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REMEDIAL ACTION WORK PLAN FOR *IN SITU* TREATMENT USING ENHANCED BIOREMEDIATION

Ekonol Polyester Resins, NYSDEC # V00653-9
6600 Walmore Rd.
Town of Wheatfield, Niagara County, New York

Prepared for:

New York State Department of Environmental Conservation
Division of Hazardous Waste Remediation
270 Michigan Avenue
Buffalo, New York 14203

Submitted by:

Atlantic Richfield Company

A BP affiliated company

4850 East 49th Street
Cuyahoga Heights, Ohio 44125

Prepared by:

PARSONS

40 LA RIVIERE DR, SUITE 350
BUFFALO, NY 14202

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SECTION 1

PROJECT DESCRIPTION

This work plan describes the methods that will be used to implement enhanced *in situ* bioremediation for chlorinated compounds of concern (COCs) in overburden and bedrock groundwater at the former Ekonol Polyester Resins facility (the Site) in Wheatfield, NY.

1.1 INTRODUCTION

The former Ekonol Polyester Resins facility is located at 6600 Walmore Road, approximately one-half mile north of Niagara Falls Boulevard (Route 62) in the Town of Wheatfield, New York (Figure 1). A former concrete secondary containment tank for process water was removed from service at the facility in October 1999 (Frontier, 2000). Results of samples from the surrounding soil, wall, and floor of the tank indicated the presence of several organic compounds. Among those detected, and later included on the target parameter list, were trichloroethene (TCE), 1,2-dichloroethene (DCE isomers), vinyl chloride (VC), 1,1,1-trichloroethane (1,1,1-TCA), and 1,1-dichloroethane (1,1-DCA), aniline, phenol, and metals, including lead and zinc.

The March 2001 Site Characterization Report and the Phase I, II, and III Site Characterization Reports (Parsons 2001, 2003, 2004a, 2004b) presented the extent of the target COCs in soil and groundwater at the Site. The Remedial Alternatives Report (RAR) (Parsons, 2006a, 2006b and 2007) described further characterization, baseline sampling and laboratory treatability testing of several *in situ* technologies for soils, shallow groundwater and bedrock groundwater.

Previous excavation in the source area removed soils impacted with COCs. Shallow groundwater (groundwater in overburden) in the vicinity of the source area remains impacted by COCs, and will be treated using an *in situ* bioreactor (Parsons, 2006a) during the remediation phase. Additionally, *in situ* bioremediation was selected for treating COCs in bedrock groundwater. This selection was based on: removal of the containment tank, site characterization, remedial alternatives assessment, laboratory treatability testing, and pilot testing. Most recently, the results of the pilot test indicate that enhanced bioremediation by the addition of a vegetable oil substrate, was capable of readily degrading Site COCs. Results of the *in situ* bioremediation pilot test in bedrock groundwater were provided to the New York State Department of Environmental Conservation (NYSDEC) in April 2009, and updated with subsequent monitoring data reported in August and December 2009.

1.2 REMEDIATION OBJECTIVES

Based on the results of the treatability study and pilot testing, the overall objective of this remedial action is to reduce the concentration of COCs to the point where monitored natural attenuation can be implemented until the concentrations of COCs in groundwater are below the remedial goals outlined in the RAR (Parsons, 2006).

The remedial work plan is designed with the following primary objectives:

- Create optimal geochemical conditions for anaerobic dechlorination.
- Enhance the rates of natural *in situ* biodegradation of COCs.
- Assess the impacts of the injection of substrates and microorganisms on hydrogeology, especially groundwater movement.

These objectives will be accomplished by constructing a bioreactor consisting of two parallel trenches composed of gravel and organic mulch in overburden material, and injecting soluble/slow-release organic substrate and microorganisms into the subsurface (bedrock) using injection wells. After the bioreactor is installed and the substrates injected, groundwater will be monitored for a reduction in the concentration of COCs in groundwater.

This remediation work plan covers two years of remediation monitoring. Subsequent to the two year monitoring event, a report will be submitted to the NYSDEC documenting the effectiveness of the remediation, and will include a revised monitoring schedule and potential future activities (e.g. additional injections or amendments). In the interim, progress reports will be submitted at 6, 12, and 18 months.

1.3 GENERAL SCOPE OF WORK

The remedial action will be comprised of three components. Details of each component are described in Section 2. The three remedial components are:

- Passive bioreactor installation for treatment of shallow groundwater. This bioreactor is comprised of two parallel trenches backfilled with a mixture of gravel and organic mulch.
- In situ bioremediation treatment of bedrock groundwater. The bedrock remediation consists of adding emulsified vegetable oil to fracture bedrock zone where COCs are most prevalent.
- Performance monitoring (i.e. groundwater sampling) of the remediation systems (above) for a period of two years.

At the conclusion of the two year monitoring period, a report will be prepared and submitted to the NYSDEC. Section 3 provides further details of the remediation reporting.

SECTION 2

SYSTEM DESIGN, INSTALLATION, AND MONITORING

2.1 HEALTH, SAFETY, SECURITY, AND THE ENVIRONMENT (HSSE)

The Health, Safety, Security, and Environment (HSSE) Plan will be updated prior to the start of field work related to implementation of the remedial measures. The HSSE Plan will include Control of Work (CoW) forms including Task Safety Environmental Analysis (TSEA), Daily Toolbox Meeting Records, and appropriate work permits (ground disturbance, hot work, overhead utilities, working at heights, etc.) that may be required to complete the work. Any subcontractors used to complete the work will meet HSSE requirements. In addition, the HSSE plan will include an updated emergency response plan in the event of a situation or unplanned occurrence requiring assistance. The plan will provide the onsite user with critical information to be used in the event of an emergency.

2.2 TECHNICAL APPROACH

The remediation included in this work plan includes two types of bio-enhanced anaerobic degradation: installation of a mulch bioreactor in soils, and addition of a slow-release vegetable oil-based substrate to bedrock groundwater. The 80% design details of construction specific to each remedial measure are provided below.

The area where the bioreactor will be installed is shown in Figure 2. The bioreactor will generally consist of a mix of wood-chip mulch and gravel emplaced below the water table in the source area (see Figure 3). Mulch will provide organic substrate to support the microbiological growth, and enhance the rates of *in situ* biodegradation of COCs. The gravel in the bioreactor will provide geotechnical strength and will limit the reduction of hydraulic conductivity of the wall. Additionally, piping will be installed in the excavation in the event that an additional carbon source needs to be added to the wall by injection of substrate.

In the bedrock, a vegetable oil emulsion will be used to create and sustain a reaction zone that supports contaminant degradation, as observed in the pilot test (Parsons, 2009). The area near the former containment tank shown in Figure 2 will be the approximate location of the treatment zone. A phased approach is planned for the bedrock remediation, so that the current subsurface geochemistry can adapt the remediation. The first phase will be implemented in the area of the former containment tank. Later phases, if needed, will expand the treatment zone to areas east and west of the former tank. In addition to focusing on the area near the former containment tank in the first phase, the pilot test area will also be monitored, and if necessary, additional substrate may be added to sustain current COC degradation.

A microbial consortium, including both *Dehalococcoides* and *Dehalobacter* species, may be added to either remediation zone (overburden or bedrock) if monitoring data indicate that the bioremediation would benefit from bioaugmentation.

2.3 FIELD ACTIVITIES AND SITE MANAGEMENT

Field activities associated with this project include mobilization, installation of system components (i.e., bioreactor trenches, injection and monitoring wells, substrate injection), and performance monitoring. Each of these activities is briefly described below.

2.3.1 Mobilization and Site Management

The following subsections outline mobilization and site management issues pertaining to field activities that will be conducted under this project.

2.3.2 Pre-Mobilization Meetings

Before mobilizing to the site for field work, the contractor will schedule and conduct a pre-mobilization meeting to verify that all necessary preparations have been completed. The scope of work will be reviewed with key project personnel, including all field staff, subcontractor representatives, facility representatives, and client representatives. Security requirements, staging areas, Investigation Derived Waste (IDW) protocols, and health and safety requirements will be reviewed.

2.3.3 Utility Locates

On-site activities will be coordinated with the property owner to ensure that any disturbance to facility operations is minimized. Well locations and the area to be cleared will be identified during the pre-mobilization meeting in advance of well installation or trench excavation.

Before commencing field activities, drilling and trenching locations will be surveyed for underground utilities. The National One Call Center (811) will be contacted for utility marking prior to arranging the private underground utility locator site visit. The hired underground utilities locater will conduct a geophysical survey as directed in the HSSE plan. The utility locate will cover an approximate 10-foot diameter area around the drilling location and five feet on either side of the trenches associated with the bioreactor. All utility location activities will be in accordance with health and safety requirements.

The field team will verify and document that all utility locates have been completed prior to performing work. Specifics of the procedures include soft digging the first 6.5 feet of each borehole, clearing excavation areas and potentially exposing existing utilities.

2.3.4 Decontamination and Staging Areas

A centralized area that is designated for decontamination of drilling and sampling equipment will be identified. All decontamination fluids will be containerized in 55-gallon drums and characterized for disposal.

2.3.5 Equipment Areas

Equipment to be employed on this project includes excavation, backfill and drilling equipment for the system components, downhole equipment for testing the borehole, pumps and piping for the substrate injection, and testing instruments for baseline and performance monitoring. Equipment laydown areas will be reviewed with facility personnel prior to well installation and substrate injection.

2.4 SYSTEMS INSTALLATION

2.4.1 Overburden Bioreactor Installation

System installation in the overburden consists of installation of a two trench bioreactor with twenty-one groundwater monitoring wells. The bioreactor trenches will be excavated in the area shown in Figure 3. The trenches will be approximately 250 feet long and 3 feet wide. The trench will be excavated to the top of bedrock. Bedrock in the vicinity of the trench ranges between 12 and 15 feet. All excavated soils will be sampled and properly disposed. Final locations will be dependent upon site conditions and plant operations.

Following excavation, the trenches will be backfilled with a mixture of organic mulch, gravel and amendments that has been specified for use in the bioreactor. The mulch will consist of a natural untreated plant material (primarily tree mulch). The specific type of mulch is based on in-season material availability. Thus, the specific type of mulch to be used will be determined prior to starting the trench excavation. Mulch/gravel material will extend from the bottom of the excavation to a depth of 5 feet below ground surface (bgs). Two horizontal substrate distribution pipes will be installed in the mulch in each trench of the bioreactor at a depth of approximately 12 feet bgs. In addition to the substrate distribution piping, three monitoring wells will be constructed inside each trench. The mulch will then be covered with a geotextile to reduce surface settling and fine soils from entering the top of the bioreactor. On top of the geotextile, a 4.5-foot layer of gravel will be added and compacted. The surface completion of the bioreactor will be concrete / asphalt. Figure 4 is a cross-section of one trench in the proposed bioreactor.

Bioreactor Performance Monitoring Well Installation

Approximately 21 monitoring wells will be installed to provide information related to the performance of the bioreactor. Five wells will be installed inside each wall, one well will be installed upgradient of the bioreactor, and five wells will be installed downgradient. The approximate locations of the bioreactor performance monitoring wells are shown in Figure 3.

The wells installed outside of the bioreactor will be constructed using the following procedures: After hand clearing the upper 6.5 feet, borehole advancement will occur by advancing 4.25-inch hollow-stem augers (HSAs) to the top of bedrock. At three (1 upgradient, 2 downgradient of the wall) locations, two-inch diameter split spoon sampling will be conducted ahead of the augering to develop a continuous record of stratigraphy. Soil samples will be collected and analyzed to estimate various metals parameters which could assist in understanding the significance of biogeochemical reactions (e.g. biologically available iron, Weak Acid extractable Iron and Manganese, Strong Acid extractable Iron and Manganese, and Acid Volatile Sulfide). After reaching refusal at approximately 13 - 15 feet BGS, the well will be installed. The well will consist of: a 5 to 10 foot PVC screen (0.01" slot), 2 inch PVC riser, flush mounted protective cover, #0 sand to a minimum of two feet above the top of screen, 3 feet of bentonite chips, and grout to the surface.

The wells installed within the wall will consist of a 5 to 10 foot PVC screen (0.01" slot), and 2 inch PVC riser. The top of the well screen will be at a depth of approximately 6 feet bgs. The mulch gravel mixture will be backfilled around the well screen to a depth of 5 feet. After the geotextile is placed on the mulch, a bentonite plug will be placed around the riser, and the gravel will be back filled around the riser to a depth of 1.5 feet bgs. A flush mounted protective cover will be installed to complete the well at the surface.

Equipment Decontamination Procedures

Any equipment used in the trenching, backfilling, drilling and/or well installation process will be decontaminated prior to use. Generally, hollow stem augers, drilling rods, and cutting heads will be steam cleaned prior to use and placed on clean plastic sheeting until used. All equipment used will be decontaminated prior to leaving the site.

Materials Decontamination

All well materials and substrate distribution piping will be inspected by the field manager and determined to be clean and acceptable prior to use. If not factory sealed, the riser, screen, end caps, and surface plugs will be cleaned prior to use with a high-pressure, steam/hot-water cleaner using approved water.

2.4.2 Bedrock System Installation

Injection and Monitoring Well Locations

The proposed locations for the injection boreholes and groundwater monitoring wells are shown in Figure 5. The well spacing is based on the radius of influence achieved in the pilot test, and an anticipated southern groundwater flow direction. The well placement may be revised if hydraulic information gained during other remediation activities suggests a large or smaller RIO is more appropriate. Final locations will be dependent upon site conditions and plant operations.

Approximately eight new wells (INJ-06D through INJ-13D) will be used to treat the bedrock groundwater in proximity to the former containment tank. The wells will be used as injection and/or withdrawal wells and are shown in Figure 5. The eight wells are distributed across the front of the Ekonol building near the location of the former tank. It is anticipated that the remediation will be implemented in a phased approach. The first phase includes the five eastern most injection wells, and then phase 2 will expand to the west to include the 3 remaining injection wells. In order to prevent groundwater displacement, an injection / withdrawal scenario is anticipated (see substrate injection section below).

Ten new monitoring wells (PMW-8D through PMW-18D) will be installed and used in combination with injection / withdraw wells (INJ-06D through INJ-13D), and existing monitoring wells to monitor the performance of the remediation. One performance monitoring well (PMW-18D) will be located approximately 300 feet upgradient of the

This location had MW-1D and RMW-1D - both had TCE and breakdown products up to 200 ppb, as recently as 8/05.

former containment area, on the north side of the Ekonol building. PMW-18D will be used as both a background monitoring well for monitoring contaminant concentrations migrating into the remediation area, and if needed, as an extraction well for generating groundwater for use as make-up water for the substrate injections.

Drilling and Well Installation

Monitoring and Injection wells: The monitoring and injection/withdrawal wells will be completed as open bedrock wells of similar construction to the pilot test injection wells. Figure 6 is a schematic profile of the well details. The following specifics outline construction of the monitoring and injections/withdrawal wells:

- After hand clearing the upper portion of the borehole, advance 6.25-inch hollow-stem augers (HSAs) to the top of bedrock.
- After reaching refusal at approximately 13 - 15 feet BGS, drill a two feet rock socket with a 6-inch air hammer, or other appropriate method.
- After drilling the rock socket, install a permanent four-inch steel well casing. The casing will be sealed in-place by tremie grouting with cement-bentonite grout from the bottom up.
- After allowing the grout to set for a minimum of 24 hours, the open boreholes will be drilled to a maximum of two feet below the water bearing fractures (observed at other wells at the site approximately 22 to 25 feet bgs). The borehole will be drilled by either 4-inch air hammer, or HQ core, depending on location. In order to reduce the loss of drill water to the formation, and potential displacement of source area groundwater, only wells in the outer ring will be cored. Alternatively, wells may be cored until water loss then air hammer drilled 1 to 2 feet below the fractured zone.

Equipment Decontamination Procedures

Any equipment used in the drilling and/or well installation process will be decontaminated prior to downhole use. Generally, hollow stem augers, drilling rods, and cutting heads will be steam cleaned prior to use and placed on clean plastic sheeting until used. All equipment used downhole will be decontaminated prior to leaving the site.

Materials Decontamination

All completion materials will be inspected by the field manager and determined to be clean and acceptable prior to use. If not, factory sealed riser, screen, end caps, and surface plugs will be cleaned prior to use with a high-pressure, steam/hot-water cleaner using approved water. Materials that cannot be cleaned to the satisfaction of the field manager will not be used.

Well Completion

The monitoring wells will be drilled as described above. Unless the borehole is deemed to be incompetent, or at risk of collapse, the wells will be left as open bedrock borehole.

If screens and sand pack is necessary, the monitoring wells will be completed with 2-inch nominal diameter, flush-threaded, stainless steel screen and riser. The screens will be factory slotted with 0.020-inch openings. The well will consist of a well screen (minimum 5-foot, varied to fit the borehole length) and riser casing to the surface. The casing string will be fitted with a locking j-cap plug.

A 10-20 sand pack will be placed around the screen from the bottom of the borehole to approximately 2 feet above the top of the screened interval. A minimum 2-foot-thick granular bentonite seal will be installed immediately above the sand pack in 0.5-foot lifts. A neat cement/bentonite grout consisting of 94 pounds of Portland cement per 4 pounds of bentonite powder will be tremied in to fill the space extending from the top of the bentonite seal to approximately 3 feet bgs. The grout will be overlain by concrete that will secure the surface completion.

Each well will be completed with a flush mount protective casing. Each injection and groundwater monitoring well will be properly identified.

Well Development

All installed injection boreholes and groundwater monitoring wells will require development prior to sampling. Development will be accomplished with over-pumping and surging techniques using a submersible pump.

Development will be continued until approximately 1.2 times the lost drilling fluid volume is recovered and until pH, temperature, specific conductance, DO, and water clarity (turbidity) stabilize.

Development water will either be collected and temporarily staged in a polyethylene tank or 55-gallon drums for later use as make-up water for mixing substrate or properly disposed of as IDW. If needed, sediment that settles out from the development water will be collected and disposed of as soil IDW.

A development record will be maintained for each monitoring well. The development record will be completed in the field by the field scientist. Development records will include:

- Well number, date, and time of development;
- Development method;
- Pre- and post-development water level and well depth;
- Volume and description of water produced;
- Field analytical measurements, including pH, temperature, and specific conductance.

After development, downhole borehole logging will be completed on all open boreholes. Logging tools may include downhole camera, caliper log, and other geophysical instruments.

Datum Survey

The locations and elevations of the newly installed monitoring wells and injection boreholes will be surveyed by a surveyor registered in the State of New York. Horizontal locations will be measured to the nearest 0.1 foot. The elevation of the ground surface adjacent to each monitoring well and measurement datum (top of the casing) will be measured relative to an existing benchmark location. Vertical elevations will be measured with respect to the National Vertical Datum of 1988 to the nearest 0.01 foot.

Substrate Selection

A slow-release substrate (emulsified vegetable oil) as used in the pilot test (SRS-FR™, or comparable) will be used for the bedrock remediation. Site groundwater will be extracted from injection / withdrawal, and other wells as needed, for use as make-up water for the injection of the substrate into the subsurface. The re-injection of contaminated groundwater for *in situ* remediation has been approved for Resource Conservation and Recovery Act (RCRA) sites by the USEPA Office of Solid Waste and Emergency Response (USEPA, 2002). This is a common practice for enhanced bioremediation under other programs as well, because the use of native groundwater reduces adverse impacts on native anaerobic microbial populations that may result from the use of oxygenated or treated potable water supplies. This results in a more rapid acclimation period after substrate addition. In the unlikely event that a sufficient volume of make-up water cannot be produced from the extraction well, the make-up water will be supplemented from a potable water source near the Site. If potable water is used, sodium bisulfate may be used to scavenge residual chlorine.

They had an injection permit from EPA Reg. 2 for the pilot test. Do they need another or was that inclusive of remediation.

Water levels will be monitored as the make-up water is collected. The water level data will be used to supplement hydrogeologic data.

Substrate Preparation and Emplacement

Groundwater will be extracted from the injection/withdrawal wells to be mixed with the emulsified vegetable oil prior to injecting. Table 1 lists the estimated volume of groundwater and emulsified vegetable oil. Sodium bromide (approximately less than 500 mg/L) may be added to the substrate as a tracer. Sodium bicarbonate will be added to the substrate (approximately 8 g/L) to buffer pH within the injection area.

Prior to substrate injection, pressure transducers and conductivity probes will be deployed in multiple wells surrounding the injection point to measure and record changes in pressure and water level elevation during injection as well as breakthrough of the substrate into the well.

The injection will proceed at INJ-06 at approximately 3-5 gallons per minute. Injection system pressures will be monitored and flow rate adjustments made as needed to avoid excessive pressure and velocity. Injection pressures will be maintained below approximately 25 pounds per square inch (psi). Simultaneously, groundwater will be withdrawn from INJ-07D through INJ-10D to limit the displacement of groundwater and aid substrate distribution. Cumulative pumping rates from the four withdraw wells will be approximately equal to injection rate.

The substrate injection at withdraw and monitoring wells will continue until a radius of influence of at least 40 feet has been achieved as documented using the methodology described below or until 4,500 gallons of substrate mixture is injected. If the distribution of substrate is irregular or less than anticipated, additional substrate may be injected into the withdraw wells.

Groundwater samples will be collected from various performance monitoring wells during the substrate injection to observe the substrate distribution. Samples will be examined for the visual presence of the vegetable emulsion, which has a milky white appearance. The total injection volumes, mass of nutrients and sodium bromide will also be recorded in the field.

Immediately following completion of the substrate injection, an injection of unamended Site groundwater will be used to help remove residual vegetable oil from the injection and withdrawal wells. The volume of this groundwater push will be 150 gallons. Additionally, up to three well volumes of water may be added to monitoring wells to reduce the likelihood of well fouling.

2.5 PERFORMANCE MONITORING

Three areas will be monitored for effectiveness of the remediation: (1) overburden groundwater near the bioreactor, (2) the bedrock treatment area and (3) the bedrock pilot test area. The areas will be characterized for local hydraulic properties, COC concentrations, and biogeochemical indicator parameters listed in Table 2. Table 2 lists the locations where groundwater samples will be collected along with parameters that will be measured in each sample. The analytical protocols that will be used during the sampling activities are summarized in Table 3. Groundwater samples will be submitted to a qualified laboratory for analysis of VOCs, total organic carbon (TOC), sulfate, chloride, dissolved gases (methane, ethane, ethene, dissolved hydrogen, and acetylene), major and minor ions, and microbiological cultures (*Dehalococcoides* and *Dehalobactor* species and TCE/VC reductase genes). Laboratory quality control procedures are described in Section 3.

Groundwater sampling will include low-flow groundwater sampling methods, records documentation, chain-of-custody procedures, and sample handling. Dissolved oxygen (DO), pH, redox potential (ORP), specific conductance, temperature, visual appearance, and depth-to-water will be recorded during monitoring well purging to establish when parameter stabilization has occurred.

After parameter stabilization has been achieved and samples for the laboratory analysis listed above have been collected, groundwater samples will be collected and analyzed in the field for ferrous iron, manganese (II), alkalinity, hydrogen sulfide, and carbon dioxide using the procedures listed in Table 3. Results of all field measurements will be recorded on well sampling records and in the field notebook.

Protocols for handling of samples from the time of sampling until the samples are delivered to the laboratory are specified in the Phase III QAPP (Parsons 2003). Procedures are provided for chain-of-custody procedures, sample preservation, sample containers and labels, and sample shipment. Samples will be shipped to the laboratory using an overnight carrier. All samples will be stored on ice prior to and during shipping.

Performance monitoring will be used to monitor the effects of the substrate injection over time by collecting groundwater samples from existing and newly-installed wells (see Table 2). Performance monitoring events will occur approximately 4 weeks, 13 weeks, and every quarter for two years thereafter.

2.6 BIOAUGMENTATION

Data from the baseline and performance monitoring event that will be conducted 4 weeks after substrate injection will be evaluated to determine if bioaugmentation will be conducted. Parameters which will be evaluated include VOCs, pH, and ORP.

Following documentation that a bioaugmentation is needed and a suitable anaerobic environment is present in the subsurface, an injection of a microbial consortium including both *Dehalococcoides* and *Deahlobacter* species will be performed. The microbial culture will consist of a natural, stable, non-pathogenic microbial consortia that contains the known dechlorinating bacteria. The bioaugmentation culture will not be genetically engineered or modified. If monitoring data suggest that the subsurface environment is not suitable for sustaining the bioaugmentation culture *in situ*, the injection of additional amendments (e.g., buffering agents) will be evaluated and used to alter the subsurface environment to a condition that is more amenable to supporting complete reductive dechlorination.

2.7 WASTE MANAGEMENT AND DISPOSAL

IDW generated during the remedial activities will include soil generated during installation of the bioreactor, injection and monitoring wells, purge water generated during development and sampling of groundwater monitoring wells, equipment decontamination rinsate, and personal protective equipment (PPE) used during sampling activities.

Soil cuttings generated during field activities will be collected in U.S. Department of Transportation-approved 55-gallon steel drums, or roll-off containers and staged onsite. A sample of the containerized soil will be collected and submitted for VOC analysis by USEPA Method SW8260B. In addition, the soil will be subjected to the toxicity characteristic leaching procedure, with the extract from that procedure analyzed for VOCs by Method SW8260B.

Purge water generated during monitoring well development and initial (baseline) groundwater sampling will be collected and properly stored in 55 gallon drums or poly tanks. This purge water will be sampled for VOCs by USEPA Method SW8260B, then used as the make-up water for substrate injection as required. All other decontamination and purge water generated during subsequent sampling events will be containerized in 55-gallon drums and staged onsite. The drums will be sampled and submitted for VOC analysis by USEPA Method SW8260B, and disposed of appropriately.

Expendable sampling equipment that may be generated during field activities (e.g., PPE, sample tubing), will be bagged, and disposed of in a trash dumpster located onsite. Miscellaneous trash generated during field activities (i.e., empty sand bags and bentonite containers) also will be placed in the dumpster. Any equipment or PPE that appears to be visually contaminated with hazardous substances will be containerized with soil IDW for proper disposal as a solid waste.

SECTION 3

DATA QUALITY MANAGEMENT AND REPORTING

3.1 DATA QUALITY MANAGEMENT

Data collection, field and laboratory analysis, and data management will be conducted in accordance with the procedures described in this work plan and the following documents:

- Parsons. 2003. *Quality Assurance Project Plan* for Phase III Investigation at Ekonol Polyester Resins, Wheatfield, New York, NYSDEC Site # V00653-9, August.

- USEPA. 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*: EPA/600/R-98/128. September.

Field QA/QC procedures will include collection of field duplicates, trip blanks, decontamination of all equipment that contacts the sample medium before and after each use, use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the laboratory for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., groundwater), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used, and water sample containers will be packaged in coolers with ice to maintain a temperature of 4° C or less.

All field sampling activities will be recorded in a bound, sequentially-paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature. Field QC samples will be collected in accordance with the program described below, and as summarized in Table 2.

QA/QC sampling will include collection and analysis of duplicate groundwater samples, trip blanks, and matrix spike samples. Internal laboratory QC procedures will involve the analysis of laboratory control samples (LCSs) and laboratory method blanks (LMBs). QA/QC objectives for each of these samples, blanks, and spikes are described below. Duplicate groundwater samples will be collected at a frequency of 1 for every 20 or fewer samples of similar matrix. Each duplicate water sample will be collected concurrently with, and by the same method as, the primary sample. Duplicate water samples will be analyzed for VOCs and geochemical parameters (i.e., methane, ethane, and ethene; TOC; nitrate and nitrite; chloride; and sulfate).

A trip blank will be analyzed to assess the effects of ambient conditions on sampling results during the transportation of samples. The trip blank will be prepared by the laboratory and will be transported inside each sample shipment containing samples for VOC analysis. Trip blanks will be analyzed for VOCs only.

Matrix spikes will be prepared in the laboratory and used to establish matrix effects for samples analyzed for VOCs. Sufficient extra sample volume will be submitted to the laboratory to allow matrix spike preparation and analysis. LCSs and LMBs will be prepared internally by the laboratory and will be analyzed each day samples from the sites are analyzed. Samples will be reanalyzed in cases where the LCS or LMB are out of the control limits. Control charts for LCSs and LMBs will be developed by the laboratory and monitored for the analytical methods used.

A data usability summary report (DUSR) will be completed in accordance with the Phase III Investigation Quality Assurance Project Plan and the NYSDEC's Data Usability Summary Report (DUSR) guidelines. The DUSR is developed by reviewing and evaluating the analytical data package. The DUSR will be used to determine whether or not the data, as presented, meet the project specific criteria for data quality and data use. Data packages will be reviewed and evaluated for items such as completeness, holding times, compliance with QC limits and specifications, analytical protocols, raw data conversion to correctly summarized results, and confirmation that the correct data qualifiers have been used. If the DUSR indicates that significant problems with some or all of the data in the package, the data will be either rejected or validated to determine if it can be used. The DUSR will discuss data deficiencies, analytical protocol deviations, and QC problems and the effect on the data. Recommendations on reanalysis and/or re-sampling will be included.

3.2 REPORTING

During the course of the remediation, progress reports will be submitted at 6, 12, and 18 months. At the conclusion of the two year monitoring period, a report will be prepared and submitted to the NYSDEC. The interim reports and two year report will update and document the results of the remediation. The reports will discuss the following topics as appropriate:

- geochemical conditions observed during the remediation;
- observed rates of biodegradation of COCs;
- observed longevity of total organic carbon in bioreactor and the bedrock injection area.
- progress of achieving the Site remediation goals for groundwater;
- injection methodology and radius of influence;
- observed impacts of the injection on hydrogeology;
- negative effects of injection, if any, including solubility of inorganics and generation of gases;
- evaluation of the area of influence of the bioreactor;
- evaluation of the bedrock treatment area, or re-injection of substrate; and
- continuation of the performance monitoring.

In addition, the reports will include a summary of field activities, analytical data, and conclusions, as appropriate. Other information in the report will include site photographs, field notes, laboratory data, and waste manifests and disposal certificates.

SECTION 4

PROJECT SCHEDULE

The following is the anticipated schedule of activities and deliverables for implementation of this remediation:

- April 1, 2010: Approval of work plan by NYSDEC.
- Summer 2010: Implementation of Bioreactor.
- Summer 2010: Begin bedrock drilling.
- Late Summer - Early Fall 2010: Bedrock substrate application.
- Fall 2010: Begin performance monitoring.

This schedule is based in part on NYSDEC approvals; therefore, is subject to change. Factors such as field conditions, availability of materials, and climate may alter the schedule in order to provide the most optimal application of remediation.

SECTION 5

REFERENCES

Frontier Technical Associates, Inc, 1999. Draft Closure Plan for Underground Spill Collection and Secondary Containment Tank at Norton Performance Plastics Corp. Ekonol Plant, Wheatfield, New York. May 25, 1999.

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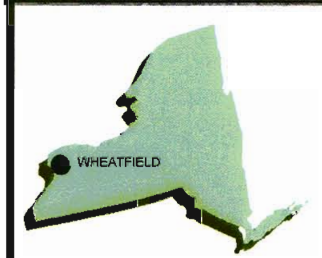
Parsons, 2004a. Phase III Site Characterization at Ekonol Polyester Resins, Wheatfield, New York NYSDEC # V00653-9. Prepared for NYSDEC on behalf of Group Environmental Management Company, January 2004.

Parsons, 2004b. Supplemental Phase III Site Characterization at Ekonol Polyester Resins, Wheatfield, New York NYSDEC # V00653-9. Prepared for NYSDEC on behalf of Group Environmental Management Company, September 2004.

Parsons, 2009a. Pilot Test Report for *in situ* Treatment Using Enhanced Bioremediation. Prepared for NYSDEC on behalf of Group Environmental Management Company, September 2004.

FIGURES



New York

LATITUDE: N43° 06' 21"
LONGITUED: W78° 55' 46"

FIGURE 1

EKONOL POLYESTER RESINS FACILITY
WHEATFIELD, NEW YORK

SITE LOCATION MAP

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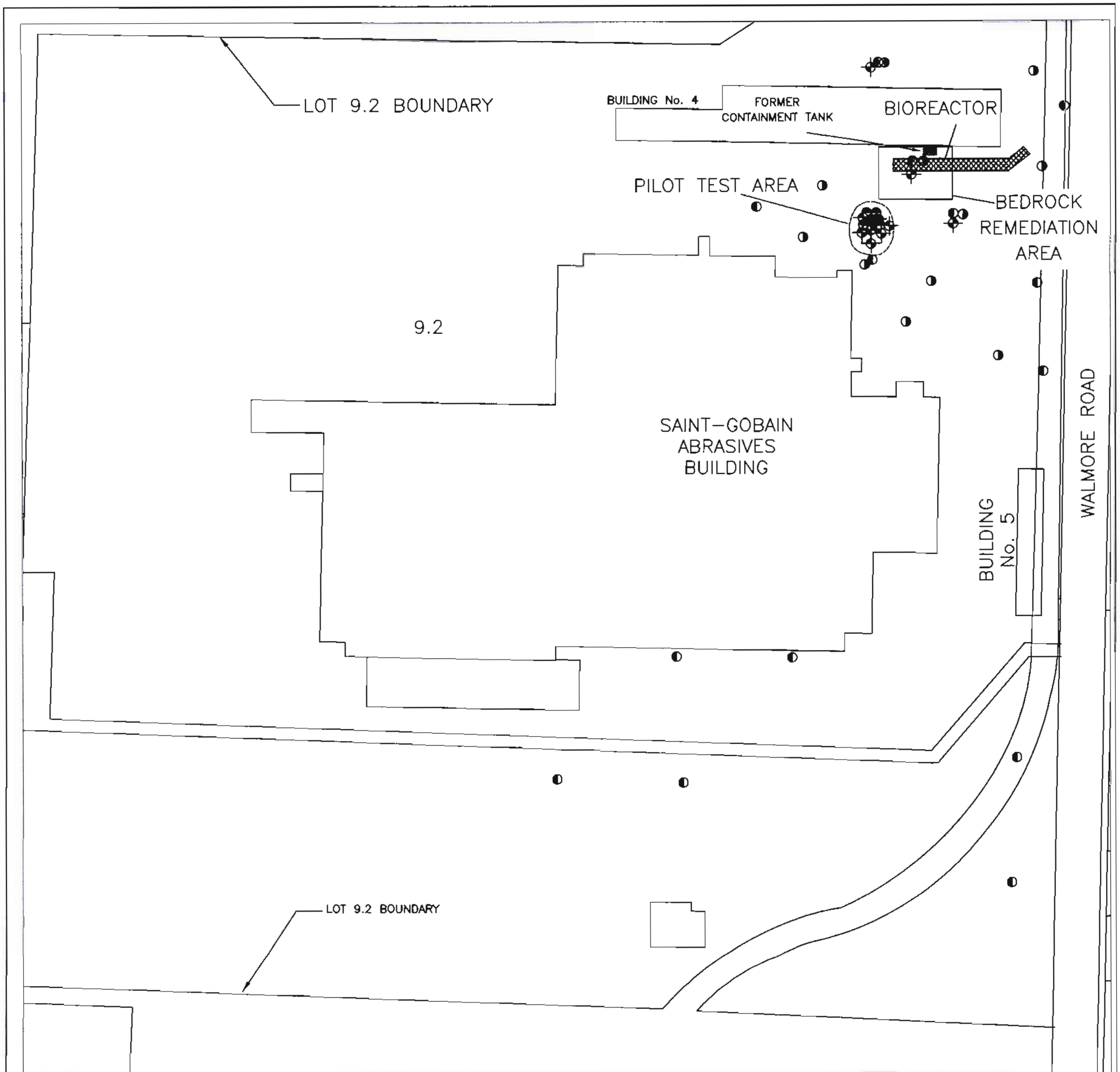

SCALE (FEET)

250 125 0 250 500

LEGEND:

- SHALLOW INVESTIGATION WELL
- BEDROCK INVESTIGATION WELL
- REPLACEMENT BEDROCK INVESTIGATION WELL AND PILOT TEST WELL

FIGURE 2

EKONOL POLYESTER
RESINS FACILITY
WHEATFIELD, NEW YORK

SITE PLAN

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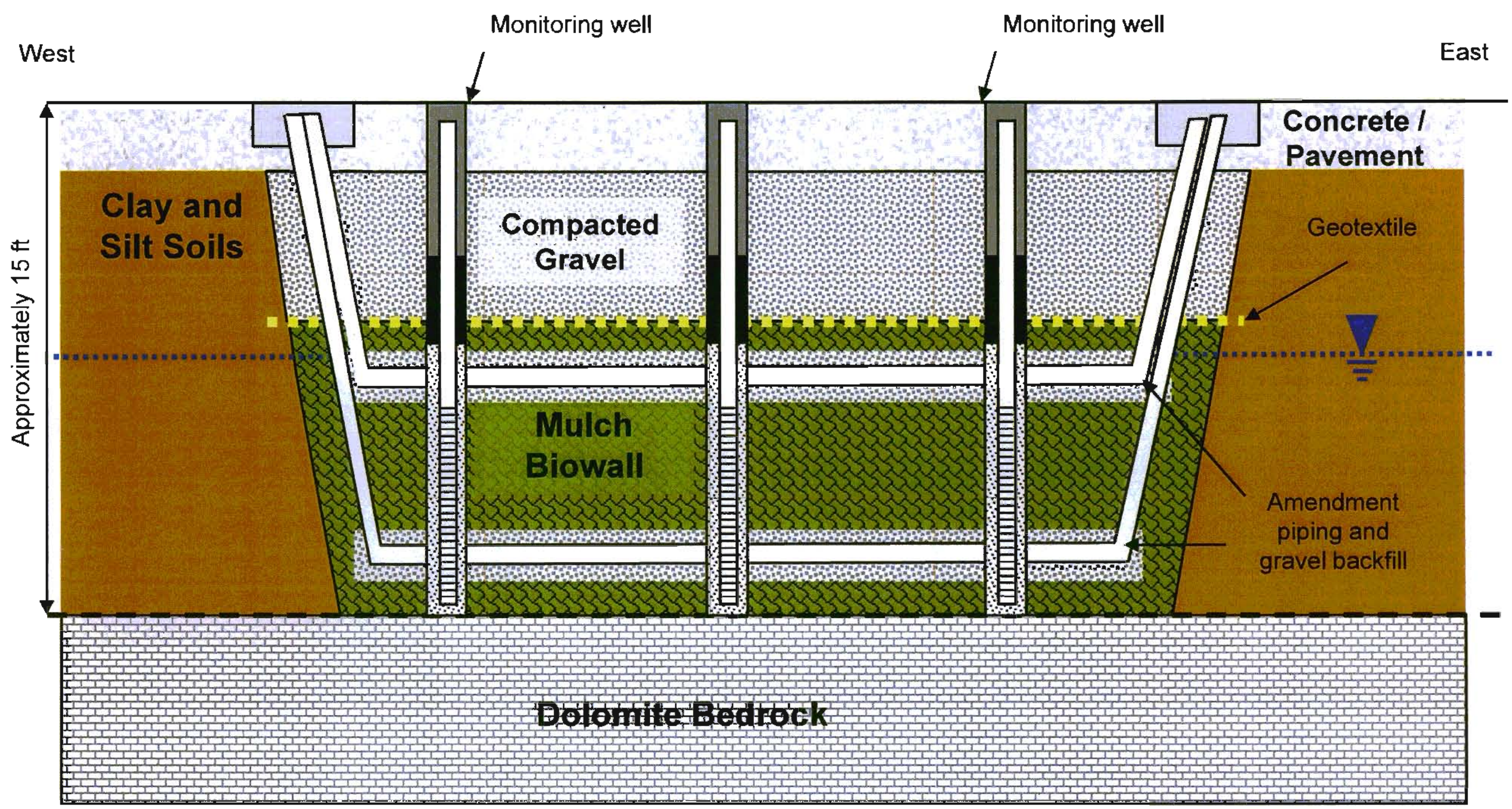

Not to scale

FIGURE 4

EKONOL POLYESTER RESINS FACILITY
WHEATFIELD, NEW YORK

CROSS-SECTION OF BIOREACTOR TRENCH

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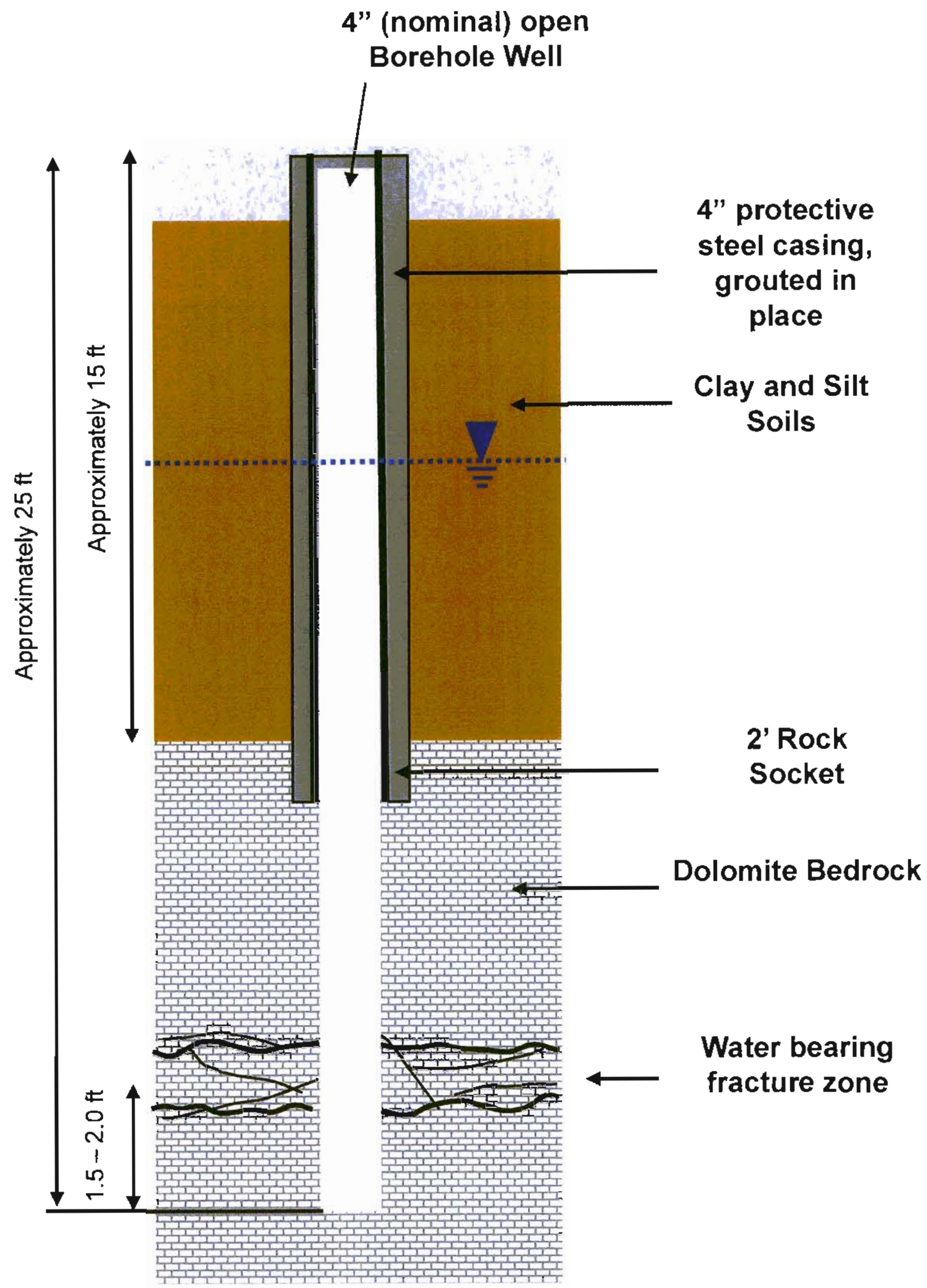

FIGURE 6

EKONOL POLYESTER RESINS FACILITY
WHEATFIELD, NEW YORK

SCHEMATIC OF BEDROCK WELL
(INJECTION AND MONITORING)

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TABLES

TABLE 1
ESTIMATED SUBSTRATE INJECTION AND LOADING RATE SCENARIO FOR INITIAL BEDROCK INJECTION

	Injection Points		Substrate Injection Mixture					Post-Emulsion Push			Total Volume		Estimated		
			Emulsion Product		Soybean Oil Component			WillClear							
Well ID	Injection Interval (feet)	Injection Spacing (feet)	Volume (gallons)	Weight (pounds)	(gallons)	(pounds)	Makeup Water (gallons)	Volume (gallons	Lactic Acid (pounds)	Makeup Water (gallons)	Substrate (pounds)	Water/ Substrate (gallons)	Injection Interval (feet)	Effective Porosity (percent)	Radius of Influence (feet)
Injection Wells															
INJ-06	15-26	22.5 x 30	500	3,978	306	2386.5	3500	0.0	0.0	150	2,514	4,150	10	1%	42
SUBTOTAL:			**500**	**3,977**	**306**	**2,387**	**3,500**	**0**	**0**	**150**	**2,514**	**4,150**			

Weight Emulsion Product (lbs): 3,977

SUBSTRATE COST ESTIMATE

Substrate Lactic Acid Concentration: 3,701 milligrams per liter

Substrate Oil Concentration: 69,061 milligrams per liter

Residual Percent Oil in Substrate Mixture: 7.4%

EFFECTIVE TREATMENT ZONE CONCENTRATIONS

Effective Lactic Acid Concentration: 54 milligrams per liter

Effective Vegetable Oil Concentration: 1,014 milligrams per liter

Total Effective Porosity of Treatment Zone + Groundwater Flux: 282,559 gallons

Total Design Factor	**0.9**	**54**	**mg/L**
Design Period (years):	**1.500**	**0.02**	
Design Period (months):	**18.0**	**4,208.6**	**gallons**
Hydrogen Demand (lbs):	**296.2**	**282,559**	**gallons**

Final Vegetable Oil Concentration (mg/L): 1,014

Vegetable Oil Design Factor 0.93

NOTES:

1. Assumes emulsion product is 60 percent soybean oil by weight.
2. Soybean oil/emulsifier mix is approximately 7.8 pounds per gallon.
3. Volumes are approxiamte and may be adjusted based on field conditions.
4. Sodium Bicarbonate may be added as a pH buffer.

TABLE 2
SUMMARY OF PROPOSED MONITORING
EKONOL POLYESTER RESINS, WHEATFIELD, NEW YORK

Location	Synoptic Water Level Measurement	VOCs[a] (SW8260B)	Methane, Ethane, Ethene (Lab SOP)	Chloride, Nitrate, Sulfate [b] (E300.1)	Dissolved Inorganics [b/c] (SW6010B)	Ortho-phosphate [b] (EPA 365.1)	Sulfide [b] (MS 4500-S2-F)	Total Organic Carbon (SW9060)	Total Inorganic Carbon (SW9060)	Microbial Population [d] (Lab SOP)	Acetylene and Hydrogen	Real time Analyses [e]	Mobile Lab Analysis [f]
Overburden Bioreactor Monitoring Wells													
OR-1S	1	1	1	1	1	1	1	1	1			1	1
OR-2S	1	1	1	1	1	1	1	1	1			1	1
OR-3S	1	1	1	1	1	1	1	1	1	1	1	1	1
OR-4S	1	1	1	1	1	1	1	1	1	1	1	1	1
OR-5S	1	1	1	1	1	1	1	1	1			1	1
OR-6S	1	1	1	1	1	1	1	1	1			1	1
OR-7S	1	1	1	1	1	1	1	1	1			1	1
OR-7S	1	1	1	1	1	1	1	1	1	1	1	1	1
OR-8S	1	1	1	1	1	1	1	1	1	1	1	1	1
OR-9S	1	1	1	1	1	1	1	1	1			1	1
OR-10S	1	1	1	1	1	1	1	1	1			1	1
PMW-1S	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-2S	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-3S	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-4S	1	1	1	1	1	1	1	1	1			1	1
PMW-5S	1	1	1	1	1	1	1	1	1			1	1
PMW-6S	1	1	1	1	1	1	1	1	1			1	1
PMW-7S	1	1	1	1	1	1	1	1	1			1	1
PMW-8S	1	1	1	1	1	1	1	1	1			1	1
PMW-9S	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-10S	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-11S	1	1	1	1	1	1	1	1	1			1	1
Bedrock Injection/Withdrawal Wells													
INJ-7D	1	1	1	1	1	1	1	1	1	1	1	1	1
INJ-8D	1	1	1	1	1	1	1	1	1			1	1
INJ-9D	1	1	1	1	1	1	1	1	1	1	1	1	1
INJ-10D	1	1	1	1	1	1	1	1	1	1	1	1	1
Bedrock Monitoring Wells													
PMW-9D	1	1	1	1	1	1	1	1	1			1	1
PMW-10D	1	1	1	1	1	1	1	1	1			1	1
PMW-11D	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-12D	1	1	1	1	1	1	1	1	1			1	1
PMW-13D	1	1	1	1	1	1	1	1	1			1	1
PMW-14D	1	1	1	1	1	1	1	1	1			1	1
PMW-15D	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-16D	1	1	1	1	1	1	1	1	1			1	1
PMW-17D	1	1	1	1	1	1	1	1	1	1	1	1	1
PMW-18D	1	1	1	1	1	1	1	1	1			1	1

TABLE 2
SUMMARY OF PROPOSED MONITORING
EKONOL POLYESTER RESINS, WHEATFIELD, NEW YORK

Location	Synoptic Water Level Measurement	VOCs[a/] (SW8260B)	Methane, Ethane, Ethene (Lab SOP)	Chloride, Nitrate, Sulfate[b/] (E300.1)	Dissolved Inorganics[b/c/] (SW6010B)	Ortho-phosphate[b/] (EPA 365.1)	Sulfide[b/] (MS 4500-S2-F)	Total Organic Carbon (SW9060)	Total Inorganic Carbon (SW9060)	Microbial Population[d/] (Lab SOP)	Acetylene and Hydrogen	Real time Analyses[e/]	Mobile Lab Analysis[f/]
Pilot Test Wells													
PMW-1D	1	1	1	1	1	1	1	1	1			1	1
INJ-01	1	1	1	1	1	1	1	1	1			1	1
PMW-2D	1	1	1	1	1	1	1	1	1	1		1	1
PMW-3D	1	1	1	1	1	1	1	1	1			1	1
PMW-4D	1	1	1	1	1	1	1	1	1			1	1
PMW-6D	1	1	1	1	1	1	1	1	1	1		1	1
RMW-4D	1	1	1	1	1	1	1	1	1			1	1
PMW-7D	1	1	1	1	1	1	1	1	1			1	1
MW-7D	1	1	1	1	1	1	1	1	1			1	1
Site Investigation Wells													
MW-1S	1	1	1	1	1	1	1	1	1			1	1
MW-2S	1	1	1	1	1	1	1	1	1	1		1	1
MW-3S	1	1	1	1	1	1	1	1	1			1	1
MW-4S	1	1	1	1	1	1	1	1	1			1	1
MW-6S	1	1	1									1	1
MW-10S	1	1	1									1	1
MW-11S	1	1	1									1	1
MW-12S	1	1	1									1	1
RMW-2D	1	1	1	1	1	1	1	1	1	1		1	1
RMW-3D	1	1	1	1	1	1	1	1	1			1	1
MW-11D	1	1	1									1	1
MW-17D	1	1	1									1	1
MW-20D	1	1	1									1	1
MW-21D	1	1	1									1	1
SUBTOTALS	59	59	59	51	51			51		19	15	59	59
QA/QC													
Duplicates		3	3	3	3			3		0	0	0	0
Matrix Spike		1											
Matrix Spike Duplicate		1											
Trip Blanks		1											
TASK TOTAL PER SAMPLING		65	62	54	54			54		19		59	59

[a/] VOCs = volatile organic compounds, including aromatic and chlorinated aliphatic hydrocarbons If present, an oil sample will also be collected and analyzed for VOCs

[b/] All metal and cation samples must be field-filtered and immediately preserved (Ca, Mg, K, Na, Fe, Mn, Al)

[c/] Dissolved inorganic compounds will consist of aluminum (Al), arsenic (As), calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), manganese(Mn), selenium (Se), and sodium (Na). Samples will be field filtered.

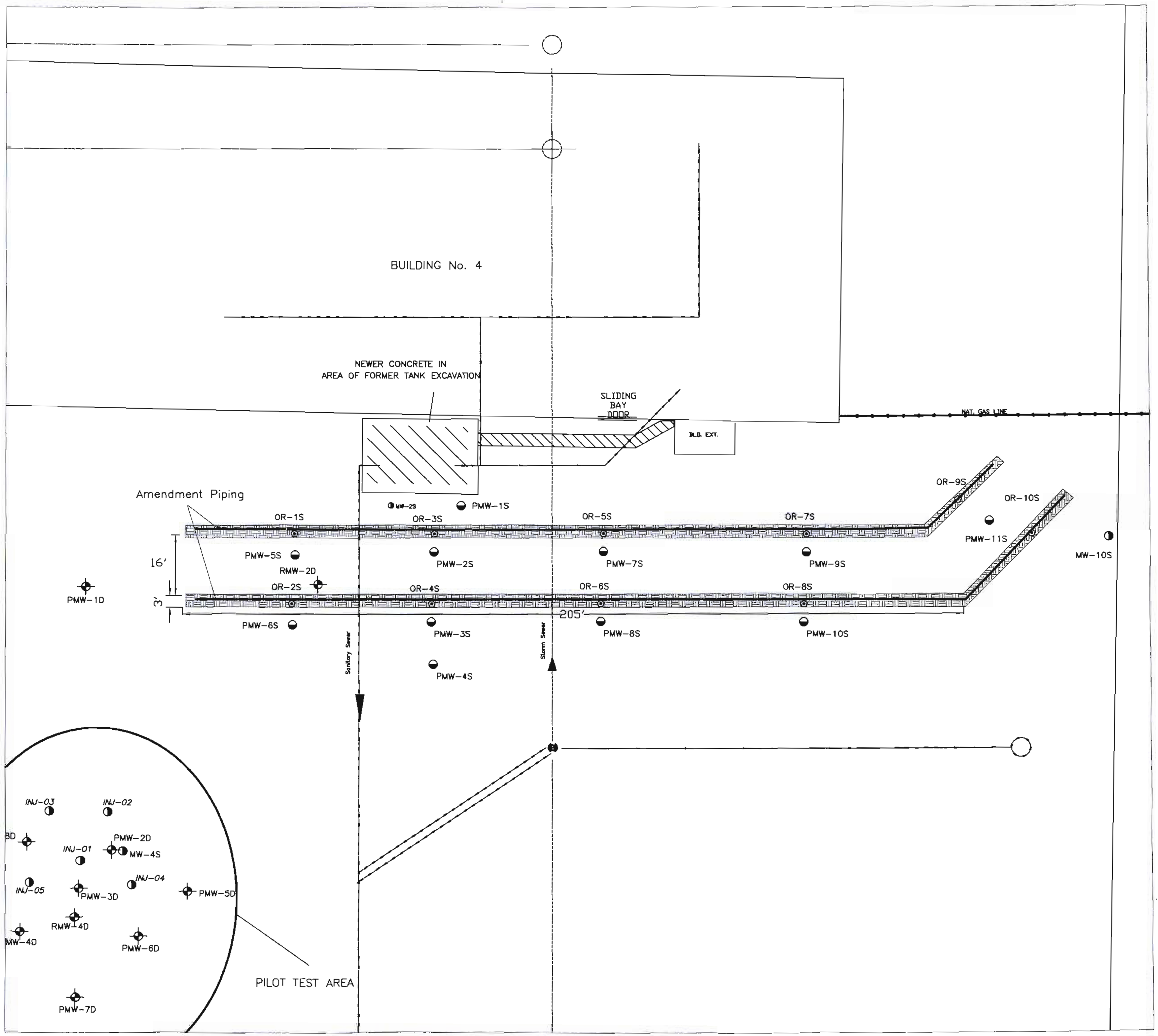
[d/] Analysis of microbial population composition will include concentration measurements of dehalococcoides and dehalobacter species in cells per milliliter

[e/] Well head analyses include dissolved oxygen, oxidation-reduction potential, pH, temperature, electrical conductivity, and visual appearance

[f/] Mobile lab analyses include carbon dioxide, alkalinity, sulfide, ferrous iron, and manganese

TABLE 3
ANALYTICAL PROTOCOLS FOR GROUNDWATER AND OIL SAMPLES
EKONOL POLYESTER RESINS, WHEATFIELD, NEW YORK

MATRIX Analyte	**METHOD**	**FIELD (F) OR ANALYTICAL LABORATORY (L)**
WATER		
Acetylene and Hydrogen	Laboratory-specific Standard Operating Procedure	L
Alkalinity (Carbonate [$CO_3^{=}$] or Bicarbonate [HCO_3^{-}])	Titrimetric, Hach Method 8221 (or similar)	F
Appearance	Visual Observation	F
Carbon Dioxide	Titrimetric, Hach Method 1436-01 (or similar)	F
Chloride, Nitrate, Sulfate	EPA Method 300.1	L
Dissolved Inorganics	SW-846 Method 6010B	L
Dissolved Oxygen	Direct-reading meter	F
Ferrous Iron (Fe^{2+})	Colorimetric, Hach Method 8146 (or similar)	F
Hydrogen Sulfide	Hach Method 8131 or HS-C	F
Manganese (Mn^{2+})	Colorimetric, Hach Method 8034 (or similar)	F
Methane, Ethane, Ethene	Laboratory-specific Standard Operating Procedure	L
Microbial Populations	Laboratory-specific Standard Operating Procedure	L
Ortho-phosphate	EPA 365.1	L
pH	Direct-reading meter	F
Redox Potential (ORP)	Direct-reading meter	F
Specific Conductivity	Direct-reading meter	F
Sulfide	MS 4500-S2-F	L
Temperature	Direct-reading meter	F
Total Organic Carbon / Total Inorganic Carbon	SW-846 9060	L
Volatile Organic Compounds (VOCs)	SW-846 8260B	L
OIL		
VOCs	SW-846 8260B	L



LEGEND:

- EXISTING SHALLOW INVESTIGATION WELL
- EXISTING REPLACEMENT BEDROCK INVESTIGATION WELL
- OVERBURDEN PERFORMANCE MONITORING WELL
- BIOREACTOR MONITORING WELL
- MULCH AND GRAVEL BIOREACTOR

30 15 0 30

SCALE BAR (FEET)

NOTES: UTILTY LOCATIONS ARE APPROXIMATE
OTHER UTILITIES MAY EXIST
FINAL LOCATIONS WILL BE DEPENDENT UPON
SITE CONDITIONS AND PLANT OPERATIONS

FIGURE 3

EKONOL POLYESTER
RESINS FACILITY
WHEATFIELD, NEW YORK

BIOREACTOR COMPONENTS
– PLAN VIEW

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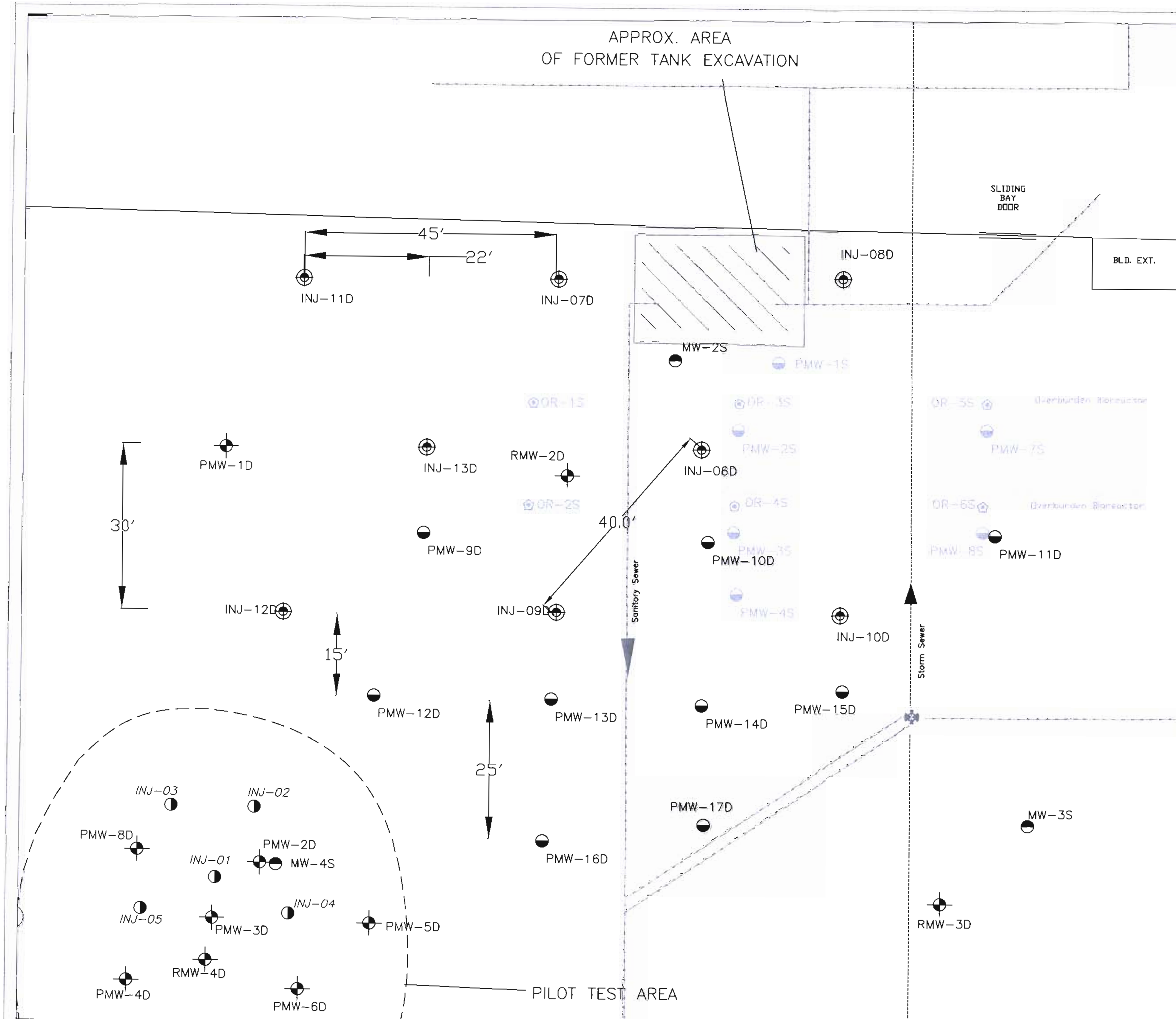

P:\\EKONOL\445144\CAD GIS\2009remWP\EK-2009 EK-2010 BEDRX REM.dwg
No XREFs

SCALE (FEET)

25 12.5 0 25 50

LEGEND:

- BEDROCK INVESTIGATION / PILOT TEST WELL
- BEDROCK REMEDIATION INJECTION/WITHDRAWAL WELL
- EXISITING PILOT TEST INJECTION WELL
- EXISITING SHALLOW INVESTIGATION WELL
- OVERBURDEN BIOREACTOR WELL
- SHALLOW REMEDIATION WELL

NOTES: SEE FIGURE 3 FOR FURTHER DETAILS REAGRDING THE OVERBURDEN BIOREACTOR

PROPOSED WELL LOCATION ARE APPROXIAMTE AND MAY BE ADJUSTED IN THE FIELD.

UTILITY LOCATIONS ARE APPROXIMATE, OTHER UTILITIES MAY EXIST.
FINAL LOCATIONS WILL BE DEPENDENT UPON SITE CONDITIONS AND PLANT OPERATIONS

FIGURE 5

EKONOL POLYESTER
RESINS FACILITY
WHEATFIELD, NEW YORK

BEDROCK REMEDIATION
LAYOUT

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