WEST 17TH STREET AND 10TH AVENUE SITE
BCP SITE #C231040
New York, NY

Operable Unit 2 (OU2) Oxygen Release Compound (ORC) Injection Work Plan

Prepared For:
17th and 10th Associates LLC
60 Columbus Circle
New York, NY 10023
FLS Project Number: 10022-004

Submitted to:
New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 2
47-40 21st Street
Long Island City, NY 11101-5407

January 2007

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1.0 INTRODUCTION

On behalf of 17th and 10th Associates, LLC, Fleming-Lee Shue, Inc. (FLS) has prepared this Operable Unit 2 (OU2) Oxygen Release Compound (ORC) Injection Work Plan for the West 17th Street and 10th Avenue Brownfield Cleanup Program (BCP) Site # C231040 (hereafter referred to as "the Site"). The Site is located on the western portion of the city block bound by West 16th Street to the south, 10th Avenue to the west and West 17th Street to the north, in the borough of Manhattan, City of New York, New York (Figure 1). A five-story residential building with street-level retail is located in the northwest corner of this geographic area; however, this structure is not considered part of the Site. For purposes of remediation, the site was divided into two areas, the area beneath/immediately adjacent to the High Line (OU2), and the remainder of the site to the north and east of the High Line (OU1).

The Remedial Action Work Plan (RAWP) for this site was submitted to the New York State Department of Environmental Conservation (NYSDEC) on November 21, 2005. Subsequently, a revised stipulation list was submitted to the NYSDEC as an amendment to the RAWP on April 24, 2006. Both the RAWP and Stipulation List were approved by NYSDEC in a letter dated April 26, 2006.

As presented in the RAWP, remediation of OU2 includes: excavation of the top 1' of surface materials; capping the area with asphalt and/or cement, with continued maintenance of the cap; treatment of groundwater and subsurface soils via enhanced biodegradation using ORC®; a deed restriction to prevent groundwater use; and post-remediation groundwater monitoring.

The purpose of this Work Plan is to detail the application and monitoring of ORC in the soil and groundwater of OU2 for the purpose of petroleum hydrocarbon (PHC) remediation. It should be noted that the work outlined in the September 2005 Supplemental Remedial Investigation Work Plan (SRIWP) will be performed in conjunction with this ORC effort. The four offsite monitoring wells planned for the off-site investigation will also be used to monitor the effectiveness of the remedy for OU-2.

This work plan has been prepared pursuant to the above-mentioned remedy selection for OU2 presented in the RAWP including Stipulations 59 and 61.

Remediation of PHCs in the soil and groundwater will be accomplished using enhanced, in-situ bioremediation. The PHC groundwater contamination is characterized by elevated levels of volatile organic compounds (VOCs), including BTEX (benzene, toluene, ethylbenzene, xylenes and petroleum-related semi-volatile organic compounds (SVOCs) (naphthalene and 2-methylnaphthalene).

The application of ORC Advanced® promotes bioremediation by enhancing the supply of oxygen in groundwater. Introducing ORC favors the development of aerobic conditions which stimulate naturally-occurring microbes that have the capability of

metabolically transforming PHCs and other organic compounds into simple by-products such as carbon dioxide, water and chloride ions. Polyaromatic hydrocarbons (PAHs), such as the naphthalenes, are also reported to be amenable to aerobic respiration. ORC Advanced® releases oxygen to the groundwater over time (typically around 12 months), and, therefore, does not require continuous or frequent operation of fixed injection equipment, which can interfere with site activities.

1.1 Site Geology and Hydrogeology

In 2005, FLS conducted a remedial investigation (RI) at the Site including a soil gas screening survey, soil gas sampling, installation and sampling of soil borings, monitoring well installation, groundwater sampling, and groundwater monitoring. Twenty-three soil borings were advanced to depths of approximately 20 feet below grade (ft-bg) and two soil samples collected at each boring location. Eight monitoring wells, MW F-1 through MW F-8, were installed and groundwater samples were collected generally around the perimeter of the site. OU2 monitoring well locations are shown on Figure 2. The information below was gathered during this RI and subsequent observations during excavation/construction.

Prior to 1865, the original Hudson River shoreline was close to the western boundary of the Site along 10th Avenue. The Site was filled sometime prior to 1865 and has since been developed with a variety of commercial, residential, and manufacturing uses, including fueling and motor vehicle repair operations.
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Most of the soil in OU2 is fill material. Along the west side of the Site, immediately east of the High Line railroad supports, there is extensive rubble fill. In OU2, at locations near the High Line columns, there is a concrete slab at approximately 8 to 9 ft-bg which is possibly old building foundations or floors. The rubble fill extends down as deep as 16 ft-bg. The native sand below the rubble fill in this location has more silt and clay than the eastern portion of the Site. The former shoreline of the Hudson River was located just off-Site to the west, possibly explaining the increase in silt.

Generally, groundwater flow across the Site is to the west, towards the Hudson River, as shown on Figures 3 and 4. The groundwater flow measured on July 13, 2005, showed a groundwater depression around well MW F-8. The depression influenced groundwater in the western portion of the Site, to the greatest extent in OU2, causing localized southerly flow towards well MW F-8. Groundwater flow measured on August 26, 2005, showed a much less severe depression around well MW F-8; however, flow is generally towards the south on OU2. Possible explanations for the depression in MW F-8 include off-site pumping, low conductivity of river deposits, or a leaking sewer along 16th Street. On a regional level, groundwater is generally flowing to the west towards the Hudson River. For the purpose of this work plan, groundwater flow in OU2 is assumed to have both a westerly and southerly component. The groundwater flow direction through OU2 will be more accurately defined in the supplemental off-site investigation. A modification to the

SRIWP, which details the revised locations of two monitoring wells and the installation of an upgradient piezometer, will be submitted separately to NYSDEC.

The depth-to-water measurements collected from OU2 in July 2005 were 14.15 ft-bg (-4.11 ft-Manhattan Borough Datum (mbd)) and 14.13 ft-bg (-3.99 ft-mbd) in monitoring wells MW F-3 and MW F-7, respectively. The depths-to water collected from OU2 in August 2005 were 13.9 ft-bg (-3.86 ft-mbd) and 13.42 ft-bg (-3.28 ft-mbd) in monitoring wells MW F-3 and MW F-7, respectively.

1.2 Summary of OU2 Groundwater Contamination

Contaminants found in the groundwater in OU2 at concentrations exceeding the NYSDEC Department of Water Technical & Operational Guidance Series (TOGS) Class GA Groundwater Standards include the following compounds: acetone, benzene, toluene, ethylbenzene, xylenes, naphthalene and 2-methylnaphthalene. For reference, the results of the RI groundwater sampling conducted on June 20-21, 2005 are included in Table 1 below. The highest levels of contaminants were detected in monitoring well MW F-3, located in the southwestern section of OU2, as shown on Figure 2.

Table 1 – Summary of VOCs in Groundwater
Monitoring Wells MW F-3 and MW F-7 in OU2
June 2005

	NYSDEC Class GA Groundwater Standards (ug/L)	MW F-3 June 21, 2005 (ug/L)	MW F-7 June 20, 2005 (ug/L)
Acetone	50	ND	**130***
Benzene	0.7	ND	**160**
Toluene	5	ND	**7.8**
Ethylbenzene	5	1.7 J	**290**
Total Xylenes	5	**33**	**509**
Total VOCs	NS	*34.7*	*966.8*
Naphthalene	10	ND	**240**
2-Methylnaphthalene	50	ND	**64**
Total SVOCs	NS	*ND*	*309*

Bold values exceed Class GA Groundwater Standards
ND = Not detected above method detection limit
NS = No standard promulgated
J = Estimated concentration
* = Acetone was detected in the dilution sample prepared by the laboratory and the associated method blank. Acetone is a common laboratory contaminant and is most likely not present in the groundwater in OU2.

The screened intervals of the monitoring wells were as follows:

MW F-3:	3.48 to 18.48 ft-bg
MW F-7:	5.03 to 20.03 ft-bg

Based on the measured depths to water, boring logs and low relative densities of the PHCs, the contaminated intervals designated for treatment are 13 to 16 ft-bg (-2.54 to -5.54 ft-mbd) in monitoring wells MW F-3 and MW F-7.

2.0 METHODOLOGY

2.1 Remedial Activities

In OU2, enhanced aerobic biodegradation using ORC Advanced® will be implemented. ORC Advanced® will be injected at selected locations to increase available oxygen and accelerate aerobic biological oxidation of the PHCs detected in this area. The groundwater cleanup objectives for OU2 are the NYSDEC TOGS Class GA Groundwater Standards. The work will be performed in accordance with the applicable sections of the RAWP including the Quality Assurance Project Plan, Construction Health and Safety Plan, and Community Air Monitoring Plan.

The scope of this groundwater remediation plan includes a one-time injection of ORC Advanced® followed by 12 months of post-remedial monitoring.

Specific remedial activities include:

1. establishment of a groundwater monitoring network comprised of four (4) new monitoring wells and an upgradient piezometer; this network will also be used to implement the SRIWP;
2. perform an initial, one time round of groundwater monitoring prior to reagent injection to establish pre-injection (interim) groundwater characteristics (PHC and geochemical conditions;
3. injection of ORC Advanced® into the subsurface to enhance biodegradation of PHCs;
4. groundwater monitoring of the well network at selected intervals and locations to track remediation progress, and;
5. analysis of the data to evaluate the effectiveness and progress of bioremediation

Each of the above activities are described in the following sections.

2.2 Monitoring Well Installation

Previously-installed monitoring wells, including those installed by FLS (MW F-1 through MW F-8), have been destroyed or removed during construction activities at the site. At this time no monitoring wells are present at the Site.

As shown on Figure 5, FLS proposes to install four groundwater monitoring wells (MW F-9 through MW F-12) in the area of OU2 for the purpose of ORC performance monitoring and satisfying the offsite SRIWP requirements. One upgradient piezometer (PZ-1) will also be installed to monitor water levels. One monitoring well will be installed immediately south of OU2 in the sidewalk along West 16th Street. One monitoring well will be installed southwest of OU2 in the sidewalk at the intersection of West 16th Street and 10th Avenue. Two additional monitoring wells will be installed immediately west of OU2 in the sidewalk along 10th Avenue. The piezometer will be 2-inches in diameter and will be installed in the sidewalk on 17th Street near the eastern end of the site. The piezometer will be used solely to measure groundwater elevations (Figure 5) and will not be sampled for analytical parameters. As discussed in Section 1.1, the regional groundwater flow across the Site is predominantly west, but, as indicated by a depression in monitoring well MW F-8, groundwater flow in OU2 may be trending south.

Monitoring wells will be installed with a hollow stem auger (HSA) drilling rig to approximately 20 ft-bg. The wells will be constructed with 2-inch diameter 10 foot long Schedule 40 PVC screen (10 or 20 slot) set 2 feet above the groundwater table. The well will be cased off with 2-inch diameter Schedule 40 PVC riser to grade. Morie No. 2 clean silica sand, or equivalent, will be tremied into the annular space to a minimum of 2-feet above the top of the well screen followed by a minimum of 2-feet of bentonite as a seal above the sand pack. Any remaining annular space will be filled with a Portland cement mix. A flush-mount box will be installed upon completion of the well.

The piezometer will be installed with a hollow stem auger (HSA) drilling rig to approximately 15 ft-bg. The PZ will be constructed with 2-inch diameter 5 foot long Schedule 40 PVC screen (10 or 20 slot) set 2 feet above the groundwater table. The well will be cased off with 2-inch diameter Schedule 40 PVC riser to grade. Morie No. 2 clean silica sand, or equivalent, will be tremied into the annular space to a minimum of 2-feet above the top of the well screen followed by a minimum of 2-feet of bentonite as a seal above the sand pack. Any remaining annular space will be filled with a Portland cement mix. A flush-mount box will be installed upon completion of the well.

The monitoring wells and piezometer will be developed by pumping with a submersible pump until the discharge is silt-free. The wells will be allowed to sit for a minimum of one week before sampling.

FLS proposes to use the offsite monitoring wells proposed in the SRIWP (MW F-9 through MW F-12) to assess the effectiveness of the ORC remedy for OU-2. The locations of these wells are provided in Figure 5. The locations of two wells, (MW F-11

and MW F-12) have been modified from the original locations in the SRIWP, due to the presence of a sidewalk vault along 10th Avenue between 16th and 17th streets. This vault is used by the U.S. Drug Enforcement Agency (DEA), and the vault's exact dimensions are unknown.

The location and elevation of each monitoring well and PZ will be surveyed to a common datum by a licensed surveyor. Complete rounds of depth-to-water measurements will be collected with an oil/water interface probe at both low-tide and high-tide. Groundwater elevation contour maps will be constructed to more accurately define the groundwater flow pattern in OU2. The depth-to-water measurements collected will help refine the ORC Advanced® injection depth.

2.3 Pre-remedial Groundwater Monitoring

The RI groundwater data collected from wells MW F-3 and MW F-7 (Table 1) will be used as a baseline for remediation of OU2. However, an additional pre-remediation groundwater sampling event will be performed prior to ORC injection. This data will be used to asses the water quality impact of site dewatering activities and the additional source removal from under the High Line as well as provide additional data used to streamline the ORC injection process.

All four downgradient wells will be sampled for both ORC baseline and SRIWP sampling parameters. In addition, two on-site temporary wells, from which grab groundwater samples will be collected, will also be on OU-2 at the historical locations of MW F-3 and MW F-7. The two temporary well points will be used for ORC baseline sampling only. Subsequent to construction, the proposed retail plaza beneath the High Line will preclude installation of post-remediation monitoring wells and groundwater sampling directly in the treatment area in OU2. However, groundwater samples from monitoring wells placed immediately downgradient of the treatment area will be used to monitor ORC effectiveness.

Low-flow sampling methods will be used to collect the water samples using a peristaltic pump. Based on the contaminants detected on-Site, groundwater samples will be analyzed for the following ORC baseline and performance parameters:

- NY STARS Gasoline List + 2-Methylnaphthalene
- Nitrate/Nitrite EPA 353.2
- Manganese, and Iron EPA 200.7

The NY STARS gasoline list + 2-Methylnaphthalene will report all the VOCs in groundwater that we detected in exceedance of the TOGS Class GA groundwater standards. The analysis of Nitrate/Nitrite, Manganese, and Iron coupled with field measurements of DO, pH, and ORP will be used to monitor the progress of the remediation. These parameters are used to asses the condition under which natural attenuation is occurring in the aquifer.

A trip blank will accompany each batch of lab glassware from the laboratory to the Site and back, and will also be analyzed for the quality assurance/quality control (QA/QC) procedure. An equipment rinsate blank (field blank) will be collected each day as part of the QA/QC procedure in order to check for contamination arising from sample collection. One matrix spike/matrix spike duplicate (MS/MSD) sample will be collected during the sampling event.

2.4 ORC Injection

The following subsections present the injection grid design, application rates and injection methods for ORC Advanced® application in OU2. Grid spacing and application rates were developed in conjunction with Regenesis, the vendor of the ORC Advanced product.

2.4.1 ORC Advanced® Grid Design and Rationale

An ORC Advanced®/water slurry mixture will be injected directly into the aquifer matrix in a grid pattern over the aerial extent, as shown in Figure 5, and the vertical depth of the contaminated interval, as defined in Section 1.2. ORC Advanced® will be injected from approximately 13 ft-bg (-2.54 ft-mbd) or the top of the water table to 16 ft-bg (-5.54 ft-mbd). The final injection depth will be based on depth-to-water measurements collected from nearby monitoring wells and previous RI data, including boring logs and groundwater data.

The treatment area beneath the High Line is approximately 5,000 square feet. A total of 28 injection points will be used to cover this area. Injection point spacing is approximately 15 feet both with and across the assumed groundwater gradient.

PHC and geochemical data from monitoring wells MW F-3 and MW F-7 and RI boring logs were used to represent conditions in OU2. The ORC Advanced® Grid Design worksheet developed by Regenesis was used as guidance in selecting the injection point spacing and ORC Advanced® injection rates. The completed worksheet, including the aquifer characteristics, design concentrations modeled, and dosage rates is presented in Appendix A.

Prior to completion of the western foundation wall in OU1, FLS supervised the addition of 50 pounds of ORC Advanced® directly upgradient of OU2 between the western foundation wall and the western sheeting wall at approximate elevation -2 to -3 ft Manhattan Borough Datum (MBD), which is roughly 2 to three feet below static water levels in that area.

2.4.2 ORC Advanced® Application Rate

Based on the manufacturer's recommendations, the ORC Advanced® injection amount necessary for OU2 is approximately 5.0 pounds (lbs) per vertical foot. (5.0 lbs/ft is the minimum rate recommended by Regenesis; however a lower application rate of 3.9 lbs/ft

was predicted in the model). Given the injection point spacing and injection rate, the estimated total initial application amount of ORC Advanced® required in the application area is:

(28 injection points) x (5 lbs ORC Advanced®/ft) x (3 ft/injection point)
= 420 lbs of ORC Advanced®

2.4.3 ORC Advanced® Application Method

Based on the manufacturer's recommendations, the 5 lb/ft dose of ORC Advanced® will be applied as a 30 percent ORC Advanced®/water slurry mixture. A geoprobe unit will be used to inject the ORC Advanced® slurry into the subsurface. Drive rods will be pushed to the target depth of approximately 16 ft-bg (-5.54 ft-mbd), assuming refusal is not met, and the ORC Advanced® slurry injected as the rods are withdrawn. The estimated radius of injection is 7 to 10 feet which will provide overlapping radii of influence based on the 15-ft injection point spacing. At each location, ORC Advanced® will be injected from approximately 13 ft-bg (-2-54 ft-mbd) to 16 ft-bg (-5.54 ft-mbd) or to the top of the water table. The final injection depth will be determined in the field based on depth-to-water measurements collected from the monitoring wells.

2.5 Post-Remediation Groundwater Monitoring and Sampling

Bioremediation effectiveness will be monitored by collecting and analyzing groundwater samples from the monitoring well network after the ORC Advanced® has been injected.

Four rounds of post-remediation groundwater monitoring are planned to evaluate remediation performance. Monitoring will be conducted at 2, 4, 8 and 12 months after injection of the ORC Advanced®. The monitoring times were selected to assess short- and long-term effects of ORC Advanced® injection on PHC concentrations and geochemistry. However, the monitoring schedule may be modified, if appropriate, based on the interim results.

Low-flow sampling methods will be used to collect the water samples using a peristaltic pump. Based on the results of previous sampling, groundwater samples will be analyzed for:

- NY STARS Gasoline List + 2-Methylnaphthalene.
- Nitrate/Nitrite EPA 353.2
- Manganese, and Iron EPA 200.7

The NY STARS gasoline list + 2-Methylnaphthalene will report all the VOCs in groundwater that we detected in exceedance of the TOGS Class GA groundwater standards. The analysis of Nitrate/Nitrite, Manganese, and Iron coupled with field measurements of DO, pH, and ORP will be used to monitor the progress of the

remediation. These parameters are used to asses the condition under which natural attenuation is occurring in the aquifer.

A trip blank will accompany each batch of lab glassware from the laboratory to the Site and back, and will also be analyzed for the QA/QC procedure. An equipment rinsate blank (field blank) will be collected each day as part of the QA/QC procedure in order to check for contamination arising from sample collection. One MS/MSD sample will be collected during the sampling event.

After each sampling event, FLS will submit a groundwater monitoring report to the NYSDEC. The reports will present the most recent data and compare it to previous groundwater sample results. Additionally, groundwater elevation contour maps for each round will be included in each report.

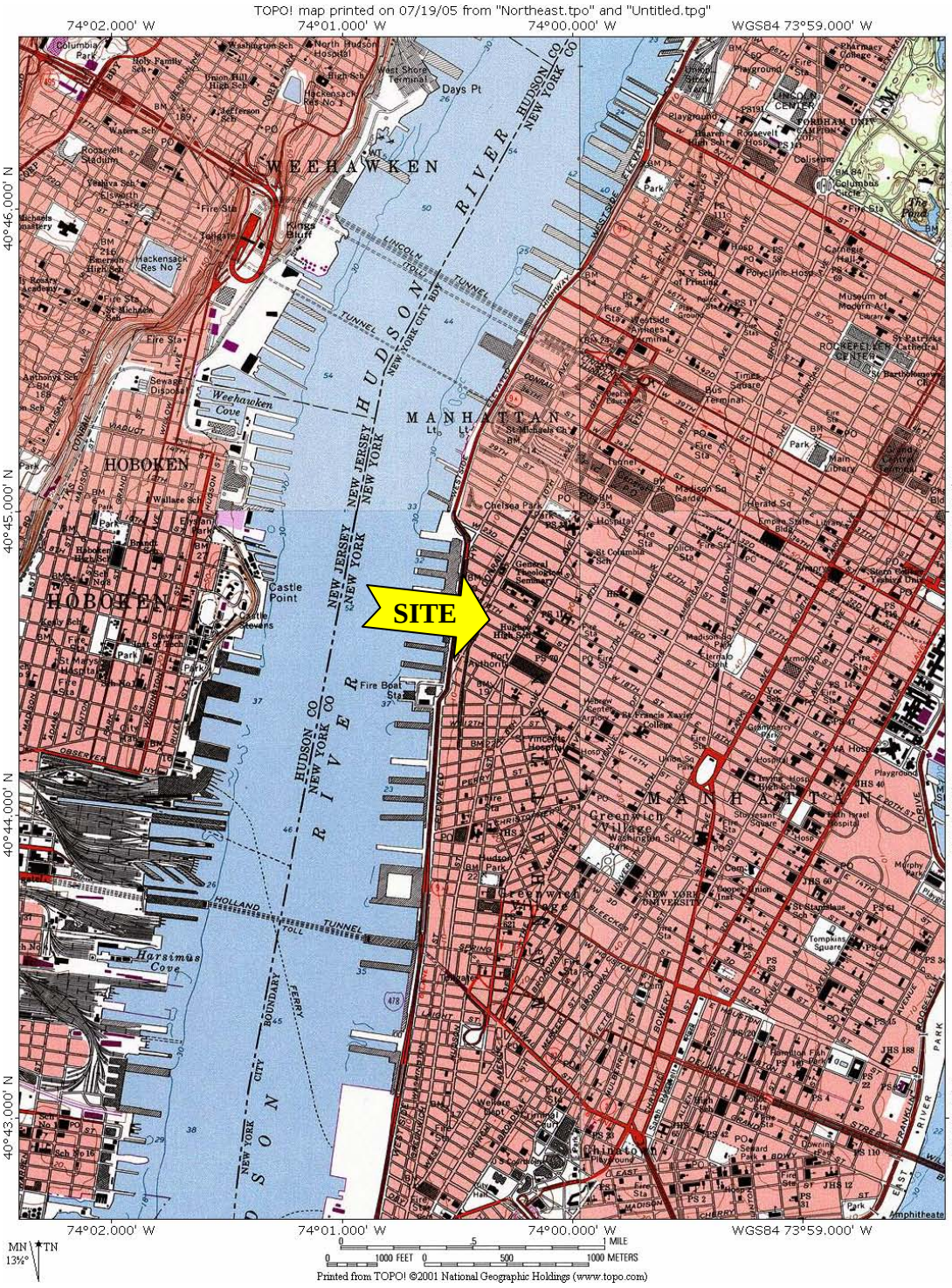
2.6 Data Analysis, Interpretation and Reporting

A comprehensive discussion of the data and the ORC Advanced® treatment effectiveness in OU2 (including post-remedial monitoring results to date) will be included in the Final Remediation Report for the site. The groundwater sample analytical reports will undergo a third party review. The third party will produce a Data Usability Summary Report (DUSR) which will be submitted to the NYSDEC in the Final Remediation Report. If necessary, the OM&M plan contained in the Final Remediation Report will also provide recommendations regarding additional monitoring and/or other post-remedial activities for OU2.

2.7 Schedule

This effort will take approximately 8 weeks to complete. A breakdown of the schedule is provided in Appendix B. Phase 1 and 2 work, which includes monitoring well installation, development, and sampling will commence shortly after NYSDEC approval of this document. These wells will be used for ORC baseline monitoring and SRIWP monitoring. Phase 3, injection of ORC is scheduled to begin approximately two weeks after the end of Phase 2; however the ORC slurry is temperature sensitive and therefore will not be injected if the ambient air temperature is below 32° F, which may cause a delay in the schedule. FLS will notify the NYSDEC case manager of exact start date one week prior to mobilization.

FIGURES



40074-F1 Central Park, NY-NJ Quadrant 7.5 Minute Topographic Map, published by the USGS, and obtained from TOPO! ©2001

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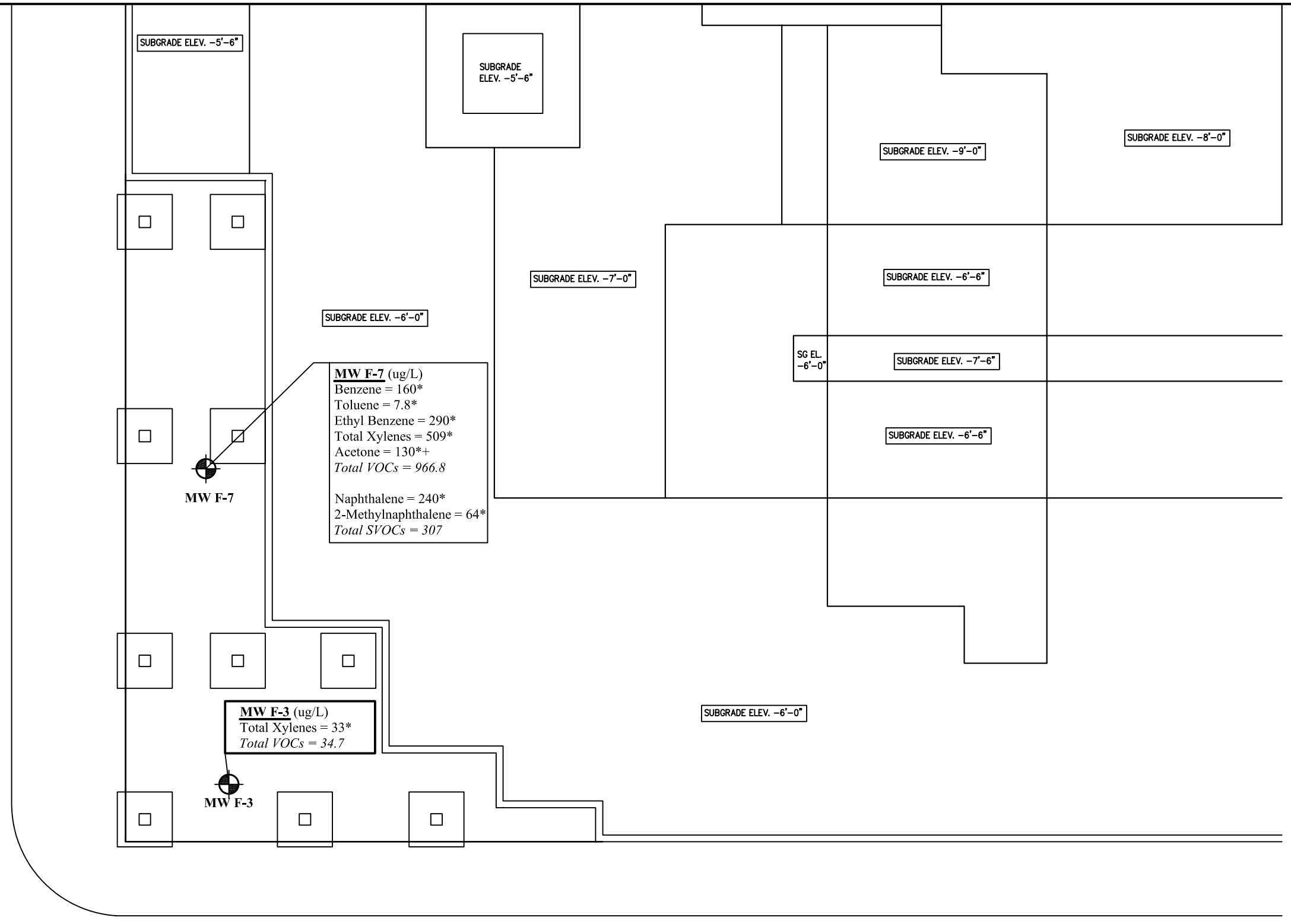
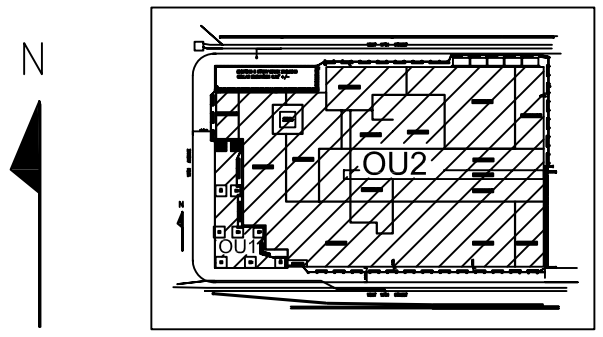
FIGURE 1: SITE LOCATION MAP

SITE: West 17th Street and 10th Avenue Site
New York, NY

CLIENT: 17th and 10th Associates L.L.C. c/o Related Companies, L.P.





Notes:
An asterisk (*) indicates that the compound was detected above the New York State Department of Environmental Conservation (NYSDEC) Division of Water Technical & Operational Guidance Series (TOGS) Class GA Groundwater Standards.

+ Acetone was detected in the dilution sample prepared by the laboratory and the associated method blank. Acetone is a common laboratory contaminant. Therefore, this contaminant is likely not present in the groundwater in OU2.

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FIGURE 2

West 17th Street and 10th Avenue Site
New York, NY

GROUNDWATER SAMPLING RESULTS IN OU2 - JUNE 2005

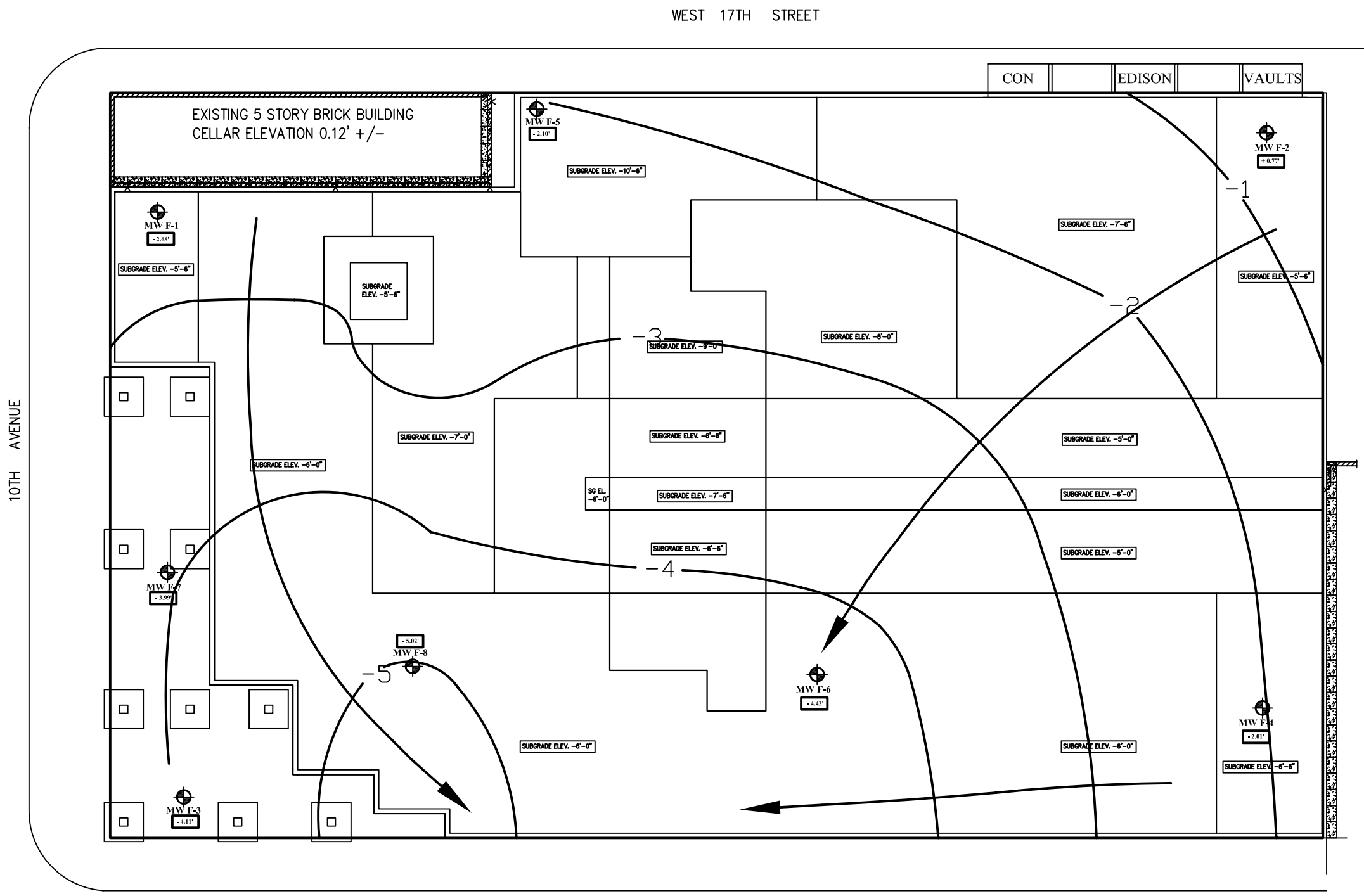
Date
January 12, 2007

Project Number
10022-004

LEGEND

FORMER MONITORING WELL LOCATION

20 10 0 20



Notes:
Elevations are presented in Manhattan Borough Datum (mbd), which is 2.75 feet above the National Geodetic Survey Datum of 1929, Mean Sea Level at Sandy Hook, New Jersey.

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FIGURE 3

West 17th Street and 10th Avenue Site
New York, NY

GROUNDWATER ELEVATION CONTOUR MAP
JULY 13, 2005

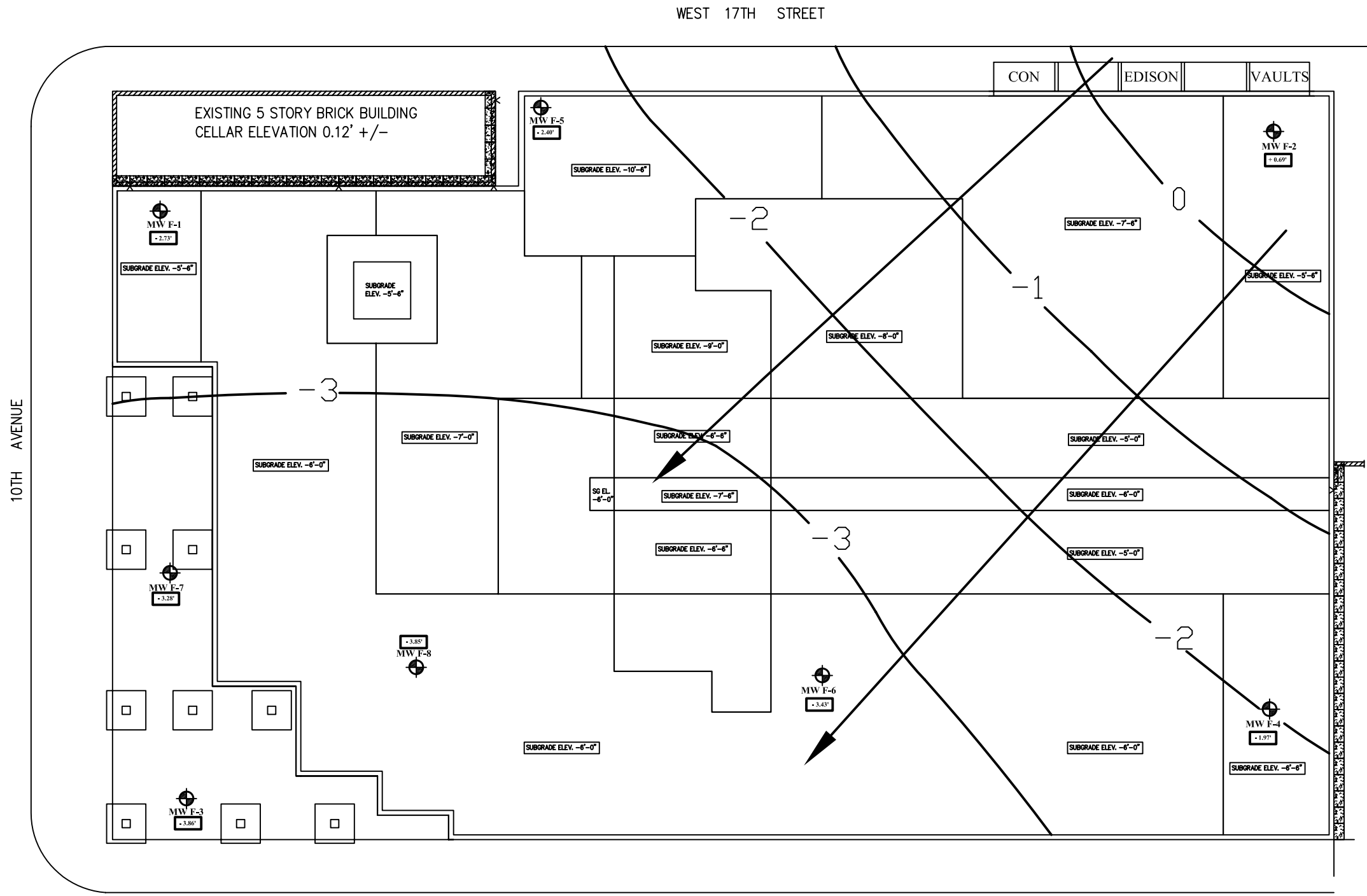
Date
January 12, 2007

Project Number
10022-004

LEGEND

- FORMER MONITORING WELL LOCATION
- 2.40' — GROUNDWATER ELEVATION (mbd)
- —3— GROUDNWATER ELEVATION CONTOUR (mbd) (Dashed where inferred)
- INFERRED GROUNDWATER FLOW DIRECTION

30 15 0 30



Notes:
Elevations are presented in Manhattan Borough Datum (mbd), which is 2.75 feet above the National Geodetic Survey Datum of 1929, Mean Sea Level at Sandy Hook, New Jersey.

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FIGURE 4

West 17th Street and 10th Avenue Site
New York, NY

GROUNDWATER ELEVATION CONTOUR MAP
AUGUST 26, 2005

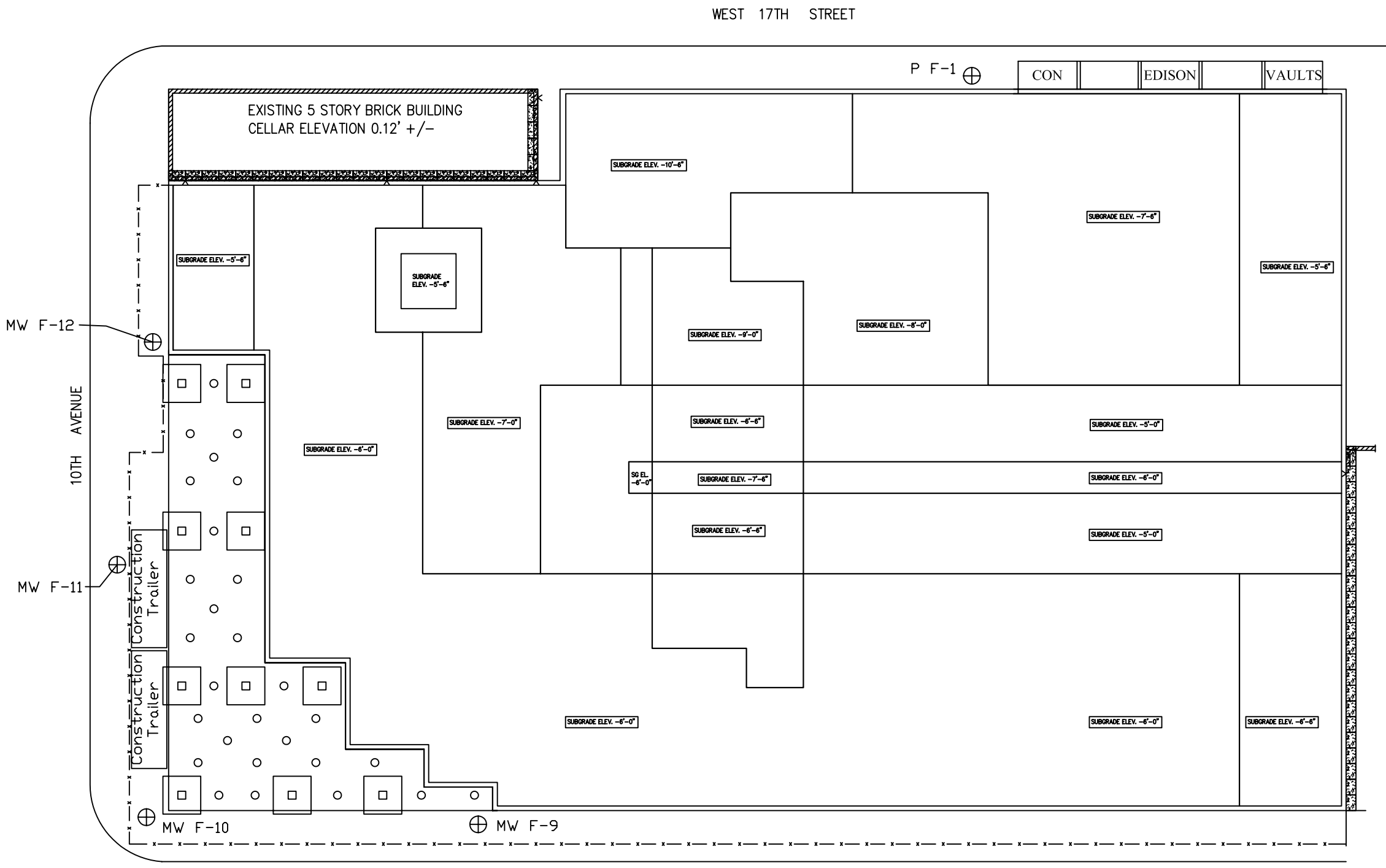
Date
January 12, 2007

Project Number
10022-004

LEGEND

- FORMER MONITORING WELL LOCATION
- 2.40' — GROUNDWATER ELEVATION (mbd)
- —3— GROUDNWATER ELEVATION CONTOUR (mbd) (Dashed where inferred)
- INFERRED GROUNDWATER FLOW DIRECTION

30 15 0 30



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New York, NY 10001

FIGURE 5

West 17th Street and 10th Avenue Site
New York, NY

PROPOSED ORC ADVANCED® INJECTION GRID AND GROUNDWATER MONITORING WELLS

Date
January 11, 2007

Project Number
10022-004

LEGEND

- ⊕ PROPOSED MONITORING WELL/PIEZOMETER LOCATION
- ○ PROPOSED ORC ADVANCED INJECTION POINT
- —x—x— APPROXIMATE LINE OF TEMPORARY WALLS

30 15 0 30

APPENDICIES

APPENDIX A

ORC Advanced® Manufacturers Grid Design Worksheet w/ Dosage Rates

ORC *Advanced* Design Software for Grid Applications Using Slurry Injection

Aug 2006

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: West 17th Street
Location: New York City
Consultant: Fleming-Lee Shue, Inc.

Estimated Plume Requiring Treatment

Width of plume (intersecting gw flow direction)	50	ft		
Length of plume (parallel to gw flow direction)	100	ft	5,000	ft^2
Depth to contaminated zone	14	ft		
Thickness of contaminated saturated zone	3	ft		
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	silty sand			
Total porosity	0.4	Effective porosity:	0.2	
Hydraulic conductivity	10	ft/day	3.5E-03	cm/sec
Hydraulic gradient	0.005	ft/ft		
Seepage velocity	91.3	ft/yr	0.250	ft/day
Treatment Zone Pore Volume	6,000	ft^3	44,886	gallons

Dissolved Phase Oxygen Demand:	Contaminant Conc. (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC-Adv Dose (lb)
Individual species that represent oxygen demand:				
Benzene	0.16	0.1	3.1	1
Toluene	0.07	0.0	3.1	0
Ethylbenzene	0.34	0.1	3.2	2
Xylenes	0.55	0.2	3.2	4
MTBE	0.00	0.0	2.7	0
cis-1,2-DCE	0.00	0.0	0.7	0
Vinyl Chloride	0.00	0.0	1.3	0
Acetone	0.13	0.0	2.2	1
Naphthalene	0.24	0.1	3.0	2
Reduced metals: Fe^{+2} and Mn^{+2}	10.00	3.7	0.1	2
naphthalene	<- pull-down menu			
Measures of total oxygen demand				
Total Petroleum Hydrocarbons (see pull-down for Koc)	0.00	0.0	3.1	0
Biological Oxygen Demand (BOD)	0.00	0.0	1.0	0
Chemical Oxygen Demand (COD)	0.00	0.0	1.0	0

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.003	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw) (Adjust Koc as necessary to provide realistic estimates)	Koc (L/kg)	Contaminant Conc. (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC-Adv Dose (lb)
Benzene	123	0.06	0.1	3.1	2
Toluene	267	0.06	0.1	3.1	2
Ethylbenzene	327	0.33	0.5	3.2	10
Xylenes	298	0.49	0.8	3.2	15
MTBE	12	0.00	0.0	2.7	0
cis-1,2-DCE	80	0.00	0.0	0.7	0
Vinyl Chloride	2.5	0.00	0.0	1.3	0
Acetone	2.2	0.00	0.0	2.2	0
Naphthalene	1000.0	0.72	1.2	3.0	21
Measures of total oxygen demand					
Total Petroleum Hydrocarbons	373	0.00	0.0	3.1	0

Summary of Estimated ORC-Adv Requirements	Dissolved Phase ORC-Adv Demand (lbs)	Sorbed Phase ORC-Adv Demand (lbs)	Additional Demand Factor (1 to 10x)	Total ORC-Adv Demand (lbs)	ORC-Adv Cost	
Total BTEX, MTBE, etc.	12	50	5.0	312	$2,909	<-
Total Petroleum Hydrocarbons	0	0	2.0	0	$0	
Biological Oxygen Demand (BOD)	0	0	2.0	0	$0	
Chemical Oxygen Demand (COD)	0	0	1.5	0	$0	

Required ORC-Adv quantity (in 25 lb increments) ----------> **325** **pounds ORC-Adv**

Delivery Design for ORC-Adv Slurry

Spacing within rows (ft)	15.0	feet
# points per row	4	points/row
Spacing between rows (ft)	15.0	ft
# of rows	7	rows
Advective travel time bet. rows (days)	60	days
Number of points in grid	28	points
ORC-Adv application rate	3.9	lbs/foot
Total ORC-Adv required	**325**	lbs of ORC-Adv

Slurry Mixing Volume for Injections

Pounds per location	15	pounds
Buckets per location	0.6	buckets
Design solids content (20-40% by wt. for injections)	30%	
Volume of water required per hole (gal)	4	gallons
Total water for mixing all holes (gal)	119	gallons
Simple ORC-Adv Backfilling: min hole dia. for 67% slurry	3.7	inches
Feasibility for slurry injection in sand: ok up to 15 lb/ft	(ok)	
Feasibility for slurry injection in silt: ok up to 10 lb/ft	(ok)	
Feasibility for slurry injection in clay: ok up to 10 lb/ft	(ok)	

Project Summary			
Number of ORC-Adv delivery points (adjust as necessary for site)			28
ORC-Adv application rate in lbs/ft (adjust as necessary for site)			5.0
ORC-Adv bulk material for slurry injection (lbs)			425
Number of 25 lb ORC-Adv buckets			17.0
ORC-Adv bulk material cost ($/lb)		$	8.95
Cost for bulk ORC-Adv material		$	3,804
Shipping and Tax Estimates in US Dollars			
Sales Tax	rate: 0.00%	$	-
Total Material Cost		$	3,804
Shipping (call for amount)		$	-
Total Regenesis Material Cost		**$**	**3,804**

ORC-Adv Slurry Injection Cost Estimate (responsibility of customer to contract work)		
Footage for each point = uncontaminated interval + ORC-Adv injection interval (ft)		17
Total length for direct push for project (ft)		476
Estimated daily installation rate (ft per day: 300 for push, 150 for drilling)		300
Estimated points per day (10 to 30 is typical for direct push)		17.6
Required number of days		2
Mob/demob cost for injection subcontractor	$	-
Daily rate for injection subcontractor ($1-2K for push, $3-4K for drill rig)	$	-
Total injection subcontractor cost for application	$	-
Total Install Cost (not including consultant, lab, etc.)	**$**	**3,804**

Other Project Cost Estimates		
Design	$	-
Permitting and reporting	$	-
Construction management	$	-
Groundwater monitoring and rpts	$	-
Other	$	-
Other	$	-
Other	$	-
Other	$	-
Total Project Cost	**$**	**3,804**

APPENDIX B

Estimated Project Schedule

Appendix B
Estimated Project Schedule
OU2 and Offsite Work
W17th and 10th Avenue Site
New York, New York
BCP # C231040

Task	Duration (Weeks From Start)																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Phase 1																		
Monitoring Well / PZ Installation																		
Monitoring Well Development																		
Post Development Time																		
Phase 2																		
Water Level Measurements																		
Temporary Well Point Installation / Sampling																		
Baseline and Offsite GW Monitoring																		
Laboratory Analysis Turnaround Time																		
Phase 3																		
ORC Injection																		
Phase 4																		
Round 1 - Post Remedial Monitoring (+2 Months)																		
Round 2 - Post Remedial Monitoring (+ 4 Months)*																		
Round 3 - Post Remedial Monitoring (+ 8 Months)*																		
Round 4 - Post Remedial Monitoring (+ 12 Months)*																		

Notes
* Not Shown on Schedule