND GEOTECHNICAL BORINGS ARE BASED ON FIELD MEASUREMENTS FROM ESTABLISHED POINTS OF REFERENCE.
3. PROPOSED TEST BORINGS TB-31 AND TB-32 WERE NOT COMPLETED ON THE R. LAVIN & SONS PROPERTY BECAUSE ADEQUATE ENVIRONMENTAL INFORMATION WAS PUBLICLY AVAILABLE.

LEGEND

MW-1	FACILITY GROUNDWATER MONITORING WELL
TB-1	TEST BORING LOCATION
GT-1	GEOTECHNICAL BORING LOCATION
	APPROXIMATE PROPERTY BOUNDARY

SCALE - FEET
0 50 100

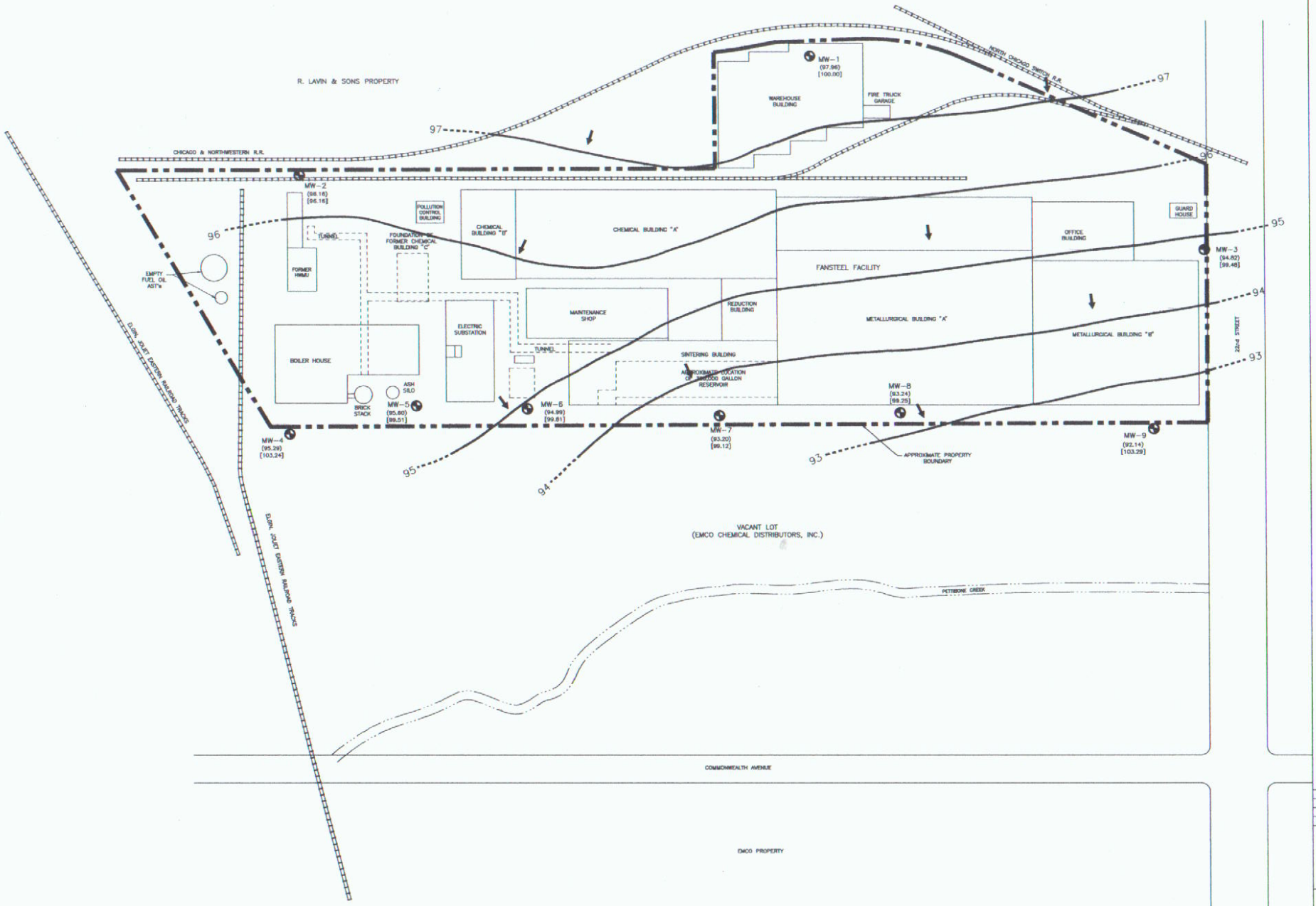
REVISION	DATE	DESCRIPTION

FIGURE 3
SAMPLE LOCATIONS
SUPPLEMENTAL GROUNDWATER AND SOIL CHARACTERIZATION
ENGINEERING EVALUATION/COST ANALYSIS
FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN GJK 6/20/01
DRAWING NUMBER
6109402

Earth Sciences Consultants, Inc.



NOTES

1. THIS FIGURE IS BASED ON A DRAWING PREPARED BY FACTORY INSURANCE ASSOCIATION AND DATED 2/9/80; ON FIGURE C-7 FROM THE VACANT LOT SITE EE/CA DATED 10/30/97; AND ON FIGURE 6 FROM THE JANUARY 2001 SITE INVESTIGATION REPORT PREPARED BY CARLSON ENVIRONMENTAL, INC.

LEGEND

MW-1	FACILITY GROUNDWATER MONITORING WELL
(97.96)	GROUNDWATER ELEVATION (MEASURED ON 6/02/01)
[100.00]	TOC ELEVATION
96	GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)
	GROUNDWATER FLOW DIRECTION
	APPROXIMATE PROPERTY BOUNDARY

SCALE – FEET
0 50 100 200

REVISION	DATE	DESCRIPTION

FIGURE 4
GROUNDWATER ELEVATION MAP

FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
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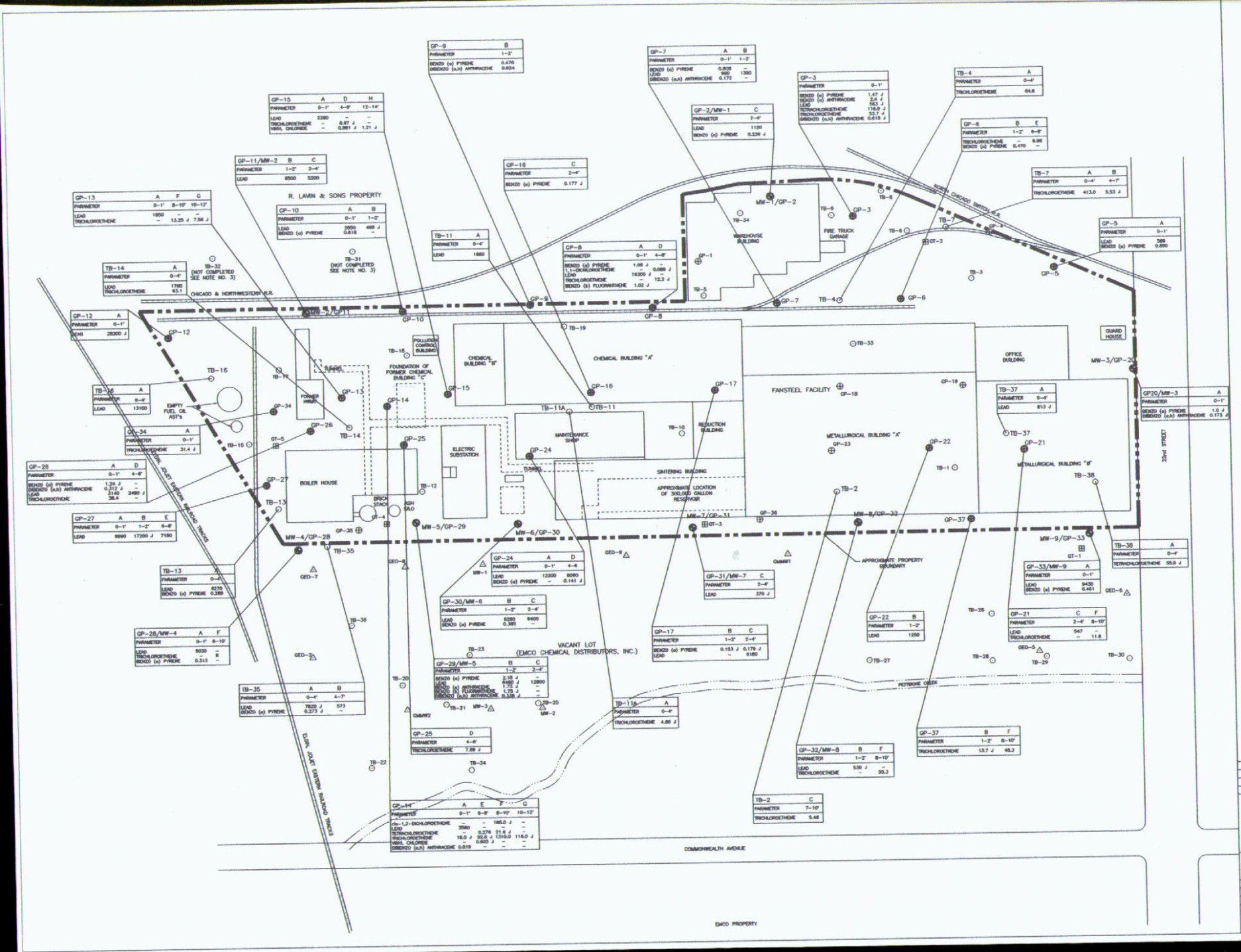
DRAWN GJA 6/28/01
DRAWING NUMBER
6109405

Earth Sciences Consultants, Inc.



NOTES

1. THIS FIGURE IS BASED ON A DRAWING PREPARED BY FACTORY INSURANCE ASSOCIATION AND DATED 2/9/60; ON FIGURE C-7 FROM THE VACANT LOT SITE EE/CA DATED 10/30/97; AND ON FIGURE 6 FROM THE JANUARY 2001 SITE INVESTIGATION REPORT PREPARED BY CARLSON ENVIRONMENTAL, INC.
2. LOCATIONS OF TEST BORINGS AND GEOTECHNICAL BORINGS ARE BASED ON FIELD MEASUREMENTS FROM ESTABLISHED POINTS OF REFERENCE.
3. PROPOSED TEST BORINGS TB-31 AND TB-32 WERE NOT COMPLETED ON THE R. LAVIN & SONS PROPERTY DUE TO LACK OF ACCESS.
4. THIS FIGURE SUMMARIZES ONLY DATA WHICH APPROACHES OR EXCEEDS ESTABLISHED USEPA SOIL SCREENING LEVELS FOR SUPERFUND SITES, PEER REVIEW DRAFT, MARCH 2001.
5. DASHES (–) INDICATE CONSTITUENTS NOT ANALYZED, NOT DETECTED, OR DETECTED BELOW ESTABLISHED SCREENING CRITERIA.
6. CONCENTRATIONS FOLLOWED BY A "J" ARE ESTIMATED. "R" INDICATES REJECTED DATA.
7. ALL CONCENTRATIONS ARE IN MILLIGRAMS PER KILOGRAM (mg/kg).

LEGEND

- MW-1 — FACILITY GROUNDWATER MONITORING WELL
- TB-1 — TEST BORING LOCATION
- GT-1 — GEOTECHNICAL BORING LOCATION
- CED SOIL BORING LOCATION
- DECOMMISSIONED EE/CA MONITORING WELL
- APPROXIMATE PROPERTY BOUNDARY

SCALE – FEET
0 50 100 150

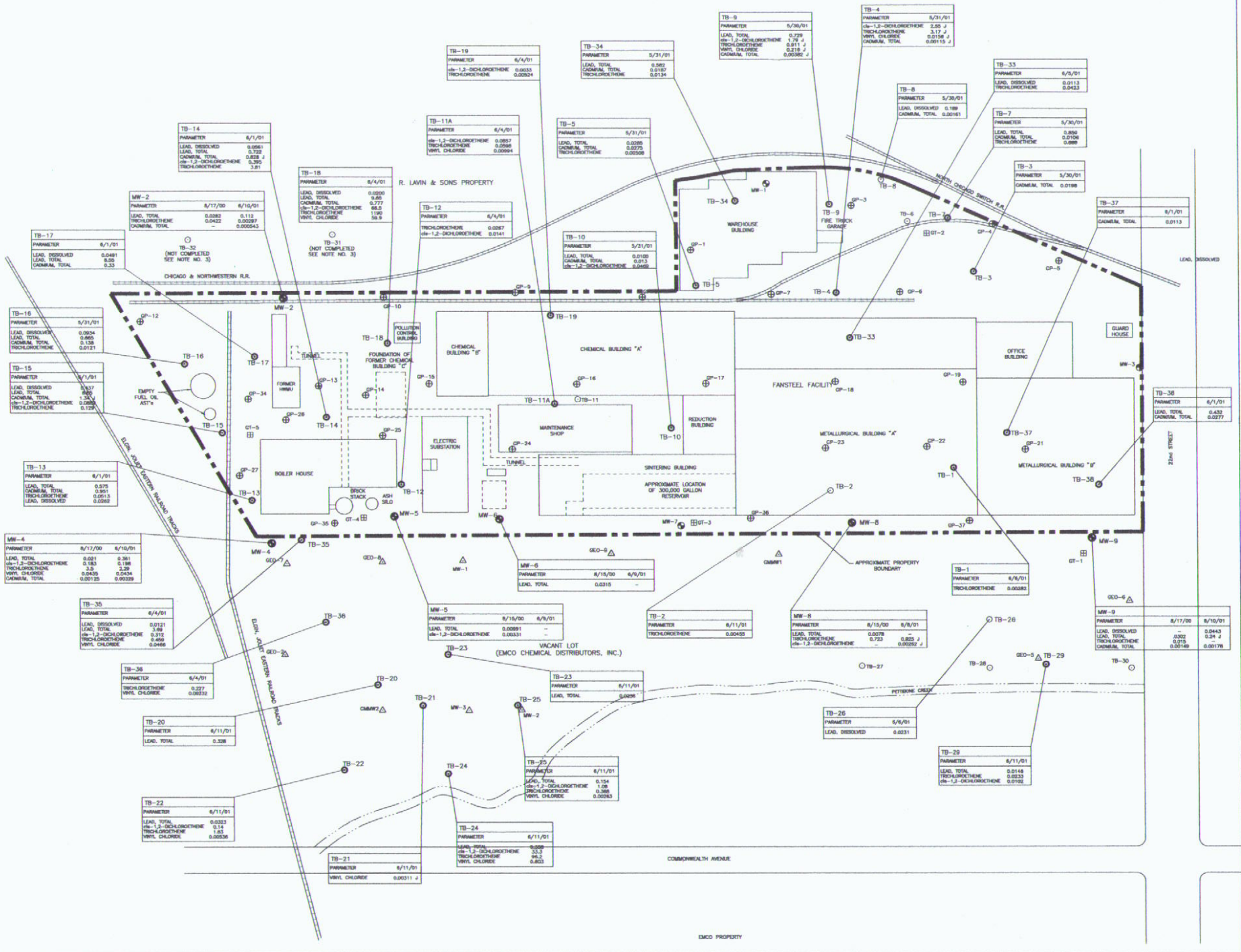
REVISION	DATE	DESCRIPTION

FIGURE 5
SUMMARY OF SOIL CHEMISTRY DATA
ENGINEERING EVALUATION/COST ANALYSIS
FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN DEF 02/3/03
DRAWING NUMBER
6109506

Earth Sciences Consultants, Inc



NOTES

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2. LOCATIONS OF TEST BORINGS AND GEOTECHNICAL BORINGS ARE BASED ON FIELD MEASUREMENTS FROM ESTABLISHED POINTS OF REFERENCE.
3. PROPOSED TEST BORINGS TB-31 AND TB-32 WERE NOT COMPLETED ON THE R. LAVIN & SONS PROPERTY DUE TO LACK OF ACCESS.
4. THIS FIGURE SUMMARIZES DATA OF THE MOST FREQUENTLY DETECTED CONSTITUENTS.
5. DASHES (-) INDICATE CONSTITUENTS NOT ANALYZED OR NOT DETECTED.
6. CONCENTRATIONS FOLLOWED BY A "J" ARE ESTIMATED, "R" INDICATES REJECTED DATA.
7. ALL CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/l).

LEGEND

MW-1	FACILITY GROUNDWATER MONITORING WELL
TB-1	TEST BORING LOCATION
GT-1	GEOTECHNICAL BORING LOCATION
	CEI SOIL BORING LOCATION
	DECOMMISSIONED EE/CA MONITORING WELL
	APPROXIMATE PROPERTY BOUNDARY

SCALE - FEET
0 50 100 150

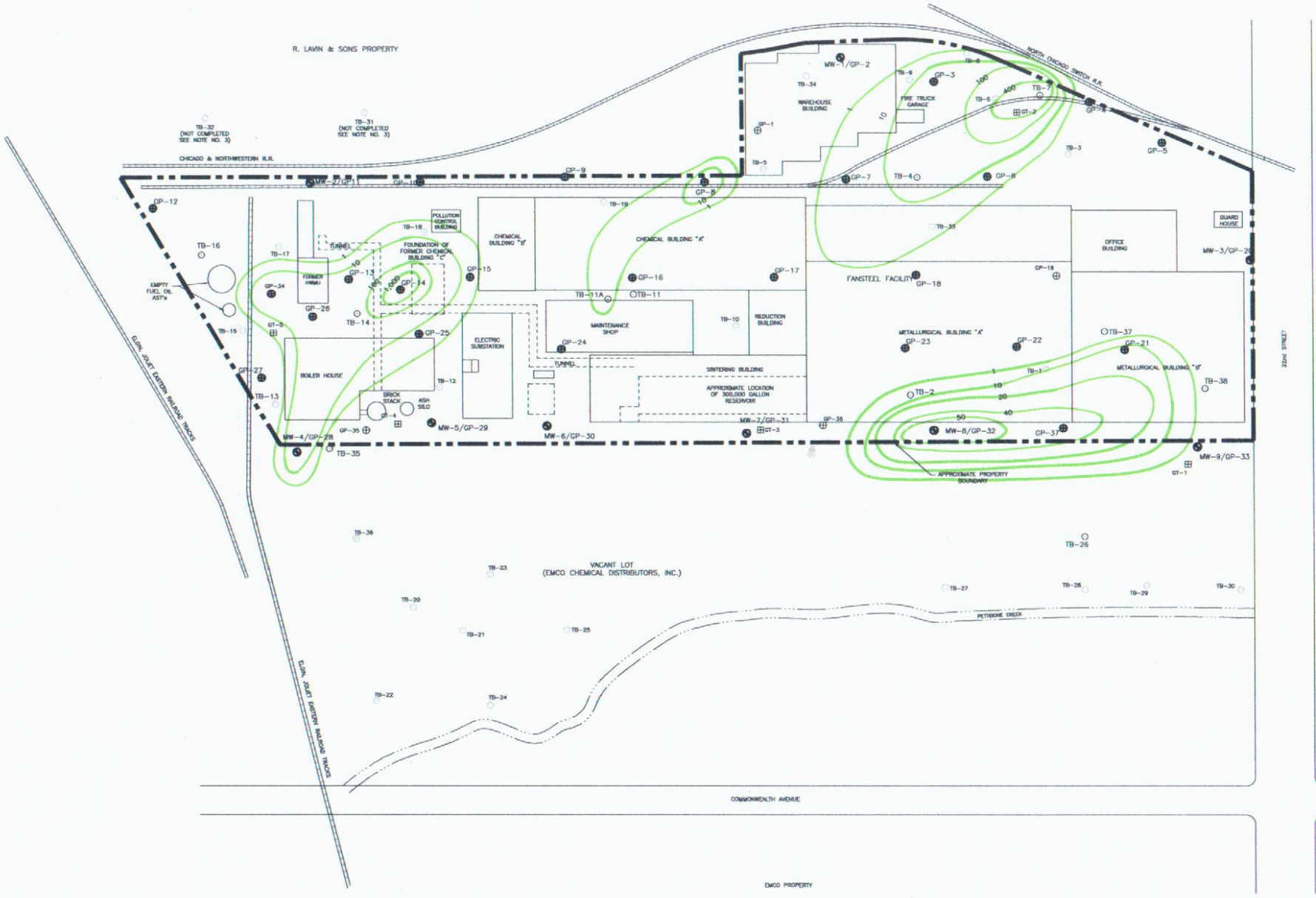
REVISION	DATE	DESCRIPTION

FIGURE 6
SUMMARY OF GROUNDWATER CHEMISTRY DATA
ENGINEERING EVALUATION/COST ANALYSIS
FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN DGB 02/05/03
DRAWING NUMBER
6109507

Earth Sciences Consultants, Inc.



NOTES

1. THIS FIGURE IS BASED ON A DRAWING PREPARED BY FACTORY INSURANCE ASSOCIATION AND DATED 2/9/80; ON FIGURE C-7 FROM THE VACANT LOT SITE EE/CA DATED 10/30/97; AND ON FIGURE 6 FROM THE JANUARY 2001 SITE INVESTIGATION REPORT PREPARED BY CARLSON ENVIRONMENTAL, INC.
2. LOCATIONS OF TEST BORINGS AND GEOTECHNICAL BORINGS ARE BASED ON FIELD MEASUREMENTS FROM ESTABLISHED POINTS OF REFERENCE.
3. PROPOSED TEST BORINGS TB-31 AND TB-32 WERE NOT COMPLETED ON THE R. LAVIN & SONS PROPERTY DUE TO LACK OF ACCESS.
4. THIS FIGURE SUMMARIZES ONLY DATA WHICH APPROACHES OR EXCEEDS ESTABLISHED USEPA SOIL SCREENING LEVELS FOR SUPERFUND SITES, PILER REVIEW DRAFT, MARCH 2001.
5. ISOCONCENTRATION CONTOURS HAVE BEEN DRAWN BASED ON MAXIMUM TCE CONCENTRATION RECORDED AT EACH SAMPLING LOCATION.
6. TCE SOIL CONCENTRATION OF 18.4 mg/kg AT GP-28 WAS CONSIDERED REJECTED DATA AS A RESULT OF DATA VALIDATION. DATA PRESENTED FOR REFERENCE ONLY.
7. ALL CONCENTRATIONS ARE IN MILLIGRAMS PER KILOGRAM (mg/kg).

LEGEND

MW-1	FACILITY GROUNDWATER MONITORING WELL
TB-1	TEST BORING LOCATION
GT-1	GEOTECHNICAL BORING LOCATION
	CEI SOIL BORING LOCATION
	APPROXIMATE PROPERTY BOUNDARY
10	TCE ISOCONCENTRATION CONTOUR (APPROXIMATE)

SCALE - FEET
0 50 100

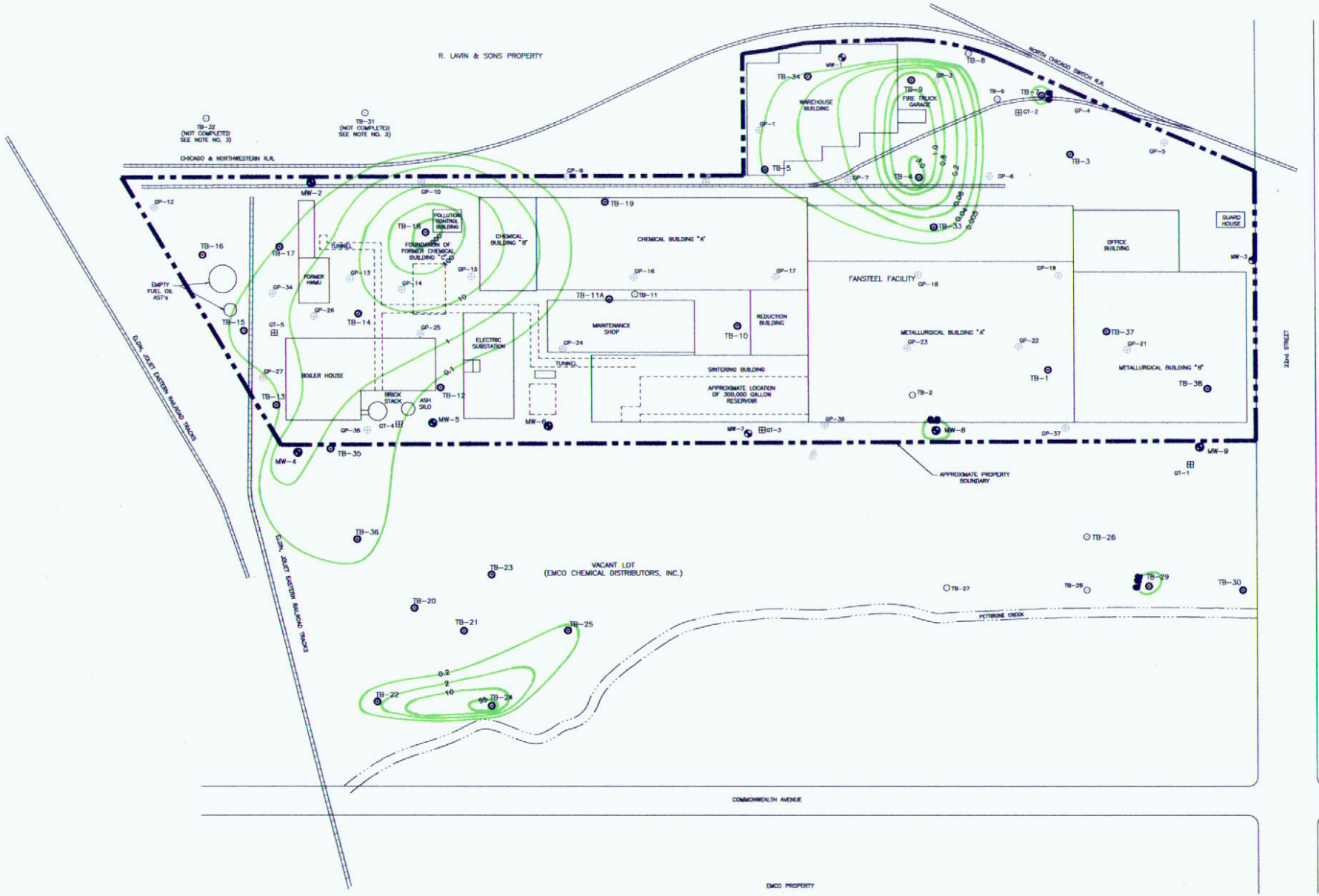
REVISION	DATE	DESCRIPTION
1	9/6/02	REVISE DATA

FIGURE 7
ISOCONCENTRATION MAP
TCE IN SOILS
ENGINEERING EVALUATION/COST ANALYSIS
FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN DEB 2/7/03
DRAWING NUMBER
6109508A

Earth Sciences Consultants, Inc.



NOTES

1. THIS FIGURE IS BASED ON A DRAWING PREPARED BY FACTORY INSURANCE ASSOCIATION AND DATED 2/9/90, ON FIGURE C-7 FROM THE VACANT LOT SITE EE/CA DATED 10/30/97, AND ON FIGURE 6 FROM THE JANUARY 2001 SITE INVESTIGATION REPORT PREPARED BY CARLSON ENVIRONMENTAL, INC.
2. LOCATIONS OF TEST BORINGS AND GEOTECHNICAL BORINGS ARE BASED ON FIELD MEASUREMENTS FROM ESTABLISHED POINTS OF REFERENCE.
3. PROPOSED TEST BORINGS TB-31 AND TB-32 WERE NOT COMPLETED ON THE R. LAVIN & SONS PROPERTY DUE TO LACK OF ACCESS.
4. ALL CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/l).

LEGEND

MW-1	FACILITY GROUNDWATER MONITORING WELL
TB-1	TEST BORING LOCATION
GT-1	GEOTECHNICAL BORING LOCATION
	CEI SOIL BORING LOCATION
	APPROXIMATE PROPERTY BOUNDARY
5.0	TCE ISOCONCENTRATION CONTOUR (APPROXIMATE)

SCALE - FEET
0 50 100

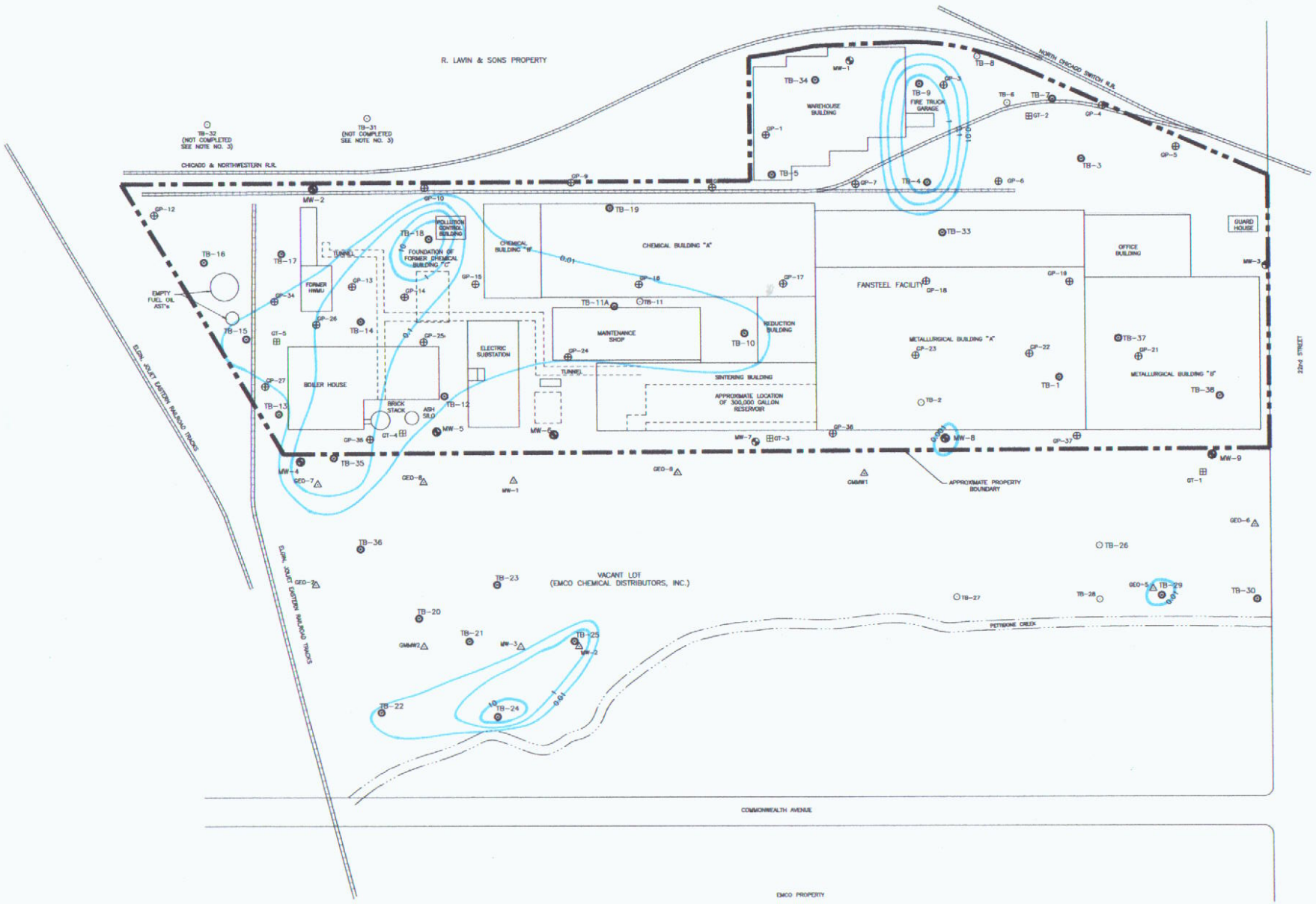
REVISION	DATE	DESCRIPTION

FIGURE 8
ISOCONCENTRATION MAP
TCE IN GROUNDWATER
ENGINEERING EVALUATION/COST ANALYSIS
FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN DEB 2/7/03
DRAWING NUMBER
6109510

Earth Sciences Consultants, Inc.



NOTES

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2. LOCATIONS OF TEST BORINGS AND GEOTECHNICAL BORINGS ARE BASED ON FIELD MEASUREMENTS FROM ESTABLISHED POINTS OF REFERENCE.
3. PROPOSED TEST BORINGS TB-31 AND TB-32 WERE NOT COMPLETED ON THE R. LAVIN & SONS PROPERTY DUE TO LACK OF ACCESS.
4. ALL CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/l).

LEGEND

MW-1	FACILITY GROUNDWATER MONITORING WELL
TB-1	TEST BORING LOCATION
GT-1	GEOTECHNICAL BORING LOCATION
	CEI SOIL BORING LOCATION
	DECOMMISSIONED EE/CA MONITORING WELL
	APPROXIMATE PROPERTY BOUNDARY
1	cis-1,2-DICHLOROETHENE ISOCONCENTRATION CONTOURS (APPROXIMATE)

SCALE - FEET
0 50 100

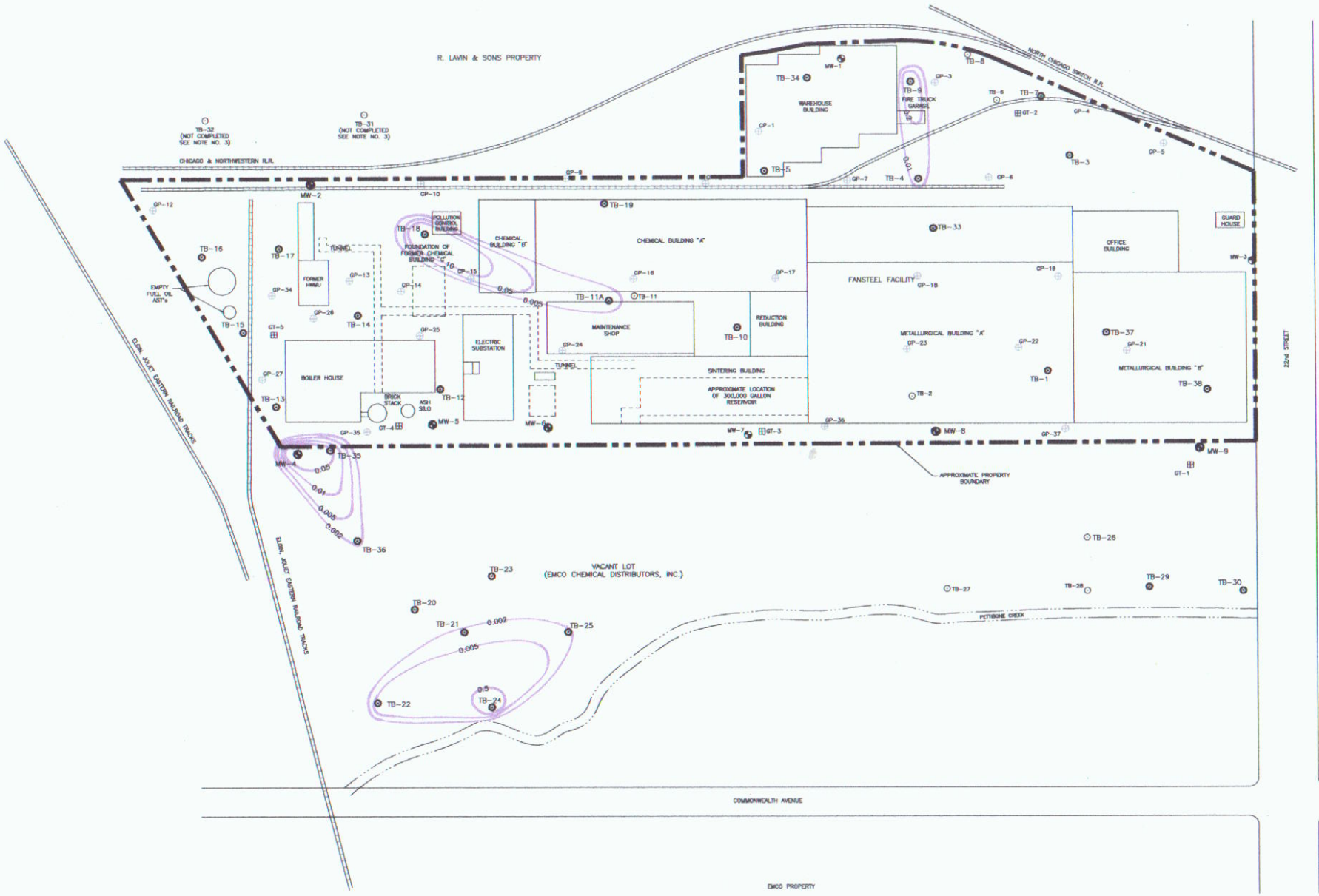
REVISION	DATE	DESCRIPTION

FIGURE 9
ISOCONCENTRATION MAP OF cis-1,2-DICHLOROETHENE IN GROUNDWATER
ENGINEERING EVALUATION/COST ANALYSIS
FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN DEB 2/7/03
DRAWING NUMBER
6109507A

Earth Sciences Consultants, Inc.



NOTES

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3. PROPOSED TEST BORINGS TB-31 AND TB-32 WERE NOT COMPLETED ON THE R. LAVIN & SONS PROPERTY DUE TO LACK OF ACCESS.
4. ALL CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/l).

LEGEND

MW-1	FACILITY GROUNDWATER MONITORING WELL
TB-1	TEST BORING LOCATION
GT-1	GEOTECHNICAL BORING LOCATION
	CEI SOIL BORING LOCATION
	APPROXIMATE PROPERTY BOUNDARY
10	VINYL CHLORIDE ISOCONCENTRATION CONTOUR (APPROXIMATE)

SCALE - FEET
0 50 100

REVISION	DATE	DESCRIPTION

FIGURE 10
ISOCONCENTRATION MAP
VINYL CHLORIDE IN GROUNDWATER
ENGINEERING EVALUATION/COST ANALYSIS
FANSTEEL INC.
NORTH CHICAGO ILLINOIS FACILITY

PREPARED FOR
FANSTEEL INC.
NORTH CHICAGO, ILLINOIS

APPROVED
CHECKED
DRAWN DEB 2/7/03
DRAWING NUMBER
6109511

Earth Sciences Consultants, Inc.

Appendix P
Evaluation of PCBs in Transformer Courtyard
Engineering Evaluation/Cost Analysis
North Chicago, Inc.
North Chicago, Illinois

1.0 Introduction

On October 7, 2004, representatives of NCI and USEPA met to discuss various topics related to the EE/CA Report for the NCI facility in North Chicago, Illinois. One of the topics involved the inclusion of the Transformer Courtyard remediation in the removal action required by the EE/CA. The Transformer Courtyard has been impacted by PCBs. On October 7, 2004, USEPA stated its preference to include the Transformer Courtyard in the EE/CA.

Initially, USEPA stated that in order to include the Transformer Courtyard in the EE/CA, a risk assessment similar to the baseline risk assessment presented in Chapter 3.0 of the EE/CA narrative would have to be performed for all applicable receptors and pathways. After risk levels were determined, risk management would be addressed as necessary. As an alternative, NCI suggested that the, "self-implementing option," under 40 CFR 761 be employed to complete the removal action for the Transformer Courtyard.

To support that alternative, NCI produced a position paper dated November 2004 for review and approval by USEPA. On December 16, 2004, USEPA responded to the position paper and stated that the self-implementing option could be used. This response was later clarified in a conference call between the parties that took place on January 19, 2005. The minutes from that call, which were formally approved by USEPA on February 1, 2005, state that the discussion of PCBs in the Transformer Courtyard will be presented in the EE/CA Report as a stand-alone appendix. The minutes also state that no risk assessment will be used to determine risk. Rather, PCB clean-up will be to levels dictated under the self-implementing option (as noted above) and that both high and low occupancy circumstances in accordance with 40 CFR 761 will be evaluated.

2.0 History and Past Investigations

PCB transformers were removed in 1982 from the Transformer Courtyard at the North Chicago facility for off-site disposal in accordance with TSCA requirements. These transformers were replaced with non-PCB transformers. No known releases from the previous PCB transformers had occurred.

Environmental sampling was conducted in 1997 and 1998 in and around the Transformer Courtyard to determine whether any historic PCB releases had occurred from the removed transformers. The sampling was directed by NCI (then Fansteel Inc.) outside counsel under a corporate audit program to identify potential environmental liabilities and associated possible remediation costs for the purposes of setting up a corporate reserve to deal with any identified liabilities.

The initial sampling event was conducted on December 29, 1997. Access to all areas within the courtyard was somewhat limited given the high voltage equipment in place. The courtyard is mostly concrete covered, although two small gravel areas that are not covered are also present. The scope of the sampling event included biased sampling based on visual observation of stains and accessibility. Three grabs samples of surface soils were collected using a 10 cm x 10 cm (100 cm^2) template to mark the area to be sampled. The surface was scraped to a depth of 1 cm and with a stainless steel trowel or similar implement yielding at least 100 grams of soil. A disposable template was used between samples to prevent contamination of subsequent samples.

Three surface wipe samples of the concrete surface were also obtained during the initial sampling event. The samples were gathered by first applying an appropriate solvent (e.g. hexane) to a piece of 11 cm filter paper or gauze pad. This moistened filter paper or gauze pad was held with a pair of stainless steel forceps and used to thoroughly swab a 100 cm^2 area as measured by a sampling template. The wipe samples were then stored in precleaned glass jars at 4 degrees C.

Based on the results of the initial round of sampling (discussed below), a second round of sampling was conducted on January 23, 1998 to determine whether PCBs identified on the concrete and soil in the courtyard had migrated. The second round of sampling consisted of geoprobing next to the courtyard in the adjacent Metallurgical Building A (access to the courtyard was not possible) to a depth of 24 feet with samples collected from each four foot interval for PCB analysis.

Figure P-1 shows the location of the Transformer Courtyard relative to the buildings on the property and the location of the samples. Surface soil samples from the initial sampling event are identified as I1S(265), I2S(266), and I3S(267). Surface wipe samples from the same event are identified as I1W(268), I2W(269), I3W(270). The geoprobe soil boring samples from the second round of sampling are identified as I101-1212 though I101-1217.

Attachment P-1 provides the PCB laboratory results on the wipe and surface soil samples (dated January 19, 1998) and the deeper soils from soil boring I101 (dated February 16, 1998) collected during the Transformer Courtyard investigation. A summary of these results is provided below.

Sample	PCB Result
Wipe Sample (I1W-268)	98,000 micrograms (Aroclor Source 1260)
Wipe Sample (I2W-269)	720 micrograms (Aroclor Source 1260)
Wipe Sample (I3W-270)	230 micrograms (Aroclor Source 1260)
Surface Soil Sample (I1S-265)	9,500 mg/kg (Aroclor Source 1260)
Surface Soil Sample (I2S-266)	3.1 mg/kg (Aroclor Source 1260)
Surface Soil Sample (I3S-267)	49 mg/kg (Aroclor Source 1260)
Soil Boring I101, 0-4 ft. (1212)	<1.0 mg/kg (none detected)
Soil Boring I101, 4-8 ft. (1213)	<1.0 mg/kg (none detected)
Soil Boring I101, 8-12 ft. (1214)	<1.0 mg/kg (none detected)
Soil Boring I101, 12-16 ft. (1215)	<1.0 mg/kg (none detected)
Soil Boring I101, 16-20 ft. (1216)	<1.0 mg/kg (none detected)
Soil Boring I101, 20-24 ft. (1217)	<1.0 mg/kg (none detected)

Based on these results, and as part of the corporate audit program, a conservative remedy was selected to remove the PCB contamination identified in the courtyard. The selected remedy was to remove 100 square feet of soil to a depth of 2 feet (more than half the exposed soil/gravel exposed in the courtyard). In addition, the surface inch of concrete was to be removed from a 500 square feet surface area of the concrete in the courtyard, covering almost one third of the entire surface area of the courtyard. These remediation presumptions were used to estimate potential costs for the determination of assigned liability resources.

3.0 Risk and Regulatory Context

As stated above, it is anticipated the self-implementing option under 40 CFR 761 will be used to address the PCB contamination in the Transformer Courtyard. This option allows the user to clean-up to predetermined levels protective of public health based on occupancy and the type of waste involved. A formal risk assessment is not required. 40 CFR 761. 61(a) is considered to be an applicable or relevant and appropriate requirement for this removal action. Administrative requirements are not considered applicable under CERCLA.

For the situation at hand, the following is a summary of the regulatory requirements under the self-implementing option.

40 CFR 761.61 is entitled, "PCB remediation waste." PCB remediation waste is defined in 40 CFR 761.3 as waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentrations: materials disposed of prior to April 18, 1978, that are currently at concentrations greater than or equal to 50 ppm PCBs, regardless of the concentration of the original spill; materials which are currently at any volume or concentrations where the original source was greater than or equal to 500 ppm PCBs beginning on April 18, 1978, or greater than or equal to 50 ppm PCBs beginning on July 2, 1979; and materials at any concentration if the PCBs are spilled or released from a source not authorized for use under this part. PCB remediation waste means soil, rags, and other debris generated as a result of any PCB spill cleanup, including among other things, soil and gravel and man-made structures such as concrete floors. Soil and gravel and concrete floors are applicable to the Transformer Courtyard.

40 CFR 761.61 provides cleanup and disposal options for PCB remediation waste. The option to be used for the Transformer Courtyard is the self-implementing option discussed in 40 CFR 761.61(a) where PCB remediation waste is cleaned to specific levels, based on regulatory requirements. The cleanup levels are specified in 40 CFR 761.61(a)(4)(i) and are applicable to both bulk PCB remediation wastes (including soil) and porous surfaces (concrete). The cleanup levels are as follows:

- High occupancy areas: The cleanup level in high occupancy areas is less than or equal to 1 ppm without further conditions. High occupancy areas where waste remains at concentrations greater than 1 ppm and less than or equal to 10 ppm shall be covered with a cap meeting the requirements in 40 CFR 761.61(a)(7) and (8).
- Low occupancy areas: The cleanup level in low occupancy areas is less than or equal to 25 ppm unless otherwise noted. Wastes may remain at a cleanup site at concentrations greater than 25 ppm and less than or equal to 50 ppm if the site is secured by a fence and marked with a sign. Wastes may remain at a cleanup site at concentrations greater than 25 ppm and less than or equal to 100 ppm if the site is covered with a cap, meeting the requirements in 40 CFR 761.61(a)(7) and (8).

Definitions of high and low occupancy areas are provided in 40 CFR 761.3. Examples of a high occupancy area would include a residence, school, day care center, sleeping quarters, a single or multiple occupancy 40-hours per week work station, a school class room, a cafeteria in an industrial facility, a control room, and a work station at an assembly line. Examples of a low occupancy area would include an electrical substation, or a location in an industrial facility where a worker spends small amounts of time per week (such as an unoccupied area outside a building, an electrical equipment vault, or in the non-office space in a warehouse where occupancy is transitory.)

40 CFR 761.61(a)(5)(i) and (iii) discusses the aspects of site cleanup applicable to bulk PCB remediation waste and porous surfaces, respectively. The requirements for both are the same. Soil washing is allowed for on-site waste cleanup under 40 CFR 761.61(a)(5)(i)(A). Decontamination of waste for on-site disposal, in accordance with 40 CFR 761.79, is also allowed under 40 CFR 761.61(a)(5)(i)(B)(3). Waste to be sent off-site with PCB concentrations less than 50 ppm can be disposed of in a permitted municipal solid waste facility. Waste to be sent off-site with concentrations greater than or equal to 50 ppm must be disposed of in a permitted hazardous waste landfill or a permitted PCB disposal facility.

40 CFR 761.61(a)(6) provides information on cleanup verification for the self-implementing option. Simply put, any person collecting and analyzing samples to verify the cleanup and on-site disposal of bulk PCB remediation waste and porous surfaces must do so in accordance with 40 CFR 761, Subpart O. Subpart O describes the methodology to be used to sample cleanup areas. One important note regarding the methodology is that wipe samples cannot be used to verify the cleanup. The cleanup must be verified with samples of at least 20 milliliters in volume.

40 CFR 761.61(a)(7) describes the requirements for a cap, if used as referenced in 40 CFR 761.61(a)(4)(i). 40 CFR 761.61(a)(8) describes deed restrictions necessary if engineering controls are used to achieve cleanup goals.

4.0 Identification of Removal Action Scope, Goals and Objectives

The scope of the removal action, as it pertains to PCBs in the Transformer Courtyard, is to address the conditions at the site that constitute a potential threat to public health, welfare, or the environment. In this instance, concentrations of PCB above those specified in 40 CFR 761.61(a)(4) for unrestricted or restricted release are considered to be a potential threat.

Consequently, the goal of the removal action is to meet the cleanup requirements in the self-implementing option. When this goal is met, the conditions in the Transformer Courtyard that caused concern will be mitigated.

The removal action objective is based on an evaluation of the identified removal action goal and the possible means through which the goals can be achieved. An attempt has been made to provide a definable objective to achieve the goal, without prejudice to possible removal/remedial alternatives that may be employed. For this instance, a logical removal action objective for the Transformer Courtyard is as follows:

Objective: Treat or remove soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i).

It should be noted that the intent is to remove/remediate the Transformer Courtyard to levels approaching or exceeded those required for low-occupancy (less than or equal to 25 ppm), without engineering or institutional controls. If practicable, a legitimate attempt will be made to clear the courtyard to levels approaching or exceeded those for high occupancy (less than or equal to 1 ppm), without engineering or institutional controls. If those levels cannot be met without unreasonable additional effort, institutional and engineering controls as specified in the applicable regulation will be implemented. These may include fencing, signs, capping, and deed restrictions.

The area may be considered a low occupancy area given the limited access to the courtyard, the fact the it serves as an electrical substation, and the fact that workers are not required to be present in the area for any significant amount of time. If the property is developed in the future, demolition of the structures around the courtyard would most likely be necessary to expose the area to potential high occupancy conditions. In that event, residual contamination that may remain above unrestricted release levels, for either low or high occupancy, will either continue to be addressed through institutional and engineering controls or will be remediated.

5.0 Identification and Analysis of Removal Action Alternatives

Several references were reviewed to identify and evaluate potential removal action alternatives for the Transformer Courtyard. These include:

- Guidance on Remedial Actions for Superfund Sites with PCB Contamination, USEPA, August 1990, EPA 540 G-90 007;
- A Guide on Remedial Actions at Superfund Sites with PCB Contamination, USEPA, August 1990, EPA Pub. 9355.4-01FS
- Engineering Issue, Technology Alternatives for the Remediation of PCB-Contaminated Soil and Sediment, USEPA, EPA/540/S-93/506
- Remediation Technologies Screening Matrix and Reference Guide (RTSMRG), Version 4.0, Federal Remediation Technology Roundtable
- PCB Decontamination Methods for Achieving TSCA Compliance During Facility Decommissioning Projects, Roy F. Weston, Inc. 2001

A listing of possible alternatives gathered from these sources, and others, includes:

- No Action
- Incineration;
- Thermal desorption;
- Chemical dehalogenation;
- Soil washing,
- Solvent extraction;
- Solidification/stabilization;
- Vitrification;
- Biological treatment/Biodegredation; and
- Excavation, removal and off-site disposal.

Several of these technologies were screened from further consideration due to relatively limited past applications and demonstrations of effectiveness for PCB contamination. These include: solidification/stabilization, vitrification, and biological treatment/biodegradation. The remaining technologies have been grouped as follows for further analysis:

- No Action,
- Thermal Treatment: incineration and thermal desorption,
- Physical/Chemical Treatment: chemical dehalogenation, soil washing, or solvent extraction, and

- Excavation, retrieval and off-site disposal.

Each alternative is discussed in the following sections. The alternatives are then evaluated based on effectiveness, implementability, and cost in accordance with applicable USEPA guidance (Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA, USEPA, August 1993, EPA540-R-93-057).

Specific evaluation criteria for evaluating the effectiveness of each alternative include:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Specific evaluation criteria for evaluating the implementability of each alternative include:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Specific evaluation criteria for evaluating the cost of each alternative include:

- Capital costs
- Annual operation and maintenance costs
- Present worth

In general, for the purposes of evaluating these technologies, it has been assumed that the PCB remediation waste present in the Transformer Courtyard will be physically removed from its present location and handled ex-situ. This would include identified concrete material from the floor and soil in the area. Ex-situ management is typical for the identified thermal treatment and

physical/chemical treatment techniques, with an exception to be discussed below in Alternative 3. However, ex-situ management would not apply to the No Action alternative. Excavation, Removal and Off-site Disposal is, by definition, an ex-situ management alternative.

The default ex-situ management of contaminated materials is supported for two reasons. First, as stated above, the identified removal/remedial technologies typically require ex-site management. Second, as stated in the Weston, Inc. 2001 reference sited above, for porous media,

> The TSCA regulations generally do not identify self-implementing procedures for decontaminating PCB-affected porous media. This is likely due to the difficulty in removing PCBs from the bulk matrix of porous materials.

Given the size of and the physical constraints in the Transformer Courtyard, it is anticipated the material would be removed with physical labor and either hand or power tools, as opposed to large earth moving equipment. Concrete surfaces would be saw cut, scabbled or scarified to remove material from the surface to a suitable depth. Soils would be excavated with hand tools or with smaller, hand directed, equipment. Materials would be removed and placed in suitable containers, most likely drums, to facilitate transport. Appropriate personal protective equipment will be used, in accordance with a site specific health and safety plan. It is likely full face respirators will be needed. See Chapter 4.0 for a discussion of the removal action objective.

5.1 Alternative 1 – No Action

The No Action alternative is included as a basis for comparison with the remaining alternatives. Under Alternative 1, No Action, the Transformer Courtyard would be left in its present condition. Exposed areas demonstrating PCB contamination above free release levels for both high and low occupancy would remain. Engineering and/or institutional controls are not included.

Effectiveness

Overall Protection of Human Health and the Environment

This alternative is not protective of human health and the environment given the risks that would remain at the site due to concentrations of PCBs above applicable cleanup levels.

Compliance with ARARs

This alternative does not comply with 40 CFR 761.61(a).

Long-Term Effectiveness

This alternative cannot achieve the removal action objective in the short or long-term since no action is taken to treat or remove soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i).

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative does not reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-Term Effectiveness

This alternative cannot achieve the removal action objective in the short or long-term since no action is taken to treat or remove soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i).

Implementability

Technical Feasibility

This alternative is technical feasible sine no action is required.

Administrative Feasibility

This alternative is administratively feasible since no action is required.

Availability of Services and Materials

This alternative requires no resources.

State Acceptance

State acceptance of this alternative is not anticipated.

Community Acceptance

Community acceptance of this alternative is not anticipated.

Cost

No costs would be incurred for this alternative.

5.2 Alternative 2 – Thermal Treatment

This alternative involves either incineration or thermal desorption of the PCB remediation waste. Incineration treats organic contaminants in solids and liquids by subjecting them to temperatures typically greater than 1,000 degrees F in the presence of oxygen, which causes volatilization, combustion, and destruction of these compounds. Thermal desorption is an ex-situ means to remove volatile and semivolatile contaminants from soil, sediment, sludge and filer cake by heating them at temperatures high enough to volatilize the organic contaminants. The vaporized organic contaminants can be captured by condensation or passing the offgas through a carbon adsorption bed or other treatment system.

These technologies produce multiple residual waste or material streams which also must be treated and/or disposed. For example, incineration produces solids from the incinerator (ash), solids and water from the air pollution control system, and air emissions. Thermal desorption produces treated and rejected media, condensed contaminants, water, particulate control system dust, spent carbon, and aqueous phase activated carbon.

Effectiveness

Overall Protection of Human Health and the Environment

If performed with appropriate controls and in accordance with applicable regulations, this alternative can protect human health and the environment through the treatment of PCB remediation waste and the disposal of residuals.

Compliance with ARARs

Incineration can be completed in accordance with 40 CFR 761.61(a)(5) and 40 CFR 761.70 of the self-implementing option. Decontamination of waste, in accordance with 40 CFR 761.79, is allowed under 40 CFR 761.61(a)(5)(i)(B)(3) of the self-implementing option.

This alternative may also comply with performance based disposal under TSCA, 40 CFR 761.61(b)(2)(i), 40 CFR 761.70(b), and 40 CFR 761.60(e), as well as 40 CFR 761.61(b)(2)(ii)

and 40 CFR 761.79(h), although these regulations are not considered the applicable or relevant and appropriate requirements in this circumstance.

Long-Term Effectiveness

This alternative will be effective in the long-term since PCB contaminants will be permanently removed from the Transformer Courtyard, to the extent practicable. In addition, PCBs will be destroyed, or PCB residuals disposed of, in accordance with applicable regulations.

Reduction of Toxicity, Mobility, or Volume through Treatment

The volume of PCBs will be reduced in the PCB remediation waste either through destruction or transfer into another media (i.e. carbon). However, the net volume of media requiring characterization, handling and/or disposal may increase given the production of treatment residuals.

Short-Term Effectiveness

The short term effectiveness of this alternative is considered moderate given the fact that thermal treatment technologies will require controls to prevent secondary risks to human health and the environment. For example, both incineration and thermal desorption must be performed in a manner to prevent offgases and residual materials from impacting remediation workers, the surrounding community, and the environment.

Implementability

Technical Feasibility

This alternative represents mature technology that has been successfully applied. However, the application of incineration and thermal desorption requires trained professionals skilled in the operation and maintenance of either on-site or off-site equipment. Other factors that may impact the feasibility of this alternative include:

- Characterization of PCB remediation waste to evaluate applicability of specific technology;
- Metals content of the waste stream (metals can contribute to residuals more toxic than original species);
- Potential production of dioxins/furans as a byproduct;

- Potential need for pilot scale treatability evaluations given relatively small PCB remediation waste volume (estimated less than 25 tons);
- Potential difficulties in reaching the required levels of contaminant removal;
- Off gas treatment and testing to meet applicable regulatory requirements; and
- Characterization of residual materials for waste determination and disposal.

Administrative Feasibility

The administrative feasibility of this alternative is considered moderate. It is not anticipated that the alternative will require off-site permits and/or waivers applicable to non-environmental laws. If on-site units are used for incineration or thermal desorption, considerations for air emissions and the associated approvals required must be made. However, as a removal action under CERCLA, only the technical considerations for the approvals need to be addressed. [In any case, the use of thermal desorption may require special consideration from the USEPA under 40 CFR 761.79(h). As of May 2004, only five requests for alternative decontamination approvals have been approved by the USEPA, according to the USEPA website.]

Availability of Services and Materials

The availability of incineration services is considered moderate to low based on a review of the RTSMRG, Version 4.0. According to the cited reference, only one off-site incinerator is permitted to burn PCBs and dioxins. (According to USEPA's web site for PCBs, there are four.) The reference also states there are approximately 10 transportable, high temperature units in operation. Thermal desorption technology is more commercially available, considering over 40 different vendors are listed in the reference.

State Acceptance

The level of state acceptance is considered to be moderate to low, given the public comments potentially associated with air emissions from an on-site operation. If the PCB remediation waste is removed from the site for treatment at another location, state acceptance is projected to be higher.

Community Acceptance

The level of community acceptance is considered moderate to low considering the potential reaction of the community to the control of air emissions associated with the alternative, if

employed on-site. If the PCB remediation waste is removed from the site for treatment at another location, community acceptance is projected to be higher.

Cost

(The physical removal of the PCB remediation waste for ex-situ treatment and/or disposal is not considered in the relative evaluation of alternatives, since ex-situ management is the assumed course of action, with one exception, as stated in Chapter 5.0.)

Incineration costs for PCB remediation wastes are expected to range between $280-$1,000/ton (EPA/540/S-93/506) to $1,500-$6,000/ton (RTSMRG).

Thermal desorption technologies for PCB remediation wastes are expected to range from $90-$380/ton (EPA/540/S-93/506) to $40-$300/ton (RTSMRG). However the costs presented in the RTSMRG reference are based on petroleum hydrocarbons and not PCBs.

Several factors that may affect these price ranges include:

- Equipment availability and mobilization/demobilization costs, if treatment on-site;
- Transportation costs, if off-site;
- The amount of material to be treated;
- Costs associated with potential treatability studies and characterization testing, both before and after treatment; and
- Costs for the management of treatment residuals.

5.3 Alternative 3 – Physical/Chemical Treatment

This alternative involves either chemical dehalogenation, soil washing, or solvent extraction.

Chemical dehalogenation employs chemical reactions to remove halogen atoms (chlorine atoms for PCBs) from organic molecules. In base-catalyzed decomposition (BCD), screened PCB material is mixed with sodium bicarbonate and heated in a rotary reactor. PCBs are completely dechlorinated and partially volatilized in this step. The PCBs in the vapor condensate, residual dust, spent carbon, and filter cake are dechlorinated after heating in a stirred-tank slurry reactor (STR) utilizing a high boiling point hydrocarbon oil, catalyst, and sodium hydroxide.

During soil washing, contaminated materials are mixed with wash water and possibly surfactants (also chelating agents for metals) to remove contaminants from the media and transfer them to the extraction fluid. The material and the wash water are then separated, and the material rinsed with clean water. Clean material is then removed from the process as product.

Solvent extraction requires the mixture of solvent and contaminated media to dissolve the organic contaminant into the solvent. The solvent is then removed from the media and sent to a separator to separate the contaminants from the solvent. The recycled solvent is then sent to the extractor unit for reuse and the contaminants are removed from the separator for disposal.

[As noted in Chapter 5.0, Alternative 3 contains an exception to the default ex-situ management of the PCB remediation waste. The exception is the potential use of solvents to remove PCB contamination from the surface of porous surfaces. The solvents are applied to the surface to extract the PCBs and then are collected for subsequent treatment and disposal. This option will be discussed separately, where applicable, as part of the alternative evaluation.]

These technologies produce multiple residual waste or material streams which also must be treated and/or disposed. The use of chemicals/solvents/wash water to remove PCBs from the waste media produces liquid and/or solid residuals with potentially more potent concentrations of contaminants than the original species. These residuals must be further processed and/or properly disposed.

Effectiveness

Overall Protection of Human Health and the Environment

If performed with appropriate controls and in accordance with applicable regulations, this alternative can protect human health and the environment through the treatment of PCB remediation waste and the disposal of residuals.

Compliance with ARARs

Soil washing is allowed for on-site waste cleanup under 40 CFR 761.61(a)(5)(i)(A). Decontamination of waste, in accordance with 40 CFR 761.79, is also allowed under 40 CFR 761.61(a)(5)(i)(B)(3) of the self-implementing option.

This alternative may also comply with performance based disposal under TSCA, 40 CFR 761.61(b)(2)(ii) and 40 CFR 761.79(h), although these regulations are not considered the applicable or relevant and appropriate requirements in this circumstance.

Long-Term Effectiveness

This alternative will be effective in the long-term since PCB contaminants will be permanently removed from the Transformer Courtyard, to the extent practicable. In addition, PCBs will be destroyed, or PCB residuals disposed of, in accordance with applicable regulations.

Reduction of Toxicity, Mobility, or Volume through Treatment

The volume of PCBs will be reduced in the PCB remediation waste either through destruction or transfer into another media (i.e. chemicals, sludge, solvents, wash water). However, the net volume of media requiring characterization, handling and/or disposal may increase given the production of treatment residuals.

Short-Term Effectiveness

The short term effectiveness of this alternative is considered moderate given the fact that physical/chemical treatment technologies will require controls to prevent secondary risks to human health and the environment. For example, the use of chemicals and solvents carries with it inherent hazards that must be acknowledged and addressed with proper planning, training and execution. In addition, it will be necessary to adequately control the use of liquids on site to prevent spills and discharges of contaminants to otherwise unaffected areas.

Implementability

Technical Feasibility

Based on EPA/540/S-93/506, the technologies discussed in this alternative are considered, "demonstrated," by the USEPA, which means they have been conducted at pilot- or full-scale at a

limited number of sites. Experienced personnel with knowledge of chemistry and the fate and transport of PCB contaminants are needed to implement the technologies. Other factors that may impact the feasibility of this alternative include:

- Characterization of PCB remediation waste to evaluate applicability of specific technology;
- Potential need for pilot scale treatability evaluations given the relatively small PCB remediation waste volume (estimated less than 25 tons);
- The ability to capture and treat residuals;
- Control of carrier media to prevent losses, spills, etc.;
- Potential offgas treatment and testing to meet applicable regulatory requirements; and
- Characterization of residual materials for waste determination and disposal.

[A serious consideration in the potential application of solvents to porous surfaces to facilitate removal of PCBs is technical feasibility. As stated in Weston, Inc. 2001,

> It should be noted, however, that such procedures may be effective at removing PCBs from the surface of porous material, but would not likely reduce PCB contaminations found at depth in bulk porous media.

It is likely that PCBs in stained areas of the concrete Transformer Courtyard extend at least a limited depth beneath the surface, given the relative porous nature of untreated concrete. If that is the case, the technical feasibility of using this in-situ option for porous surfaces is limited. In addition, based on field experience, the migration of PCBs back to the surface after solvent extraction has been performed on porous surfaces has been documented.]

Administrative Feasibility

The administrative feasibility of this alternative is considered to be moderate. It is not anticipated that the alternative will require off-site permits and/or waivers applicable to non-environmental laws. However, the use of physical/chemical treatment may require special consideration from the USEPA under 40 CFR 761.79(h). As of May 2004, only five requests for alternative decontamination approvals have been approved by the USEPA, according to the USEPA website.

Availability of Services and Materials

In 1993, the BCD technology was developed in the United States and licensed to two companies in Australia. However, it appears from the references cited that the technology is not frequently used. The last application referenced on the BCD Group, Inc. website is a 1997 U.S. Navy project.

Soil washing has been used in the United States with some success. However, as noted in RTSMRG, Version 4.0, commercialization of the technology is not extensive. USEPA's website lists 15 vendors who offer the technology.

Solvent extraction is considered to be moderately available with 10 vendors listed on USEPA's website offering the service.

State Acceptance

The level of state acceptance is considered to be moderate to high, based on the limited potential for off-site effects, such as air emissions. However, concerns regarding control of carrier media may be an issue.

Community Acceptance

The level of community acceptance is considered to be moderate to high, based on the limited potential for off-site effects, such as air emissions. However, concerns regarding control of carrier media may be an issue.

Cost

(The physical removal of the PCB remediation waste for ex-situ treatment and/or disposal is not considered in the relative evaluation of alternatives, since ex-situ management is the assumed course of action, with one exception, as stated in Chapter 5.0.)

BCD costs for PCB remediation wastes are expected to range between $225-$580/ton (EPA/540/S-93/506) to $200-$500/ton (RTSMRG).

Soil washing for PCB remediation wastes is expected to range from $60-$230/ton (EPA/540/S-93/506) to $170/ton (RTSMRG).

Solvent extraction for PCB remediation waste is expected to range from $110-$540/ton (EPA/540/S-93/506) to $100-$400/ton (RTSMRG).

Several factors that may affect these price ranges include:

- Equipment availability and mobilization/demobilization costs, if treatment on-site;
- Transportation costs, if off-site;
- The amount of material to be treated;
- Costs associated with potential treatability studies and characterization testing, both before and after treatment; and
- Costs for the management of treatment residuals.

5.4 Alternative 4 – Excavation, Removal and Off-Site Disposal

This alternative involves the physical removal, to the extent practicable, of soils and concrete impacted by PCBs and the packaging of the retrieved materials for transport to and disposal at a hazardous waste or TSCA permitted landfill. Chapter 5.0 provides additional information on methods anticipated for physical removal.

Effectiveness

Overall Protection of Human Health and the Environment

If performed with appropriate controls and in accordance with applicable regulations, this alternative can protect human health and the environment through the removal and disposal of PCB remediation waste.

Compliance with ARARs

This alternative complies directly with the requirements of 40 CFR 761.61(a)(5)(B) for bulk PCB remediation waste .

Long-Term Effectiveness

This alternative will be effective in the long-term since PCB contaminants will be permanently removed from the Transformer Courtyard, to the extent practicable. In addition, PCB remediation waste will be disposed of in accordance with applicable regulations.

Reduction of Toxicity, Mobility, or Volume through Treatment

No treatment is performed in this alternative.

Short-Term Effectiveness

The short term effectiveness of this alternative is considered high relative to other alternatives considered. No ancillary risks above and beyond those associated with material removal, transport and disposal are present.

Implementability

Technical Feasibility

This technical feasibility of this alternative is considered to be high. Excavation, retrieval and off-site disposal is practiced routinely in the United States to manage waste materials, including PCB remediation waste. Other factors that may impact the feasibility of this alternative include:

- Characterization of PCB remediation waste to profile the material for disposal;
- Difficulties associated the removal activities considering the limited work space in the Transformer Courtyard; and
- Potential classification of the waste materials as both hazardous waste and PCB remediation waste.

Administrative Feasibility

The administrative feasibility of this alternative is considered high. It is not anticipated that the alternative will require off-site permits and/or waivers applicable to non-environmental laws.

Availability of Services and Materials

The availability of incineration services is considered moderate to high. According to USEPA's web site for PCBs, there are nine landfill currently permitted to accept PCB contaminated waste materials.

State Acceptance

The level of state acceptance is considered to be high. The technology is common and presents limited technical concerns.

Community Acceptance

The level of community acceptance is considered to be high. The technology is common and presents limited technical concerns.

Cost

(The physical removal of the PCB remediation waste for ex-situ treatment and/or disposal is not considered in the relative evaluation of alternatives, since ex-situ management is the assumed course of action, with one exception, as stated in Chapter 5.0.)

Based on a vendor's budgetary estimate, the cost for transportation and disposal is estimated at $150/ton.

Several factors that may affect these price ranges include:

- Potential increases in transportation costs due to rising fuel prices;
- Verification of the waste profile; and
- Volatility in the landfill disposal prices.

6.0 Comparison of Removal Action Alternatives

The four removal alternatives for the Transformer Courtyard were compared based on effectiveness, implementability, and cost. Considering effectiveness, Alternative 1 would not be effective in protecting human health and the environment since the removal action objective would not be met. Alternative 1 would also not be effective in the short or long term and would not reduce toxicity, mobility, or volume of the contaminants through treatment. Alternatives 2, 3 and 4 would be effective in protecting of human health and the environment by achieving the removal objective. The three alternatives would also be effective in the long term since PCBs would be permanently removed from the Transformer Courtyard, to the extent practicable. Alternatives 2, 3 and 4 are compliant with identified ARARs, although technologies specified in Alternatives 2 and 3 may require special consideration by the USEPA. Alternatives 2 and 3 would be moderately effective in reducing toxicity, mobility, or volume through treatment;

Alternative 4 would not achieve reduction since no treatment is proposed. Alternatives 2 and 3 would be moderately effective in the short term with considerations for additional handling and management of waste materials taken into account. The short term effectiveness of Alternative 4 would be high since limited additional handling would be involved, beyond the excavation and removal activities themselves. Based on the information presented, Alternative 4 is considered to be the most effective alternative, followed by Alternatives 2 and 3, and then Alternative 1.

Regarding implementability, Alternative 1 would be easily implemented but with minimal opportunity for state and community acceptance. In general, Alternatives 2 and 3 would be moderately feasible. However, Alternative 2 may be less feasible than Alternative 3, considering potential concerns due to air emissions. The implementability of Alternative 4 would be high for feasibility, availability, and acceptance. Therefore, comparatively, Alternative 4 is the most easily implemented, followed by Alternatives 3, 2 and 1 respectively.

Lastly, the costs per ton for each alternative have been compared. Alternative 1 is the least costly followed by Alternatives 4, 3 and 2 respectively.

7.0 Recommended Removal Action Alternative

The recommended removal action alternative for the Transformer Courtyard is Alternative 4, Excavation, Removal and Off-site Disposal. This alternative fulfills the removal action objective of treating or removing soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i). In addition, this alternative is considered to be the most effective, implementable, and cost effective (aside from the No Action Alternative) option evaluated for this analysis.

Appendix K
Information on VLEACH Modeling
VLEACH Modeling to Assist in Exposure Assessment
North Chicago, Inc.
North Chicago, Illinois

To assist with the risk assessment, Earth Sciences Consultants, Inc. and Penn Environmental and Remediation, Inc. performed VLEACH modeling to evaluate the rate at which subsurface volatile organic compounds can be released to the atmosphere from soil and shallow groundwater.

VLEACH is a numerical model that computes solute transport by infiltration and vapor transport by diffusion from the groundwater to the vadose zone to the surface. The following three routes of exposure were considered:

- Contaminant in unsaturated zone soil
- Contaminant in Groundwater
- Combined contaminant in groundwater and unsaturated zone soil

In evaluating the volatilization from contaminants in unsaturated zone soils the constituent of concern was assumed to be present at the site-wide maximum detected soil concentration throughout the soil column. During the 25-year simulation time, this mass eventually migrated to the groundwater or the air through infiltration and was depleted from the soil zone.

In evaluating the volatilization from contaminants in the groundwater zone, the constituent of concern was assumed to be present at the site-wide maximum detected groundwater concentration, and at zero concentration in the soils (i.e., to eliminate double counting of the soil concentrations). During the 25-year simulation time, the groundwater represented a source of continuous supply to the soil and surface as the constituent of concern migrated to the surface through vapor-phase diffusion.

Each scenario was modeled assuming the following:

- Soil thickness of 5 feet
- Soil Density 1.5 grams per cubic centimeter
- Total porosity of 43 percent
- Moisture content by volume 15 percent
- Air-filled porosity of 28 percent
- Organic carbon content of 0.6 percent
- Infiltration rate of 0.62 feet (7.5 inches) per year.

The time and space model was discretized into 10 cells each 0.5 feet thick and run on time steps o 0.2 years.

Compound specific properties are default parameters from USEPA, (1996) *Soil Screening Guidance: Users Guide.* EPA/540/R-96/018 Attachment C. These were chosen to equal those used in other phases of the risk assessment. Other sources of chemical data included Montgomery and Welkom (1990) *Groundwater Chemicals Desk Reference*, Volumes 1 and 2. Table 1 presents the specific values and their associated references.

The VLEACH Manual chapters 2.0 and 3.0 present the conceptual model and mathematical framework for VLEACH simulations.

Table 1
Chemical Parameters and References

	Pure Component Water solubility, S (mg/L)	Ref	Diffusivity in air, D_a (m^2/day)	(cm^2/s)	Ref	Henry's Law constant H' (unitless)	H (atm-m^3/mol)	Ref	Organic Carbon Partition Coefficient, K_{oc} (cm^3/g)	Log K_{oc}	Ref
Trichloroethene	1100	3	0.68256	0.079	3	0.422	0.010319	3	166	2.22	3
1,l-Dichloroethene	3000	1	0.7776	0.09	3	1.07	0.026165	3	59	1.77	1
Cis-1,2-dichloroethene	3500	3	0.635904	0.0736	3	0.167	0.004084	3	35.5	1.55	3
Trans-1,2-dichloroethene	6600	3'	0.610848	0.0707	3	0.385	0.009414	3	147	2.17	3'
Tetrachloroethene	260	3'	0.62208	0.072	3	0.754	0.018438	3	155	2.19	3
Vinyl Chloride	5000	3#	0.91584	0.106	3	1.11	0.027143	3	18.6	1.27	3
1,1,1-Trichlorethane	1400	1	0.67392	0.078	3	0.705	0.017239	3	110	2.04	3
1,1-Dichlorethane	5500	1	0.641088	0.0742	3	0.23	0.005624	3	31.6	1.50	3
1,1,2-Trichlorethane	4500	1	0.67392	0.078	3	0.0374	0.000915	3	50.1	1.70	3
1,2-Dichlorethane	8690	1	0.89856	0.104	3	0.0401	0.000981	3	17.4	1.24	3
Chloroethane	5740	1	0.9504	0.11	4	0.447	0.010931	1	15	1.18	2
Chloroform	9300	1	0.89856	0.104	3	0.15	0.003668	3	39.8	1.60	3
Methylene Chloride	1320	3#	0.87264	0.101	3	0.0898	0.002196	3	11.7	1.07	3
Toluene	515	1	0.75168	0.087	3	0.272	0.006651	3	182	2.26	3
n-Propyl-benzene	60	1b	0.6048	0.07	4	0.4088	0.009996	1b	900	2.95	1b
sec-Butyl-benzene	17.6	1b	0.67392	0.078	4	0.469302	0.011476	1b	900	2.95	1b
1,2,4-Trimethyl-benzene	52	1b	0.6048	0.07	4	0.233016	0.005698	1b	3000	3.48	1b
1,2,4-Trichloro-benzene	31.3	1b	0.2592	0.03	3	0.0582	0.001423	3	1780	3.25	3
1,3,5-Trimethyl-benzene	48	1b	0.6048	0.07	4	0.160658	0.003929	1b	1560	3.19	1b

References:

1 Welkom and Montgomery (1990) *Groundwater Chemicals Desk Reference* vol 1.

1b Welkom and Montgomery (1990) *Groundwater Chemicals Desk Reference* vol 2.

2 Ravi and Johnson (1993) VLEACH, A One-Dimensional Finite Difference Vadose-Zone Leaching Model, Appendix A

3 USEPA, (1996) Soil Screening Guidance: Users Guide. EPA/540/R-96/018 Attachment C.

3# Solubility for methylene chloride used in original simulations was 1320. Should be corrected to 13,200
Solubility for vinyl chloride used in simulation was 5000, should be corrected to 2,760
It should be noted that solubility is not used in the calculation of the flux. This value is used to evaluate if the end results are within acceptable chemical specific levels. The change of these numbers has no impact on the end results.

3' Solubility for t-1,2-DCE in Soil Screening Guidance is 6,300, k_{oc} is 52.5, solubility for PCE is 200,

4 Computed from Superfund Exposure Evaluation Manual method for estimation for estimating molecular diffusivities.

(Revised May 2005)

Appendix I
Hazardous Waste Management Unit
Contingent Closure/Postclosure Plan
North Chicago, Inc.
North Chicago, Illinois

I-1.0 Introduction

This Contingent Closure/Postclosure Plan (Plan) has been written to modify the currently approved closure plan for the former Hazardous Waste Management Unit (HWMU) located at the NCI facility in North Chicago, Illinois. The original plan, dated December 18, 1987, was approved by the Illinois Environmental Protection Agency (IEPA) on March 15, 1988 with subsequent plan modifications approved on November 4, 1988 (Log No. C-378-M-1), June 30, 1989 (Log No. C-378-M-2), February 13, 1990 (Log No. C-378-M-3), February 5, 1991 (Log No. C-378-M-4), August 9, 1991 (Log No. C-378-M-5), and February 13, 1992 (Log No. C-378-M-6). This Plan now incorporates the recommended removal action alternative presented in the Engineering Evaluation/Cost Analysis (EE/CA) Report, required as a result of the U.S. Environmental Protection Agency (USEPA) September 21, 2000 Administrative Order (AO) for the Fansteel (now NCI) North Chicago facility. Once the EE/CA Report is approved by the USEPA, and after consultation with IEPA, this Plan will be considered final.

Permitting and administrative requirements are not considered applicable or relevant and appropriate under Section 121(e) of CERCLA. Therefore, the submittal of a Post-Closure Care Part B Permit Application (RCRA Interim Status Closure and Post-Closure Care Plans General Form, LPC-PA18) is considered unnecessary. However, for completeness, once proper closure of the HWMU has been achieved, a certification of closure and an associated closure documentation report (as required by 35 IAC 725.215) will be submitted. These documents will be submitted to USEPA and IEPA for review and/or approval. Once the remedy is completed (i.e. when the removal action field activities are complete, operation and maintenance period not included) IEPA will terminate NCI's interim status as a TSD facility.

A draft EE/CA Report was submitted on July 11, 2001. A draft Closure Plan for the HWMU was presented as Appendix L of that draft report. IEPA transmitted comments on the draft Closure Plan via letter dated September 17, 2001. A revised closure plan (Proposed Contingent Closure/Postclosure Plan) was included in Appendix I of the February 2003 version of the EE/CA Report to address the IEPA

comments. This current Plan is written to consolidate responses to past concerns while addressing recent issues. See Section 2.2.3 of the May 2005 EE/CA Report for additional information.

I-2.0 Regulatory References and Requirements

The HWMU under consideration is the former tank storage area located toward the northeastern portion of the NCI facility. The location is centered on a partially dismantled one-story building with transite walls and ceiling and a 30-foot-by-50-foot concrete floor slab. Two 13,500-gallon tanks were contained within the building. The tanks, which had been used to store waste oils from the plant, were remediated and removed from the building in 1990.

Since the tanks lacked proper secondary containment, and clean closure as defined under 35 IAC 724.297(a) is not the recommended remedial alternative proposed in the May 2005 EE/CA Report, the requirements of 35 IAC 725.297(b) and (c) should apply. This means that the tank system:

- Must be closed, and postclosure care performed, in accordance with the closure and postclosure care requirements for landfills (35 IAC 725.410); and
- Must adhere to the requirements for the closure and postclosure of landfills under 35 IAC Subpart G (Closure and Postclosure Care) and 35 IAC Subpart H (Financial Requirements);

The requirements under 35 IAC 725.410 for the closure and postclosure of a landfill are listed below.

For closure, a final cover must be designed and constructed to:

- provide long-term minimization of migration of liquids through the closed landfill;
- function with minimal maintenance
- promote drainage and minimize erosion and abrasion of the cover;
- accommodate settling and subsidence, and
- have a permeability less than or equal to the permeability of any natural subsoils present.

For postclosure, the owner/operator must comply with all postclosure care period requirements contained in 35 IAC 725.217-220 including:

- Final cover maintenance;
- Leachate detection system maintenance and monitoring;
- Groundwater monitoring system maintenance and monitoring;
- Storm water control to prevent final cover damage; and
- Benchmark protection and maintenance.

Under Subpart G (Closure and Postclosure Care), the performance standard for the closure is stated in 35 IAC 725.211 as follows:

- Minimize the need for further maintenance;
- Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated site run-off or hazardous waste decomposition products to the ground or surface waters or to the atmosphere; and
- Complies with the requirements of 35 IAC 725.297 and 410.

Specific closure plan contents are listed in 35 IAC 725.212. Subpart H (Financial Requirements) requires a detailed cost estimate for closure and postclosure care in addition to requirements for financial assurance. The costs for long-term operation and maintenance at the facility have been included in the cost estimates provided in the EE/CA Report. These costs are all inclusive for the implementation of the removal action under CERCLA and for the closure and subsequent postclosure care of the HWMU under IEPA hazardous waste requirements. The funding of these remediation activities was discussed in the Fansteel Plan of Reorganization (POR) filed on July 24, 2003 with the U.S. Bankruptcy Court in the District of Delaware and consists of financial notes and other funding obligations. The funding mechanism described in the POR is intended to satisfy, and shall be in lieu of, any RCRA financial assurance requirements that could be imposed by the IEPA for the closure/postclosure of the HWMU.

Regulatory Interpretation:

It should be noted that NCI considers the terms of 35 IAC 725.210(d) to be applicable. This conclusion was reached since an enforceable document (USEPA September 21, 2000 AO) required that an EE/CA be performed to evaluate the NCI North Chicago facility in its entirety, including the regulated HWMU. In accordance with 35 IAC 725.210(d)(1), the HWMU is situated with other areas of concern and a release has occurred that is likely attributable to the HWMU or the areas of concern. Also, in accordance with 35 IAC 725.210(d)(2), it is not necessary to apply the requirements of 35 IAC Subpart G because alternate requirements (in this case as presented in the EE/CA Report) will protect human health and the environment, and will satisfy the closure performance standard of 35 IAC 725.211(a) and (b).

I-3.0 Closure Plan

It has been documented in several reports (Carlson Environmental, Inc. 1993, 2000; Earth Sciences Consultants, Inc. 2003) that contaminants are present in and around the HWMU area. Closure of the former HWMU will consist of two primary remedial activities: installation of an asphalt cover and limited in-situ groundwater treatment to facilitate groundwater plume management. These activities are specified components of the recommended remedial alternative presented in the May 2005 EE/CA Report. Each component is discussed briefly in the following sections.

I-3.1 Installation of Asphalt Cover

Exposed areas around the former HWMU will be paved with an asphalt cover to act as an engineering control, or more specifically, an engineered barrier. The cover will mitigate the following exposure pathways to the soil beneath:

- direct contact,
- ingestion, and
- fugitive dust inhalation.

The cover will also prevent sediment loss and erosion and promote storm water run-off. This will serve to maintain cover stability, and limit the infiltration and percolation of storm water.

The asphalt cover will be placed on a prepared subbase that has been graded and sloped to promote drainage. A storm water management system will be designed and constructed to remove storm water from the paved areas and direct it away from the property.

I-3.2 In-Situ-Groundwater Treatment

In-situ-groundwater treatment will be employed to address the source area located near GP-14 and TB-18. Hydrogen Release Compound will be injected into the source area (approximately 5 to 15 feet below grade) in order to remediate groundwater through biological reductive dechlorination. The intent of the selected remedial alternative is to target the source area in order to limit future expansion of the plume and to promote the dissipation of the plume over time through natural processes.

I-3.3 Compliance with Regulations

The closure activities described above meet the objectives of the Closure Performance Standard, 35 IAC 725.211(a) and (b) as presented in Chapter 2.0. Maintenance [35 IAC 725.211(a)] will be required to

maintain the effectiveness of the asphalt cover, complete the in-situ groundwater treatment (short term) and monitor groundwater during postclosure.

It is also concluded that the closure activities will meet the terms of 35 IAC 725.211(b) based on the conclusions of the EE/CA Report. It was determined in the EE/CA Report for the NCI North Chicago facility that an asphalt cover was sufficient to mitigate risks due to exposure to lead in surface soils. This conclusion was reached during the remedial alternative evaluation since an engineered barrier of this type can effectively prevent direct contact, ingestion, and fugitive dust inhalation. An asphalt cover can also limit storm water infiltration, although not to the same degree as landfill grade final cover, utilizing geomembranes or geocomposites. However, the use of an asphalt cover is still preferable in this instance since the infiltration and percolation of contaminants to groundwater are not considered to be significant pathways of concern in the EE/CA, per agreement with the USEPA, given the conditions at the site. 35 IAC 725.410 contemplates a landfill grade cover as a closure requirement for landfills. It is Fansteel's position that an asphalt cover can be used and that compliance with the 35 IAC 725.211(a) and (b) is the overriding factor, based on the evaluation of risk presented in the EE/CA Report and the regulatory interpretation presented in Chapter 2.0. In addition, the in-situ treatment of the groundwater plume source area will be protective of human health and the environment since the action will facilitate the control and management of the plume and promote the natural dissipation of the plume over time. As stated in the EE/CA Report, groundwater receptors in the area do not exist, now or in the future.

I-3.4 Plans and Procedures

Plans and procedures for health and safety, sampling and analysis and quality control and assurance will be developed and presented in conjunction with the Removal Action Work Plan to be generated and submitted by others at a later date.

I-4.0 Postclosure Plan

Postclosure care requirements include groundwater monitoring and maintenance of the asphalt cover and the groundwater monitoring system. Specific details regarding postclosure monitoring and maintenance will be developed and presented with the Removal Action Work Plan to be submitted by others at a later date, after review and approval of the EE/CA Report for the NCI North Chicago facility by the USEPA.

The costs for long-term operation and maintenance at the facility have been included in the cost estimates provided in the EE/CA Report. These costs are all inclusive for the implementation of the removal action under CERCLA and for the closure and subsequent postclosure care of the HWMU under IEPA hazardous waste requirements. The funding of these remediation activities was discussed in the Fansteel Plan of Reorganization (POR) filed on July 24, 2003 with the U.S. Bankruptcy Court in the District of Delaware and consists of financial notes and other funding obligations. The funding mechanism described in the POR is intended to satisfy, and shall be in lieu of, any RCRA financial assurance requirements that could be imposed by the IEPA for the closure/postclosure of the HWMU.

References

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USEPA 1988. Superfund Exposure Assessment Manual.

USEPA 1996. Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response. EPA/540/R-95/128. May.

USEPA 2001. Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

USEPA 2003. Integrated Risk Information System (IRIS). (www.epa.gov/ngispgm3/iris).

PARTICULATE EMISSION FACTOR - CONSTRUCTION

$$PEF = Q/C_{sr} \times 1/F_D \times \left[\frac{T \times A_R}{556 \times (W/3)^{0.4} \times (365-p)/365 \times Sum(VKT)} \right]$$

$$Q/C_{sr} = A \times \exp\ (\ln A_S - B)^2/C)$$

Symbol	Definition (units)	Default	Reference
PEF	Particulate Emission Factor (m^3/kg)	9296407.369	Site-specific
Q/C_{sr}	Inverse of a 1-h avg. air concentration along a straight road bisecting a 8 acre square site (g/m^2 -s/kg/m^3)	15.58753425	USEPA 2001
A	Constant (unitless)	12.9351	USEPA 2001
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific
B	Constant (unitless)	5.7383	USEPA 2001
C	Constant (unitless)	71.7711	USEPA 2001
F_D	Dispersion correction factor	0.185	USEPA 2001
T	Total time over which construction occurs (s)	21600000	USEPA 2001
A_R	Surface area of contaminated road segment (m^2)	2743.2	Site-specific
W	Mean vehicle weight (tons)	8	USEPA 2001
p	Number of days with at least 0.01 inches of precipitation (days/year)	120	USEPA 2001
Sum(VKT)	Sum of fleet vehicl kilometers traveled during the exposure duration (km)	972	USEPA 2001

W assumptions: 20 two-ton cars and 10 20-ton trucks = 30 vehicles

Sum(VKT) assumptions:

Assume that the site is 8 acres configured as a square with the unpaved road segment dividing the square evenly. The road length equals the square root of the 8 acres

30 vehicles x 0.18 km/day x 36 weeks/yr x 5 days/week = 972

A_R assumptions:

Based on VKT, the road length is 180 m and assume the road width is 50 ft. (15.24 m).

84.2569419	Q/C_{sr} x $1/F_D$
5.9253E+10	T x A_R
1.48042869	$(W/3)^{0.4}$
0.67123288	(365-p)/365
537033.984	556 x $(W/3)^{0.4}$ x (365-p)/365 x Sum(VKT)
110334.023	T x A_R/556 x $(W/3)^{0.4}$ x (365-p)/365 x Sum(VKT)
9296407.37	PEF

2.07944154	Ln A_S
13.3872452	$(\text{Ln } A_S - B)^2$
0.18652696	$(\text{Ln } A_S - B)^2/C$
1.20505711	$e^{(\text{Ln AS - B})2/C}$
15.5875342	A x $e^{(\text{Ln AS - B})2/C}$ Q/C_{sr}

32388.664	8 acres/0.000247acres/m^2
179.968508	sqrt(32388.66)
0.18	km

Volatilization Factors - Construction Worker

$$VF = \frac{Q/C_{vol}}{J_t}$$

Symbol	Definition (units)	Default	Reference
VF	Volatilization Factor (m^3/kg)	Chemical Specific	
Q/C_{vol}	Inverse of the mean conc. at center of square source (g/m^2*s per kg/m^3) Chicago Area	61.73660321	USEPA 2001
J_t	Average release flux (g/m^2*s)	Chemical-specific	VLEACH

Q/C_{vol} Calculation

$Q/C_{vol} = A \times \exp((\ln A_{site} - B)^2/C)$

2.079442	Ln Asite
279.069	$(\ln A_S - B)^2$
1.297619	$(\ln A_S - B)^2/C$
3.66057	$e^{(\ln A_S - B)2/C}$
61.7366	$A \times e^{(\ln A_S - B)2/C}$

A	Constant (unitless)	16.8653	USEPA 2001
B	Constant (unitless)	18.7848	USEPA 2001
C	Constant (unitless)	215.0624	USEPA 2001
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific

Per the Draft SSL Guidance, VF is only applicable to volatiles.

COPCs for Soil	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
Tetrachloroethene	4.44E+08	61.73660321	1.39E-07	4.07E-01	3.15E+07	0.0929
Trichloroethene	4.51E+07	61.73660321	1.37E-06	4.01E+00	3.15E+07	0.0929
Vinyl Chloride	4.52E+10	61.73660321	1.37E-09	4.00E-03	3.15E+07	0.0929

COPCs for Groundwater	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
1,1,1-Trichloroethane	1.56E+09	61.73660321	3.96E-08	1.16E-01	3.15E+07	0.0929
1,1-Dichloroethane	5.48E+09	61.73660321	1.13E-08	3.30E-02	3.15E+07	0.0929
1,1-Dichloroethene	1.07E+10	61.73660321	5.77E-09	1.69E-02	3.15E+07	0.0929
1,2-Dichloroethane	3.62E+11	61.73660321	1.71E-10	5.00E-04	3.15E+07	0.0929
Chloroethane	7.23E+10	61.73660321	8.53E-10	2.50E-03	3.15E+07	0.0929
Chloroform	3.62E+11	61.73660321	1.71E-10	5.00E-04	3.15E+07	0.0929
n-Propylbenzene	2.38E+14	61.73660321	2.59E-13	7.60E-07	3.15E+07	0.0929
1,1,2-Trichloroethane	2.35E+15	61.73660321	2.62E-14	7.69E-08	3.15E+07	0.0929
1,2,4-Trichlorobenzene	2.76E+15	61.73660321	2.24E-14	6.55E-08	3.15E+07	0.0929
1,2,4-Trimethylbenzene	2.58E+11	61.73660321	2.39E-10	7.00E-04	3.15E+07	0.0929
1,3,5-Trimethylbenzene	2.01E+11	61.73660321	3.07E-10	9.00E-04	3.15E+07	0.0929
Cis-1,2-Dichloroethene	1.66E+07	61.73660321	3.71E-06	1.09E+01	3.15E+07	0.0929
Methylene chloride	1.20E+10	61.73660321	5.15E-09	1.51E-02	3.15E+07	0.0929
Sec-Butylbenzene	1.64E+11	61.73660321	3.75E-10	1.10E-03	3.15E+07	0.0929
Tetrachloroethene	1.86E+09	61.73660321	3.31E-08	9.70E-02	3.15E+07	0.0929
Toluene	3.01E+11	61.73660321	2.05E-10	6.00E-04	3.15E+07	0.0929
Trans-1,2-Dichloroethene	7.54E+09	61.73660321	8.19E-09	2.40E-02	3.15E+07	0.0929
Trichloroethene	3.40E+05	61.73660321	1.82E-04	5.32E+02	3.15E+07	0.0929
Vinyl Chloride	1.90E+06	61.73660321	3.25E-05	9.53E+01	3.15E+07	0.0929

GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
CONSTRUCTION SCENARIO - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Carcinogenic - Inhalation of Ambient Air

$$TRi = \frac{CSFi \times Cs \times IRAa \times EFo \times EDo}{VFs \times BWa \times ATc}$$

Noncarcinogenic - Inhalation of Ambient Air

$$THQ = \frac{Cs \times IRAa \times EFo \times EDo}{RfDi \times VFs \times BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
RfDo	Reference dose factor oral (mg/kg*day)	Chemical-specific	USEPA 2002
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2002
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
EFo	Exposure frequency - construction (day/year)	250	USEPA 2001
EDo	Exposure duration - construction (year)	1	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cw	Groundwater concentration (mg/L)	Maximum detection concentration	
PEF	Particulate emission factor (m^3/kg)	Site - specific	USEPA 2001

SOIL EXPOSURE PARAMETER INPUT VALUES
CONSTRUCTION WORKER - INGESTION, INHALATION AND DERMAL CONTACT
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Combined Exposures to Carcinogens in Soil

Ingestion

$$RISK = \frac{CSFo \times Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATc}$$

Inhalation

$$RISK = \frac{CSFi \times Cs \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Dermal Contact

$$RISK = \frac{CSFo \times Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATc}$$

Combined Exposures to Noncarcinogens in Soil

Ingestion

$$RISK = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{RfDo \times BWa \times ATn}$$

Inhalation

$$RISK = \frac{Cs \times IRAo \times EFo \times EDo}{RfDi \times VF \text{ for } PEF \times BWa \times ATn}$$

Dermal Contact

$$RISK = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{RfDo \times BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2003
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2003
RfDo	Reference dose factor oral (mg/kg*day)	Chemical-specific	USEPA 2003
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2003
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATn	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
IRSo	Soil ingestion - occupational (mg/day)	330	USEPA 2001
EFo	Exposure frequency - contruction (day/year)	250	USEPA 2001
EDo	Exposure duration - construction (year)	1	USEPA 2001
PEF	Particulate emission factor (m^3/kg)	Site-specific	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
CF	Conversion factor (kg/mg)	1.00E-06	
SA	Skin surface area (cm^2/event)	3300	USEPA 2001
ABS	Chemical specific absorption factor	chemical-specific	USEPA 2001
AF	Soil to skin adherence factor (mg/cm^2)	0.3	USEPA 2001
ABS Factors:			
	Cadmium	0.001	
	PAHs	0.13	

EXPOSURE POINT CONCENTRATION FOR GROUNDWATER
MAXIMUM DETECTED CONCENTRATION
CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Constituents of Concern	Maximum Detected Concentration (mg/L)
1,1,1-Trichloroethane	0.157
1,1-Dichloroethane	0.145
1,1-Dichloroethene	0.0132
1,2-Dichloroethane	0.0097
Chloroethane	0.0038
Chloroform	0.0022
1,2,4-Trimethylbenzene	0.0034
1,3,5-Trimethylbenzene	0.0063
Cis-1,2-Dichloroethene	66.5
Methylene chloride	0.125
Sec-Butylbenzene	0.0023
Tetrachloroethene	0.858
Toluene	0.002
Trans-1,2-Dichloroethene	0.0653
Trichloroethene	1190
Vinyl Chloride	59.9

(1) The exposure point concentration is the 95% UCL.

EXPOSURE POINT CONCENTRATION
SOILS INGESTION - CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Constituents of Concern	Ingestion Maximum Detected Concentration (mg/kg)	Inhalation Maximum Detected Concentration (mg/kg)
Tetrachloroethene	116	116
Trichloroethene	413	1310
Vinyl chloride	NA	1.2
Benzo(a)anthracene	2.4	ND
Benzo(a)pyrene	0.2165	ND

ND - Not Detected
NA - Not a COC for Ingestion/Dermal Contact

CALCULATION OF GROUNDWATER RISK TO CONSTRUCTION WORKER

Carcinogenic
Inhalation

$$RISK = \frac{CSFi \times Cs \times IRAa \times EFo \times EDo}{VF \times BWa \times ATc}$$

Noncarcinogenic
Inhalation

$$RISK = \frac{Cs \times IRAa \times EFo \times EDo}{RfDi \times VF \times BWa \times ATn}$$

Chemical	CSFo	CSFi	MRLo	MRLi	VFs	Risk Cancer	Risk Noncancer
1,1,1-Trichloroethane	NA	NA	NA	2.00E-01	1.56E+09	NA	9.85E-11
1,1-Dichloroethane	NA	NA	NA	NA	5.48E+09	NA	NA
1,1-Dichloroethene	NA	NA	9.00E-03	5.71E-03	1.07E+10	NA	4.23E-11
1,2-Dichloroethane	9.10E-02	9.10E-02	2.00E-01	1.71E-01	3.62E+11	6.82E-18	3.06E-14
Chloroethane	NA	NA	NA	4.29E+00	7.23E+10	NA	2.40E-15
Chloroform	NA	8.05E-02	1.00E-02	5.70E-03	3.62E+11	1.37E-18	2.09E-13
1,2,4-Trimethylbenzene	NA	NA	NA	NA	2.58E+11	NA	NA
1,3,5-Trimethylbenzene	NA	NA	NA	NA	2.01E+11	NA	NA
Cis-1,2-Dichloroethene	NA	NA	3.00E-01	NA	1.66E+07	NA	NA
Methylene chloride	7.50E-03	1.65E-03	6.00E-02	8.57E-02	1.20E+10	4.80E-17	2.38E-11
Sec-Butylbenzene	NA	NA	NA	NA	1.64E+11	NA	NA
Tetrachloroethene	5.20E-02	1.00E-02	5.00E-02	1.14E-02	1.86E+09	1.29E-14	7.89E-09
Toluene	NA	NA	2.00E-02	2.29E-02	3.01E+11	NA	5.67E-14
Trans-1,2-Dichloroethene	NA	NA	2.00E-01	5.71E-02	7.54E+09	NA	2.97E-11
Trichloroethene	4.00E-01	4.00E-01	2.00E-01	2.86E-02	3.40E+05	3.91E-06	2.39E-02
Vinyl Chloride	1.50E+00	3.10E-02	2.00E-05	8.60E-03	1.90E+06	2.73E-09	7.18E-04
						3.92E-06	2.47E-02

NA - Information for this constituent is not available.

Appendix P

PCBs in Transformer Courtyard

Appendix P
Evaluation of PCBs in Transformer Courtyard
Engineering Evaluation/Cost Analysis
North Chicago, Inc.
North Chicago, Illinois

1.0 Introduction

On October 7, 2004, representatives of NCI and USEPA met to discuss various topics related to the EE/CA Report for the NCI facility in North Chicago, Illinois. One of the topics involved the inclusion of the Transformer Courtyard remediation in the removal action required by the EE/CA. The Transformer Courtyard has been impacted by PCBs. On October 7, 2004, USEPA stated its preference to include the Transformer Courtyard in the EE/CA.

Initially, USEPA stated that in order to include the Transformer Courtyard in the EE/CA, a risk assessment similar to the baseline risk assessment presented in Chapter 3.0 of the EE/CA narrative would have to be performed for all applicable receptors and pathways. After risk levels were determined, risk management would be addressed as necessary. As an alternative, NCI suggested that the, "self-implementing option," under 40 CFR 761 be employed to complete the removal action for the Transformer Courtyard.

To support that alternative, NCI produced a position paper dated November 2004 for review and approval by USEPA. On December 16, 2004, USEPA responded to the position paper and stated that the self-implementing option could be used. This response was later clarified in a conference call between the parties that took place on January 19, 2005. The minutes from that call, which were formally approved by USEPA on February 1, 2005, state that the discussion of PCBs in the Transformer Courtyard will be presented in the EE/CA Report as a stand-alone appendix. The minutes also state that no risk assessment will be used to determine risk. Rather, PCB clean-up will be to levels dictated under the self-implementing option (as noted above) and that both high and low occupancy circumstances in accordance with 40 CFR 761 will be evaluated.

2.0 History and Past Investigations

PCB transformers were removed in 1982 from the Transformer Courtyard at the North Chicago facility for off-site disposal in accordance with TSCA requirements. These transformers were replaced with non-PCB transformers. No known releases from the previous PCB transformers had occurred.

Environmental sampling was conducted in 1997 and 1998 in and around the Transformer Courtyard to determine whether any historic PCB releases had occurred from the removed transformers. The sampling was directed by NCI (then Fansteel Inc.) outside counsel under a corporate audit program to identify potential environmental liabilities and associated possible remediation costs for the purposes of setting up a corporate reserve to deal with any identified liabilities.

The initial sampling event was conducted on December 29, 1997. Access to all areas within the courtyard was somewhat limited given the high voltage equipment in place. The courtyard is mostly concrete covered, although two small gravel areas that are not covered are also present. The scope of the sampling event included biased sampling based on visual observation of stains and accessibility. Three grabs samples of surface soils were collected using a 10 cm x 10 cm (100 cm^2) template to mark the area to be sampled. The surface was scraped to a depth of 1 cm and with a stainless steel trowel or similar implement yielding at least 100 grams of soil. A disposable template was used between samples to prevent contamination of subsequent samples.

Three surface wipe samples of the concrete surface were also obtained during the initial sampling event. The samples were gathered by first applying an appropriate solvent (e.g. hexane) to a piece of 11 cm filter paper or gauze pad. This moistened filter paper or gauze pad was held with a pair of stainless steel forceps and used to thoroughly swab a 100 cm^2 area as measured by a sampling template. The wipe samples were then stored in precleaned glass jars at 4 degrees C.

Based on the results of the initial round of sampling (discussed below), a second round of sampling was conducted on January 23, 1998 to determine whether PCBs identified on the concrete and soil in the courtyard had migrated. The second round of sampling consisted of geoprobing next to the courtyard in the adjacent Metallurgical Building A (access to the courtyard was not possible) to a depth of 24 feet with samples collected from each four foot interval for PCB analysis.

Figure P-1 shows the location of the Transformer Courtyard relative to the buildings on the property and the location of the samples. Surface soil samples from the initial sampling event are identified as I1S(265), I2S(266), and I3S(267). Surface wipe samples from the same event are identified as I1W(268), I2W(269), I3W(270). The geoprobe soil boring samples from the second round of sampling are identified as I101-1212 though I101-1217.

Attachment P-1 provides the PCB laboratory results on the wipe and surface soil samples (dated January 19, 1998) and the deeper soils from soil boring I101 (dated February 16, 1998) collected during the Transformer Courtyard investigation. A summary of these results is provided below.

Sample	PCB Result
Wipe Sample (I1W-268)	98,000 micrograms (Aroclor Source 1260)
Wipe Sample (I2W-269)	720 micrograms (Aroclor Source 1260)
Wipe Sample (I3W-270)	230 micrograms (Aroclor Source 1260)
Surface Soil Sample (I1S-265)	9,500 mg/kg (Aroclor Source 1260)
Surface Soil Sample (I2S-266)	3.1 mg/kg (Aroclor Source 1260)
Surface Soil Sample (I3S-267)	49 mg/kg (Aroclor Source 1260)
Soil Boring I101, 0-4 ft. (1212)	<1.0 mg/kg (none detected)
Soil Boring I101, 4-8 ft. (1213)	<1.0 mg/kg (none detected)
Soil Boring I101, 8-12 ft. (1214)	<1.0 mg/kg (none detected)
Soil Boring I101, 12-16 ft. (1215)	<1.0 mg/kg (none detected)
Soil Boring I101, 16-20 ft. (1216)	<1.0 mg/kg (none detected)
Soil Boring I101, 20-24 ft. (1217)	<1.0 mg/kg (none detected)

Based on these results, and as part of the corporate audit program, a conservative remedy was selected to remove the PCB contamination identified in the courtyard. The selected remedy was to remove 100 square feet of soil to a depth of 2 feet (more than half the exposed soil/gravel exposed in the courtyard). In addition, the surface inch of concrete was to be removed from a 500 square feet surface area of the concrete in the courtyard, covering almost one third of the entire surface area of the courtyard. These remediation presumptions were used to estimate potential costs for the determination of assigned liability resources.

3.0 Risk and Regulatory Context

As stated above, it is anticipated the self-implementing option under 40 CFR 761 will be used to address the PCB contamination in the Transformer Courtyard. This option allows the user to clean-up to predetermined levels protective of public health based on occupancy and the type of waste involved. A formal risk assessment is not required. 40 CFR 761. 61(a) is considered to be an applicable or relevant and appropriate requirement for this removal action. Administrative requirements are not considered applicable under CERCLA.

For the situation at hand, the following is a summary of the regulatory requirements under the self-implementing option.

40 CFR 761.61 is entitled, "PCB remediation waste." PCB remediation waste is defined in 40 CFR 761.3 as waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentrations: materials disposed of prior to April 18, 1978, that are currently at concentrations greater than or equal to 50 ppm PCBs, regardless of the concentration of the original spill; materials which are currently at any volume or concentrations where the original source was greater than or equal to 500 ppm PCBs beginning on April 18, 1978, or greater than or equal to 50 ppm PCBs beginning on July 2, 1979; and materials at any concentration if the PCBs are spilled or released from a source not authorized for use under this part. PCB remediation waste means soil, rags, and other debris generated as a result of any PCB spill cleanup, including among other things, soil and gravel and man-made structures such as concrete floors. Soil and gravel and concrete floors are applicable to the Transformer Courtyard.

40 CFR 761.61 provides cleanup and disposal options for PCB remediation waste. The option to be used for the Transformer Courtyard is the self-implementing option discussed in 40 CFR 761.61(a) where PCB remediation waste is cleaned to specific levels, based on regulatory requirements. The cleanup levels are specified in 40 CFR 761.61(a)(4)(i) and are applicable to both bulk PCB remediation wastes (including soil) and porous surfaces (concrete). The cleanup levels are as follows:

- High occupancy areas: The cleanup level in high occupancy areas is less than or equal to 1 ppm without further conditions. High occupancy areas where waste remains at concentrations greater than 1 ppm and less than or equal to 10 ppm shall be covered with a cap meeting the requirements in 40 CFR 761.61(a)(7) and (8).
- Low occupancy areas: The cleanup level in low occupancy areas is less than or equal to 25 ppm unless otherwise noted. Wastes may remain at a cleanup site at concentrations greater than 25 ppm and less than or equal to 50 ppm if the site is secured by a fence and marked with a sign. Wastes may remain at a cleanup site at concentrations greater than 25 ppm and less than or equal to 100 ppm if the site is covered with a cap, meeting the requirements in 40 CFR 761.61(a)(7) and (8).

Definitions of high and low occupancy areas are provided in 40 CFR 761.3. Examples of a high occupancy area would include a residence, school, day care center, sleeping quarters, a single or multiple occupancy 40-hours per week work station, a school class room, a cafeteria in an industrial facility, a control room, and a work station at an assembly line. Examples of a low occupancy area would include an electrical substation, or a location in an industrial facility where a worker spends small amounts of time per week (such as an unoccupied area outside a building, an electrical equipment vault, or in the non-office space in a warehouse where occupancy is transitory.)

40 CFR 761.61(a)(5)(i) and (iii) discusses the aspects of site cleanup applicable to bulk PCB remediation waste and porous surfaces, respectively. The requirements for both are the same. Soil washing is allowed for on-site waste cleanup under 40 CFR 761.61(a)(5)(i)(A). Decontamination of waste for on-site disposal, in accordance with 40 CFR 761.79, is also allowed under 40 CFR 761.61(a)(5)(i)(B)(3). Waste to be sent off-site with PCB concentrations less than 50 ppm can be disposed of in a permitted municipal solid waste facility. Waste to be sent off-site with concentrations greater than or equal to 50 ppm must be disposed of in a permitted hazardous waste landfill or a permitted PCB disposal facility.

40 CFR 761.61(a)(6) provides information on cleanup verification for the self-implementing option. Simply put, any person collecting and analyzing samples to verify the cleanup and on-site disposal of bulk PCB remediation waste and porous surfaces must do so in accordance with 40 CFR 761, Subpart O. Subpart O describes the methodology to be used to sample cleanup areas. One important note regarding the methodology is that wipe samples cannot be used to verify the cleanup. The cleanup must be verified with samples of at least 20 milliliters in volume.

40 CFR 761.61(a)(7) describes the requirements for a cap, if used as referenced in 40 CFR 761.61(a)(4)(i). 40 CFR 761.61(a)(8) describes deed restrictions necessary if engineering controls are used to achieve cleanup goals.

4.0 Identification of Removal Action Scope, Goals and Objectives

The scope of the removal action, as it pertains to PCBs in the Transformer Courtyard, is to address the conditions at the site that constitute a potential threat to public health, welfare, or the environment. In this instance, concentrations of PCB above those specified in 40 CFR 761.61(a)(4) for unrestricted or restricted release are considered to be a potential threat.

Consequently, the goal of the removal action is to meet the cleanup requirements in the self-implementing option. When this goal is met, the conditions in the Transformer Courtyard that caused concern will be mitigated.

The removal action objective is based on an evaluation of the identified removal action goal and the possible means through which the goals can be achieved. An attempt has been made to provide a definable objective to achieve the goal, without prejudice to possible removal/remedial alternatives that may be employed. For this instance, a logical removal action objective for the Transformer Courtyard is as follows:

Objective: Treat or remove soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i).

It should be noted that the intent is to remove/remediate the Transformer Courtyard to levels approaching or exceeded those required for low-occupancy (less than or equal to 25 ppm), without engineering or institutional controls. If practicable, a legitimate attempt will be made to clear the courtyard to levels approaching or exceeded those for high occupancy (less than or equal to 1 ppm), without engineering or institutional controls. If those levels cannot be met without unreasonable additional effort, institutional and engineering controls as specified in the applicable regulation will be implemented. These may include fencing, signs, capping, and deed restrictions.

The area may be considered a low occupancy area given the limited access to the courtyard, the fact the it serves as an electrical substation, and the fact that workers are not required to be present in the area for any significant amount of time. If the property is developed in the future, demolition of the structures around the courtyard would most likely be necessary to expose the area to potential high occupancy conditions. In that event, residual contamination that may remain above unrestricted release levels, for either low or high occupancy, will either continue to be addressed through institutional and engineering controls or will be remediated.

5.0 Identification and Analysis of Removal Action Alternatives

Several references were reviewed to identify and evaluate potential removal action alternatives for the Transformer Courtyard. These include:

- Guidance on Remedial Actions for Superfund Sites with PCB Contamination, USEPA, August 1990, EPA 540 G-90 007;
- A Guide on Remedial Actions at Superfund Sites with PCB Contamination, USEPA, August 1990, EPA Pub. 9355.4-01FS
- Engineering Issue, Technology Alternatives for the Remediation of PCB-Contaminated Soil and Sediment, USEPA, EPA/540/S-93/506
- Remediation Technologies Screening Matrix and Reference Guide (RTSMRG), Version 4.0, Federal Remediation Technology Roundtable
- PCB Decontamination Methods for Achieving TSCA Compliance During Facility Decommissioning Projects, Roy F. Weston, Inc. 2001

A listing of possible alternatives gathered from these sources, and others, includes:

- No Action
- Incineration;
- Thermal desorption;
- Chemical dehalogenation;
- Soil washing,
- Solvent extraction;
- Solidification/stabilization;
- Vitrification;
- Biological treatment/Biodegredation; and
- Excavation, removal and off-site disposal.

Several of these technologies were screened from further consideration due to relatively limited past applications and demonstrations of effectiveness for PCB contamination. These include: solidification/stabilization, vitrification, and biological treatment/biodegradation. The remaining technologies have been grouped as follows for further analysis:

- No Action,
- Thermal Treatment: incineration and thermal desorption,
- Physical/Chemical Treatment: chemical dehalogenation, soil washing, or solvent extraction, and

- Excavation, retrieval and off-site disposal.

Each alternative is discussed in the following sections. The alternatives are then evaluated based on effectiveness, implementability, and cost in accordance with applicable USEPA guidance (Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA, USEPA, August 1993, EPA540-R-93-057).

Specific evaluation criteria for evaluating the effectiveness of each alternative include:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Specific evaluation criteria for evaluating the implementability of each alternative include:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Specific evaluation criteria for evaluating the cost of each alternative include:

- Capital costs
- Annual operation and maintenance costs
- Present worth

In general, for the purposes of evaluating these technologies, it has been assumed that the PCB remediation waste present in the Transformer Courtyard will be physically removed from its present location and handled ex-situ. This would include identified concrete material from the floor and soil in the area. Ex-situ management is typical for the identified thermal treatment and

physical/chemical treatment techniques, with an exception to be discussed below in Alternative 3. However, ex-situ management would not apply to the No Action alternative. Excavation, Removal and Off-site Disposal is, by definition, an ex-situ management alternative.

The default ex-situ management of contaminated materials is supported for two reasons. First, as stated above, the identified removal/remedial technologies typically require ex-site management. Second, as stated in the Weston, Inc. 2001 reference sited above, for porous media,

> The TSCA regulations generally do not identify self-implementing procedures for decontaminating PCB-affected porous media. This is likely due to the difficulty in removing PCBs from the bulk matrix of porous materials.

Given the size of and the physical constraints in the Transformer Courtyard, it is anticipated the material would be removed with physical labor and either hand or power tools, as opposed to large earth moving equipment. Concrete surfaces would be saw cut, scabbled or scarified to remove material from the surface to a suitable depth. Soils would be excavated with hand tools or with smaller, hand directed, equipment. Materials would be removed and placed in suitable containers, most likely drums, to facilitate transport. Appropriate personal protective equipment will be used, in accordance with a site specific health and safety plan. It is likely full face respirators will be needed. See Chapter 4.0 for a discussion of the removal action objective.

5.1 Alternative 1 – No Action

The No Action alternative is included as a basis for comparison with the remaining alternatives. Under Alternative 1, No Action, the Transformer Courtyard would be left in its present condition. Exposed areas demonstrating PCB contamination above free release levels for both high and low occupancy would remain. Engineering and/or institutional controls are not included.

Effectiveness

Overall Protection of Human Health and the Environment

This alternative is not protective of human health and the environment given the risks that would remain at the site due to concentrations of PCBs above applicable cleanup levels.

Compliance with ARARs

This alternative does not comply with 40 CFR 761.61(a).

Long-Term Effectiveness

This alternative cannot achieve the removal action objective in the short or long-term since no action is taken to treat or remove soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i).

Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative does not reduce the toxicity, mobility, or volume of contaminants through treatment.

Short-Term Effectiveness

This alternative cannot achieve the removal action objective in the short or long-term since no action is taken to treat or remove soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i).

Implementability

Technical Feasibility

This alternative is technical feasible sine no action is required.

Administrative Feasibility

This alternative is administratively feasible since no action is required.

Availability of Services and Materials

This alternative requires no resources.

State Acceptance

State acceptance of this alternative is not anticipated.

Community Acceptance

Community acceptance of this alternative is not anticipated.

Cost

No costs would be incurred for this alternative.

5.2 Alternative 2 – Thermal Treatment

This alternative involves either incineration or thermal desorption of the PCB remediation waste. Incineration treats organic contaminants in solids and liquids by subjecting them to temperatures typically greater than 1,000 degrees F in the presence of oxygen, which causes volatilization, combustion, and destruction of these compounds. Thermal desorption is an ex-situ means to remove volatile and semivolatile contaminants from soil, sediment, sludge and filer cake by heating them at temperatures high enough to volatilize the organic contaminants. The vaporized organic contaminants can be captured by condensation or passing the offgas through a carbon adsorption bed or other treatment system.

These technologies produce multiple residual waste or material streams which also must be treated and/or disposed. For example, incineration produces solids from the incinerator (ash), solids and water from the air pollution control system, and air emissions. Thermal desorption produces treated and rejected media, condensed contaminants, water, particulate control system dust, spent carbon, and aqueous phase activated carbon.

Effectiveness

Overall Protection of Human Health and the Environment

If performed with appropriate controls and in accordance with applicable regulations, this alternative can protect human health and the environment through the treatment of PCB remediation waste and the disposal of residuals.

Compliance with ARARs

Incineration can be completed in accordance with 40 CFR 761.61(a)(5) and 40 CFR 761.70 of the self-implementing option. Decontamination of waste, in accordance with 40 CFR 761.79, is allowed under 40 CFR 761.61(a)(5)(i)(B)(3) of the self-implementing option.

This alternative may also comply with performance based disposal under TSCA, 40 CFR 761.61(b)(2)(i), 40 CFR 761.70(b), and 40 CFR 761.60(e), as well as 40 CFR 761.61(b)(2)(ii)

and 40 CFR 761.79(h), although these regulations are not considered the applicable or relevant and appropriate requirements in this circumstance.

Long-Term Effectiveness

This alternative will be effective in the long-term since PCB contaminants will be permanently removed from the Transformer Courtyard, to the extent practicable. In addition, PCBs will be destroyed, or PCB residuals disposed of, in accordance with applicable regulations.

Reduction of Toxicity, Mobility, or Volume through Treatment

The volume of PCBs will be reduced in the PCB remediation waste either through destruction or transfer into another media (i.e. carbon). However, the net volume of media requiring characterization, handling and/or disposal may increase given the production of treatment residuals.

Short-Term Effectiveness

The short term effectiveness of this alternative is considered moderate given the fact that thermal treatment technologies will require controls to prevent secondary risks to human health and the environment. For example, both incineration and thermal desorption must be performed in a manner to prevent offgases and residual materials from impacting remediation workers, the surrounding community, and the environment.

Implementability

Technical Feasibility

This alternative represents mature technology that has been successfully applied. However, the application of incineration and thermal desorption requires trained professionals skilled in the operation and maintenance of either on-site or off-site equipment. Other factors that may impact the feasibility of this alternative include:

- Characterization of PCB remediation waste to evaluate applicability of specific technology;
- Metals content of the waste stream (metals can contribute to residuals more toxic than original species);
- Potential production of dioxins/furans as a byproduct;

- Potential need for pilot scale treatability evaluations given relatively small PCB remediation waste volume (estimated less than 25 tons);
- Potential difficulties in reaching the required levels of contaminant removal;
- Off gas treatment and testing to meet applicable regulatory requirements; and
- Characterization of residual materials for waste determination and disposal.

Administrative Feasibility

The administrative feasibility of this alternative is considered moderate. It is not anticipated that the alternative will require off-site permits and/or waivers applicable to non-environmental laws. If on-site units are used for incineration or thermal desorption, considerations for air emissions and the associated approvals required must be made. However, as a removal action under CERCLA, only the technical considerations for the approvals need to be addressed. [In any case, the use of thermal desorption may require special consideration from the USEPA under 40 CFR 761.79(h). As of May 2004, only five requests for alternative decontamination approvals have been approved by the USEPA, according to the USEPA website.]

Availability of Services and Materials

The availability of incineration services is considered moderate to low based on a review of the RTSMRG, Version 4.0. According to the cited reference, only one off-site incinerator is permitted to burn PCBs and dioxins. (According to USEPA's web site for PCBs, there are four.) The reference also states there are approximately 10 transportable, high temperature units in operation. Thermal desorption technology is more commercially available, considering over 40 different vendors are listed in the reference.

State Acceptance

The level of state acceptance is considered to be moderate to low, given the public comments potentially associated with air emissions from an on-site operation. If the PCB remediation waste is removed from the site for treatment at another location, state acceptance is projected to be higher.

Community Acceptance

The level of community acceptance is considered moderate to low considering the potential reaction of the community to the control of air emissions associated with the alternative, if

employed on-site. If the PCB remediation waste is removed from the site for treatment at another location, community acceptance is projected to be higher.

Cost

(The physical removal of the PCB remediation waste for ex-situ treatment and/or disposal is not considered in the relative evaluation of alternatives, since ex-situ management is the assumed course of action, with one exception, as stated in Chapter 5.0.)

Incineration costs for PCB remediation wastes are expected to range between $280-$1,000/ton (EPA/540/S-93/506) to $1,500-$6,000/ton (RTSMRG).

Thermal desorption technologies for PCB remediation wastes are expected to range from $90-$380/ton (EPA/540/S-93/506) to $40-$300/ton (RTSMRG). However the costs presented in the RTSMRG reference are based on petroleum hydrocarbons and not PCBs.

Several factors that may affect these price ranges include:

- Equipment availability and mobilization/demobilization costs, if treatment on-site;
- Transportation costs, if off-site;
- The amount of material to be treated;
- Costs associated with potential treatability studies and characterization testing, both before and after treatment; and
- Costs for the management of treatment residuals.

5.3 Alternative 3 – Physical/Chemical Treatment

This alternative involves either chemical dehalogenation, soil washing, or solvent extraction.

Chemical dehalogenation employs chemical reactions to remove halogen atoms (chlorine atoms for PCBs) from organic molecules. In base-catalyzed decomposition (BCD), screened PCB material is mixed with sodium bicarbonate and heated in a rotary reactor. PCBs are completely dechlorinated and partially volatilized in this step. The PCBs in the vapor condensate, residual dust, spent carbon, and filter cake are dechlorinated after heating in a stirred-tank slurry reactor (STR) utilizing a high boiling point hydrocarbon oil, catalyst, and sodium hydroxide.

During soil washing, contaminated materials are mixed with wash water and possibly surfactants (also chelating agents for metals) to remove contaminants from the media and transfer them to the extraction fluid. The material and the wash water are then separated, and the material rinsed with clean water. Clean material is then removed from the process as product.

Solvent extraction requires the mixture of solvent and contaminated media to dissolve the organic contaminant into the solvent. The solvent is then removed from the media and sent to a separator to separate the contaminants from the solvent. The recycled solvent is then sent to the extractor unit for reuse and the contaminants are removed from the separator for disposal.

[As noted in Chapter 5.0, Alternative 3 contains an exception to the default ex-situ management of the PCB remediation waste. The exception is the potential use of solvents to remove PCB contamination from the surface of porous surfaces. The solvents are applied to the surface to extract the PCBs and then are collected for subsequent treatment and disposal. This option will be discussed separately, where applicable, as part of the alternative evaluation.]

These technologies produce multiple residual waste or material streams which also must be treated and/or disposed. The use of chemicals/solvents/wash water to remove PCBs from the waste media produces liquid and/or solid residuals with potentially more potent concentrations of contaminants than the original species. These residuals must be further processed and/or properly disposed.

Effectiveness

Overall Protection of Human Health and the Environment

If performed with appropriate controls and in accordance with applicable regulations, this alternative can protect human health and the environment through the treatment of PCB remediation waste and the disposal of residuals.

Compliance with ARARs

Soil washing is allowed for on-site waste cleanup under 40 CFR 761.61(a)(5)(i)(A). Decontamination of waste, in accordance with 40 CFR 761.79, is also allowed under 40 CFR 761.61(a)(5)(i)(B)(3) of the self-implementing option.

This alternative may also comply with performance based disposal under TSCA, 40 CFR 761.61(b)(2)(ii) and 40 CFR 761.79(h), although these regulations are not considered the applicable or relevant and appropriate requirements in this circumstance.

Long-Term Effectiveness

This alternative will be effective in the long-term since PCB contaminants will be permanently removed from the Transformer Courtyard, to the extent practicable. In addition, PCBs will be destroyed, or PCB residuals disposed of, in accordance with applicable regulations.

Reduction of Toxicity, Mobility, or Volume through Treatment

The volume of PCBs will be reduced in the PCB remediation waste either through destruction or transfer into another media (i.e. chemicals, sludge, solvents, wash water). However, the net volume of media requiring characterization, handling and/or disposal may increase given the production of treatment residuals.

Short-Term Effectiveness

The short term effectiveness of this alternative is considered moderate given the fact that physical/chemical treatment technologies will require controls to prevent secondary risks to human health and the environment. For example, the use of chemicals and solvents carries with it inherent hazards that must be acknowledged and addressed with proper planning, training and execution. In addition, it will be necessary to adequately control the use of liquids on site to prevent spills and discharges of contaminants to otherwise unaffected areas.

Implementability

Technical Feasibility

Based on EPA/540/S-93/506, the technologies discussed in this alternative are considered, "demonstrated," by the USEPA, which means they have been conducted at pilot- or full-scale at a

limited number of sites. Experienced personnel with knowledge of chemistry and the fate and transport of PCB contaminants are needed to implement the technologies. Other factors that may impact the feasibility of this alternative include:

- Characterization of PCB remediation waste to evaluate applicability of specific technology;
- Potential need for pilot scale treatability evaluations given the relatively small PCB remediation waste volume (estimated less than 25 tons);
- The ability to capture and treat residuals;
- Control of carrier media to prevent losses, spills, etc.;
- Potential offgas treatment and testing to meet applicable regulatory requirements; and
- Characterization of residual materials for waste determination and disposal.

[A serious consideration in the potential application of solvents to porous surfaces to facilitate removal of PCBs is technical feasibility. As stated in Weston, Inc. 2001,

> It should be noted, however, that such procedures may be effective at removing PCBs from the surface of porous material, but would not likely reduce PCB contaminations found at depth in bulk porous media.

It is likely that PCBs in stained areas of the concrete Transformer Courtyard extend at least a limited depth beneath the surface, given the relative porous nature of untreated concrete. If that is the case, the technical feasibility of using this in-situ option for porous surfaces is limited. In addition, based on field experience, the migration of PCBs back to the surface after solvent extraction has been performed on porous surfaces has been documented.]

Administrative Feasibility

The administrative feasibility of this alternative is considered to be moderate. It is not anticipated that the alternative will require off-site permits and/or waivers applicable to non-environmental laws. However, the use of physical/chemical treatment may require special consideration from the USEPA under 40 CFR 761.79(h). As of May 2004, only five requests for alternative decontamination approvals have been approved by the USEPA, according to the USEPA website.

Availability of Services and Materials

In 1993, the BCD technology was developed in the United States and licensed to two companies in Australia. However, it appears from the references cited that the technology is not frequently used. The last application referenced on the BCD Group, Inc. website is a 1997 U.S. Navy project.

Soil washing has been used in the United States with some success. However, as noted in RTSMRG, Version 4.0, commercialization of the technology is not extensive. USEPA's website lists 15 vendors who offer the technology.

Solvent extraction is considered to be moderately available with 10 vendors listed on USEPA's website offering the service.

State Acceptance

The level of state acceptance is considered to be moderate to high, based on the limited potential for off-site effects, such as air emissions. However, concerns regarding control of carrier media may be an issue.

Community Acceptance

The level of community acceptance is considered to be moderate to high, based on the limited potential for off-site effects, such as air emissions. However, concerns regarding control of carrier media may be an issue.

Cost

(The physical removal of the PCB remediation waste for ex-situ treatment and/or disposal is not considered in the relative evaluation of alternatives, since ex-situ management is the assumed course of action, with one exception, as stated in Chapter 5.0.)

BCD costs for PCB remediation wastes are expected to range between $225-$580/ton (EPA/540/S-93/506) to $200-$500/ton (RTSMRG).

Soil washing for PCB remediation wastes is expected to range from $60-$230/ton (EPA/540/S-93/506) to $170/ton (RTSMRG).

Solvent extraction for PCB remediation waste is expected to range from $110-$540/ton (EPA/540/S-93/506) to $100-$400/ton (RTSMRG).

Several factors that may affect these price ranges include:

- Equipment availability and mobilization/demobilization costs, if treatment on-site;
- Transportation costs, if off-site;
- The amount of material to be treated;
- Costs associated with potential treatability studies and characterization testing, both before and after treatment; and
- Costs for the management of treatment residuals.

5.4 Alternative 4 – Excavation, Removal and Off-Site Disposal

This alternative involves the physical removal, to the extent practicable, of soils and concrete impacted by PCBs and the packaging of the retrieved materials for transport to and disposal at a hazardous waste or TSCA permitted landfill. Chapter 5.0 provides additional information on methods anticipated for physical removal.

Effectiveness

Overall Protection of Human Health and the Environment

If performed with appropriate controls and in accordance with applicable regulations, this alternative can protect human health and the environment through the removal and disposal of PCB remediation waste.

Compliance with ARARs

This alternative complies directly with the requirements of 40 CFR 761.61(a)(5)(B) for bulk PCB remediation waste .

Long-Term Effectiveness

This alternative will be effective in the long-term since PCB contaminants will be permanently removed from the Transformer Courtyard, to the extent practicable. In addition, PCB remediation waste will be disposed of in accordance with applicable regulations.

Reduction of Toxicity, Mobility, or Volume through Treatment

No treatment is performed in this alternative.

Short-Term Effectiveness

The short term effectiveness of this alternative is considered high relative to other alternatives considered. No ancillary risks above and beyond those associated with material removal, transport and disposal are present.

Implementability

Technical Feasibility

This technical feasibility of this alternative is considered to be high. Excavation, retrieval and off-site disposal is practiced routinely in the United States to manage waste materials, including PCB remediation waste. Other factors that may impact the feasibility of this alternative include:

- Characterization of PCB remediation waste to profile the material for disposal;
- Difficulties associated the removal activities considering the limited work space in the Transformer Courtyard; and
- Potential classification of the waste materials as both hazardous waste and PCB remediation waste.

Administrative Feasibility

The administrative feasibility of this alternative is considered high. It is not anticipated that the alternative will require off-site permits and/or waivers applicable to non-environmental laws.

Availability of Services and Materials

The availability of incineration services is considered moderate to high. According to USEPA's web site for PCBs, there are nine landfill currently permitted to accept PCB contaminated waste materials.

State Acceptance

The level of state acceptance is considered to be high. The technology is common and presents limited technical concerns.

Community Acceptance

The level of community acceptance is considered to be high. The technology is common and presents limited technical concerns.

Cost

(The physical removal of the PCB remediation waste for ex-situ treatment and/or disposal is not considered in the relative evaluation of alternatives, since ex-situ management is the assumed course of action, with one exception, as stated in Chapter 5.0.)

Based on a vendor's budgetary estimate, the cost for transportation and disposal is estimated at $150/ton.

Several factors that may affect these price ranges include:

- Potential increases in transportation costs due to rising fuel prices;
- Verification of the waste profile; and
- Volatility in the landfill disposal prices.

6.0 Comparison of Removal Action Alternatives

The four removal alternatives for the Transformer Courtyard were compared based on effectiveness, implementability, and cost. Considering effectiveness, Alternative 1 would not be effective in protecting human health and the environment since the removal action objective would not be met. Alternative 1 would also not be effective in the short or long term and would not reduce toxicity, mobility, or volume of the contaminants through treatment. Alternatives 2, 3 and 4 would be effective in protecting of human health and the environment by achieving the removal objective. The three alternatives would also be effective in the long term since PCBs would be permanently removed from the Transformer Courtyard, to the extent practicable. Alternatives 2, 3 and 4 are compliant with identified ARARs, although technologies specified in Alternatives 2 and 3 may require special consideration by the USEPA. Alternatives 2 and 3 would be moderately effective in reducing toxicity, mobility, or volume through treatment;

Alternative 4 would not achieve reduction since no treatment is proposed. Alternatives 2 and 3 would be moderately effective in the short term with considerations for additional handling and management of waste materials taken into account. The short term effectiveness of Alternative 4 would be high since limited additional handling would be involved, beyond the excavation and removal activities themselves. Based on the information presented, Alternative 4 is considered to be the most effective alternative, followed by Alternatives 2 and 3, and then Alternative 1.

Regarding implementability, Alternative 1 would be easily implemented but with minimal opportunity for state and community acceptance. In general, Alternatives 2 and 3 would be moderately feasible. However, Alternative 2 may be less feasible than Alternative 3, considering potential concerns due to air emissions. The implementability of Alternative 4 would be high for feasibility, availability, and acceptance. Therefore, comparatively, Alternative 4 is the most easily implemented, followed by Alternatives 3, 2 and 1 respectively.

Lastly, the costs per ton for each alternative have been compared. Alternative 1 is the least costly followed by Alternatives 4, 3 and 2 respectively.

7.0 Recommended Removal Action Alternative

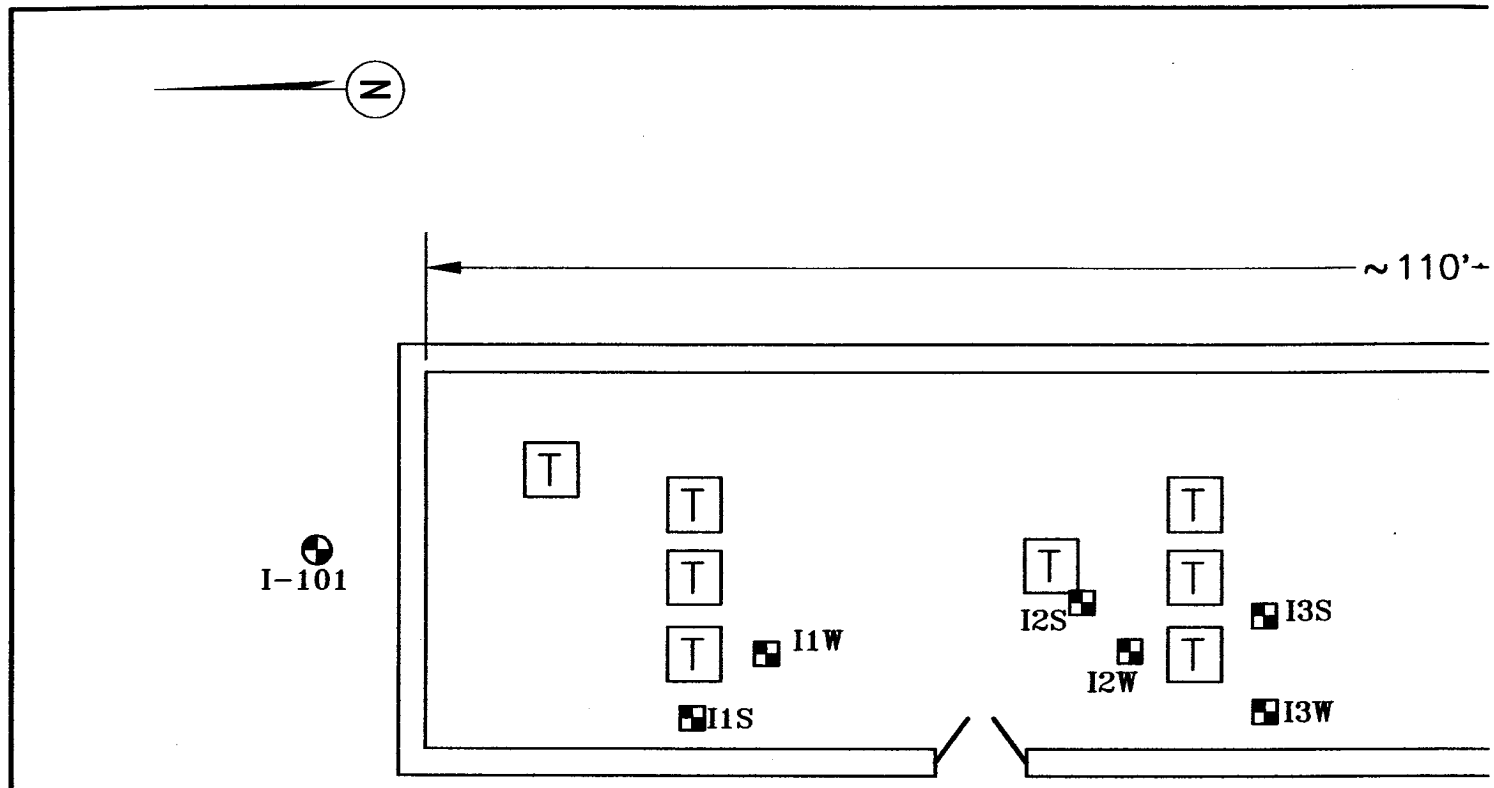
The recommended removal action alternative for the Transformer Courtyard is Alternative 4, Excavation, Removal and Off-site Disposal. This alternative fulfills the removal action objective of treating or removing soils and concrete surfaces impacted by PCBs in the Transformer Courtyard to cleanup levels specified in 40 CFR 761.61(a)(4)(i). In addition, this alternative is considered to be the most effective, implementable, and cost effective (aside from the No Action Alternative) option evaluated for this analysis.

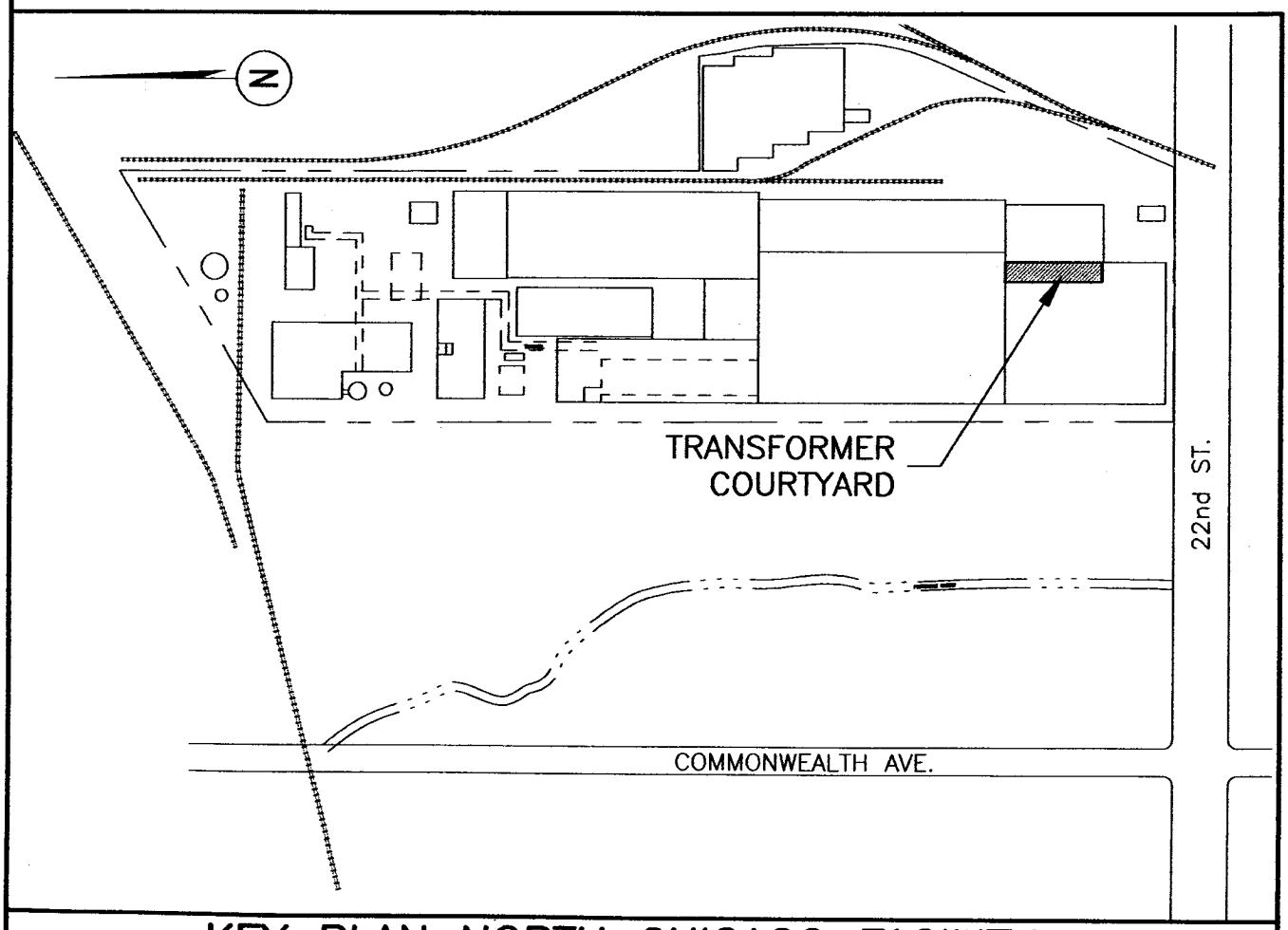
Table P-1
Cost Estimate
PCBs in Transformer Courtyard

CAPITAL COST	Unit	Quantity	Unit Cost	Total
Planning and Preparation				
Characterization of Area/Material	Lump Sum	1	$15,000	$15,000
Project Admin and Management	Lump Sum	1	$5,000	$5,000
Health and Safety Supplies and Equip.	Lump Sum	1	$5,000	$5,000
Survey (Excavation and Verifaction)	Day	2	$2,000	$4,000
Construction (Excavation, Removoal, T&D)				
CQA	Lump Sum	1	$20,000	$20,000
Mobilization/Demobilization	Lump Sum	1	$5,000	$5,000
Site Preparation	Lump Sum	1	$10,000	
Concrete Removal	Lump Sum	1	$20,000	$20,000
Soil Removal	Lump Sum	1	$5,000	$5,000
Soil T&D (Haz)	Ton	15	$150	$2,250
Confirmation Sampling and Analysis	Lump Sum	1	$15,000	$15,000
Backfill Material	Cubic Yard	10	$7	$70
Placement and Compaction	Cubic Yard	10	$7	$70
Contingency Second Round	Lump Sum	1	$30,000	$30,000
Subtotal				$126,390
Total Capital Costs				$126,000

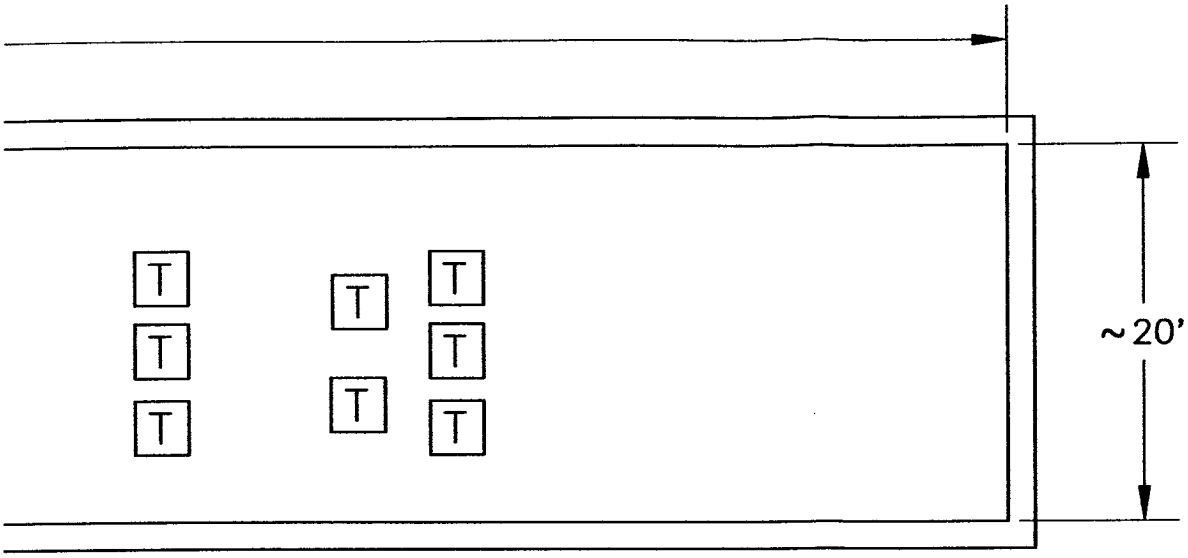
ANNUAL O&M COSTS	Unit	Quantity	Unit Cost	Total

TOTAL CAPITAL COST		**$126,000**
PRESENT WORTH		**$126,000**
	Interest Rate	7%
	Term (years)	30





KEY PLAN NORTH CHICAGO FACILITY



SCALE – FEET

0 10 20 30

FIGURE P–1
TRANSFORMER COURTYARD

NORTH CHICAGO FACILITY
NORTH CHICAGO, ILLINOIS

PREPARED FOR
NORTH CHICAGO, INC.
NORTH CHICAGO, ILLINOIS

LEGEND

T TRANSFORMER

I1S SURFACE SAMPLE LOCATION

I1W WIPE SAMPLE LOCATION

I–101 BORING LOCATION

APPROVED	
CHECKED	
DRAWN	DEB 4/29/05
DRAWING NUMBER	PA4179201

Penn E&R
Environmental & Remediation, Inc.

References

USEPA 1986. Superfund Public Health Evaluation Manual. Office of Emergency Response and Remedial Respon EPA 540/1-86/060.

USEPA 1988. Superfund Exposure Assessment Manual.

USEPA 2001. Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

USEPA 2003. Integrated Risk Information System (IRIS). (www.epa.gov/ngispgm3/iris).

Volatilization Factors - Outdoor Worker

$$VF = \frac{Q/C_{vol}}{J_t}$$

Symbol	Definition (units)	Default	Reference
VF	Volatilization Factor (m^3/kg)	Chemical Specific	
Q/C_{vol}	Inverse of the mean conc. at center of square source (g/m^2*s per kg/m^3) Chicago Area	61.73660321	USEPA 2001
J_t	Average release flux (g/m^2*s)	Chemical-specific	VLEACH

Q/C_{vol} Calculation

$Q/C_{vol} = A \times \exp((\ln A_{site} - B)^2/C)$

2.079442	Ln Asite
279.069	$(\ln A_S - B)^2$
1.297619	$(\ln A_S - B)^2/C$
3.66057	$e^{(\ln A_S - B)2/C}$
61.7366	$A \times e^{(\ln A_S - B)2/C}$

A	Constant (unitless)	16.8653	USEPA 2001
B	Constant (unitless)	18.7848	USEPA 2001
C	Constant (unitless)	215.0624	USEPA 2001
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific

Per the Draft SSL Guidance, VF is only applicable to volatiles.

COPCs for Soil	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
Tetrachloroethene	4.44E+08	61.73660321	1.39E-07	4.07E-01	3.15E+07	0.0929
Trichloroethene	4.51E+07	61.73660321	1.37E-06	4.01E+00	3.15E+07	0.0929

COPCs for Groundwater	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
Tetrachloroethene	1.86E+09	61.73660321	3.31E-08	9.70E-02	3.15E+07	0.0929
Trichloroethene	3.40E+05	61.73660321	1.82E-04	5.32E+02	3.15E+07	0.0929

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR OUTDOOR WORKER

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	3.40E+05	1.00E-04	1.35E+03	1.93E+04

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR OUTDOOR WORKER

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	3.40E+05	1.00E-05	1.35E+02	1.93E+04

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR OUTDOOR WORKER

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	3.40E+05	1.00E-06	1.35E+01	1.93E+04

CALCULATION OF SOIL CONCENTRATION BASED ON RISK LEVELS FOR OUTDOOR WORKER

Combined Exposures to Carcinogens in Industrial Soil

$$Cs = \frac{BWa \times ATc \times Risk\ Level}{EFo \times EDo \times [(CSFo \times IRSo \times CF)+((CSFi \times IRAa)/VF\ or\ PEF)+(CSFo \times SA \times AF \times ABS \times CF)]}$$

Combined Exposures to Noncarcinogens in Industrial Soil

$$Cs = \frac{BWa \times ATc \times Risk\ Level}{EFo \times EDo \times [((IRSo \times CF)/RfDo)+((IRAa)/(VF\ or\ PEF \times RfDi)+((SA \times AF \times ABS \times CF)/RfDo)]}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF or PEF	ABS	Risk Level	Cancer Soil Concentration mg/kg	Noncancer Soil Concentration mg/kg
Tetrachloroethene	5.20E-02	1.00E-02	1.00E-02	1.70E-01	4.44E+08	0.00	1.00E-04	6.11E+03	5.68E+04
Benzo(a)pyrene (1)	7.30E+00	NA	NA	NA	NA	0.13	1.00E-04	2.34E+01	NA

NA - Information for this constituent is not available.

1. The EPC is the lognormal RME.
2. Dermal contact pathway is not evaluted for VOCs.
3. Route-to-route extrapolations were not used; therefore, benzo(a)pyrene was not evaluated for inhalation.

References

USEPA 1986. Superfund Public Health Evaluation Manual. Office of Emergency Response and Remedial Respon EPA 540/1-86/060.

USEPA 1988. Superfund Exposure Assessment Manual.

USEPA 2001. Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

USEPA 2003. Integrated Risk Information System (IRIS). (www.epa.gov/ngispgm3/iris).

Volatilization Factors - On-site Trespasser

$$VF = \frac{Q/C_{vol}}{J_t}$$

Symbol	Definition (units)	Default	Reference
VF	Volatilization Factor (m^3/kg)	Chemical Specific	
Q/C_{vol}	Inverse of the mean conc. at center of square source (g/m^2*s per kg/m^3) Chicago Area	61.73660321	USEPA 2001
J_t	Average release flux (g/m^2*s)	Chemical-specific	VLEACH

Q/C_{vol} Calculation

$Q/C_{vol} = A \times \exp((\ln A_{site} - B)^2/C)$

2.079442	Ln Asite
279.069	$(\ln A_S - B)^2$
1.297619	$(\ln A_S - B)^2/C$
3.66057	$e^{(\ln A_S - B)2/C}$
61.7366	$A \times e^{(\ln A_S - B)2/C}$

A	Constant (unitless)	16.8653	USEPA 2001
B	Constant (unitless)	18.7848	USEPA 2001
C	Constant (unitless)	215.0624	USEPA 2001
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific

Per the Draft SSL Guidance, VF is only applicable to volatiles.

COPCs for Groundwater	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
Trichloroethene	3.40E+05	61.73660321	1.82E-04	5.32E+02	3.15E+07	0.0929

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR ON-SITE TRESPASSER

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	3.40E+05	1.00E-04	2.87E+04	1.15E+05

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR ON-SITE TRESPASSER

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	3.40E+05	1.00E-05	2.87E+03	1.15E+05

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR ON-SITE TRESPASSER

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	3.40E+05	1.00E-06	2.87E+02	1.15E+05

GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
ON-SITE TRESPASSER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Symbol	Definition (units)	Default	Reference
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2002
Risk Level	Target cancer risk - On-site trespasser	10^{-6}; 10^{-5}; 10^{-4}	
Risk Level	Target hazard quotient	1	USEPA 2001
BWa	Body weight - adolesence (kg)	50	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adolesence(m^3/day)	10	USEPA 2001
EFo	Exposure frequency - On-site trespasser (day/year)	54	
EDo	Exposure duration - On-site trespasser (year)	7	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cgw	Groundwater concentration (mg/L)	Maximum detection concentration	

(1) The body weight for the following ranges is provided in the USEPA Exposure Factors Handbook:

	Boys and Girls
Age	Mean Weight
9<12	36
12<15	50.6
15<18	61.2

The on-site trespasser for this site ranges in age from 10 to 17. The average of these body weights was used at the body weight for the site receptor.

References

USEPA 1986. Superfund Public Health Evaluation Manual. Office of Emergency Response and Remedial Respon
EPA 540/1-86/060.

USEPA 1988. Superfund Exposure Assessment Manual.

USEPA 2001. Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.
OSWER 9355.4-24.

USEPA 2003. Integrated Risk Information System (IRIS). (www.epa.gov/ngispgm3/iris).

RISK BASED REMEDIATION GOALS
CONSTRUCTION WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

AMBIENT AIR - GROUNDWATER

Parameter	Exposure Point Concentration (ug/L)	Ambient Air Exposure Carcinogenic (ug/L)			Ambient Air Exposure Noncarcinogenic (ug/L)
		1×10^{-4}	1×10^{-5}	1×10^{-6}	
Trichloroethene	1.19E+06	3.04E+07	3.04E+06	3.04E+05	1.74E+07

GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
CONSTRUCTION WORKER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Symbol	Definition (units)	Default	Reference
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2002
Risk Level	Target cancer risk - Construction Worker	10^{-6}; 10^{-5}; 10^{-4}	
Risk Level	Target hazard quotient	1	USEPA 2001
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
EFo	Exposure frequency - Construction worker (day/year)	250	
EDo	Exposure duration - Construction worker (year)	1	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cgw	Groundwater concentration (mg/L)	Maximum detection concentration	

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR CONSTRUCTION WORKER

Carcinogenic

$$Cgw = \frac{VF \times BWa \times ATc \times Risk\ Level}{CSFi \times IRAa \times EFo \times EDo}$$

Noncarcinogenic

$$Cgw = \frac{RfDi \times VF \times xBWa \times xATn \times Risk\ Level}{IRAa \times EFo \times EDo}$$

Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	3.40E+05	1.00E-06	3.04E+02	1.74E+04

CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR CONSTRUCTION WORKER

Carcinogenic

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Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
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CALCULATION OF GROUNDWATER CONCENTRATION BASED ON RISK LEVELS FOR CONSTRUCTION WORKER

Carcinogenic

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Chemical	CSFo	CSFi	RfDo	RfDi	VF	Risk Level	Groundwater Concentration mg/L Cancer	Noncancer
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Volatilization Factors - Outdoor Worker

$$VF = \frac{Q/C_{vol}}{J_t}$$

Symbol	Definition (units)	Default	Reference
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J_t	Average release flux (g/m^2*s)	Chemical-specific	VLEACH

Q/C_{vol} Calculation

$Q/C_{vol} = A \times \exp((\ln A_{site} - B)^2/C)$

2.079442	Ln Asite
279.069	$(\ln A_S - B)^2$
1.297619	$(\ln A_S - B)^2/C$
3.66057	$e^{(\ln A_S - B)2/C}$
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A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific

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COPCs for Groundwater	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
Trichloroethene	3.40E+05	61.73660321	1.82E-04	5.32E+02	3.15E+07	0.0929

References

USEPA 1986. Superfund Public Health Evaluation Manual. Office of Emergency Response and Remedial Response. EPA 540/1-86/060.

USEPA 1988. Superfund Exposure Assessment Manual.

USEPA 2001. Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

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SUMMARY OF TOTAL RISK
INDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Medium	Estimated Lifetime Carcinogenic Risk (ILCR)	Estimated Non-Carcinogenic Hazard Quotient (HQ)
Groundwater		
Inhalation to indoor air	2.6E-02	1.8E+01
Soil		
Inhalation to indoor air	4.3E-01	3.3E+02
Incidential Ingestion	1.1E-06	5.7E-03
	4.6E-01	**350.94**

CALCULATION OF SOIL RISK TO OUTDOOR WORKER

Combined Exposures to Carcinogens in Industrial Soil

Ingestion

$$\text{RISK} = \frac{\text{CSFo x Cs x IRSo x CF x EFo x EDo}}{\text{BWa x ATc}}$$

Inhalation

$$\text{RISK} = \frac{\text{CSFi x Cs x IRAa x EFo x EDo}}{\text{VF or PEF x BWa x ATc}}$$

Dermal Contact

$$\text{RISK} = \frac{\text{CSFo x Cs x SA x AF x ABS x CF x EFo x EDo}}{\text{BWa x ATc}}$$

Combined Exposures to Noncarcinogens in Industrial Soil

Ingestion

$$\text{RISK} = \frac{\text{Cs x IRSo x CF x EFo x EDo}}{\text{RfDo x BWa x ATn}}$$

Inhalation

$$\text{RISK} = \frac{\text{Cs x IRAa x EFo x EDo}}{\text{RfDi x VF for PEF x BWa x ATn}}$$

Dermal Contact

$$\text{RISK} = \frac{\text{Cs x SA x AF x ABS x CF x EFo x EDo}}{\text{RfDo x BWa x ATn}}$$

							Cancer				Noncancer			
Chemical	**CSFo**	**CSFi**	**RfDo**	**RfDi**	**VF or PEF**	**ABS**	Ingestion Risk	Inhalation Risk	Dermal Contact Risk	Cummulative Risk	Ingestion Risk	Inhalation Risk	Dermal Contact Risk	Cummulative Risk
Lead (1)	NA	NA	NA	NA	8.95E+08	1.00	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5.20E-02	1.00E-02	1.00E-02	1.70E-01	4.44E+08	1.00	1.90E-06	1.64E-10	NA	1.90E-06	1.02E-02	2.70E-07	NA	1.02E-02
Trichloroethene	4.00E-01	4.00E-01	3.00E-04	1.00E-02	4.51E+07	1.00	NA	7.30E-07	NA	7.30E-07	NA	5.11E-04	NA	5.11E-04
Vinyl chloride	1.50E+00	3.10E-02	3.00E-03	2.86E-02	4.52E+10	1.00	NA	5.17E-14	NA	5.17E-14	NA	NA	NA	NA
Benzo (a) pyrene (1)	7.30E+00	NA	NA	NA	8.95E+08	0.13	7.60E-07	NA	6.52E-07	1.41E-06	NA	NA	NA	NA
							2.66E-06	7.30E-07	6.52E-07	4.04E-06	1.02E-02	5.11E-04	0.00E+00	1.07E-02

NA - Information for this constituent is not available.

1. The EPC is the lognormal RME.
2. Dermal contact pathway is not evaluted for VOCs.

CALCULATION OF GROUNDWATER RISK TO OUTDOOR WORKER

Carcinogenic
Inhalation

$$RISK = \frac{CSFi \times Cw \times IRAa \times EFo \times EDo}{VF \times BWa \times ATc}$$

Noncarcinogenic
Inhalation

$$RISK = \frac{Cw \times IRAa \times EFo \times EDo}{RfDi \times VF \times BWa \times ATn}$$

Chemical	CSFo		CSFi	RfDo	RfDi	VF	Risk Cancer	Risk Noncancer
1,1,1-Trichloroethane	NA		NA	2.80E-01	6.30E-01	1.56E+09	NA	2.81E-11
1,1-Dichloroethane	NA		NA	NA	NA	5.48E+09	NA	NA
1,1-Dichloroethene	NA		NA	5.00E-02	5.70E-02	5.67E+11	NA	7.19E-14
1,2-Dichloroethane	9.10E-02		9.10E-02	NA	NA	3.62E+11	1.53E-16	NA
Chloroethane	NA		NA	NA	2.90E+00	7.23E+10	NA	3.19E-15
Chloroform	NA		8.05E-02	1.00E-02	NA	3.62E+11	2.94E-17	NA
1,2,4-Trimethylbenzene	NA		NA	5.00E-02	1.70E-03	2.58E+11	NA	1.36E-12
1,3,5-Trimethylbenzene	NA		NA	NA	NA	2.01E+11	NA	NA
Cis-1,2-Dichloroethene	NA		NA	NA	NA	1.66E+07	NA	NA
Methylene chloride	7.50E-03		1.65E-03	6.00E-02	NA	1.20E+10	1.08E-15	NA
Sec-Butylbenzene	NA		NA	NA	NA	1.64E+11	NA	NA
Tetrachloroethene	5.20E-02		1.00E-02	1.00E-02	1.70E-01	1.86E+09	4.49E-14	7.39E-11
Toluene	NA		NA	2.00E-01	1.14E-01	3.01E+11	NA	1.03E-14
Trans-1,2-Dichloroethene	NA		NA	2.00E-02	NA	7.54E+09	NA	NA
Trichloroethene	4.00E-01		4.00E-01	3.00E-04	1.00E-02	3.40E+05	8.80E-05	6.16E-02
Vinyl Chloride	1.50E+00		3.10E-02	3.00E-03	2.86E-02	1.90E+06	6.15E-08	1.94E-04
							8.81E-05	6.18E-02

NA - Information for this constituent is not available.

EXPOSURE POINT CONCENTRATION
SOILS INGESTION AND INHALATION
OUTDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Constituents of Concern	Ingestion Maximum Detected Concentration (mg/kg)	Inhalation Maximum Detected Concentration (mg/kg)
Lead (1)	2466.8	NA
Tetrachloroethene	116.0	116.0
Trichloroethene	NA	1,310.0
Vinyl chloride	NA	1.2
Benzo (a) pyrene (1)	0.33	NA

(1) The ingestion exposure point is the log normal 95% UCL.
NA - Not Applicable

EXPOSURE POINT CONCENTRATION FOR GROUNDWATER
MAXIMUM DETECTED CONCENTRATION
OUTDOOR WORKER
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Constituents of Concern	Maximum Detected Concentration (mg/L)
1,1,1-Trichloroethane	0.157
1,1-Dichloroethane	0.145
1,1-Dichloroethene	0.0132
1,2-Dichloroethane	0.0097
Chloroethane	0.0038
Chloroform	0.0021
1,2,4-Trimethylbenzene	0.0034
1,3,5-Trimethylbenzene	0.0063
Cis-1,2-Dichloroethene	66.5
Methylene chloride	0.125
Sec-Butylbenzene	0.0023
Tetrachloroethene	0.133
Toluene	0.002
Trans-1,2-Dichloroethene	0.0653
Trichloroethene	1190
Vinyl Chloride	59.9

EXPOSURE PARAMETER INPUT VALUES
OUTDOOR WORKER - INGESTION, INHALATION AND DERMAL CONTACT
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Combined Exposures to Carcinogens in Soil

Ingestion

$$RISK = \frac{CSFo \times Cs \times IRSo \times CF \times EFo \times EDo}{BWa \times ATc}$$

Inhalation

$$RISK = \frac{CSFi \times Cs \times IRAo \times EFo \times EDo}{VF \text{ or } PEF \times BWa \times ATc}$$

Dermal Contact

$$RISK = \frac{CSFo \times Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{BWa \times ATc}$$

Combined Exposures to Noncarcinogens in Soil

Ingestion

$$RISK = \frac{Cs \times IRSo \times CF \times EFo \times EDo}{RfDo \times BWa \times ATn}$$

Inhalation

$$RISK = \frac{Cs \times IRAo \times EFo \times EDo}{RfDi \times VF \text{ for } PEF \times BWa \times ATn}$$

Dermal Contact

$$RISK = \frac{Cs \times SA \times AF \times ABS \times CF \times EFo \times EDo}{RfDo \times BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2003
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2003
RfDo	Reference dose factor oral (mg/kg*day)	Chemical-specific	USEPA 2003
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2003
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATn	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
IRSo	Soil ingestion - adult (mg/day)	100	USEPA 2001
EFo	Exposure frequency - outdoor worker (day/year)	225	
EDo	Exposure duration - outdoor worker (year)	25	
PEF	Particulate emission factor (m^3/kg)	Site - specific	USEPA 2001
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
CF	Conversion factor (kg/mg)	1.00E-06	
SA	Skin surface area (cm^2/event)	3300	USEPA 2001
ABS	Chemical specific absorption factor	chemical-specific	USEPA 2001
AF	Soil to skin adherence factor (mg/cm^2)	0.2	USEPA 2001
ABS Factors:			
	Cadmium	0.001	
	PAHs	0.13	

GROUNDWATER EXPOSURE PARAMETER INPUT VALUES
OUTDOOR WORKER - INHALATION OF AMIBIENT AIR
FANSTEEL, INC.
NORTH CHICAGO, ILLINOIS FACILITY

Carcinogenic - Inhalation of Ambient Air

$$RISK = \frac{CSFi \times Cw \times IRAa \times EFo \times EDo}{VFs \times BWa \times ATc}$$

Noncarcinogenic - Inhalation of Ambient Air

$$RISK = \frac{Cw \times IRAa \times EFo \times EDo}{RfDi \times VFs \times BWa \times ATn}$$

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
CSFi	Cancer slope factor inhaled $(mg/kg*day)^{-1}$	Chemical-specific	USEPA 2002
RfDo	Reference dose factor oral (mg/kg*day)	Chemical-specific	USEPA 2002
RfDi	Reference dose factor inhaled (mg/kg*day)	Chemical-specific	USEPA 2002
BWa	Body weight - adult (kg)	70	USEPA 2001
ATc	Averaging time - carcinogens (days)	25550	USEPA 2001
ATa	Averaging time - noncarcinogens (days)	ED*365	USEPA 2001
IRAa	Inhalation rate - adult (m^3/day)	20	USEPA 2001
EFo	Exposure frequency - outdoor worker (day/year)	225	
EDo	Exposure duration - outdoor worker (year)	25	
VFs	Volatilization factor - soil (m^3/kg)	Chemical-specific	USEPA 2001
Cw	Groundwater concentration (mg/L)	Maximum detection concentration	
PEF	Particulate emission factor (m^3/kg)	Site - specific	USEPA 2001

Volatilization Factors - Outdoor Worker

$$VF = \frac{Q/C_{vol}}{J_t}$$

Symbol	Definition (units)	Default	Reference
VF	Volatilization Factor (m^3/kg)	Chemical Specific	
Q/C_{vol}	Inverse of the mean conc. at center of square source (g/m^2*s per kg/m^3) Chicago Area	61.73660321	USEPA 2001
J_t	Average release flux (g/m^2*s)	Chemical-specific	VLEACH

Q/C_{vol} Calculation

$Q/C_{vol} = A \times \exp((\ln A_{site} - B)^2/C)$

2.079442	Ln Asite
279.069	$(\ln A_S - B)^2$
1.297619	$(\ln A_S - B)^2/C$
3.66057	$e^{(\ln A_S - B)2/C}$
61.7366	$A \times e^{(\ln A_S - B)2/C}$

A	Constant (unitless)	16.8653	USEPA 2001
B	Constant (unitless)	18.7848	USEPA 2001
C	Constant (unitless)	215.0624	USEPA 2001
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific

Per the Draft SSL Guidance, VF is only applicable to volatiles.

COPCs for Soil	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
Tetrachloroethene	4.44E+08	61.73660321	1.39E-07	4.07E-01	3.15E+07	0.0929
Trichloroethene	4.51E+07	61.73660321	1.37E-06	4.01E+00	3.15E+07	0.0929
Vinyl Chloride	4.52E+10	61.73660321	1.37E-09	4.00E-03	3.15E+07	0.0929

COPCs for Groundwater	VF	Q/C_{vol}	J_t	VLEACH Flux	Conversion yr to s	Conversion ft^2 to m^2
1,1,1-Trichloroethane	1.56E+09	61.73660321	3.96E-08	1.16E-01	3.15E+07	0.0929
1,1-Dichloroethane	5.48E+09	61.73660321	1.13E-08	3.30E-02	3.15E+07	0.0929
1,1-Dichloroethene	5.67E+11	61.73660321	1.09E-10	3.19E-04	3.15E+07	0.0929
1,2-Dichloroethane	3.62E+11	61.73660321	1.71E-10	5.00E-04	3.15E+07	0.0929
Chloroethane	7.23E+10	61.73660321	8.53E-10	2.50E-03	3.15E+07	0.0929
Chloroform	3.62E+11	61.73660321	1.71E-10	5.00E-04	3.15E+07	0.0929
n-Propylbenzene	2.38E+14	61.73660321	2.59E-13	7.60E-07	3.15E+07	0.0929
1,1,2-Trichloroethane	2.35E+15	61.73660321	2.62E-14	7.69E-08	3.15E+07	0.0929
1,2,4-Trichlorobenzene	2.76E+15	61.73660321	2.24E-14	6.55E-08	3.15E+07	0.0929
1,2,4-Trimethylbenzene	2.58E+11	61.73660321	2.39E-10	7.00E-04	3.15E+07	0.0929
1,3,5-Trimethylbenzene	2.01E+11	61.73660321	3.07E-10	9.00E-04	3.15E+07	0.0929
Cis-1,2-Dichloroethene	1.66E+07	61.73660321	3.71E-06	1.09E+01	3.15E+07	0.0929
Methylene chloride	1.20E+10	61.73660321	5.15E-09	1.51E-02	3.15E+07	0.0929
Sec-Butylbenzene	1.64E+11	61.73660321	3.75E-10	1.10E-03	3.15E+07	0.0929
Tetrachloroethene	1.86E+09	61.73660321	3.31E-08	9.70E-02	3.15E+07	0.0929
Toluene	3.01E+11	61.73660321	2.05E-10	6.00E-04	3.15E+07	0.0929
Trans-1,2-Dichloroethene	7.54E+09	61.73660321	8.19E-09	2.40E-02	3.15E+07	0.0929
Trichloroethene	3.40E+05	61.73660321	1.82E-04	5.32E+02	3.15E+07	0.0929
Vinyl Chloride	1.90E+06	61.73660321	3.25E-05	9.53E+01	3.15E+07	0.0929

PARTICULATE EMISSION FACTOR

$$PEF = Q/C_{wind} \times \left[\frac{3600\ s/h}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)} \right]$$

$$Q/C_{wind} = A \times \exp\ (\ln A_S - B)^2/C)$$

Symbol	Definition (units)	Default	Reference
PEF	Particulate Emission Factor (m^3/kg)	894935526.7	Site-specific
Q/C_{wind}	Inverse of mean concentration at center of a 8 acre square site (g/m^2 -s/kg/m^3)	61.73660321	USEPA 2001
A	Constant (unitless)	16.8653	USEPA 2001
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific
B	Constant (unitless)	18.7848	USEPA 2001
C	Constant (unitless)	215.0624	USEPA 2001
$F_{(x)}$	Function dependent on Um/Ut derived using Cowherd et al. (1985)	0.194	USEPA 2001
V	Fraction of vegetated cover (unitless)	0.5	USEPA 2001
U_m	Mean annual wind speed (m/s)	4.69	USEPA 2001
U_t	Equivalent threshold value of windspeed at 7m (m/s)	11.32	USEPA 2001

0.5	(1-v)
0.07111795	$(U_m/U_t)^3$
0.00024834	denominator
14496028	3600/denominator
894935527	Q/C * 3600/denominator
2.07944154	Ln A_S
279.069001	$(\text{Ln } A_S - B)^2$
1.29761874	$(\text{Ln } A_S - B)^2/C$
3.66056953	$e^{(\text{Ln AS - B})2/C}$
61.7366032	$A \times e^{(\text{Ln AS - B})2/C}$

References

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OSWER 9355.4-24.

USEPA 2003. Integrated Risk Information System (IRIS). (www.epa.gov/ngispgm3/iris).

CALCULATION OF SOIL RISK TO CONSTRUCTION WORKER

Combined Exposures to Carcinogens in Industrial Soil

Ingestion

$$\text{RISK} = \frac{\text{CSFo x Cs x IRSo x CF x EFo x EDo}}{\text{BWa x ATc}}$$

Inhalation

$$\text{RISK} = \frac{\text{CSFi x Cs x IRAa x EFo x EDo}}{\text{VF or PEF x BWa x ATc}}$$

Dermal Contact

$$\text{RISK} = \frac{\text{CSFo x Cs x SA x AF x ABS x CF x EFo x EDo}}{\text{BWa x ATc}}$$

Combined Exposures to Noncarcinogens in Industrial Soil

Ingestion

$$\text{RISK} = \frac{\text{Cs x IRSo x CF x EFo x EDo}}{\text{RfDo x BWa x ATn}}$$

Inhalation

$$\text{RISK} = \frac{\text{Cs x IRAa x EFo x EDo}}{\text{RfDi x VF for PEF x BWa x ATn}}$$

Dermal Contact

$$\text{RISK} = \frac{\text{Cs x SA x AF x ABS x CF x EFo x EDo}}{\text{RfDo x BWa x ATn}}$$

							Cancer				Noncancer			
Chemical	**CSFo**	**CSFi**	**MRLo**	**MRLi**	**VF or PEF**	**ABS**	Ingestion Risk	Inhalation Risk	Dermal Contact Risk	Cummulative Risk	Ingestion Risk	Inhalation Risk	Dermal Contact Risk	Cummulative Risk
Tetrachloroethene	5.20E-02	1.00E-02	5.00E-02	1.14E-02	4.44E+08	1	2.78E-07	7.30E-12	NA	2.78E-07	7.49E-03	4.47E-06	NA	7.50E-03
Trichloroethene	4.00E-01	4.00E-01	2.00E-01	2.86E-02	4.51E+07	1	NA	3.24E-08	NA	3.24E-08	NA	1.99E-04	NA	1.99E-04
Vinyl chloride	1.50E+00	3.10E-02	2.00E-05	8.60E-03	4.52E+10	1	NA	2.30E-15	NA	2.30E-15	NA	6.04E-10	NA	6.04E-10
Benzo(a)anthracene	7.30E-01	NA	NA	NA	9.30E+06	0.13	8.08E-08	NA	3.15E-08	1.12E-07	NA	NA	NA	0.00E+00
Benzo(a)pyrene	7.30E+00	NA	NA	NA	9.30E+06	0.13	7.29E-08	NA	2.84E-08	1.01E-07	NA	NA	NA	0.00E+00
							4.32E-07	3.25E-08	6.00E-08	5.24E-07	7.49E-03	2.03E-04	0.00E+00	7.69E-03

1. Dermal contact pathway is not evaluated for VOCs.

VLEACH MODELING VOLATILE RELEASE RATE SUMMARY

Compound of Concern		TCE	TCE	TCE	TCE	TCE	PCE	PCE	PCE	11DCE	11DCE	11DCE
Concentration in Groundwater	µg/l		1,190,000	1,190,000	117,000	23		133	133		13	13
Initial Concentration in Soil	µg/kg	1,310,000		1,310,000			116,000		116,000	86		86
Instantaneous Release Rates	(g/sq ft/yr)											
0.2 years		45.794	520.87	520.87	51.212	0.010	7.257	0.094	7.352	1.37E-02	1.65E-02	3.02E-02
1 year		31.428	524.87	524.87	51.605	0.010	3.935	0.096	4.030	2.54E-03	1.68E-02	1.94E-02
2 years		19.536	528.06	528.06	51.918	0.010	1.821	0.097	1.918	2.99E-04	1.69E-02	1.72E-02
7 years		1.668	532.41	532.41	52.346	0.010	0.035	0.097	0.133	4.28E-09	1.69E-02	1.69E-02
25 years		8.96E-05	532.74	532.74	52.378	0.010	9.39E-09	0.097	0.097	1.96E-27	1.69E-02	1.69E-02
Average Release Rates	(g/sq ft/yr)											
1 year		38.282	522.97	561.25	51.418	0.010	5.471	0.095	5.566	7.01E-03	1.67E-02	2.37E-02
2 years		31.067	524.94	556.01	51.612	0.010	4.005	0.096	4.101	3.93E-03	1.68E-02	2.07E-02
7 years		13.868	529.39	543.26	52.049	0.010	1.446	0.097	1.543	1.14E-03	1.69E-02	1.80E-02
25 years		4.006	531.78	535.78	52.284	0.010	0.407	0.097	0.504	3.19E-04	1.69E-02	1.72E-02

VLEACH MODELING VOLATILE F

Compound of Concern		Vinyl Chloride	Vinyl Chloride	Vinyl Chloride	111-TCA	1,1-DCA	1,2-DCA	Chloro-ethane	Chloro-form	112-TCA	Methylene Chloride
Concentration in Groundwater	µg/l		59,900	59,900	157	145	9.7	3.8	2.1	0.002	125
Initial Concentration in Soil	µg/kg	1,200		1,200							
Instantaneous Release Rates	(g/sq ft/yr)										
0.2 years		0.311	93.319	93.630	0.113	0.032	0.0005	0.0025	0.0005	7.66E-08	0.0150
1 year		0.012	95.251	95.263	0.115	0.033	0.0005	0.0025	0.0005	7.67E-08	0.0151
2 years		1.67E-04	95.314	95.314	0.116	0.033	0.0005	0.0025	0.0005	7.68E-08	0.0151
7 years		1.76E-14	95.315	95.315	0.116	0.033	0.0005	0.0025	0.0005	7.69E-08	0.0151
25 years		5.48E-51	95.315	95.315	0.116	0.033	0.0005	0.0025	0.0005	7.70E-08	0.0151
Average Release Rates	(g/sq ft/yr)										
1 year		0.110	94.630	94.740	0.114	0.033	0.0005	0.0025	0.0005	7.66E-08	0.0150
2 years		0.056	94.968	95.024	0.115	0.033	0.0005	0.0025	0.0005	7.67E-08	0.0151
7 years		0.016	95.216	95.232	0.116	0.033	0.0005	0.0025	0.0005	7.69E-08	0.0151
25 years		0.004	95.287	95.292	0.116	0.033	0.0005	0.0025	0.0005	7.69E-08	0.0151

VLEACH MODELING VOLATILE F

Compound of Concern		trans-1,2-DCE	cis-1,2-DCE	PCE	PCE	n-Propyl-benzene	124-trichlorobenzene	124-trimethylbenzene	135-trimethylbenzene	sec-Butyl-benzene	Toluene
Concentration in Groundwater	µg/l	65.3	66500	133	858	0.002	0.003	3.4	6.3	2.3	2
Initial Concentration in Soil	µg/kg										
Instantaneous Release Rates	(g/sq ft/yr)										
0.2 years		0.023	10.705	0.094	0.610	7.4822E-07	6.5186E-08	0.0007	0.0009	0.0011	0.0006
1 year		0.024	10.808	0.096	0.618	7.4971E-07	6.5208E-08	0.0007	0.0009	0.0011	0.0006
2 years		0.024	10.856	0.097	0.623	7.5141E-07	6.5235E-08	0.0007	0.0009	0.0011	0.0006
7 years		0.024	10.877	0.097	0.627	7.5775E-07	6.5363E-08	0.0007	0.0009	0.0011	0.0006
25 years		0.024	10.877	0.097	0.627	7.6580E-07	6.5723E-08	0.0007	0.0009	0.0011	0.0006
Average Release Rates	(g/sq ft/yr)										
1 year		0.023	10.762	0.095	0.614	7.4897E-07	6.5197E-08	0.0007	0.0009	0.0011	0.0006
2 years		0.024	10.802	0.096	0.618	7.4986E-07	6.5211E-08	0.0007	0.0009	0.0011	0.0006
7 years		0.024	10.853	0.097	0.624	7.5351E-07	6.5276E-08	0.0007	0.0009	0.0011	0.0006
25 years		0.024	10.870	0.097	0.627	7.6033E-07	6.5478E-08	0.0007	0.0009	0.0011	0.0006

PARTICULATE EMISSION FACTOR **Outdoor worker and On-site trespasser**

$$PEF = Q/C_{wind} \times \left[\frac{3600 \text{ s/h}}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)} \right]$$

$$Q/C_{wind} = A \times \exp\ (\ln A_S - B)^2/C)$$

Symbol	Definition (units)	Default	Reference	
PEF	Particulate Emission Factor (m^3/kg)	894935526.7	Site-specific	0.5 (1-v)
Q/C_{wind}	Inverse of mean concentration at center of a 8	61.73660321	USEPA 2001	0.07111795 $(U_m/U_t)^3$
	acre square site (g/m^2 -s/kg/m^3)			0.00024834 denominator
A	Constant (unitless)	16.8653	USEPA 2001	14496028 3600/denominator
A_S	Areal extent of site surface soil contamination (acres)	8	Site-specific	894935527 Q/C * 3600/denominator
B	Constant (unitless)	18.7848	USEPA 2001	
C	Constant (unitless)	215.0624	USEPA 2001	
$F_{(x)}$	Function dependent on Um/Ut derived using Cowherd et al. (1985)	0.194	USEPA 2001	
V	Fraction of vegetated cover (unitless)	0.5	USEPA 2001	2.07944154 Ln A_S
U_m	Mean annual wind speed (m/s)	4.69	USEPA 2001	279.069001 $(\text{Ln } A_S - B)^2$
U_t	Equivalent threshold value of windspeed at 7m (m/s)	11.32	USEPA 2001	1.29761874 $(\text{Ln } A_S - B)^2/C$
				3.66056953 $e^{(\text{Ln AS - B})2/C}$
				61.7366032 A x $e^{(\text{Ln AS - B})2/C}$