Orangeburg (Orangetown) Shopping Center
ROCKLAND COUNTY, NEW YORK

Remedial Action Work Plan

NYSDEC Site Number: C344066

FINAL

Prepared for:
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DECEMBER 2011

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CERTIFICATIONS

I, Justin R. Moses, PE, am currently a registered professional engineer licensed by the State of New York, and that this Remedial Action Work Plan Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. I, Justin R. Moses, of Kleinfelder, located at One Corporate Drive, Suite 201, Bohemia, New York, am certifying as Owner's Designated Site Representative and I have been authorized and designated by all site owners to sign this certification for the site.

077926	12/19/11	
NYS Professional Engineer #	Date	Signature

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LIST OF ACRONYMS

Acronym	Definition
AA	Remedial Alternatives Analysis
AOC	Area of Concern
BCA	Brownfield Cleanup Agreement
BCP	Brownfield Cleanup Program
bgs	below ground surface
CCR	Construction Completion Report
cDCE	cis-1,2-Dichloroethene
COD	Chemical Oxygen Demand
CPP	Community Participation Plan
CSM	Conceptual Site Model
CTR	Connecticut Tank Removal, Inc
DCE	Cis-1,2-Dichloroethene
DER	Division of Environmental Remediation
DNAPL	Dense Non-Aqueous Phase Liquid
DUSR	Data Usability Summary Report
EIP	Electronic Interface Probe
ESA	Environmental Site Assessment
FOIA	Freedom of Information Act
ft	Feet
FWIA	Fish and Wildlife Impact Analysis
HVAC	Heating, Venting, and Air Conditioning
IC/EC	Institutional Controls/Engineering Controls
IP	Injection Point or Injection Well
in wc	Inches of Water Column
IRM	Interim Remedial Measure
IRMWP	Interim Remedial Measures Work Plan
IWP	Investigation Work Plan
JLJ	JLJ Management Co., Inc.
KLF	Kleinfelder, Inc.
µg/L	micrograms per liter
µg/m3	micrograms per cubic meter
mg/L	milligrams per liter
MNA	Monitored Natural Attenuation
msl	mean sea level
mV	millivolt
NRCS	Natural Resource Conservation Service
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSGS	New York State Geological Survey
OM&M	Operation, Monitoring and Maintenance
ORP	Oxidation Reduction Potential
PCE	Tetrachloroethene
PID	Photo Ionization Detector
PVC	polyvinyl chloride

Acronym	Definition
QA/QC	Quality Assurance/Quality Control
OM&M	Operations, Maintenance and Monitoring
RAO	Remedial Action Objective
RI	Remedial Investigation
RAWP	Remedial Action Work Plan
SCG	Standards, Criteria, Guidelines
SCO	Soil Cleanup Objectives
SDG	Sample Data Group
SSD	Sub-Slab Depressurization
SSDS	Sub-Slab Depressurization System
SVOC	Semi-Volatile Organic Compound
TCE	Trichloroethene
TOC	Total Organic Carbon
tDCE	trans-1,2-Dichloroethene
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VC	Vinyl Chloride
VOC	Volatile Organic Compound

REMEDIAL ACTION WORK PLAN

1.0 INTRODUCTION

Kleinfelder, Inc (KLF) has prepared this Remedial Action Work Plan (RAWP) on behalf of JLJ Management Company (JLJ) for the Orangeburg (Orangetown) Shopping Center (Brownfield Cleanup Program [BCP] Site #C344066) located in Town of Orangetown, County of Rockland, New York (hereinafter the Site). JLJ Management Company (JLJ) entered into a Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (NYSDEC) in January 2007, to investigate and remediate a portion of its property (the Orangetown Shopping Center) located in Hamlet of Orangeburg, New York. Figure 1 presents the location of the Site.

The Site is approximately 1.33-acre in size. It is situated within an 11-acre retail property identified as a portion of Block 1 and Lot 67 on Orangetown Tax Map # 74.10. The boundaries of the retail property include Orangeburg Road to the north, residential homes and Highview Avenue to the south, residential homes and Oak Street to the east, and Dutch Hill Road to the west together with commercial and office properties (see Figure 1). The shopping center has seven distinct building components, including five retail buildings (see Site Layout, Figure 2). The surrounding area is a well-developed village/town setting, characterized by general business, commercial, and institutional (public) development. The Town of Orangetown designates this general area as a Commercial (CS) Zone. This Site is being remediated to commercial use, and will be used for commercial (retail) property for the foreseeable future.

KLF prepared and submitted a remedial Alternatives Analysis Report (AAR) to the NYSDEC and New York State Department of Health (NYSDOH) in September 2011. Based on the findings of the remedial investigation (RI), RI Addendum, the various interim remedial measures (IRMs), and AAR, this RAWP was prepared following the NYSDEC Division of Environmental Remediation (DER) Draft Brownfield Cleanup Program Guide (BCP Guide), 6 NYCRR Part 375 Environmental Remediation Programs (Part 375) effective December 14, 2006, and the NYSDEC Technical Guidance for Site Investigation and Remediation (DER-10) dated May 2010 (NYSDEC 2010).

2.0 INVESTIGATION SUMMARY

Section 2 summarizes the investigations performed at the Site; and it concludes with an updated version of the Site's exposure assessment.

2.1 Site Investigations

JLJ retained KLF to investigate the site between 2007 and 2008 as described in the final RI report (KLF 2008a) and subsequent investigations discussed in the RI Addendum Report (KLF 2011e). These investigations are summarized below.

2.1.1 Remedial Investigation

The RI was performed following the approval of the Investigation Work Plan (IWP, KLF 2007a) approved by the NYSDEC in July 2007. From July through December 2007, KLF completed remedial investigation activities, which included:

- Installation of seven soil borings, which were completed as monitoring wells (MW-8A/-B, MW-9A/-B/-C, MW-11A/-B, MW-12A/-B/-C, MW-13, MW14, and MW-15) between September 25 and October 5, 2007. See Appendix B of the RI Report for the boring and well logs.
- Installation of three piezometers (PZ-4, PZ-5, and PZ-6) on October 2, 2007, slightly north of MW-5 to approximately 12 feet (ft) below ground surface (bgs) using a hand Geoprobe. Screened intervals were placed at 12 to 7 ft bgs, 7 to 5 ft bgs, and 5 to 3 ft bgs, respectively.
- The first round of groundwater sampling was conducted prior to intrusive work in September 2007; these data guided the selection of boring/well locations for the RI. The second round involved the sampling of both previously existing and newly installed wells in October 2007. Each well was gauged for depth to water, depth to bottom, and for the presence of Dense Non-Aqueous Phase Liquid (DNAPL) using an electronic interface probe (EIP). Groundwater depth measurements collected during this investigation indicated groundwater flows in an easterly direction.
- A soil vapor intrusion assessment to evaluate the potential for soil vapor intrusion as an exposure pathway was conducted on July 12, 2007 and November 27 to December 6, 2007 at three general locations. These include: the shops in Buildings #1 and #2 at Orangetown Shopping Center; the vacant tenant space in Orangetown Shopping Center (Building #3) south of Building #2; and abutting off-Site properties along Highview Avenue and Oak Street. Soil, groundwater and soil vapor samples collected during this investigation indicated the presence of chlorinated solvents. Refer to Tables 6, 7B and 8 in the RI Report for more

details. Refer to the Figure 2 and Figure 3 for locations of the wells, piezometers and soil vapor points sampled during this investigation.

2.1.2 Remedial Investigation Addendum

KLF completed additional remedial investigation activities (KLF 2011e), which included:

- Completion of well repairs to MW-7, MW-8 and MW-12D on May 22, 2008.
- Five (5) rounds of groundwater sampling and one well gauging event have occurred between November 2008 and August 2010. Groundwater samples have indicated the presence of chlorinated solvents. Concentrations of chlorinated solvents are highest along the eastern side of Building #2 in the vicinity of Sparkle Cleaners. Analytical results of the groundwater sampling events are summarized in Table 1a of the report.
- Advancement of three soil borings (B-1, B-2 and B-3) to assess subsurface soil below Sparkle Cleaners was completed in February 2009. Analytical data indicated the presence of low concentrations of chlorinated solvents. The concentrations of some detected analytes in samples B-2 and B-3 were greater than the NYSDEC Protection of Groundwater standards. Analytical results of the sub-slab samples are summarized in Table 3 of the report.
- Completion of several soil vapor assessments between February and October 2009. Soil vapor samples have indicated the presence of vapor phase chlorinated solvents. Concentrations of chlorinated solvents are highest along the eastern side of Building #2 in the vicinity of Sparkle Cleaners. Analytical results of the soil vapor and air assessment samples are summarized in Table 4 of the report.
- Collection of eight surface soil samples (SS-1 through SS-8) along the wooded slope located east of the paved area to the rear of Building #2 in April 2010. These soil samples were collected at the request of the NYSDEC to evaluate the potential for exposure to Site-related chemicals. Metals, volatile organic compounds (VOCs), and pesticides were either below laboratory reporting limits or below applicable regulatory criteria. Semi-volatile organic compounds (SVOCs) were detected in some soil samples at concentrations above the NYSDEC Restricted-Residential Use Soil Cleanup Objective and/or NYSDEC Restricted-Commercial Use Soil Cleanup Objective. Analytical results of the surface soil samples are summarized in Table 2 of that report.

Based upon the RI and RI Addendum findings, KLF concluded that the chlorinated solvent plume in groundwater along the eastern boundary of the Site and soils containing residual contamination around the southeastern segment of the foundation of Building #2 and under Sparkle Cleaners requires remedial action.

2.2 *Exposure Assessment*

A public health exposure assessment qualitatively considers the potential for people to be exposed to contamination originating from the Site. According to the New York State Department of Health (NYSDOH), as cited in Appendix 3B of DER-10 (NYSDEC 2010), there are five elements necessary to have a complete Exposure Pathway:

1. A contaminant source, such as any waste disposal area;
2. A contaminant release and transport mechanism, which might carry contaminants from the source to points where exposure may occur;
3. A point of exposure, where actual or potential human contact with contaminated media may occur;
4. A route of exposure (inhalation, ingestion, absorption); and
5. A receptor population, such as people who could be exposed to the contaminants at the point of exposure.

Decisions regarding whether an exposure pathway exists or not are based upon the following:

- An **exposure pathway**, as defined, **exists** when all of these elements exist.
- A **potential exposure pathway exists** when one or more of the elements are not fully known, but the others are present and identifiable.
- An **exposure pathway does not exist** when any one of the five elements does not exist, has not existed in the past, and will not exist in the future.

2.2.1 Contaminant Source and Area of Concern

As discussed in the RI Addendum (KLF 2011e), KLF concluded that a leaking sewer fitting at Sparkle Cleaners is the most likely source of chlorinated solvents in soil and groundwater found at the Site. Of course, the data from the sub-slab soil borings cannot rule out another dry cleaner solvent source (under Sparkle Cleaners) or transport mechanism (such as, solvent released from the sewer flowing or pushed under the building by groundwater). The additional soils data discussed in Section 4.1 of the RI Addendum and the findings of the focused soil removal IRM (KLF 2011c) indicate residual contamination beneath the building.

The NYSDEC defines areas of concern (AOCs) as (§1.8(a) NYSDEC 2010):

> *[A]ny existing or former location(s) where hazardous substances, hazardous wastes, or petroleum are or were known or suspected to have been discharged, generated, manufactured, refined, transported, stored, handled, treated, released, disposed, or where hazardous substances, hazardous wastes, or petroleum have or may have migrated.*

Based upon the available data, KLF confirms its original (see the RI report, KLF 2008a) conclusion of a single AOC: the source area under the southeastern corner and the area east of Building #2 (see Plate 2). This AOC includes possible soil (such as soils under Sparkle Cleaners), groundwater, and/or soil vapor contamination.

2.2.2 Release/Transport Mechanisms

The following release/transport mechanisms have been identified for the Site:

- **Migration from Soil into Groundwater**—the available data indicate that the soil source was located around the sewer line behind (east of) Sparkle Cleaners. Based upon current evidence, it is believed that the release occurred outside, away from the foundation with localized groundwater mounding resulting from roof drainage pushing contaminated groundwater below the building. However, based upon the sub-slab soil data presented in Section 4.1.1, additional soil contamination may have resulted from mounded groundwater causing lateral movement under the building's eastern foundation. The focused soil removal IRM resulted in considerable removal of the source, although some soil contamination may remain underneath Sparkle Cleaners (KLF 2011c).
- **Migration of Contaminated Groundwater**—migration of contaminated groundwater has occurred on the Site, consistent with groundwater flow and flow from localized groundwater mounding. The overburden aquifer plume continues northeastward extending at least to MW-15A located in Oak Street. Mounding and localized radial flow may occur following precipitation events within the source area.
- **Volatilization into Air**—the potential for VOCs, such as the chemicals observed in soil or groundwater, to volatilize into soil gas and then into either ambient air or intrude into indoor air at nearby buildings appears to have been realized in and immediately surrounding Building #2. The available data presented in the RI report and herein do not indicate a complete pathway is present at the off-Site residential buildings evaluated to date.

Based on a review of the release/transport mechanisms, the potential exists for both groundwater plume migration and volatilization of chlorinated solvents into air.

2.2.3 Points of Exposure

The following have been identified as the potential points of exposure:

- **Use of Potable Water**— the commercial buildings and residential dwellings in this area are served by public water. It does not appear that drinking water is a point of exposure, based upon a survey of registered wells (see the RI report, KLF 2008a); however, this possible point of exposure cannot be eliminated because unregistered wells may exist downgradient of the Site.
- **Construction**—disturbance of subsurface soils will likely be performed in the upper 7-feet of surface soils within the AOC in the future. The concentrations detected in soils generally are very low in concentration to non-detect, except for immediately around the suspected source sewer line. KLF concludes that there is minimal potential exposure to workers or the nearby community. The potential exposure to impacted soils within the area of the sewer line was significantly reduced by the soil removal IRM, although some soil contamination may remain underneath Sparkle Cleaners (KLF 2011c).
- **Volatilization of Groundwater Contamination**—groundwater measurements made during RI and this assessment indicate a water table at approximately 40-feet bgs (with the possibility of limited areas with a shallower, perched, water table). As discussed above, the potential for vapors to emanate from the volatilization of VOCs from soil or groundwater through penetrations in building foundations, sumps, unpaved surfaces, etc., is documented for the southeastern end of Building #2. A SSDS was installed within Building #2 as part of the IRM effort to mitigate this exposure pathway (see CCR #2, KLF 2011d). The potential for similar concerns exists at the properties above the groundwater plume to the east and northeast of the Site; however, the available data presented in the RI report and herein indicate no completed pathways are present.

In summary, there appears to be a complete exposure pathway present at the Site via volatilization within Building #2; and this vapor intrusion to indoor air pathway has been mitigated.

2.2.4 Routes of Exposure

The following have been identified as the potential routes of exposure:

- **Ingestion of Contaminated Groundwater**—is unlikely because no down-gradient receptors are identifiable.

- **Inhalation of VOCs from Soil Vapor**—is possible in and immediately surrounding Building #2; however, the role of airborne or local sources must be taken into consideration when reviewing indoor air quality data for surrounding residences.
- **Absorption through Dermal Contact of Contaminated Soils and Groundwater**—contact with soil is not a route of exposure for routine commercial workers because shallow soils are not generally contaminated, although some soil contamination may remain underneath Sparkle Cleaners and near the rear, eastern foundation (KLF 2011c). Groundwater is present on-Site as both a perched water table (just below pavement) and an overburden aquifer at about 35-40 ft bgs. The overburden aquifer may be as shallow as approximately 15 ft bgs off site. Dermal contact with groundwater is not anticipated during normal construction related activities off-Site, but is possible near the building due to the perched water table.

In summary, there appears to be a complete route of exposure via inhalation of VOCs from soil vapor at the Site, which has been mitigated. Potentially complete exposure pathways exists for groundwater (on-Site and possibly downgradient off-Site) and for soils via volatilization (behind Building #2 near the back of the Sparkle Cleaner store).

2.2.5 Receptor Population

There are several private residential dwellings that are potential receptors immediately due east and northeast (downgradient) of the Site, along Oak Street. Across Oak Street is an apartment complex. There are three private residential dwellings that are potential receptors immediately due south/southeast (cross-gradient) of the Site, along Highview Avenue. One school, Tappan Zee High School is between ¼ and ½ mile due north of the Site. Dominican College is about ½ mile due north of the Site. Schaefer Elementary School is beyond ½ mile southwest of the Site. All of these sensitive receptors are either upgradient or cross-gradient from the Site.

The receptor population on site consists of commercial personnel and construction (utility, etc.) personnel. Downgradient of the Subject Property the receptor population might include occupants of downgradient commercial businesses and residential dwellings, as well as construction (utility, etc.) personnel.

2.2.6 Conclusions about Exposure Potential

Based on a review of the above elements, KLF concludes:

- That a complete human exposure pathway exists for soil vapor at the Site, and that the construction of the SSDS has mitigated the pathway.
- That potentially complete human exposure pathways exists for:
  - Sub-surface soils around the southeastern foundation wall under Building #2.
  - On-Site groundwater and
  - Possibly, down gradient off-site groundwater.

2.2.7 Fish and Wildlife Resource Impact Assessment

The NYSDEC requires the completion of the first component (i.e., Resource Characterization) of a Fish and Wildlife Resources Impact Analysis (FWIA, see §3.10.1 and Appendix 3C of DER-10 (NYSDEC 2010). The FWIA Decision Key was included in the RI report. Based on the findings of that report, KLF concluded that the completion of a FWIA was not justified. The current data do not change the basis of that conclusion.

3.0 INTERIM REMEDIAL MEASURES SUMMARY

Remediation at the Site began following the NYSDEC-approved set of IRMs as described in the IRM Work Plan (or IRMWP, dated June 2008, revised August 2008, and approved November 4, 2008). The IRMWP included the following:

- Focused soil excavation to treat the source area,
- Development and implementation of a vapor intrusion mitigation plan (specifically, a sub-slab depressurization system [SSDS]) at the dry cleaner store (Sparkle Cleaners) and surrounding tenant spaces, and
- Bioaugmentation treatment of sub-surface saturated soils and groundwater behind the dry cleaner store.

3.1 Source Removal

KLF oversaw the remedial excavation of the source area soil in January 2009 (KLF 2011c). The excavation area was located around the faulty sewer pipe behind the Sparkle Cleaners shop in Building #2 (Plate 3). The total depth of the excavation ranged from 3 to 4 feet and was limited by Building #2 to the west, and gas and sewer lines to the south and east, respectively. Three additional test pits were excavated to the south and east of the natural gas line to evaluate the lateral extent of residual impact observed in the southeastern corner of the excavation. During excavation activities a perched water table was encountered which required dewatering. Water recovered from the excavation was pumped into a fractionation tank for temporary storage.

Nine endpoint samples were collected and submitted for laboratory analysis. These results demonstrated detectable concentrations of Site-related constituents of concern at concentrations greater than restricted commercial use and groundwater protection soil cleanup objectives (SCOs). The SCOs for this Site are summarized in Table 1 and soil analytical results from the source area excavation and test pits are summarized in Table 4 of CCR #1 (KLF 2011c).

Approximately 52 tons of soil was removed from the source area. Approximately 12.90 tons of soil was classified as hazardous waste and transported to Michigan Disposal Waste Treatment Plant. Approximately 39.53 tons of soil was classified as non-hazardous waste and transported to ESMI in New York. Additionally, 1,790 gallons of water was recovered from the excavation and transported as non-hazardous waste to Bridgeport United Recycling. The excavation area was backfilled with virgin crushed stone.

This IRM achieved a decrease in the volume of impacted soils within the known source area. Soils with detectable chlorinated VOCs above SCOs remain along the eastern wall of Building #2; and, it also appears impacted soils are under the building (KLF 2011c and 2011e). The extent of source removal was limited by the location of Building #2 and presence of underground utilities (*e.g.*, natural gas line, sewer, and water). Because of these limitations, no additional source removal is feasible. KLF believes that the source removal IRM has gone a long way to achieving the soil RAOs discussed in Section 4.2.2 (KLF 2011c). The remaining impacted soils will require the placement of an institutional control easement (see Section 6.2) and additional treatment (see Section 6.4) to achieve the soil RAOs.

3.2 SSDS

Because of the residual contaminated subsurface soil and contaminated groundwater, a SSDS was designed to mitigate potential vapor intrusion from residual chlorinated VOC contamination into the southern portion of Building #2, which businesses include: Sparkle Cleaners, The Deli Spot, and New China House (KLF 2011d). The SSDS is configured to create a negative pressure (relative to the indoor environment) within the area beneath the concrete floor slabs of the businesses within the southern portion of Building #2 thereby minimizing the potential for migration of contaminant vapor into the indoor air (KLF 2009).

The system was installed between February and May 2010, and it was activated in May 2010. A performance (vacuum response) test was conducted on the system and it was determined that the system, as originally designed, did not achieve the performance standard, and it was subsequently modified.

Additional system performance testing was completed in June 2010 and a modified plan prepared (KLF 2010a), and approved by NYSDEC in August 2010. KLF implemented the modifications between August and September 2010. KLF re-started the system with additional blowers in place on September 29, 2010, and verified operation with another performance (vacuum response) test.

Late in 2010, KLF observed that ongoing heating, venting, and air conditioning (HVAC) issues in the building potentially impacted system performance. These issues were the result of foundation leaking and backdraft issues associated with furnaces and other fans. These issues were resolved in early 2011. KLF re-inspected the facility in March to verify resolution of the issues. In late March 2011, KLF filled various foundation and wall cracks in an effort to increase vacuum under the slab. In late April 2011, three vapor monitoring points were replaced in the New China Restaurant and another system check performed. This test verified that the system achieved measured vacuum greater than 0.0025 inches of water column (in-wc) across the slab in the three tenant spaces. SSDS performance is summarized in Tables 2 through 4 of CCR #2 (KLF 2011d).

3.3 Bioaugmentation Treatment System

Because of the presence of contaminated groundwater and residual soil contamination under Building #2, a bioaugmentation treatment system was designed. This treatment promotes *in situ* microbial degradation of contaminants in saturated soil and groundwater. Addition of a biostimulant (molasses in this case) to subsurface soil and groundwater has been shown to act as an electron donor that stimulates metabolic reduction of chlorinated VOCs to ethene via microorganisms that have been detected as being present at a site, as have bacteria of the genus *Dehalococcoides* (in MW-5 and MW-6) and *Dehalobacter* (in MW-5) (KLF 2008a).

Bioaugmentation injection points and manifold piping were installed after the source removal excavation between February and April 2010 (KLF 2011f). A batch injection tank connects to the manifold via manual gate valves to direct electron donor solution (a 10% molasses solution) to control flow to the injection points.

Baseline and post-injection sampling (from a network of monitoring wells), monitoring, and laboratory analysis provide the means to monitor treatment effectiveness. The first round of injections was in May, July and November 2010.The first round of treatment indicates bioaugmentation is enhancing biodegradation and dechlorination of the contaminants. The results also suggest that additional injections of electron donor solution would enhance treatment. After discussions with NYSDEC, KLF proposed a revised injection approach, which was approved (KLF 2011b) by NYSDEC on April 11, 2011.

KLF observed bioaugmentation carry-over from the December injection to the 2011 baseline event in April in wells nearest the injection points (KLF 2011f). Then, with the addition of more molasses, biodegradation/dechlorination were increased substantially, leading to falling pH (interpreted as an increase in metabolic waste products, organic acids, etc.) in wells near the injection gallery. The decrease in VC and ethene production in MW-3 is notable with the drop to a pH just below 5.0 standard units and a significant spike in TOC. In contrast, the increase of VC and ethene production in MW-4 (and somewhat less in MW-2) is seen as an encouraging sign that conditions were slowly improving in these wells. The stability of MW-8A and - 8B suggest that insufficient TOC is reaching this area (MW-8A) or depth (MW-8B) to influence the geochemical environment sufficiently to increase biodegradation/dechlorination. KLF interprets the rebound of DCE in June as follows. MW-5 is near the source area and is somewhat upgradient of the injection gallery. The DCE concentrations in MW-5 are much higher than the other wells. The treatment trend was encouraging (looking at DCE, PCE, and TCE results), until the rebound in June. The rebound can be seen (Chart 1) in MW-5, MW-3, MW-4, and MW-8B). MW-2 saw a decrease, while MW-8A remained steady. KLF is of the opinion that residual DCE in the source area around the eastern foundation of Building #2 and under Sparkle Cleaners continues to release chlorinated solvents to groundwater from desorption of the constituent from the soils. Some rebound also may be the result of an increase in unfavorable geochemical conditions (decreasing pH, perhaps the result of higher than necessary TOC) leading to a fall-off of dechlorination (drop in ethene production).

KLF interprets the results of the second treatment round as confirmation that the approach can and will deliver effective remediation. Dechlorination occurs upon achieving appropriate geochemical conditions, as demonstrated to date (KLF 2011f). For this treatment to be ultimately effective, three modifications are required:

- **Increase Spatial Distribution of Biostimulant**—the current injection influence on geochemistry is too localized around the proximity of injection. Additional injection points will achieve greater distribution and better treatment efficacy.
- **Manage pH**—although it is generally acceptable across the monitoring network, pH drop occurs at locations with elevated total organic carbon (TOC). Adding a buffering agent to the injection solution will mitigate such behavior.
- **Injection Flexibility**—injection frequency and biostimulant volume and concentration needs to be flexible based on observed geochemical conditions. In order to optimize treatment requires sustaining appropriate geochemical conditions in the treatment area. This will require monitoring of conditions and subsequent adjustment of biostimulant injection.

4.0 REMEDIAL ACTION GOALS AND OBJECTIVES

The remedial action goals and objectives for this Site have been developed following the outline presented in 6 NYCRR 375.

4.1 Remedial Action Goals

The goal of the remedial program for the Orangetown Shopping Center BCP site is to achieve a cleanup that is fully protective of public health and the environment per 6 NYCRR Part 375-3.8, and which addresses as necessary all impacted environmental media, such as soil, groundwater, and indoor air. The remedy will involve the use of the following actions, in their hierarchy of preference:

- Source removal (to the extent practical, soil in this case),
- Treatment of residual soil contamination, as well as the groundwater plume to meet applicable soil and groundwater quality goals (see below),
- Containment (the Site is an ongoing commercial enterprise with buildings and pavement covering the BCP), and
- Elimination of exposure (to address potential exposure to indoor air intrusion of volatiles).

At the request of JLJ and as discussed with NYSDEC, the remediation alternatives discussed in this AAR are expected to conform to the requirements of a Track 4 cleanup restricted to commercial land use, defined in 6 NYCRR 375-3.8(e) as follows:

> *Restricted use with site-specific soil cleanup objectives. The following provisions apply to a site, or portion thereof, being addressed pursuant to Track 4:*
>
> *(i) in developing the site-specific soil cleanup objectives, the Applicant may, solely or in combination:*
>
> *(a) use the soil cleanup objectives, as set forth in subpart 375-6;*
>
> *(b) develop or modify site specific soil cleanup objectives, as set forth at section 375-6.9; or*
>
> *(c) propose site-specific soil cleanup objectives which are protective of public health and the environment;*
>
> *(ii) the remedial program may include the use of long-term institutional or engineering controls to address all media; and*
>
> *(iii) exposed surface soils in a Track 4 remedy will be addressed as follows:…*

(b) for commercial use:

(1) the top one foot of all exposed surface soils which exceed the site background values for contaminants of concern and are not otherwise covered by the components of the development of the site (e.g. buildings, pavement), shall not exceed the applicable contaminant-specific soil cleanup objectives as set forth in subparagraph (2)(ii) above; and

(2) where it is necessary to utilize off-site soil to achieve this requirement, the soil brought to the site will satisfy the requirements of subdivision 375-6.7(d);

The NYSDEC considers this Site a Significant Threat as defined in 6 NYCRR 375-3.7. Therefore, based on the results of the RI and RI Addendum, several Remedial Action Objectives (RAOs) were identified for this Site.

4.2 Remedial Action Objectives

The following RAOs for the Orangetown Shopping Center BCP site have been identified, in accordance with guidance in 6 NYCRR 375-4.1, to protect public health and the environment.

4.2.1 Groundwater RAOs

- Public Health Protection RAOs
  - Prevent ingestion of groundwater containing contaminant levels exceeding drinking water standards
  - Prevent contact with or inhalation of volatiles emanating from contaminated groundwater
- Environmental Protection RAOs
  - Restore groundwater aquifer, to the extent practicable, to pre-disposal/pre-release conditions
  - Remove the source of ground or surface water contamination

4.2.2 Soil RAOs

- Public Health Protection RAOs
  - Prevent ingestion/direct contact with contaminated soil
  - Prevent inhalation of or exposure to contaminants volatilizing from contaminated soil
- Environmental Protection RAOs
  - Prevent migration of contaminants that would result in groundwater or surface water contamination.

4.2.3 Soil Vapor RAOs

- Public Health Protection RAOs
  - Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at a site.

4.3 Operable Units

The Operable Units (OUs) at the site currently include the following:

- 01A—Soil (soil excavation)
- 01B—In-Situ Treatment (soil and groundwater)
- 01C—Soil Vapor (Mitigation)

5.0 ENGINEERING EVALUATION OF THE REMEDY

KLF prepared this RAWP and the AAR (KLF 2011g) on behalf of JLJ.

The AAR evaluates various remedial technologies and assemblies of technologies for their ability to achieve the remedial goals and RAOs detailed in Section 4. The evaluation was performed following the approach discussed in Chapter 4 of DER-10 (NYSDEC 2010). Based upon the alternatives analysis, KLF recommended Assembly B as the best remedial alternative, and this remedy includes:

- **Institutional Control (IC)**—implementation of an Environmental Easement (or EE, see JLJ 2011)
- **Engineering Controls (or ECs)**—which includes the following components:
  - **SSDS**—this indoor air vapor intrusion mitigation system is in place and functioning as designed (see KLF 2011d)
  - **Bioaugmentation Treatment**—this sub-surface soil-groundwater treatment system is in place and functioning (see KLF 2011f)
  - **Building-Pavement Cover**—that is, Building #2 (see Figure 2) and the pavement along the south and east walls of the building
- **Site Management Plan (SMP)**—the site will be subject to a SMP that guides the operation and maintenance of the remedial system, various ECs, and the IC, as well as on-going monitoring (including periodic certification that the controls and systems remain in place & are effective.

While not a remedial technology per se, ICs/ECs (such as an environmental easement [EE]) may serve as components of a proposed remedial program where a remedial program is implemented with approval of the NYSDEC pursuant to Section 1.2(a) of DER-10 (NYSDEC 2010), for example under the BCP. KLF is of the opinion that Assembly B:

- Will effectively remediate the Site,
- Address the significant threat that the NYSDEC has determined is present, and
- Achieve to the extent practical the identified Site RAOs, in a cost effective manner, while limiting the exposure of contaminants to the surrounding community and reducing the contaminants found in the subsurface and mitigation of the potential for indoor air intrusion of chlorinated solvent vapor.

6.0 PROJECT PLANS AND SPECIFICATIONS

This section provides technical information with respect to the soil and groundwater remediation activities.

6.1 Introduction

The general sequence of remediation activities is:

- Source removal (This action is not a component of this RAWP [it was an IRM, see KLF 2011c]. We mention it here for completeness and continuity.)
- Institutional Control (IC) (Section 6.2)
- Engineering Controls (or ECs)
    - SSDS (Section 6.3)
    - Bioaugmentation Treatment (Section 6.4)
    - Building-Pavement Cover (Section 6.5)
- Site Management Plan (SMP, see Section 7.0)

6.2 Institutional Control (IC)

ICs at the Site include an Environmental Easement (EE) to provide ongoing protection of human health and environment at the Site. Additionally, no new drinking water wells can be installed, and there are no known existing drinking water wells. Existing business and dwellings and any new business and dwellings are to be connected to city water to avoid any potential hazards from the Site. JLJ has filed an EE with the NYSDEC (JLJ 2011).

6.3 EC #1—SSDS

As discussed in Section 3.2, the Site has a SSDS installed; the system is operating as designed (KLF 2011d). KLF has completed performance testing and based on the results, the system is achieving effective mitigation of the indoor vapor exposure pathway, meeting the RAO discussed in Section 4.2.3. The system will continue to operate as required under this RAWP until such time that the need for mitigation of the vapor intrusion pathway is achieved or the remedial objectives are met, and the NYSDEC and NYSDOH allow system operation to be discontinued.

6.4 EC #2—Bioaugmentation Remedial System

As discussed in Section 3.3, the Site has an installed and operable bioaugmentation treatment system. This IRM was implemented as a way to begin to address both the soil RAOs (see Section 4.2.2) and the groundwater RAOs (see Section 4.2.1). This treatment system is operating and effective; nonetheless, to achieve effective remediation will require a modification of this IRM (discussed in Section 6.5) and the placement of an IC-EE (see Section 6.2) to achieve the soil and groundwater RAOs.

Although the data from this IRM indicates injections of the 10% molasses solution has been successful in treating the source area, the radius of influence is insufficient to address the groundwater plume and there is a need to buffer in-situ pH and have greater flexibility of biostimulant injection to manage subsurface geochemistry. Thus, to improve bioaugmentation within the plume and achieve RAOs, KLF seeks to install ten additional injection well points in front of the concrete retaining wall and groundwater monitoring wells behind the concrete retaining wall. These additional injection points (injection gallery) will serve as a biologically active area. Additionally, if site conditions and treatment performance prove it necessary, three lateral injection well points below Sparkle Cleaners will be installed to more directly address sub-slab soils that remain impacted.

The following activities will modify the existing bioaugmentation IRM into a remedial system:

- Installation of additional injection and monitoring wells,
- Baseline groundwater sampling and monitoring,
- Lateral injection points below the floor slab within Sparkle Cleaners will be installed (if needed following TOC testing in groundwater below the building),
- Injection and post-injection monitoring, and
- Rebound monitoring.

6.4.1 Installation of Additional Injection and Monitoring Wells

KLF proposes an additional injection gallery through placement of multiple injection well points to treat impacted groundwater leaving the Site. As shown in Figure 8, the injection gallery will be located slightly west of the concrete retaining wall and will be approximately 100 to 120 feet in length. Ten (±) injection wells (or injection points, IP) will be installed approximately every 10 feet along the length of the injection gallery (Figure 8).

Each injection well (IP) installed within this injection gallery will consist of a nested-pair well, which will contain a shallow and deep well component. The shallow well component will be installed above competent rock or to a depth of 25 ft bgs, while the deep well component will be installed to a depth of 45 ft bgs. The injection wells will be constructed using Schedule 40 PVC and 10 ft of 0.040-inch slotted Schedule 40 PVC screen at least 1-inch in diameter. The annular space around the well screen will be backfilled using #2 sand to at least 2-feet above the well screen interval. The remaining space would be filled with a concrete grout well seal using a tremie-pipe. The injection well points will be completed within a protective watertight bolt-down roadbox set in a concrete pad. Additionally, each injection well point will be fitted with lockable, watertight caps. Figure 8 presents the proposed injection gallery.

In addition to the injection well points, six additional monitoring wells (currently called MW-A through MW-F) will be installed to evaluate the effects of bioaugmentation to the plume (see Figure 8).

- Two monitoring wells installed inside the Sparkle Cleaners store to a depth of between 15 to 20 ft bgs in order to evaluate the presence of TOC.
- One shallow monitoring well installed within the source removal area (west of MW-3) to a depth of approximately 10 ft bgs.
- Three monitoring wells installed east of the concrete retaining wall to monitor to effectiveness of the new injection gallery and ensure groundwater leaving the Site is being treated. These will be installed with a 5-foot screen section above the observed bedrock surface and a shallower 10-foot screen section bridging the water table.

Each of these monitoring wells will be constructed using Schedule 40 PVC and 10 feet of 0.040-inch slotted PVC screen and completed within a protective watertight bolt-down roadbox set in a concrete pad. Refer to Figure 8 for the locations of the proposed monitoring wells.

6.4.2 Baseline Groundwater Sampling and Monitoring

Prior to injections baseline groundwater sampling will be conducted using the existing monitoring well network (MW-2 through MW-5 and MW-8A/B) as well as the newly installed monitoring wells. Groundwater samples will be collected from each well and submitted for laboratory analysis of selected chlorinated VOCs, ethane, vinyl chloride (VC) and TOC. Groundwater at each well also will be monitored for temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO) and turbidity.

6.4.3 Lateral Injection Points

If laboratory analysis of groundwater samples collected from the newly installed wells within Sparkle Cleaners indicates the presence of TOC at concentrations greater than 50 milligrams/Liter (mg/L) for two consecutive quarters then lateral injection points will not be installed below the Sparkle Cleaners floor slab. The wells will continue to be used as monitoring points to assess bioaugmentation below the building. However, if laboratory analysis of the newly installed wells indicates the presence of TOC at concentrations less than 50 mg/L then lateral injection points would be installed to facilitate bioaugmentation below the Sparkle Cleaners facility.

Three lateral injection points would be installed within a 60-foot long trench that would be 1-foot wide and 2 to 3-feet deep. The first injection point would be located approximately 10 feet west of the source removal area, the second injection point would be located approximately 30 feet west of the source removal area and the third injection point would be located approximately 60 feet west of the source removal area. Each lateral injection point would be constructed using 10-feet of 1-inch diameter 0.020-inch slotted Schedule 40 PVC screen and 1-inch diameter Schedule 40 PVC casing to the stub-up location. The lateral piping would be backfilled with gravel and covered with concrete. Refer to Figure 9 for the location of the proposed lateral injection points.

6.4.4 Injection and Post-Injection Monitoring

A 10% molasses solution will be injected to the existing well points on a bi-monthly (every other month) schedule and to the newly installed injection well points on a bi-weekly (every other week) basis. Injections of molasses will be done using the existing conveyance piping and portable mixing tank. Injections to the new wells will use low-pressure injection (0-10 pounds per square inch [PSI]) by either gravity feed or pump from the mixing tank. No new conveyance piping is planned for the new injection well points.

Post-injection groundwater samples will be collected several days after the injection from the newly installed wells for laboratory analysis of selected chlorinated VOCs, ethene, VC and TOC to monitor the progress of the injections. Additionally, measurements of temperature, pH, ORP, DO and turbidity will be collected periodically.

For the first year, injections will continue on a bi-monthly (existing well points) and bi-weekly (new well points) schedule until suitable reducing conditions are observed. The frequency of injections will then be adjusted in order to maintain reducing conditions in the source area and area of newly installed injection wells. If after the first year significant reducing conditions have not been observed, an alternative approach may be evaluated in consultation with NYSDEC."

Based on the performance of the bioaugmentation IRM, KLF expects that less frequent injections will be needed to maintain appropriate conditions and avoid potential adverse effects of over stimulation. In the event that appropriate aquifer pH (6 to 8) and TOC concentration (greater than 50 mg/L) cannot be simultaneously maintained, then the injection solution may be buffered with sodium bicarbonate to counteract the organic acids generated from biological activity.

6.4.5 Rebound Monitoring

Key wells will be sampled quarterly for laboratory analysis of select chlorinated VOCs, ethene, VC and TOC for one year following completion of the injection program to monitor rebound. Measurements of temperature, pH, ORP, DO and turbidity will be collected at these wells on a quarterly basis for one year. Additionally, the Site monitoring wells will be sampled for laboratory analysis of chlorinated VOCs via United States Environmental Protection Agency (USEPA) Method 8260 and ethene within one year of the cessation of the injections.

If dissolved chlorinated VOC concentrations increase consistently in key wells over the rebound-monitoring period, then injections may be resumed in select portions of the treatment area, in consultation with NYSDEC. If concentrations remain steady then groundwater monitoring will be continued until asymptotic conditions are demonstrated or compliance with SCGs is achieved and NYSDEC and NYSDOH concur.

Additional injections and/or groundwater monitoring and sampling per the operations, maintenance and monitoring (OM&M) plan will continue until SCGs are met for soil and groundwater or until asymptotic conditions are achieved. At this point, KLF will submit a project closure report after consultation with NYSDEC and NYSDOH.

6.5 EC#3—Building-Pavement Cover

The third EC is Building-Pavement cover provided by Building #2 (see Figure 2) and the pavement along the south and east walls of the building. This cover provides an effective barrier to potential exposure posed by contaminated subsurface soils and perched groundwater. The shopping center has been at this property since the mid-1960s and remains a viable commercial enterprise. This cover system will remain in place for the foreseeable future providing an effective protective control of exposure to remaining soil contamination.

7.0 SITE MANAGEMENT PLAN (SMP)

KLF prepared a SMP (KLF 2011h) on behalf of JLJ, in accordance with the requirements in DER-10 (NYSDEC 2010) and other guidelines. An SMP addresses the means for implementing ICs and ECs that are required for the site. It provides a detailed description of the procedures required to manage remaining contamination at the site after completion of remedial action, including:

1. Implementation and management of ECs and IC,
2. Media monitoring,
3. Operation and maintenance of treatment, collection, containment, or recovery systems,
4. Performance of periodic inspections, certification of results, and submittal of Periodic Review Reports, and
5. Defining criteria for termination of treatment system operations.

8.0 HEALTH AND SAFETY

All work will be conducted under the health and safety and community air monitoring plans included in the IRM Work Plan (KLF 2008b), and as updated for inclusion in the SMP (KLF 2011h).

9.0 SCHEDULE

Currently, the SSDS and bioaugmentation systems are operating, and will continue operation as directed by NYSDEC. Together with the approval of the RAWP and SMP, anticipated in fall 2011, KLF will implement the changes to the bioaugmentation system described in Section 6 within 45-90 days pending coordination with tenants, weather, and contractor availability.

Actual scheduling and sequencing of project activities will be revised, as necessary, based on approvals, access to off-Site areas, contractor availability, etc. The schedule will be adjusted as preparations proceed and NYSDEC will be advised at least 7 days prior to beginning a new activity.

10.0 REPORTING

With the consent of NYSDEC, KLF will submit within the required 2011 timeframe a Final Engineering Report, that will incorporate the CCR's for source removal, SSDS, and bioagumentation treatment system, as well as confirm the activities discussed in this plan. Other reports documenting Site conditions and activities will continue to be submitted on a monthly basis, per the requirements of the BCA and the bioagumentation and SSDS OM&M plans, which are incorporated as part of the SMP.

11.0 REFERENCES

KLF, 2007a, Remedial Investigation Work Plan, Orangeburg (Orangetown) Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, dated July 2007

KLF, 2008a, Remedial Investigation Report, Orangeburg (Orangetown) Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, dated May 2008, revised August 2008

KLF, 2008b, Interim Remedial Measures Work Plan, Orangeburg (Orangetown) Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, dated June 2008, revised August 2008

KLF, 2009, Design Letter Report – Sub-Slab Depressurization System, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated September 2009

KLF, 2010a, Biostimulation Injection System Letter, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated January 29, 2010

KLF, 2010b, Sub-Slab Depressurization System Design Revision Letter, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated July 2010

KLF, 2011a, Biostimulation Injection System Revision Letter, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated April 1, 2011

KLF, 2011b, Revised Underground Injection Plan Letter, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated April 26, 2011

KLF, 2011c, Construction Completion Report #1 Source Removal, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated June 2011

KLF, 2011d, Construction Completion Report #2 Sub-Slab Depressurization System, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated August 2011

KLF, 2011e, Remedial Investigation Addendum Report, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated July 2011

KLF, 2011f, Construction Completion Report #3 Bioaugmentation Treatment, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated August 2011

KLF, 2011g, Alternatives Analysis Report, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated September 2011

KLF, 2011h, Site Management Plan, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, dated September 2011

JLJ, 2011, Environmental Easement, Orangetown Shopping Center, 1-45 Orangetown Shopping Center, Orangeburg, New York, 10962, recorded September 2011

New York State Department of Environmental Conservation (NYSDEC), various dates, Brownfield Cleanup Program Fact Sheet for Orangeburg Shopping Center, dated September 2007 through February 2010

NYSDEC, 2007, Brownfield Cleanup Program Citizen Participation Program for Orangeburg Shopping Center, dated March 2007

NYSDEC, 2007, Brownfield Cleanup Program Notice for Orangeburg Shopping Center, dated October 2007

NYSDEC, 2010, DER-10/Technical Guidance for Site Investigation and Remediation, dated May 3, 2010

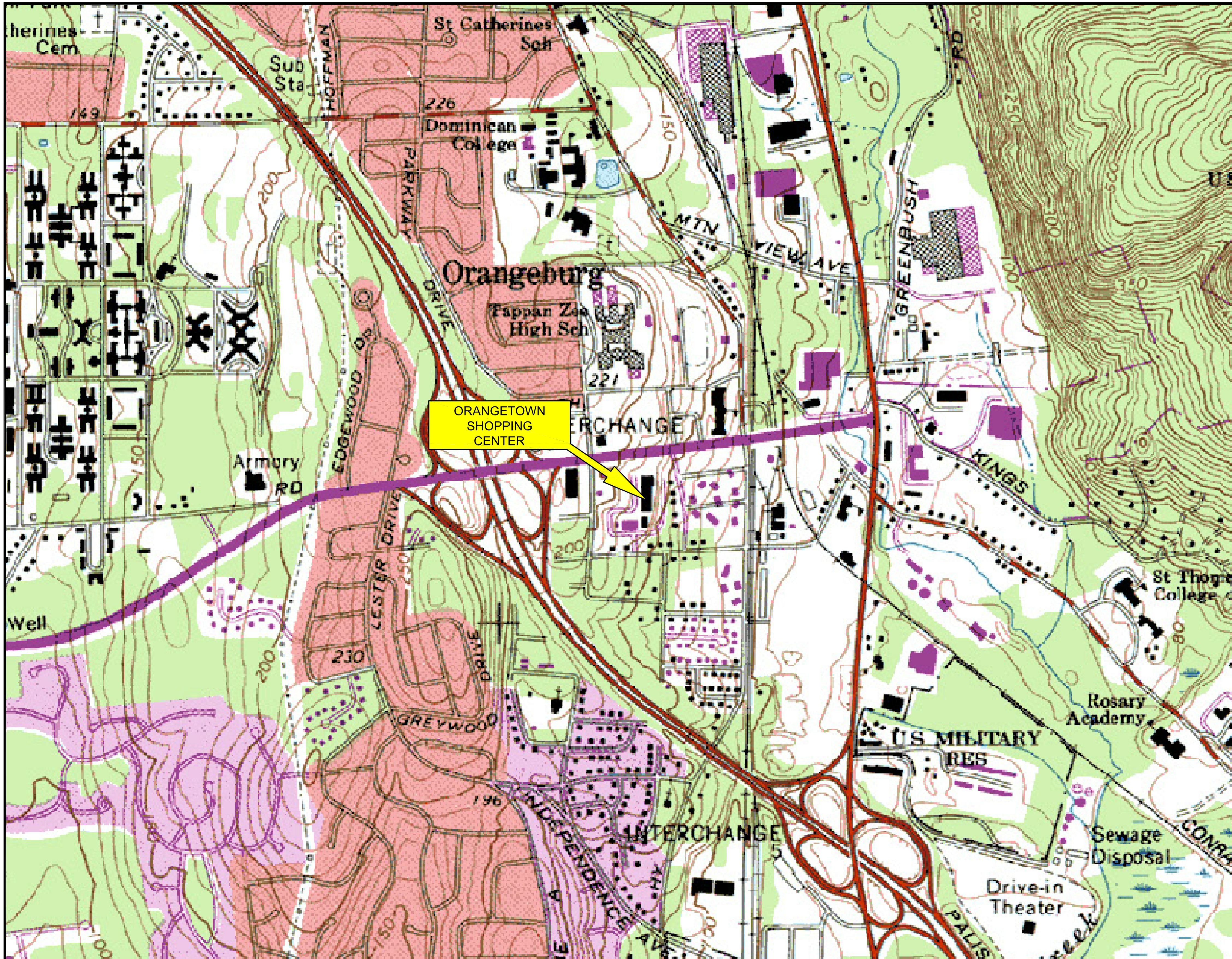
New York State Department of Health (NYSDOH), 2002, Generic Community Air Monitoring Plan, Troy, NY, December 2002

Table 1
New York State Soil Cleanup Objectives (SCO)
Orangeburg Shopping Center BCP Site #C344066
Orangeburg, NY

Analyte	Restricted Use Commercial	Protection of Groundwater
Volatile Organics		
1,1,1,2-Tetrachloroethane	NE	NE
1,1,1-Trichloroethane	500	0.68
1,1,2,2-Tetrachloroethane	NE	NE
1,1,2-Trichloroethane	NE	NE
1,1-Dichloroethane	240	0.27
1,1-Dichloroethene	500	0.33
1,1-Dichloropropene	NE	NE
1,2,3-Trichlorobenzene	NE	NE
1,2,3-Trichloropropane	NE	NE
1,2,4,5-Tetramethylbenzene	NE	NE
1,2,4-Trichlorobenzene	NE	NE
1,2,4-Trimethylbenzene	190	3.6
1,2-Dibromo-3-chloropropane	NE	NE
1,2-Dibromoethane	NE	NE
1,2-Dichlorobenzene	500	1.1
1,2-Dichloroethane	30	0.02
1,2-Dichloropropane	NE	NE
1,3,5-Trimethylbenzene	190	8.4
1,3-Dichlorobenzene	280	2.4
1,3-Dichloropropane	NE	NE
1,4-Dichlorobenzene	130	1.8
1,4-Diethylbenzene	NE	NE
2,2-Dichloropropane	NE	NE
2-Butanone	500	0.12
2-Hexanone	NE	NE
4-Ethyltoluene	NE	NE
4-Methyl-2-pentanone	NE	NE
Acetone	500	0.05
Acrylonitrile	NE	NE
Benzene	44	0.06
Bromobenzene	NE	NE
Bromochloromethane	NE	NE
Bromodichloromethane	NE	NE
Bromoform	NE	NE
Bromomethane	NE	NE
Carbon disulfide	NE	NE
Carbon tetrachloride	22	0.76
Chlorobenzene	500	1.1
Chloroethane	NE	NE
Chloroform	350	0.37
Chloromethane	NE	NE
cis-1,2-Dichloroethene	500	0.25
cis-1,3-Dichloropropene	NE	NE
Dibromochloromethane	NE	NE
Dibromomethane	NE	NE
Dichlorodifluoromethane	NE	NE
Ethylbenzene	390	1
Hexachlorobutadiene	NE	NE
Isopropylbenzene	NE	NE
Methyl tert butyl ether	500	0.93
Methylene chloride	500	0.05
n-Butylbenzene	NE	NE
n-Propylbenzene	500	3.9
Naphthalene	500	12
o-Chlorotoluene	NE	NE
o-Xylene	500	1.6
p-Chlorotoluene	NE	NE
p-Isopropyltoluene	NE	NE
p/m-Xylene	500	1.6
sec-Butylbenzene	500	11
Styrene	NE	NE
tert-Butylbenzene	500	5.9
Tetrachloroethene	150	1.3
Toluene	500	0.7
trans-1,2-Dichloroethene	500	0.19
trans-1,3-Dichloropropene	NE	NE
Trichloroethene	200	0.47
Trichlorofluoromethane	NE	NE
Vinyl acetate	NE	NE
Vinyl chloride	13	0.02
Organochlorine Pesticides by EPA 8081A		
4,4'-DDD	92	14
4,4'-DDE	62	17
4,4'-DDT	47	136
Aldrin	0.68	0.19
Alpha-BHC	3.4	0.02
Beta-BHC	3	0.09
Chlordane	24	2.9
Delta-BHC	500	0.25
Dieldrin	1.4	0.1
Endosulfan I	200	102
Endosulfan II	200	102
Endosulfan sulfate	200	1000
Endrin	89	0.06
Endrin ketone	NE	NE
Heptachlor	15	0.38
Heptachlor epoxide	NE	NE
Lindane	9.2	0.1
Methoxychlor	NE	NE
trans-Chlordane	NE	NE

Notes: NE Not Established **Units:** mg/kg (ppm)

Source: New York State Register and Official Compilation of Codes, Rules and Regulations of the State of New York (NYCRR) Chapter IV-Quality Services Subpart 375-6: Remedial Program Soil Cleanup Objectives (SCOs)



0 500 1,000 2,000

APPROXIMATE SCALE (feet)

N

LATITUDE: 41° 02' 40.82" N

LONGITUDE: 73° 57' 09.83" W

USGS 7.5' SERIES TOPOGRAPHIC MAP, NYACK NEW YORK-NEW JERSEY QUADRANGLE

QUADRANGLE LOCATION

NOTES:

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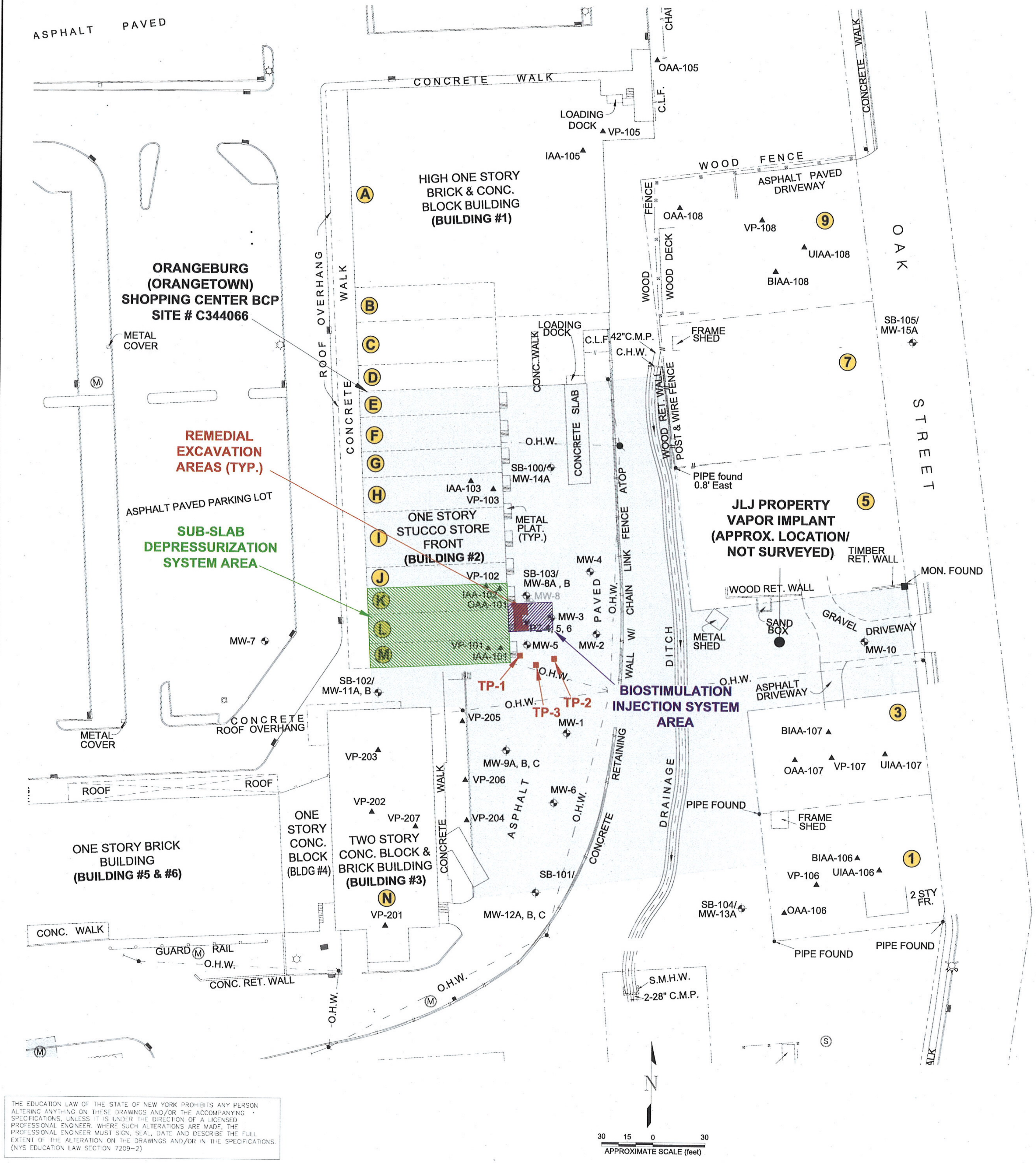
PROJECT NO.	69972
DRAWN:	02/11/11
DRAWN BY:	CTH
CHECKED BY:	KAF
FILE NAME: 69972RAWPJUL11.dwg	

LOCUS PLAN

ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

PLATE

1



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LEGEND

	PROPERTY BOUNDARY
	HYDRANT
	UTILITY POLE
	ELECTRIC COVER
	MANHOLE COVER (UNKNOWN)
	TELEPHONE MANHOLE COVER
	CATCH BASIN
	LIGHT POLE
Ⓢ	SEWER MANHOLE
C.L.F	C.L.F CHAIN LINK FENCE
C.H.W.	C.H.W. CONCRETE HEAD WALL
C.M.P	C.M.P. CORRUGATED METAL PIPE
O.H.W.	O.H.W. OVERHEAD WIRES
R.C.P.	R.C.P. REINFORCED CONCRETE PIPE
S.M.H.W.	S.M.H.W. STONE MASONRY HEAD WALL
	MONITORING WELL
	MONITORING WELL (PAVED OVER OR ABANDONED)
	PIEZOMETER
	VAPOR POINT/AMBIENT AIR SAMPLE
#	STREET ADDRESS NUMBER

COMMERCIAL STORE ID TABLE (BUILDING #2)

A	CVS PHARMACY
B	ORANGE FARM MARKET
C	RAINBOW LAUNDROMAT
D	MAGIE TOUCH NAILS
E	STELLA LUNA
F	TIP TOP SHOPPER
G	ALL STATE INSURANCE
H	HIKARO SUSHI
I	KARATE
J	JIU JITSU
K	THE DELI SPOT
L	SPARKLE CLEANERS
M	NEW CHINA HOUSE
N	DUNKIN DONUTS & DISCOUNT STORE

STATE OF NEW YORK
JUSTIN R. MOSES
LICENSED PROFESSIONAL ENGINEER
NO. 077926

SOURCE:

1. LAND LINK SURVEYORS P.C. SURVEY MAP DATED NOVEMBER 4, 2003.
2. SURVEY AMENDED TO SHOW NEW CERTIFICATION JUNE 1, 2005.
3. SURVEY AMENDED WELL LOCATION DECEMBER 19, 2007.
4. ADDITIONAL WELLS MW10, MW12, AND MW13 LOCATED DECEMBER 27, 2007

NOTES:

1. THE PREMISES SHOWN HEREON DESIGNATED AS LOT 1 ON A CERTAIN MAP ENTITLED " SUBDIVISION OF PROPERTY ORANGETOWN CENTER" AS FILED IN THE ROCKLAND COUNTY CLERK'S OFFICE ON FEBRUARY 26, 1990 AS MAP No. 6427 IN Book 111 Page 59 AND ARE DESCRIBED IN DEED RECORDED REEL 404, PAGE 2555.
2. THE DIMENSIONS SHOWN HEREON, FROM THE STRUCTURES TO THE PROPERTY LINE ARE NOT INTENDED TO BE USED FOR THE ERECTION OF FENCES, STRUCTURES OR ANY OTHER IMPROVEMENT.
3. ENCROACHMENTS BELOW GRADE AND/OR SUBSURFACE FEATURES, IF ANY, NOT LOCATED OR SHOWN HEREON.

NO.	REVISION	BY	DATE

KLEINFELDER ENGINEERING P.C.
ONE CORPORATE DRIVE, SUITE 201
BOHEMIA, NEW YORK 11716
PH. (631) 218-0612 FAX. (631) 218-0787
www.kleinfelder.com

PROJ. NO. 69972	ACAD FILE: 69972RAWPJUL11.dwg
DRAWN BY: CTH	CHECKED BY: KAF
	DESIGNED BY:

SITE PLAN

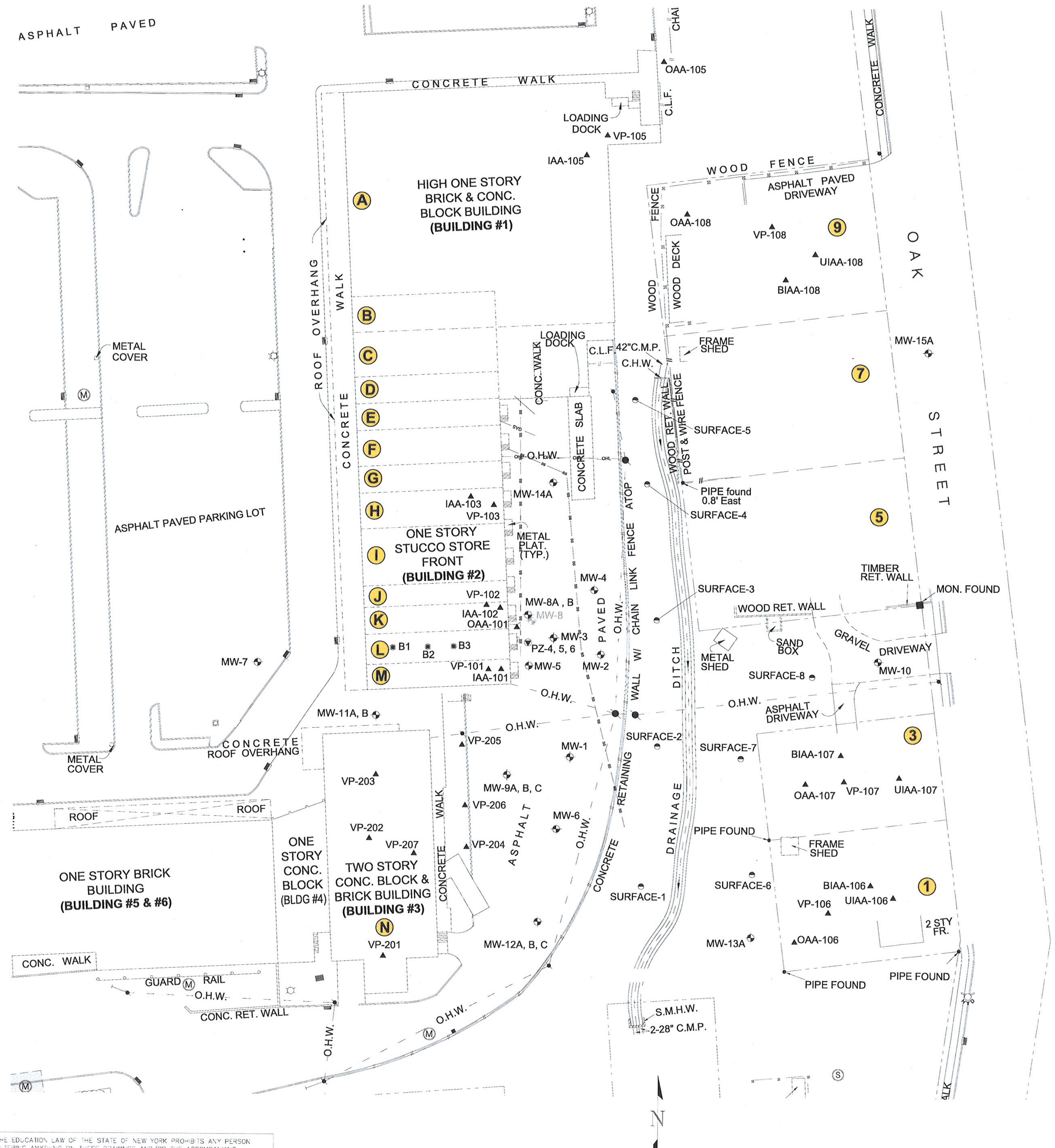
ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

FOR REDUCED PLANS: ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

DATE: 07/15/11

SCALE: AS SHOWN

PLATE 2



30 15 0 30
APPROXIMATE SCALE (feet)

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LEGEND

- PROPERTY BOUNDARY
- HYDRANT
- UTILITY POLE
- ELECTRIC COVER
- MANHOLE COVER (UNKNOWN)
- TELEPHONE MANHOLE COVER
- CATCH BASIN
- LIGHT POLE
- SEWER MANHOLE
- C.L.F — C.L.F CHAIN LINK FENCE
- C.H.W. — C.H.W. CONCRETE HEAD WALL
- C.M.P — C.M.P. CORRUGATED METAL PIPE
- O.H.W. — O.H.W. OVERHEAD WIRES
- R.C.P. — R.C.P. REINFORCED CONCRETE PIPE
- S.M.H.W. — S.M.H.W. STONE MASONRY HEAD WALL
- MONITORING WELL
- MONITORING WELL (PAVED OVER OR ABANDONED)
- PIEZOMETER
- VAPOR POINT/AMBIENT AIR SAMPLE
- SUB-SLAB SOIL SAMPLE
- SURFACE SOIL SAMPLE
- # STREET ADDRESS NUMBER

COMMERCIAL STORE ID TABLE (BUILDING #2)

A	CVS PHARMACY
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M	NEW CHINA HOUSE
N	DUNKIN DONUTS & DISCOUNT STORE

STATE OF NEW YORK JUSTIN R. MOSES LICENSED PROFESSIONAL ENGINEER NO. 077926

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4. ADDITIONAL WELLS MW10, MW12, AND MW13 LOCATED DECEMBER 27, 2007

NOTES:

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3. ENCROACHMENTS BELOW GRADE AND/OR SUBSURFACE FEATURES, IF ANY, NOT LOCATED OR SHOWN HEREON.
4. GROUNDWATER GAUGED AND SAMPLED ON APRIL 29, 2010.
5. MONITORING WELL MW-12A NOT INCLUDED IN GROUNDWATER CONTOURING DUE TO ANOMALOUS DATA.

NO.	REVISION	BY	DATE

KLEINFELDER ENGINEERING P.C.
ONE CORPORATE DRIVE, SUITE 201
BOHEMIA, NEW YORK 11716
PH. (631) 218-0612 FAX. (631) 218-0787
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PROJ. NO.	ACAD FILE:
69972	69972RAWPJUL11.dwg

DRAWN BY:	CHECKED BY:	DESIGNED BY:
CTH	KAF	

SITE PLAN AND SAMPLING LOCATIONS

ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

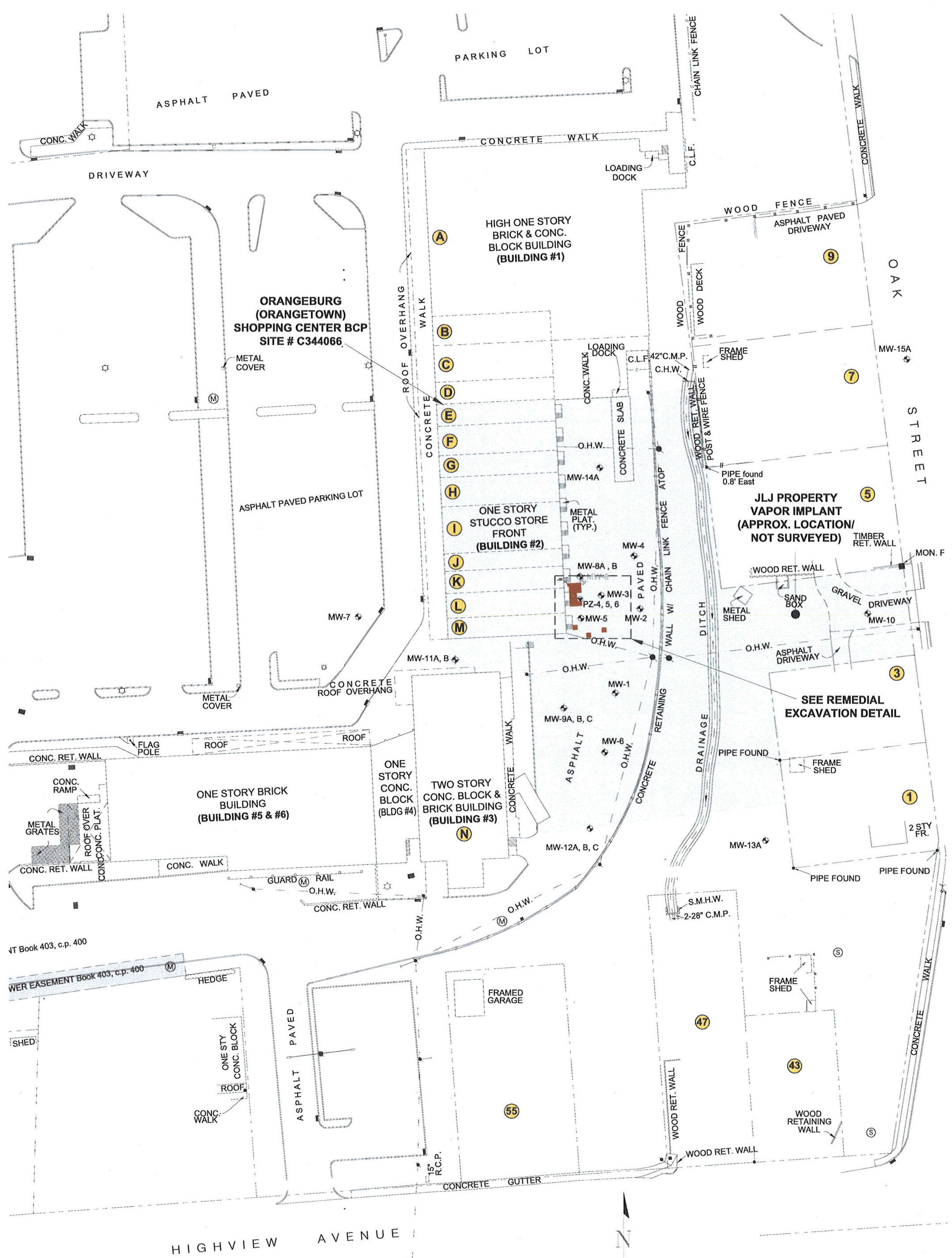
FOR REDUCED PLANS: ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

THIS DRAWING AND ALL INFORMATION CONTAINED HEREIN IS THE PROPERTY OF KLEINFELDER ENGINEERING, P.C. AND IS NOT TO BE USED BY ANYONE OTHER THAN THE CLIENT WITHOUT WRITTEN CONSENT.

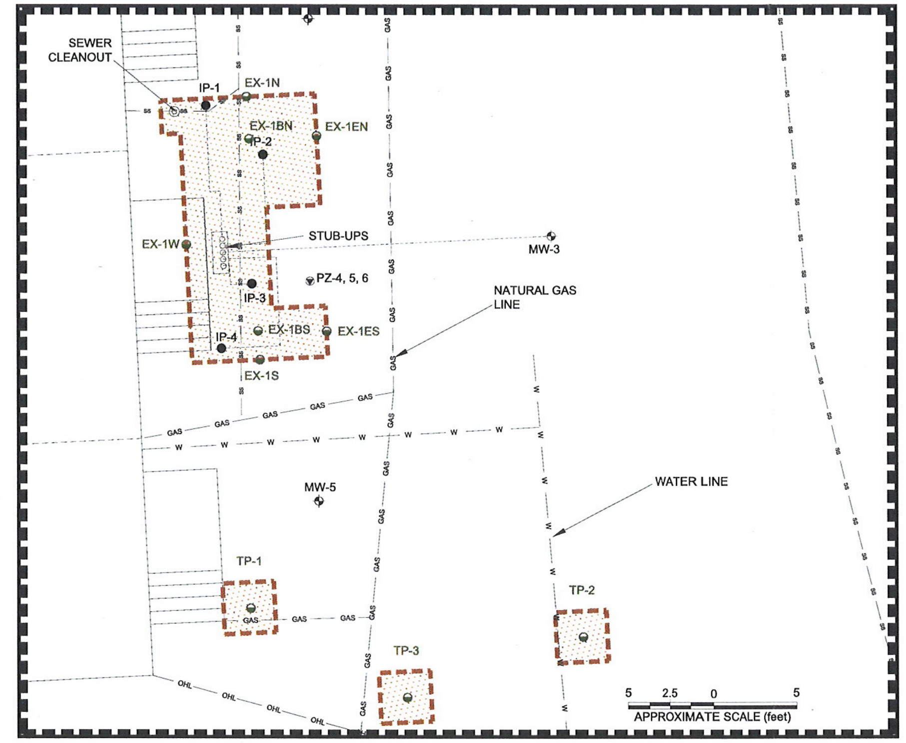
DATE: 07/14/11

SCALE: AS SHOWN

PLATE 3



REMEDIAL EXCAVATION DETAIL



LEGEND

PROPERTY BOUNDARY
HYDRANT
UTILITY POLE
ELECTRIC COVER
MANHOLE COVER (UNKNOWN)
TELEPHONE MANHOLE COVER
CATCH BASIN
LIGHT POLE
SEWER MANHOLE
C.L.F CHAIN LINK FENCE
C.H.W. CONCRETE HEAD WALL
C.M.P. CORRUGATED METAL PIPE
O.H.W. OVERHEAD WIRES
R.C.P. REINFORCED CONCRETE PIPE
S.M.H.W. STONE MASONRY HEAD WALL
MONITORING WELL
MONITORING WELL (PAVED OVER OR ABANDONED)
PIEZOMETER
VAPOR POINT/AMBIENT AIR SAMPLE
STREET ADDRESS NUMBER
REMEDIAL EXCAVATION
SOIL SAMPLE LOCATION
BIOSTIMULATION INJECTION POINT

COMMERCIAL STORE ID TABLE (BUILDING #2)

A	CVS PHARMACY
B	ORANGE FARM MARKET
C	RAINBOW LAUNDROMAT
D	MAGIE TOUCH NAILS
E	STELLA LUNA
F	TIP TOP SHOPPER
G	ALL STATE INSURANCE
H	HIKARO SUSHI
I	KARATE
J	JIU JITSU
K	THE DELI SPOT
L	SPARKLE CLEANERS
M	NEW CHINA HOUSE
N	DUNKIN DONUTS & DISCOUNT STORE

STATE OF NEW YORK JUSTIN R. ... LICENSED PROFESSIONAL ENGINEER NO. 077928

SOURCE:

1. LAND LINK SURVEYORS P.C. SURVEY MAP DATED NOVEMBER 4, 2003.
2. SURVEY AMENDED TO SHOW NEW CERTIFICATION JUNE 1, 2005.
3. SURVEY AMENDED WELL LOCATION DECEMBER 19, 2007.
4. ADDITIONAL WELLS MW10, MW12, AND MW13 LOCATED DECEMBER 27, 2007

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NO.	REVISION	BY	DATE
		-	-

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REMEDIAL EXCAVATION AND SAMPLE LOCATION MAP

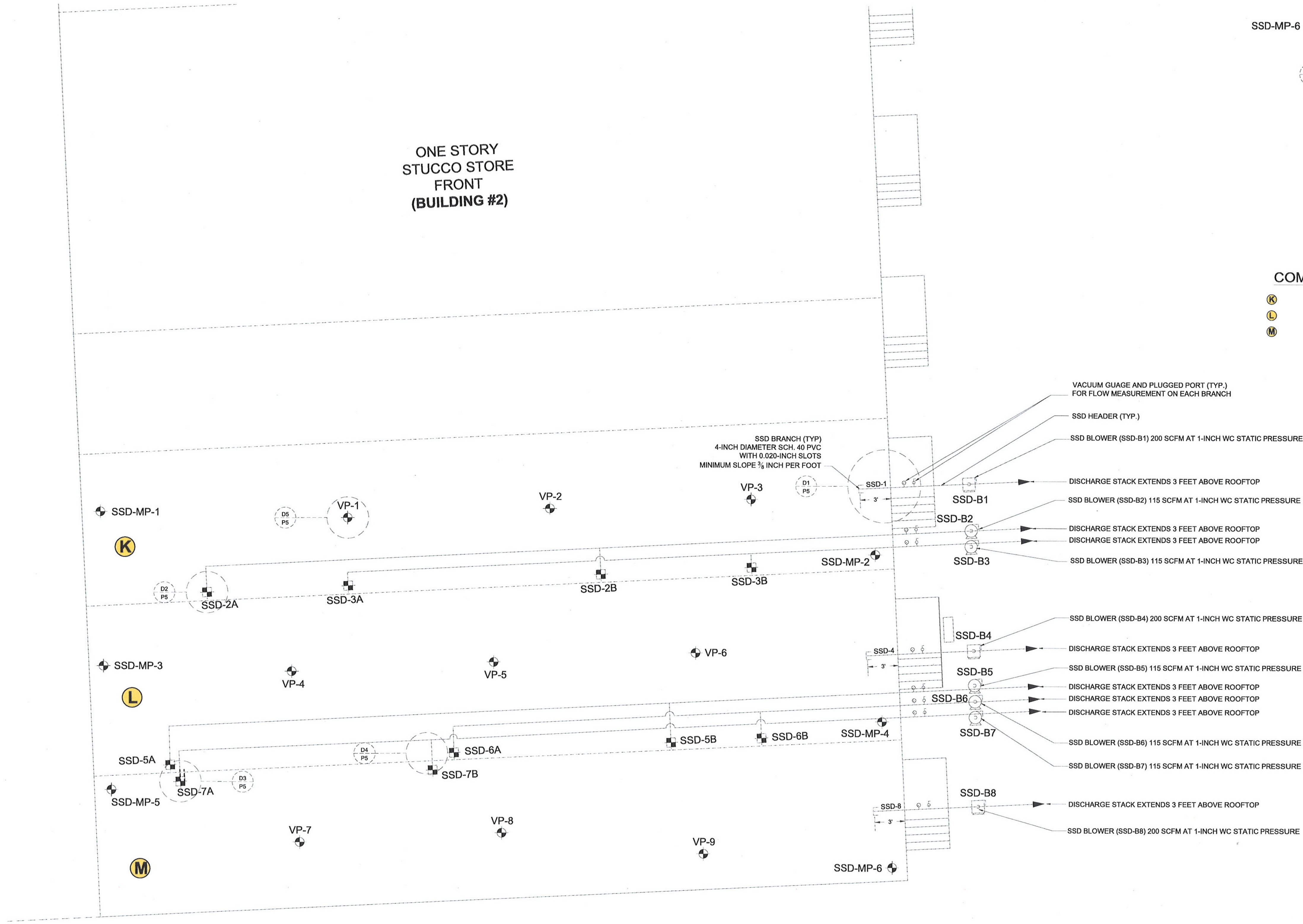
ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

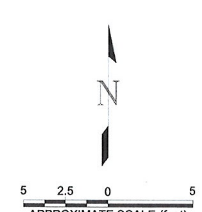
FOR REDUCED PLANS: ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

DATE: 07/15/11

SCALE: AS SHOWN

PLATE 4



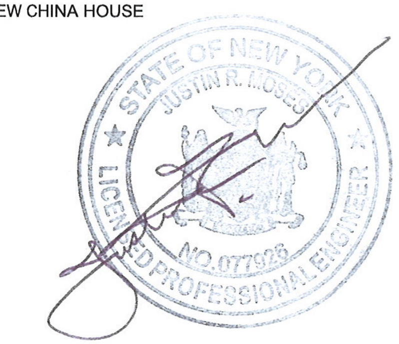


LEGEND

SSD-MP-6	SUB-SLAB MONITORING PORT
	SUB-SLAB VAPOR EXTRACTION WELL
D1 P5	DETAIL NUMBER PLATE NUMBER
	SSD BLOWER (115 SCFM)
	SSD BLOWER (200 SCFM)
	VACUUM GAUGE
	PLUGGED PORT

COMMERCIAL STORE ID TABLE (BUILDING #2)

K	THE DELI SPOT
L	SPARKLE CLEANERS
M	NEW CHINA HOUSE



NOTES:

1. THE EXTRACTION PIPING INSIDE THE BUILDING IS ROUTED ABOVE THE SUB-CEILING OR ALONG THE EXTERIOR WALL.
2. DISCHARGE STACKS EXTEND 3 FEET ABOVE THE ROOFTOP (TYP.).

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NO.	REVISION	BY	DATE
1	ADDED ADDITIONAL SAMPLING LOCATIONS	CTH	10/14/10
△			
△			
△			
△			

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CTH	KAF	

SUB-SLAB DEPRESSURIZATION SYSTEM CONFIGURATION

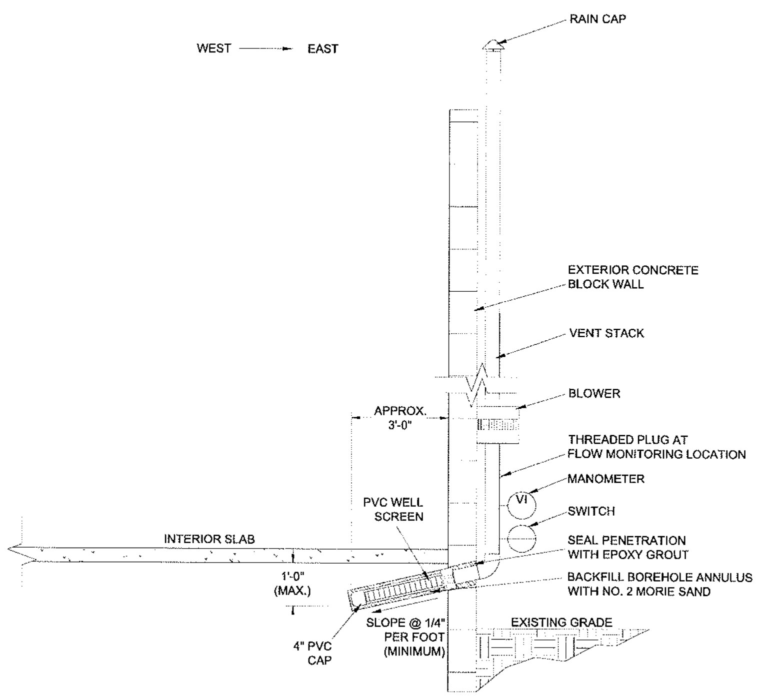
ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

FOR REDUCED PLANS:
ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

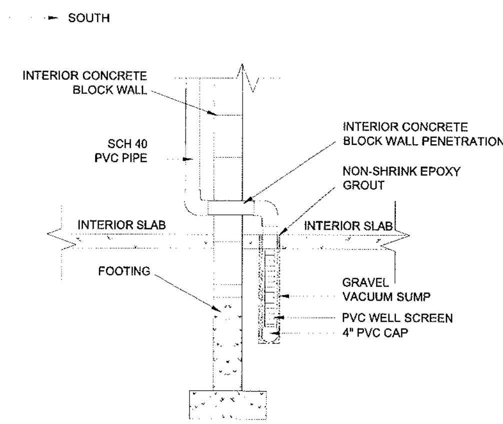
DATE: 07/15/11

SCALE: AS SHOWN

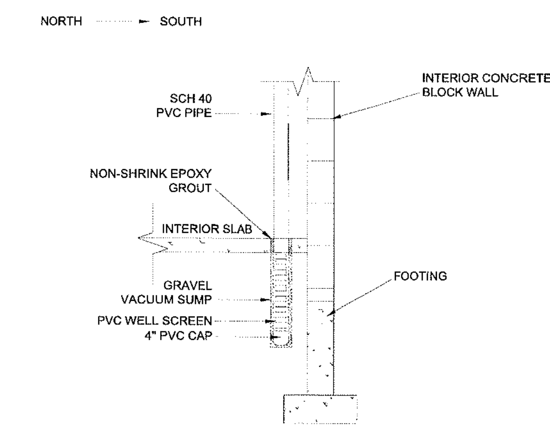
PLATE 5



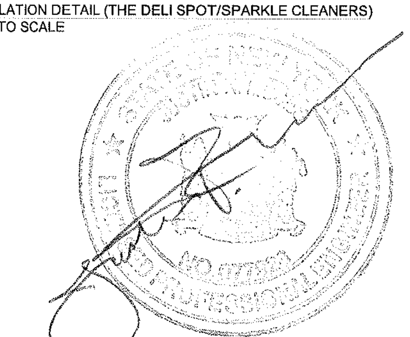
D1 / P5 TYPICAL SUB-SLAB DEPRESSURIZATION BRANCH INSTALLATION DETAIL (SSD-6-8)
NOT TO SCALE

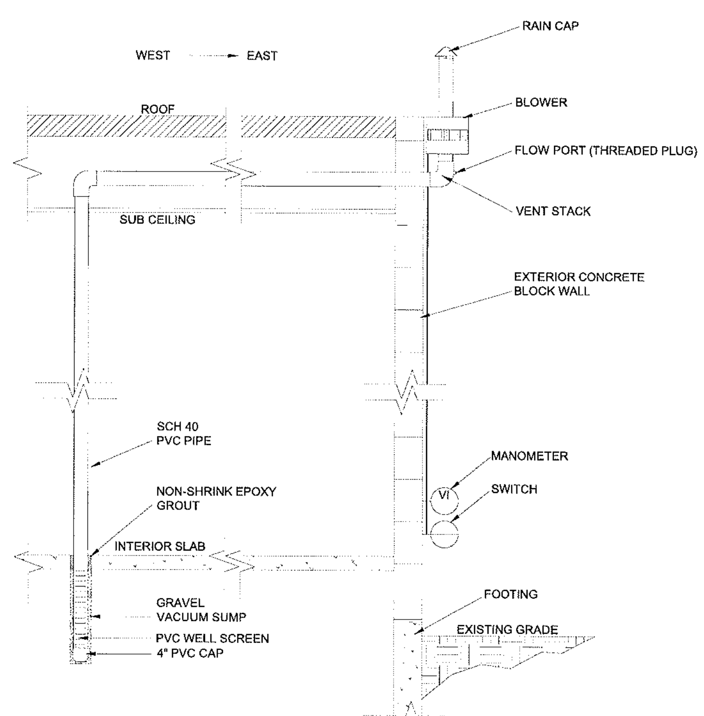


D3 / P5 TYPICAL SUB-SLAB VAPOR EXTRACTION INSTALLATION DETAIL (NEW CHINA HOUSE)
NOT TO SCALE

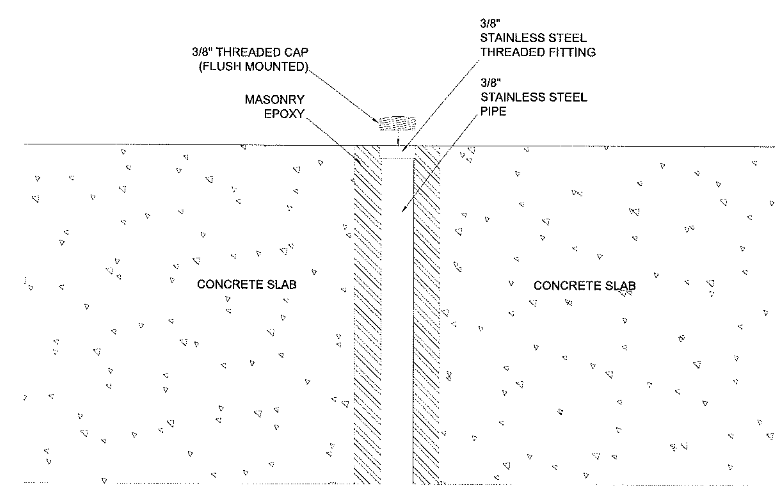


D4 / P5 TYPICAL SUB-SLAB VAPOR EXTRACTION INSTALLATION DETAIL (THE DELI SPOT/SPARKLE CLEANERS)
NOT TO SCALE





D2 / P5 TYPICAL SUB-SLAB VAPOR EXTRACTION INSTALLATION DETAIL (THE DELI SPOT/SPARKLE CLEANERS)
NOT TO SCALE



D5 / P5 TYPICAL SUB-SLAB DEPRESSURIZATION MONITORING POINT INSTALLATION DETAIL
NOT TO SCALE

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NO	REVISION	BY	DATE
1	ADDED ADDITIONAL DETAILS	CTH	10/14/10

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PROJ. NO	ACAD FILE:	
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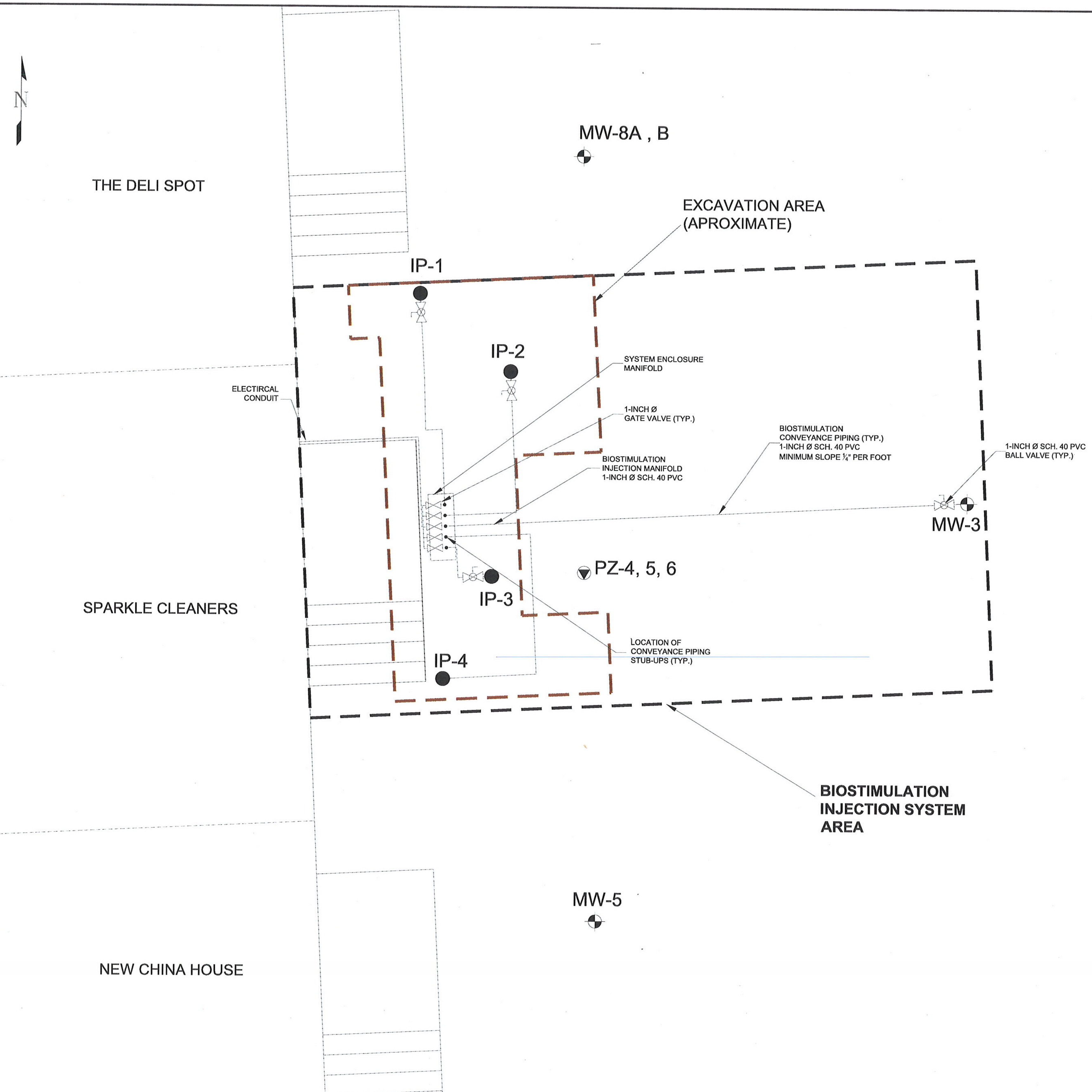
CTH	KAF	

SUB-SLAB DEPRESSURIZATION SYSTEM DETAILS

ORANGETOWN SHOPPING CENTER
145 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

FOR REDUCED PLANS
ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

DATE: 07/15/11
SCALE: AS SHOWN
PLATE: 6

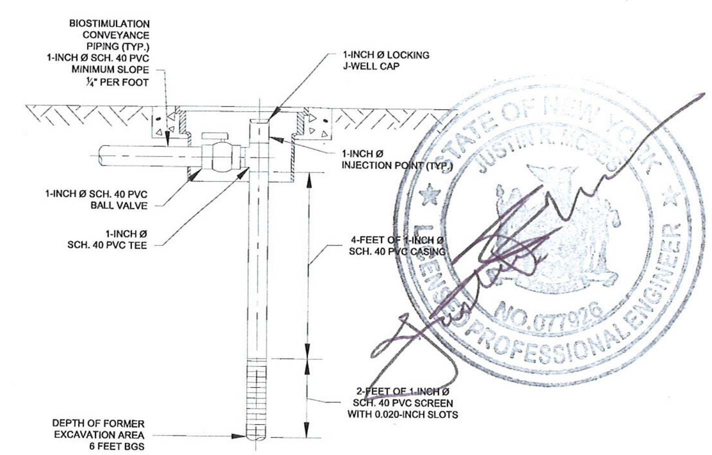


MW-2

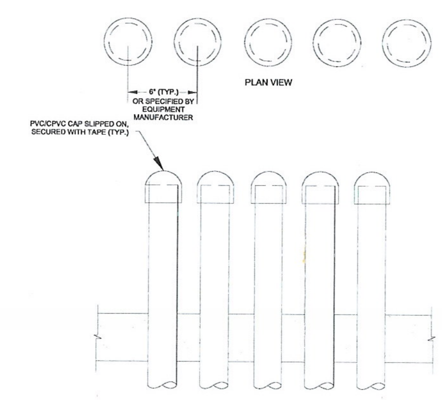
2 1 0 2
APPROXIMATE SCALE (feet)

LEGEND

IP-4 ●	BIOSTIMULATION INJECTION POINT
MW-8A , B	MONITORING WELLS
PZ-4, 5, 6	PIEZOMETER



BIOSTIMULATION INJECTION WELL DETAIL



STUB-UP WELL DETAIL

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NO.	REVISION	BY	DATE
		-	-

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PROJ. NO.	ACAD FILE:
69972	69972RAWPJUL11.dwg

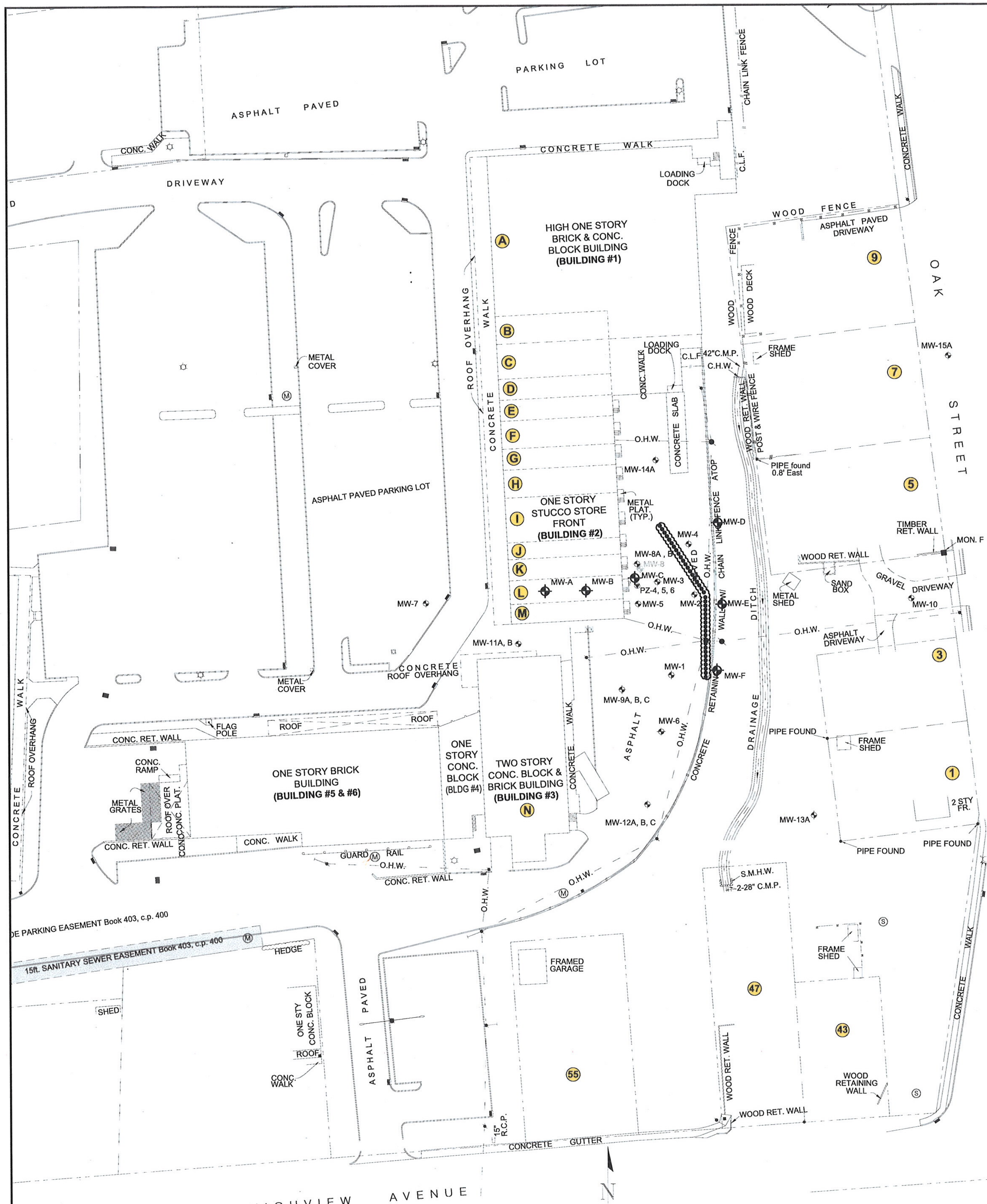
DRAWN BY:	CHECKED BY:	DESIGNED BY:
CTH	KAF	

BIOSTIMULATION INJECTION WELL CONFIGURATION

ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

FOR REDUCED PLANS: ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

DATE: 07/15/11
SCALE: AS SHOWN
PLATE 7



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LEGEND

PROPERTY BOUNDARY
HYDRANT
UTILITY POLE
ELECTRIC COVER
MANHOLE COVER (UNKNOWN)
TELEPHONE MANHOLE COVER
CATCH BASIN
LIGHT POLE
SEWER MANHOLE
C.L.F — C.L.F CHAIN LINK FENCE
C.H.W. — C.H.W. CONCRETE HEAD WALL
C.M.P — C.M.P. CORRUGATED METAL PIPE
O.H.W. — O.H.W. OVERHEAD WIRES
R.C.P. — R.C.P. REINFORCED CONCRETE PIPE
S.M.H.W. — S.M.H.W. STONE MASONRY HEAD WALL
MONITORING WELL
MONITORING WELL (PAVED OVER OR ABANDONED)
PIEZOMETER
VAPOR POINT/AMBIENT AIR SAMPLE
STREET ADDRESS NUMBER
PROPOSED MONITORING WELL
PROPOSED INJECTION GALLERY (WITH INJECTION POINTS)

COMMERCIAL STORE ID TABLE (BUILDING #2)

A	CVS PHARMACY
B	ORANGE FARM MARKET
C	RAINBOW LAUNDROMAT
D	MAGIE TOUCH NAILS
E	STELLA LUNA
F	TIP TOP SHOPPER
G	ALL STATE INSURANCE
H	HIKARO SUSHI
I	KARATE
J	JIU JITSU
K	THE DELI SPOT
L	SPARKLE CLEANERS
M	NEW CHINA HOUSE
N	DUNKIN DONUTS & DISCOUNT STORE

STATE OF NEW YORK — JUSTIN R. ... — LICENSED PROFESSIONAL ENGINEER — NO. 072...

SOURCE:

1. LAND LINK SURVEYORS P.C. SURVEY MAP DATED NOVEMBER 4, 2003.
2. SURVEY AMENDED TO SHOW NEW CERTIFICATION JUNE 1, 2005.
3. SURVEY AMENDED WELL LOCATION DECEMBER 19, 2007.
4. ADDITIONAL WELLS MW10, MW12, AND MW13 LOCATED DECEMBER 27, 2007

NOTES:

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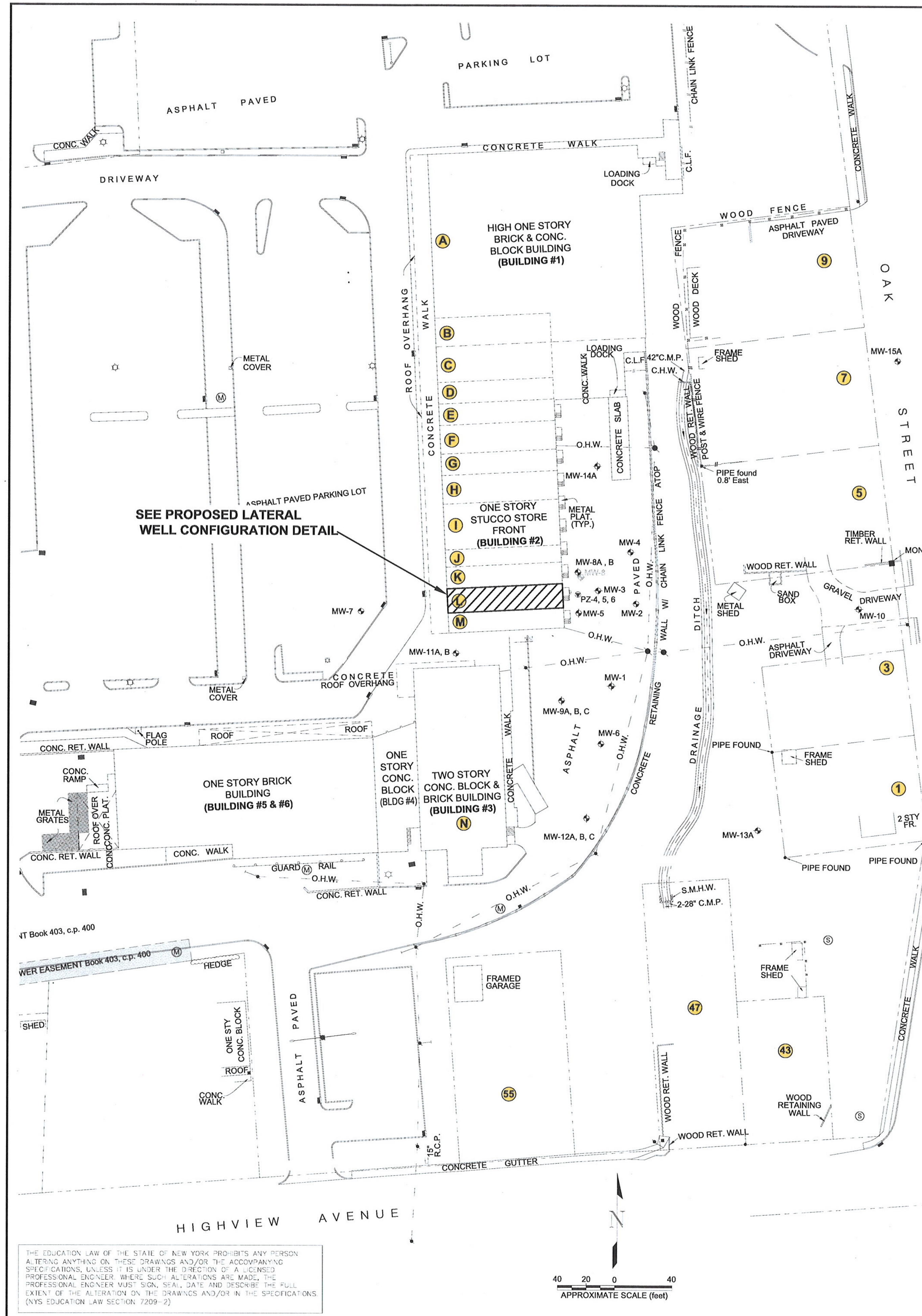
SITE PLAN WITH PROPOSED INJECTION GALLERY AND MONITORING WELL LOCATIONS

ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

FOR REDUCED PLANS: ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

DATE: 07/18/11
SCALE: AS SHOWN
PLATE 8



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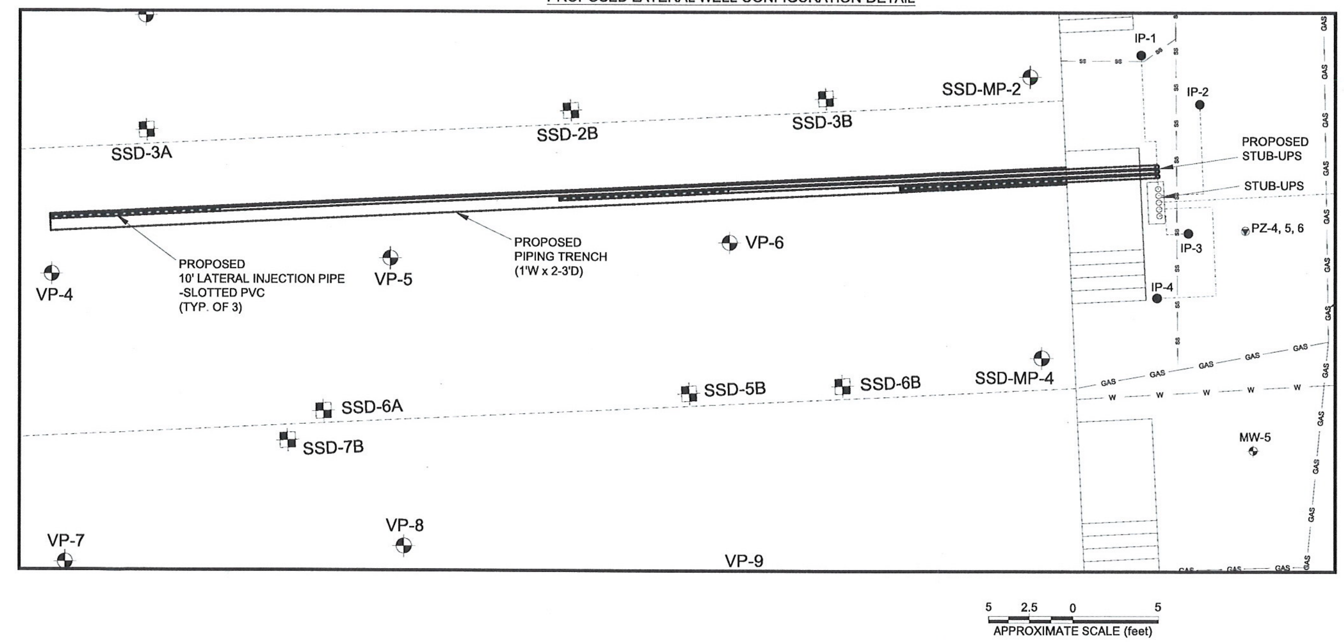
PROPOSED LATERAL WELL CONFIGURATION DETAIL



LEGEND

- PROPERTY BOUNDARY
- HYDRANT
- UTILITY POLE
- ELECTRIC COVER
- MANHOLE COVER (UNKNOWN)
- TELEPHONE MANHOLE COVER
- CATCH BASIN
- LIGHT POLE
- SEWER MANHOLE
- C.L.F CHAIN LINK FENCE
- C.H.W. CONCRETE HEAD WALL
- C.M.P CORRUGATED METAL PIPE
- O.H.W. OVERHEAD WIRES
- R.C.P. REINFORCED CONCRETE PIPE
- S.M.H.W. STONE MASONRY HEAD WALL
- MONITORING WELL
- MONITORING WELL (PAVED OVER OR ABANDONED)
- PIEZOMETER
- VAPOR POINT/AMBIENT AIR SAMPLE
- STREET ADDRESS NUMBER
- IP-4 BIOSTIMULATION INJECTION POINT

COMMERCIAL STORE ID TABLE (BUILDING #2)

A	CVS PHARMACY
B	ORANGE FARM MARKET
C	RAINBOW LAUNDROMAT
D	MAGIE TOUCH NAILS
E	STELLA LUNA
F	TIP TOP SHOPPER
G	ALL STATE INSURANCE
H	HIKARO SUSHI
I	KARATE
J	JIU JITSU
K	THE DELI SPOT
L	SPARKLE CLEANERS
M	NEW CHINA HOUSE
N	DUNKIN DONUTS & DISCOUNT STORE

STATE OF NEW YORK
LICENSED PROFESSIONAL ENGINEER

SOURCE:

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NO	REVISION	BY	DATE

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DRAWN BY:	CHECKED BY:	DESIGNED BY:
CTH	KAF	

LATERAL INJECTION WELL CONFIGURATION

ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

FOR REDUCED PLANS: ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

DATE: 07/18/11
SCALE: AS SHOWN
PLATE 9

New York State Department of Environmental Conservation

FACT SHEET

Brownfield Cleanup Program

Orangetown Shopping Center
Site #C344066
Town of Orangetown, NY

December 2008

Interim Remedial Action to Address Brownfield Site Contamination to Begin

Construction is about to begin at the Orangetown Shopping Center located at the corner of Dutch Hill Road and Orangeburg Road in the Town of Orangetown, Rockland County under New York's Brownfield Cleanup Program (BCP). See attached map for the location of the site. Kleinfelder East, Inc. (environmental consultant for the owner, JLJ Management Company) will soon begin remedial activities to address contamination at the site with oversight provided by the New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH).

NYSDEC previously accepted an application submitted by JLJ Management Company to participate in the BCP. The application proposes that the site will continue to be used for commercial purposes.

Highlights of the Upcoming Site Remedial Activities
Remedial activities have several goals:

1) Remediate contamination at the site to a level that is fully protective of public health and the environment, and
2) Account for the intended or reasonably anticipated future use of the site.

"Remedial activities" and *"remediation"* refer to all necessary actions to address any known or suspected contamination associated with the site.

Tasks to resolve the data gaps identified in previous investigations include the following with approximate schedule as noted:

- Evaluation, repair and sampling of damaged groundwater monitoring wells (January 2009);
- Gauging and sampling of all[1] groundwater monitoring wells (January 2009 and May 2009);
- Investigation of soil beneath Sparkle Cleaners and an investigation of soil vapor beneath the Sparkle Cleaners building (January 2009 through March 2009);
- Indoor air and soil vapor sampling at several properties. The property tenants or owners will be contacted to schedule sampling. (January 2009 through March 2009).

Brownfield Cleanup Program: New York's Brownfield Cleanup Program (BCP) encourages the voluntary cleanup of contaminated properties known as "brownfields" so that they can be reused and redeveloped. These uses include recreation, housing and business.

A **brownfield** is any real property that is difficult to reuse or redevelop because of the presence or potential presence of contamination.

For more information about the BCP, visit:
www.dec.state.ny.us/website/der/bcp

[1] A list of all groundwater monitoring wells may be found in Section 4.1.1 of the Remedial Investigation Report.

The interim remedial measures will include the following:

- Development and implementation of a vapor intrusion mitigation plan at Sparkle Cleaners (March 2009);
- Review and evaluation of the operating procedures, heating, ventilation and air conditioning (HVAC) system and plumbing system at Sparkle Cleaners (February 2009);
- Soil excavation of the on-site source area which will involve operating heavy equipment on-site during the work period and trucking of waste materials off-site on a limited number of days near the end of the work period. Sewer service to three tenants of the shopping center *may* be interrupted for short periods of time during the excavation process. During the excavation process, dust and vapor monitoring will be conducted, the results of which will be submitted to the NYSDOH on a weekly basis. Prior to the start of excavation, utilities in the area of the excavation will be identified by a utility locating service. (January 2009 through February 2009).
- Following soil excavation, chemical treatment or biological augmentation will be evaluated as a means of addressing any residual material which could not be removed by excavation and if needed to address contaminants in groundwater. Typically, chemical treatments of the type under consideration would require the use of drilling equipment to inject the treatment chemicals into the subsurface. No interference to off-site properties is expected.

Next Steps

JLJ Management Company is expected to begin remedial activities at the Orangetown Shopping Center on or about January 5, 2009. These activities are anticipated to take about six months to complete. The remedial excavation portion of the remediation will be conducted in one month or less. NYSDEC and the NYSDOH will oversee the remedial activities. Within 90 days of completing remedial activities, JLJ Management Company must submit to NYSDEC a Construction Completion Report (CCR). The CCR will describe the Interim Remedial Measures (IRM) completed and certify that the requirements of the IRM Work Plan were followed.

Following completion of the IRM, further sampling of groundwater, indoor air and soil vapor will likely be necessary. Following any further investigation/monitoring activities that may be necessary, an Addendum to the Remedial Investigation (RI) Report will be submitted for review by the NYSDEC and NSYDOH. The NYSDEC will complete its review, have any necessary revisions made and, if appropriate, approve the RI Report Addendum. The approved RI Report Addendum will be placed in the document repositories. JLJ Management may then develop a Remedial Work Plan. This plan describes how the Applicant would address any contamination remaining related to the brownfield site. The remedial work would be performed with oversight by NYSDEC and NYSDOH. When JLJ Management submits a Remedial Work Plan for approval, NYSDEC will announce the availability of the draft plan for public review and a 45-day comment period.

NYSDEC will keep the public informed throughout the investigation and remediation of the Orangetown Shopping Center Site.

Background

The site is located at the southeast comer of Orangeburg and Dutch Hill Roads in Orangeburg, NY, and is situated in a suburban area of mixed land use. It consists of an approximately 1.2-acre portion of the 11 - acre parcel which is improved with a shopping center. The shopping center is comprised of five buildings and a total of seven distinct building components. The area is a well-developed village/town setting, characterized by general business, commercial, and institutional (public) development. The Town of Orangetown designates this general area as a Commercial (CS) Zone.

The site had been used as farmland, a camp, an amphitheater, and the current retail shopping center. There has been a dry cleaner operating at the shopping center since approximately 1966. Investigations performed to date have confirmed the presence of contamination caused by the release of dry cleaning fluid.

JLJ Management applied to the Brownfield Cleanup Program in May 2006 and the Brownfield Cleanup Agreement between the NYSDEC and JLJ Management was executed by the NYSDEC in January 2007.

The Remedial Investigation Work Plan was approved July 2007 and the investigation was conducted in Fall 2007. A Remedial Investigation Report, detailing work performed to date, was completed in August 2008.

FOR MORE INFORMATION

Document Repositories

Document repositories have been established at the following locations to help the public to review important project documents. These documents include the RI Report and the application to participate in the BCP accepted by NYSDEC:

Orangeburg Library
20 South Greenbush Road
Orangeburg, NY 10962
Attn: Nancy Wissman, Director
Phone: (845) 359-2244
Hours:
Mon-Thurs 10:00 am - 9:00 pm
Fri-Sat 10:00 am - 5:00 pm
Sun 1:00 pm - 5:00 pm

NYSDEC Region 3 Office
21 S. Putt Comers Road
New Paltz, NY 12561
Attn: Michael Knipfing
Phone: (845) 256-3154
Hours:
Mon - Fri 8:30 am - 4:45 pm
By Appointment

NYSDEC Remedial Bureau C
625 Broadway, 11th Floor
Albany, NY 12233-7014
Attn: Joshua Cook
Phone: 1-866-520-2334
Hours:
Mon – Fri 7:30 am – 3:45 pm
By Appointment

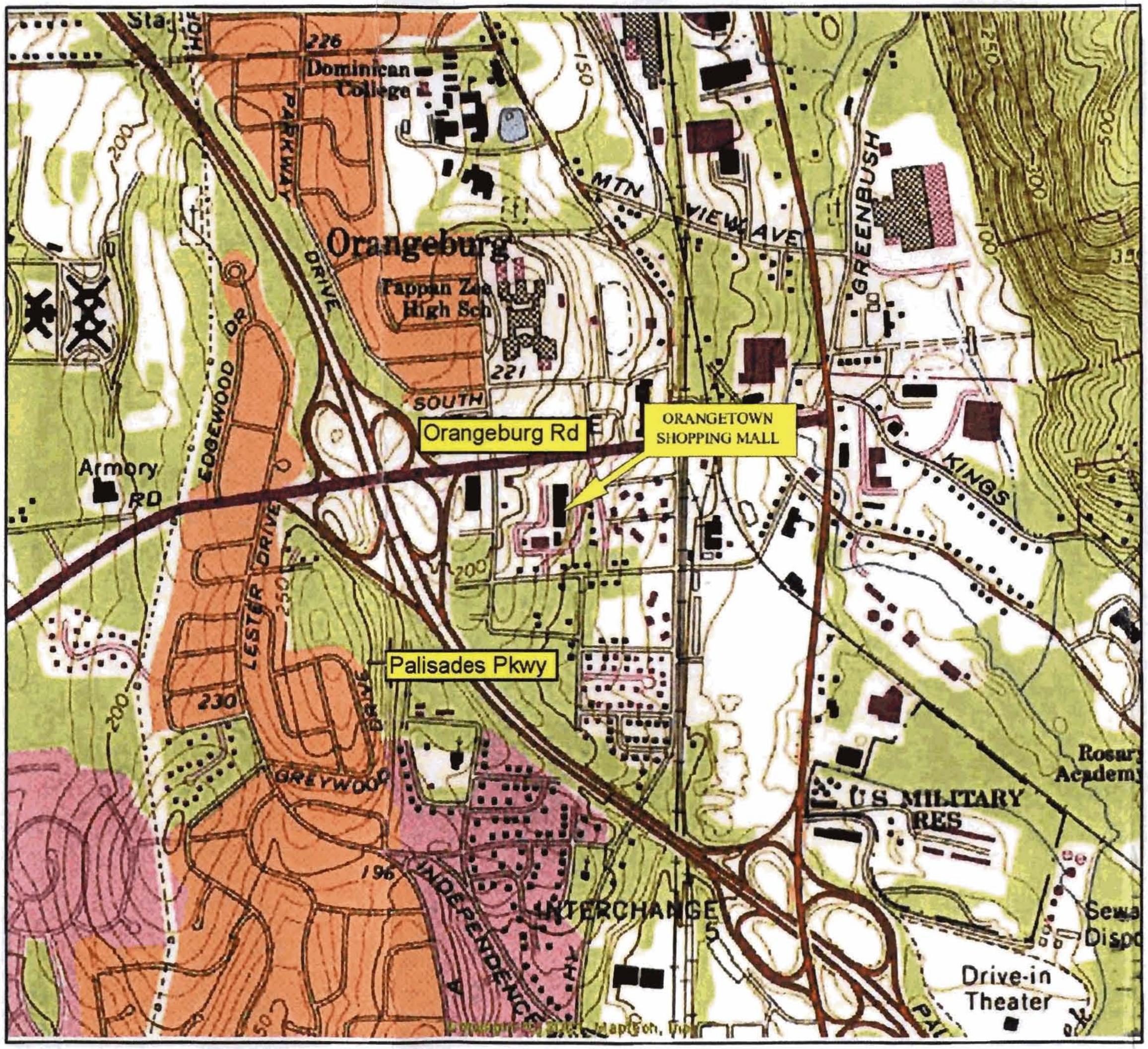
Who to Contact

Comments and questions are always welcome and should be directed as follows:

Project Related Questions
Joshua Cook
NYSDEC Remedial Bureau C
625 Broadway, 11th Floor
Albany, NY 12233-7014
1-866-520-2334
jpcook@gw.dec.state.ny.us

Health Related Questions
Nathan Walz
New York State Department of Health
Bureau of Environmental Exposure Investigation
547 River Street
Troy, NY 12180-2216
1-800-458-1158 ext. 27880
nmw02@health.state.ny.us

If you know someone who would like to be added to the project mailing list, have them contact the NYSDEC project manager above. We encourage you to share this fact sheet with neighbors and tenants, and/or post this fact sheet in a prominent area of your building for others to see.



0 900 1800
Scale in feet

LATITUDE: 41° 02' 42.13" N
LONGITUDE: 73° 57' 18.05" W

QUADRANGLE LOCATION

FIGURE 1
SITE LOCATION

ORANGETOWN SHOPPING CENTER
1-45 ORANGE BURG SHOPPING CENTER
ORANGEBURG, NEW YORK

DRAWN BY:	-	SCALE:	1" = 900'
REVISED BY:	CTH	PROJECT NUMBER:	69972
CHECKED BY:	-	SOURCE: USGS 7.5' Topographic Map,	
DATE:	FEBRUARY 7, 2007	Nyack, NY-NJ Quad.	

KLEINFELDER
EXPECT MORE®

New York State Department of Environmental Conservation
Division of Environmental Remediation
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625 Broadway, Albany, New York 12233-7014
Phone: (518) 402-9662 • **Fax:** (518) 402-9679
Website: www.dec.ny.gov

Joe Martens
Commissioner

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

RE: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Construction Completion Report – Bioagumentation Treatment

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH) have reviewed the revised Construction Completion Report 3 dated August 2011 (the report) for the Bioagumentation Treatment Interim Remedial Measure (IRM) conducted at the above referenced site, which was prepared by Kleinfelder, Inc. (KLF) on behalf of JLJ Management Company (Participant). The report is hereby approved.

Please ensure a hard copy is available in each document repository. If you have any questions or comments please feel free to contact Jamie Verrigni at (518) 402-9662.

Sincerely,

George W Heitzman

George Heitzman, P.E.
Chief, Remedial Section A
Remedial Bureau C
Division of Environmental Remediation

ec: G. Heitzman
J. Verrigni
C. Bethoney - NYSDOH
N. Walz - NYSDOH
Robert Soniker – JLJ Management Company – robertsoniker@kamso.com
Kurt Frantzen – Kleinfelder, Inc. – kfrantzen@kleinfelder.com
Benjamin Rieger – Kleinfelder, Inc. – brieger@kleinfelder.com

INTERNATIONAL YEAR OF FORESTS · 2011

New York State Department of Environmental Conservation
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Joe Martens
Commissioner

August 9, 2011

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
CCR 2 – Soil Vapor Intrusion Mitigation

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH) have reviewed the revised Construction Completion Report 2 dated August 2011 (the report) for the soil vapor intrusion mitigation Interim Remedial Measure (IRM) conducted at the above referenced site, which was prepared by Kleinfelder, Inc. (KLF) on behalf of JLJ Management Company (Participant). The report is hereby approved.

Please ensure a hard copy is available in each document repository. If you have any questions feel free to contact me or Jamie Verrigni.

Sincerely,

Joshua P. Cook, P.E.
Environmental Engineer I
Division of Environmental Remediation

INTERNATIONAL YEAR OF FORESTS · 2011

ec: G. Heitzman
J. Verrigni
J. Cook
C. Bethoney
N. Walz
Robert Soniker
Kurt Frantzen
Benjamin Rieger

New York State Department of Environmental Conservation
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Joe Martens
Commissioner

July 13, 2011

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Remedial Investigation Report Addendum

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH) have reviewed the revised Remedial Investigation Addendum Report (report) dated July 2011 for the Orangetown Shopping Center site (site), which was prepared by Kleinfelder, Inc. on behalf of JLJ Management Company (Participant).

The Department does not agree with one of the conclusions regarding soil contamination below the slab of Sparkle Cleaners. Contamination in soil borings B-2 and B-3 was first encountered at the bottom of the boring (10-12 below the slab), and therefore it is possible the contamination extends deeper and the contamination detected may be indicative of an adjacent source area. Tetrachloroethene (PCE) and other dense non-aqueous phase liquids (DNAPLs) commonly migrate in narrow bands (fingers). The data obtained suggest there may be such a finger in the immediate vicinity. The sample from boring B-3, collected from the interval of 10 to 12 feet below the slab (bgs), did not exhibit higher levels of cis-1,2-dichloroethene (cis-1,2-DCE) as asserted in the report. This sample had elevated levels of PCE, and less elevated levels of PCE's degradation products, trichloroethene (TCE) and cis-1,2-DCE. In boring B-3, 10-12 feet bgs, PCE was detected at 24 parts per million (ppm), while cis-12-DCE and TCE were detected at 1 ppm and 3.6 ppm, respectively. The level of contamination in this sample, which is higher than nearly every other soil sample collected at the site to date, combined with the relative levels of PCE and its degradation products do not support the conclusion that this contamination is a result of groundwater mounding and migration from the known source area around the sewer line.

This is the only portion of the report that the Department is modifying. Pursuant to 6 NYCRR 375-1.6(d)(3), the Participant must respond in writing within 15 days as to whether the

Department's modification will be accepted, and the revised report must be submitted to the Department and NYSDOH within 30 days of the date of this letter. Alternatives to accepting the Department's modification are set forth at 6 NYCRR 375-1.6(d)(3)(ii) and (iii).

If the modifications are accepted, please sign the report, attach this letter to it and submit the final report. The report, along with this letter, must also be sent to the document repositories. If you have any questions, please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook, P.E.
Environmental Engineer I
Division of Environmental Remediation

ec: G. Heitzman
J. Verrigni
J. Cook
C. Bethoney
N. Walz
Robert Soniker
Kurt Frantzen
Benjamin Rieger

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Joe Martens
Commissioner

April 11, 2011

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Revised Biostimulation Injection Design

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH) have reviewed the revised design dated April 1, 2011 for the *in-situ* groundwater treatment Interim Remedial Measure (IRM) being conducted at the above referenced site, which was prepared by Kleinfelder, Inc. (KLF) on behalf of JLJ Management Company (Participant). The plan is hereby approved. All work must comply with the unmodified sections of the IRM Work Plan (*e.g.*, quality assurance plan). The Participant must obtain and comply with any necessary local and federal permits.

If you have any questions, please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook, P.E.
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

ec: G. Heitzman
C. Bethoney
N. Walz
Robert Soniker
Kurt Frantzen
Benjamin Rieger
Justin Moses

New York State Department of Environmental Conservation
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Website: www.dec.ny.gov

Joe Martens
Commissioner

April 11, 2011

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Revised Biostimulation Injection Design

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH) have reviewed the revised design dated April 1, 2011 for the *in-situ* groundwater treatment Interim Remedial Measure (IRM) being conducted at the above referenced site, which was prepared by Kleinfelder, Inc. (KLF) on behalf of JLJ Management Company (Participant). The plan is hereby approved. All work must comply with the unmodified sections of the IRM Work Plan (*e.g.*, quality assurance plan). The Participant must obtain and comply with any necessary local and federal permits.

If you have any questions, please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook, P.E.
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

ec: G. Heitzman
C. Bethoney
N. Walz
Robert Soniker
Kurt Frantzen
Benjamin Rieger
Justin Moses

INTERNATIONAL YEAR OF FORESTS · 2011

New York State Department of Environmental Conservation
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Joe Martens
Commissioner

March 24, 2011

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Construction Completion Report 1–Soil Excavation

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH) have reviewed the revised Construction Completion Report 1 (CCR 1) for the soil excavation Interim Remedial Measure (IRM) conducted at the above referenced site, which was prepared by Kleinfelder, Inc. (KLF) on behalf of JLJ Management Company (Participant). The Department offers the following comments:

- Section 2.2, 2nd Paragraph, 2nd Bullet–This sentence must be modified to clearly state that the soil cleanup objectives (SCOs) for the protection of groundwater are applicable to the site.
- Section 2.2, 3rd Paragraph–This section must be modified to clarify that all four conditions listed in the bullets must be met in order for an exemption to be granted to the applicability of the groundwater SCOs.
- Appendix C–A copy of the Part 364 permit for RAM Transport must be included.

Please make these changes, have the engineer of record stamp and sign the report and Figure 3, and submit the final CCR 1. One hard copy and one electronic copy must be submitted to the Department. One hard copy must be sent to each of the document repositories. One electronic copy must be sent to NYSDOH. If you have any questions, please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook, P.E.
Environmental Engineer I

ec: G. Heitzman
J. Cook
C. Bethoney
N. Walz
Robert Soniker
Kurt Frantzen
Benjamin Rieger
Justin Moses, P.E.

New York State Department of Environmental Conservation
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Alexander B. Grannis
Commissioner

August 9, 2010

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Sub-Slab Depressurization Systems – Re-Design

Dear Mr Soniker:

The New York State Department of Environmental Conservation (Department) and New York State Department of Health have completed their review of the revised design of the sub-slab depressurization systems for the above referenced site, submitted via a letter dated July 21, 2010. The plan is hereby accepted. Note, if the system is unable to create the necessary vacuum, it would need to be redesigned.

It is suggested that each header pipe be connected to alternating extraction points. This way there is potential for one of the blowers for each space to be turned off, should it be determined that two blowers per space is sufficient to generate adequate vacuum.

Implementation and reporting should be conducted in accordance with the schedule contained in the previously-approved design letter. The Department requires notification at least seven days prior to commencing field activities. If you have any questions, please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

ec: M. Ryan
J. Cook
N. Walz
J. Nealon
Benjamin Rieger
Kurt Frantzen
Justin Moses

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Alexander B. Grannis
Commissioner

January 5, 2010

Hilton Soniker
JLJ Mangement Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C3-44-066
Town of Orangetown, Rockland County
IRM Biostimulation Injection Design

Dear Mr. Soniker:

The New York State Department of Health and the New York State Department of Environmental Conservation (Department) have completed their review of the remedial design for the IRM biostimulation injection for the above referenced site, submitted via a letter dated December 2, 2009. The plan is hereby approved. Please make sure a copy of this design document is sent to each of the project's document repositories.

The Department requires notification at least seven days prior to commencing field activities. All necessary notifications must be made and any necessary permits or approvals must be obtained. If you have any questions, please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

c: J. Cook/file
ec: M. Ryan
J. Cook
M. VanValkenburg
N. Walz
Hilton Soniker
Benjamin Rieger
Justin Moses

New York State Department of Environmental Conservation
Division of Environmental Remediation
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Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

November 3, 2009

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Sub-Slab Depressurization Systems

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) has completed its review of the remedial design for the sub-slab depressurization systems for the above referenced site, submitted via a letter dated October 28, 2009. The plan is hereby approved. Please make sure a copy of this design document is sent to each of the project's document repositories. The Department requires notification at least seven days prior to commencing field activities. If you have any questions please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

c: J. Cook/file
ec: M. Ryan
J. Cook
M. VanValkenburg
N. Walz
Hilton Soniker (JLJ Management Company)
Justin Moses (Kleinfelder)
Benjamin Rieger (Kleinfelder)
Kurt Frantzen (Kleinfelder)

New York State Department of Environmental Conservation
Division of Environmental Remediation
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625 Broadway, Albany, New York 12233-7014
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Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

March 6, 2009

Benjamin Rieger
Kleinfelder
99 Lamberton Road, Suite 201
Windsor, CT 06095

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Soil Stockpiles

Dear Ben:

The New York State Department of Environmental Conservation (Department) has reviewed the analytical results of the waste characterization sampling performed for the soil stockpiles generated as part of the remedial program for the Orangetown Shopping Center site (Site) under the Brownfield Cleanup Agreement between the property owner, JLJ Management Company, and the Department. The Site is undertaking a remedial program as the result of the disposal of dry cleaning solvents, specifically tetrachloroethene (PCE).

The results for samples SS-1 and SS-3 show the levels of PCE and its associated degradation products are below "contained-in" criteria, and as such, the soil stockpiles associated with these samples may be handled and disposed of as non-hazardous industrial solid waste, to be disposed of at a facility permitted under 6 NYCRR Part 360. The soil stockpile(s) associated with SS-2 do not meet the contained in criteria and, therefore, this determination does not apply to those soils.

Please note, this does not mean any of the soil is acceptable for unrestricted use. If you have any questions or concerns please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

c: J. Cook/file
Hilton Soniker (JLJ Management Company)

ec: M. Ryan
J. Cook

New York State Department of Environmental Conservation
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625 Broadway, Albany, New York 12233-7014
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Alexander B. Grannis
Commissioner

July 27, 2007

Kurt A. Frantzen, PhD, CHMM
Kleinfelder
99 Lamberton Road, Suite 201
Windsor, CT 06095

Re: Orangeburg Shopping Center
Site ID No. C3-44-066
Town of Orangetown, Rockland County
Remedial Investigation Work Plan

Dear Dr. Frantzen,

This letter confirms and documents the New York State Department of Environmental Conservation's (Department's) approval of the Remedial Investigation Work Plan dated July 2007 for the above referenced site.

The Department would appreciate at least one week notice prior to commencing field work. If you have any questions or concerns please do not hesitate to contact me at (518) 402-9564.

Sincerely,

Joshua P. Cook
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

c: J. Cook/file

ec: M. Ryan
J. Cook
M. Rivara (DOH)
N. Walz (DOH)
eDocs

New York State Department of Environmental Conservation
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Alexander B. Grannis
Commissioner

November 4, 2008

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Interim Remedial Measures Work Plan

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) has completed its review of the Interim Remedial Measures (IRM) Work Plan dated August 2008 and prepared by Kleinfelder for the subject site and a 30-day public comment period on the IRM Work Plan was completed November 3. Based upon the information and representations given in the Work Plan and previous reports, including the Remedial Investigation Report dated August 2008, the Work Plan is hereby approved.

Please note, as discussed in the work plan, certain actions included in the IRM Work Plan will require submittal of design information for the Department's review and approval prior to implementation of the work.

Please contact the Department's Project Manager, Joshua Cook, at 518-402-9564 at your earliest convenience to discuss scheduling of the various tasks.

Sincerely,

Robert Schick
Director
Remedial Bureau C
Division of Environmental Remediation

cc: J. Cook/file
Kurt Frantzen

ec: R. Schick
M. Ryan
J. Cook
N. Walz
M. Van Valkenburg
C. Quinn (RCDOH)

Kurt Frantzen

From: Benjamin Rieger
Sent: Tuesday, December 21, 2010 3:00 PM
To: Kurt Frantzen
Subject: FW: JLJ - remedation system fence
Attachments: Part.002

From: Joshua Cook [mailto:jpcook@gw.dec.state.ny.us]
Sent: Monday, April 05, 2010 8:13 AM
To: Benjamin Rieger
Subject: Re: JLJ - remedation system fence

The change regarding the tank and fence is acceptable.

Thanks for the update. Please let me know once the power is connected. Note, the O&M Manual is still needed, and is in fact overdue.

Josh

>>> "Benjamin Rieger" <BRieger@kleinfelder.com> 4/2/2010 1:29 PM >>>
Josh, Guessing you are off today. Hope you enjoy the long weekend.

I wanted to get in our request relative to the fence at JLJ before the next monthly report.

As we discussed on the phone we would like to propose not installing the fence around the remedation equipment. Rather we would like to bring the batch tank out for each injection but not store it on site. We would then enclose the manifold within a small locking storage container. This will allow us to avoid the potential zoning issues associated with the fence.

Also so you are up to speed on schedule, we are still waiting on O&R to connect the power.

Benjamin B. Rieger
Project Manager
99 Lamberton Road
Windsor, CT 06095
o| 860-683-4200
c| 860-847-1108

February 16, 2010

To Whom It May Concern:

Due to an administrative error, the original Fact Sheet dated January-February 2010 and sent to you during the week of February 12, 2010 should be disregarded and replaced with the attached Fact Sheet, dated February 2010.

We apologize for any inconvenience.

Sincerely,

Kleinfelder, Inc.

 99 Lamberton Road, Suite 201, Windsor, CT 06095 p|860.683.4200 f|860.683.4206

New York State Department of Environmental Conservation

FACT SHEET

Brownfield Cleanup Program

Orangetown Shopping Center
Site #C344066
Town of Orangetown, NY

February 2010

Interim Remedial Action to Begin at Brownfield Site

Action is about to begin under New York's Brownfield Cleanup Program that will address contamination at the Orangetown Shopping Center Site ("site") located near the intersection of Highview Avenue and Oak Street in the Town of Orangetown, Rockland County. Seep map for site location.

The upcoming action for the site includes installing systems in three retail spaces in the shopping plaza building on-site to prevent the intrusion of contaminated vapors into the building (similar to radon systems). The cleanup action also includes injecting a non-toxic liquid into the subsurface to remediate the groundwater at the site. Further information regarding these activities is included below.

The cleanup activities will be performed by the property owner, JLJ Management Company ("applicant"), through their engineering consultant, Kleinfelder, Inc. The New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH) will provide oversight.

Based on the findings of the investigation performed thus far, NYSDEC in consultation with the NYSDOH has determined that the site poses a significant threat due to elevated concentrations of contaminants in groundwater and soil vapor. The activities discussed below have been designed to address the identified contamination and the threat posed.

Highlights of the Upcoming Site Mitigation Activities
The upcoming cleanup activities are intended to:

1) address contamination at the site to achieve cleanup levels that protect public health and the environment, and
2) account for the intended or reasonably anticipated future use of the site.
3) assess the effectiveness of the groundwater injections to determine if it will be an appropriate full-scale remedy for the groundwater contamination at and emanating from the site.

Brownfield Cleanup Program: New York's Brownfield Cleanup Program (BCP) encourages the voluntary cleanup of contaminated properties known as "brownfields" so that they can be reused and redeveloped. These uses include recreation, housing and business.

A **brownfield** is any real property that is difficult to reuse or redevelop because of the presence or potential presence of contamination.

For more information about the BCP, visit: **www.dec.ny.gov/chemical/8450.html**

The systems to be installed in the shopping plaza building are called sub-slab depressurization systems and are similar to a residential radon system. They prevent intrusion of contaminated vapors into a building by maintaining a lower air pressure below the slab of the building than the air pressure within the building. A system will be installed at the dry cleaner and at the retail spaces on either side of the dry cleaner. The installation will require drilling a hole into the exterior rear wall of each of the three retail spaces in order to install piping for the system. The hole will be drilled into the wall below the level of the floor slab. The piping for each system will be connected to a fan which will be mounted to the rear of the building. The fans will run continuously to maintain the necessary pressure difference, and will vent above the roof of the building.

The construction of the injection system will require the installation of several shallow wells to the rear of the dry cleaner. The wells will extend approximately 6 feet below ground and will be installed through a vacuum excavation process. The newly installed injection wells and one existing groundwater monitoring well will be connected via subsurface piping to a drum of the fluid to be injected. The substance selected for the injection is a mixture of molasses and water and will promote the natural processes that break down the site contaminants (tetrachloroethene, trichloroethene, *cis*-1,2-dichloroethene and vinyl chloride) into non-toxic compounds (primarily ethane and ethane). Following the installation, the fluid will be injected into the wells several times over several months. Groundwater samples will be collected over that period and used to determine if the approach is an effective remedy for the groundwater contamination.

Next Steps

The applicant is expected to begin installation of the sub-slab depressurization systems on or about February 15th. It is anticipated the installation of the systems will take about four to five days. The systems will run until it is determined they are no longer needed. The applicant is expected to begin construction of the injection system on or about February 22nd. It is anticipated the construction of the injection system will take about four to five days. Once the system is installed, several injection events will be conducted over several months.

After the applicant completes these cleanup activities, it will prepare a Construction Completion Report and submit it to NYSDEC. The Construction Completion Report will describe the cleanup activities completed and certify they were completed in accordance with the work plan.

Background

NYSDEC previously accepted an application from the applicant to participate in the Brownfield Cleanup Program (BCP). The application proposed that the site will continue to be used for commercial purposes.

The Orangetown Shopping Center BCP site is a 1.2-acre portion of the shopping plaza, located near the southeast corner of the shopping plaza. The shopping plaza is located at the southeast comer of Orangeburg and Dutch Hill Roads in Orangeburg, NY, and is comprised of an 11-acre parcel and contains several commercial buildings. The plaza is situated in a suburban area of mixed land use, and is surrounded predominantly by commercial and residential properties.

The site had been used as farmland, a camp, an amphitheater, and the current retail shopping center. There has been a dry cleaner operating at the shopping center since approximately 1966. Investigations performed to date have confirmed the presence of contamination caused by the release of dry cleaning fluid.

JLJ Management applied to the Brownfield Cleanup Program in May 2006, and the Brownfield Cleanup Agreement between the NYSDEC and JLJ Management was executed by the NYSDEC in January 2007. The Remedial Investigation Work Plan was approved July 2007, and the investigation was conducted in Fall 2007. A Remedial Investigation Report, dated August 2008 was developed which details that work, though some further investigation has been completed since and some further work is still needed. The Remedial Investigation Report will be supplemented with information from those activities once they are completed.

An Interim Remedial Measures Work Plan was approved in August 2008, which included details for three remedial activities; the two activities described above, and the excavation and off-site disposal of a small area of contaminated soils (approximately 30 tons) located to the rear of the dry cleaner. The excavation field work was completed in January 2009.

FOR MORE INFORMATION

Where to Find Information

Project documents are available at the following location(s) to help the public stay informed. These documents include the Interim Remedial Measures Work Plan.

Orangeburg Library
20 South Greenbush Road
Orangeburg, NY 10962
Attn: Nancy Wissman, Director
Phone: (845) 359-2244
Hours:
Mon-Thurs 10:00 am - 9:00 pm
Fri-Sat 10:00 am - 5:00 pm
Sun 1:00 pm - 5:00 pm

NYSDEC Region 3 Office
21 S. Putt Comers Road
New Paltz, NY 12561
Attn: Michael Knipfing
Phone: (845) 256-3 154
Hours:
Mon - Fri 8:30 am - 4:45 pm
By Appointment

NYSDEC Remedial Bureau C
625 Broadway, 11th Floor
Albany, NY 12233-7014
Attn: Joshua Cook
Phone: 1-866-520-2334
Hours:
Mon – Fri 7:30 am – 3:45 pm
By Appointment

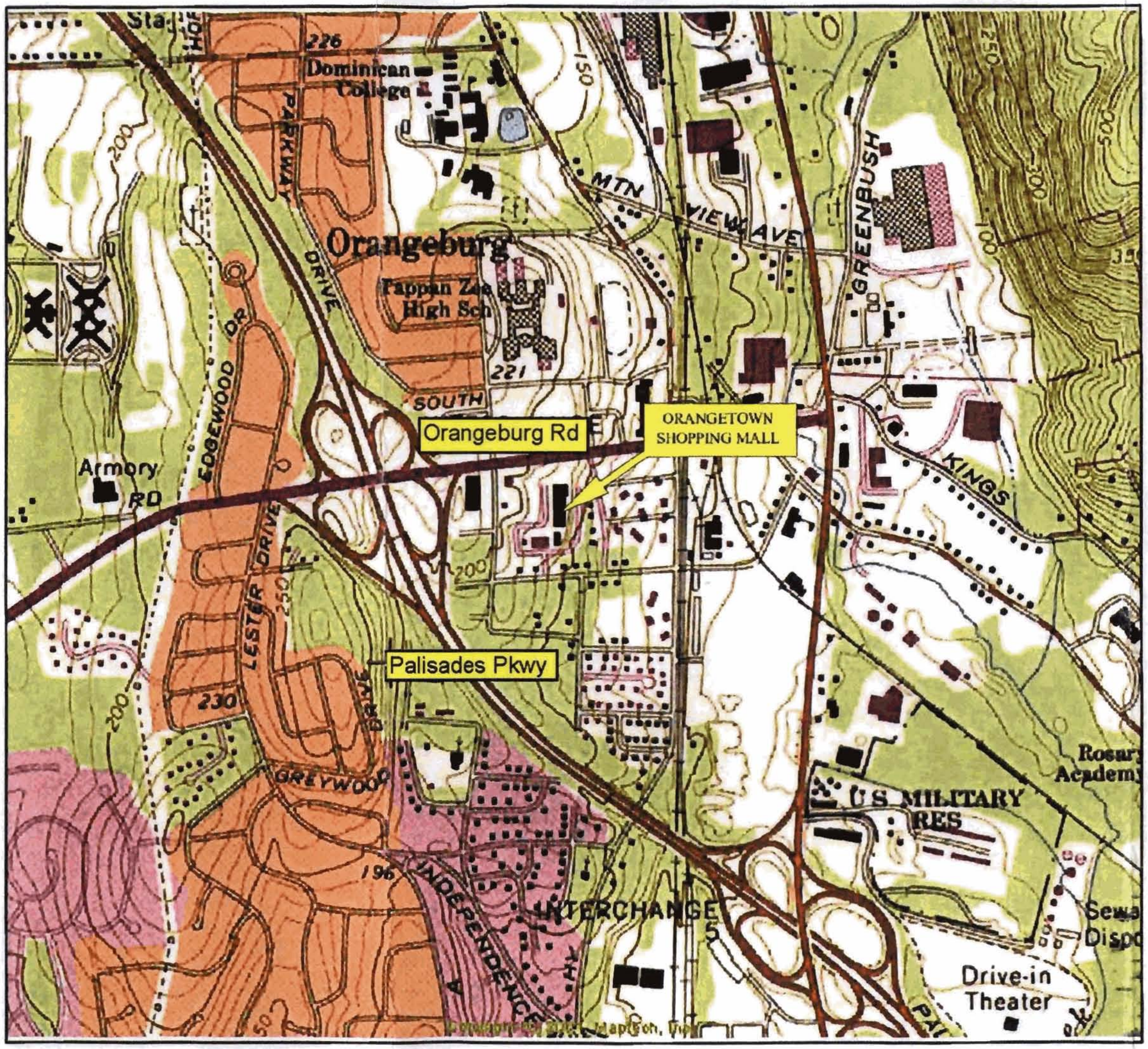
Who to Contact

Comments and questions are always welcome and should be directed as follows:

Project Related Questions
Joshua Cook
NYSDEC Remedial Bureau C
jpcook@gw.dec.state.ny.us

Health Related Questions
Nathan Walz
New York State Department of Health
nmw02@health.state.ny.us

If you know someone who would like to be added to the site contact list, have them contact the NYSDEC project manager above. We encourage you to share this fact sheet with neighbors and tenants, and/or post this fact sheet in a prominent area of your building for others to see.



0 900 1800
Scale in feet

LATITUDE: 41° 02' 42.13" N
LONGITUDE: 73° 57' 18.05" W

QUADRANGLE LOCATION

FIGURE 1
SITE LOCATION

ORANGETOWN SHOPPING CENTER
1-45 ORANGE BURG SHOPPING CENTER
ORANGEBURG, NEW YORK

DRAWN BY:	-	SCALE:	1" = 900'
REVISED BY:	CTH	PROJECT NUMBER:	69972
CHECKED BY:	-	SOURCE: USGS 7.5' Topographic Map,	
DATE:	FEBRUARY 7, 2007	Nyack, NY-NJ Quad.	

KLEINFELDER
EXPECT MORE®

Type or print all information. See reverse for instructions.

OMB No. 2040-0042 Approval Expires 4/30/07

EPA

INVENTORY OF INJECTION WELLS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF GROUND WATER AND DRINKING WATER

(This information is collected under the authority of the Safe Drinking Water Act)

1. DATE PREPARED *(Year, Month, Day)*: 1/25/2010

2. FACILITY ID NUMBER:

PAPERWORK REDUCTION ACT NOTICE

The public reporting burden for this collection of information is estimated at about 0.5 hour per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief, Information Policy Branch, 2136, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460, and to the Office of Management and Budget, Paperwork Reduction Project, Washington, DC 20503.

3. TRANSACTION TYPE *(Please mark one of the following)*

- [ ] Deletion
- [ ] Entry Change
- [X] First Time Entry
- [ ] Replacement

4. FACILITY NAME AND LOCATION

A. NAME *(last, first, and middle initial)*: Orangetown Shopping Center

B. STREET ADDRESS/ROUTE NUMBER: 1-45 Orangetown Shopping Center

C. LATITUDE

DEG	MIN	SEC
41	02	40.82

D. LONGITUDE

DEG	MIN	SEC
73	57	09.83

E. TOWNSHIP/RANGE

TOWNSHIP	RANGE	SECT	1/4 SECT

F. CITY/TOWN: Orangetown

G. STATE: NY

H. ZIP CODE: 10962

I. NUMERIC COUNTY CODE: ROC

J. INDIAN LAND *(mark "x")*: [ ] Yes [X] No

5. LEGAL CONTACT:

A. TYPE *(mark "x")*: [X] Owner [ ] Operator

B. NAME *(last, first, and middle initial)*: JLJ Management Company c/o Soniker , Hilton

C. PHONE *(area code and number)*: (212) 949-4111

D. ORGANIZATION: JLJ Management Company

E. STREET/P.O. BOX: 197 Trenor Drive

F. CITY/TOWN: New Rochelle

G. STATE: New York

H. ZIP CODE: 10804

I. OWNERSHIP *(mark "x")*

- [X] PRIVATE
- [ ] STATE
- [ ] PUBLIC
- [ ] FEDERAL
- [ ] SPECIFY OTHER

6. WELL INFORMATION:

A. CLASS AND TYPE		B. NUMBER OF WELLS: COMM	NON-COMM	C. TOTAL NUMBER OF WELLS	D. WELL OPERATION STATUS: UC	AC	TA	PA	AN
5	X26		5	5	5				
				0					
				0					
				0					
				0					
				0					
				0					

COMMENTS *(Optional)*: See attached Project Narrative for additional details on injection well type

KEY:

DEG = Degree
MIN = Minute
SEC = Second

SECT = Section
1/4 SECT = Quarter Section

COMM = Commercial
NON-COMM = Non-Commercial

AC = Active
UC = Under Construction
TA = Temporarily Abandoned
PA = Permanently Abandoned and Approved by State
AN = Permanently Abandoned and not Approved by State

EPA Form 7520-16 (Rev. 8-01)

VIA US Mail

April 26, 2011

UIC Permit Administrator
United States Environmental Protection Agency – Region 2
290 Broadway
New York, New York 10007-1866

Re: Revised Underground Injection Plan
Orangeburg (Orangetown) Shopping Center Site
1-45 Orangetown Shopping Center, Orangeburg, Rockland County, NY 10962
NYSDEC Site Number: C344066

Dear Sir or Madam:

On behalf of JLJ Management Co. (JLJ), Kleinfelder East, Inc. (KLF) wishes to provide notice of a revised injection plan for Class V injection wells at the above referenced property. The injection has been approved by the New York State Department of Environmental Conservation (NYSDEC) and the Class V wells were previously registered with the United States Environmental Protection Agency (USEPA). Copies of the USEPA underground injection control well inventory form, NYSDEC approval letter, and revised injection plan are attached for your reference. If you have any questions please feel free to contact me at 860-847-1108.

Very truly yours,
Kleinfelder East, Inc.

Benjamin Rieger, LEP, LEED AP
Project Manager

CC: H Soniker—JLJ
G Litwin & N Walz—NYSDOH
J. Cook - NYSDEC

Attachments:
UIC Well Inventory Form
NYSDEC Approval Letter
Revised Injection Plan

Type or print all information. See reverse for instructions.

OMB No. 2040-0042 Approval Expires 4/30/07

INVENTORY OF INJECTION WELLS

EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF GROUND WATER AND DRINKING WATER

(This information is collected under the authority of the Safe Drinking Water Act)

1. DATE PREPARED *(Year, Month, Day)*: 1/25/2010

2. FACILITY ID NUMBER:

PAPERWORK REDUCTION ACT NOTICE

The public reporting burden for this collection of information is estimated at about 0.5 hour per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief, Information Policy Branch, 2136, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460, and to the Office of Management and Budget, Paperwork Reduction Project, Washington, DC 20503.

3. TRANSACTION TYPE *(Please mark one of the following)*

- [ ] Deletion
- [X] First Time Entry
- [ ] Entry Change
- [ ] Replacement

4. FACILITY NAME AND LOCATION

A. NAME *(last, first, and middle initial)*: Orangetown Shopping Center

B. STREET ADDRESS/ROUTE NUMBER: 1-45 Orangetown Shopping Center

	DEG	MIN	SEC
C. LATITUDE	41	02	40.82
D. LONGITUDE	73	57	09.83

E. TOWNSHIP/RANGE

TOWNSHIP	RANGE	SECT	1/4 SECT

F. CITY/TOWN: Orangetown

G. STATE: NY

H. ZIP CODE: 10962

I. NUMERIC COUNTY CODE: ROC

J. INDIAN LAND *(mark "x")*: [ ] Yes [X] No

5. LEGAL CONTACT:

A. TYPE *(mark "x")*: [X] Owner [ ] Operator

B. NAME *(last, first, and middle initial)*: JLJ Management Company c/o Soniker , Hilton

C. PHONE *(area code and number)*: (212) 949-4111

D. ORGANIZATION: JLJ Management Company

E. STREET/P.O. BOX: 197 Trenor Drive

F. CITY/TOWN: New Rochelle

G. STATE: New York

H. ZIP CODE: 10804

I. OWNERSHIP *(mark "x")*

- [X] PRIVATE
- [ ] PUBLIC
- [ ] SPECIFY OTHER
- [ ] STATE
- [ ] FEDERAL

6. WELL INFORMATION:

A. CLASS AND TYPE		B. NUMBER OF WELLS: COMM	B. NUMBER OF WELLS: NON-COMM	C. TOTAL NUMBER OF WELLS	D. WELL OPERATION STATUS: UC	AC	TA	PA	AN
5	X26		5	5	5				
				0					
				0					
				0					
				0					
				0					
				0					

COMMENTS *(Optional)*: See attached Project Narrative for additional details on injection well type

KEY:

DEG = Degree
MIN = Minute
SEC = Second

SECT = Section
1/4 SECT = Quarter Section

COMM = Commercial
NON-COMM = Non-Commercial

AC = Active
UC = Under Construction
TA = Temporarily Abandoned
PA = Permanently Abandoned and Approved by State
AN = Permanently Abandoned and not Approved by State

EPA Form 7520-16 (Rev. 8-01)

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau C, 11th Floor
625 Broadway, Albany, New York 12233-7014
Phone: (518) 402-9662 • **Fax:** (518) 402-9679
Website: www.dec.ny.gov

Joe Martens
Commissioner

April 11, 2011

Hilton Soniker
JLJ Management Company
197 Trenor Drive
New Rochelle, NY 10804

Re: Orangetown Shopping Center
Site ID No. C344066
Town of Orangetown, Rockland County
Revised Biostimulation Injection Design

Dear Mr. Soniker:

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health (NYSDOH) have reviewed the revised design dated April 1, 2011 for the *in-situ* groundwater treatment Interim Remedial Measure (IRM) being conducted at the above referenced site, which was prepared by Kleinfelder, Inc. (KLF) on behalf of JLJ Management Company (Participant). The plan is hereby approved. All work must comply with the unmodified sections of the IRM Work Plan (*e.g.*, quality assurance plan). The Participant must obtain and comply with any necessary local and federal permits.

If you have any questions, please do not hesitate to contact me at (518) 402-9662.

Sincerely,

Joshua P. Cook, P.E.
Environmental Engineer I
Remedial Bureau C
Division of Environmental Remediation

ec: G. Heitzman
C. Bethoney
N. Walz
Robert Soniker
Kurt Frantzen
Benjamin Rieger
Justin Moses

INTERNATIONAL YEAR OF FORESTS · 2011

DELIVERED VIA FEDERAL EXPRESS

April 1, 2011

Mr. Josh Cook
New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau C
625 Broadway – 11th Floor
Albany, New York 12233-7014

Subject: **Biostimulation Injection System, Revised**
Orangetown Shopping Center
1-45 Orangetown Shopping Center
Orangeburg, New York 10962
NYSDEC Index No. A3-0563-0906
NYSDEC Site No. C344066

Dear Mr. Cook:

Kleinfelder, Inc. (KLF), on behalf of JLJ Management Company (JLJ), is submitting this plan to request approval from the New York State Department of Environmental Conservation (NYSDEC) for the continuation of the biostimulation injection system interim remedial measure (IRM) at the referenced site in the Town of Orangetown, County of Rockland, New York. The biostimulation injection system IRM has been revised based upon findings from the first round of biostimulant injections completed in May, July, and November 2010. This revised plan includes a second round of injections with monitoring.

Background and Site Description

Based upon the available evidence, the dry cleaning operation (Sparkle Cleaners) had a historic release of Perchloroethylene (PCE) through a leaking sewer line (RemVer 2005). Initial indications of potential impact to the site were discovered in 2004, which led to a Site Characterization, subsequent notification of NYSDEC in 2005 and application to the BCP in 2006.

JLJ entered into a Brownfield Cleanup Agreement (BCA) with the NYSDEC in January 2007, to investigate and remediate a portion of its property (the Orangetown Shopping Center) located in Hamlet of Orangeburg, Town of Orangetown, County of Rockland, New York (Brownfield Cleanup Program [BCP] Site #C344066). The Orangetown (Orangeburg) Shopping Center BCP site (hereinafter the site) is approximately 1.2-acre in size, and is situated within an 11-acre retail property identified as a portion of Block 1 and Lot 67 on Orangetown Tax Map # 74.10 (see Plate 1). The boundaries of the retail property include Orangeburg Road to the north, residential homes and Highview Avenue to the south, residential homes and Oak Street to the east, and Dutch Hill Road to the west together with commercial and office properties, a suburban area of mixed land use within a retail strip shopping center, which includes a dry cleaning operation (Plate 2).

Kleinfelder conducted a remedial investigation (RI) at the site in 2007-2008; subsequently, IRM's were proposed and planned, and then initiated in 2009.

Previous injections and Monitoring Data

The biostimulation IRM was implemented in 2010 with three separate injection events in May, July, and November 2010. KLF performed baseline and post-injection monitoring and sampling to monitor the effectiveness of this initial biostimulation treatment. After each injection, several weeks elapsed to allow the biostimulant to enter the subsurface soil column and the local groundwater prior to re-sampling of groundwater.

The monitoring well network included MW-2, MW-4, MW-5, and MW-8A (shallow) / -8B (deep). Monitoring included measurement of groundwater temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen, and turbidity. Collected groundwater samples were submitted for laboratory analysis: Total Organic Carbon (TOC), Electron Acceptors (e.g., nitrate [NO_3^-], iron [Fe^{+3}], manganese [Mn^{+2}], and sulfate [SO_4]), as well as chlorinated Volatile Organic Compounds (VOCs).

Injection Events and Biostimulant Volume per Injection Point

Injection Event	Date	% Solution	IP-1	IP-2	IP-3	IP-4	MW-3	Total Event Volume
1	05/20/10	25 †	20	20	20	20	120	200
2	07/29/10	10	0	25	100	0	25	150
3	11/18/10	10	10	80	0	0	60	150

Note: volumes injected in gallons
† The first injection used 25% molasses by error, USEPA injection permit allowed 10% solution
IP-1 through IP-4 are within the gravel backfill of the remedial excavation area

The initial injections were at an annualized total of 1920 lbs molasses (80 gallons (960 lbs) over a six-month period).

Biostimulant Injection IRM - Groundwater Sampling Events

Injection	GW Sampling Date	Alpha Lab Report #	Data Included
Baseline	04/29/10	L1006386	See Tables 1 & 2
1	06/16/10	L1009164	See Tables 1 & 2
2	08/09/10	L1012239	See Tables 1 & 2
3	12/13/10 –12/14/10	L1020006	See Tables 1 & 2

Table 1 (attached) presents the groundwater monitoring data for the monitoring events. Table 2 (attached) presents well-specific monitoring data for the sampling events listed above. The laboratory analytical reports for the baseline sampling and injection events #1, #2, and #3 are included as Attachment 1.

As discussed in the RI report (KLF 2008), while subsurface conditions at the site were conducive to natural biodegradation of the more halogenated compounds, the conditions were not adequately electronegative (or reducing) to support quantitatively effective dechlorination of dichloroethene (DCE) and vinyl chloride (VC).

Methanogenic conditions prevail in many contamination plumes after all other electron acceptors (O_2, NO_3, Fe^{+3}, and SO_4) have been used up by other subsurface microbes. It is under methanogenic conditions that the anaerobic degradation of DCE and VC occur most readily (ITRC 2008).

The IRM was designed to create more reducing conditions through the subsurface addition of molasses (electron donor) and thereby increase microbial degradation efficacy. TOC concentrations (Table 2) indicate a limited carbon source prior to the injections and increased TOC concentrations in wells influenced by the molasses injections.

KLF interprets the groundwater monitoring data as demonstrating improved conditions for anaerobic microbial degradation and dechlorination based on the following tabulated comparisons of the pre-injection baseline data to the December 2010 data.

Location/Item	*MW-2*	*MW-4*	*MW-5*	*MW-8A*	*MW-8B*
DCE Concentration	Stable	Increase	Decrease	Increase	Stable
VC Concentration	Stable	Increase	Increase	Increase	Stable
ORP	Decrease	Decrease	Decrease	(3)	Stable
Nitrate	Stable	Decrease	Decrease	Decrease	Decrease
Sulfate	Stable	Decrease	Decrease	Decrease	Decrease
Ferrous Iron	Increase(1)	Decrease	Decrease	Stable	Stable
TOC	Increase(2)	Increase	Increase	Increase	Increase

(1) – total iron also increased
(2) – increase not sustained following the first injection
(3) – insufficient data

Acceptable pH levels to promote biodegradation (the pH for optimal growth of *D. ethenogenes* was measured during monitoring events during the injection period). The bacterium capable of complete reductive dechlorination of PCE to ethene, is between 6.8 and 7.5 with slower dechlorination occurring above and below this pH range (Falatko, et al. 2011).

The lack of full attainment of methanogenic conditions in some wells influenced by the initial injections may indicate insufficient carbon or inadequate duration of carbon source supplementation. The results following the initial biostimulation round of three injection events indicate that biodegradation is occurring at the site and that the conditions to promote biodegradation could be enhanced through additional injections of electron donor solution. Therefore, Kleinfelder has concluded that the findings support the continued application of this IRM and additional molasses injection (in concentration and frequency of injection) and more time is required to optimize the efficacy of this remedial technology.

DATA EVALUATION USING MODELING

Estimating the required substrate addition to achieve methanogenic conditions within the aquifer is complicated by challenges in estimating natural oxygen addition to the aquifer, estimation of existing anion concentrations within the aquifer, and by the extent to which NAPL may remain within the subsurface. A rough estimate of the total quantity of substrate required to overcome the background anion concentrations and flux into the treatment area can be made using the *Substrate Estimating Tool for Enhanced Anaerobic Bioremediation of Chlorinated Solvents* model developed for the Environmental Security Technology Certification Program of the United States Department of Defense (SERDP). The modeled total quantity required is highly dependent on the duration of the treatment period and model design factor. The design factor is used to adjust the model for unknowns, such as, the potential for NAPL remaining in the subsurface.

KLF populated two iterations of the model using site-specific groundwater analytical data that represented the potential range of hydrologic conditions.

- The low range model was populated using low-end hydrologic parameters from the literature for this type of geological setting and average site groundwater chemistry data. The design factor in the low range model was set at unity (1) reflecting no additional substrate to account for model unknowns.

- The high range model was populated using high-end hydrologic parameters from the literature for this type of geological setting and the same groundwater chemistry data as the low range model. The design factor was set to a mid-level value of 10, to reflect uncertainty in model input.

The input, calculation tables, and model output for both scenarios are attached and summarized below.

Model	*Input Hydraulic Conductivity*	*Input Hydraulic Gradient*	*Input Porosity*	*Design Factor*	*Modeled Annual Substrate Recommendation*
Low Range	0.01 ft/day	0.1 ft/ft	25%	1	239 lbs
High Range	0.57 ft/day	0.1 ft/ft	15%	10	7,675 lbs

REVISED IRM PLAN

Based on the post-injection groundwater monitoring data and the modeled substrate recommendations presented herein, KLF recommends the following revisions to the approved 2008 IRM protocol (Kleinfelder 2008):

- Six additional injections of biostimulant
    - Frequency of twice per month
    - Total of three months of operation
- Injection volume of 10% molasses will remain the same at 150-gallons
    - 15 gallons molasses twice monthly or 30 gallons per month
- Injection of 30 gallons (360 lbs at 12 lbs/gallon) per month represents an annualized injection total of 4,320 lbs

Groundwater monitoring will use the same set of wells (with the addition of MW-3) with samples collected prior to the first injection event and twice per month for the second and third months of injection. In-field measurements and laboratory analytical methods will remain the same with the exception that ethene will be added to the analysis. KLF proposes to add ethene as an analyte because it is a degradation product of VC. Monitoring this analyte will provide data regarding the completeness of biodegradation.

The sampling ofMW-3 is recommended to provide additional monitoring data to evaluate the effectiveness of this IRM.

Schedule

The next injection will be conducted within 15 days of approval of this plan and United States Environmental Protection Agency approval of the revised injection permit. The subsequent five injections will be conducted on a bi-weekly basis.

The baseline groundwater sampling event will be conducted prior to the initial injection. Additional groundwater sampling will be conducted bi-weekly during the second and third months of injection.

If you require additional information, please contact the undersigned at (860) 683-4200.

Very truly yours,
KLEINFELDER , INC.

Digitally signed by Justin Moses
Date: 2011.04.05 13:59:50 -04'00'

Justin R. Moses, PE
Senior Project Manager

Digitally signed by Ben Rieger
Date: 2011.04.05 14:03:32 -04'00'

Benjamin Rieger, LEP, LEED AP
Project Manager

Attachments:
Tables 1 – Biostimulation Monitoring Data
Plate 1 – Locus Plan
Plate 2 – Site Plan
Model - input tables and output

cc: Hilton Soniker – JLJ Management Company

References

Strategic Environmental Research and Development Program (SERDP) Guidance Model: http://serdp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/ER-200627

ITRC, 2008, *In Situ Bioremediation of Chlorinated Ethene: DNAPL Source Zones.* Interstate Technology and Regulatory Council; Bioremediation of DNAPLs Team.

Kleinfelder, 2008, *Remedial Investigation*, Orangeburg (Orangetown Shopping Center), 1-45 Orangetown Shopping Center, Orangeburg, New York USA, dated May 2008, revised August 2008.

Kleinfelder, 2008, *Interim Remedial Measures Work Plan*, Orangeburg (Orangetown Shopping Center), 1-45 Orangetown Shopping Center, Orangeburg, New York USA, dated June 2008, revised August 2008.

RemVer, 2005, Phase II Environmental Site Assessment Site Characterization Report.

Falatko, David M et al, 2011, *Proceedings of the Annual International Conference on Soils, Sediments, Water and Energy,* Vol. 16, Art. 8

Domenico & Schwartz, 1990, *Physical and Chemical Hydrogeology*.

Table 1
Biostimulation Monitoring Data
Orangetown Shopping Center - Brownfield Site #C344066
Orangeburg, New York

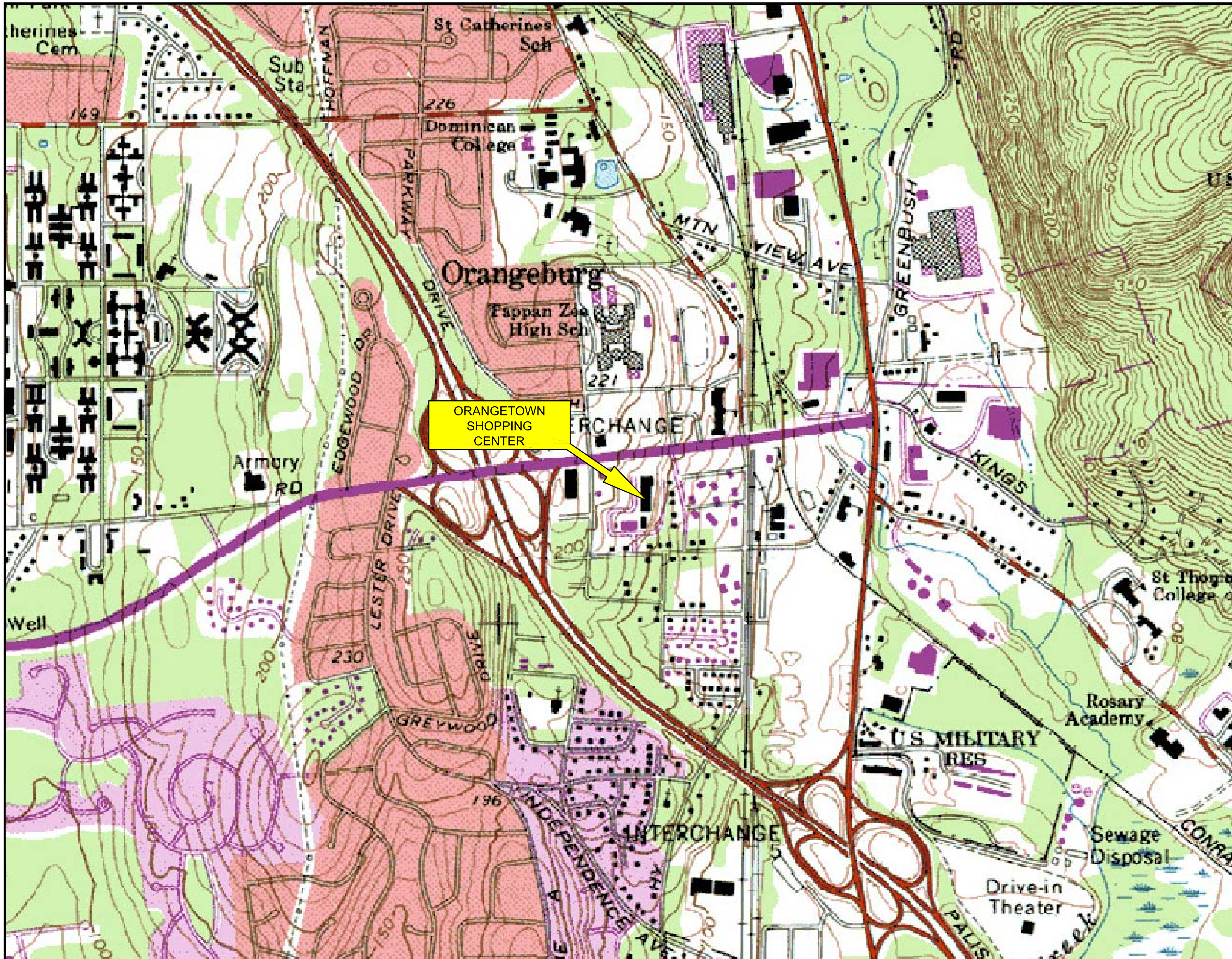
		2	2	2	2 D	2	4	4	4 D	4	4	5	5 D	5	5	5	8A	8A	8A	8A	8A D	8B	8B	8B	8B
		04/29/10	06/16/10	08/09/10	08/09/10	12/14/10	04/30/10	06/16/10	06/16/10	08/09/10	12/14/10	04/29/10	04/29/10	06/16/10	08/09/10	12/14/10	04/29/10	06/16/10	08/09/10	12/14/10	12/14/10	04/29/10	06/16/10	08/09/10	12/14/10
DCE	ug/l	2,000	1,000	1,900	2,000	dry	160	840	680	1,400	dry	13,000	13,000	14,000	12,000	7,200	1,000	1,300	dry	2,500	2,900	5,200	380	1,800	3,600
tDCE	ug/l	75	38	30	38	dry	4	15	15	15	dry	380	300	190	190	190	38	8	dry	30	120	150	4	8	38
PCE	ug/l	50	25	20	25	dry	3	10	10	10	dry	250	200	120	120	120	25	5	dry	20	1.7	100	3	5	25
TCE	ug/l	50	25	20	25	dry	5.1	10	10	10	dry	250	200	120	120	120	39	41	dry	54	73	110	3.8	59	60
VC	ug/l	100	50	40	50	dry	5	20	20	23	dry	500	400	250	250	1,800	50	12	dry	40	30	200	5	10	50
Redox	mV	-23	-152	-134	-134	dry	114	-224	-224	-227	dry	-160	-160	-147	-192	grab	111	90	dry	grab	grab	-20	9	58	grab
pH	standard units	6.2	6.63	6.2	6.2	dry	6.5	6.48	6.48	6.58	dry	6.56	6.56	6.4	6.33	grab	6.5	6.3	dry	grab	grab	6.7	6.62	6.34	grab
DO	mg/l	1.1	0.93	0.59	0.59	dry	1.3	0.45	0.45	0.58	dry	2.04	2.04	1.6	1.34	grab	1.7	1.26	dry	grab	grab	2.9	2.85	2.33	grab
TOC	ug/l	3,800	26,000	3,800	3,800	dry	2,200	98,000	97,000	58,000	dry	4,300	4,200	3,000	5,700	24,000	1,400	2,000	dry	4,400	2,500	1,100	1,200	1,300	4,000
SO4	ug/l	38,000	35,000	28,000	28,000	dry	32,000	46,000	41,000	10,000	dry	11,000	12,000	14,000	10,000	10,000	31,000	34,000	dry	11,000	19,000	33,000	35,000	34,000	19,000
NO3	ug/l	310	100	320	100	dry	2,500	600	640	100	dry	370	3,800	200	100	250	1,900	860	dry	130	610	2,200	6,400	1,300	390
Fe-total	ug/l	1,600	2,000	7,300	7,100	dry	50	1,800	1,700	1,800	dry	1,800	2,000	600	930	3,100	100	50	dry	49,000	42,000	130	60	60	54,000
FE-ous	ug/l	NA	640	2,600	2,500	dry	NA	1,400	1,400	500	dry	NA	NA	500	870	500	NA	500	dry	500	500	NA	500	500	500
Fe-ic	ug/l	NA	1,400	4,700	4,600	dry	NA	500	500	1,800	dry	NA	NA	600	500	3,100	NA	500	dry	49,000	42,000	NA	500	500	54,000
Mn	ug/l	14,400	NA	NA	NA	dry	21	NA	NA	NA	dry	1,390	1,520	NA	NA	NA	10	NA	dry	NA	NA	99	NA	NA	NA

All samples low flow unless indicated otherwise grab = grab sample

Source: Alpha Laboratory Reports - L1006386, L1009164, L1012239, and L1020006 Redox, pH, and DO data available in KLF Daily Field Reports (see Appendix D in CCR-3 and herein for 12/14/10)

Notes:
ug/l = micrograms per liter
mg/L = mg/L
D = Duplicate Sample
NA = not analyzed
DCE = cis-1,2-Dichloroethene
TCE = Trichloroethene
VC = Vinyl chloride
Redox = Oxidation-Reduction Potential
tDCE = trans-1,2-Dichloroethene
PCE = Tetrachloroethene
Fe-total = total iron
Fe-ous = Ferrous iron
Fe-ic = Ferric iron
pH = standard units
DO = Dissolved oxygen
TOC = Total organic carbon
SO4 = Sulfate anion
NO3 = Nitrogen, nitrate
Mn = Manganese

Not detected at the stated detection limit



0 500 1,000 2,000
APPROXIMATE SCALE (feet)

LATITUDE: 41° 02' 40.82" N

LONGITUDE: 73° 57' 09.83" W

N

USGS 7.5' SERIES TOPOGRAPHIC MAP,
NYACK NEW YORK-NEW JERSEY
QUADRANGLE

QUADRANGLE
LOCATION

NOTES:

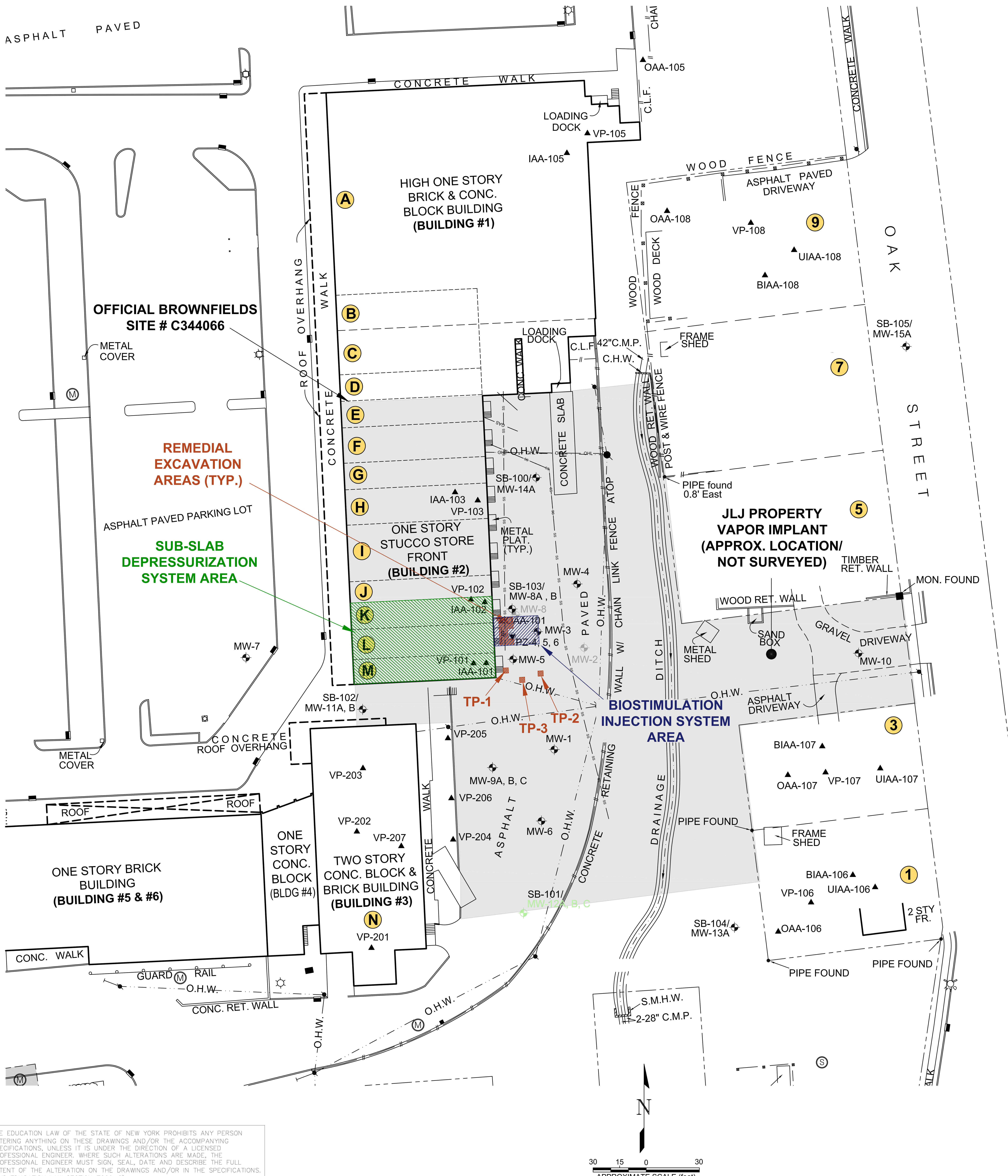
KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	69972
DRAWN:	12/15/2010
DRAWN BY:	CTH
CHECKED BY:	KAF
FILE NAME:	69972CCRNOV10.dwg

LOCUS PLAN

ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

PLATE
1



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LEGEND

	PROPERTY BOUNDARY
	HYDRANT
	UTILITY POLE
	ELECTRIC COVER
	MANHOLE COVER (UNKNOWN)
	TELEPHONE MANHOLE COVER
	CATCH BASIN
	LIGHT POLE
	SEWER MANHOLE
C.L.F	C.L.F CHAIN LINK FENCE
C.H.W.	C.H.W. CONCRETE HEAD WALL
C.M.P	C.M.P. CORRUGATED METAL PIPE
O.H.W.	O.H.W. OVERHEAD WIRES
R.C.P.	R.C.P. REINFORCED CONCRETE PIPE
S.M.H.W.	S.M.H.W. STONE MASONRY HEAD WALL
	MONITORING WELL
	MONITORING WELL (PAVED OVER OR ABANDONED)
	PIEZOMETER
	VAPOR POINT/AMBIENT AIR SAMPLE
#	STREET ADDRESS NUMBER

COMMERCIAL STORE ID TABLE (BUILDING #2)

A	CVS PHARMACY
B	ORANGE FARM MARKET
C	RAINBOW LAUNDROMAT
D	MAGIE TOUCH NAILS
E	STELLA LUNA
F	TIP TOP SHOPPER
G	ALL STATE INSURANCE
H	HIKARO SUSHI
I	KARATE
J	JIU JITSU
K	THE DELI SPOT
L	SPARKLE CLEANERS
M	NEW CHINA HOUSE
N	DUNKIN DONUTS & DISCOUNT STORE

SOURCE:

1. LAND LINK SURVEYORS P.C. SURVEY MAP DATED NOVEMBER 4, 2003.
2. SURVEY AMENDED TO SHOW NEW CERTIFICATION JUNE 1, 2005.
3. SURVEY AMENDED WELL LOCATION DECEMBER 19, 2007.
4. ADDITIONAL WELLS MW10, MW12, AND MW13 LOCATED DECEMBER 27, 2007

NOTES:

1. THE PREMISES SHOWN HEREON DESIGNATED AS LOT 1 ON A CERTAIN MAP ENTITLED " SUBDIVISION OF PROPERTY ORANGETOWN CENTER" AS FILED IN THE ROCKLAND COUNTY CLERK'S OFFICE ON FEBRUARY 26, 1990 AS MAP No. 6427 IN Book 111 Page 59 AND ARE DESCRIBED IN DEED RECORDED REEL 404, PAGE 2555.
2. THE DIMENSIONS SHOWN HEREON, FROM THE STRUCTURES TO THE PROPERTY LINE ARE NOT INTENDED TO BE USED FOR THE ERECTION OF FENCES, STRUCTURES OR ANY OTHER IMPROVEMENT.
3. ENCROACHMENTS BELOW GRADE AND/OR SUBSURFACE FEATURES, IF ANY, NOT LOCATED OR SHOWN HEREON.
4. CERTIFICATIONS INDICATED HEREON SIGNIFY THAT THIS MAP WAS PREPARED FROM AN ACTUAL FIELD SURVEY CONDUCTED ON THE DATE SHOWN AND THAT SAID SURVEY WAS PERFORMED IN ACCORDANCE WITH THE EXISTING " CODE OF PRACTICE FOR LAND SURVEYS " ADOPTED BY THE NEW YORK STATE ASSOCIATION OF PROFESSIONAL LAND SURVEYORS. THIS CERTIFICATION SHALL RUN ONLY TO THE PARTY FOR WHOM THIS SURVEY WAS PREPARED AND ON THEIR BEHALF TO THE TITLE COMPANY AND LENDING INSTITUTION LISTED HEREON. THIS CERTIFICATION SHALL NOT BE TRANSFERABLE.

NO.	REVISION	BY	DATE
-	-	-	-

KLEINFELDER ENGINEERING P.C.
ONE CORPORATE DRIVE, SUITE 201
BOHEMIA, NEW YORK 11716
PH. (631) 218-0612 FAX (631) 218-0787
www.kleinfelder.com

PROJ. NO. 69972
ACAD FILE: 69972CCRNOV10.dwg
DESIGNED BY: PV
CHECKED BY: KAF
DRAWN BY: CTH

SITE PLAN

ORANGETOWN SHOPPING CENTER
1-45 ORANGEBURG ROAD
ORANGEBURG, NEW YORK

FOR REDUCED PLANS: ORIGINAL IN INCHES
0 0.5 1.0 1.5 2.0

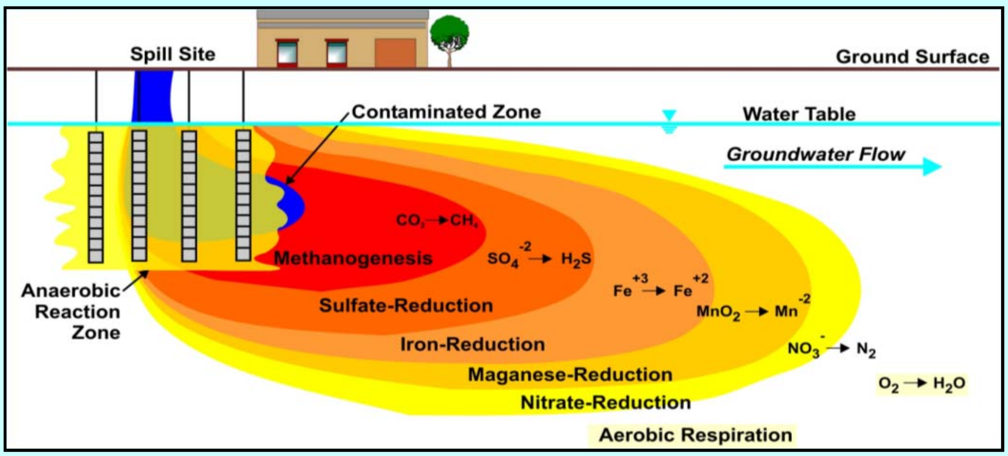
DATE: 12/13/2010
SCALE: AS SHOWN
PLATE 2

SUBSTRATE ESTIMATING TOOL FOR
ENHANCED ANAEROBIC BIOREMEDIATION OF CHLORINATED SOLVENTS

Version 1.0

September 2009

Site Data Input Table	Calculation Tables	Output Summary Table
TABLE S.1 - INPUT TABLE	Table S.2 - Substrate Calculations in Hydrogen	TABLE S.5 - OUTPUT TABLE
	Table S.3 - Hydrogen Produced by Common Substrates	PRINT SUMMARY TABLE
	Table S.4 - Estimated Substrate Requirements for	



This Substrate Estimating Tool for Enhanced Anaerobic Bioremediation of Chlorinated Solvents has been developed by Parsons Infrastructure & Technology Group, Inc. (Parsons) for the Environmental Security Technology Certification Program (ESTCP). This substrate estimating tool is made available on an as-is basis without guarantee or warranty of any kind, express or implied. The United States Government, Parsons, the authors, and the reviewers accept no liability resulting from the use of this substrate estimating tool or its documentation; nor does the above warrant or otherwise represent in any way the accuracy, adequacy, efficacy, or applicability of the contents hereof. This substrate estimating tool is intended soley for educational and site screening purposes. Implementation of the substrate estimating tool and interpretation or use of the results provided in the model are the sole responsibility of the user. The cost estimating tool is provided free of charge for everyone to use, but is not supported in any way by the United States Government or Parsons. Mention of trade names in this report is for information purposes only; no endorsement is implied.

Table S.1 Input for Substrate Requirements in Hydrogen Equivalents

Site Name: JLJ Orangetown - High Model

RETURN TO COVER PAGE

NOTE: Unshaded boxes are user input.

1. Treatment Zone Physical Dimensions	Values	Range	Units	User Notes
Width (Perpendicular to predominant groundwater flow direction)	80	1-10,000	feet	estimated area of impacted groundwater from parking lot area
Length (Parallel to predominant groundwater flow)	30	1-1,000	feet	
Saturated Thickness	20	1-100	feet	15 above rock and 5 included to account for perched area
Treatment Zone Cross Sectional Area	1600	--	ft^2	
Treatment Zone Volume	48,000	--	ft^3	
Treatment Zone Total Pore Volume (total volume x total porosity)	53,870	--	gallons	
Treatment Zone Effective Pore Volume (total volume x effective porosity)	53,870	--	gallons	
Design Period of Performance	1.0	.5 to 5	year	
Design Factor (times the electron acceptor hydrogen demand)	10.0	2 to 20	unitless	

2. Treatment Zone Hydrogeologic Properties

Total Porosity	15%	.05-50	percent	estimate
Effective Porosity	15%	.05-50	percent	estimate
Average Aquifer Hydraulic Conductivity	0.57	.01-1000	ft/day	Domenico & Schwartz 1990
Average Hydraulic Gradient	0.1	0.0001-0.1	ft/ft	based on phase 2
Average Groundwater Seepage Velocity through the Treatment Zone	0.38	--	ft/day	
Average Groundwater Seepage Velocity through the Treatment Zone	138.7	--	ft/yr	
Average Groundwater Flux through the Treatment Zone	249,061	--	gallons/year	
Soil Bulk Density	1.86	1.4-2.0	gm/cm^3	based on hydro letter report
Soil Fraction Organic Carbon (foc)	0.05%	0.01-10	percent	estimate

3. Native Electron Acceptors

A. Aqueous-Phase Native Electron Acceptors

Oxygen	2.9	0.01 to 10	mg/L	site data
Nitrate	2.10	0.1 to- 20	mg/L	site data
Sulfate	35	10 to 5,000	mg/L	site data
Carbon Dioxide (estimated as the amount of Methane produced)	8.5	0.1 to 20	mg/L	site data 2005

B. Solid-Phase Native Electron Acceptors

Manganese (IV) (estimated as the amount of Mn (II) produced)	10	0.1 to 20	mg/L	estimated
Iron (III) (estimated as the amount of Fe (II) produced)	10	0.1 to 20	mg/L	estimated

4. Contaminant Electron Acceptors

Tetrachloroethene (PCE)	0.000	--	mg/L	site data - average concentration within source area used
Trichloroethene (TCE)	0.093	--	mg/L	site data - average concentration within source area used
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	5.750	--	mg/L	site data - average concentration within source area used
Vinyl Chloride (VC)	0.051	--	mg/L	site data - average concentration within source area used
Carbon Tetrachloride (CT)	0.000	--	mg/L	site data - average concentration within source area used
Trichloromethane (or chloroform) (CF)	0.000	--	mg/L	site data - average concentration within source area used
Dichloromethane (or methylene chloride) (MC)	0.000	--	mg/L	site data - average concentration within source area used
Chloromethane	0.000	--	mg/L	site data - average concentration within source area used
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	--	mg/L	site data - average concentration within source area used
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	--	mg/L	site data - average concentration within source area used
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	--	mg/L	site data - average concentration within source area used
Chloroethane	0.000	--	mg/L	site data - average concentration within source area used
Perchlorate	0.000	--	mg/L	site data - average concentration within source area used

5. Aquifer Geochemistry (Optional Screening Parameters)

A. Aqueous Geochemistry

Oxidation-Reduction Potential (ORP)	0	-400 to +500	mV	site data - average value
Temperature	20	5.0 to 30	ºC	site data
pH	6.7	4.0 to 10.0	su	site data
Alkalinity	500	10 to 1,000	mg/L	estimate
Total Dissolved Solids (TDS, or salinity)	100	10 to 1,000	mg/L	estimate
Specific Conductivity	600	100 to 10,000	µs/cm	estimate
Chloride	200	10 to 10,000	mg/L	site data
Sulfide - Pre injection	50.0	0.1 to 100	mg/L	ND less than 100
Sulfide - Post injection	100.0	0.1 to 100	mg/L	estimate - some sulfur compounds within the injected solution

B. Aquifer Matrix

Total Iron	5000	200 to 20,000	mg/kg	site data
Cation Exchange Capacity	NA	1.0 to 10	meq/100 g	estimate
Neutralization Potential	1.0%	1.0 to 100	Percent as $CaCO_3$	estimate

NOTES:

Table S.2 Substrate Calculations in Hydrogen Equivalents

Site Name: **JLJ Orangetown - High Model**

RETURN TO COVER PAGE

NOTE: Open cells are user input.

1. Treatment Zone Physical Dimensions

	Values	Range	Units
Width (Perpendicular to predominant groundwater flow direction)	80	1-10,000	feet
Length (Parallel to predominant groundwater flow)	30	1-1,000	feet
Saturated Thickness	20	1-100	feet
Treatment Zone Cross Sectional Area	1600	--	ft^2
Treatment Zone Volume	48,000	--	ft^3
Treatment Zone Total Pore Volume (total volume x total porosity)	53,870	--	gallons
Design Period of Performance	1.0	.5 to 5	year

2. Treatment Zone Hydrogeologic Properties

	Values	Range	Units
Total Porosity	0.15	.05-50	
Effective Porosity	0.15	.05-50	
Average Aquifer Hydraulic Conductivity	0.57	.01-1000	ft/day
Average Hydraulic Gradient	0.1	0.1-0.0001	ft/ft
Average Groundwater Seepage Velocity through the Treatment Zone	0.38	--	ft/day
Average Groundwater Seepage Velocity through the Treatment Zone	138.7	--	ft/yr
Average Groundwater Flux through the Treatment Zor 0	249,061	--	gallons/year
Soil Bulk Density	1.86	1.4-2.0	gm/cm^3
Soil Fraction Organic Carbon (foc)	0.0005	0.0001-0.1	

3. Initial Treatment Cell Electron-Acceptor Demand (one total pore volume)

A. Aqueous-Phase Native Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Oxygen	2.9	1.30	7.94	0.16	4
Nitrate (denitrification)	2.1	0.94	10.25	0.09	5
Sulfate	35	15.73	11.91	1.32	8
Carbon Dioxide (estimated as the amount of methane produced)	8.5	3.82	1.99	1.92	8
Soluble Competing Electron Acceptor Demand (lb.)				**3.50**	

B. Solid-Phase Native Electron Acceptors (Based on manganese and iron produced)	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Manganese (IV) (estimated as the amount of Mn (II) produced)	10.0	25.28	27.25	0.93	2
Iron (III) (estimated as the amount of Fe (II) produced)	10.0	25.28	55.41	0.46	1
Solid-Phase Competing Electron Acceptor Demand (lb.)				**1.38**	

C. Soluble Contaminant Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Tetrachloroethene (PCE)	0.000	0.00	20.57	0.00	8
Trichloroethene (TCE)	0.093	0.04	21.73	0.00	6
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	5.750	2.58	24.05	0.11	4
Vinyl Chloride (VC)	0.051	0.02	31.00	0.00	2
Carbon Tetrachloride (CT)	0.000	0.00	19.08	0.00	8
Trichloromethane (or chloroform) (CF)	0.000	0.00	19.74	0.00	6
Dichloromethane (or methylene chloride) (MC)	0.000	0.00	21.06	0.00	4
Chloromethane	0.000	0.00	25.04	0.00	2
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.00	20.82	0.00	8
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.00	22.06	0.00	6
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.00	24.55	0.00	4
Chloroethane	0.000	0.00	32.00	0.00	2
Perchlorate	0.000	0.00	12.33	0.00	6
Total Soluble Contaminant Electron Acceptor Demand (lb.)				**0.11**	

D. Sorbed Contaminant Electron Acceptors (Soil Concentration = Koc x foc x Cgw)	Koc (mL/g)	Soil Conc. (mg/kg)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Tetrachloroethene (PCE)	263	0.00	0.00	20.57	0.00	8
Trichloroethene (TCE)	107	0.00	0.03	21.73	0.00	6
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	45	0.13	0.72	24.05	0.03	4
Vinyl Chloride (VC)	3.0	0.00	0.00	31.00	0.00	2
Carbon Tetrachloride (CT)	224	0.00	0.00	19.08	0.00	8
Trichloromethane (or chloroform) (CF)	63	0.00	0.00	19.74	0.00	6
Dichloromethane (or methylene chloride) (MC)	28	0.00	0.00	21.06	0.00	4
Chloromethane	25	0.00	0.00	25.04	0.00	2
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	117	0.00	0.00	20.82	0.00	8
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	105	0.00	0.00	22.06	0.00	6
Dichloroethane (1,1-DCA and 1,2-DCA)	30	0.00	0.00	24.55	0.00	4
Chloroethane	3	0.00	0.00	32.00	0.00	2
Perchlorate	0.0	0.00	0.00	12.33	0.00	6
Total Sorbed Contaminant Electron Acceptor Demand (lb.)					**0.03**	

(continued)

Table S.2 Substrate Calculations in Hydrogen Equivalents

4. Treatment Cell Electron-Acceptor Flux (per year)

A. Soluble Native Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Oxygen	2.9	6.01	7.94	0.76	4
Nitrate (denitrification)	2.1	4.36	10.25	0.43	5
Sulfate	35	72.74	11.91	6.11	8
Carbon Dioxide (estimated as the amount of Methane produced)	8.5	17.67	1.99	8.88	8
Total Competing Electron Acceptor Demand Flux (lb/yr)				**16.2**	

B. Soluble Contaminant Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Tetrachloroethene (PCE)	0.000	0.00	20.57	0.00	8
Trichloroethene (TCE)	0.093	0.19	21.73	0.01	6
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	5.750	11.95	24.05	0.50	4
Vinyl Chloride (VC)	0.051	0.11	31.00	0.00	2
Carbon Tetrachloride (CT)	0.000	0.00	19.08	0.00	8
Trichloromethane (or chloroform) (CF)	0.000	0.00	19.74	0.00	6
Dichloromethane (or methylene chloride) (MC)	0.000	0.00	21.06	0.00	4
Chloromethane	0.000	0.00	25.04	0.00	2
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.00	20.82	0.00	8
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.00	22.06	0.00	6
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.00	24.55	0.00	4
Chloroethane	0.000	0.00	32.00	0.00	2
Perchlorate	0.000	0.00	12.33	0.00	6
Total Soluble Contaminant Electron Acceptor Demand Flux (lb/yr)				**0.51**	

Initial Hydrogen Requirement First Year (lb)	**21.7**
Total Life-Cycle Hydrogen Requirement (lb)	**21.7**

5. Design Factors

Microbial Efficiency Uncertainty Factor	2X - 4X
Methane and Solid-Phase Electron Acceptor Uncertainty	2X - 4X
Remedial Design Factor (e.g., Substrate Leaving Reaction Zone)	1X - 3X
Design Factor	**10.0**
Total Life-Cycle Hydrogen Requirement with Design Factor (lb)	**217.0**

6. Acronyns and Abbreviations

^oC =degrees celsius
μs/cm = microsiemens per centimeter
cm/day = centimeters per day
cm/sec = centimeters per second
ft^2 = square feet
ft/day = feet per day
ft/ft = foot per foot
ft/yr = feet per year
gm/cm^3 = grams per cubic centimeter
kg of CaCO3 per mg = kilograms of calcium carbonate per milligram
lb = pounds
meq/100 g = milliequivalents per 100 grams
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
m/m = meters per meters
mV = millivolts
m/yr = meters per year
su = standard pH units
wt/wt H2 = concetration molecular hydrogen, weight per weight

Table S.3

Hydrogen Produced by Fermentation Reactions of Common Substrates

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Substrate	Molecular Formula	Substrate Molecular Weight (gm/mole)	Moles of Hydrogen Produced per Mole of Substrate	Ratio of Hydrogen Produced to Substrate (gm/gm)	Range of Moles H_2/Mole Substrate
Lactic Acid	$C_3H_6O_3$	90.1	2	0.0448	**2 to 3**
Molasses (assuming 100% sucrose)	$C_{12}H_{22}O_{11}$	342	8	0.0471	**8 to 11**
High Fructose Corn Syrup (assuming 50% fructose and 50% glucose)	$C_6H_{12}O_6$	180	4	0.0448	**4 to 6**
Ethanol	C_2H_6O	46.1	2	0.0875	**2 to 6**
Whey (assuming 100% lactose)	$C_{12}H_{22}O_{11}$	342	11	0.0648	**11**
HRC® (assumes 40% lactic acid and 40% glycerol by weight)	$C_{39}H_{56}O_{39}$	956	28	0.0590	**28**
Linoleic Acid (Soybean Oil, Corn Oil, Cotton Oil)	$C_{18}H_{32}O_2$	281	16	0.1150	**16**

Table S.4
Estimated Substrate Requirements for Hydrogen Demand in Table S.3

Design Life (years): 1

Substrate	Design Factor	Pure Substrate Mass Required to Fulfill Hydrogen Demand (pounds)	Substrate Product Required to Fulfill Hydrogen Demand (pounds)	Substrate Mass Required to Fulfill Hydrogen Demand (milligrams)	Effective Substrate Concentration (mg/L)
Lactic Acid	10.0	4,848	4,848	2.20E+09	1,918
Sodium Lactate Product (60 percent solution)	10.0	4,848	10,057	2.20E+09	1,918
Molasses (assuming 6 0	10.0	4,605	7,675	2.09E+09	1,822
HFCS (assuming 40% fructose and 40% glucose by weight)	10.0	4,849	6,061	2.20E+09	1,918
Ethanol Product (assuming 80% ethanol by weight)	10.0	2,479	3,099	1.12E+09	981
Whey (assuming 100% lactose)	10.0	3,346	4,780	1.52E+09	1,324
HRC® (assumes 40% lactic acid and 40% glycerol by weight)	10.0	3,675	3,675	1.67E+09	1,163
Linoleic Acid (Soybean Oil, Corn Oil, Cotton Oil)	10.0	1,887	1,887	8.56E+08	746
Commercial Vegetable Oil Emulsion Product (60% oil by weight)	10.0	1,887	3,145	8.56E+08	746

NOTES: Sodium Lactate Product

1. Assumes sodium lactate product is 60 percent sodium lactate by weight.
2. Molecular weight of sodium lactate (CH_3-CHOH-COONa) = 112.06.
3. Molecular weight of lactic Acid ($C_6H_6O_3$) = 90.08 .
4. Therefore, sodium lactate product yields 48.4 (0.60 x (90.08/112.06)) percent by weight lactic acid.
5. Weight of sodium lactate product = 11.0 pounds per gallon.
6. Pounds per gallon of lactic acid in product = 1.323 x 8.33 lb/gal H2O x 0.60 x (90.08/112.06) = 5.31 lb/gal.

NOTES: Standard HRC Product

1. Assumes HRC product is 40 percent lactic acid and 40 percent glycerol by weight.
2. HRC® weighs approximately 9.18 pounds per gallon.

NOTES: Vegetable Oil Emulsion Product

1. Assumes emulsion product is 60 percent soybean oil by weight.
2. Soybean oil is 7.8 pounds per gallon.
3. Assumes specific gravity of emulsion product is 0.96.

Table S.5 Output for Substrate Requirements in Hydrogen Equivalents

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Site Name: **JLJ Orangetown - High Model**

1. Treatment Zone Physical Dimensions

	Values	Units	Values	Units
Width (perpendicular to groundwater flow)	80	feet	24	meters
Length (parallel to groundwater flow)	30	feet	9.1	meters
Saturated Thickness	20	feet	6.1	meters
Design Period of Performance	1	years	1	years

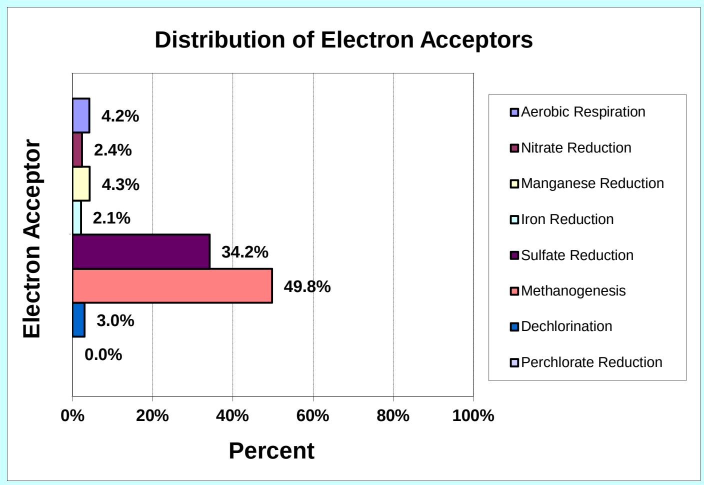
2. Treatment Zone Hydrogeologic Properties

	Values	Units	Values	Units
Total Porosity	0.15	percent	0.15	percent
Effective Porosity	0.15	percent	0.15	percent
Average Aquifer Hydraulic Conductivity	0.57	ft/day	2.0E-04	cm/sec
Average Hydraulic Gradient	0.1	ft/ft	0.1	m/m
Average Groundwater Seepage Velocity	0.38	ft/day	1.2E+01	cm/day
Average Groundwater Seepage Velocity	139	ft/yr	42.3	m/yr
Total Treatment Zone Pore Volume	53,870	gallons	203,916	liters
Groundwater Flux (per year)	249,061	gallons/year	942,771	liters/year
Total Groundwater Volume Treated (over entire design period)	302,931	gallons total	1,146,687	liters total

3. Distribution of Electron Acceptor Demand

	Percent of Total	Hydrogen Demand (lb)
Aerobic Respiration	4.2%	0.920
Nitrate Reduction	2.4%	0.518
Sulfate Reduction	34.2%	7.429
Manganese Reduction	4.3%	0.928
Iron Reduction	2.1%	0.456
Methanogenesis	49.8%	10.797
Dechlorination	3.0%	0.651
Perchlorate Reduction	0.0%	0.000
Totals:	**100.00%**	**21.70**

Hydrogen demand in pounds/gallon:	7.16E-05
Hydrogen demand in grams per liter:	8.58E-03



4. Substrate Equivalents: Design Factor = 10.0

Effective concentration is for total volume of groundwater treated.

Product	Quantity (lb)	Quantity (gallons)	Effective Concentration (mg/L)	
1. Sodium Lactate Product	10,057	914	1,918	as lactic acid
2. Molasses Product	7,675	640	1,822	as sucrose
3. Fructose Product	6,061	541	1,918	as fructose
4. Ethanol Product	3,099	449	981	as ethanol
5. Sweet Dry Whey (lactose)	4,780	sold by pound	1,324	as lactose
6. HRC®	3,675	sold by pound	1,163	as 40% lactic acid/40% glycerol
7. Linoleic Acid (Soybean Oil)	1,887	242	746	as soybean oil
8. Emulsified Vegetable Oil	3,145	403	746	as soybean oil

Notes:
1. Quantity assumes product is 60% sodium lactate by weight.
2. Quantity assumes product is 60% sucrose by weight and weighs 12 pounds per gallon.
3. Quantity assumes product is 80% fructose by weight and weighs 11.2 pounds per gallon.
4. Quantity assumes product is 80% ethanol by weight and weighs 6.9 pounds per gallon.
5. Quantity assumes product is 70% lactose by weight.
6. Quantity assumes HRC® is 40% lactic acid and 40% glycerol by weight.
7. Quantity of neat soybean oil, corn oil, or canola oil.
8. Quantity assumes commercial product is 60% soybean oil by weight.

SUBSTRATE ESTIMATING TOOL FOR
ENHANCED ANAEROBIC BIOREMEDIATION OF CHLORINATED SOLVENTS

Version 1.0

September 2009

Site Data Input Table	Calculation Tables	Output Summary Table
TABLE S.1 - INPUT TABLE	Table S.2 - Substrate Calculations in Hydrogen	TABLE S.5 - OUTPUT TABLE
	Table S.3 - Hydrogen Produced by Common Substrates	PRINT SUMMARY TABLE
	Table S.4 - Estimated Substrate Requirements for	

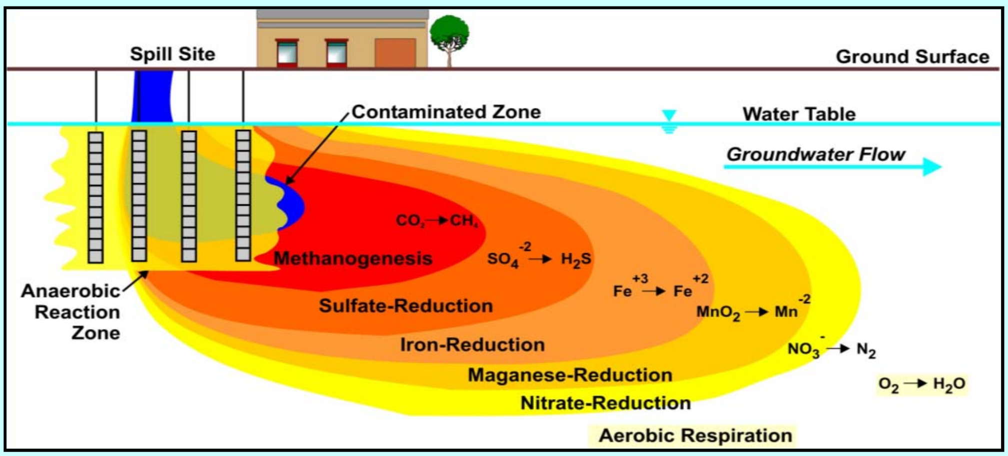


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Table S.1 Input for Substrate Requirements in Hydrogen Equivalents

Site Name: JLJ Orangetown - Low Model

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NOTE: Unshaded boxes are user input.

1. Treatment Zone Physical Dimensions	Values	Range	Units	User Notes
Width (Perpendicular to predominant groundwater flow direction)	80	1-10,000	feet	estimated area of impacted groundwater from parking lot area
Length (Parallel to predominant groundwater flow)	30	1-1,000	feet	
Saturated Thickness	20	1-100	feet	15 above rock and 5 included to account for perched area
Treatment Zone Cross Sectional Area	1600	--	ft^2	
Treatment Zone Volume	48,000	--	ft^3	
Treatment Zone Total Pore Volume (total volume x total porosity)	107,741	--	gallons	
Treatment Zone Effective Pore Volume (total volume x effective porosity)	89,784	--	gallons	
Design Period of Performance	1.0	.5 to 5	year	
Design Factor (times the electron acceptor hydrogen demand)	1.0	2 to 20	unitless	
2. Treatment Zone Hydrogeologic Properties				
Total Porosity	30%	.05-50	percent	estimate
Effective Porosity	25%	.05-50	percent	estimate
Average Aquifer Hydraulic Conductivity	0.01	.01-1000	ft/day	Domenico & Schwartz 1990
Average Hydraulic Gradient	0.1	0.0001-0.1	ft/ft	based on phase 2
Average Groundwater Seepage Velocity through the Treatment Zone	0.00	--	ft/day	
Average Groundwater Seepage Velocity through the Treatment Zone	1.5	--	ft/yr	
Average Groundwater Flux through the Treatment Zone	4,369	--	gallons/year	
Soil Bulk Density	1.86	1.4-2.0	gm/cm^3	based on hydro letter report
Soil Fraction Organic Carbon (foc)	0.05%	0.01-10	percent	estimate
3. Native Electron Acceptors				
A. Aqueous-Phase Native Electron Acceptors				
Oxygen	2.9	0.01 to 10	mg/L	site data
Nitrate	2.10	0.1 to- 20	mg/L	site data
Sulfate	35	10 to 5,000	mg/L	site data
Carbon Dioxide (estimated as the amount of Methane produced)	8.5	0.1 to 20	mg/L	site data 2005
B. Solid-Phase Native Electron Acceptors				
Manganese (IV) (estimated as the amount of Mn (II) produced)	10	0.1 to 20	mg/L	estimated
Iron (III) (estimated as the amount of Fe (II) produced)	10	0.1 to 20	mg/L	estimated
4. Contaminant Electron Acceptors				
Tetrachloroethene (PCE)	0.000	--	mg/L	site data - average concentration within source area used
Trichloroethene (TCE)	0.093	--	mg/L	site data - average concentration within source area used
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	5.750	--	mg/L	site data - average concentration within source area used
Vinyl Chloride (VC)	0.051	--	mg/L	site data - average concentration within source area used
Carbon Tetrachloride (CT)	0.000	--	mg/L	site data - average concentration within source area used
Trichloromethane (or chloroform) (CF)	0.000	--	mg/L	site data - average concentration within source area used
Dichloromethane (or methylene chloride) (MC)	0.000	--	mg/L	site data - average concentration within source area used
Chloromethane	0.000	--	mg/L	site data - average concentration within source area used
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	--	mg/L	site data - average concentration within source area used
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	--	mg/L	site data - average concentration within source area used
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	--	mg/L	site data - average concentration within source area used
Chloroethane	0.000	--	mg/L	site data - average concentration within source area used
Perchlorate	0.000	--	mg/L	site data - average concentration within source area used
5. Aquifer Geochemistry (Optional Screening Parameters)				
A. Aqueous Geochemistry				
Oxidation-Reduction Potential (ORP)	0	-400 to +500	mV	site data - average value
Temperature	20	5.0 to 30	ºC	site data
pH	6.7	4.0 to 10.0	su	site data
Alkalinity	500	10 to 1,000	mg/L	estimate
Total Dissolved Solids (TDS, or salinity)	100	10 to 1,000	mg/L	estimate
Specific Conductivity	600	100 to 10,000	µs/cm	estimate
Chloride	200	10 to 10,000	mg/L	site data
Sulfide - Pre injection	50.0	0.1 to 100	mg/L	ND less than 100
Sulfide - Post injection	100.0	0.1 to 100	mg/L	estimate - some sulfur compounds within the injected solution
B. Aquifer Matrix				
Total Iron	5000	200 to 20,000	mg/kg	site data
Cation Exchange Capacity	NA	1.0 to 10	meq/100 g	estimate
Neutralization Potential	1.0%	1.0 to 100	Percent as $CaCO_3$	estimate

NOTES:

Table S.2 Substrate Calculations in Hydrogen Equivalents

Site Name: **JLJ Orangetown - Low Model**

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NOTE: Open cells are user input.

1. Treatment Zone Physical Dimensions

	Values	Range	Units
Width (Perpendicular to predominant groundwater flow direction)	80	1-10,000	feet
Length (Parallel to predominant groundwater flow)	30	1-1,000	feet
Saturated Thickness	20	1-100	feet
Treatment Zone Cross Sectional Area	1600	--	ft^2
Treatment Zone Volume	48,000	--	ft^3
Treatment Zone Total Pore Volume (total volume x total porosity)	89,784	--	gallons
Design Period of Performance	1.0	.5 to 5	year

2. Treatment Zone Hydrogeologic Properties

	Values	Range	Units
Total Porosity	0.3	.05-50	
Effective Porosity	0.25	.05-50	
Average Aquifer Hydraulic Conductivity	0.01	.01-1000	ft/day
Average Hydraulic Gradient	0.1	0.1-0.0001	ft/ft
Average Groundwater Seepage Velocity through the Treatment Zone	0.00	--	ft/day
Average Groundwater Seepage Velocity through the Treatment Zone	1.5	--	ft/yr
Average Groundwater Flux through the Treatment Zor 0	4,369	--	gallons/year
Soil Bulk Density	1.86	1.4-2.0	gm/cm^3
Soil Fraction Organic Carbon (foc)	0.0005	0.0001-0.1	

3. Initial Treatment Cell Electron-Acceptor Demand (one total pore volume)

A. Aqueous-Phase Native Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Oxygen	2.9	2.17	7.94	0.27	4
Nitrate (denitrification)	2.1	1.57	10.25	0.15	5
Sulfate	35	26.22	11.91	2.20	8
Carbon Dioxide (estimated as the amount of methane produced)	8.5	6.37	1.99	3.20	8
Soluble Competing Electron Acceptor Demand (lb.)				**5.83**	

B. Solid-Phase Native Electron Acceptors (Based on manganese and iron produced)	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Manganese (IV) (estimated as the amount of Mn (II) produced)	10.0	7.86	27.25	0.29	2
Iron (III) (estimated as the amount of Fe (II) produced)	10.0	7.86	55.41	0.14	1
Solid-Phase Competing Electron Acceptor Demand (lb.)				**0.43**	

C. Soluble Contaminant Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Tetrachloroethene (PCE)	0.000	0.00	20.57	0.00	8
Trichloroethene (TCE)	0.093	0.07	21.73	0.00	6
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	5.750	4.31	24.05	0.18	4
Vinyl Chloride (VC)	0.051	0.04	31.00	0.00	2
Carbon Tetrachloride (CT)	0.000	0.00	19.08	0.00	8
Trichloromethane (or chloroform) (CF)	0.000	0.00	19.74	0.00	6
Dichloromethane (or methylene chloride) (MC)	0.000	0.00	21.06	0.00	4
Chloromethane	0.000	0.00	25.04	0.00	2
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.00	20.82	0.00	8
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.00	22.06	0.00	6
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.00	24.55	0.00	4
Chloroethane	0.000	0.00	32.00	0.00	2
Perchlorate	0.000	0.00	12.33	0.00	6
Total Soluble Contaminant Electron Acceptor Demand (lb.)				**0.18**	

D. Sorbed Contaminant Electron Acceptors (Soil Concentration = Koc x foc x Cgw)	Koc (mL/g)	Soil Conc. (mg/kg)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Tetrachloroethene (PCE)	263	0.00	0.00	20.57	0.00	8
Trichloroethene (TCE)	107	0.00	0.03	21.73	0.00	6
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	45	0.13	0.72	24.05	0.03	4
Vinyl Chloride (VC)	3.0	0.00	0.00	31.00	0.00	2
Carbon Tetrachloride (CT)	224	0.00	0.00	19.08	0.00	8
Trichloromethane (or chloroform) (CF)	63	0.00	0.00	19.74	0.00	6
Dichloromethane (or methylene chloride) (MC)	28	0.00	0.00	21.06	0.00	4
Chloromethane	25	0.00	0.00	25.04	0.00	2
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	117	0.00	0.00	20.82	0.00	8
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	105	0.00	0.00	22.06	0.00	6
Dichloroethane (1,1-DCA and 1,2-DCA)	30	0.00	0.00	24.55	0.00	4
Chloroethane	3	0.00	0.00	32.00	0.00	2
Perchlorate	0.0	0.00	0.00	12.33	0.00	6
Total Sorbed Contaminant Electron Acceptor Demand (lb.)					**0.03**	

(continued)

Table S.2 Substrate Calculations in Hydrogen Equivalents

4. Treatment Cell Electron-Acceptor Flux (per year)

A. Soluble Native Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Oxygen	2.9	0.11	7.94	0.01	4
Nitrate (denitrification)	2.1	0.08	10.25	0.01	5
Sulfate	35	1.28	11.91	0.11	8
Carbon Dioxide (estimated as the amount of Methane produced)	8.5	0.31	1.99	0.16	8
Total Competing Electron Acceptor Demand Flux (lb/yr)				**0.3**	

B. Soluble Contaminant Electron Acceptors	Concentration (mg/L)	Mass (lb)	Stoichiometric demand (wt/wt h_2)	Hydrogen Demand (lb)	Electron Equivalents per Mole
Tetrachloroethene (PCE)	0.000	0.00	20.57	0.00	8
Trichloroethene (TCE)	0.093	0.00	21.73	0.00	6
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	5.750	0.21	24.05	0.01	4
Vinyl Chloride (VC)	0.051	0.00	31.00	0.00	2
Carbon Tetrachloride (CT)	0.000	0.00	19.08	0.00	8
Trichloromethane (or chloroform) (CF)	0.000	0.00	19.74	0.00	6
Dichloromethane (or methylene chloride) (MC)	0.000	0.00	21.06	0.00	4
Chloromethane	0.000	0.00	25.04	0.00	2
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.00	20.82	0.00	8
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.00	22.06	0.00	6
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.00	24.55	0.00	4
Chloroethane	0.000	0.00	32.00	0.00	2
Perchlorate	0.000	0.00	12.33	0.00	6
Total Soluble Contaminant Electron Acceptor Demand Flux (lb/yr)				**0.01**	

Initial Hydrogen Requirement First Year (lb)	**6.8**
Total Life-Cycle Hydrogen Requirement (lb)	**6.8**

5. Design Factors

Microbial Efficiency Uncertainty Factor	2X - 4X
Methane and Solid-Phase Electron Acceptor Uncertainty	2X - 4X
Remedial Design Factor (e.g., Substrate Leaving Reaction Zone)	1X - 3X
Design Factor	**1.0**
Total Life-Cycle Hydrogen Requirement with Design Factor (lb)	**6.8**

6. Acronyns and Abbreviations

^{o}C =degrees celsius
μs/cm = microsiemens per centimeter
cm/day = centimeters per day
cm/sec = centimeters per second
ft^2 = square feet
ft/day = feet per day
ft/ft = foot per foot
ft/yr = feet per year
gm/cm^3 = grams per cubic centimeter
kg of CaCO3 per mg = kilograms of calcium carbonate per milligram
lb = pounds
meq/100 g = milliequivalents per 100 grams
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
m/m = meters per meters
mV = millivolts
m/yr = meters per year
su = standard pH units
wt/wt H2 = concetration molecular hydrogen, weight per weight

Table S.3

Hydrogen Produced by Fermentation Reactions of Common Substrates

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Substrate	Molecular Formula	Substrate Molecular Weight (gm/mole)	Moles of Hydrogen Produced per Mole of Substrate	Ratio of Hydrogen Produced to Substrate (gm/gm)	Range of Moles H_2/Mole Substrate
Lactic Acid	$C_3H_6O_3$	90.1	2	0.0448	**2 to 3**
Molasses (assuming 100% sucrose)	$C_{12}H_{22}O_{11}$	342	8	0.0471	**8 to 11**
High Fructose Corn Syrup (assuming 50% fructose and 50% glucose)	$C_6H_{12}O_6$	180	4	0.0448	**4 to 6**
Ethanol	C_2H_6O	46.1	2	0.0875	**2 to 6**
Whey (assuming 100% lactose)	$C_{12}H_{22}O_{11}$	342	11	0.0648	**11**
HRC® (assumes 40% lactic acid and 40% glycerol by weight)	$C_{39}H_{56}O_{39}$	956	28	0.0590	**28**
Linoleic Acid (Soybean Oil, Corn Oil, Cotton Oil)	$C_{18}H_{32}O_2$	281	16	0.1150	**16**

Table S.4
Estimated Substrate Requirements for Hydrogen Demand in Table S.3

Design Life (years): 1

Substrate	Design Factor	Pure Substrate Mass Required to Fulfill Hydrogen Demand (pounds)	Substrate Product Required to Fulfill Hydrogen Demand (pounds)	Substrate Mass Required to Fulfill Hydrogen Demand (milligrams)	Effective Substrate Concentration (mg/L)
Lactic Acid	1.0	151	151	6.86E+07	192
Sodium Lactate Product (60 percent solution)	1.0	151	314	6.86E+07	192
Molasses (assuming 6 0	1.0	144	239	6.51E+07	183
HFCS (assuming 40% fructose and 40% glucose by weight)	1.0	151	189	6.86E+07	192
Ethanol Product (assuming 80% ethanol by weight)	1.0	77	97	3.51E+07	98
Whey (assuming 100% lactose)	1.0	104	149	4.73E+07	133
HRC® (assumes 40% lactic acid and 40% glycerol by weight)	1.0	115	115	5.20E+07	117
Linoleic Acid (Soybean Oil, Corn Oil, Cotton Oil)	1.0	59	59	2.67E+07	75
Commercial Vegetable Oil Emulsion Product (60% oil by weight)	1.0	59	98	2.67E+07	75

NOTES: Sodium Lactate Product

1. Assumes sodium lactate product is 60 percent sodium lactate by weight.
2. Molecular weight of sodium lactate (CH_3-CHOH-COONa) = 112.06.
3. Molecular weight of lactic Acid ($C_6H_6O_3$) = 90.08 .
4. Therefore, sodium lactate product yields 48.4 (0.60 x (90.08/112.06)) percent by weight lactic acid.
5. Weight of sodium lactate product = 11.0 pounds per gallon.
6. Pounds per gallon of lactic acid in product = 1.323 x 8.33 lb/gal H2O x 0.60 x (90.08/112.06) = 5.31 lb/gal.

NOTES: Standard HRC Product

1. Assumes HRC product is 40 percent lactic acid and 40 percent glycerol by weight.
2. HRC® weighs approximately 9.18 pounds per gallon.

NOTES: Vegetable Oil Emulsion Product

1. Assumes emulsion product is 60 percent soybean oil by weight.
2. Soybean oil is 7.8 pounds per gallon.
3. Assumes specific gravity of emulsion product is 0.96.

Table S.5 Output for Substrate Requirements in Hydrogen Equivalents

Site Name: **JLJ Orangetown - Low Model**

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1. Treatment Zone Physical Dimensions

	Values	Units	Values	Units
Width (perpendicular to groundwater flow)	80	feet	24	meters
Length (parallel to groundwater flow)	30	feet	9.1	meters
Saturated Thickness	20	feet	6.1	meters
Design Period of Performance	1	years	1	years

2. Treatment Zone Hydrogeologic Properties

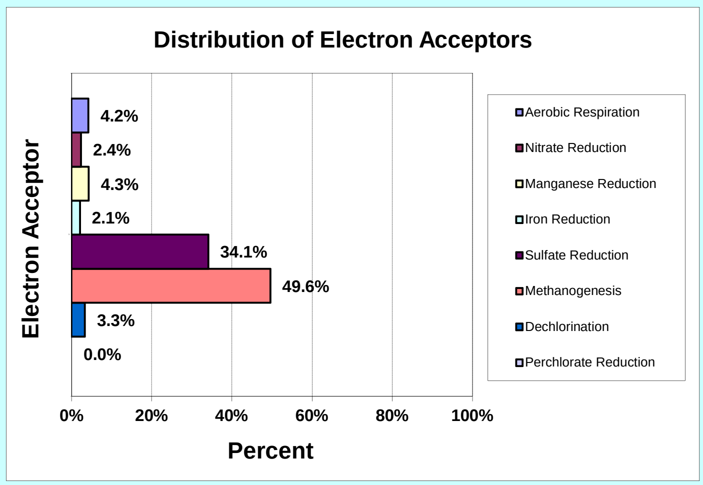
	Values	Units	Values	Units
Total Porosity	0.3	percent	0.3	percent
Effective Porosity	0.25	percent	0.25	percent
Average Aquifer Hydraulic Conductivity	0.01	ft/day	3.5E-06	cm/sec
Average Hydraulic Gradient	0.1	ft/ft	0.1	m/m
Average Groundwater Seepage Velocity	0.00	ft/day	1.2E-01	cm/day
Average Groundwater Seepage Velocity	1	ft/yr	0.4	m/yr
Total Treatment Zone Pore Volume	89,784	gallons	339,860	liters
Groundwater Flux (per year)	4,369	gallons/year	16,540	liters/year
Total Groundwater Volume Treated (over entire design period)	94,153	gallons total	356,400	liters total

3. Distribution of Electron Acceptor Demand

	Percent of Total	Hydrogen Demand (lb)
Aerobic Respiration	4.2%	0.286
Nitrate Reduction	2.4%	0.161
Sulfate Reduction	34.1%	2.309
Manganese Reduction	4.3%	0.288
Iron Reduction	2.1%	0.142
Methanogenesis	49.6%	3.356
Dechlorination	3.3%	0.224
Perchlorate Reduction	0.0%	0.000
Totals:	**100.00%**	**6.77**

Hydrogen demand in pounds/gallon: 7.19E-05

Hydrogen demand in grams per liter: 8.61E-03



4. Substrate Equivalents: Design Factor = 1.0

Product	Quantity (lb)	Quantity (gallons)	Effective Concentration (mg/L)	Effective concentration is for total volume of groundwater treated.
1. Sodium Lactate Product	314	29	192	as lactic acid
2. Molasses Product	239	20	183	as sucrose
3. Fructose Product	189	17	192	as fructose
4. Ethanol Product	97	14	98	as ethanol
5. Sweet Dry Whey (lactose)	149	sold by pound	133	as lactose
6. HRC®	115	sold by pound	117	as 40% lactic acid/40% glycerol
7. Linoleic Acid (Soybean Oil)	59	8	75	as soybean oil
8. Emulsified Vegetable Oil	98	13	75	as soybean oil

Notes:
1. Quantity assumes product is 60% sodium lactate by weight.
2. Quantity assumes product is 60% sucrose by weight and weighs 12 pounds per gallon.
3. Quantity assumes product is 80% fructose by weight and weighs 11.2 pounds per gallon.
4. Quantity assumes product is 80% ethanol by weight and weighs 6.9 pounds per gallon.
5. Quantity assumes product is 70% lactose by weight.
6. Quantity assumes HRC® is 40% lactic acid and 40% glycerol by weight.
7. Quantity of neat soybean oil, corn oil, or canola oil.
8. Quantity assumes commercial product is 60% soybean oil by weight.