Prepared for:

Arkema Inc.
King-of-Prussia, PA

WORKPLAN FOR A PILOT TEST OF *IN SITU* BIOREMEDIATION OF PERCHLORATE IN GROUNDWATER AT THE FORMER ATOFINA CHEMICALS SITE, PORTLAND, OREGON

Prepared by:

GEOSYNTEC CONSULTANTS
130 Research Lane, Suite 2
Guelph, Ontario N1G 5G3

GeoSyntec Project Number TR0162
March 2006

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

GeoSyntec Consultants Incorporated (GeoSyntec) was retained by Arkema Incorporated (Arkema) to conduct a laboratory biotreatability study to: i) evaluate the potential to biodegrade perchlorate in groundwater at the former ATOFINA Chemicals Inc. facility in Portland, Oregon (the Site; **Figure 1**); and ii) assess whether enhanced in situ bioremediation (EISB) may be an appropriate remediation technology for the Site groundwater. The results of the biotreatability study indicated that perchlorate could be biodegraded through the addition of appropriate nutrients (electron donors) and bioaugmentation with perchlorate-reducing bacteria. Based on the results of the biotreatability study, Arkema has retained GeoSyntec to develop an approach for field pilot testing of EISB at the Site.

This Workplan summarizes the key results of the biotreatability study, and provides details regarding design and execution of two potential EISB pilot test options (active recirculation and passive biobarrier) for the Site groundwater. To determine the optimal EISB approach to pilot test, GeoSyntec has identified several data needs that need to be addressed. Pre-design data collection activities are planned and are described herein. Following completion of the data collection and analysis activities, the most suitable pilot test approach will be implemented to demonstrate the efficacy of the EISB technology under field conditions, for possible full-scale implementation at the Site.

The remainder of this Workplan is divided into eight sections:

- Section 2 provides a description of current Site conditions, geology, hydrogeology, and groundwater chemistry;

- Section 3 provides background information on perchlorate biodegradation and presents the methodology, results and conclusions from the laboratory biotreatability study;

- Section 4 discusses the uncertainties and data needs required to select an appropriate remedial approach (active or passive system) for pilot scale implementation;

- Section 5 presents the pilot test objectives, the approach and methodology for the active and passive pilot test systems, and the process for selecting and notifying appropriate stakeholders of the pilot test approach selected;

- Section 6 provides a project schedule; and

- Section 7 provides references.

2. SITE DESCRIPTION

The following subsections briefly describe the Site geology and hydrogeology (Section 2.1) and the groundwater chemistry (Section 2.2).

2.1 Site Geology and Hydrogeology

The Site geology consists of fill, overlying a sequence of dark gray-brown and black sands interspersed with laterally discontinuous silts/fine sands, overlying a layer of silt with some clay and fine sand, overlying competent basaltic bedrock. Two main groundwater flow zones have been identified for the Site, including: a shallow zone that begins at an approximate depth of 25 feet below ground surface (bgs), and has a variable thickness of about 8 to 16 feet; and an intermediate zone that begins at an approximate depth of 40 feet bgs, and has a variable thickness of about 6 to 10 feet. In downgradient areas of the Site near well MWA-27, the silt layer that separates the shallow and intermediate flow zones appears to be absent, and as a result, the sand sequence likely behaves as a single flow zone in this area. The water table occurs within the top of the dark gray-brown sand unit, and in some areas in the base of the fill unit, at an approximate depth of 25 feet bgs. The groundwater elevation fluctuates seasonally by as much as 5 to 10 feet across the Site.

Figure 2 presents a generalized hydrostratigraphic cross-section across the Site, oriented parallel to groundwater flow. The hydrogeology beneath the site, which is subdivided into shallow, intermediate and deep aquifer zones, have each of these zones generally separated by semi-continuous layers of lesser permeability sandy silt. As described further below, perchlorate impacts at the Site are generally confined to the shallow and intermediate zones, and as such, these two zones are the focus of the design concepts presented herein. Near the suspected perchlorate source area, located to the northeast of the Chlorate Cell Room (referred to henceforth as the “Source Area”), the shallow and intermediate zones are separated by a continuous sandy silt layer. This silt layer appears to pinch out beneath the salt pad located to the northeast of the Source Area, and the aquifer becomes a continuous sandy layer with interbedded sequences of thin discontinuous sandy silt layers. This area downgradient of the Source Area where the aquifer is continuous is referred to henceforth as the “Downgradient Area”.

The hydraulic conductivity (K) of the aquifer materials appears to decrease with depth, with values ranging from 5.9 ft/day to 34 ft/day in the shallow zone, 0.04 ft/day to 21 ft/day in the intermediate zone, and 0.3 ft/day in the deepest zone, which is separated from the intermediate zone by a second continuous silt and clay layer (ERM, 2005). It should be noted that these K values were determined from slug testing (Exponent, 1999), and thus may be lower than actual values by an order of magnitude or more.

The hydraulic gradient (∇h) is high in the Source Area, and decreases downgradient near the Willamette River, approximately corresponding to the area where the silt layer separating the shallow and intermediates zones pinches out. From water elevation contours measured in 2003, it appears that estimates of ∇h of 0.037 ft/ft in the Source Area and 0.004 ft/ft in the Downgradient Area are reasonable estimates for both shallow and intermediate zones. Porosity was assumed to be 0.3 (professional judgment) at all depths. Based on these values of K, ∇h, and porosity, the groundwater velocity was estimated to range between 56 ft/year (in the Downgradient Area) to 770 ft/year (in the Source Area).

2.2 Groundwater Chemistry

Perchlorate and chromium are present in a co-mingled plume that appears to emanate from the former Chlorate Cell Room and migrates to the northeast in the direction of the Willamette River. Based on July 2003, May 2005 and September 2005 groundwater data, a maximum perchlorate concentration of about 300 milligrams per liter (mg/L) was detected at shallow zone well MWA-25, which is a downgradient well near the former Chlorate Cell Room. The chromium concentration at this well in June 2003 was 9.79 mg/L. Perchlorate and chromium concentrations are generally lower in the intermediate flow zone in areas where the silt layer separates the flow zones. In downgradient reaches of the plume, where this silt layer appears to be absent, the shallow and intermediate flow zones appear to merge, and elevated perchlorate concentrations are detected in wells screened deeper in the sand sequence (e.g., MWA-32i; 200 mg/L in July 2003). These perchlorate concentrations, while relatively high, are well within the range of biodegradable concentrations. The distribution of perchlorate supports the site conceptual model described above.

Figures 3a and **3b** show the distributions of perchlorate in the shallow and intermediate zones, respectively (data provided by ERM). In the Source Area, the concentrations of perchlorate in the shallow and intermediate zones are similar, indicating the need for bioremediation of both groundwater zones. The perchlorate in the shallow zone appears to be migrating to the east-northeast from the Source Area to the river, whereas the perchlorate in the intermediate zone appears to be migrating in a more northeasterly direction (see **Figures 3a and 3b** for perchlorate distribution). Chlorate concentrations in samples obtained from wells MWA-32i (intermediate depth, Downgradient Area) and MWA-25 (shallow depth, Source Area) for the biotreatability study ranged between 5,000 to 9,000 mg/L. Therefore, electron donor demand calculations for the design concepts must account for the concentration of chlorate in the groundwater.

Review of supporting groundwater chemistry data (**Table 1**) reveals two potential concerns with respect to inducing perchlorate biodegradation in situ, namely: elevated pH (~9.5 to 10.7) in shallow zone wells near the former Chlorate Cell Room, and also at intermediate zone well MWA-34i; and elevated chloride (up to 164,000 mg/L) in shallow and intermediate zone wells located near the former salt pads and adjacent to the Willamette River. These conditions do not appear to co-occur, and the biotreatability tests described in this report therefore evaluated the extent to which each of these unique Site conditions affects perchlorate biodegradation. Electron acceptors are present that may influence electron donor demand and system performance, including nitrate, chlorate and sulfate, and these were considered in design of the bioremediation treatability study. Perchlorate reduction can be accomplished without inducing sulfate reduction, provided that the amount of electron donor added is balanced against the amount of perchlorate that needs to be degraded. However, if a bioremediation approach is selected that injects bulk quantities of slow-release electron donors, then sulfate reduction will likely occur and may produce hydrogen sulfide, which typically precipitates as metal-sulfides.

3. OVERVIEW OF PERCHLORATE BIODEGRADATION STUDIES

The following subsections provide a brief overview of the perchlorate biodegradation mechanism (Section 3.1), the approach and methodology for the Site biotreatability study (Section 3.2), the results of the Site biotreatability study (Section 3.3), and the conclusions from the Site biotreatability study (Section 3.4).

3.1 Perchlorate Biodegradation Mechanism

Perchlorate biodegradation results from microbially-mediated redox reactions, whereby perchlorate serves as the electron acceptor, and is reduced via chlorate to chlorite. Chlorite then undergoes a biologically mediated dismutation/ disproportionation reaction, releasing chloride and oxygen (**Figure 4**). The oxygen is subsequently reduced to carbon dioxide (CO_2), provided electron donors are available. Both chlorate and chlorite are transient intermediates, and are typically not observed during in situ perchlorate reduction (reaction rates for these intermediates are typically too rapid for detection). At this Site, however, chlorate is present in the groundwater, and would be expected to degrade via the reduction reaction shown in **Figure 4**.

A variety of electron donors have been used to stimulate perchlorate reduction, including organic acids (e.g., acetate, lactate, oleate), alcohols (e.g., ethanol), sugars (e.g., molasses, corn syrup), edible oils (e.g., canola and soybean oil), and waste products (e.g., manure). While perchlorate-reducing bacteria are generally thought to be ubiquitous (dozens of perchlorate-reducing bacteria have been identified in the scientific literature), laboratory microcosm studies presented in this Workplan using site groundwater and aquifer materials showed that geochemical conditions in the subsurface at the Site, specifically those limited areas of high pH and high chloride, are fairly inhibitory to perchlorate reduction, and as such, addition of perchlorate–reducing bacteria will likely be required to achieve the desired level of biodegradation of these constituents (see Section 4).

3.2 Biotreatability Study Objectives, Approach and Methodology

A laboratory biotreatability study was conducted by SiREM Laboratories of Guelph, Ontario (SiREM; a wholly-owned division of GeoSyntec) to confirm the ability to bioremediate perchlorate in the Site groundwater, given the unique groundwater conditions (e.g., elevated pH and chloride). As a secondary goal, the study assessed the fate of chromium, which is understood to be present in the Site groundwater primarily in hexavalent form, under the varying biotreatment conditions. The study evaluated the potential to jointly treat perchlorate and hexavalent chromium via in situ bioremediation, or to sequence in situ bioremediation of perchlorate with chromium treatment. Chromium treatment was performed through calcium polysulfide (CPS) reduction, which reduces soluble hexavalent chromium to insoluble trivalent chromium.

The objectives of the biotreatability study were to:

- determine whether elevated pH inhibits perchlorate reduction, and, if so, evaluate the potential to buffer the groundwater to a more favorable pH (less than 9) and achieve subsequent perchlorate biodegradation;

- determine whether elevated chloride inhibits perchlorate reduction, and, if so test several dilutions to assess the chloride concentration break point for perchlorate reduction;

- evaluate whether electron donor and CPS can be jointly added to microcosms containing Site soil and groundwater to promote simultaneous biological reduction of perchlorate and chemical reduction of chromium; and

- assess the potential of bioaugmentation of the site materials with specific perchlorate-degrading bacteria to increase the rate and extent of perchlorate biodegradation.

Treatability testing was conducted using materials from two test locations at the Site:

- MWA-25 (the inferred source area) - the area immediately downgradient from the Chlorate Cell Room, where perchlorate and chromium are present in groundwater with elevated pH; and

- MWA-32i - a downgradient location adjacent to the Willamette River, where perchlorate and chromium are present in groundwater with elevated chloride (but acceptable pH).

Site soil and groundwater were used to construct a variety of control and treatment microcosms for each test location:

i) Sterile control to assess losses of perchlorate due to abiotic transformation or experimental processes (both MWA-25 and MWA-32i).

ii) Electron donor treatments for MWA-25: a neutral pH electron donor (ethanol + acetate) and an acidic pH electron donor (citric acid) selected for potential to both buffer pH and promote perchlorate biodegradation. When no perchlorate degradation was observed in the ethanol + acetate microcosms after about 4 weeks of incubation, they were buffered to a lower pH to evaluate whether this would improve degradation.

iii) Combined CPS-electron donor treatments, to evaluate whether both reactants can be added simultaneously to promote biological reduction of perchlorate and chemical reduction of chromium.

iv) Electron donor treatment for MWA-32i: a neutral pH electron donor (ethanol + acetate). The fate of perchlorate was monitored over time in these microcosms. When no perchlorate degradation was observed after about 4 weeks of incubation, a 10-fold dilution of these microcosms was tested to evaluate whether this would improve degradation.

v) A combined CPS-electron donor (ethanol + acetate) treatment, to evaluate whether both reactants can be added simultaneously to promote biological reduction of perchlorate and chemical reduction of chromium.

vi) A sequential CPS-electron donor (ethanol and acetate) treatment, to assess the ability to initially reduce chromium with CPS, followed by biological reduction of perchlorate.

Treatment and control microcosms were constructed by filling 250 milliliter (mL) (nominal volume) glass bottles with 60 g of soil and 210 mL of associated groundwater, leaving a small headspace for gas production (e.g., CO_2). Microcosms were sealed with Mininert™ valves to allow repetitive sampling of each microcosm, and the microcosms were incubated at room temperature in an anaerobic chamber. Resazurin was added to the microcosms to confirm development of appropriate anaerobic-reducing redox conditions in the microcosms (resazurin is clear under anaerobic conditions but turns pink if exposed to oxygen). The microcosms were incubated in an anaerobic chamber for a period of up to 36 weeks, and were sampled on an as needed basis for analysis of perchlorate, chloride, added electron donors (ethanol, acetate, citrate), and competing electron acceptors (e.g., nitrate, chlorate, sulfate). Sample intervals varied by treatment based on observed rates of substrate consumption and degradation activity. Selected microcosms were re-spiked with perchlorate and/or electron donors during the incubation period to confirm degradation activity and/or to maintain electron donor availability. Analyses were conducted by SiREM, with the exception of chromium, which was conducted by North Creek Analytical Laboratories, Bothell, WA. Perchlorate analyses were conducted by SiREM by ion chromatography (IC) following USEPA Method 314.0. To confirm the accuracy of these analyses, confirmatory samples were submitted to Severn-Trent Laboratories (Arvada, CO) for analysis of perchlorate by IC-mass spectrometry (IC/MS) following Method SW846 method 8321A. Relative percent differences (RPDs) were 4% and 7% for the two samples in which SiREM detected perchlorate. STL detected perchlorate in the other two samples, but at levels below the SiREM quantitation limit for this study (20 micrograms per liter [ug/L]), so RPDs could not calculated for those two samples. These results indicate good agreement between the two methods, providing confidence in the accuracy of the SiREM analyses. Comparative results are provided in Appendix A.

3.3 Biotreatability Study Results

This section presents and discusses the results for the source area and downgradient area. Analytical data for the source and downgradient areas are provided in Appendix B.

3.3.1 Source Area (MWA-25)

Key results can be summarized as follows:

- Citric Acid Treatment: In these microcosms, the concentration of perchlorate declined rapidly from ~285 mg/L to <0.02 mg/L within 7 days following electron donor addition. To confirm this result, the citric acid microcosms were re-spiked with perchlorate (~290 mg/L) and concentrations again declined to <0.02 mg/L within 7 days (**Figure 5**). Despite the encouraging result, little consumption of citrate or reduction in chlorate was observed coincident with this perchlorate mass loss, and as such, it is not clear whether this activity was entirely due to biological causes.

- Citric Acid + CPS Treatment: Following the encouraging results of the citric acid treatment, a treatment was constructed to evaluate whether citric acid and CPS could be simultaneously added to treat both perchlorate and chromium. In this treatment, perchlorate did not biodegrade. Bioaugmentation with a perchlorate reducing microbial culture did not improve the rate of perchlorate biodegradation. The reasons for the difference in perchlorate biodegradation between the citric acid alone and the citric acid + CPS treatments are unclear, but may be the results of microbial heterogeneity in the soils used to construct the varying citric acid treatment microcosms. Of note, an increase in chromium concentration from about 10 mg/L to 26 mg/L was observed in this treatment, likely as a result of mobilization due to the low pH; however, the chromium was present as trivalent, not hexavalent, chromium.

- Ethanol & Acetate Treatment: The addition of electron donor (ethanol + acetate) did not result in biodegradation of perchlorate (**Figure 5**). Buffering of pH also failed to improve perchlorate degradation in this treatment.

- Ethanol & Acetate + CPS Treatment: The addition of CPS simultaneously with electron donor (ethanol and acetate) resulted in reduction of chromium concentrations from ~9.5 mg/L to approximately 0.1 mg/L within 4 hours (Appendix B). These data suggest that CPS and electron donor can be added together in a single injection event, without adversely affecting CPS performance. However, perchlorate did not biodegrade in this treatment (**Figure 5**), even with pH buffering.

- CPS Pre-Treatment - Ethanol & Acetate Treatment: The addition of CPS 4 hours prior to electron donor addition resulted in reduction of chromium concentrations from ~9.5 mg/L to approximately 0.1 mg/L within 4 hours (Appendix B). Through 150 days of incubation, perchlorate biodegradation was not observed (**Figure 5**). After 146 days, the microcosms were bioaugmented with a perchlorate-reducing microbial culture adapted to elevated concentrations of total dissolved solids. Following bioaugmentation, perchlorate concentrations declined from an average of 267 mg/L to 38 mg/L within 107 days (through the end of the study). Of note, perchlorate declined to <0.8 mg/L in one of the three replicates, indicating that treatment of perchlorate to low levels is possible. The reasons for the variability in perchlorate degradation rates between replicate microcosms are unclear.

3.3.2 Downgradient Area (MWA-32i)

Key results can be summarized as follows:

- Ethanol + Acetate Treatment: No perchlorate biodegradation was observed in the MWA-32i microcosms over the first 44 days of incubation, likely due to the high chloride concentrations. After 146 days, selected microcosms were diluted ten-fold to reduce the concentration of chloride in the groundwater in these microcosms from >26,000 mg/L to ~2,600 mg/L.

Dilution alone failed to stimulate perchlorate biodegradation. On 7 June 2004, two of the three replicate microcosms were bioaugmented with a perchlorate-reducing microbial culture. Rapid biodegradation of perchlorate to <0.2 and <0.8 mg/L, respectively, was observed within three weeks of bioaugmentation (**Figure 6**). To confirm perchlorate biodegradation activity, the microcosms were re-spiked with perchlorate (target of 250 mg/L). Perchlorate concentrations declined to an average of 18 mg/L by the end of September 2004, with concentrations less than 0.8 mg/L in two of the three replicate microcosms.

- CPS Pre-Treatment - Ethanol + Acetate Treatment: No perchlorate biodegradation was observed in these microcosms over more than 150 days of incubation, likely due to the elevated chloride. After 146 days, the microcosms were bioaugmented with a perchlorate-reducing microbial culture. Little change in perchlorate concentrations was observed, and the microcosms were re-augmented with microbial culture on 21 days later. Perchlorate biodegradation was not observed following the second bioaugmentation. In response, the microcosms were diluted two-fold to reduce the concentration of chloride from >26,000 mg/L to ~13,000 mg/L. Perchlorate concentrations then declined to an average of 85 mg/L by the end of September 2004 (**Figure 6**).

3.4 Conclusions from the Biotreatability Study

Key conclusions of the biotreatability study can be summarized as follows:

- CPS treatment does not appear to adversely affect or interfere with biodegradation activity and should be pursued for hexavalent chromium.

- The concentration of chloride significantly affects the rate and extent of perchlorate reduction. A chloride concentration below 14,000 mg/L appears to be required to initiate perchlorate reduction.

- Data for citric acid treatments were ambiguous, showing rapid biodegradation under initial test conditions but essentially no biodegradation in a treatment containing CPS. The presence of CPS is not suspected to be the cause of the limited perchlorate biodegradation. Rather, microbial heterogeneity in the soils used to construct the varying citric acid treatment microcosms is suspected to be the cause. Ethanol and acetate do not promote perchlorate reduction unless microcosms are bioaugmented.

- Bioaugmentation with a perchlorate-reducing microbial culture significantly improves the rate and extent of perchlorate reduction in both the source and downgradient area microcosms, and is likely to be required in those areas to achieve successful EISB at the Site.

4. PILOT TEST PRE-DESIGN CHARACTERIZATION ACTIVITIES

During development of potential pilot test approaches for the Site, GeoSyntec identified several key uncertainties that need to be resolved before completing pilot test design. The main uncertainties/data needs were: i) delineation of the potential perchlorate distribution in vadose zone soils that may serve as a long-term source to groundwater; and ii) hydraulic characterization of the aquifer in areas where electron donor injection and possibly groundwater extraction activities would occur. Pre-design data collection activities to address these data needs are described in Sections 4.1 and 4.2, respectively.

4.1 Assessment of Vadose Zone Perchlorate Distribution

Delineation of the perchlorate distribution in unsaturated Site soils in the perchlorate study area will be conducted to assess whether the vadose zone may serve as a potential long-term source of perchlorate to groundwater. In the event that perchlorate is determined to be present at elevated concentrations in the vadose zone soils, then remediation alternatives for the vadose zone may be contemplated, and potentially added to the pilot testing program.

Soil cores will be collected from the perchlorate study area in two phases. Phase 1 will consist of an initial screening to: (i) evaluate whether more extended sampling is warranted; and (ii) assess the correlation between soil lithology and perchlorate distribution in the vadose zone to optimize soil sampling locations and degree of vertical discretization for a potential second phase of sampling. To address these goals, soil cores will be obtained from four locations shown on **Figure 7** to a total depth of 5 ft below the watertable (approximately 25 to 30 ft bgs), with soil samples obtained from these cores at three foot intervals for further analysis. Ideally, the soil cores will be collected using rotosonic drilling techniques, which minimize disturbance of the cores. Soil cores will be logged for soil properties, and samples will then be collected at the specified depth intervals for perchlorate and chlorate analysis. The samples will be obtained by cutting a section of core approximately 2 inches thick (if the sample is cohesive), removing the surface where there was contact with the core barrel, and weighing 250 grams directly into a 500 ml wide mouth plastic jar. For loose material, a grab sample will be collected, and a 250 gram weighed sample will be placed directly into a 500 ml wide mouth plastic jar. Each 250 g soil sample will be field-extracted by filling the jar with 250 mL of deionized water, and placing the jar on a shaker table for 1 hour. The 1:1 extraction method, which GeoSyntec has developed and has used with regulatory approval at multiple sites in California, preserves the low detection limit of water using an appropriate analytical method such as EPA Method 314.0. Since the samples are not dried prior to field extraction and analysis, corrections to dry weight equivalent concentration will be made through coincidental collection of soil moisture measurements for an appropriate subset of soil samples throughout the soil core.

Two options are available for analyzing the extract for perchlorate concentrations, including a perchlorate ion selective electrode (ISE), and ion chromatography (IC). The perchlorate ISE method remains the most rapid method for concentrations greater than 1 mg/L (or 1 mg/kg for soils using a 1:1 extraction). It is also the only method that can be used routinely in the field. However, there may be some potential for interference with chloride and chlorate ions, both of which may potentially be present in the vadose zone at concentrations that are greater than the perchlorate. The IC method, on the other hand, is more accurate, particularly for low perchlorate concentrations, and is not impacted by interferences, but the cost for analysis is higher and the analysis cannot be completed in the field. It is recommended that a pre-sampling screening test, consisting of a direct comparison between ISE and IC methods using site groundwater, be conducted to evaluate the potential for interference with the ISE probe. If the pre-screening test indicates that the ISE method will provide reasonable perchlorate measurements, then the majority of the analyses will be conducted in the field using ISE with a subset (20%) of the samples (corresponding to locations of high perchlorate) sent to STL for confirmation analysis of perchlorate and chlorate by IC methods. However, if the pre-screening test indicates that the ISE method is not applicable for this site, all samples will be sent to the SiREM laboratory for screening analysis of perchlorate and chlorate by IC methods, and a subset (10%) will be sent to STL for confirmatory analysis of perchlorate. One equipment blank will also be obtained at the end of each day and the samples will be sent to a lab for perchlorate analysis.

For the ISE analyses, the ionic strength of the sample will be adjusted prior to analysis by decanting a 50 ml aliquot of extract into an appropriate sized bottle, and adding 1 mL of ionic strength adjusting (ISA) solution (concentrated solution of ammonium sulfate). The perchlorate concentration will be measured for each 50 mL aliquot using the perchlorate ISE, with results compared to standard curves prepared using external standards made following ISE manufacturer instructions. Samples to be submitted for IC analysis will consist of a 50 mL sample of each soil sample extract decanted into a 50 ml centrifuge tube. pH and electrical conductivity (EC) or specific conductance will also be monitored in the field, in particular the latter as the relationship between perchlorate and the total levels of soluble salts can be indicative of important transport properties. EC and pH are measured by inserting the respective probes directly into the extract solution in the extraction jar.

If the results of the analyses from the Phase 1 sampling indicate that perchlorate is widely distributed throughout the vadose zone, then a second phase of sampling will be undertaken to delineate the approximate extent of vadose zone soil impacts. The Phase 2 sampling will consist of up to 12 boreholes distributed within the approximate 400 ft by 400 ft area delineated in **Figure 7**. The exact location and number of boreholes for Phase 2 will be determined based on the results of the initial screening. Five soil samples will be obtained from each soil core at 5 ft depth intervals; sampling depths may be altered as necessary to correspond to the soil lithology found to contain perchlorate during the Phase 1 screening. The approximate targeted sampling area shown in **Figure 7** was selected to correspond to the most likely distribution of perchlorate in the vadose zone soil given the perchlorate concentration distribution in the groundwater. Sampling locations may also be modified as necessary to account for existing infrastructure.

4.2 Hydraulic Testing Program

Hydraulic testing will be conducted to assess the hydraulic properties of the aquifer for the purposes of completing pilot test design, and for collecting the required hydraulic data for assessment of potential full-scale EISB configurations (e.g., injection and/or extraction well spacing and rates). Testing will be conducted at three locations (see **Figure 8**), including: i) a location immediately upgradient from the former Chlorate Cell Room near existing shallow well MWA-33; ii) the MWA-25 area immediately downgradient of the former Chlorate Cell Room; and iii) a downgradient area near the river (i.e., MWA-19 area). These locations were selected to reflect areas with different geologic/hydraulic conditions, and also corresponding to likely locations for injection and/or extraction activities for potential pilot testing and/or full-scale EISB. At this time, hydraulic testing will be conducted solely for the shallow aquifer at each location, primarily to guide pilot test design. Proposed activities will include a step-drawdown test in each area to evaluate the specific capacity of each well, and a constant-discharge test in each area to determine the transmissivity and storage coefficient of the shallow aquifer.

Installation of a suitable pumping well will be required at each location for the hydraulic testing program. Specifically, a 4-inch PVC well will be installed in the vicinity of the existing shallow monitoring well (MWA-33, MWA-25, MWA-19) at each of the three locations. The pumping well will be screened across the shallow aquifer at an equivalent interval to the corresponding monitoring well (generally ten foot screens with an interval from 20 to 35 ft bgs). For each location, the pumping well will be installed at a distance of 15 to 25 feet from the existing monitoring well. During pump testing, drawdown in both the extraction well and the associated shallow aquifer monitoring well will be monitored using pressure transducers and data loggers (short-term rental). In addition, drawdown in intermediate aquifer monitoring wells MWA-48i and MWA-34i, co-located with shallow aquifer wells MWA-25 and MWA-19, respectively, will be monitored to quantify the degree of hydraulic interconnection between the shallow and intermediate aquifers during pumping of the shallow aquifer. For the MWA-33 location, a single 2-inch PVC monitoring well will be installed in the intermediate aquifer (anticipated screen depth of 35 to 45 ft bgs) to allow for assessment of baseline perchlorate concentrations in this area, and to monitor hydraulic response during testing of the shallow aquifer pumping well. There is currently no intermediate aquifer well in this area of the Site. To the extent possible, the new wells for the hydraulic testing program will be installed during the Phase 1 vadose zone soil testing program. In the case of the pumping well co-located with MWA-25, it should be possible to collect the vadose zone soil data during installation of this well, to reduce the total number of boreholes drilled during the two programs. Well installation will be conducted in accordance with standard well installation procedures, and following local and/or state well permitting and installation guidelines.

Step-drawdown testing at each new pumping well will consist of extracting groundwater from the well at a series of increasing flow rates for a period of about one hour per step, and monitoring the dynamic water level changes either by regular sounding with a manual water level tape or using a pressure transducer and data logger. The test will consist of three to five flow rates, distributed across the range of sustainable pumping rates. Pumping will begin at low flow rates and will proceed to higher flow rates. Based on current hydraulic assumptions (see Section 2.1), pumping rate steps of 5, 10 and 15 gpm appear to be reasonable starting steps. These rates will be adjusted based on field observations for each well. From these tests, the sustainable well yield of each pumping well will be estimated for the follow-on constant-rate discharge tests.

Constant-rate discharge testing will be conducted at a pumping rate that is near the sustainable well yield, and will be conducted for up to four hours per pumping well. Prior to initiating the constant-rate discharge tests, the water level at the pumping well will be allowed to return to a static condition following the step-drawdown test. Automatic (using a data-logger and pressure transducers) and manual water level readings will be recorded at regular intervals in the pumping wells and nearby monitoring wells for several hours prior to, during, and for several hours after the constant-discharge test. The range of the pressure transducers will be sufficient to span the range of water levels expected during the test. The drawdown data will be evaluated with appropriate graphical methods to determine aquifer parameters, including storage coefficient, transmissivity, and hydraulic conductivity (vertical and horizontal), and to assess the sustainable extraction/recharge rates, capture zone of the extraction wells, impact of pumping at various depths, and radius of influence of injection wells. This information, combined with lithologic data collected during installation of the wells, will be used to optimize system extraction and injection rates for pilot and potential full-scale applications, number of extraction/reinjection wells, and to assess the need for nested wells.

During the constant-rate discharge tests, groundwater samples will be collected from the pumping wells at the start and end of the testing (under pumping conditions) for analysis of field parameters (DO, ORP, pH, specific conductance, TDS) and key geochemical parameters (perchlorate, chlorate, chloride, nitrate, nitrite, sulfate) to assess changes in groundwater chemistry under pumping conditions. Samples will be submitted to an appropriate contract laboratory for analysis following published analytical protocols. **Table 2** provides a summary of analytical details for these analyses, including analytical methods, container size and type, preservation method, and sample holding times.

5. FIELD PILOT TEST PROGRAM

A variety of EISB approaches have been successfully used to achieve bioremediation of perchlorate in groundwater, including: i) active recirculation systems, whereby soluble electron donors (e.g., acetate, lactate, ethanol) are injected and circulated through the impacted aquifer; and ii) passive systems, whereby relatively insoluble, slow-release electron donors [e.g., emulsified vegetable oil (EVO), chitin, HRC^{TM}] are injected into the aquifer to create biobarriers that treat the groundwater as it flows through the induced biologically active zone (BAZ) under natural gradient. Both EISB approaches have specific advantages, limitations, and uncertainties, but both approaches have potential to successfully remediate perchlorate in the Site groundwater. The choice of EISB approach (particularly for full-scale remediation) depends largely on the remedial action objectives, the distribution of perchlorate that requires treatment, and the hydraulics of the area to be treated. These issues have been identified as key uncertainties requiring resolution, and the pre-design data collection activities described in Section 4 will address these data needs to allow for a more accurate assessment of potential full-scale EISB approaches. This will in turn guide selection and design of the most appropriate pilot testing approach. Given the uncertainties described above, this section outlines EISB design concepts for pilot testing of both an active and a passive system. Once the pre-design data are collected and Arkema and GeoSyntec can assess the impacts of the new data on the full-scale EISB system design and cost, the appropriate EISB pilot test approach (active or passive) best suited for the Site will be selected. Arkema will provide the Oregon Department of Environmental Quality (ODEQ) with a letter report summarizing the results of the pre-design data collection activities, and notifying ODEQ of the EISB pilot test approach that will be implemented, along with the associated schedule.

The following subsections provide: a summary of the advantages, limitations and uncertainties of the active and passive EISB approaches (Section 5.1); the objectives of EISB testing for the Site (Section 5.2); details regarding design, installation, operation and performance monitoring of an active EISB pilot test approach (Section 5.3) and a passive EISB pilot test approach (Section 5.4); and a description of the data interpretation and reporting activities that will be conducted following the completion of the active or passive pilot test (Section 5.5).

5.1 Overview of Pilot Test Design Alternatives

As indicated above, several bioremediation approaches exist for perchlorate in groundwater, with the choice being dependent largely on the method by which electron donor is delivered to the subsurface. Electron donor delivery alternatives include: i) addition of soluble electron donors via active recirculation-based systems; or ii) injection of slow-release electron donors to create a passive bioremediation approach. **Figures 9a** and **9b** provide general conceptualizations of active and passive EISB designs. Each of these electron donor delivery approaches has specific benefits and limitations. For example, active recirculation designs allow the amount of electron donor being added to be balanced with the amount of perchlorate (and other electron acceptors such as oxygen, nitrate and chlorate) in the groundwater, which reduces consumption (wastage) of electron donor by undesirable microbial processes. For the Arkema Site, active recirculation of the groundwater will also produce a beneficial impact with regards to equilibrating the concentrations of constituents that may be inhibiting microbial activity and perchlorate reduction. For example, by extracting groundwater in the various target areas, it may be possible to balance chloride concentrations and pH so that these conditions are not inhibitory to ensuing in situ biodegradation in the re-injection zone. The main disadvantage of an active recirculation approach is that it requires ex situ infrastructure for water extraction/recirculation and electron donor delivery, which may impede Site development.

By comparison with active systems, the main advantage of a passive bioremediation approach is that it does not require ex situ infrastructure, and the lifespan of the injected electron donors may be years, requiring infrequent injections. However, the benefit of decreased O&M must be balanced against the increased capitalization cost of the system due to the increased number of injection points required to deliver the electron donors through the target treatment area. Additional limitations of a passive approach include: (i) the potential for inadequate treatment in areas where groundwater conditions are less amenable to microbial growth (i.e., localized areas of high pH or high chloride); and (ii) the potential development of strongly anaerobic and reduced geochemical zones that impact secondary groundwater quality (e.g., aesthetic properties such as elevated concentrations of dissolved metals) due to addition of large volumes of electron donor, however these conditions will likely mitigate prior to discharge to the Willamette River.

5.2 Pilot Test Objectives

The objectives of EISB pilot testing, independent of the specific pilot test approach are to:

1. Evaluate the rate and extent of perchlorate biodegradation that can be achieved under field conditions in the shallow aquifer, through electron donor addition and bioaugmentation with perchlorate-reducing bacteria;

2. Demonstrate the concentration to which perchlorate can be biodegraded in the shallow aquifer for the purposes of assessing technology performance and evaluating suitable remedial goals;

3. Assess the impacts of the EISB process on chlorate and other geochemical parameters in the shallow aquifer; and

4. Generate performance, design and cost data that can be used for evaluation and possible selection of the in situ bioremediation technology for full-scale application at the Site.

In addition to these overall EISB objectives, the following objectives will apply to the active EISB pilot test:

A1. Assess the ability to balance elevated pH and chloride concentrations so as to reduce inhibitory conditions for perchlorate biodegradation;

A2. Evaluate the dosing rate for electron donor required to achieve perchlorate biodegradation; and

A3. Identify design and operational factors that influence the successful performance of the active EISB approach (such as biofouling of electron donor delivery wells) and optimize system operation with respect to these factors.

The following objectives will apply to the passive EISB pilot test:

B1. Assess the achievable radius of influence of the electron donor injections for the slow-release electron donor (a key design and cost parameter);

B2. Assess the ability of the passive EISB approach to function within areas of high pH or high chloride; and

B3. Assess electron donor longevity, to predict frequency of electron donor injections.

The scope of work to address these objectives through pilot testing is described in the following sections.

5.3 Active EISB Pilot Test

Pilot testing of the active EISB approach will employ a closed-loop recirculation system, whereby groundwater is extracted from the shallow aquifer, amended with soluble electron donor (e.g., benzoate, citrate or acetate), and recharged back to the aquifer via a single shallow aquifer recharge well, to promote perchlorate biodegradation in situ. The following sections summarize the key details regarding anticipated pilot test layout, infrastructure, pilot test area (PTA) characterization, operations and maintenance, performance monitoring, and anticipated duration.

Layout: Based on review of the site data, it appears that the MWA-25 area may be a suitable location for the active PTA, based on access, groundwater conditions, and relevance to a potential full-scale active EISB application. Groundwater will be extracted using the pumping well (PT-2) installed as part of the hydraulic testing program. Groundwater recharge will require installation of a new 4-inch PVC injection well (RW-1) located upgradient of the extraction well, and ideally upgradient of well MWA-25, to allow use of MWA-25 for performance monitoring. **Figure 10** (inset) provides a potential layout for the active EISB pilot testing infrastructure. Final well placements/spacings will be determined based on the results of the hydraulic testing program. One additional monitoring well (PMW-1) will also likely be required to assess perchlorate biodegradation performance within the recirculation loop (tentative locations shown in **Figure 10**), however if possible IW-3, IW-4 or IW-5 (shallow wells upgradient of MWA-25) may be used for this purpose.

Infrastructure: The active recirculation system will consist of a number of automated components which will serve to: 1) extract groundwater from the extraction well; 2) record flow rate and volume totals; 3) measure field parameters using in-line electrodes; 4) introduce conservative tracer and/or electron donor to the extracted groundwater; and 5) recharge the amended groundwater to the PTA via the recharge well (RW-1). Groundwater extraction will be accomplished using a dedicated downhole stainless steel pump. The extracted groundwater will be directed through a filter system to remove particulates. The filter system will be followed by an in-line monitoring electrode to measure pH in the extracted groundwater. An in-line flow sensor installed down-stream of the filter will be used to continuously measure the flow rate of extracted groundwater. Output (4 to 20 mA signal) from the flow sensor will be used to: i) provide feedback control to the pump to maintain steady extraction/recirculation rates; and ii) control the delivery rate of tracer and/or electron donor solution to the feed groundwater to maintain a fixed concentration of these components in the amended groundwater. The amended groundwater will then pass through an in-line mixer and will be recharged via a submerged delivery line in the recharge well. Electron donor delivery equipment will include an electron donor storage tank with secondary containment and metering pump. The system will be fitted with manual sampling ports at the extraction well head to allow collection of samples to measure analyte concentrations in the extracted groundwater, and immediately following the mixing column (just prior to recharge) to measure tracer/electron donor concentrations in the feed groundwater.

System operation will be controlled using a programmable logic controller (PLC). The control system will record the groundwater extraction rate and total, individual pH electrode measurements, and water levels in the extraction and recharge wells at suitable intervals. The extraction well will be instrumented with a low-level water sensor/pump-shutoff to limit drawdown and protect the pump. Similarly, the recharge well will be instrumented with a high-level sensor/pump-shutoff to prevent overflow in the event of biofouling or well plugging, and will also be instrumented with a pressure transducer to facilitate real-time evaluation of well fouling. The system will be designed to send notification to the project team in case of shutdown. All powered equipment will be operated on automatic reset to prevent startup problems related to power supply interruptions.

The electron donor delivery components (metering pump, meters, etc) will be housed in a secure, temperature-controlled construction trailer or temporary building, located within a secure fenced enclosure. Arkema will be responsible for securing electrical service for the construction trailer.

To prevent biofouling of the electron donor delivery well, the pilot test system will be instrumented with a pilot-scale chlorine dioxide generator and injection system to allow periodic dosing of the well. Chlorine dioxide is commonly used to disinfect drinking water, and to prevent biofilm formation in ex situ treatments systems, cooling towers and industrial applications. The byproducts of chlorine dioxide disinfection are chloride and oxygen, which are already present in the aquifer; hence no new compounds are being introduced to groundwater. Typically, the chlorine dioxide reacts with organic material to produce chlorite, which is dismutated by perchlorate-reducing bacteria as part of their normal metabolism, to chloride as the final product. No trihalomethanes, haloacetic acids, or similar disinfectant byproducts are produced by the reaction of chlorine dioxide with groundwater constituents. This approach has been successfully used in field demonstrations in California, Nevada and Utah, with approval by the prevailing regulatory authorities.

Baseline Geochemical Characterization: Groundwater samples will be collected for baseline characterization of groundwater chemistry in the PTA, and will include the injection and extraction wells and associated monitoring wells. Baseline analyses will include: field parameters (DO, ORP, pH, specific conductance and temperature), perchlorate, chlorate, anions (bromide, chloride, nitrate, nitrite, phosphate and sulfate), metals (dissolved), biological oxygen demand (BOD) and chemical oxygen demand (COD), and metabolic products (e.g., sulfide, methane). Samples will be collected following standard sampling protocols established for the Site. Analyses will be conducted by STL following published analytical protocols. **Table 2** summarizes the parameters that will be analyzed as part of the baseline characterization, and provides details of analytical methods, container size and type, preservation method, and sample holding times.

Tracer Testing: A conservative tracer test will be conducted prior to electron donor addition to: 1) evaluate groundwater flow patterns in the PTA; 2) confirm groundwater flow velocities and system residence times; and 3) confirm approximate sample times for the performance monitoring wells (i.e., when tracer and/or electron donor-amended groundwater would be expected to reach the performance monitoring wells). A conservative tracer (i.e., bromide) will be added at a time-weighted average (TWA) concentration of about 25 mg/L to the re-injected groundwater for a period of 7 days. During the tracer test, groundwater samples will be collected on a semi-weekly basis from the performance monitoring wells for analysis by IC methods. Breakthrough curves for the tracer will be generated based on the collected data to confirm the groundwater flow velocity and residence times between the delivery well and performance monitoring wells. The data will also be used to calibrate a local PTA numerical flow model to optimize system operating conditions and predict sampling schedules based on travel times.

Operations & Maintenance: Electron donor (selection to be finalized based on availability and cost) will be added using a pulsed-addition mode (one hour pulse per day) to minimize microbial fouling of the delivery well. The estimated TWA electron donor addition concentration to treat the perchlorate will be estimated based on the baseline groundwater chemistry data. Chlorine dioxide dosing will be accomplished through either daily doses (1 hour daily pulses) of low concentrations (1 to 2 mg/L) of chlorine dioxide, or semi-weekly doses of higher concentrations (10 to 20 mg/L). Both approaches have been used with similar success in controlling biofouling. Routine oversight will include inspection of the groundwater circulation system, filling of electron donor supply tanks, periodic dosing of the recharge well with chlorine dioxide for biofouling control, replacement of filters, periodic downloading of automated data collection systems, and groundwater sampling.

Performance Monitoring: Performance monitoring and assessment will be conducted for a period of 12 months. The in-line electrode will measure pH in the extracted groundwater at appropriate intervals (e.g., daily), and these data will be logged to the computer. Groundwater samples will be collected from the various PTA wells on a weekly, bi-weekly or monthly basis (depending on parameter). **Table 3a** summarizes the anticipated sampling for the active pilot test. The frequency of sampling will be determined once the hydraulic program is completed, and may be modified during the pilot test in response to tracer test results and field observations. Sampling will be conducted following standard sampling protocols approved for the site. Details regarding the analytical techniques and sample handling are summarized in **Table 2**.

<u>Bioaugmentation:</u> The pilot test will be initiated with electron donor addition and bioaugmented with the perchlorate-reducing culture that was used in the biotreatability studies to achieve effective perchlorate reduction. This culture has been used to successfully seed fluidized bed bioreactors at a site in Nevada. Bioaugmentation will be conducted by delivering the culture to the PTA via the recharge well through a submerged delivery line. A nitrogen gas blanket in the delivery vessel will be used to prevent/limit oxygen contact with the culture during delivery. The survival and fate of the introduced bacteria will then be tracked using molecular analytical techniques for groundwater samples.

<u>Duration:</u> It is anticipated that the active EISB pilot test would be conducted for a period of 12 months.

5.4 Passive EISB Pilot Test

Pilot testing of the passive EISB approach will involve injection of slow-release electron donors (EVO) into the shallow aquifer to promote perchlorate biodegradation in situ, followed by monitoring using a network of monitoring wells. Given the significant impacts of pH and elevated chloride concentrations on perchlorate biodegradation rates in the Site biotreatability studies, it is recommended that small-scale passive EISB pilot tests be conducted in two areas of the Site: one with elevated pH (near MWA-35); the other in an elevated chloride area (near MWA-47). The following sections summarize the key details regarding anticipated pilot test layout, infrastructure, PTA characterization, operations and maintenance, performance monitoring, and anticipated duration.

<u>Layout:</u> Based on review of the site data, it appears that the MWA-35 area may be a suitable location for the high pH area passive pilot test area (referred to as the high pH PTA) and the MWA-47 area may be a suitable location for the high chloride pilot test area (referred to as the high Cl^- PTA), based on access, groundwater conditions, and relevance to a potential full-scale EISB application. **Figure 11** provides a potential layout for the passive EISB pilot testing infrastructure, which includes an upgradient monitoring well to provide baseline geochemical data, 6 EVO injection wells aligned along the direction of groundwater flow, and two monitoring wells located within the expected EVO distribution zone to evaluate the achievable radius of injection of the EVO and to assess perchlorate biodegradation performance. EVO injection wells will also be used for ongoing evaluation of perchlorate biodegradation performance. Final well placements/spacings will be determined based on the results of the hydraulic testing program.

Infrastructure: The only permanent infrastructure required for the passive pilot tests are the injection and monitoring wells. Temporary equipment will be used for injection of the EVO. The injection equipment will consist of a manifold containing one or more proportional feed pumps (for dosing EVO to the injection feed at a constant rate), flow meters for tracking amendment rates, a pump for injecting the amendment feed into the wells, pressure gauges for monitoring system pressure, hose, and valves for flow control. The hose coming from the injection manifold will be attached to each well using a specialized pressure wellhead fitting that will allow for pressurized injections, if necessary. Multiple wells may be injected into at the same time using this equipment, allowing for efficient dosing of the wells and minimizing professional oversight labor. Tracer may be amended to the amendment feed line using the same manifold. The injection equipment may be rented from the EVO supplier, or may be manufactured by GeoSyntec staff, depending upon which option is more cost effective.

Baseline Geochemical Characterization: Groundwater samples will be collected for baseline characterization of groundwater chemistry in the PTA, and will include the EVO injection wells and associated monitoring wells. Baseline analyses will include: field parameters (DO, ORP, pH, specific conductance and temperature), perchlorate, chlorate, anions (bromide, chloride, nitrate, nitrite, phosphate and sulfate), metals (dissolved), BOD and COD and metabolic products (e.g., sulfide, methane). Samples will be collected following standard sampling protocols established for the Site. Analyses will be conducted by STL following published analytical protocols. **Table 2** summarizes the parameters that will be analyzed as part of the baseline characterization, and provides details of analytical methods, container size and type, preservation method, and sample holding times.

Tracer Testing: A conservative tracer test will be conducted during electron donor addition to confirm delivery of the injected fluid to the targeted ROI. Some delay between the breakthrough of tracer and the breakthrough of EVO is common, given that EVO tends to sorb to soil surfaces and thus be retarded. Understanding the degree of retardation allows for a better understanding on the required EVO volumes for injection to distribute EVO within a targeted ROI. A conservative tracer (i.e., bromide) will be added at a time-weighted average (TWA) concentration of about 25 mg/L to the EVO amendment feed during the entire duration of EVO injection. Groundwater samples will be collected hourly from surrounding monitoring wells for analysis by IC.

A second conservative tracer test will be conducted upon completion of the EVO injection to: i) evaluate groundwater flow patterns in both PTAs; ii) confirm groundwater flow velocities and system residence times; and iii) confirm approximate sample times for the performance monitoring wells (i.e., when tracer and/or electron donor-amended groundwater would be expected to reach the performance monitoring wells). A total of 2,400 gallons of 200 mg/L bromide solution will be injected into the upgradient monitoring well over a period of 4 to 6 hours to distribute the tracer in an approximate 6 ft radius around the injection well. During the second tracer test, groundwater samples will be collected on a regular basis (e.g., weekly) from the performance monitoring wells for analysis by IC. Tracer breakthrough curves will be generated based on the collected data to confirm the groundwater flow velocity and residence times between the delivery point and performance monitoring wells. The data will also be used to calibrate a local PTA numerical flow model to optimize system operating conditions and predict sampling schedules based on travel times.

Operations & Maintenance: EVO injections will occur one time only, at the initiation of the pilot testing. During injection of the EVO, COD (directly related to EVO concentration in the groundwater) and field parameters will be monitored along with tracer breakthrough to evaluate the achievable ROI. Breakthrough of the EVO may be visually confirmed by a milky color to the groundwater, indicating higher concentrations of EVO at the monitoring point. The EVO injection rate and volume amended to each injection well will be finalized based on the results of baseline geochemical characterization and hydraulic testing of the PTA groundwater. Routine oversight includes groundwater sampling only.

<u>Performance Monitoring:</u> Performance monitoring and assessment will be conducted for a period of 12 months. **Table 3b** summarizes the anticipated sampling for the passive pilot test. The frequency of sampling will be determined once the hydraulic program is completed, and may be modified during the pilot test in response to tracer test results field observations. Sampling will be conducted following standard sampling protocols approved for the Site. Details regarding the analytical techniques and sample handling are summarized in **Table 2**.

<u>Bioaugmentation:</u> The pilot test will be initiated with electron donor addition and bioaugmented (via the EVO injection points) with the perchlorate-reducing culture that was used in the biotreatability studies. This culture has been used to successfully seed fluidized bed bioreactors at a site in Nevada. Bioaugmentation will be conducted by delivering the culture to the PTA via the injection wells through a submerged delivery line. A nitrogen gas blanket in the delivery vessel will be used to prevent/limit oxygen contact with the inoculum during delivery. The survival and fate of the introduced bacteria will then be tracked using molecular analytical techniques for groundwater samples.

<u>Duration:</u> It is anticipated that the passive EISB pilot test would be conducted for a period of 12 months.

5.5 Data Interpretation and Reporting

The data obtained from the EISB pilot test (either active or passive) will be tabulated, reviewed and interpreted to estimate the rate and extent of degradation of perchlorate. To the extent possible, factors affecting bioremediation performance will be identified and optimized through the pilot test. GeoSyntec will prepare a Pilot Test Report containing detailed study methods, all data generated during the study, our assessment of the data, conclusions, and recommendations. This information will then be used by the project team for evaluation and possible selection of a full-scale in situ bioremediation approach for the Site.

To maintain project schedules, GeoSyntec will provide Arkema with monthly project status updates detailing project progress and status, and notifying Arkema of known or anticipated changes in project scope, schedule or costs. It is anticipated that Arkema will periodically update the agencies as to study progress.

6. SCHEDULE

Following approval of this workplan, pre-design investigation activities will be conducted to address key uncertainties that need to be resolved before completing the pilot test design. Once the pre-design data are collected and Arkema and GeoSyntec can assess the impacts of the new data on the full-scale EISB system design and cost, the appropriate EISB pilot test approach (active or passive) best suited for the Site will be selected. These activities are expected to take approximately 3 months. Arkema will provide ODEQ with a letter report summarizing the results of the pre-design data collection activities, and notifying ODEQ of the EISB pilot test approach that will be implemented. Based on a current understanding of the availability of subcontractors, the above activities and letter report are anticipated to be submitted by the end of June 2006.

The design, implementation and start-up of a passive pilot test is expected to take approximately 3 months from the time of selection of the pilot test approach. The implementation of an active pilot test will require approximately 2 months for design and an additional month for construction, based on a system that would have low automation and would be manually controlled by a systems operator. As discussed in previous sections, the pilot test will run for a maximum of 12 months. A final Pilot Test Report will be submitted at the end of October 2007, within 1 month following completion of the test. The Report will discuss the results and conclusions of the pilot test as well as future activities to be conducted for full scale implementation.

7. REFERENCES

ERM, 2005. Remedial Investigation Report, Arkema Facility, Portland, Oregon.

Exponent 1999. *Elf Atochem Acid Plant Area Remedial Investigation Interim Data Report.* Exponent, Lake Oswego, Oregon. June 1999.

TABLE 1
BASELINE GROUNDWATER GEOCHEMISTRY
Arkema Facility, Portland, Oregon

Analyte (mg/L)	Source Area (MWA-25)	Downgradient (MWA-32i)
Perchlorate	285	215
Chlorate	7,545	4,050
Chloride	2,571	27,028
Nitrite as nitrogen	< 2	< 10
Nitrate	< 2	< 10
Sulfate	206	237
Bromide	< 14	< 70
Phosphate	< 5	< 25
pH	9.68	6.97

Notes:
mg/L - milligrams per liter
Data collected by ERM in July 2003

TABLE 2
ANALYTICAL DETAILS
Arkema Facility, Portland, Oregon

Parameter	Analytical Method	Method Number	Quantitation Limit	Sample Container	Preservative	Holding Time
Field Parameters (pH, DO, ORP, specific conductance, temperature)	Ion Specific Electrode	Field	Varies	NA	NA	NA
Perchlorate, chlorate	Ion Chromatography	EPA 314	4 μg/L	120 mL plastic	cool to 4°C	28 days
Anions (bromide, chloride nitrate, nitrite, sulfate, phosphate)	Ion Chromatography	EPA 300	0.03 to 0.05 mg/L	120 mL plastic	cool to 4°C	2 to 28 days
Metals (dissolved)	Ion Chromatography, field filter for dissolved	SW-846, 6010	varies	500 mL plastic	nitric acid to pH<2, cool to 4°C	28 days
Methane	Gas Chromatography/ Flame Ionizing Detector	RSK-175 or EPA 8015B	10 μg/L	2 x 40 mL VOA	cool to 4°C	14 days
Sulfide	Titrimetry, Potentiometry	NB 3653:139	0.3 mg/L	500 mL plastic	zinc acetate, sodium hydroxide to pH>9, cool to 4°C	7 days
Biochemical Oxygen Demand	Oxygen Electrode	EPA 405.1 or SM5210	1.0 mg/L	2 x 1L amber glass	cool to 4°C	2 days
Chemical Oxygen Demand	Titrimetry	EPA 410.1-.2	3.0 mg/L	250 mL plastic	sulfuric acid to pH<2, cool to 4°C	28 days
Perchlorate-reducing bacteria	PCR Assay	NA	NA	2 x 1L plastic	cool to 4°C	30 days

Notes:
NA - Not Applicable

TABLE 3a
ANTICIPATED SAMPLING FREQUENCY - ACTIVE EISB PILOT TEST
Arkema Facility, Portland, Oregon

Parameter	**Sampling Frequency**				
	Baseline	**Semi-Weekly**	**Bi-Weekly**	**Monthly**	**Quarterly**
Baseline Characterization					
Water Levels	PTA-1 & 2[1]	--	--	--	--
Field Parameters[2]	PTA-1 & 2	--	--	--	--
Perchlorate, Chlorate	PTA-1 & 2	--	--	--	--
Anions[3]	PTA-1 & 2	--	--	--	--
Dissolved Metals	PTA-1 & 2	--	--	--	--
Methane	PTA-1 & 2	--	--	--	--
Sulfide	PTA-1 & 2	--	--	--	--
BOD, COD	PTA-1 & 2	--	--	--	--
Perchlorate-reducers (PCR assay)	EW-1/RW-1	--	--	--	--
Tracer Testing (8 Weeks)*					
Water Levels	--	PTA-1 Wells	PTA-2 Wells	--	--
Bromide	--	PTA-1 Wells	PTA-2 Wells	--	--
Performance Monitoring (12 Months)*					
Water Levels	--	--	PTA-1 Wells	--	PTA-2 Wells
Field Parameters[2]	--	--	PTA-1 Wells	--	PTA-2 Wells
Perchlorate, Chlorate	--	--	PTA-1 Wells	--	PTA-2 Wells
Anions[3]	--	--	PTA-1 Wells	--	PTA-2 Wells
Electron Donor (to be determined)	--	--	PTA-1 Wells	--	--
Dissolved Metals	--	--	--	PTA-1 Wells	--
Methane	--	--	--	--	PTA-1 Wells
Sulfide	--	--	--	--	PTA-1 Wells
Perchlorate-reducers (PCR assay)	--	--	--	--	PTA-1 Wells

Notes:

BOD - Biochemical Oxygen Demand

COD - Chemical Oxygen Demand

PTA - Pilot Test Area

1 - PTA-1 Wells = PT-2, RW-1, PMW-1 (or IW-3, IW-4, IW-5) , MWA-25

- PTA-2 Wells = MWA-35, MWA-36, MWA-37, MWA-48i, MWA-28d

2 - Field Parameters = pH, dissolved oxygen, oxidation-reduction potential, specific conductance, temperature

3 - Anions = bromide, chloride, nitrate, nitrite, sulfate, phosphate

* Sampling frequency may increase/decrease during the pilot test depending upon concentration trends and baseline results

TABLE 3b
ANTICIPATED SAMPLING FREQUENCY - PASSIVE EISB PILOT TEST
Arkema Facility, Portland, Oregon

Parameter	Sampling Frequency			
	Baseline	**Weekly**	**Monthly**	**Quarterly**
Baseline Characterization				
Water Levels	PTA-1 & 2[1]	--	--	--
Field Parameters[2]	PTA-1 & 2	--	--	--
Perchlorate, Chlorate	PTA-1 & 2	--	--	--
Anions[3]	PTA-1 & 2	--	--	--
Dissolved Metals	PTA-1 & 2	--	--	--
Methane	PTA-1 & 2	--	--	--
Sulfide	PTA-1 & 2	--	--	--
BOD, COD	PTA-1 & 2	--	--	--
Perchlorate-reducers (PCR assay)	MWA-35; MWA-30	--	--	--
Tracer Testing (12 Weeks)*				
Water Levels	--	PTA-1 & 2	--	--
Bromide	--	PTA-1 & 2	--	--
Performance Monitoring (12 Months)*				
Water Levels	--	--	PTA-1 & 2	--
Field Parameters[2]	--	--	PTA-1 & 2	--
Perchlorate, Chlorate	--	--	PTA-1 & 2	--
Anions[3]	--	--	PTA-1 & 2	--
Electron Donor (to be determined)	--	--	PTA-1 & 2	--
Dissolved Metals	--	--	--	PTA 1 & 2
Methane	--	--	--	PTA 1 & 2
Sulfide	--	--	--	PTA 1 & 2
Perchlorate-reducers (PCR assay)	--	--	--	PTA 1 & 2

Notes:

BOD - Biochemical Oxygen Demand

COD - Chemical Oxygen Demand

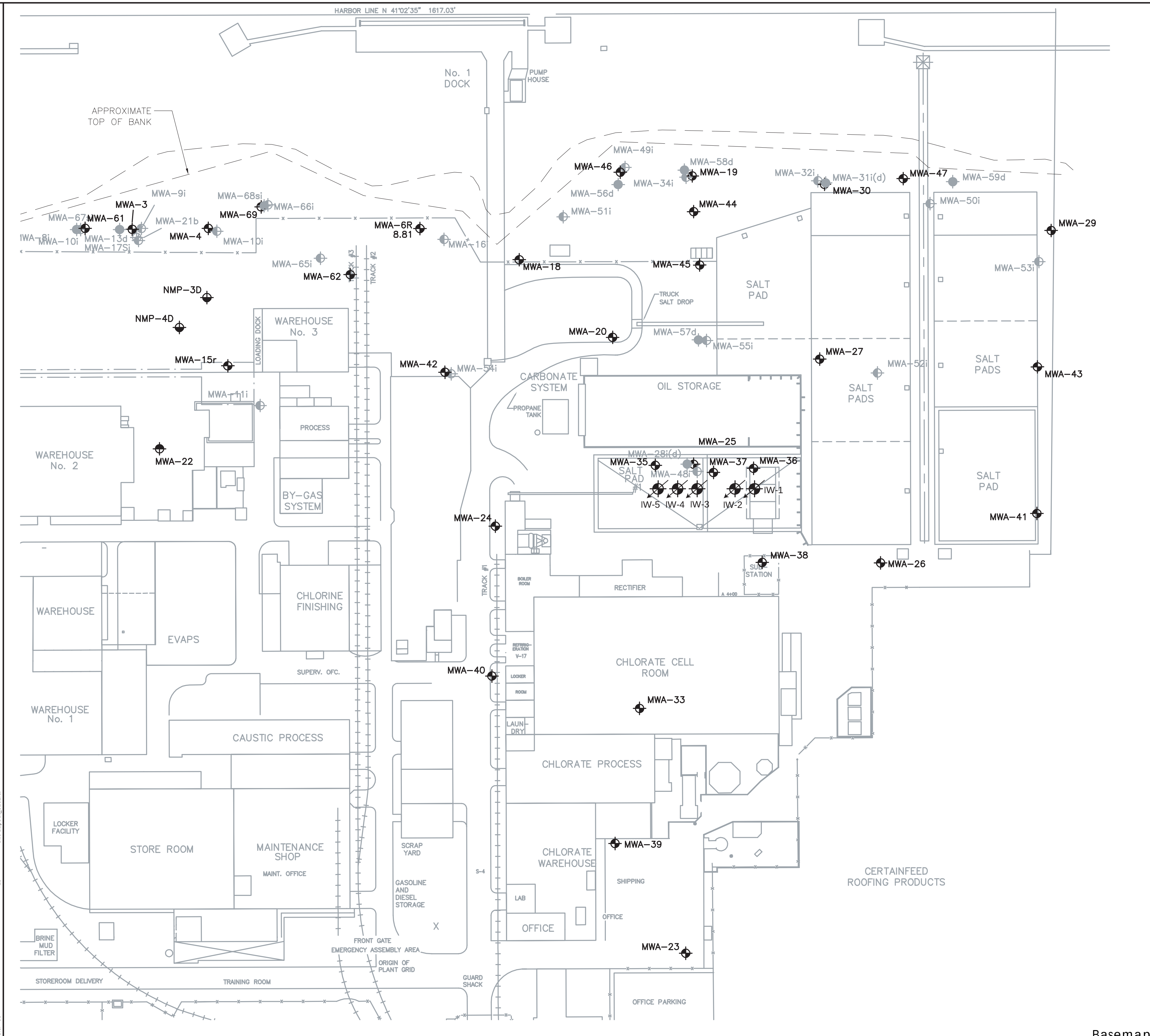
PTA - Pilot Test Area

1 - PTA-1 Wells = MWA35, PMW-1, PMW-2
  - PTA-2 Wells = MWA-30, PMW-3, PMW-4

2 - Field Parameters = pH, dissolved oxygen, oxidation-reduction potential, specific conductance, temperature

3 - Anions = bromide, chloride, nitrate, nitrite, sulfate, phosphate

* Sampling frequency may increase/decrease during the pilot test depending upon concentration trends and baseline results



LEGEND

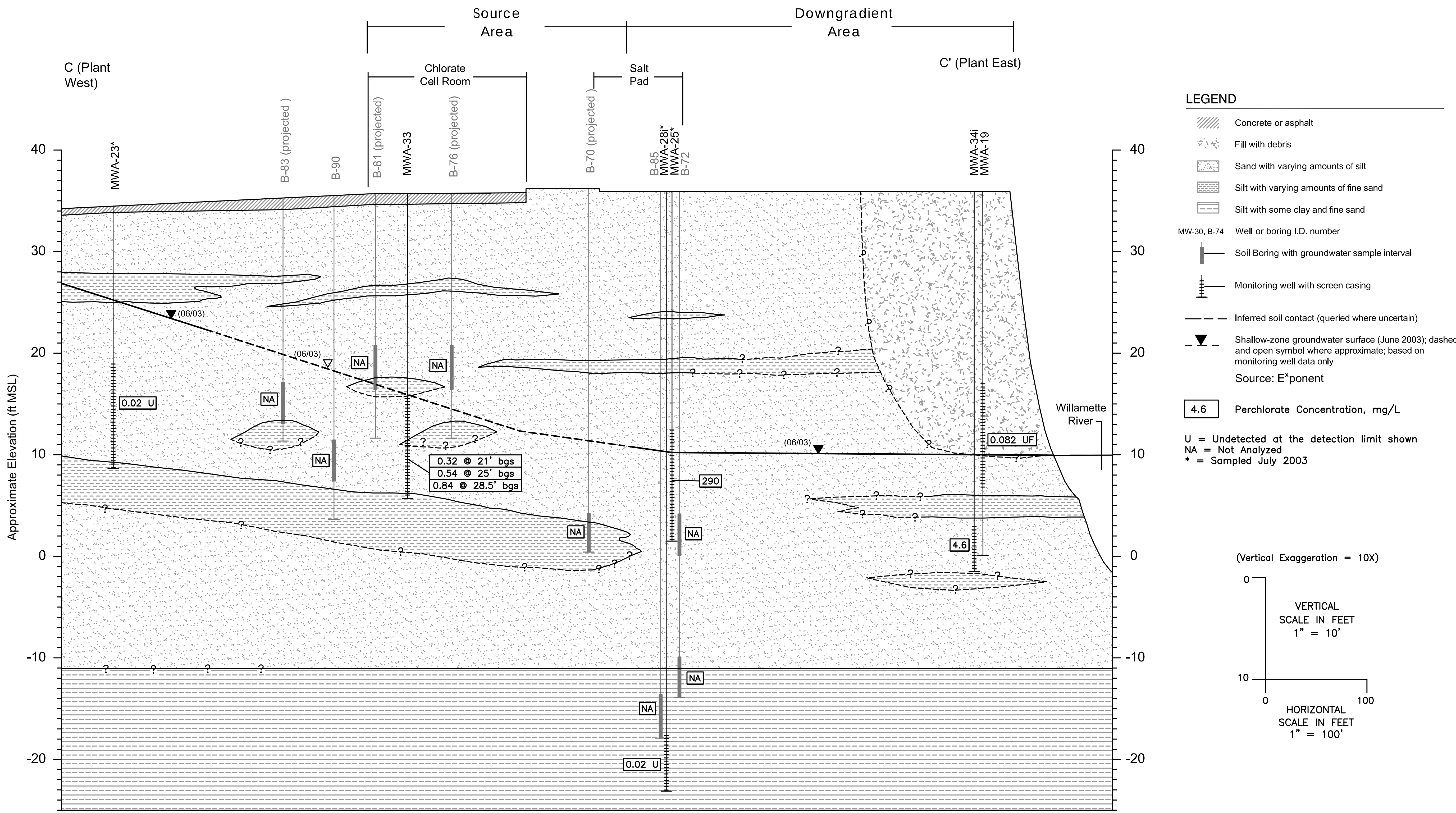
- Monitoring well, shallow zone
- Monitoring well, intermediate zone
- Monitoring well, deep zone
- Injection well
- Willamette River bank

Note:
A number of buildings and structures noted on this diagram have been demolished and/or removed.

Basemap provided by ERM

Site Map
Arkema Facility, Portland, Oregon

March 2006	Figure: **1**	GeoSyntec Consultants

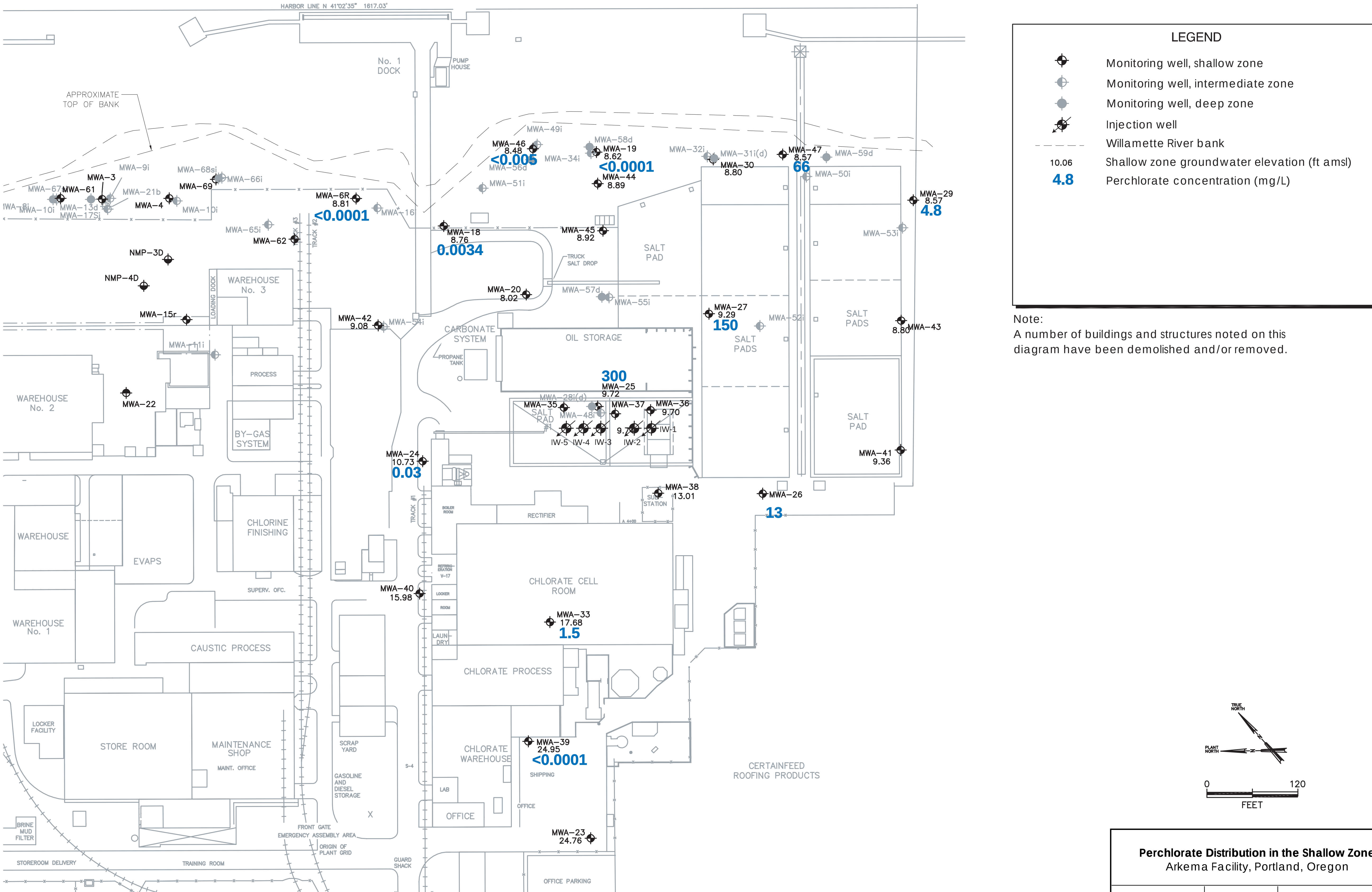


Drawing provided by ERM

Hydrostratigraphic Cross Section
Arkema Facility, Portland, Oregon

March 2006 | Figure: **2** | GEOSYNTEC CONSULTANTS

TR0162 Cross Section.ai

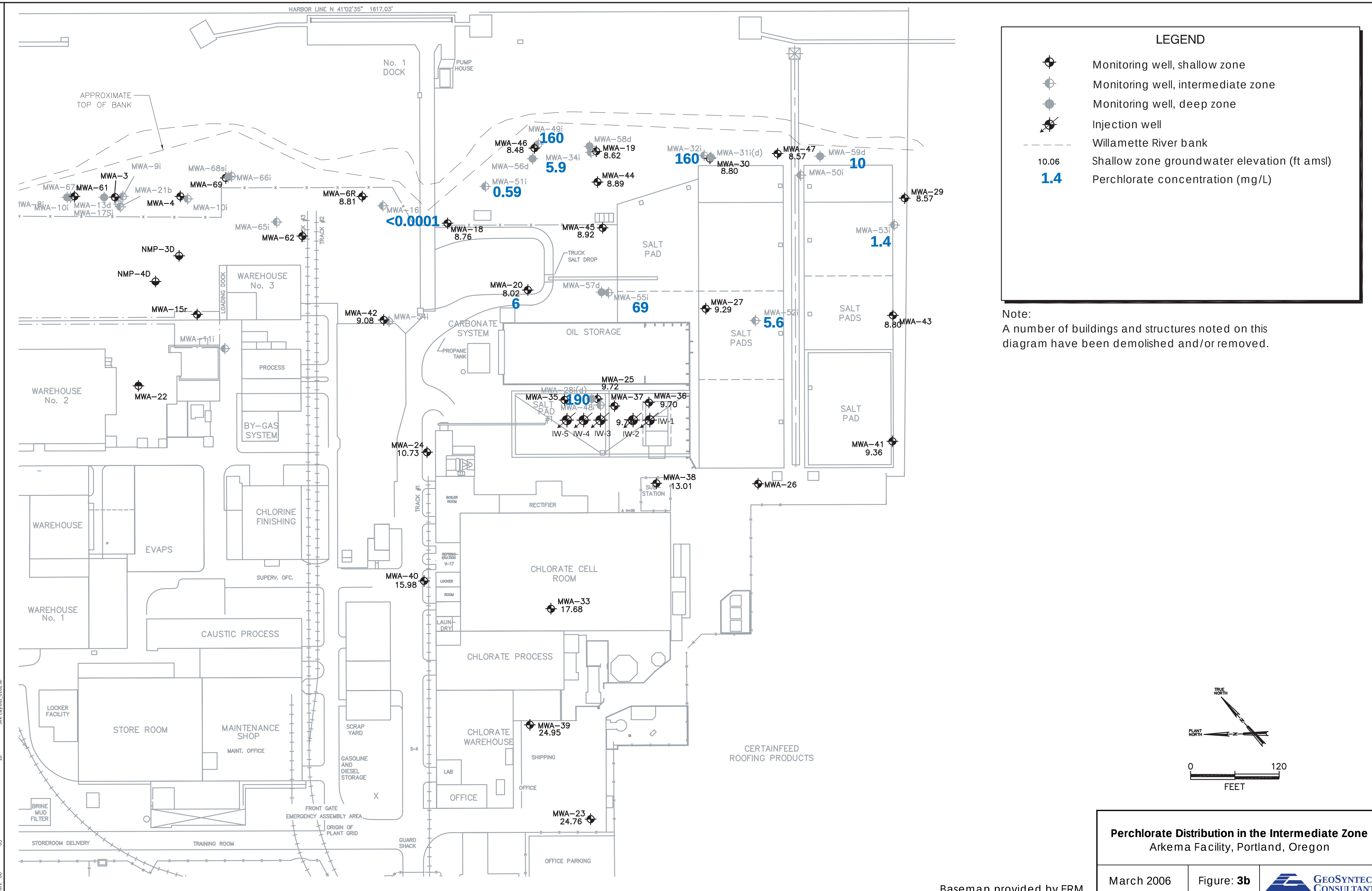


Note:
A number of buildings and structures noted on this diagram have been demolished and/or removed.

Basemap provided by ERM

Perchlorate Distribution in the Shallow Zone
Arkema Facility, Portland, Oregon

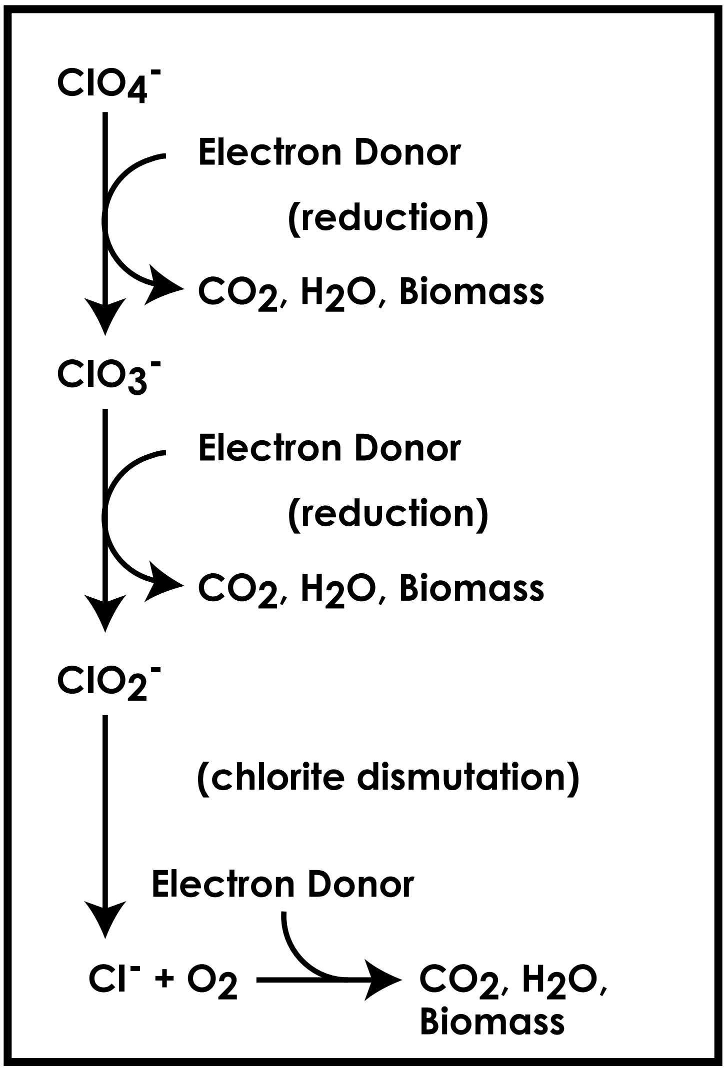
March 2006 | Figure: **3a** | GeoSyntec Consultants



Perchlorate Distribution in the Intermediate Zone
Arkema Facility, Portland, Oregon

Basemap provided by ERM

March 2006	Figure: **3b**	GeoSyntec Consultants

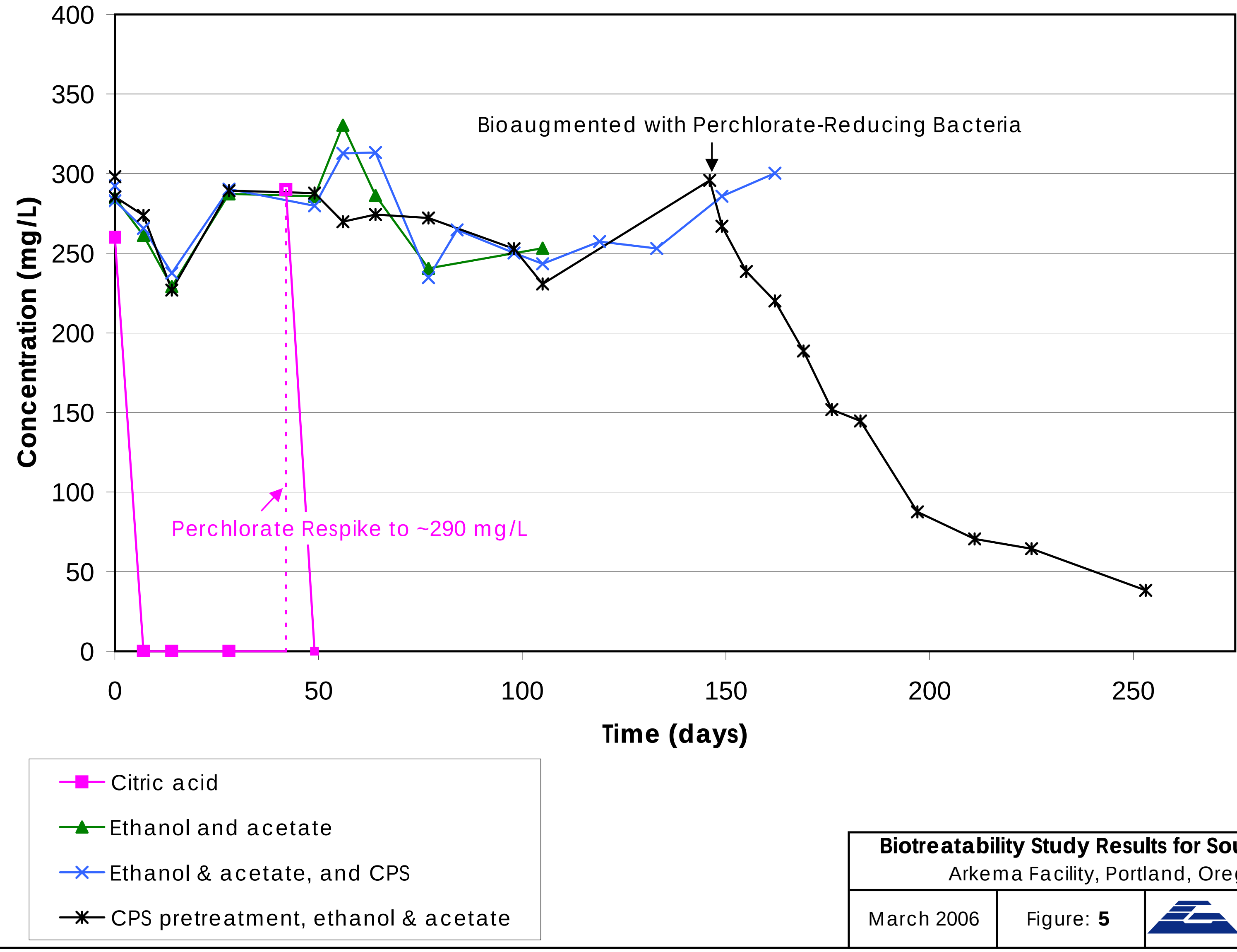


Pathway for the Biodegradation of Perchlorate

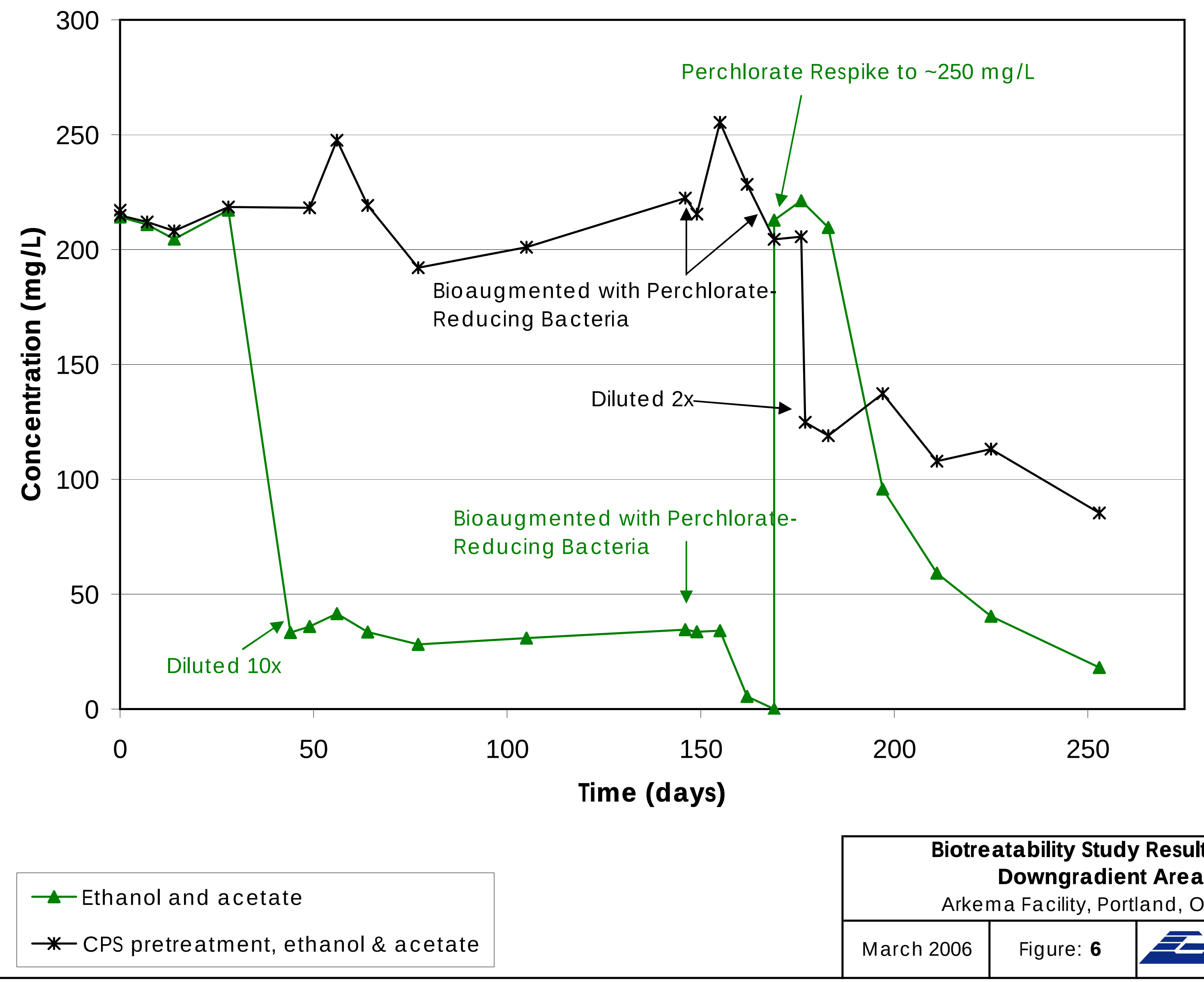
Arkema Facility, Portland, Oregon

March 2006	Figure: **4**	GeoSyntec Consultants

Reduction Pathway_Perchlorate.ai



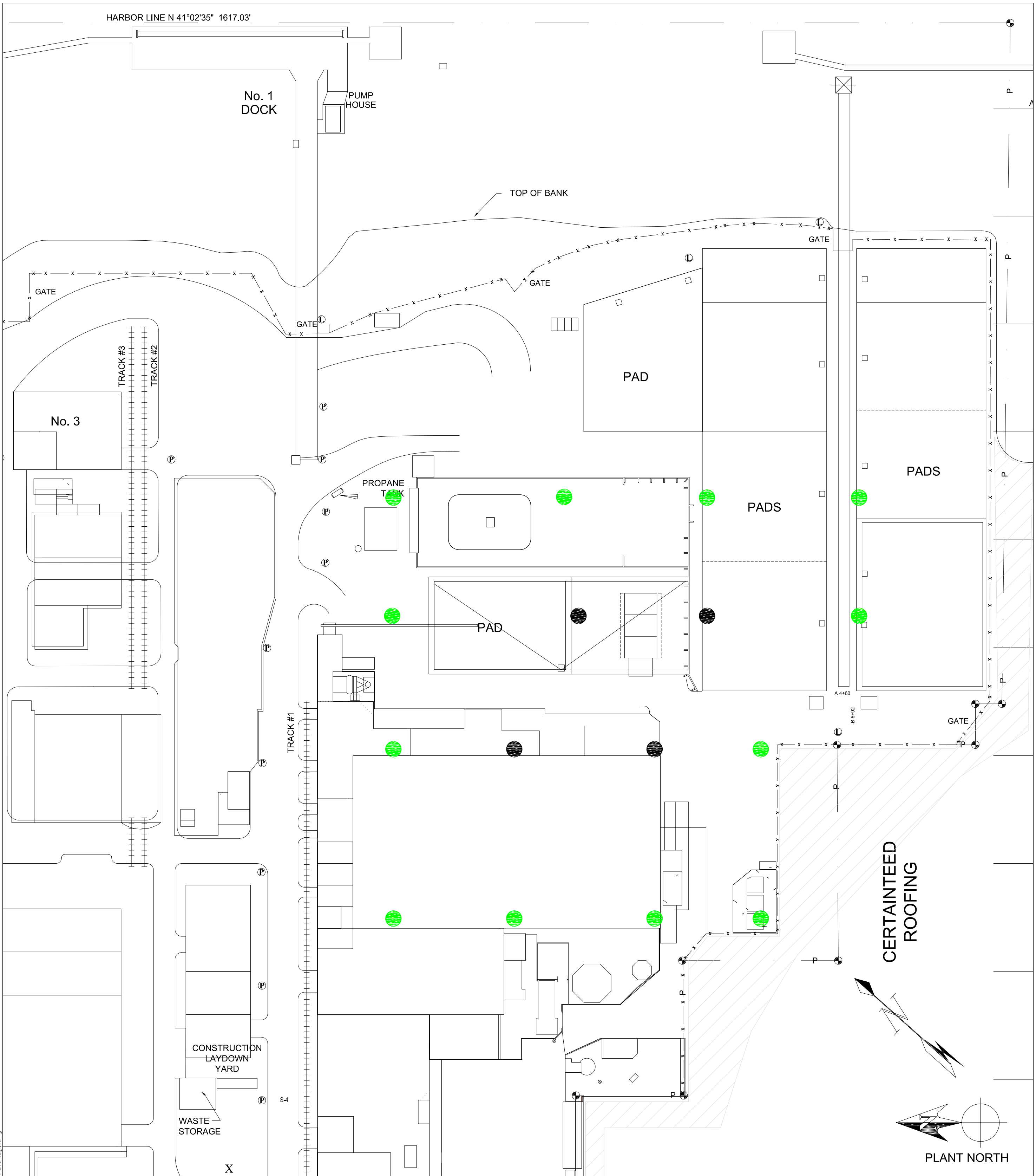
Biotreatability Study Results for Source Area		
Arkema Facility, Portland, Oregon		
March 2006	Figure: **5**	GeoSyntec Consultants



Biotreatability Study Results from Downgradient Area

Arkema Facility, Portland, Oregon

March 2006	Figure: **6**	GEOSYNTEC CONSULTANTS



LEGEND

LEGAL BOUNDARY, EASEMENT

RAILROAD

FENCE

LIGHT POLE, POWER POLE

PHASE 1 BOREHOLE LOCATION

POTENTIAL PHASE 2 BOREHOLE LOCATION

SOURCE: ARKEMA INC. 2005

0 100 200

Scale (ft)

Vadose Zone Sampling Locations

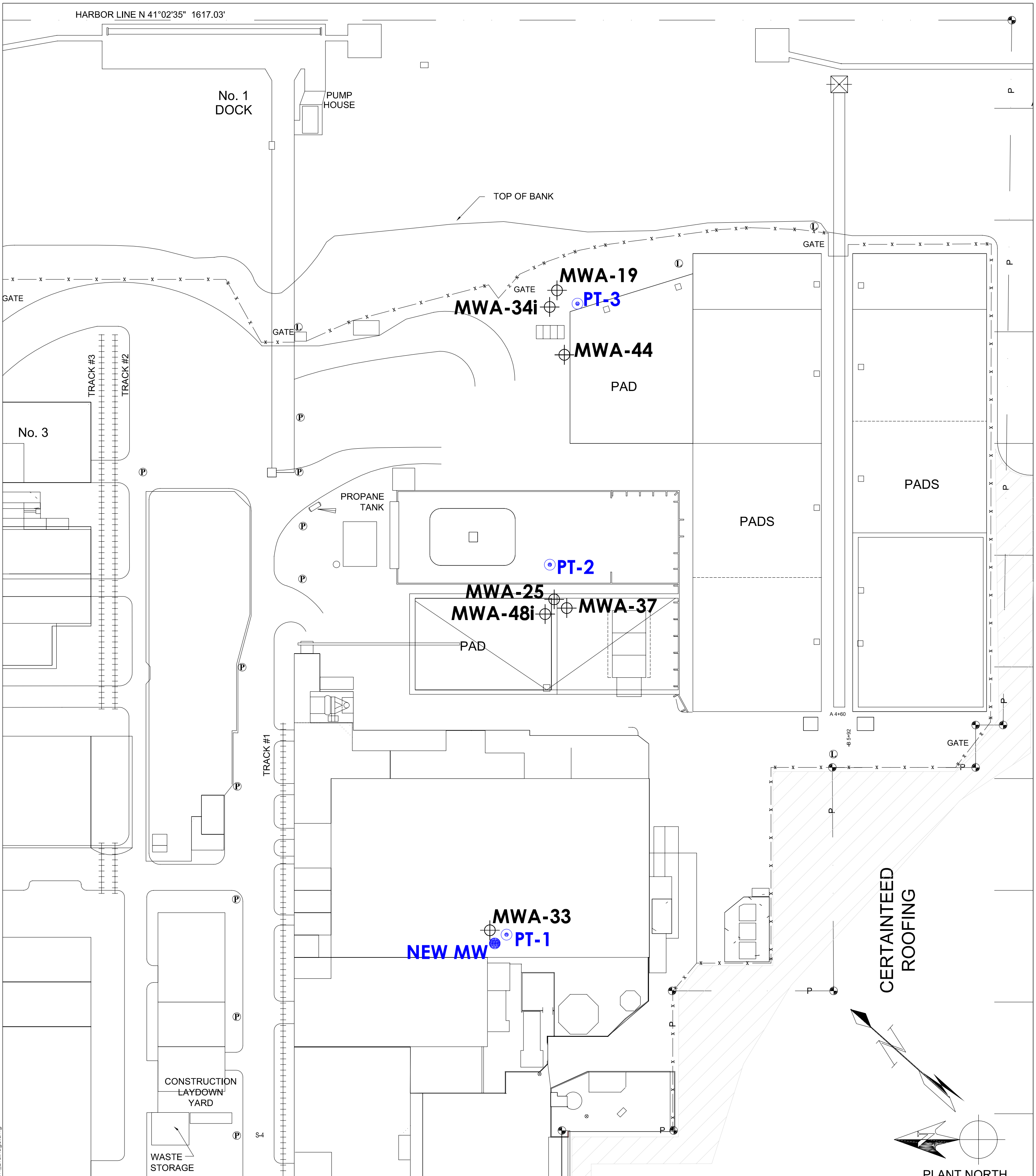
Arkema Facility, Portland, Oregon

March 2006

Figure: **7**

GEOSYNTEC CONSULTANTS

P:\Graphics\GeoSyntec PROJECTS\TR0162_ATOFINA\AutoCAD\Arkema_SW_Drainage.dwg



LEGEND

LEGAL BOUNDARY, EASEMENT
RAILROAD
FENCE
LIGHT POLE, POWER POLE
PROPOSED NEW PUMP TEST EXTRACTION WELL IN SHALLOW DEPTHS
EXISTING MONITORING WELL
PROPOSED NEW INTERMEDIATE DEPTH MONITORING WELL

SOURCE: ARKEMA INC. 2005

0 100 200
Scale (ft)

Proposed Locations for Hydraulic Testing

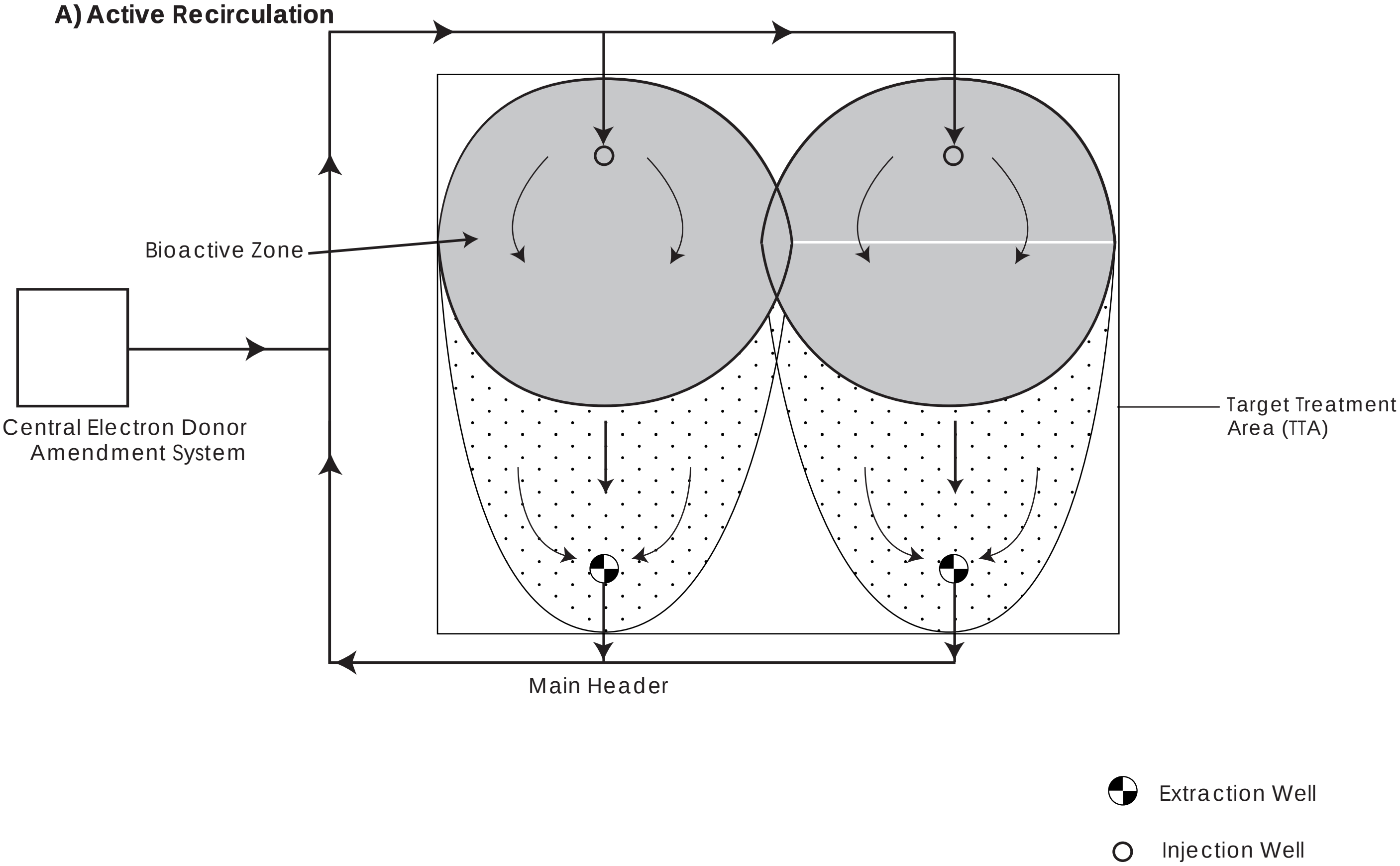
Arkema Facility, Portland, Oregon

March 2006 | Figure: **8**

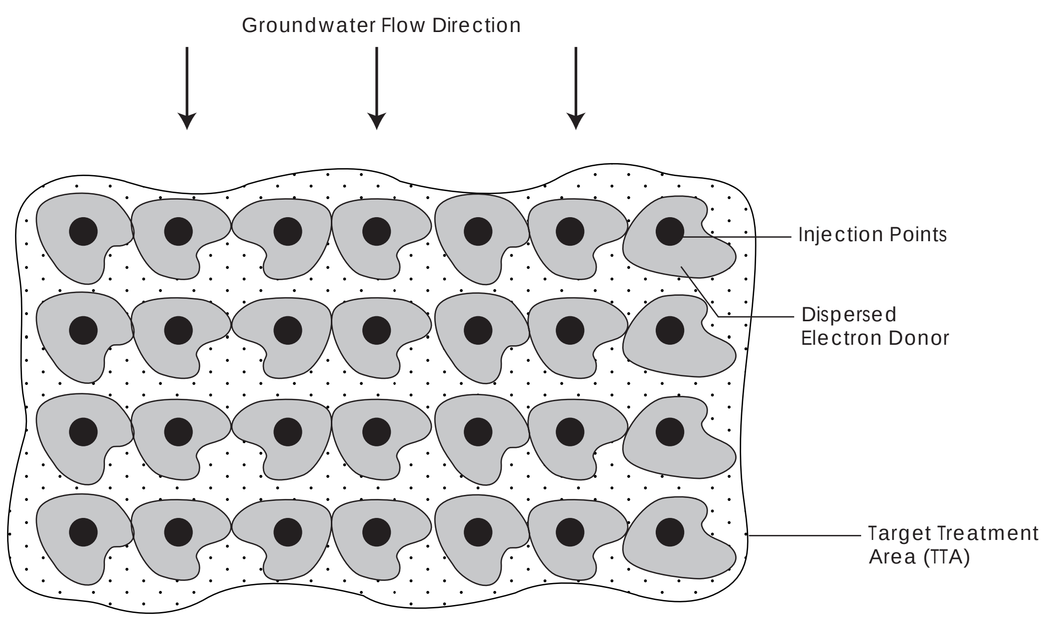
GEOSYNTEC CONSULTANTS

P:\Graphics\GeoSyntec PROJECTS\TR0162_ATOFINA\AutoCAD\Arkema_SW_Drainage.dwg

A) Active Recirculation



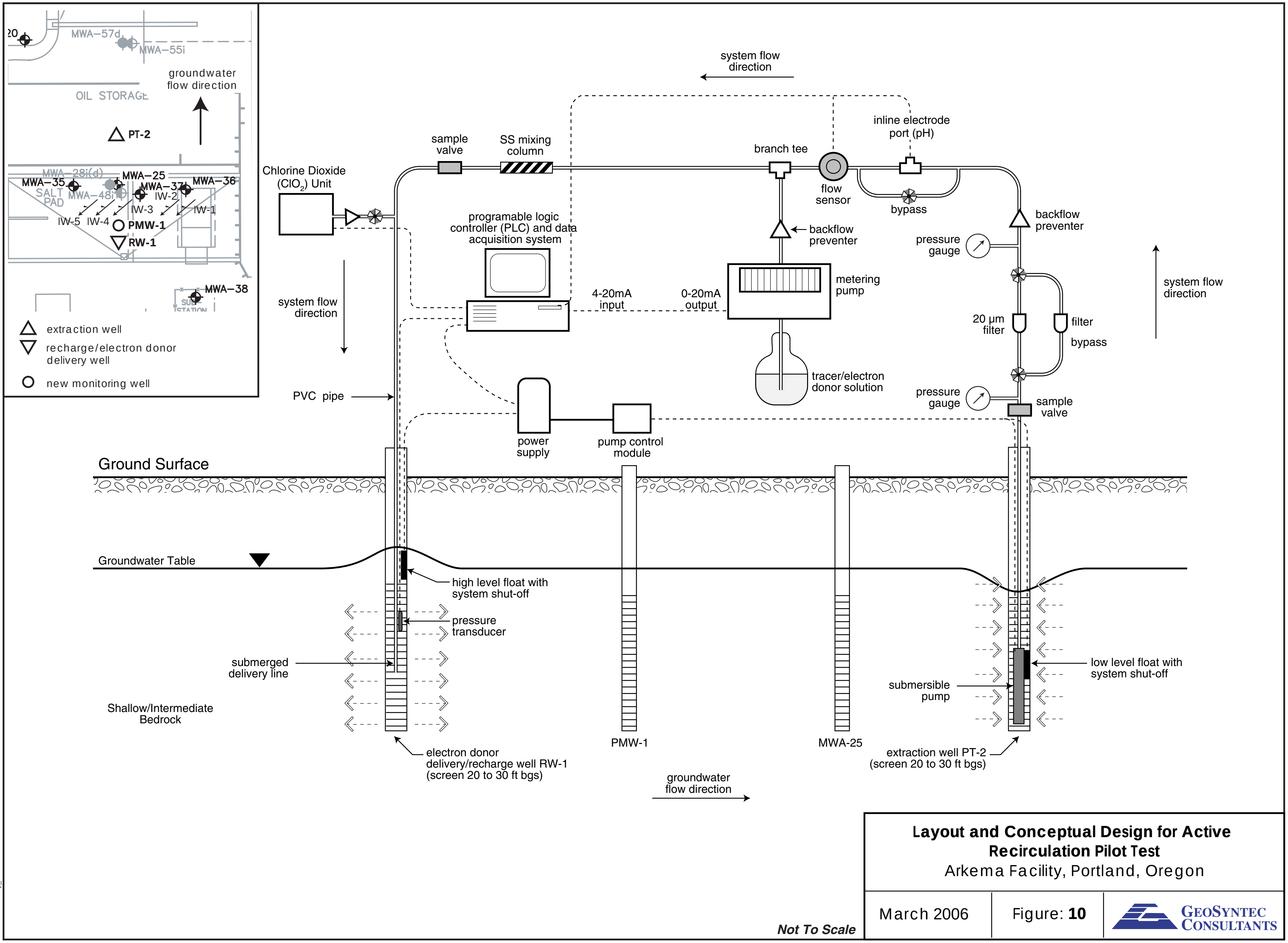
B) Passive Bioremediation using Slow Release Electron Donors



Conceptualization of In Situ Bioremediation Approaches for Perchlorate in Groundwater
Arkema Facility, Portland, Oregon

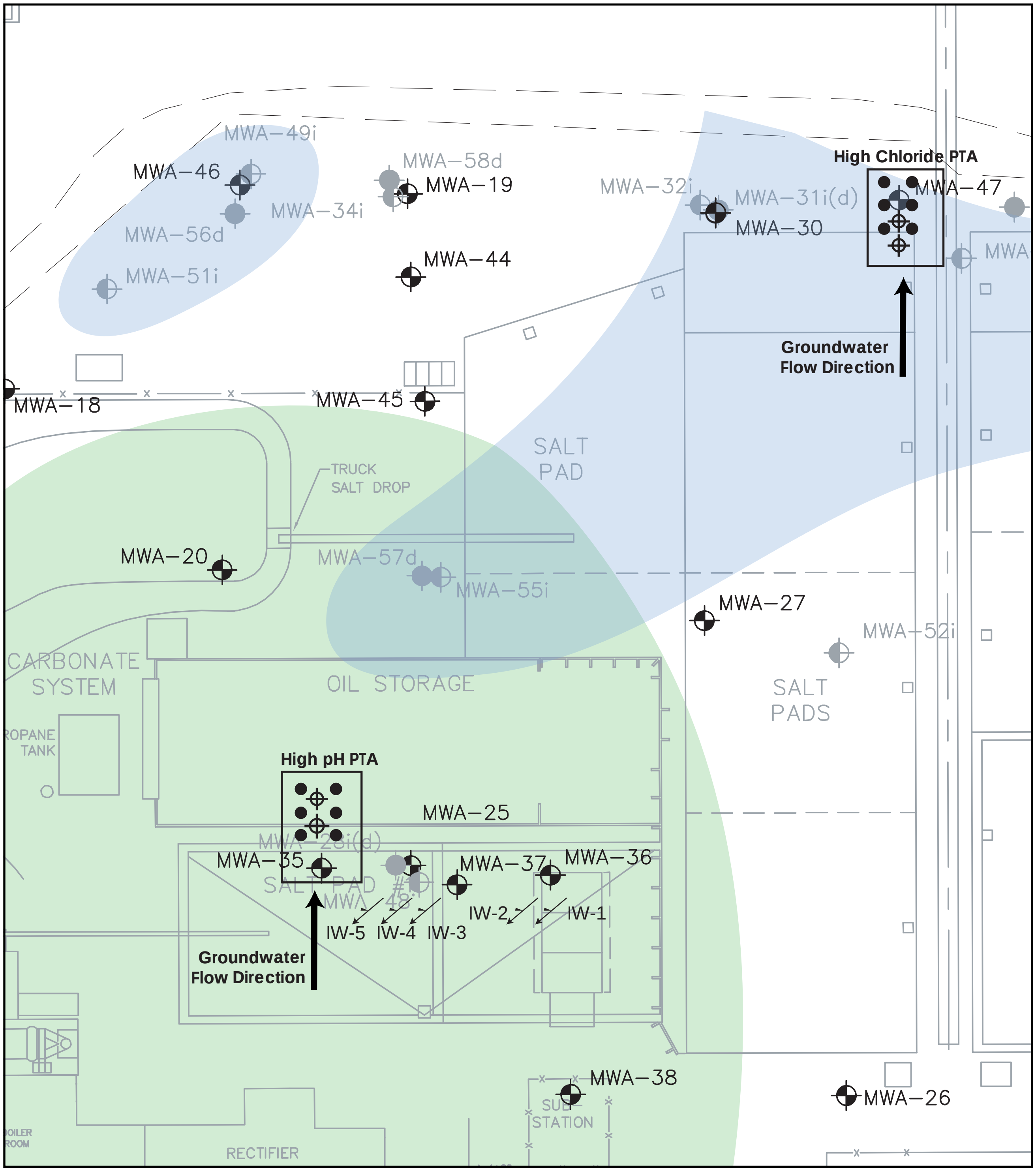
March 2006	Figure: **9**	GEOSYNTEC CONSULTANTS

conceptualization schematics.ai



Layout and Conceptual Design for Active Recirculation Pilot Test
Arkema Facility, Portland, Oregon

March 2006 | Figure: **10** | GeoSyntec Consultants



Basemap provided by ERM

LEGEND

- Monitoring well, shallow zone
- Monitoring well, Intermediate zone
- Monitoring well, deep zone
- Injection well
- Willamette river bank
- Chloride > 10,000 mg/L
- pH > 9
- New monitoring well
- EVO injection well

TRUE NORTH

PLANT NORTH

0 120

FEET

Note:
A number of buildings and structures noted on this diagram have been demolished and/or removed.

Design of Passive Bioremediation Pilot Tests
Arkema Facility, Portland, Oregon

March 2006	Figure: **11**	GeoSyntec Consultants

EVO injection_ZOOM.ai 00 07 09 10

APPENDIX A

COMPARATIVE PERCHLORATE ANALYSIS FROM SELECTED BIOTREATABILITY STUDY SAMPLES

APPENDIX A
COMPARATIVE PERCHLORATE ANALYSIS FROM SELECTED BIOTREATABILITY STUDY SAMPLES
Arkema Facility, Portland, Oregon

Sample Number	Perchlorate by IC[1] (mg/L)	Perchlorate by SW 846 8321A[2] (mg/L)	RPD (%)
TR0162-7	298	320	7%
TR0162-15	0.06 U	0.0019	--
TR0162-19	0.06 U	0.013	--
TR0162-25	80	83	4%

Notes:
[1] - analyses by SiREM Laboratory (Guelph, ON, Canada)
[2] - analyses by Severn-Trent Laboratories (Arvada, CO)
U - not detected; associated value is quantitation limit
RPD - relative percent difference
IC - ion chromatography
mg/L - milligrams per liter
-- - RPD not calculated; one result is non-detect

APPENDIX B

ANALYTICAL DATA FROM BIOTREATABILITY STUDY

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04	Sterile control	1	5.4	2585	<0.02	<0.02	202	<0.14	<0.05	7257	291	--	--	7
13-Jan-04	Sterile control	2	2.3	2468	<0.02	0.60	197	<0.14	<0.05	7254	288	--	--	--
13-Jan-04	Sterile control	3	3.1	2600	<0.02	<0.02	185	<0.14	<0.05	7261	285	--	--	--
13-Jan-04	average		3.6	2551	<0.02	0.20	195	<0.14	<0.05	7257	288			
20-Jan-04	Sterile control	1	2.1	2526	<0.02	0.81	211	<0.14	<0.05	7277	275	--	--	--
20-Jan-04	Sterile control	2	1.7	2288	<0.02	<0.02	210	<0.14	<0.05	6837	281	--	--	7
20-Jan-04	Sterile control	3	3.0	2180	<0.02	<0.02	173	<0.14	<0.05	6073	280	--	--	--
20-Jan-04	average		2.3	2331	<0.02	0.27	198	<0.14	<0.05	6729	279			
27-Jan-04	Sterile control	1	14	2362	<0.02	0.81	182	<0.14	<0.05	6611	246	--	--	7
27-Jan-04	Sterile control	2	3.0	2260	<0.02	<0.02	195	<0.14	<0.05	6783	260	--	--	--
27-Jan-04	Sterile control	3	3.6	2171	<0.02	<0.02	185	<0.14	<0.05	6203	225	--	--	--
27-Jan-04	average		6.8	2264	<0.02	0.27	187	<0.14	<0.05	6532	244			
10-Feb-04	Sterile control	1	8.0	2432	<0.02	0.81	214	<0.14	<0.05	6921	282	--	--	7
10-Feb-04	Sterile control	2	5.0	2003	<0.02	<0.02	155	<0.14	<0.05	5763	286	--	--	--
10-Feb-04	Sterile control	3	5.7	2473	<0.02	<0.02	197	<0.14	<0.05	6858	286	--	--	--
10-Feb-04	average		6.2	2303	<0.02	0.27	189	<0.14	<0.05	6514	285			
26-Feb-04	Sterile control	1	Added 8,955 mg/L of citric acid											
26-Feb-04	Sterile control	1	3.4	2613	<0.28	<0.02	257	<0.14	<0.05	7410	320	2721	--	2.77
26-Feb-04	average		3.4	2613	<0.28	0.00	257	<0.14	<0.05	7410	320			
2-Mar-04	Sterile control	1	0.3	2297	<0.28	<0.02	214	<0.14	<0.05	7553	239	3324	--	3
2-Mar-04	Sterile control	2	1.7	2586	<0.28	<0.02	230	<0.14	<0.05	7793	298	--	--	--
2-Mar-04	Sterile control	3	0.8	2706	<0.28	<0.02	244	<0.14	<0.05	7625	267	--	--	--
2-Mar-04	average		0.9	2530	<0.28	<0.02	229	<0.14	<0.05	7657	268			
9-Mar-04	Sterile control	1	3.8	2018	<0.28	<0.02	165	<0.14	<0.05	6251	259	2718	--	3
9-Mar-04	Sterile control	2	4.8	2365	<0.28	<0.02	208	<0.14	<0.05	6798	344	--	--	--
9-Mar-04	Sterile control	3	5.1	2596	<0.28	<0.02	226	<0.14	<0.05	7266	345	--	--	--
9-Mar-04	average		4.6	2326	<0.28	<0.02	200	<0.14	<0.05	6772	316			
17-Mar-04	Sterile control	1	0.83	2275	<0.28	<0.02	191	<0.14	<0.05	7113	318	3343	--	--
17-Mar-04	Sterile control	2	1.1	1800	<0.28	<0.02	149	<0.14	<0.05	5965	298	--	--	--
17-Mar-04	Sterile control	3	1.3	2662	<0.28	<0.02	225	<0.14	<0.05	8620	296	--	--	--
17-Mar-04	average		1.1	2246	<0.28	<0.02	189	<0.14	<0.05	7233	304			
30-Mar-04	Sterile control	1	4.4	2013	<0.28	<0.02	264	<0.14	<0.05	5900	199	2951	--	--
30-Mar-04	Sterile control	2	1.4	2023	<0.28	<0.02	205	<0.14	<0.05	5772	232	--	--	--
30-Mar-04	Sterile control	3	1.3	2468	<0.28	<0.02	239	<0.14	<0.05	6793	224	--	--	--
30-Mar-04	average		2.4	2168	<0.28	<0.02	236	<0.14	<0.05	6155	218			
27-Apr-04	Sterile control	1	4.3	2827	<0.28	<0.02	305	<0.14	<0.05	7490	247	--	--	--
27-Apr-04	Sterile control	2	2.7	2098	<0.28	<0.02	193	<0.14	<0.05	6273	269	--	--	--
27-Apr-04	Sterile control	3	4.9	2355	<0.28	<0.02	272	<0.14	<0.05	6392	266	--	--	--
27-Apr-04	average		4.0	2426	<0.28	<0.02	257	<0.14	<0.05	6718	261			

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04	Citric acid	4	2.4	2565	<0.02	<0.02	231	<0.14	<0.05	7495	262	3652	--	4
13-Jan-04	Citric acid	5	2.2	2209	<0.02	<0.02	204	<0.14	<0.05	6865	255	3117	--	--
13-Jan-04	Citric acid	6	1.6	1582	<0.02	<0.02	151	<0.14	<0.05	4847	264	2468	--	--
13-Jan-04	average		2.1	2119	<0.02	<0.02	195	<0.14	<0.05	6402	260	3079		
20-Jan-04	Citric acid	4	4.8	2222	<0.02	<0.02	245	<0.14	<0.05	6739	<0.02	3497	--	--
20-Jan-04	Citric acid	5	3.2	2055	<0.02	<0.02	199	<0.14	<0.05	6334	<0.02	3300	--	--
20-Jan-04	Citric acid	6	5.1	2395	<0.02	<0.02	247	<0.14	<0.05	7249	<0.02	3233	--	4
20-Jan-04	average		4.4	2224	<0.02	<0.02	231	0.00	<0.05	6774	<0.02	3343		
								<0.14						
27-Jan-04	Citric acid	4	1.2	1924	<0.02	<0.02	216	<0.14	<0.05	6689	<0.02	3601	--	--
27-Jan-04	Citric acid	5	1.7	1958	<0.02	<0.02	216	<0.14	<0.05	6840	<0.02	3741	--	--
27-Jan-04	Citric acid	6	2.3	1950	<0.02	<0.02	218	<0.14	<0.05	6721	<0.02	3713	--	4
27-Jan-04	average		1.7	1944	<0.02	<0.02	217	<0.14	<0.05	6750	<0.02	3685		
10-Feb-04	Citric acid	4	6.5	1839	<0.02	<0.02	166	<0.14	<0.05	5228	<0.02	2791	--	--
10-Feb-04	Citric acid	5	6.9	1598	<0.02	<0.02	145	<0.14	<0.05	4653	<0.02	2572	--	4
10-Feb-04	Citric acid	6	1.7	2408	<0.02	<0.02	255	<0.14	<0.05	7108	<0.02	3675	--	--
10-Feb-04	average		5.0	1948	<0.02	<0.02	188	<0.14	<0.05	5663	<0.02	3013		
24-Feb-04	Citric acid	4	Perchlorate respiked to 290 mg/L											
24-Feb-04	Citric acid	5	Perchlorate respiked to 290 mg/L											
24-Feb-04	Citric acid	6	Perchlorate respiked to 290 mg/L											
24-Feb-04														
2-Mar-04	Citric acid	4	6.3	2330	<0.28	<0.02	236	<0.14	<0.05	6609	<0.02	3259	--	4
2-Mar-04	Citric acid	5	5.9	2174	<0.28	<0.02	224	<0.14	<0.05	6412	<0.02	3313	--	--
2-Mar-04	Citric acid	6	1.2	2201	<0.28	<0.02	211	<0.14	<0.05	6257	<0.02	3272	--	--
2-Mar-04	average		4.4	2235	<0.28	<0.02	224	<0.14	<0.05	6426	<0.02	3282		
30-Mar-04	Citric acid + CPS	47	7.7	2069	<0.28	<0.02	255	<0.14	<0.05	6662	175	4332	--	--
30-Mar-04	Citric acid + CPS	48	4.4	1702	<0.28	<0.02	213	<0.14	<0.05	5818	168	3767	--	--
30-Mar-04	Citric acid + CPS	49	15	2025	<0.28	<0.02	260	<0.14	<0.05	6893	183	6117	--	--
30-Mar-04			9.1	1932	<0.28	<0.02	242	<0.14	<0.05	6458	175	4739		
6-Apr-04	Citric acid + CPS	47	1.2	2271	<0.28	<0.02	310	<0.14	<0.05	6748	250	3833	--	--
6-Apr-04	Citric acid + CPS	48	14	2012	<0.28	<0.02	267	<0.14	<0.05	6390	263	3676	--	--
6-Apr-04	Citric acid + CPS	49	8.8	2032	<0.28	<0.02	321	<0.14	<0.05	6107	263	5217	--	--
6-Apr-04			7.9	2105	<0.28	<0.02	299	<0.14	<0.05	6415	259	4242		
27-Apr-04	Citric acid + CPS	47	17	2340	<0.28	<0.02	312	<0.14	<0.05	5621	253	--	--	3.93
27-Apr-04	Citric acid + CPS	48	19	3209	<0.28	<0.02	320	<0.14	<0.05	6271	236	--	--	3.89
27-Apr-04	Citric acid + CPS	49	24	3093	<0.28	<0.02	346	<0.14	<0.05	5060	225	--	--	3.73
27-Apr-04			20	2881	<0.28	<0.02	326	<0.14	<0.05	5651	238			
7-Jun-04	Citric acid + CPS	47	180	3735	<0.28	<0.02	580	<0.14	<0.05	NA	301	868	--	--
7-Jun-04	Citric acid + CPS	48	124	3101	<0.28	<0.02	482	<0.14	<0.05	NA	273	752	--	--
7-Jun-04	Citric acid + CPS	49	176	3524	<0.28	<0.02	696	<0.14	<0.05	NA	271	1289	--	--
7-Jun-04			160	3453	<0.28	<0.02	586	<0.14	<0.05		282	970		
7-Jun-04	Citric acid + CPS		Bioaugmented all three reps with perchlorate degrading culture											

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
10-Jun-04	Citric acid + CPS	47	101	2681	<0.28	<0.02	374	<0.14	<0.05	6907	282	576	--	4.4
10-Jun-04	Citric acid + CPS	48	93	2416	<0.28	<0.02	349	<0.14	<0.05	6639	267	574	--	4.4
10-Jun-04	Citric acid + CPS	49	133	2552	<0.28	<0.02	463	<0.14	<0.05	6382	266	861	--	4.2
10-Jun-04			109	2549	<0.28	<0.02	395	<0.14	<0.05	6643	272	671		
16-Jun-04	Citric acid + CPS	47	118	2344	<0.28	<0.02	312	<0.14	<0.05	5978	266	466	--	--
16-Jun-04	Citric acid + CPS	48	128	2352	<0.28	<0.02	338	<0.14	<0.05	6411	259	531	--	--
16-Jun-04	Citric acid + CPS	49	156	2338	<0.28	<0.02	411	<0.14	<0.05	5888	NA	729	--	--
16-Jun-04			134	2345	<0.28	<0.02	354	<0.14	<0.05	6092	263	575		
23-Jun-04	Citric acid + CPS	47	258	3060	<0.28	<0.02	435	<0.14	<0.05	7873	272	599	--	--
23-Jun-04	Citric acid + CPS	48	242	3261	<0.28	<0.02	480	<0.14	<0.05	8627	256	684	--	--
23-Jun-04	Citric acid + CPS	49	259	2837	<0.28	<0.02	520	<0.14	<0.05	7215	248	851	--	--
23-Jun-04			253	3053	<0.28	<0.02	479	<0.14	<0.05	7905	259	711		
28-Jun-04	Citric acid + CPS		Re-Bioaugmented all three reps with perchlorate degrading culture											
30-Jun-04	Citric acid + CPS	47	32	2830	<0.28	<0.02	484	<0.14	<0.05	7018	269	518	--	--
30-Jun-04	Citric acid + CPS	48	34	2844	<0.28	<0.02	411	<0.14	<0.05	7433	256	594	--	--
30-Jun-04	Citric acid + CPS	49	44	2774	<0.28	<0.02	477	<0.14	<0.05	6533	251	829	--	--
30-Jun-04			37	2816	<0.28	<0.02	457	<0.14	<0.05	6995	259	647		
7-Jul-04	Citric acid + CPS	47	250	2857	<0.02	<0.02	420	<0.14	<0.05	7205	262	559	--	--
7-Jul-04	Citric acid + CPS	48	278	2788	<0.28	<0.02	421	<0.14	<0.05	9441	247	508	--	--
7-Jul-04	Citric acid + CPS	49	371	3407	<0.28	<0.02	759	<0.14	<0.05	10489	250	786	--	--
7-Jul-04			300	3017	<0.28	<0.02	534	<0.14	<0.05	9045	253	618		
14-Jul-04	Citric acid + CPS	47	207	2410	<0.02	<0.02	331	<0.14	<0.05	5873	240	557	--	--
14-Jul-04	Citric acid + CPS	48	185	1954	<0.28	<0.02	291	<0.14	<0.05	5080	243	531	--	--
14-Jul-04	Citric acid + CPS	49	258	2028	<0.28	<0.02	375	<0.14	<0.05	4947	219	701	--	--
14-Jul-04			217	2131	<0.28	<0.02	332	<0.14	<0.05	5300	234			

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04	Ethanol and acetate	7	2434	2406	<0.02	<0.02	208	<0.14	<0.05	7224	286	--	1898	7
13-Jan-04	Ethanol and acetate	8	2363	2083	<0.02	<0.02	171	<0.14	<0.05	6562	275	--	1812	--
13-Jan-04	Ethanol and acetate	9	2402	2364	<0.02	<0.02	190	<0.14	<0.05	6999	294	--	1864	--
	average		2399	2284	<0.02	<0.02	190	<0.14	<0.05	6928	285		1858	
20-Jan-04	Ethanol and acetate	7	3011	2346	<0.02	<0.02	193	<0.14	<0.05	6261	256	--	1489	--
20-Jan-04	Ethanol and acetate	8	2900	2132	<0.02	<0.02	179	<0.14	<0.05	5809	258	--	1544	--
20-Jan-04	Ethanol and acetate	9	3152	2443	<0.02	<0.02	215	<0.14	<0.05	6351	270	--	1820	7
	average		3021	2307	<0.02	<0.02	196	<0.14	<0.05	6140	261		1618	
27-Jan-04	Ethanol and acetate	7	2925	2662	<0.02	<0.02	211	<0.14	<0.05	6626	226	--	1759	--
27-Jan-04	Ethanol and acetate	8	3194	2409	<0.02	<0.02	196	<0.14	<0.05	6198	229	--	1837	7
27-Jan-04	Ethanol and acetate	9	3370	2515	<0.02	<0.02	199	<0.14	<0.05	6402	232	--	1722	--
	average		3163	2529	<0.02	<0.02	202	<0.14	<0.05	6408	229		1773	
10-Feb-04	Ethanol and acetate	7	2416	2107	<0.02	<0.02	164	<0.14	<0.05	5233	289	--	1681	7
10-Feb-04	Ethanol and acetate	8	2799	2678	<0.02	<0.02	203	<0.14	<0.05	6313	280	--	1870	--
10-Feb-04	Ethanol and acetate	9	2911	2867	<0.02	<0.02	209	<0.14	<0.05	6681	293	--	1747	--
	average		2709	2551	<0.02	<0.02	192	<0.14	<0.05	6075	287		1766	
27-feb-04 - 03-mar-0	Ethanol and acetate	7	Added HCl to bottle #7 to attempt to bring pH down to pH=5.5											
2-Mar-04	Ethanol and acetate	7	2282	2767	<0.28	<0.02	159	<0.14	<0.05	4876	297	--	1663	6
2-Mar-04	Ethanol and acetate	8	2637	2045	<0.28	<0.02	155	<0.14	<0.05	4855	273	--	1793	--
2-Mar-04	Ethanol and acetate	9	2773	2149	<0.28	<0.02	166	<0.14	<0.05	5037	287	--	1551	--
	average		2564	2320	<0.28	<0.02	160	<0.14	<0.05	4923	286		1669	
3-Mar-04	Ethanol and acetate	7	pH samples taken											5.07
4-Mar-04	Ethanol and acetate	7	pH samples taken											5.15
9-Mar-04	Ethanol and acetate	7	2667	3829	<0.28	<0.02	203	<0.14	<0.05	5971	328	--	--	5.17
9-Mar-04	Ethanol and acetate	8	2830	2453	<0.28	<0.02	202	<0.14	<0.05	5881	328	--	--	7.27
9-Mar-04	Ethanol and acetate	9	2719	2646	<0.28	<0.02	197	<0.14	<0.05	5944	335	--	--	7.25
9-Mar-04	average		2739	2976	<0.28	<0.02	201	<0.14	<0.05	5932	330			
17-Mar-04	Ethanol and acetate	7	3112	4616	<0.28	<0.02	266	<0.14	<0.05	7393	282	--	1469	--
17-Mar-04	Ethanol and acetate	8	2921	3036	<0.28	<0.02	223	<0.14	<0.05	6682	283	--	1845	--
17-Mar-04	Ethanol and acetate	9	3009	2662	<0.28	<0.02	239	<0.14	<0.05	6929	294	--	1713	--
17-Mar-04	average		3014	3438	<0.28	<0.02	243	<0.14	<0.05	7001	286		1676	
30-Mar-04	Ethanol and acetate	7	2444	3574	<0.28	<0.02	246	<0.14	<0.05	5354	244	--	1565	5.30
30-Mar-04	Ethanol and acetate	8	2607	2640	<0.28	<0.02	274	<0.14	<0.05	5713	227	--	1468	--
30-Mar-04	Ethanol and acetate	9	2699	2775	<0.28	<0.02	311	<0.14	<0.05	6101	251	--	1490	--
30-Mar-04	average		2583	2996	<0.28	<0.02	277	<0.14	<0.05	5723	240		1508	
27-Apr-04	Ethanol and acetate	7	2455	3296	<0.28	<0.02	181	<0.14	<0.05	5468	249	--	--	5.19
27-Apr-04	Ethanol and acetate	8	2038	2507	<0.28	<0.02	208	<0.14	<0.05	4014	250	--	--	6.83
27-Apr-04	Ethanol and acetate	9	2493	2544	<0.28	<0.02	248	<0.14	<0.05	5319	261	--	--	7.14
27-Apr-04	average		2329	2782	<0.28	<0.02	212	<0.14	<0.05	4934	253			

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04(T=0)	Ethanol and acetate + CPS	10	2224	2257	<0.02	<0.02	205	<0.14	<0.05	6955	289	--	1662	--
13-Jan-04(T=0)	Ethanol and acetate + CPS	11	2325	2395	<0.02	<0.02	216	<0.14	<0.05	7011	295	--	3399	--
13-Jan-04(T=0)	Ethanol and acetate + CPS	12	2459	2485	<0.02	<0.02	217	<0.14	<0.05	7694	292	--	0	--
13-Jan-04	average		2336	2379	<0.02	<0.02	213	<0.14	<0.05	7220	292		1687	
13-Jan-04(T=4)	Ethanol and acetate + CPS	10	2591	2426	<0.02	<0.02	213	<0.14	<0.05	7488	282	--	1636	8
13-Jan-04(T=4)	Ethanol and acetate + CPS	11	2701	2637	<0.02	0.64	228	<0.14	<0.05	7757	284	--	3914	--
13-Jan-04(T=4)	Ethanol and acetate + CPS	12	2730	2596	<0.02	<0.02	233	<0.14	<0.05	8054	283	--	0	--
13-Jan-04	average		2674	2553	<0.02	0.21	225	<0.14	<0.05	7766	283		1850	
20-Jan-04	Ethanol and acetate + CPS	10	2934	2429	<0.02	<0.02	214	<0.14	<0.05	6899	262	--	1492	7
20-Jan-04	Ethanol and acetate + CPS	11	3044	2387	<0.02	<0.02	208	<0.14	<0.05	6921	269	--	3680	--
20-Jan-04	Ethanol and acetate + CPS	12	3078	2272	<0.02	<0.02	191	<0.14	<0.05	6548	266	--	2030	--
	average		3019	2363	<0.02	<0.02	205	<0.14	<0.05	6790	266		2401	
27-Jan-04	Ethanol and acetate + CPS	10	2854	2488	<0.02	<0.02	208	<0.14	<0.05	6575	239	--	1547	7
27-Jan-04	Ethanol and acetate + CPS	11	3400	2514	<0.02	<0.02	247	<0.14	<0.05	6913	230	--	4058	--
27-Jan-04	Ethanol and acetate + CPS	12	2924	2320	<0.02	<0.02	193	<0.14	<0.05	6278	244	--	2494	--
	average		3059	2441	<0.02	<0.02	216	<0.14	<0.05	6589	237		2700	
10-Feb-04	Ethanol and acetate + CPS	10	2462	2879	<0.02	<0.02	241	<0.14	<0.05	5880	286	--	1450	7
10-Feb-04	Ethanol and acetate + CPS	11	2897	2715	<0.02	<0.02	211	<0.14	<0.05	6758	295	--	3827	--
10-Feb-04	Ethanol and acetate + CPS	12	2864	2797	<0.02	<0.02	223	<0.14	<0.05	6605	289	--	2090	--
	average		2741	2797	<0.02	<0.02	225	<0.14	<0.05	6415	290		2456	
27-feb-04 - 03-mar-0	Ethanol and acetate + CPS	10	Added HCl to bottle #10 (tested OUTSIDE glovebox) to attempt to bring pH down to pH=5.5											
2-Mar-04	Ethanol and acetate + CPS	10	36	5031	<0.28	<0.02	222	<0.14	<0.05	322	274	--	529	6.89
2-Mar-04	Ethanol and acetate + CPS	11	2686	2045	<0.28	<0.02	151	<0.14	<0.05	4858	282	--	3548	--
2-Mar-04	Ethanol and acetate + CPS	12	2254	2244	<0.28	<0.02	179	<0.14	<0.05	4658	284	--	1970	--
	average		1659	3107	<0.28	<0.02	184	<0.14	<0.05	3279	280		2016	
2-Mar-04	Ethanol and acetate + CPS	10	Added HCl to bottle #10 to attempt to bring pH down to pH=5.5											
3-Mar-04	Ethanol and acetate + CPS	10	pH samples taken											6.37
4-Mar-04	Ethanol and acetate + CPS	10	pH samples taken											6.31
4-Mar-04	Ethanol and acetate + CPS	10	Added HCl to bottle #10 to attempt to bring pH down to pH=5.5											
9-Mar-04	Ethanol and acetate + CPS	10	200	8134	<0.28	<0.02	293	<0.14	<0.05	0.86	274	--	--	--
9-Mar-04	Ethanol and acetate + CPS	11	2864	3193	<0.28	<0.02	234	<0.14	<0.05	6300	308	--	--	--
9-Mar-04	Ethanol and acetate + CPS	12	2842	3136	<0.28	<0.02	247	<0.14	<0.05	5767	356	--	--	--
9-Mar-04	average		1968	4821	<0.28	<0.02	258	<0.14	<0.05	4023	313			
9-Mar-04	Ethanol and acetate + CPS	11	Added HCl to bottle #11 (tested INSIDE glovebox) to attempt to bring pH down to pH=5.5											7.10
10-Mar-04	Ethanol and acetate + CPS	11	pH samples taken											5.88
11-Mar-04	Ethanol and acetate + CPS	11	pH samples taken											5.69
17-Mar-04	Ethanol and acetate + CPS	10	467	9505	<0.28	<0.02	326	<0.14	<0.05	<0.2	280	--	<10	--
17-Mar-04	Ethanol and acetate + CPS	11	3326	5212	<0.28	<0.02	243	<0.14	<0.05	7913	382	--	3556	--
17-Mar-04	Ethanol and acetate + CPS	12	2495	4739	<0.28	<0.02	289	<0.14	<0.05	3995	278	--	1414	--
17-Mar-04	average		2096	6485	<0.28	<0.02	286	<0.14	<0.05	3970	313		1657	
17-Mar-04	Ethanol and acetate + CPS	11	--	--	--	--	--	--	--	--	--	--	--	5.75

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
			Analyte											
30-Mar-04	Ethanol and acetate + CPS	10	511	7051	<0.28	<0.02	126	<0.14	<0.05	<0.2	219	--	351	7.1
30-Mar-04	Ethanol and acetate + CPS	11	2683	4272	<0.28	<0.02	220	<0.14	<0.05	5764	236	--	3351	6.03
30-Mar-04	Ethanol and acetate + CPS	12	1630	5801	<0.28	<0.02	393	<0.14	<0.05	39	249	--	277	--
30-Mar-04	average		1608	5708	<0.28	<0.02	247	<0.14	<0.05	1934	235		1326	
6-Apr-04	Ethanol and acetate + CPS	10	731	7934	<0.28	<0.02	26	<0.14	<0.05	<0.2	248	--	--	--
6-Apr-04	Ethanol and acetate + CPS	11	2803	4517	<0.28	<0.02	243	<0.14	<0.05	6191	240	--	--	--
6-Apr-04	Ethanol and acetate + CPS	12	1411	5651	<0.28	<0.02	340	<0.14	<0.05	3.4	306	--	--	--
6-Apr-04	average		1648	6034	<0.28	<0.02	203	<0.14	<0.05	2065	265			
20-Apr-04	Ethanol and acetate + CPS	10	450	7938	<0.28	<0.02	2.5	<0.14	<0.05	<0.2	246	--	40	--
20-Apr-04	Ethanol and acetate + CPS	11	2647	4473	<0.28	<0.02	253	<0.14	<0.05	5942	246	--	3793	--
20-Apr-04	Ethanol and acetate + CPS	12	1724	5970	<0.28	<0.02	404	<0.14	<0.05	3.8	258	--	35	--
20-Apr-04	average		1607	6127	<0.28	<0.02	220	<0.14	<0.05	1982	250		1289	
23-Apr-04	Ethanol and acetate + CPS		fed bottles 10 and 12 70uL of EtOH											
27-Apr-04	Ethanol and acetate + CPS	10	687	6631	<0.28	<0.02	6.4	<0.14	<0.05	<0.2	241	--	--	6.52
27-Apr-04	Ethanol and acetate + CPS	11	2705	4436	<0.28	<0.02	263	<0.14	<0.05	5883	234	--	--	6.06
27-Apr-04	Ethanol and acetate + CPS	12	1405	4456	<0.28	<0.02	254	<0.14	<0.05	<0.2	255	--	--	7.11
27-Apr-04	average		1599	5174	<0.28	<0.02	175	<0.14	<0.05	1961	243			
11-May-04	Ethanol and acetate + CPS	10	1110	9082	<0.28	<0.02	5.1	<0.14	<0.05	<0.2	255	--	546	--
11-May-04	Ethanol and acetate + CPS	11	2626	5257	<0.28	<0.02	335	<0.14	<0.05	7346	261	--	3754	5.72
11-May-04	Ethanol and acetate + CPS	12	1537	6127	<0.28	<0.02	366	<0.14	<0.05	<0.2	257	--	<1	--
11-May-04	average		1757	6822	<0.28	<0.02	235	<0.14	<0.05	2449	257		1434	
17-May-04	Ethanol and acetate + CPS		fed bottles 10 and 12 70uL of EtOH											
25-May-04	Ethanol and acetate + CPS	10	1405	8109	<0.28	<0.02	8.8	<0.14	<0.05	<0.2	261	--	--	6.41
25-May-04	Ethanol and acetate + CPS	11	2563	4070	<0.28	<0.02	223	<0.14	<0.05	6227	226	--	--	5.76
25-May-04	Ethanol and acetate + CPS	12	1839	5774	<0.28	<0.02	258	<0.14	<0.05	<0.2	273	--	--	7.34
25-May-04	average		1935	5984	<0.28	<0.02	163	<0.14	<0.05	2076	253			
10-Jun-04	Ethanol and acetate + CPS	10	2080	10723	<0.28	<0.02	1.7	<0.14	<0.05	<0.2	278	--	--	6.5
10-Jun-04	Ethanol and acetate + CPS	11	3414	6061	<0.28	<0.02	357	<0.14	<0.05	9478	287	--	--	5.9
10-Jun-04	Ethanol and acetate + CPS	12	2075	6159	<0.28	<0.02	34	<0.14	<0.05	<0.2	293	--	--	7.5
10-Jun-04	average		2523	7648	<0.28	<0.02	131	<0.14	<0.05	3159	286			
23-Jun-04	Ethanol and acetate + CPS	10	2123	10339	<0.28	<0.02	9.2	<0.14	<0.05	2.6	320	--	17	--
23-Jun-04	Ethanol and acetate + CPS	11	3389	6157	<0.28	<0.02	386	<0.14	<0.05	9322	287	--	1953	--
23-Jun-04	Ethanol and acetate + CPS	12	2414	7238	<0.28	<0.02	15	<0.14	<0.05	196.8	294	--	<1	--
23-Jun-04	average		2642	7911	<0.28	<0.02	137	<0.14	<0.05	3174	300		657	
24-Jun-04	Ethanol and acetate + CPS		fed bottles# 10 and 12 140uL of EtOH											

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04(T=0)	CPS pretreatment, ethanol + acetate	13	18	2356	<0.02	<0.02	200	<0.14	<0.05	7046	295	--	NA	--
13-Jan-04(T=0)	CPS pretreatment, ethanol + acetate	14	9.2	2524	<0.02	<0.02	213	<0.14	<0.05	7437	300	--	NA	--
13-Jan-04(T=0)	CPS pretreatment, ethanol + acetate	15	6.3	2324	<0.02	<0.02	200	<0.14	<0.05	7160	299	--	NA	--
13-Jan-04	average		11	2402	<0.02	<0.02	204	<0.14	<0.05	7214	298			
13-Jan-04(T=4)	CPS pretreatment, ethanol + acetate	13	2827	2526	<0.02	<0.02	218	<0.14	<0.05	7569	287	--	2105	8
13-Jan-04(T=4)	CPS pretreatment, ethanol + acetate	14	2894	2735	<0.02	<0.02	225	<0.14	<0.05	8102	285	--	2217	--
13-Jan-04(T=4)	CPS pretreatment, ethanol + acetate	15	2915	2576	<0.02	<0.02	236	<0.14	<0.05	8016	285	--	2243	--
13-Jan-04	average		2878	2612	<0.02	<0.02	226	<0.14	<0.05	7896	285		2188	
20-Jan-04	CPS pretreatment, ethanol + acetate	13	3504	2447	<0.02	<0.02	217	<0.14	<0.05	6494	275	--	1956	--
20-Jan-04	CPS pretreatment, ethanol + acetate	14	3560	2515	<0.02	<0.02	208	<0.14	<0.05	6953	274	--	2111	7
20-Jan-04	CPS pretreatment, ethanol + acetate	15	3532	2251	<0.02	0.80	195	<0.14	<0.05	6580	273	--	2133	--
	average		3532	2405	<0.02	0.27	207	<0.14	<0.05	6676	274		2067	
27-Jan-04	CPS pretreatment, ethanol + acetate	13	3261	2431	<0.02	<0.02	202	<0.14	<0.05	6278	219	--	2125	--
27-Jan-04	CPS pretreatment, ethanol + acetate	14	3649	2623	<0.02	<0.02	231	<0.14	<0.05	6450	228	--	1994	--
27-Jan-04	CPS pretreatment, ethanol + acetate	15	3724	2434	<0.02	0.80	198	<0.14	<0.05	6463	233	--	2308	7
	average		3545	2496	<0.02	0.27	211	<0.14	<0.05	6397	227		2142	
10-Feb-04	CPS pretreatment, ethanol + acetate	13	3671	2654	<0.02	<0.02	234	<0.14	<0.05	6406	289	--	2142	7
10-Feb-04	CPS pretreatment, ethanol + acetate	14	3458	2451	<0.02	<0.02	253	<0.14	<0.05	5561	289	--	2191	--
10-Feb-04	CPS pretreatment, ethanol + acetate	15	3777	2461	<0.02	0.80	231	<0.14	<0.05	6301	290	--	2275	--
	average		3635	2522	<0.02	0.27	239	<0.14	<0.05	6089	289		2203	
27-feb-04 - 03-mar-0	CPS pretreatment, ethanol + acetate	13	Added HCl to bottle #13 to attempt to bring pH down to pH=5.5											
2-Mar-04	CPS pretreatment, ethanol + acetate	13	2443	2694	<0.28	<0.02	150	<0.14	<0.05	4430	288	--	1773	6.51
2-Mar-04	CPS pretreatment, ethanol + acetate	14	2897	2099	<0.28	<0.02	156	<0.14	<0.05	4503	287	--	2093	--
2-Mar-04	CPS pretreatment, ethanol + acetate	15	3062	1976	<0.28	<0.02	156	<0.14	<0.05	4896	289	--	1977	--
	average		2801	2256	<0.28	<0.02	154	<0.14	<0.05	4610	288		1948	
3-Mar-04	CPS pretreatment, ethanol + acetate	13	pH samples taken											5.74
4-Mar-04	CPS pretreatment, ethanol + acetate	13	pH samples taken											6.05
4-Mar-04	CPS pretreatment, ethanol + acetate	13	Added HCl to bottle #13 to attempt to bring pH down to pH=5.5											
9-Mar-04	CPS pretreatment, ethanol + acetate	13	3253	4436	<0.28	<0.02	229	<0.14	<0.05	6134	351	--	--	--
9-Mar-04	CPS pretreatment, ethanol + acetate	14	3236	3024	<0.28	<0.02	225	<0.14	<0.05	6191	224	--	--	--
9-Mar-04	CPS pretreatment, ethanol + acetate	15	3809	2680	<0.28	<0.02	225	<0.14	<0.05	6590	235	--	--	--
9-Mar-04	average		3433	3380	<0.28	<0.02	226	<0.14	<0.05	6305	270			
9-Mar-04	CPS pretreatment, ethanol + acetate	14	Added HCl to bottle #14 to attempt to bring pH down to pH=5.5											7.23
10-Mar-04	CPS pretreatment, ethanol + acetate	14	pH samples taken											6.23
11-Mar-04	CPS pretreatment, ethanol + acetate	14	pH samples taken											6.07
17-Mar-04	CPS pretreatment, ethanol + acetate	13	3367	5156	<0.28	<0.02	260	<0.14	<0.05	6647	252	--	1974	--
17-Mar-04	CPS pretreatment, ethanol + acetate	14	3326	4560	<0.28	<0.02	252	<0.14	<0.05	6535	275	--	1469	--
17-Mar-04	CPS pretreatment, ethanol + acetate	15	4454	3246	<0.28	<0.02	339	<0.14	<0.05	7900	295	--	2475	--
17-Mar-04	average		3716	4321	<0.28	<0.02	283	<0.14	<0.05	7027	274		1973	
17-Mar-04	CPS pretreatment, ethanol + acetate	14	--	--	--	--	--	--	--	--	--	--	--	5.95

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
30-Mar-04	CPS pretreatment, ethanol + acetate	13	2826	4233	<0.28	<0.02	323	<0.14	<0.05	5393	257	--	1682	6.38
30-Mar-04	CPS pretreatment, ethanol + acetate	14	3076	4548	<0.28	<0.02	319	<0.14	<0.05	5788	307	--	1757	6.50
30-Mar-04	CPS pretreatment, ethanol + acetate	15	3818	2865	<0.28	<0.02	332	<0.14	<0.05	6603	252	--	1769	--
30-Mar-04	average		3240	3882	<0.28	<0.02	325	<0.14	<0.05	5928	272		1736	
20-Apr-04	CPS pretreatment, ethanol + acetate	13	3103	5231	<0.28	<0.02	344	<0.14	<0.05	6341	245		1977	--
20-Apr-04	CPS pretreatment, ethanol + acetate	14	3435	5855	<0.28	<0.02	416	<0.14	<0.05	7092	261		1944	--
20-Apr-04	CPS pretreatment, ethanol + acetate	15	3432	3214	<0.28	<0.02	351	<0.14	<0.05	6829	252		1927	--
20-Apr-04	average		3323	4767	<0.28	<0.02	370	<0.14	<0.05	6754	253		1949	
27-Apr-04	CPS pretreatment, ethanol + acetate	13	2770	4296	<0.28	<0.02	275	<0.14	<0.05	5221	229	--	--	6.37
27-Apr-04	CPS pretreatment, ethanol + acetate	14	2736	4004	<0.28	<0.02	237	<0.14	<0.05	4827	225	--	--	6.48
27-Apr-04	CPS pretreatment, ethanol + acetate	15	3279	2557	<0.28	<0.02	253	<0.14	<0.05	5200	239	--	--	7.17
27-Apr-04	average		2928	3619	<0.28	<0.02	255	<0.14	<0.05	5083	231			
7-Jun-04	CPS pretreatment, ethanol + acetate	13	3205	5509	<0.28	<0.02	324	<0.14	<0.05	7422	297	--	--	--
7-Jun-04	CPS pretreatment, ethanol + acetate	14	3226	5288	<0.28	<0.02	331	<0.14	<0.05	7038	294	--	--	--
7-Jun-04	CPS pretreatment, ethanol + acetate	15	2254	6608	<0.28	<0.02	291	<0.14	<0.05	1.7	297	--	--	--
7-Jun-04	average		2895	5802	<0.28	<0.02	315	<0.14	<0.05	4821	296			
7-Jun-04	CPS pretreatment, ethanol + acetate		Bioaugmented all three reps with perchlorate degrading culture											
10-Jun-04	CPS pretreatment, ethanol + acetate	13	3366	5608	<0.28	<0.02	370	<0.14	<0.05	7332	281	--	--	6.5
10-Jun-04	CPS pretreatment, ethanol + acetate	14	3297	5194	<0.28	<0.02	359	<0.14	<0.05	6655	280	--	--	6.6
10-Jun-04	CPS pretreatment, ethanol + acetate	15	2242	5729	<0.28	<0.02	209	<0.14	<0.05	1.7	239	--	--	7.3
10-Jun-04	average		2968	5510	<0.28	<0.02	313	<0.14	<0.05	4663	267			
16-Jun-04	CPS pretreatment, ethanol + acetate	13	2519	4815	<0.28	<0.02	262	<0.14	<0.05	4909	272	--	796	--
16-Jun-04	CPS pretreatment, ethanol + acetate	14	2725	5194	<0.28	<0.02	295	<0.14	<0.05	5157	255	--	860	--
16-Jun-04	CPS pretreatment, ethanol + acetate	15	2168	4975	<0.28	<0.02	121	<0.14	<0.05	29	190	--	<0.1	--
16-Jun-04	average		2470	4995	<0.28	<0.02	226	<0.14	<0.05	3365	239		552	
16-Jun-04	CPS pretreatment, ethanol + acetate		fed bottles #13 and 14 195 uL of EtOH and #15 70uL of EtOH											
23-Jun-04	CPS pretreatment, ethanol + acetate	13	856	9136	<0.28	<0.02	412	<0.14	<0.05	92	271	--	1828	--
23-Jun-04	CPS pretreatment, ethanol + acetate	14	966	8479	<0.28	<0.02	356	<0.14	<0.05	<0.2	272	--	1818	--
23-Jun-04	CPS pretreatment, ethanol + acetate	15	3285	7156	<0.28	<0.02	130	<0.14	<0.05	<0.2	117	--	<1	--
23-Jun-04	average		1702	8257	<0.28	<0.02	299	<0.14	<0.05	31	220		1215	
24-Jun-04	CPS pretreatment, ethanol + acetate		fed bottle#15 140 uL of EtOH											
30-Jun-04	CPS pretreatment, ethanol + acetate	13	573	7215	<0.28	<0.02	254	<0.14	<0.05	<0.2	240	--	1366	--
30-Jun-04	CPS pretreatment, ethanol + acetate	14	802	7531	<0.28	<0.02	280	<0.14	<0.05	<0.2	238	--	1495	--
30-Jun-04	CPS pretreatment, ethanol + acetate	15	3353	6154	<0.28	<0.02	63	<0.14	<0.05	<0.2	88	--	53	--
30-Jun-04	average		1576	6967	<0.28	<0.02	199	<0.14	<0.05	<0.2	189		971	
7-Jul-04	CPS pretreatment, ethanol + acetate	13	894	6378	<0.02	<0.02	207	<0.14	<0.05	<0.2	193	--	1260	--
7-Jul-04	CPS pretreatment, ethanol + acetate	14	1363	8788	<0.28	<0.02	340	<0.14	<0.05	<0.2	195	--	1379	--
7-Jul-04	CPS pretreatment, ethanol + acetate	15	2935	5186	<0.28	<0.02	21	<0.14	<0.05	<0.2	67	--	<1	--
7-Jul-04	average		1731	6784	<0.28	<0.02	189	<0.14	<0.05	<0.2	152		880	
8-Jul-04	CPS pretreatment, ethanol + acetate		fed bottle#13 and 14 25uL of EtOH and #15 140 uL of EtOH											
14-Jul-04	CPS pretreatment, ethanol + acetate	13	1331	7035	<0.02	<0.02	216	<0.14	<0.05	<0.2	175	--	1097	--
14-Jul-04	CPS pretreatment, ethanol + acetate	14	1843	6840	<0.28	<0.02	30	<0.14	<0.05	<0.2	187	--	687	--
14-Jul-04	CPS pretreatment, ethanol + acetate	15	3196	5386	<0.28	<0.02	5.4	<0.14	<0.05	<0.2	72	--	190	--
14-Jul-04	average		2123	6420	<0.28	<0.02	84	<0.14	<0.05	<0.2	145		658	

APPENDIX B-1
ANALYTICAL RESULTS FOR SOURCE AREA (MWA-25)
Arkema Facility, Portland, Oregon

Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
22-Jul-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											
28-Jul-04	CPS pretreatment, ethanol + acetate	13	2367	6841	<0.28	<0.02	63	<0.14	<0.05	<0.2	116	--	201	--
28-Jul-04	CPS pretreatment, ethanol + acetate	14	2656	6751	<0.28	<0.02	80	<0.14	<0.05	<0.2	114	--	104	--
28-Jul-04	CPS pretreatment, ethanol + acetate	15	3328	5324	<0.28	<0.02	3.9	<0.14	<0.05	<0.2	33	--	185	--
28-Jul-04	average		2784	6305	<0.28	<0.02	49	<0.14	<0.05	<0.2	88		163	
3-Aug-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											
11-Aug-04	CPS pretreatment, ethanol + acetate	13	2376	6252	<0.28	<0.02	45	<0.14	<0.05	<0.2	98	--	<1	--
11-Aug-04	CPS pretreatment, ethanol + acetate	14	2546	6387	<0.28	<0.02	65	<0.14	<0.05	<0.2	105	--	<1	--
11-Aug-04	CPS pretreatment, ethanol + acetate	15	3251	5353	<0.28	<0.02	2.7	<0.14	<0.05	<0.2	8.5	--	90	--
11-Aug-04	average		2724	5997	<0.28	<0.02	37	<0.14	<0.05	<0.2	71		30	
12-Aug-04	CPS pretreatment, ethanol + acetate		fed reps #1 and #2 100uL of EtOH and rep #3 50 uL of EtOH											
13-Aug-04	CPS pretreatment, ethanol + acetate	13	--	--	--	--	--	--	--	--	--	--	--	~5-6
13-Aug-04	CPS pretreatment, ethanol + acetate	14	--	--	--	--	--	--	--	--	--	--	--	~5-6
13-Aug-04	CPS pretreatment, ethanol + acetate	15	--	--	--	--	--	--	--	--	--	--	--	~6-7
13-Aug-04	average													
16-Aug-04	CPS pretreatment, ethanol + acetate		adjusted the pH of reps#1 and #2 back up to ~7											
13-Aug-04	CPS pretreatment, ethanol + acetate	13	--	--	--	--	--	--	--	--	--	--	--	7.08
13-Aug-04	CPS pretreatment, ethanol + acetate	14	--	--	--	--	--	--	--	--	--	--	--	6.82
25-Aug-04	CPS pretreatment, ethanol + acetate	13	2942	7683	<0.28	<0.02	32	<0.14	<0.05	<0.2	88	--	233	--
25-Aug-04	CPS pretreatment, ethanol + acetate	14	3066	7989	<0.28	<0.02	55	<0.14	<0.05	<0.2	103	--	311	--
25-Aug-04	CPS pretreatment, ethanol + acetate	15	4525	6659	<0.28	<0.02	<0.03	<0.14	<0.05	<0.2	1.9	--	8.2	--
25-Aug-04	average		3511	7444	<0.28	<0.02	29	<0.14	<0.05	<0.2	64		184	
8-Sep-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											
16-Sep-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											
22-Sep-04	CPS pretreatment, ethanol + acetate	13	3196	7200	<0.28	<0.02	1.4	<0.14	<0.05	<0.2	55	--	1.5	--
22-Sep-04	CPS pretreatment, ethanol + acetate	14	3395	7429	<0.28	<0.02	21	<0.14	<0.05	<0.2	60	--	4.6	--
22-Sep-04	CPS pretreatment, ethanol + acetate	15	3948	5212	<0.28	<0.02	4.8	<0.14	<0.05	<0.2	<0.8	--	1.6	--
22-Sep-04	average		3513	6613	<0.28	<0.02	8.9	<0.14	<0.05	<0.2	38		2.6	

Notes:
mg/L - milligrams per liter
uL - microliters
CPS - calcium polysulfide
EtOH - ethanol

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04	Sterile control	16	8.5	26391	<0.02	<0.02	421	<0.14	<0.05	4375	214	--	--	6
13-Jan-04	Sterile control	17	4.1	25935	<0.02	<0.02	417	<0.14	<0.05	4292	219	--	--	--
13-Jan-04	Sterile control	18	14	26136	<0.02	<0.02	372	<0.14	<0.05	4323	216	--	--	--
13-Jan-04	average		9.0	26154	<0.02	<0.02	403	<0.14	<0.05	4330	216			
20-Jan-04	Sterile control	16	15	27014	<0.02	<0.02	416	<0.14	<0.05	4307	197	--	--	6
20-Jan-04	Sterile control	17	12	26847	<0.02	<0.02	412	<0.14	<0.05	4283	200	--	--	--
20-Jan-04	Sterile control	18	12	26894	<0.02	0.49	423	<0.14	<0.05	4298	209	--	--	--
20-Jan-04	average		13	26918	<0.02	0.16	417	<0.14	<0.05	4296	202			
27-Jan-04	Sterile control	16	2.3	24958	<0.02	<0.02	381	<0.14	<0.05	3981	182	--	--	--
27-Jan-04	Sterile control	17	5.3	25052	<0.02	<0.02	382	<0.14	<0.05	4012	186	--	--	6
27-Jan-04	Sterile control	18	2.4	24579	<0.02	0.49	336	<0.14	<0.05	3940	189	--	--	--
27-Jan-04	average		3.3	24863	<0.02	0.16	366	<0.14	<0.05	3978	186			
10-Feb-04	Sterile control	16	3.4	24585	<0.02	<0.02	391	<0.14	<0.05	3910	208	--	--	--
10-Feb-04	Sterile control	17	3.6	25881	<0.02	<0.02	408	<0.14	<0.05	4091	208	--	--	6
10-Feb-04	Sterile control	18	3.2	25564	<0.02	0.49	383	<0.14	<0.05	4053	209	--	--	--
10-Feb-04	average		3.4	25343	<0.02	0.16	394	<0.14	<0.05	4018	209			
2-Mar-04	Sterile control	16	3.6	25645	<0.28	<0.02	422	<0.14	<0.05	4030	213	--	--	--
2-Mar-04	Sterile control	17	53	24942	<0.28	<0.02	431	<0.14	<0.05	4034	209	--	--	6
2-Mar-04	Sterile control	18	3.3	25545	<0.28	<0.02	406	<0.14	<0.05	4158	206	--	--	--
2-Mar-04	average		20	25377	<0.28	<0.02	420	<0.14	<0.05	4074	209			
9-Mar-04	Sterile control	16	4.7	28237	<0.28	<0.02	349	<0.14	<0.05	4454	244	--	--	--
9-Mar-04	Sterile control	17	3.6	27793	<0.28	<0.02	349	<0.14	<0.05	4377	237	--	--	--
9-Mar-04	Sterile control	18	4.2	27452	<0.28	<0.02	343	<0.14	<0.05	4333	248	--	--	--
9-Mar-04	average		4	27827	<0.28	<0.02	347	<0.14	<0.05	4388	243			
17-Mar-04	Sterile control	16	2.2	27393	<0.28	<0.02	342	<0.14	<0.05	4332	210	--	--	--
17-Mar-04	Sterile control	17	2.4	28050	<0.28	<0.02	352	<0.14	<0.05	4445	214	--	--	--
17-Mar-04	Sterile control	18	1.4	26876	<0.28	<0.02	374	<0.14	<0.05	4320	217	--	--	--
17-Mar-04	average		2.0	27440	<0.28	<0.02	356	<0.14	<0.05	4366	214			
30-Mar-04	Sterile control	16	0.67	24656	<0.28	<0.02	408	<0.14	<0.05	4056	183	--	--	--
30-Mar-04	Sterile control	17	0.68	24939	<0.28	<0.02	401	<0.14	<0.05	4085	189	--	--	--
30-Mar-04	Sterile control	18	0.64	25073	<0.28	<0.02	347	<0.14	<0.05	4066	182	--	--	--
30-Mar-04	average		0.66	24889	<0.28	<0.02	385	<0.14	<0.05	4069	185			
27-Apr-04	Sterile control	16	7.2	23480	<0.28	<0.02	358	<0.14	<0.05	3755	200	--	--	--
27-Apr-04	Sterile control	17	7.6	25232	<0.28	<0.02	381	<0.14	<0.05	4030	203	--	--	--
27-Apr-04	Sterile control	18	6.1	23409	<0.28	<0.02	356	<0.14	<0.05	3728	188	--	--	--
27-Apr-04	average		7.0	24040	<0.28	<0.02	365	<0.14	<0.05	3838	197			

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04	Ethanol and acetate	19	1473	25906	<0.02	0.3303	385	<0.14	<0.05	4296	206	--	1028	6
13-Jan-04	Ethanol and acetate	20	1476	26209	<0.02	<0.02	399	<0.14	<0.05	4390	221	--	1081	--
13-Jan-04	Ethanol and acetate	21	1479	25837	<0.02	<0.02	392	<0.14	<0.05	4308	216	--	983	--
13-Jan-04	average		1476	25984	<0.02	0.11	392	<0.14	<0.05	4331	214		1031	
20-Jan-04	Ethanol and acetate	19	1656	26797	<0.02	<0.02	413	<0.14	<0.05	4053	210	--	950	--
20-Jan-04	Ethanol and acetate	20	1802	25969	<0.02	<0.02	399	<0.14	<0.05	3932	211	--	904	6
20-Jan-04	Ethanol and acetate	21	1760	26692	<0.02	<0.02	404	<0.14	<0.05	4042	211	--	851	--
20-Jan-04	average		1739	26486	<0.02	<0.02	405	<0.14	<0.05	4009	211		902	
27-Jan-04	Ethanol and acetate	19	1740	25139	<0.02	<0.02	394	<0.14	<0.05	3799	216	--	1090	6
27-Jan-04	Ethanol and acetate	20	1803	25121	<0.02	<0.02	383	<0.14	<0.05	3759	219	--	1038	--
27-Jan-04	Ethanol and acetate	21	1732	25047	<0.02	<0.02	384	<0.14	<0.05	3783	179	--	1018	--
27-Jan-04	average		1758	25102	<0.02	<0.02	387	<0.14	<0.05	3780	205		1049	
10-Feb-04	Ethanol and acetate	19	1776	26372	<0.02	<0.02	385	<0.14	<0.05	3881	218	--	1021	--
10-Feb-04	Ethanol and acetate	20	1855	26885	<0.02	<0.02	414	<0.14	<0.05	3933	217	--	1050	6
10-Feb-04	Ethanol and acetate	21	1752	26218	<0.02	<0.02	382	<0.14	<0.05	3838	216	--	1014	--
10-Feb-04	average		1795	26492	<0.02	<0.02	393	<0.14	<0.05	3884	217		1028	
26-Feb-04	Ethanol and acetate	19	diluted 10X with Millipore water											
26-Feb-04	Ethanol and acetate	20	diluted 10X with Millipore water											
26-Feb-04	Ethanol and acetate	21	diluted 10X with Millipore water											
26-Feb-04	average													
26-Feb-04	Ethanol and acetate	19	217	2546	<0.28	<0.02	56	<0.14	<0.05	597	36	--	--	6.19
26-Feb-04	Ethanol and acetate	20	198	3062	<0.28	<0.02	46	<0.14	<0.05	451	35	--	--	6.08
26-Feb-04	Ethanol and acetate	21	193	3103	<0.28	<0.02	46	<0.14	<0.05	459	29	--	--	6.25
26-Feb-04	average		202	2904	<0.28	<0.02	49	<0.14	<0.05	502	33			
2-Mar-04	Ethanol and acetate	19	245	1390	<0.28	<0.02	81	<0.14	<0.05	672	39	--	128	6
2-Mar-04	Ethanol and acetate	20	252	1167	<0.28	<0.02	81	<0.14	<0.05	666	37	--	174	--
2-Mar-04	Ethanol and acetate	21	222	2311	<0.28	<0.02	69	<0.14	<0.05	567	32	--	90	--
2-Mar-04	average		240	1623	<0.28	<0.02	77	<0.14	<0.05	635	36		131	
9-Mar-04	Ethanol and acetate	19	233	1150	<0.28	<0.02	70	<0.14	<0.05	735	45	--	--	--
9-Mar-04	Ethanol and acetate	20	232	1196	<0.28	<0.02	65	<0.14	<0.05	707	43	--	--	--
9-Mar-04	Ethanol and acetate	21	203	2083	<0.28	<0.02	58	<0.14	<0.05	598	37	--	--	--
9-Mar-04	average		222	1477	<0.28	<0.02	65	<0.14	<0.05	680	42			
17-Mar-04	Ethanol and acetate	19	228	1677	<0.28	<0.02	63	<0.14	<0.05	621	36	--	98	--
17-Mar-04	Ethanol and acetate	20	265	1273	<0.28	<0.02	78	<0.14	<0.05	755	35	--	139	--
17-Mar-04	Ethanol and acetate	21	218	2052	<0.28	<0.02	59	<0.14	<0.05	554	29	--	93	--
17-Mar-04	average		237	1667	<0.28	<0.02	67	<0.14	<0.05	644	33		110	
30-Mar-04	Ethanol and acetate	19	251	1197	<0.28	<0.02	82	<0.14	<0.05	660	30	--	--	--
30-Mar-04	Ethanol and acetate	20	228	1992	<0.28	<0.02	69	<0.14	<0.05	559	29	--	--	--
30-Mar-04	Ethanol and acetate	21	221	2632	<0.28	<0.02	70	<0.14	<0.05	542	25	--	--	--
30-Mar-04	average		233	1940	<0.28	<0.02	73	<0.14	<0.05	587	28			
27-Apr-04	Ethanol and acetate	19	520	3527	<0.28	<0.02	62	<0.14	<0.05	485	34	--	--	6.62
27-Apr-04	Ethanol and acetate	20	435	2732	<0.28	<0.02	42	<0.14	<0.05	363	31	--	--	6.42
27-Apr-04	Ethanol and acetate	21	443	2871	<0.28	<0.02	50	<0.14	<0.05	390	27	--	--	6.49
27-Apr-04	average		466	3043	<0.28	<0.02	51	<0.14	<0.05	413	31			

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
7-Jun-04	Ethanol and acetate	19	231	1736	<0.28	<0.02	74	<0.14	<0.05	761	37	--	--	--
7-Jun-04	Ethanol and acetate	20	250	1078	<0.28	<0.02	83	<0.14	<0.05	838	36	--	--	--
7-Jun-04	Ethanol and acetate	21	217	2413	<0.28	<0.02	71	<0.14	<0.05	687	30	--	--	--
7-Jun-04	average		233	1742	<0.28	<0.02	76	<0.14	<0.05	762	35			
7-Jun-04	Ethanol and acetate		Bioaugmented all three reps with perchlorate degrading culture											
10-Jun-04	Ethanol and acetate	19	176	1250	<0.28	<0.02	76	<0.14	<0.05	564	36	--	--	6.7
10-Jun-04	Ethanol and acetate	20	194	1861	<0.28	<0.02	73	<0.14	<0.05	592	35	--	--	6.6
10-Jun-04	Ethanol and acetate	21	204	3760	<0.28	<0.02	64	<0.14	<0.05	584	30	--	--	6.7
10-Jun-04	average		192	2291	<0.28	<0.02	71	<0.14	<0.05	580	34			
16-Jun-04	Ethanol and acetate	19	58	1879	<0.28	<0.02	67	<0.14	<0.05	78	37	--	26	--
16-Jun-04	Ethanol and acetate	20	86	2620	<0.28	<0.02	63	<0.14	<0.05	193	35	--	32	--
16-Jun-04	Ethanol and acetate	21	131	3615	<0.28	<0.02	58	<0.14	<0.05	241	30	--	26	--
16-Jun-04	average		91	2705	<0.28	<0.02	63	<0.14	<0.05	171	34		28	
16-Jun-04	Ethanol and acetate		Fed all three reps 24uL of EtOH											
23-Jun-04	Ethanol and acetate	19	99	1286	<0.28	<0.02	74	<0.14	<0.05	0.30	<0.8	--	164	--
23-Jun-04	Ethanol and acetate	20	103	1359	<0.28	<0.02	78	<0.14	<0.05	<0.2	8.4	--	134	--
23-Jun-04	Ethanol and acetate	21	88	2019	<0.28	<0.02	70	<0.14	<0.05	5.2	8.1	--	111	--
23-Jun-04	average		97	1555	<0.28	<0.02	74	<0.14	<0.05	1.8	5.5		136	
30-Jun-04	Ethanol and acetate	19	70	2076	<0.28	<0.02	66	<0.14	<0.05	<0.2	<0.8	--	157	--
30-Jun-04	Ethanol and acetate	20	88	2865	<0.28	<0.02	60	<0.14	<0.05	<0.2	<0.8	--	113	--
30-Jun-04	Ethanol and acetate	21	91	1906	<0.28	<0.02	71	<0.14	<0.05	<0.2	<0.8	--	92	--
30-Jun-04			83	2282	<0.28	<0.02	66	<0.14	<0.05	<0.2	<0.8		121	
30-Jun-04	Ethanol and acetate		Re-spiked all three reps to ~250mg/L ClO4 Fed all three reps 50uL of EtOH and 741mg/L acetate											
30-Jun-04	Ethanol and acetate	19	--	--	--	--	--	--	--	--	231	--	--	--
30-Jun-04	Ethanol and acetate	20	--	--	--	--	--	--	--	--	202	--	--	--
30-Jun-04	Ethanol and acetate	21	--	--	--	--	--	--	--	--	206	--	--	--
30-Jun-04											213			
7-Jul-04	Ethanol and acetate	19	347	1020	<0.02	<0.02	78	<0.14	<0.05	0.25	251	--	194	--
7-Jul-04	Ethanol and acetate	20	323	1806	<0.28	<0.02	66	<0.14	<0.05	1.5	212	--	145	--
7-Jul-04	Ethanol and acetate	21	337	1157	<0.28	<0.02	74	<0.14	<0.05	0.30	200	--	123	--
7-Jul-04			336	1328	<0.28	<0.02	73	<0.14	<0.05	0.7	221		154	
8-Jul-04	Ethanol and acetate		Fed all three reps 25uL of EtOH											

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
14-Jul-04	Ethanol and acetate	19	416	4342	<0.02	<0.02	68	<0.14	<0.05	<0.2	249	--	479	--
14-Jul-04	Ethanol and acetate	20	411	4178	<0.28	<0.02	66	<0.14	<0.05	11	185	--	337	--
14-Jul-04	Ethanol and acetate	21	390	3601	<0.28	<0.02	58	<0.14	<0.05	13	195	--	306	--
14-Jul-04			406	4040	<0.28	<0.02	64	<0.14	<0.05	8.0	210		374	
22-Jul-04	Ethanol and acetate		Fed all three reps 50uL of EtOH											
28-Jul-04	Ethanol and acetate	19	342	4407	<0.28	<0.02	67	<0.14	<0.05	<0.4	0.42	--	552	--
28-Jul-04	Ethanol and acetate	20	416	4252	<0.28	<0.02	68	<0.14	<0.05	12	147	--	432	--
28-Jul-04	Ethanol and acetate	21	392	3569	<0.28	<0.02	58	<0.14	<0.05	2.9	140	--	360	--
28-Jul-04			383	4076	<0.28	<0.02	65	<0.14	<0.05	5.0	96		448	
3-Aug-04	Ethanol and acetate		Fed all three reps 25uL of EtOH											
11-Aug-04	Ethanol and acetate	19	428	3887	<0.28	<0.02	0.10	<0.14	<0.05	<0.2	0.19	--	607	--
11-Aug-04	Ethanol and acetate	20	358	3650	<0.28	<0.02	54	<0.14	<0.05	<0.2	129	--	460	--
11-Aug-04	Ethanol and acetate	21	367	3572	<0.28	<0.02	57	<0.14	<0.05	<0.2	48	--	429	--
11-Aug-04			384	3703	<0.28	<0.02	37	<0.14	<0.05	<0.2	59		499	
12-Aug-04	Ethanol and acetate		Fed all three reps 25uL of EtOH											
13-Aug-04	Ethanol and acetate	19	--	--	--	--	--	--	--	--	--	--	--	~6-7
13-Aug-04	Ethanol and acetate	20	--	--	--	--	--	--	--	--	--	--	--	~6-7
13-Aug-04	Ethanol and acetate	21	--	--	--	--	--	--	--	--	--	--	--	~6-7
13-Aug-04														
25-Aug-04	Ethanol and acetate	19	527	3592	<0.28	<0.02	<0.03	<0.14	<0.05	<0.2	0.29	--	296	--
25-Aug-04	Ethanol and acetate	20	388	3977	<0.28	<0.02	60	<0.14	<0.05	0.46	118	--	489	--
25-Aug-04	Ethanol and acetate	21	322	2985	<0.28	<0.02	46	<0.14	<0.05	<0.2	2.9	--	489	--
25-Aug-04			412	3518	<0.28	<0.02	35	<0.14	<0.05	0.15	40		424	
8-Sep-04	Ethanol and acetate		Fed all three reps 50uL of EtOH											
16-Sep-04	Ethanol and acetate		Fed all three reps 50uL of EtOH											
22-Sep-04	Ethanol and acetate	19	729	4419	<0.28	<0.02	0.22	<0.14	<0.05	<0.4	<0.8	--	<1	--
22-Sep-04	Ethanol and acetate	20	412	4323	<0.28	<0.02	66	<0.14	<0.05	<0.4	54	--	305	--
22-Sep-04	Ethanol and acetate	21	445	3704	<0.28	<0.02	0.20	<0.14	<0.05	<0.4	<0.8	--	196	--
22-Sep-04			529	4149	<0.28	<0.02	22	<0.14	<0.05	<0.4	18		167	

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04(T=0)	Ethanol and acetate + CPS	22	1480	26334	<0.02	<0.02	378	<0.14	<0.05	4397	220	--	903	6
13-Jan-04(T=0)	Ethanol and acetate + CPS	23	1424	25889	<0.02	0.29	387	<0.14	<0.05	4324	220	--	1001	--
13-Jan-04(T=0)	Ethanol and acetate + CPS	24	1588	26281	<0.02	<0.02	366	<0.14	<0.05	4349	235	--	1038	--
13-Jan-04	average		1497	26168	<0.02	0.10	377	<0.14	<0.05	4357	225		981	
13-Jan-04(T=4)	Ethanol and acetate + CPS	22	1610	27826	<0.02	<0.02	415	<0.14	<0.05	4699	213	--	1015	--
13-Jan-04(T=4)	Ethanol and acetate + CPS	23	1490	26435	<0.02	0.33	409	<0.14	<0.05	4415	213	--	1073	--
13-Jan-04(T=4)	Ethanol and acetate + CPS	24	1645	26782	<0.02	<0.02	365	<0.14	<0.05	4431	212	--	1040	--
13-Jan-04	average		1581	27014	<0.02	0.11	396	<0.14	<0.05	4515	213		1043	
20-Jan-04	Ethanol and acetate + CPS	22	1835	26437	<0.02	<0.02	403	<0.14	<0.05	4121	211	--	950	6
20-Jan-04	Ethanol and acetate + CPS	23	1700	26606	<0.02	<0.02	412	<0.14	<0.05	4012	210	--	904	--
20-Jan-04	Ethanol and acetate + CPS	24	1718	23955	<0.02	<0.02	326	<0.14	<0.05	3742	214	--	851	--
20-Jan-04	average		1751	25666	<0.02	<0.02	380	<0.14	<0.05	3958	212		902	
27-Jan-04	Ethanol and acetate + CPS	22	1826	25362	<0.02	<0.02	369	<0.14	<0.05	3840	200	--	896	--
27-Jan-04	Ethanol and acetate + CPS	23	1738	25132	<0.02	<0.02	398	<0.14	<0.05	3762	185	--	1080	6
27-Jan-04	Ethanol and acetate + CPS	24	1965	25497	<0.02	<0.02	372	<0.14	<0.05	3835	190	--	913	--
27-Jan-04	average		1843	25330	<0.02	<0.02	380	<0.14	<0.05	3813	192		963	
10-Feb-04	Ethanol and acetate + CPS	22	1834	26836	<0.02	<0.02	387	<0.14	<0.05	3973	216	--	971	--
10-Feb-04	Ethanol and acetate + CPS	23	1757	26522	<0.02	<0.02	443	<0.14	<0.05	3849	217	--	960	6
10-Feb-04	Ethanol and acetate + CPS	24	1989	26515	<0.02	<0.02	389	<0.14	<0.05	3925	218	--	883	--
10-Feb-04	average		1860	26624	<0.02	<0.02	406	<0.14	<0.05	3916	217		938	
26-Feb-04	Ethanol and acetate + CPS	22	Added 606mg/L citric acid											
26-Feb-04	Ethanol and acetate + CPS	23	Added 606mg/L citric acid											
26-Feb-04	Ethanol and acetate + CPS	24	Added 606mg/L citric acid											
26-Feb-04														
26-Feb-04	Ethanol and acetate + CPS	22	1957	26306	<0.28	<0.02	454	<0.14	<0.05	4024	228	278	--	5.52
26-Feb-04	Ethanol and acetate + CPS	23	1858	26327	<0.28	<0.02	438	<0.14	<0.05	4006	275	189	--	5.68
26-Feb-04	Ethanol and acetate + CPS	24	1943	23215	<0.28	<0.02	398	<0.14	<0.05	3606	226	237	--	5.50
26-Feb-04	average		1919	25283	<0.28	<0.02	430	<0.14	<0.05	3879	243	235		
2-Mar-04	Ethanol and acetate + CPS	22	1332	23897	<0.28	<0.02	419	<0.14	<0.05	3564	204	118	780	--
2-Mar-04	Ethanol and acetate + CPS	23	1256	22862	<0.28	<0.02	411	<0.14	<0.05	3326	304	110	783	--
2-Mar-04	Ethanol and acetate + CPS	24	1455	23842	<0.28	<0.02	426	<0.14	<0.05	3549	195	124	717	5
2-Mar-04	average		1348	23533	<0.28	<0.02	419	<0.14	<0.05	3480	234	118	760	
9-Mar-04	Ethanol and acetate + CPS	22	1311	24250	<0.28	<0.02	304	<0.14	<0.05	4112	254	228	--	--
9-Mar-04	Ethanol and acetate + CPS	23	1283	24406	<0.28	<0.02	307	<0.14	<0.05	4053	246	206	--	--
9-Mar-04	Ethanol and acetate + CPS	24	1437	24077	<0.28	<0.02	308	<0.14	<0.05	4073	243	206	--	--
9-Mar-04	average		1344	24244	<0.28	<0.02	306	<0.14	<0.05	4079	248	213		
17-Mar-04	Ethanol and acetate + CPS	22	1367	24014	<0.28	<0.02	315	<0.14	<0.05	4086	240	187	653	--
17-Mar-04	Ethanol and acetate + CPS	23	1349	24049	<0.28	<0.02	318	<0.14	<0.05	3728	218	183	612	--
17-Mar-04	Ethanol and acetate + CPS	24	1464	22136	<0.28	<0.02	303	<0.14	<0.05	4031	217	171	582	--
17-Mar-04	average		1393	23400	<0.28	<0.02	312	<0.14	<0.05	3948	225	180	616	
30-Mar-04	Ethanol and acetate + CPS	22	1314	20464	<0.28	<0.02	327	<0.14	<0.05	3567	175	287	--	--
30-Mar-04	Ethanol and acetate + CPS	23	1254	20577	<0.28	<0.02	317	<0.14	<0.05	3458	176	242	--	--
30-Mar-04	Ethanol and acetate + CPS	24	1449	20880	<0.28	<0.02	334	<0.14	<0.05	3620	175	244	--	--
30-Mar-04	average		1339	20640	<0.28	<0.02	326	<0.14	<0.05	3548	175	258		
27-Apr-04	Ethanol and acetate + CPS	22	2191	24915	<0.28	<0.02	409	<0.14	<0.05	3606	193		--	6.26
27-Apr-04	Ethanol and acetate + CPS	23	2118	29264	<0.28	<0.02	433	<0.14	<0.05	4162	203		--	6.49
27-Apr-04	Ethanol and acetate + CPS	24	2027	22526	<0.28	<0.02	326	<0.14	<0.05	3283	194		--	6.19
27-Apr-04	average		2112	25568	<0.28	<0.02	389	<0.14	<0.05	3683	197			

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

Date	Treatment	Bottle	Analyte											
			Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
13-Jan-04(T=0)	CPS pretreatment, ethanol + acetate	25	9.1	27002	<0.02	<0.02	405	<0.14	<0.05	4476	210	--	NA	--
13-Jan-04(T=0)	CPS pretreatment, ethanol + acetate	26	1.7	29990	<0.02	<0.02	468	<0.14	<0.05	5061	219	--	NA	--
13-Jan-04(T=0)	CPS pretreatment, ethanol + acetate	27	2.9	26484	<0.02	0.5615	414	<0.14	<0.05	4437	223	--	NA	--
13-Jan-04	average		4.5	27825	<0.02	0.19	429	<0.14	<0.05	4658	217			
13-Jan-04(T=4)	CPS pretreatment, ethanol + acetate	25	1353	27993	<0.02	<0.02	439	<0.14	<0.05	4675	214	--	1290	6
13-Jan-04(T=4)	CPS pretreatment, ethanol + acetate	26	1531	27827	<0.02	<0.02	389	<0.14	<0.05	4656	216	--	1212	--
13-Jan-04(T=4)	CPS pretreatment, ethanol + acetate	27	1676	26920	<0.02	0.2928	385	<0.14	<0.05	4486	215	--	1322	--
13-Jan-04	average		1520	27580	<0.02	0.10	404	<0.14	<0.05	4606	215		1275	
20-Jan-04	CPS pretreatment, ethanol + acetate	25	1796	25877	<0.02	<0.02	404	<0.14	<0.05	3868	211	--	1240	--
20-Jan-04	CPS pretreatment, ethanol + acetate	26	1776	26059	<0.02	<0.02	394	<0.14	<0.05	3955	212	--	1040	--
20-Jan-04	CPS pretreatment, ethanol + acetate	27	1805	20910	<0.02	<0.02	322	<0.14	<0.05	3120	213	--	1082	6
20-Jan-04	average		1792	24282	<0.02	<0.02	373	<0.14	<0.05	3648	212		1121	
27-Jan-04	CPS pretreatment, ethanol + acetate	25	1792	25281	<0.02	<0.02	370	<0.14	<0.05	3784	218	--	1181	--
27-Jan-04	CPS pretreatment, ethanol + acetate	26	1918	25092	<0.02	<0.02	355	<0.14	<0.05	3799	220	--	1215	6
27-Jan-04	CPS pretreatment, ethanol + acetate	27	2114	25347	<0.02	<0.02	365	<0.14	<0.05	3817	187	--	1067	--
27-Jan-04	average		1942	25240	<0.02	<0.02	363	<0.14	<0.05	3800	208		1154	
10-Feb-04	CPS pretreatment, ethanol + acetate	25	1837	26134	<0.02	<0.02	440	<0.14	<0.05	3804	219	--	1200	--
10-Feb-04	CPS pretreatment, ethanol + acetate	26	1958	25826	<0.02	<0.02	401	<0.14	<0.05	3814	219	--	1103	6
10-Feb-04	CPS pretreatment, ethanol + acetate	27	2115	26334	<0.02	<0.02	384	<0.14	<0.05	3891	218	--	1132	--
10-Feb-04	average		1970	26098	<0.28	<0.02	408	<0.14	<0.05	3836	219		1145	
2-Mar-04	CPS pretreatment, ethanol + acetate	25	1551	21864	<0.28	<0.02	359	<0.14	<0.05	3108	217	--	1181	--
2-Mar-04	CPS pretreatment, ethanol + acetate	26	1705	22277	<0.28	<0.02	347	<0.14	<0.05	3194	219	--	1238	6
2-Mar-04	CPS pretreatment, ethanol + acetate	27	1956	23432	<0.28	<0.02	409	<0.14	<0.05	3364	219	--	1089	--
2-Mar-04	average		1737	22524	<0.28	<0.02	372	<0.14	<0.05	3222	218		1169	
9-Mar-04	CPS pretreatment, ethanol + acetate	25	1756	29196	<0.28	<0.02	381	<0.14	<0.05	4214	244	--	--	--
9-Mar-04	CPS pretreatment, ethanol + acetate	26	1981	29321	<0.28	<0.02	383	<0.14	<0.05	4233	250	--	--	--
9-Mar-04	CPS pretreatment, ethanol + acetate	27	1972	27457	<0.28	<0.02	349	<0.14	<0.05	3979	249	--	--	--
9-Mar-04	average		1903	28658	<0.28	<0.02	371	<0.14	<0.05	4142	248			
17-Mar-04	CPS pretreatment, ethanol + acetate	25	1794	26968	<0.28	<0.02	373	<0.14	<0.05	4045	216	--	1152	--
17-Mar-04	CPS pretreatment, ethanol + acetate	26	2032	30289	<0.28	<0.02	418	<0.14	<0.05	4494	221	--	1076	--
17-Mar-04	CPS pretreatment, ethanol + acetate	27	2098	27442	<0.28	<0.02	359	<0.14	<0.05	4052	221	--	1042	--
17-Mar-04	average		1975	28233	<0.28	<0.02	383	<0.14	<0.05	4197	219		1090	
30-Mar-04	CPS pretreatment, ethanol + acetate	25	1682	23826	<0.28	<0.02	398	<0.14	<0.05	3498	194	--	--	--
30-Mar-04	CPS pretreatment, ethanol + acetate	26	1815	23460	<0.28	<0.02	398	<0.14	<0.05	3470	185	--	--	--
30-Mar-04	CPS pretreatment, ethanol + acetate	27	2080	25179	<0.28	<0.02	432	<0.14	<0.05	3731	197	--	--	--
30-Mar-04	average		1859	24155	<0.28	<0.02	409	<0.14	<0.05	3566	192			
27-Apr-04	CPS pretreatment, ethanol + acetate	25	2039	26090	<0.28	<0.02	387	<0.14	<0.05	3728	204	--	--	6.75
27-Apr-04	CPS pretreatment, ethanol + acetate	26	2151	23807	<0.28	<0.02	334	<0.14	<0.05	3390	203	--	--	6.72
27-Apr-04	CPS pretreatment, ethanol + acetate	27	2450	24779	<0.28	<0.02	347	<0.14	<0.05	3531	197	--	--	6.69
27-Apr-04	average		2213	24892	<0.28	<0.02	356	<0.14	<0.05	3550	201			
7-Jun-04	CPS pretreatment, ethanol + acetate	25	1739	28514	<0.28	<0.02	424	<0.14	<0.05	4679	221	--	--	--
7-Jun-04	CPS pretreatment, ethanol + acetate	26	1813	27006	<0.28	<0.02	447	<0.14	<0.05	4468	223	--	--	--
7-Jun-04	CPS pretreatment, ethanol + acetate	27	1975	27853	<0.28	<0.02	390	<0.14	<0.05	4562	223	--	--	--
7-Jun-04	average		1842	27791	<0.28	<0.02	420	<0.14	<0.05	4570	222			

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
7-Jun-04	CPS pretreatment, ethanol + acetate		Bioaugmented all three reps with perchlorate degrading culture											
10-Jun-04	CPS pretreatment, ethanol + acetate	25	1968	30819	<0.28	<0.02	517	<0.14	<0.05	5190	214	--	--	6.8
10-Jun-04	CPS pretreatment, ethanol + acetate	26	1977	28526	<0.28	<0.02	472	<0.14	<0.05	4796	214	--	--	6.8
10-Jun-04	CPS pretreatment, ethanol + acetate	27	2054	27305	<0.28	<0.02	437	<0.14	<0.05	4532	218	--	--	6.8
10-Jun-04	average		1999	28883	<0.28	<0.02	475	<0.14	<0.05	4840	215			
16-Jun-04	CPS pretreatment, ethanol + acetate	25	1637	25805	<0.28	<0.02	401	<0.14	<0.05	3898	229	--	516	--
16-Jun-04	CPS pretreatment, ethanol + acetate	26	1737	25175	<0.28	<0.02	405	<0.14	<0.05	3851	226	--	501	--
16-Jun-04	CPS pretreatment, ethanol + acetate	27	1949	25813	<0.28	<0.02	421	<0.14	<0.05	4005	311	--	490	--
16-Jun-04	average		1774	25598	<0.28	<0.02	409	<0.14	<0.05	3918	255		503	
16-Jun-04	CPS pretreatment, ethanol + acetate		Fed all three reps 120uL of EtOH											
23-Jun-04	CPS pretreatment, ethanol + acetate	25	1688	28042	<0.28	<0.02	401	<0.14	<0.05	3974	264	--	901	--
23-Jun-04	CPS pretreatment, ethanol + acetate	26	1849	29788	<0.28	<0.02	437	<0.14	<0.05	4265	216	--	849	--
23-Jun-04	CPS pretreatment, ethanol + acetate	27	1992	28630	<0.28	<0.02	421	<0.14	<0.05	4176	205	--	911	--
23-Jun-04	average		1843	28820	<0.28	<0.02	420	<0.14	<0.05	4138	228		887	
28-Jun-04	CPS pretreatment, ethanol + acetate		Re-Bioaugmented all three reps with perchlorate degrading culture											
30-Jun-04	CPS pretreatment, ethanol + acetate	25	1469	24504	<0.28	<0.02	331	<0.14	<0.05	3121	204	--	705	--
30-Jun-04	CPS pretreatment, ethanol + acetate	26	1560	26275	<0.28	<0.02	374	<0.14	<0.05	3368	205	--	701	--
30-Jun-04	CPS pretreatment, ethanol + acetate	27	1884	27597	<0.28	<0.02	399	<0.14	<0.05	3658	204	--	762	--
30-Jun-04	average		1638	26125	<0.28	<0.02	368	<0.14	<0.05	3382	205		723	
7-Jul-04	CPS pretreatment, ethanol + acetate	25	1487	26243	<0.02	<0.02	434	<0.14	<0.05	2981	207	--	695	--
7-Jul-04	CPS pretreatment, ethanol + acetate	26	1018	22129	<0.28	<0.02	327	<0.14	<0.05	1516	202	--	646	--
7-Jul-04	CPS pretreatment, ethanol + acetate	27	1579	24981	<0.28	<0.02	410	<0.14	<0.05	2816	208	--	794	--
7-Jul-04	average		1361	24451	<0.28	<0.02	390	<0.14	<0.05	2437	206		712	
8-Jul-04	CPS pretreatment, ethanol + acetate		Diluted all reps 2X with D.I. water											
8-Jul-04	CPS pretreatment, ethanol + acetate	25	--	--	--	--	--	--	--	--	124	--	--	--
8-Jul-04	CPS pretreatment, ethanol + acetate	26	--	--	--	--	--	--	--	--	114	--	--	--
8-Jul-04	CPS pretreatment, ethanol + acetate	27	--	--	--	--	--	--	--	--	136	--	--	--
8-Jul-04	average										125			
14-Jul-04	CPS pretreatment, ethanol + acetate	25	845	12641	<0.02	<0.02	208	<0.14	<0.05	1133	115	--	152	--
14-Jul-04	CPS pretreatment, ethanol + acetate	26	423	13399	<0.28	<0.02	195	<0.14	<0.05	31	110	--	114	--
14-Jul-04	CPS pretreatment, ethanol + acetate	27	988	14002	<0.28	<0.02	208	<0.14	<0.05	1242	132	--	178	--
14-Jul-04	average		752	13347	<0.28	<0.02	204	<0.14	<0.05	802	119		148	
22-Jul-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											
28-Jul-04	CPS pretreatment, ethanol + acetate	25	394	13827	<0.28	<0.02	205	<0.14	<0.05	<0.2	144	--	<1	--
28-Jul-04	CPS pretreatment, ethanol + acetate	26	477	13649	<0.28	<0.02	194	<0.14	<0.05	<0.2	117	--	117	--
28-Jul-04	CPS pretreatment, ethanol + acetate	27	579	14772	<0.28	<0.02	214	<0.14	<0.05	<0.2	151	--	170	--
28-Jul-04	average		483	14083	<0.28	<0.02	204	<0.14	<0.05	<0.2	137		96	
3-Aug-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											

APPENDIX B-2
ANALYTICAL RESULTS FOR DOWNGRADIENT AREA (MWA-32i)
Arkema Facility, Portland, Oregon

			Analyte											
Date	Treatment	Bottle	Acetate mg/L	Chloride mg/L	Nitrite-N mg/L	Nitrate mg/L	Sulphate mg/L	Bromide mg/L	Phosphate mg/L	Chlorate mg/L	Perchlorate mg/L	Citrate mg/L	Ethanol mg/L	pH
11-Aug-04	CPS pretreatment, ethanol + acetate	25	639	14358	<0.28	<0.02	25	<0.14	<0.05	<0.2	114	--	<1	--
11-Aug-04	CPS pretreatment, ethanol + acetate	26	771	13205	<0.28	<0.02	1.3	<0.14	<0.05	<0.2	96	--	<1	--
11-Aug-04	CPS pretreatment, ethanol + acetate	27	764	14823	<0.28	<0.02	58	<0.14	<0.05	<0.2	114	--	<1	--
11-Aug-04	average		725	14128	<0.28	<0.02	28	<0.14	<0.05	<0.2	108		<1	
12-Aug-04	CPS pretreatment, ethanol + acetate		fed all three reps 100uL of EtOH											
13-Aug-04	CPS pretreatment, ethanol + acetate	25	--	--	--	--	--	--	--	--	--	--	--	~6-7
13-Aug-04	CPS pretreatment, ethanol + acetate	26	--	--	--	--	--	--	--	--	--	--	--	~6-7
13-Aug-04	CPS pretreatment, ethanol + acetate	27	--	--	--	--	--	--	--	--	--	--	--	~6-7
13-Aug-04	average													
25-Aug-04	CPS pretreatment, ethanol + acetate	25	1109	21880	<0.28	<0.02	3	<0.14	<0.05	<0.2	117	--	159	--
25-Aug-04	CPS pretreatment, ethanol + acetate	26	870	13398	<0.28	<0.02	<0.03	<0.14	<0.05	<0.2	96	--	112	--
25-Aug-04	CPS pretreatment, ethanol + acetate	27	1106	19398	<0.28	<0.02	24	<0.14	<0.05	<0.2	126	--	172	--
25-Aug-04	average		1029	18225	<0.28	<0.02	9	<0.14	<0.05	<0.2	113		148	
8-Sep-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											
16-Sep-04	CPS pretreatment, ethanol + acetate		fed all three reps 50uL of EtOH											
22-Sep-04	CPS pretreatment, ethanol + acetate	25	927	14576	<0.28	<0.02	1.1	<0.14	<0.05	<0.4	87	--	<1	--
22-Sep-04	CPS pretreatment, ethanol + acetate	26	941	13799	<0.28	<0.02	0.62	<0.14	<0.05	<0.4	71	--	<1	--
22-Sep-04	CPS pretreatment, ethanol + acetate	27	1050	15780	<0.28	<0.02	0.49	<0.14	<0.05	<0.4	98	--	<1	--
22-Sep-04	average		973	14718	<0.28	<0.02	0.73	<0.14	<0.05	<0.4	85		<1	

Notes:
mg/L - milligrams per liter
uL - microliters
CPS - calcium polysulfide
EtOH - ethanol