SL-N/A-C

Modified Stabilization Plan

General Chemical Corporation
91 133 – 135 Leland Street
Framingham, Massachusetts

MADEP RTN 3 - 19174
EPA ID No. MAD019371079

MARCH 31, 2004

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March 31, 2004

Mr. Jeffrey Chormann
Executive Office of Environmental Affairs
Massachusetts Department of Environmental Protection
One Winter Street
Boston, Massachusetts 02108

RE: Modified Stabilization Plan
General Chemical Corporation
133 – 135 Leland Street
Framingham, Massachusetts 01702

MADEP RTN 3 - 19174 EPA ID No. MAD019371079
Web File No. 04-E-005

Dear Mr. Chormann:

Enclosed please find a Modified Stabilization Plan submitted for MADEP RTN 3 - 19174, a disposal site located at the General Chemical Corporation facility, 133 – 135 Leland Street in Framingham, Massachusetts. This Modified Stabilization Plan is submitted on behalf of General Chemical Corporation, as an alternative to the 'Stabilization Plan' submitted by GZA GeoEnvironmental, Inc. (dated December 2001). The proposed Plan is designed to comply with the MADEP's *Decision with Modifications* dated November 2, 2000; Section I B of (6)(i)(1) of the General Chemical Corporation License; and Section 12.2 Stabilization Measures of the MADEP's *Decision* dated April 20, 1999.

If you have any questions concerning this submittal, please contact our office at your convenience.

Very truly yours,
Web Engineering Associates, Inc.

Jonathan A. Aisner, LSP
Senior Project Manager

cc: Mr. Michael Persico; President, General Chemical Corp.
Mr. Roy Swartz; Mgr. of Regulatory Compliance, General Chemical Corp.

Enclosure

MODIFIED STABILIZATION PLAN

GENERAL CHEMICAL CORPORATION
133 – 135 LELAND STREET
FRAMINGHAM, MASSACHUSETTS

MADEP RTN 3 - 19174

EPA ID No. MAD019371079

Submitted by:

General Chemical Corporation
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Framingham, Massachusetts 01702

Prepared by:

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March 31, 2004

MODIFIED STABILIZATION PLAN

GENERAL CHEMICAL CORPORATION
133 – 135 LELAND STREET
FRAMINGHAM, MASACHUSETS
MADEP RTN: 3 – 19174 EPA ID: MAD019371079

TABLE OF CONTENS

MODIFIED STABILIZATION PLAN

GENERAL CHEMICAL CORPORATION
133 – 135 LELAND STREET
FRAMINGHAM, MASSACHUSETTS

MADEP RTN 3 - 19174 EPA ID No. MAD019371079

1.0 INTRODUCTION

1.1 Background

Web Engineering Associates, Inc. (Web Engineering), as the successor environmental consultant of record for General Chemical Corporation, has prepared the following Modified Stabilization Plan pursuant to the requirements set forth in the Massachusetts Department of Environmental Protection (MADEP) Decision with Modifications dated November 2, 2000, Section I B of (6)(i)(1) of the License, and Section 12.2 Stabilization Measures of the MADEP April 20, 1999 Decision.

The Site consists of approximately 12 acres of land situated within a mixed residential and industrial area of Framingham, Massachusetts. It is located on the United States Geological Survey (U.S.G.S.) Topographic Map Series Framingham, Massachusetts 7.5 Minute Quadrangle (dated 1987), at approximately 42°16'23" North Latitude and 71°24'00" West Longitude. The approximate U.T.M. coordinates are 302,000 Meters East and 4,682,400 Meters North (Figure 1- Site Location Map). A detailed discussion with regard to the site location and description of the Site is found in the GZA GeoEnvironmental, Inc. "Supplemental Assessment Plan" dated December 14, 2001 (GZA, 2001a).

The General Chemical Corporation facility (hereinafter referred to as "the Site") was assigned Release Tracking Number (RTN) 3 - 19174 by the Massachusetts Department of Environmental Protection (MADEP), following notification of releases of Oil and/or Hazardous Materials (OHM) to the environment. The primary constituents of concern, as described in numerous historical site investigations, include Volatile Organic Compounds or VOCs, with sources from a variety of chlorinated and non-chlorinated/aromatic compounds stored at the facility. These constituents have impacted groundwater at and in the immediate vicinity of the General Chemical Corporation facility, and to a much lesser extent nearby surface waters. The primary parent constituents of concern include chlorinated and aromatic VOCs, principally: tetrachloroethylene (also known as

Perchloroethylene, "Perc" or PCE), 1,1,1-trichloroethylene (or TCE), 1,1,1-trichloroethane (or TCA), dichloromethane and 1,4-dioxane. The primary degradation constituents of concern of the aforementioned, include 1,1-dichloroethene, *cis*-1,2-dichloroethene, 1,1-dichloroethane and vinyl chloride. Many of these constituents are present in the groundwater as both dense, non-aqueous phase liquids (DNAPL) and dissolved products.

The General Chemical Corporation property has a lengthy ownership and compliance history with multiple consultants, and complicated and varied contaminants in a variety of environmental media. Numerous environmental studies have been performed at the Site since 1992. These studies are discussed in greater detail in the GZA GeoEnvironmental, Inc. "Supplemental Assessment Plan" dated December 14, 2001 (GZA, 2001a). Recent literature documenting the nature and extent of surface/subsurface impact and proposed remedial actions was presented in the GZA GeoEnvironmental, Inc. "Supplemental Assessment Plan" dated December 14, 2001 (GZA, 2001a) and in the GZA GeoEnvironmental, Inc. "Stabilization Plan" dated December 14, 2001 (GZA, 2001b). The most recent surface and subsurface hydrogeologic and environmental impact data is presented in the GZA GeoEnvironmental, Inc. "Semi-Annual Assessment Monitoring Report (AMR) June 2003 Program" dated November 5, 2003 (GZA, 2003). GZA GeoEnvironmental, Inc. has proposed a site stabilization plan consisting of a groundwater extraction and treatment (air stripping and activated carbon adsorption) system in an effort to control the release of constituents of concern to potential exposure points and to reduce the concentration of the constituents of concern within the impacted media. Treated groundwater would therefore be discharged to nearby surface waters (i.e. storm drains) through implementation of National Pollution Discharge Elimination System (NPDES) permitting.

Web Engineering proposes the utilization of a modified groundwater extraction and treatment system that uses enhanced bioremediation (for the initial reduction in the concentrations of constituents of concern) and the re-introduction of the biologically treated groundwater to the subsurface to complete an effective *ex-situ/in-situ* closed-loop site stabilization/remediation system with the capability of reaching a Permanent Solution and a level of No Significant Risk in a more timely and cost-effective manner. A significant advantage of this groundwater extraction and treatment system is that a NPDES (or other) discharge permit would not be required during operation of the system.

1.2 Response Action Objectives

The objective of this Modified Stabilization Plan is to present information on the installation, operation and maintenance, and monitoring of the proposed groundwater recovery and biotreatment system. Conceptual site stabilization descriptions and designs will be presented in this report. The proposed groundwater stabilization system includes the installation of groundwater recovery wells, a groundwater biological and granular activated carbon treatment system, and a groundwater re-distribution system consisting primarily of injection trenches/galleys and wells. The conceptual site stabilization designs and proposed design and operating parameters of the groundwater recovery and treatment system will be discussed in Section 3.0 of this report.

Groundwater recovery and treatment systems and *in situ* direct injection systems, similar to the stabilization actions proposed in this Modified Stabilization Plan, utilizing bioremediation as the principal method of reducing concentrations of constituents of concern in groundwater, have been successful at reducing chlorinated and non-chlorinated impacts to groundwater at numerous sites throughout the Commonwealth of Massachusetts and the United States. Web Engineering has successfully stabilized and remediated several sites in Massachusetts that are similar to the referenced Site, using the systems described herein, as referenced in Appendix A. It is the opinion of Web Engineering that reducing concentrations of chlorinated and non-chlorinated VOCs to GW-2/GW-3 risk characterization standards for groundwater, or approaching or achieving background and thus achieving a Permanent Solution and a level of No Significant Risk is technologically feasible based on response action evaluations and documented success of the in-place (or otherwise proposed) systems at similar disposal sites.

As previously mentioned, groundwater at and in the immediate vicinity of the Site has been impacted with chlorinated and non-chlorinated VOCS, with sources from a variety of solvents stored at the facility. At this time, Massachusetts Contingency Plan Method 1 Groundwater Category GW-2/GW-3 risk characterization standards (wherever and whenever applicable) have been selected as the target concentrations deemed appropriate for risk reduction in the interest of maintaining the level of No Significant Risk and achieving a Permanent Solution at the Site. An MCP Method 3 Risk Assessment may also be performed with respect to certain areas of concern within the Site, notably the nearby surface waters such as Course Brook and the Drainage Ditch.

It is believed that implementation of this Modified Stabilization Plan will result in achievement of a level of No Significant Risk with respect to the constituents of concern within the various media at the Site. This Modified Stabilization Plan has been prepared with the goal of achieving a Permanent Solution and a level of No Significant Risk to health, safety, public welfare and the environment at RTN 3 – 19174 under 310 CMR 40.0000, the Massachusetts Contingency Plan (the MCP) and M.G.L. 21E. This Modified Stabilization Plan will also comply with the MADEP's "Decision with Modifications" dated November 2, 2000, Section I B of (6)(i)(1) of the License, and Section 12.2 *Stabilization Measures* of the MADEP's April 20, 1999 Decision, while at the same time meeting all appropriate performance standards.

1.3 RELEVANT CONTACTS

General Chemical Corporation

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Contact: Mr. Jeffrey Riotte, Vice President
Mr. Jonathan Aisner, Senior Project Manager
Mr. Michael Hudson, Project Engineer

Other Persons

Implementation of the various site stabilization activities as described in this Modified Stabilization Plan, including system inspection, operation and/or maintenance, will be performed by Web Engineering Associates, Inc. (Web Engineering) and/or General Chemical personnel as appropriate. Web Engineering personnel may be contacted as indicated in Section 1.3. Outside vendors (i.e. drillers, construction personnel, analytical testing laboratories, risk assessors, etc.) will be recommended by Web Engineering and will perform the work subject to the approval of General Chemical Corporation.

2.0 SITE CHARACTERISTICS

2.1 Site Hydrogeology

The Site is situated within the Coastal Lowlands physiographic subregion of the Lower New England Physiographic Province of the United States. The coastal lowlands subregion is characterized by level or nearly levels plains and small, gently rolling, irregular hills and rounded knobs of low relief, generally not exceeding 120 meters above sea level. Topographic configurations and characteristic soil types are a result of glacial activity (Denny, 1982). The topographic configuration of the Site (and vicinity) is depicted in Figure 1. The Site is situated in a region of relatively level topography with gently rolling hills of relatively low relief to the north and southeast. Topographic elevations remain rather constant to the west and east. The general regional topographic gradient in this region is to the east-northeast, with local variations, while the local topography slopes gently to the south toward a nearby wetland associated with Course Brook, located approximately 0.5 mile to the southeast.

The regional geology is characterized by unconsolidated coarse granular fill overlying strata of sand, interbedded sand and silty sand and dense, glacial till. Soil boring logs prepared by GZA GeoEnvironmental, Inc. (GZA, 2001a) indicate a local geology comprised of approximately three to ten feet of granular fill material (fine-coarse sand, sand and gravel) overlying twenty to (approximately) fifty feet of interbedded sand and silt, greater than forty feet of clay and silt, and up to fifty feet of glacial till. Bedrock, consisting of pink to gray, fine to coarse-grained, moderately fractured to competent granodiorite, is encountered at depths greater than (approximately) forty feet below grade surface.

Based on site reconnaissance and a review of U.S. Geological Survey (USGS) 7.5 Minute topographic and geologic maps, surface water features abound in the vicinity of the Site. A west to east-trending Massachusetts Water Resource Authority (MWRA) (Sudbury) aqueduct bisects the Site, and is located approximately 100 feet to the south of the General Chemical Corporation facility. The aqueduct is considered by the MWRA as a backup water supply for the City of Boston, however it is presently not in use and has not been used for many years. Vegetated wetlands are situated within the Site, with boundaries located approximately 200 and 350 feet to the south of the General Chemical Corporation facility. An unnamed, northwest to southeast-trending man-made surface water drainage ditch is also located approximately 250 feet to the southwest and south of the General Chemical Corporation facility. The drainage ditch flows to Course Brook, a roughly southwest to northeast trending surface water body located approximately 0.5 mile to the south of the General Chemical Corporation facility. Course Brook is a tributary of Fisk Pond, located approximately 1.5 miles to the northeast of the General Chemical Corporation facility.

The depth to groundwater was recently measured by GZA GeoEnvironmental, Inc. in several groundwater monitoring wells. Groundwater is encountered at depths of between 1.5 feet below grade surface (in monitor well CDW-19S located just to the west of the man-made drainage ditch) to nearly 12.0 feet below grade surface (at monitor well GZ-6 located to the northeast of the facility, near the school property). The average depth to groundwater at the Site is anticipated between three to five feet below grade surface. Historically, groundwater levels are high during the spring or "wet season", and lower during late summer and fall or "dry season" (GZA, 2001a; GZA, 2003).

GZA GeoEnvironmental, Inc. identified two distinct overburden groundwater zones: a shallow, upper groundwater zone consisting of sand deposits with high permeability, and a deeper, lower groundwater zone consisting of sand-silt-clay deposits with lower permeabilities. The groundwater gradient (flow direction) in the upper sandy groundwater zone is generally south to southeast based on recent information provided by GZA GeoEnvironmental, Inc., however GZA GeoEnvironmental, Inc. has inferred that a southwest to northeast-trending groundwater divide, exists to the north of and roughly paralleling Leland Street. The groundwater gradient north of the groundwater divide is inferred to be to the north-northwest. The groundwater gradient (flow direction) in the lower silty groundwater zone is roughly north to south based on recent information provided by GZA GeoEnvironmental, Inc. (GZA, 2003). In an unconfined aquifer, such as found at the Site, the direction of groundwater flow is in a downgradient direction, generally perpendicular to the groundwater contours. The gently sloping groundwater gradient at the General Chemical Corporation property indicates a relatively low groundwater flow velocity. Groundwater velocity has been estimated to be approximately 0.14 feet/day.

The monitoring wells (both overburden and bedrock) were also gauged by GZA GeoEnvironmental, Inc. to determine the presence and measure the thickness of separate or free phase dense non-aqueous phase liquid (DNAPL). DNAPL was not present in any of the monitor wells gauged by GZA GeoEnvironmental, Inc. GZA GeoEnvironmental, Inc. data also indicates that the bedrock aquifer has not been impacted by constituents of concern.

2.2 Environmental Media and Constituents of Concern

The primary constituents of concern at the General Chemical Corporation site include chlorinated and aromatic VOCs, principally: tetrachloroethylene (PCE), 1,1,1-trichloroethylene (or TCE), 1,1,1-trichloroethane (or TCA), dichloromethane and 1,4-dioxane. The primary degradation constituents of concern (of the aforementioned primary constituents) include: 1,1-dichloroethene, *cis*-1,2-dichloroethene, 1,1-dichloroethane and vinyl chloride. These constituents have penetrated the vadose and saturated zones of the upper soil and groundwater zone (i.e. sand zone), through the lower soil and groundwater zone (silty zone), to the top of the more competent and less permeable glacial till layer.

These constituents of concern may be present in the groundwater as dissolved products (and possibly as DNAPL) that migrate downgradient within the upper and lower groundwater zones. These constituents have been observed to discharge within the surface waters of the Drainage Ditch and Course Brook (GZA, 2001a). An in-depth discussion regarding the nature and extent, as well as the fate and transport of the constituents of concern within the various site media, was presented in the GZA GeoEnvironmental, Inc. Supplemental Assessment Plan (GZA, 2001a).

Site constituents of concern have not impacted the bedrock, according to the GZA GeoEnvironmental, Inc. data obtained from the monitoring and testing of three onsite bedrock wells. As mentioned above, site constituents of concern have, however, impacted the surface water and sediments within the Drainage Ditch, and the surface water of Course Brook.

2.3 Significant Changes in Site Conditions

GZA GeoEnvironmental, Inc. recently completed a groundwater assessment to determine whether significant changes in site conditions have occurred at the Site since completion of the Supplemental Assessment Plan in December of 2001. The GZA "Assessment and Monitoring Report", dated November 5, 2003 (GZA, 2003), presented a discussion of the hydrology and environmental chemistry of the groundwater, based on recent data obtained from fourteen groundwater wells and four surface water sampling locations along the drainage ditch. In summary, the GZA data obtained during this monitoring period indicated that the general hydrogeologic characteristics and environmental chemistry of the groundwater at the Site has not changed significantly since the GZA monitoring program commenced in 2000. Generally speaking, groundwater levels are low in the summer and fall, rise somewhat during the winter, and are highest during the spring. Concentrations of the constituents of concern have decreased over the years, as expected since the chlorinated compounds will attenuate under un-enhanced conditions. GZA concluded that there was not any correlation between seasonal groundwater fluctuations and the concentrations of the constituents of concern.

Conditions at the Site are not anticipated to undergo any significant changes during implementation and completion of the Modified Stabilization Plan activities.

2.4 Areas of Concern Requiring Response Actions

Web Engineering has identified two general areas that will require stabilization measures as described in this Modified Stabilization Plan. These areas are as follows:

- ***Area 1***

  Area 1 is located to the northeast of the MWRA aqueduct (and Right-of-Way), generally within the General Chemical Corporation facility boundaries and slightly beyond. Groundwater in this area has been impacted by chlorinated and non-chlorinated VOCs, from historical releases occurring at the Site. A closed-loop groundwater stabilization and recovery and treatment system, consisting of groundwater recovery wells, NAPL recovery, an *ex situ/in situ* bioremediation system and a series of groundwater recharge trenches and injection wells is proposed as the preferred alternative for the impacted upper and lower groundwater zones in this area. *In situ* bioremediation via direct injection into select injection wells will also serve as a supplementary/polishing site stabilization alternative in this area. A discussion of the treatment system is provided in Section 3.0. Groundwater exhibiting the highest concentrations of the constituents of concern (i.e. in groundwater monitor wells GZ-1, CDW-5, CDW-6, GZA-13 and EW-PZ-2S) is anticipated to be recovered and treated in the treatment system installed within this area. In addition, any impacted groundwater that may infiltrate the basement of the facility warehouse will be treated within the Area 1 system.

- ***Area 2***

Area 2 is located to the south and southwest of the MWRA aqueduct, generally within the vicinity of the south side of the MWRA aqueduct Right-of-Way, and within and near the drainage ditch. Groundwater (and surface water) in this area has been impacted by chlorinated and non-chlorinated VOCs, from historical releases occurring at the Site. A second, smaller-scale, closed-loop groundwater stabilization/recovery and treatment system, consisting of groundwater recovery wells, NAPL recovery system (if necessary), an *ex situ /in situ* bioremediation system and a groundwater recharge trench and injection wells is proposed as the preferred alternative for the impacted upper and lower groundwater zones in this area. *In situ* bioremediation via direct injection into select injection wells will also serve as a supplementary/polishing site stabilization alternative in this area. A discussion of the treatment system is also provided in Section 3.0. Groundwater exhibiting the highest concentrations of the constituents of concern (i.e. in groundwater monitor wells CDW-9, CDW-19, CDW-19DD, GZA-14M, PZ-2S and PZ-3D) is anticipated to be recovered and treated in the treatment system installed within this area.

2.4 Areas of Concern Requiring Monitoring Only

As previously mentioned, there are several additional areas of concern that will not necessarily require stabilization measures, but nonetheless will require monitoring for constituents of concern, remedial additives and hydrologic impacts. These locations will be monitored on a routine basis throughout the site stabilization activities implemented elsewhere within the Site, and the results of gauging, sampling, analytical testing, etc. will be documented. (Please note that these activities are separate from the formal Assessment and Monitoring Program [AMP] and the results will not be formally reported). These areas are as follows:

- The area to the north and northwest of the GZA-delineated groundwater divide (additional groundwater monitor wells are also anticipated to be installed to monitor groundwater and constituents of concern at this location);
- Surface waters and sediments of the nearby wetlands and the Drainage Ditch will be monitored for constituents of concern (if a hydraulic connection between the shallow groundwater and the surface water of the Drainage Ditch exists, it is anticipated that microbes and nutrients will ultimately reach the media of the Drainage Ditch and augmented attenuation of the constituents of concern via indirect bio-augmentation will result);
- Surface waters (and sediments if warranted) of Course Brook will be monitored for constituents of concern;

3.0 ENGINEERING DESIGN

3.1 Conceptual Stabilization Designs

Web Engineering proposes to utilize a combination of bioremediation and carbon absorption, to reduce the concentrations of constituents of concern in the groundwater (and surface water) at the Site. A groundwater stabilization and recovery and biological treatment system is proposed to effectively reduce the concentrations of constituents of concern to levels whereby a Permanent Solution is achieved and a level of No Significant Risk to health, safety, public welfare and the environment exists. The design of the groundwater stabilization and recovery and treatment system is based on the downgradient recovery of impacted groundwater (through a series of shallow and deep overburden aquifer recovery wells), treatment of the impacted groundwater in a series of DNAPL recovery and aerobic/anaerobic biological treatment tanks using Granular Activated Carbon (GAC) as the last bioreactor, and subsequent upgradient subsurface re-injection of treated groundwater (though a series of injection trenches and wells), thereby creating a closed-loop system. The proposed groundwater stabilization and recovery and treatment system is designed to capture (stabilize) and reduce the concentrations of constituents of concern within the entire subsurface VOC plume in a more timely and cost-effective manner than by more traditional or conventional methods, such as air stripping. It is believed that implementation of the proposed groundwater stabilization and recovery and treatment system will: (1) accelerate the reduction of constituents of concern in the shallow and deeper overburden groundwater aquifers via the creation of a treatment system that not only reduces constituent concentrations within the primary (*ex situ*) treatment units (i.e. the bioreactors) but also reduces constituent concentrations *in situ* through inoculation of the subsurface with VOC-degrading microbes (thus creating groundwater treatment throughout the entire system); (2) continue to mitigate and prevent significant release migration to offsite properties (e.g. drainage ditch, Course Brook, wetlands, etc.); and (3) enhance the degradation of constituents of concern within the offsite areas of concern including the drainage ditch and Course Brook.

As previously mentioned, Web Engineering has identified two general areas that will require remedial actions as described in this Modified Stabilization Plan:

> *Area 1* is located to the northeast of the MWRA aqueduct (and Right-of-Way), generally within the General Chemical Corporation facility boundaries and slightly beyond; and
>
> *Area 2* is located to the south and southwest of the MWRA aqueduct, generally within the vicinity of the south side of the MWRA aqueduct Right-of-Way, and within and near the drainage ditch.

Groundwater stabilization and recovery, treatment, and re-injection will be implemented separately in each of these areas. That is, Area 1 and Area 2 will have a separate and distinct set of recovery wells, sheltered and secured *ex situ/in situ* biological treatment systems, injection trenches and injection wells, and groundwater monitoring wells.

3.1.1 Groundwater Recovery and Treatment

The treatment of the impacted groundwater begins with groundwater recovery from a series of groundwater recovery wells installed within each area of concern. Four groundwater recovery wells (RW-1, RW-2, RW-3 and RW-4) will be installed within Area 1, within the radius of influence of highest groundwater impact as determined through historical groundwater sampling and testing. The location of these recovery wells closely parallel the railroad tracks, as depicted in Figure 2. Two groundwater recovery wells (RW-5 and RW-6) will be installed within Area 2: RW-5 will be installed within the radius of influence of highest groundwater impact (presently in the vicinity of groundwater monitor wells CDW-19 and GZA-19DD) and RW-6 will be installed as an intercept along the Drainage Ditch. The locations of these recovery wells are also depicted in Figure 2.

Figure 3 illustrates the conceptual remedial design of the groundwater recovery-treatment-recharge system. The impacted groundwater extracted from the recovery wells will be pumped to a series of tanks for initial biological treatment. The groundwater treatment systems will be contained within secured structures.

Three 800-1,200 gallon capacity tanks are anticipated to be installed at Area 1. The first tank (Tank 1-1) will be a still tank (or separation tank) designed to capture and contain any light or dense non-aqueous phase liquid while concurrently commencing the biodegradation process. The second tank (Tank 1-2) will be an active aeration tank and bioreactor designed to facilitate the aerobic degradation of constituents of concern. A constant supply of diffused air will be pumped into the bottom of this tank to provide an aerobic environment for the microbes. The remedial additives consist of a proprietary blend of exogenous, naturally occurring, non-pathogenic VOC-degrading microbes of the *Archaea* domain, nutrients and non-toxic/non-pathogenic liquid biocatalyst that provides essential nutrients to the system. MicroSorb Environmental Products, Inc supplies the remedial additives. These remedial additives will be placed within the second tank. The third tank (Tank 1-3) will be another still tank designed to facilitate anaerobic degradation of constituents of concern. The treated groundwater, laden with VOC-degrading microbes, nutrients and liquid biocatalyst, will then be pumped through a particulate filtration system (capable of reducing or eliminating the presence of oxidized metals, such as iron and manganese, and other inorganic particulate material from the treatment system) and then into a granular activated carbon (GAC) bioreactor for final treatment.

The biologically-treated groundwater is pumped into upgradient recharge trenches and/or injection wells. The granular carbon within the GAC vessels provide a medium for microbial growth, and thus the constituents of concern are concurrently absorbed by the carbon, degraded by the microbes, reabsorbed and ultimately discharged to the subsurface. A biocatalyst generator will be installed to continually supply biocatalyst to the bioreactor tanks. A heat exchange system, to optimize treatment during the colder winter months, may also be installed as part of the treatment system if necessary.

Two tanks are anticipated to be installed at Area 2. The first tank (Tank 2-1) will serve as the active aeration tank and bioreactor designed to facilitate the aerobic degradation of constituents of concern. A constant supply of diffused air will be pumped into the bottom of this tank to provide an aerobic environment for the microbes. The remedial additives (consisting of VOC-degrading microbes, nutrients and liquid biocatalyst) will be placed within this tank. The second tank (Tank 2-2) will be a still tank designed to facilitate anaerobic degradation of constituents of concern. The treated groundwater, laden with VOC-degrading microbes, nutrients and liquid biocatalyst, will then be pumped through a particulate filtration system and then into a granular activated carbon (GAC) vessel for final treatment prior to discharge into upgradient recharge trenches and/or injection wells. A biocatalyst generator will also be installed in Area 2 to continually supply essential nutrients to the bioreactor tanks.

3.1.2 Groundwater Recharge

The treated groundwater (remedial wastewater) will be directed back to the groundwater at each Area via a series of groundwater recharge trenches and injection wells. Two recharge trenches (RT1-1 and RT1-2) and four injection wells (IW-1 through IW-4) are to be installed within Area 1. One recharge trench (RT2-1) and two injection wells (IW-5 and IW-6) are to be installed within Area 2, as depicted in Figure 2. The recharge trenches will be installed upgradient of the areas of critical subsurface impact. The recharge trenches will be installed to depths at or just above the groundwater table (an anticipated 3 to 5 feet below grade surface). Each recharge trench will be filled with stone to allow for the return of the treated groundwater to the subsurface. Each recharge trench (between 80 to 100 feet in length) will have a holding capacity of up to 3,000 – 4,000 gallons. The effluent from the groundwater treatment system will be directed through dedicated piping to the recharge trenches via active pumping or gravity flow.

Each groundwater recharge trench will be filled with stone that will allow the treated groundwater to infiltrate the subsurface and subsequently flow downgradient toward the recovery wells, in effect flushing the groundwater plume.

In the event that discharge through recharge trenches is temporarily infeasible due to high groundwater, treated groundwater will be directed into the injection wells that will serve as secondary back-up recharge points. The injection wells will be installed within, adjacent and/or within proximity to the recharge trenches. As tertiary backup to the proposed groundwater recharge system, treated groundwater may also be directed into the more highly impacted groundwater monitoring wells.

3.1.3 *In Situ Bioremediation of Groundwater (Bioinjection)*

Web Engineering also proposes the *in situ* biological treatment of groundwater within both Areas 1 and 2 at the Site through direct inoculation to impacted soil and groundwater with a proprietary blend of exogenous, naturally-occurring, non-pathogenic microorganisms of the *Archaea* domain supplemented with nutrients and liquid biocatalyst. The microbes are capable of migrating through soil and groundwater in search of food sources (i.e. carbon) such as those constituents of concern found at the Site (e.g. chlorinated solvents). Figure 4 depicts a conceptual model of subsurface soil and groundwater media impacted by a release of constituents of concern such as those found at the Site. Although the conceptual model may not reflect identical conditions at the Site, similar conditions do exist. Figure 4 also depicts a typical *in situ* bioremediation system, similar to that which will be utilized at the Site, consisting of specified bioinjection well points at strategic locations to effectively treat subsurface soil and/or groundwater impacts. Existing upgradient and downgradient groundwater monitor wells will be utilized to monitor for nutrients necessary for microbial activity, plume migration, and physiochemical characteristics of groundwater media. Please note that the purpose of these specific injection points are not designed to biologically treat the larger subsurface plume within the entire Site; rather, the intent of the direct *in situ* injection system will be to augment treatment in specific areas/wells of concern, either those areas that specifically need additional microbes and nutrients to augment the biodegradation process, or to degrade the constituents of concern (including degradation products) to levels that approach background concentrations and which no longer pose a risk.

The microbes will be introduced into specific well point(s), such as monitor wells GZ-1, CDW-5, CDW-6, GZA-13 and EW-PZ-2S within Area 1, and wells CDW-9, CDW-19D, GZA-14M, GZA-19DD, PZ-2S and PZ-3D (all within the vicinity of greatest groundwater impacts at the present time). Additional injection points may also be utilized throughout the Site if necessary. Additional injection wells may also be installed upgradient, downgradient and/or cross-gradient of areas of subsurface impact if necessary, for the purpose of ensuring more complete treatment and to compensate for seasonal variations in the direction of groundwater flow and depth of groundwater. The (tentative) locations of the injection wells are depicted in Figure 2.

The subsurface will be injected with a blend of microbes, nutrients and liquid biocatalyst. These remedial additives will be discussed further in Section 3.2.6. The microbes, nutrients and liquid biocatalyst will be administered into the soil and groundwater, under low pressure or gravity flow, at each designated injection well point. Low-pressure injection is recommended in order to maintain control of the applications and to maximize the effectiveness of the volume of additives during each application. Low-pressure injection will also insure symmetrical infiltration of the bioremediation additives through the radii of influence at each injection point. In the event additional injection wells need to be installed, overlap of remedial product within adjacent radii of influence is anticipated, and is expected to maintain complete coverage within the areas of concern. Upgradient and/or cross-gradient injection of the microbial products will further insure complete and widespread application and enhance downgradient biodegradation of constituents of concern at the site. Hydraulic control of the aquifer(s) will be maintained, and verified through the program of groundwater gauging and monitoring for constituents of concern and microbial additives. Residual impacts to soil and groundwater are anticipated to be adequately treated using this technology.

3.1.4 Bioaugmentation and Monitored Attenuation

Bioaugmentation is a technology whereby a supplemental consortium of microbes (and nutrients) are directly or indirectly added to a given media to accelerate the contaminant degradation process already taking place due to the presence of naturally occurring microbes in that given media. Attenuation is the ability of the biochemical and physiochemical characteristics of surface water and sediment to reduce the concentrations of constituents of concern.

Bioaugmentation at the Site may involve the indirect introduction of a mixture of microbes, nutrients and liquid biocatalyst to the surface water and sediments, such as those media within the drainage ditch, Course Brook and/or the wetlands, in order to further reduce the concentrations of constituents of concern to achieve a Permanent Solution and a level of No Significant Risk. GZA GeoEnvironmental, Inc. has noted the effective and steady decrease in the concentrations of constituents of concern within impacted surface water media at the Site (i.e. the Drainage Ditch and Course Brook) based on surface water sampling and analytical testing performed between years 2000-2003 (GZA, 2001a, 2003). This is indicative of some biodegradation in the absence of aggressive remedial activity. The biochemical and physiochemical characteristics of the surface water and sediment within these locations appear to be conducive for natural bioremediation and are anticipated to result in the reduction, detoxification and/or destruction of the constituents of concern which may be present in the media at these locations. Bioaugmentation is best suited for those areas where constituents of concern are present at concentrations that warrant further response actions, but where response actions such as surface water recovery and treatment and management of impacted sediments are cost-prohibitive.

Additionally, the microbial consortium along with biocatalyst could also be directly added to these receptors to augment the biodegradation process. Implementation of the bioaugmentation procedure would include the following steps: (1) mobilization of treatment materials to these areas; (2) microbes, nutrients and biocatalyst would be mixed in a tank and subsequently applied to the surface waters and/or sediments; and constituents of concern within the treated media would be allowed to biodegrade; and (3) surface waters and sediments within these areas would be periodically sampled and analytically tested for VOCs to determine biodegradation rates and do determine whether VOC concentrations have been adequately reduced to levels protective of human health and the environment. The monitoring of the attenuation of the constituents of concern would be facilitated through routine collection of surface water and sediment samples, analytical testing and subsequent evaluation.

3.2 Design and Operating Parameters

3.2.1 Groundwater Recovery Wells

Groundwater recovery well locations will vary depending upon access to the designated well installation areas. Selection of the precise location of the recovery wells will be made in the field by Web Engineering in corroboration with General Chemical Corporation, and in consideration of proximity to existing Site features such as structures and utilities and health and safety of field and operational personnel. The wells will be installed in areas that facilitate adequate groundwater capture, and mitigate and/or prevent migration of constituents of concern to both onsite and offsite sensitive environmental receptors such as the drainage ditch, the wetlands, the MWRA aqueduct and Course Brook. Dig Safe will be notified prior to soil boring/well installation activities. All appropriate performance standards with respect to well installation will be met during site activities.

Depths of the wells may vary dependent upon field observations, but will generally be installed to depths of up to 40 feet below grade surface (within the shallow and deeper overburden zones of groundwater impact). Soil borings advanced for well installation will be completed using a rotary drill rig. Installation of wells within more competent lithologies (i.e. glacial till or bedrock) are not anticipated at this time. The groundwater recovery wells will be constructed of six-inch (inside diameter) polyvinyl chloride (PVC) pipe with 0.010" or 0.020" slotted screen and solid riser, and completed with expandable locking caps and flush-mounted or standing road boxes. The wells will be screened from total depth to approximately two feet below grade surface. Clean environmental sand will be placed within the annular space between the borehole and the well material, from approximately one to two feet below grade surface to total depth. Bentonite and/or a cement-bentonite grout will be placed between one to two feet below grade surface to seal the borehole. The borehole will then be filled to grade surface with cement.

A centrifugal pump will be installed at the bottom of each recovery well. Electrical and groundwater recovery components will be installed within a utility trench from the wellhead to the treatment area. A (approximately) 4' X 4' X 4' utility distribution manhole, complete with metal cover, will be installed around the top of each recovery well for access during operation, maintenance and monitoring of the system.

If groundwater recovery wells are required to depths within the more competent strata, alternate drilling methods will be used such as large diameter hollow stem auger or roller bit, air hammer and/or wireline HQ coring system.

Based on our present knowledge of Site conditions, four groundwater recovery wells (RW-1, RW-2, RW-3 and RW-4) are anticipated to be installed within Area 1, and two groundwater recovery wells (RW-5 and RW-6) are anticipated to be installed within Area 2. In Area 1, the recovery wells are anticipated to be installed on an 80' to 100' spacing between existing groundwater monitor wells CDW-2 and CDW-7, as depicted in Figure 2. In Area 2, RW-5S and RW-5D are anticipated to be installed at or in the immediate vicinity of monitor well CDW-19D/GZA-19DD, where both the upper sand and lower silt aquifers are impacted. Recovery well RW-5S will be installed within the upper (silty) aquifer to a depth of approximately 25' bgs (or at the sand/silt interface); and RW-5D will be installed within the lower (sandy) aquifer to a total depth of approximately 40' bgs as identified at the silt/till interface. Recovery well RW-6 is anticipated to be installed along the drainage ditch in the vicinity GZA surface water sampling station SW-9. The determination whether additional bioinjection wells and/or groundwater monitoring wells will be necessary will be at the discretion of Web Engineering.

Groundwater is anticipated to be recovered at a rate between ten to fifteen gallons per minute (gpm), distributed between the four recovery wells in Area 1 and the two recovery wells in Area 2. The primary function of recovery well RW-6 is to maintain hydraulic control of the Site and to mitigate offsite migration of constituents of concern. The primary function of recovery wells RW-1 through RW-6 is to intercept and recover the majority of the groundwater with elevated concentrations of constituents of concern. Influent discharge lines will be sufficiently insulated against the cold weather to deter freezing during the cold, winter months. The treatment systems are anticipated to be housed within insulated structures, allowing the components of the treatment systems to function at capacity during both warmer and colder months of the year.

3.2.2 Groundwater Treatment System

The recovered groundwater will be directed into a series of two to three vertical, 800 – 1,200 gallon capacity bioreactor tanks. Microbes, nutrients and biocatalyst will be added to dedicated tanks in each area. Addition of microbes, nutrients and biocatalyst will continue in the bioreactors on a routine basis and will consist of a combination of MicroSorb® DC (dechlorinating microbes), SC (aromatic VOC-degrading microbes), nutrients and an air pump.

The biocatalyst generators will also operate, providing essential nutrients and enzymes to the system. Each system will add liquid biocatalyst to the effluent at rates of up to 20 gallons per hour. Biocatalyst activator is anticipated to be added to the systems at a rate of up to 10 ounces per week.

A centrifugal pump will then direct the biologically-treated water through a sequestering system and/or a series of large (up to 25 micron) bag filters, installed to remove oxidized metals and particulates (primarily iron and manganese) from the effluent water. If a metals sequestering system is utilized to control the iron and manganese, each system will consist of a dosing pump that will dispense the metal sequestering agent, compatable with the treatment system, to the treatment liquid at a rate proportional to the rate of each treatment system flow-rate. The filtration system will consist of bag filters (with an adequate particulate removal rating), support baskets and metal housings. The effluent will then pass through a liquid phase GAC vessel as a final bioreactor prior to discharge into the groundwater recharge trenches or wells. The effluent water is anticipated to be divided between the recharge trenches and injection wells. A conservative estimate indicates that at an average recovery rate of 10 - 15 gallons per minute, approximately 14,400 - 21,600 gallons of treated groundwater could be recovered, treated and discharged per day through the array of recharge points.

3.2.3 Groundwater Recharge Trenches/Galleys

The treated groundwater will be re-introduced to the groundwater within each Area, through a series of groundwater recharge trenches and injection wells. Two recharge trenches (RT1-1 and RT1-2) and four injection wells (IW-1 through IW-4) are anticipated to be installed within Area 1. One recharge trench (RT2-1) and two injection wells (IW-5 and IW-6) are anticipated to be installed within Area 2, as depicted in Figure 2.

As previously mentioned, the recharge trenches will be installed upgradient of the areas of critical subsurface impact, to depths at or just above the groundwater table (an anticipated 3 to 5 feet below grade surface). The groundwater recharge trenches will be mechanically excavated, with approximate dimensions of 80'-100' X 4' X 3-6' (or to top of groundwater). A four-inch diameter perforated PVC pipe will be installed horizontally at the base of each recharge trench. Each groundwater recharge trench will be lined with a geotextile fabric (to prevent infiltration of fine-grained sediment that may plug the recharge system) then subsequently filled with ¾" stone (that will allow the treated groundwater to fill the trench and passively infiltrate the subsurface and subsequently flow downgradient). Each recharge trench will have a holding capacity of up to 3,000 – 4,000 gallons. The effluent from the groundwater treatment system will be directed through dedicated piping to the horizontal perforated piping within the recharge trenches via active pumping or gravity flow. The piping will be insulated against freezing during cold winter months of operation.

3.2.4 *Injection Wells*

If the discharge through recharge trenches is temporarily infeasible due to high groundwater, treated groundwater will be directed into the injection wells that will serve as secondary back up recharge points. The injection wells are designed to provide the impacted areas of the subsurface with highly treated groundwater containing microbes and nutrients to further augment the biological degradation of the constituents of concern. The injection wells will be installed within, adjacent and/or within proximity of (i.e. within 100 feet) the recharge trenches. As tertiary backup to the proposed groundwater recharge system, treated groundwater may also be directed into the more highly impacted groundwater monitoring wells.

Installation of the injection wells will follow similar protocols for recovery well installation. Depths of the wells may vary dependent upon field observations, site geology and depth of subsurface impacts, but will generally be installed to depths of up to 40 to 60 feet below grade surface (within the shallow and deeper overburden zones of groundwater impact). Soil borings advanced for well installation will be completed using a rotary drill rig. Installation of wells within more competent lithologies (i.e. glacial till or bedrock) are not anticipated at this time. The groundwater injection wells will be constructed of six-inch (inside diameter) polyvinyl chloride (PVC) pipe with 0.010" or 0.020" slotted screen and solid riser, and completed with large utility manholes. The wells will be screened between total depth to approximately ten feet below grade surface, and within specific zones of subsurface impact, i.e. the upper sand zone or the lower silt zone, or both. Clean environmental sand will be placed within the annular space between the borehole and the well material, from approximately ten feet below grade surface to total depth. Bentonite and/or a cement-bentonite grout will be placed at the top of the screened interval and at the top of the well. The borehole will then be filled to grade surface with cement.

Injection wells IW-1, IW-3, IW-4, IW-5 and IW-6 are anticipated to be installed within or adjacent to the groundwater recharge trenches. A hydraulic connection between these injection wells and the groundwater recharge trenches would enable the groundwater recharge system to accommodate the concurrent infiltration of treated groundwater to the subsurface through both the recharge trenches and the injection wells. The injection wells will be installed upgradient of the recovery wells and will serve to: (1) flush impacted groundwater toward the recovery wells; and (2) re-distribute microbes and nutrients to more significantly impacted areas of the subsurface. These injection wells will be screened within the upper and/or lower zones of subsurface impact and will be fitted with an interchangeable seal designed to accommodate active groundwater recharge through low-pressure injection or passive groundwater recharge through gravity flow.

3.2.5 Groundwater Monitoring Wells

Generally speaking, the existing groundwater monitoring wells located at and in the vicinity of the Site will continue to be utilized for the purpose of monitoring the groundwater for constituents of concern, microbial additives and physiochemical characteristics of the groundwater.

Four to six additional groundwater monitoring wells are proposed to be installed to the north and northeast of Area 1, as depicted in Figure 2. Four wells will be installed along Leland Street and designated as WMW-1S, WMW-1D, WMW-2S and WMW-2D. Wells WMW-1S and WMW-1D will be installed adjacent to each other as will WMW-2S and WMW-2D. WMW-1S and WMW-2S will be installed to monitor the upper (shallow) sand aquifer; WMW-1D and WMW-2D will be installed to monitor the lower (deeper) silt aquifer. These wells will be installed for the purpose of: (1) confirming the presence and extent of and determining the hydrologic characteristics of the groundwater divide identified by GZA GeoEnvironmental, Inc.; (2) determining and monitoring the effects of the groundwater recovery and recharge on the groundwater divide in both the upper and lower aquifers; and (3) ensuring the maintenance of hydraulic control during groundwater recovery and treatment through a program of routine groundwater gauging and analytical testing for constituents of concern and remedial additives. One to two additional wells (WMW-3 and, if necessary WMW-4) will be installed adjacent to the school property, to the northeast of the Site. These wells will be installed for the purpose of ensuring the maintenance of hydraulic control during groundwater recovery and treatment through a program of routine groundwater gauging and analytical testing for constituents of concern and remedial additives. Again, these data obtained from these proposed wells are considered separate from the existing AMP.

The groundwater monitoring wells will be constructed of two-, four or six-inch (inside diameter) polyvinyl chloride (PVC) pipe with 0.010" or 0.020" slotted screen and solid riser, and completed with expandable locking caps and flush-mounted or standing road boxes. The wells will be screened between total depth to approximately two feet below grade surface, and within the upper sand zone or the lower silt zone, or both. Clean environmental sand will be placed within the annular space between the borehole and the well material, from approximately one to two feet below grade surface to total depth. Bentonite and/or a cement-bentonite grout will be placed between one to two feet below grade surface to seal the borehole. The borehole will then be filled to grade surface with cement.

3.2.6 Remedial Additives

The product proposed for use at the Site is a proprietary blend of naturally occurring, exogenous, non-pathogenic microbes of the *Archaea* domain, which have been cultured to augment the development and metabolic/reproductive rates of select strains. These microbes have a preference for metabolizing long-chain and cyclic petroleum hydrocarbons and chlorinated solvents, such as those found at the Site. The microbes and associated remedial additives (i.e. nutrients) will be provided by MicroSorb® Environmental Products, Inc. (MicroSorb®) of Norwell, MA.

The microbial products contain a consortium of petroleum hydrocarbon-degrading and dechlorinating microbes (including MicroSorb® DC and MicroSorb® SC) at concentrations of up to 90 billion microbes per gram. Approximately one pound of microbes and 0.2 pounds of nutrients are typically added to the bioreactor tank(s) each week. Approximately ten ounces of biocatalyst activator are typically added to a biocatalyst generator each week. These materials are added to the groundwater treatment system daily. Generally, 0.5 pound of MicroSorb® DC, 0.5 pound MicroSorb® SC, 0.2 pound nutrients and 50 gallons of biocatalyst will be routinely injected into each bioinjection well. Additional microbes will be added (to the subsurface) on an as needed basis. Information on the MicroSorb® products is included in Appendix A.

Typical nutrient mixtures that are applied are analogous to a common 20-30-20, non-urea plant food with a balanced Nitrate/Nitrogen content. The optimal concentration of nutrient mixture is 13 mg/l of which 20% (approximately 2.6 mg/l) is total Nitrogen and 1.2 % (approximately 0.16 mg/l) is nitrogen as Nitrate. The addition of the nutrient mixture typically does not produce a Nitrate/Nitrogen level in downgradient wells in excess of the Massachusetts Groundwater Quality Standards established under 314 CMR 6.00 (10 mg/l). The amount of nutrients to be added to the subsurface will be dependent upon the results of analytical testing for background nitrogen levels in groundwater prior to commencement of treatment, and periodic testing of the groundwater during treatment. Information on nutrient additives are also presented in Appendix A.

The proprietary, water-based biocatalyst that produces essential nutrients and enzymes that facilitates an accelerated microbial metabolic-reproductive rate, is introduced into the subsurface simultaneously with the microbes. The biocatalyst is non-pathogenic, non-toxic and non-flammable, and is further described in Appendix A. The liquid biocatalyst will have no adverse impact on soil, groundwater or surface water quality at the Site or beyond.

3.2.7 Safety Controls

<u>Groundwater Recovery, Treatment and Recharge System</u>

The groundwater recovery and treatment system will operate on a 24 hour per day basis, seven days per week. Groundwater recovery (and containment within the bioreactors) will be controlled by high and low level probes installed within the treatment tanks. A high level probe within the injection trenches will also shut off the system automatically upon overload. Non-aqueous phase liquid (NAPL) collected in the system will be contained within the first treatment tank at each Area, thus eliminating the need for offsite disposal. Groundwater recovery and recharge rates will be monitored (controlled) through an individual series of flow meters and adjustable flow valves for each recovery and recharge point. Web

Engineering, in conjunction with General Chemical Corporation personnel, will oversee the day-to-day operation of the treatment system.

Bioinjection, Bioaugmentation and Monitored Attenuation

Safety control devices, including (but not limited to) containment structures, leak detection devices, run-off controls, pressure valves, bypass systems or safety cutoffs, are not applicable to these remedial actions at this time.

3.3 Anticipated Biodegradation Process and Treatability

The objective of the bioremediation process at the Site will be to augment or accelerate the natural and enhanced biodegradation rates of constituents of concern in the subsurface soil, groundwater and nearby surface water and sediments where present. Groundwater stabilization and recovery-treatment-recharge systems operated by Web Engineering have been successful at reducing concentrations of constituents of concern at similar sites throughout the Commonwealth of Massachusetts. Due to the complexities of the Site, both in terms of hydrogeology, release history, the dynamics of the groundwater recovery-treatment-recharge system, etc., it is expected that occasional rebounding of constituents of concern will occur. However, the effect of these Site complexities are anticipated to be easily overcome through unique and innovative engineering design, to where the system performs within expectations. The degradation of the constituents of concern at the Site are expected to continue, and it is anticipated that such concentrations at the Site and beyond, will be reduced to applicable Massachusetts Contingency Plan risk standards and achievement of a level of No Significant Risk. Web Engineering anticipates a minimum of 30% reduction (treatment system performance standard) in the concentrations of the constituents of concern within the treatment system, that is, between the groundwater influent (prior to treatment) and groundwater effluent (following treatment). It is anticipated that between 98-100% destruction of the chlorinated compounds will occur during the proposed site activities.

The microbes metabolize the constituents, using the carbon as the primary food source and releasing carbon dioxide and water. Microbes tend to metabolize and reproduce more rapidly in the presence of greater amounts and concentrations of the constituents of concern. The inherent ability of the microbes to migrate toward food sources, coupled with rapid metabolic and reproductive rates, allows for a more ubiquitous, and thus more efficient, rate of biodegradation within the affected subsurface media.

Web Engineering recently completed a Bench Test to determine biodegradation rates and efficiencies for the destruction of the constituents of concern. On February 6, 2004 a sample was obtained for baseline testing (prior to microbial treatment). The groundwater was treated with microbes, nutrients and biocatalyst. A second sample was obtained for testing after twelve days of treatment (February 18, 2004) and a third sample was obtained for testing after 21 days of treatment. The results of the Bench Test, to date, are presented in Table 1.

Table 1

Constituent of Concern (GW-2/GW-3 standard)	Baseline Test Before Treatment (02.06.04)	Degradation Test After 12 Days (02.18.04)	Degradation Test After 21 Days (02.27.04)	% Reduction
Cis-1,2-DCE (30,000/50,000)	6,000	4	< 0.5	100
1,1,1-TCA (4,000/50/000)	1,900	1	< 0.5	100
TCE (300/20,000)	7,000	13	0.8	99.99
PCE (3,000/5,000)	240	3	< 0.5	100
Results are in parts per billion or ppb				

The constituent 1,4-Dioxane was not detected in 02.06.04 test (using a detection limit of 12,000 ppb and a dilution factor of 500) and may have been masked by high concentrations of chlorinated solvents. Results of the test on the sample obtained on 2-27-04 indicate that the only constituent of concern present at detectable concentrations is Trichloroethene at 0.8 ppb. 1,4-Dioxane was not present, using a lower detection limit of 500 ppb. In essence, all constituents of concern have been reduced to concentrations well below applicable MCP risk standards. 1,4-Dioxane was either not present in the original sample or it has been reduced to a level below 500 ppb.

As mentioned, it is anticipated that 98-100% destruction of the constituents of concern will occur during operation of the treatment system, thus downgradient impacts to various surface waters and/or sediments of the drainage ditch, Course Brook, the wetlands, etc., are not anticipated to be exacerbated. To the contrary, it is anticipated that bioaugmentation will occur, to a degree, within these surface water features as the effluent water will contain a consortium of microbes. Web Engineering will continue to monitor the effluent discharge on a routine basis.

3.4 Management of Remediation Wastes

A certain amount of remediation waste is anticipated to be generated during the implementation of the proposed response actions. A description of anticipated remediation waste and associated management follows:

Soil

The generation of soil as remediation waste is anticipated in association with the advancement of soil boring(s) (in preparation for groundwater recovery/monitor/injection well installation) and installation of the recharge trenches. A significant amount of soil (possibly between 300 – 350 cubic yards [450 – 525 tons]) is anticipated to be generated in association with well and trench construction. The soils recovered during the system installation activities will be screened in the field for the presence of volatile organic compounds (VOCs) using jar headspace methods. Generated soils will either be containerized in D.O.T.-approved 55 gallon drums or will be stockpiled on site on, and covered with 4-6 ml polyethylene sheeting. The soils will be analytically tested initially for the presence and concentration of VOCs. Testing for hazardous waste characteristics may also be required. In the event it is determined that offsite management of the soil is required (or preferred), the soils will be sampled and analytically tested for various parameters required for transport and disposal to an appropriate soil recycling or disposal facility. Proper waste management protocols and documentation will be followed at all times.

Groundwater

An undetermined amount of groundwater is anticipated to be generated during construction of the groundwater treatment systems and development of the groundwater recovery, injection and monitoring wells. Minor amounts of groundwater may be containerized in D.O.T.-approved 55 gallon drums.

However, if the generation of significant amounts of groundwater appears likely, the groundwater will be containerized in an appropriate vessel and will subsequently be transferred to the General Chemical Corporation facility or will be transferred to and processed through the on site groundwater recovery and treatment system, then re-injected into the subsurface.

A program of soil/groundwater sampling and analytical testing will be implemented to monitor for treatment of generated wastes.

Other Remediation Waste

Intangible remediation wastes which may be generated include hay bales, polyethylene sheeting, piping, bag filters, bailers, sampling gloves, absorbent pads or socks, etc. are not anticipated to be of adverse impact to the environment and will be containerized and disposed in an appropriate manner.

3.5 Potential Impacts from Implementation of the Stabilization Plan

The operation of the various treatment systems and operations described in this Modified Stabilization Plan (i.e. groundwater recovery and treatment, bioinjection, bioaugmentation and monitored attenuation) are not anticipated to have any significant adverse impact on existing onsite or offsite surface or subsurface environmental receptors. Further, the installation, operation, maintenance and/or monitoring of the various treatment systems are not anticipated to have any adverse impact on nearby environmental receptors or other natural resource areas, such as the Drainage Ditch, Course Brook, the MWRA aqueduct, the wetlands, etc.

The following procedures will be implemented at the disposal site in order to maintain compliance with the "Management Procedures for Remedial Wastewater and Remedial Additives" under Section 310 CMR 40.0040 of the Massachusetts Contingency Plan:

- The quantity of additives will be sufficiently small such that their application to the groundwater will not affect the surface or subsurface soil or any other subsurface structures, or cause any mounding, flooding, or breakout to the ground surface;

- The microbial mixture is the *Archaea*, and therefore does not contain any pathogenic or coliform bacteria and the biocatalyst is a carbon-enriched water that is processed from naturally-occurring organic materials. Accordingly, their application will have no impact on the quality of the groundwater at the disposal site. The nutrients may raise the nitrogen levels in the groundwater; however, the amount of nutrients added to the subsurface will be sufficiently low such that the Massachusetts Groundwater Quality Standards established under 314 CMR 6.00 will not be exceeded.

  Note: nitrogen levels in the groundwater will be monitored on a regular basis to insure compliance with these applicable standards.

- The application of microbes, nutrients and liquid biocatalyst will not exacerbate the existing conditions or inhibit the natural attenuation of the existing soil and/or groundwater.

3.6 Inspections and Monitoring

Soil Boring Advancement/Well Installation

The advancement of soil borings, soil sampling (if warranted), installation of groundwater recovery/injection/monitoring wells, groundwater sampling, management of remediation wastes, surface application and subsurface injection of treatment system mixtures (i.e. microbes, nutrients and biocatalyst) and the overall operation, maintenance and monitoring of the groundwater recovery and treatment and bioinjection systems will be performed under the supervision of Web Engineering. Web Engineering, in conjunction with General Chemical Corporation personnel, will perform all treatment system applications and will inspect and monitor the systems for effectiveness.

Groundwater Recovery and Treatment System

Inspection and monitoring activities for the groundwater recovery and treatment system typically occur at a minimum of two to three times per week. Since the bioreactors require the routine addition of nutrients and microbes, and the biocatalyst generator requires the routine addition of biocatalyst activator, inspections are anticipated to occur on each business day. Inspection and monitoring activities for each event are recorded on an Inspection and Monitoring Log, and kept on site in the structure housing the treatment system. Inspection and monitoring reports are submitted to the applicable regulatory agencies, including the MADEP, on (at a minimum) a semi-annual basis.

The routine inspections, performed by Web Engineering in conjunction with General Chemical Corporation personnel, will monitor a variety of conditions within the groundwater recovery and treatment system at the Site, and document the routine additives of bioaugmentation, including the addition of microbes, nutrients and biocatalyst activator. Pressure, temperature, air flow, flow for influent and effluent groundwater, etc. will be monitored at various locations along the treatment system to insure that the system is not over pressurized and is functioning at optimum efficiencies. Treatment system vessel pressures will be closely monitored as well to better determine the frequency of changing bag filters, monitoring for breakthrough of GAC vessels, etc. The pumping volume of the (bioreactor tank) air pump, maintained at approximately one cubic foot per minute, will be monitored. The flow rate of fresh water through each biocatalyst generator is anticipated to be no greater than approximately 20 gallons per hour. Groundwater elevations at selected groundwater monitoring well locations will be carefully monitored to assist in the maintenance of a proper effluent recharge to the groundwater, and to insure that groundwater does not breakout at the surface. All treatment system influent and effluent flow rates and volumes will be recorded on the Inspection and Monitoring Logs. Occasional adjustments to the groundwater recovery and treatment system are anticipated to be made to maximize water volumes, concentration levels of the influent, mitigate off site migration of compounds, and insure appropriate recharge rates. A licensed Class 2 Waste Water Operator will inspect the system at least quarterly during treatment operations.

Water samples will be collected from the influent, middle and effluent sampling ports of the groundwater recovery and treatment systems on a routine basis. Laboratory analytical results collected from the systems will be tabulated and included in the status reports. All samples will be collected directly from the sampling ports after purging the ports of a reasonable volume (approximately two gallons) of water. Samples of groundwater will be tested for VOCs and 1,4-Dioxane.

Note: It should be noted that laboratory analytical methodologies have limitations that may mislead the reader. When analyzing samples with elevated levels of constituents, dilutions to the original sample may be required. These dilutions increase detection levels and therefore may not allow for the detection of constituents present at concentrations below the detection level of the analytical test. For example, the concentration of 1,4-Dioxane in a given groundwater sample may be masked by the higher detection levels for the identification of chlorinated solvents. For this reason, 1,4-Dioxane may be analytically tested separately from the halogenated and other non-halogenated VOCs. As dilution factors decrease in a given groundwater sample, 1,4-Dioxane and other VOCs may be detected under the same analytical test.

One to two granular-activated carbon drums will be installed to treat the effluent vapor discharge from the bioreactors. A Photo-Ionization Detector (PID) or Organic Vapor Meter (OVM) will be used to evaluate the effectiveness of the carbon drums and monitor for (off-gas) VOC levels. The drums will be evaluated at three locations: at the influent, midway between the two vessels, and at the effluent discharge. The results of the monitoring will be entered on the Inspection and Monitoring Log.

The Inspection and Monitoring Log will also include a variety of additional information, including (but not limited to) date and initial time of inspection and time of departure, initial of the inspecting party, pressure gauge data, air pump and biocatalyst generator data, water levels for selected monitor wells and sumps, plug pressures and flow volumes and rates, water and treatment structure temperatures, etc.

Groundwater Monitoring/Recovery Wells

Field data and laboratory analysis will be collected in a number of wells at the Site and downgradient of the Site in order to determine if remedial additives and/or constituents of concern are migrating off the Site. This data will be summarized in the semi-annual status reports. The physical parameters of the aquifer will be measured in each monitor well using a YSI model 650 multi meter, that is placed down well prior to purging. The meter will be calibrated by the supplier prior to usage, and daily by the field engineer. The YSI will measure such parameters as temperature, dissolved oxygen, pH, oxidation/reduction potential (ORP) and specific conductivity. Groundwater will also be monitored for turbidity. Groundwater levels and screening for the presence of non-aqueous phase liquids will be measured using a Solinst Watermark Interface Probe Model H. All data will be recorded in a field notebook. A copy of the summary data will be kept on site for reference.

Groundwater samples will be obtained from selected groundwater monitoring wells on a quarterly to semi-annual basis, and analytically tested for constituents of concern (VOCs and 1,4-Dioxane) and remedial additives. Recovery wells will also be sampled on a routine basis. Samples obtained from these wells will be tested for VOCs and 1,4-Dioxane, as well as remedial additives as deemed necessary. Low flow groundwater monitoring and sampling techniques will be utilized in accordance with United States Environmental Protection Agency (EPA) guidelines.

Groundwater levels will be monitored on a routine basis during the proposed site stabilization activities. Groundwater levels will be monitored primarily for the purpose of: (1) identifying areas of groundwater mounding; and (2) ensure the constituents of concern remain within the capture zones of the recovery wells. Groundwater levels will be monitored at least once per month for the first year of system operation, and on a quarterly basis for each year thereafter.

Remedial Additives Monitoring

Remedial additives monitoring will include dissolved oxygen, nitrates, nitrites, total nitrogen, ammonia, sulfates, total phosphorus and total potassium. The analytical tests will be compared to applicable MCP risk standards and federal drinking water standards and/or surface water standards, within the MCP, 310 CMR 40.0000 or 314 CMR 6.00. The analytical results of these parameters will be very useful to establish the effectiveness of the biological treatment system and distribution of bioremediation additives.

Offsite Environmental Receptors

The offsite environmental receptors include (but may not be limited to) the Drainage Ditch, Course Brook and the MWRA Aqueduct.

These environmental receptors located off the subject property will also be routinely assessed. Upstream, midstream and downstream samples from the surface waters of the Drainage Ditch, Course Brook (and if necessary the MWRA

Aqueduct) will collected on a routine basis. Sediment samples from the Drainage Ditch and Course Brook Data and groundwater samples from the Leland Street and offsite School property wells will also be obtained routinely. The samples will be analytically tested for VOCs and 1,4-Dioxane and remedial additives (dissolved oxygen, nitrates, nitrites, total nitrogen, ammonia, sulfates, total phosphorus and total potassium) if deemed appropriate. The data will be summarized in the status reports. Anticipated sampling points are depicted in Figure 2.

Field Screening and Soil Sample Collection

Soil samples will be obtained during soil boring advancement if deemed appropriate based on evidence of significant impact by field observation. Soil samples will be evaluated in the field using a Photoionization Detector (PID) or Organic Vapor Meter (OVM), equipped with a 10.6 eV lamp and calibrated to a benzene or isobutylene standard, before each daily usage. Upon collecting the soil sample, the sampler will slowly move the PID/OVM along the sample. Every six inches, the sample will be disturbed and the PID/OVM tip will be inserted to determine Total Organic Vapor (TOV) levels at that point. Soil samples exceeding 100 TOV units will be noted in the field logbook. A second, spilt sample will be collected for Head Space Test analysis. Head Space Test analysis will be completed in accordance with MADEP protocol. Analytical testing of soil samples is not anticipated at this time. If at any time, soil sampling and analytical testing is deemed appropriate the soil sampling for laboratory analysis will be completed in accordance with the appropriate MADEP and EPA methodology, such as field extraction Method 5035 for VOCs, EPA analytical test methods 8260B Modified for VOCs, or 8021B for halogenated and/or aromatic VOCs, EPA Method 8260B using the GC/MS-SIM method for 1,4-Dioxane.

Analytical Testing Parameters

All laboratory analytical will be performed by a State Certified laboratory, based on the contaminants of concern at the Site. The following analytical test methodologies may be utilized:

- Volatile Organic Compounds (VOC) - EPA Method 8260B Extended List (using Gas Chromatography/Mass Spectrometry or GC/MS)

- Halogenated Volatile Organics – EPA Method 8021B
(using Gas Chromatography/Electrolitic Conductivity Detector or GC/ELCD)

- Aromatic and Halogenated Volatile Organics – EPA Method 8021B
(using Gas Chromatography/ Photoionization Detection/ Electrolitic Conductivity Detector or GC/PID/ELCD)

- 1,4-Dioxane – EPA Method 8260B Modified
(using Gas Chromatography/Mass Spectrometry-Selected Ion Monitoring or GC/MS-SIM)

4.0 PLANS AND SPECIFICATIONS

4.1 Plans, Specifications and Procedures

Details and specifications of the various treatment systems have been discussed in Section 3.0, and detailed graphically in Figures 2 through 4.

The site activities proposed in this Modified Stabilization Plan will be performed by and/or under the supervision of Web Engineering, in conjunction with General Chemical Corporation. Web Engineering will assume responsibility for overall treatment system management and recommendations regarding operational changes which may be necessary to complete the site activities necessary to achieve a Permanent Solution and maintain a level of No Significant Risk to health, safety, public welfare and the environment.

Web Engineering personnel may be contacted at 781.878.7766. Advancement of soil borings and installation of wells are anticipated to be performed by Soil Exploration of Leominster, MA (telephone: 978.840.0391). Analytical testing of the soil and groundwater samples are anticipated to be performed by Groundwater Analytical of Buzzards Bay, MA (telephone 508.759.4441) or Alpha Analytical of Westborough, MA (telephone 508.898.9220). Remedial (contractor) services are anticipated to be provided by General Chemical Corporation (or a licensed contractor selected by General Chemical Corporation).

Treatment system operations will require routine maintenance and monitoring. Injection wells, monitor wells, recovery wells, etc. will be periodically inspected for efficiency or damage. Wells determined to be inefficient or damaged may require replacement or repair. Wells will be gauged for constituents of concern and remedial additives as discussed in previous sections. The groundwater will also be gauged and tested for hydraulic containment, contaminant migration, elevation in nutrient levels and groundwater mounding.

Upon completion of construction activities and the initial implementation of the site stabilization activities, a final inspection of the treatment systems will be performed by Web Engineering. The final inspection will be performed to ensure that the treatment system has been constructed and that the site activities have been implemented in accordance with the construction plans and specifications as proposed in this Plan (or appropriate modifications to this Plan). A Final Inspection Report, with "As-Built" Plans, will then be prepared and submitted to the appropriate regulatory agencies.

4.2 Permit Requirements

Dig Safe will be notified prior to installation of soil borings, groundwater wells and construction of the stabilization/treatment system. A Dig Safe Permit will be obtained at that time. The treatment system will discharge to the subsurface at locations that are hydrologically up-gradient of the treatment system influent, accordingly a discharge permit will not be required. No other permits are anticipated to be required for the treatment systems or assessment activities at the Site, and Web Engineering is not aware of any additional permits that may be required at this time. The Town of Framingham Conservation Commission will be advised regarding the activities at the Site, and to determine the need of any special authorizations or permits required by the Town of Framingham.

General Chemical Corporation has a number of identification numbers and compliance activities that mandate permits as a course of their daily operation as an Adequately Regulated Site. Web Engineering does not believe that these types of permits pertain to the groundwater recovery and treatment systems or the assessment activities at the Site. Other federal and/or local permits, licenses and/or other approvals are not anticipated to be pertinent to the proposed remedial activities.

The implementation, monitoring and management of the proposed Comprehensive Response Action will be performed in a manner appropriate and adequate to protect health, safety, public welfare and the environment, in compliance with provisions of M.G.L. c.21E and within the guidelines of the Massachusetts Contingency Plan, and in accordance with all other applicable laws, regulations, orders, permits and approvals applicable to such Comprehensive Response Actions. Appropriate performance standards will be met throughout all phases of work associated with this Modified Stabilization Plan.

4.3 Property Access and Public Involvement

There are currently no relevant property access restrictions or other issues associated with the construction and operation of the proposed remedial actions. Notification of the intent to commence site activities will be provided to the following entities, and contact will be made to obtain permission for access if necessary:

- Town of Framingham Board of Selectmen
- Town of Framingham Board of Health
- Town of Framingham Conservation Commission
- Massachusetts Water Resource Authority
- Century Estates Condominiums
- Wilson School
- New York/New Haven & Hartford Railroad
- Boston Edison/NSTAR Electric

4.4 Project Schedule

The installation of the groundwater recovery wells, groundwater injection wells and groundwater monitoring wells is scheduled to begin within 60 days following submittal to and subsequent approval of this Modified Stabilization Plan by General Chemical Corporation and the Massachusetts Department of Environmental Protection. Groundwater and surface water sampling and analytical testing for constituents of concern and for the establishment of baseline physiochemical parameters of the groundwater (and soil, surface water and sediment as deemed appropriate) will commence following installation and development of the wells. The construction of the groundwater recovery and treatment system will commence concurrently with well installation activities, and is anticipated to be completed within four to eight weeks. Site activities performed under this Modified Stabilization Plan will continue until all response actions as stipulated in this Plan are completed, at which time a Response Action Completion Statement will be prepared and submitted to the Massachusetts Department of Environmental Protection.

4.5 Health and Safety Planning

The construction and operations as described in this Modified Stabilization Plan will be performed under a Health and Safety Plan (HASP) prepared by Web Engineering. A copy of the Health and Safety Plan will be provided to General Chemical Corporation.

5.0 REFERENCES

Denny, Charles S., "Geomorphology of New England", United States Geological Survey Professional Paper 1208, dated 1982 (Denny, 1982).

GZA GeoEnvironmental, Inc., "Supplemental Assessment Plan, General Chemical Corporation, 133-135 Leland Street, Framingham, Massachusetts, RTN 3-19174, EPA ID # MAD 019371079, Volumes I and II", dated December 14, 2001 (GZA, 2001a).

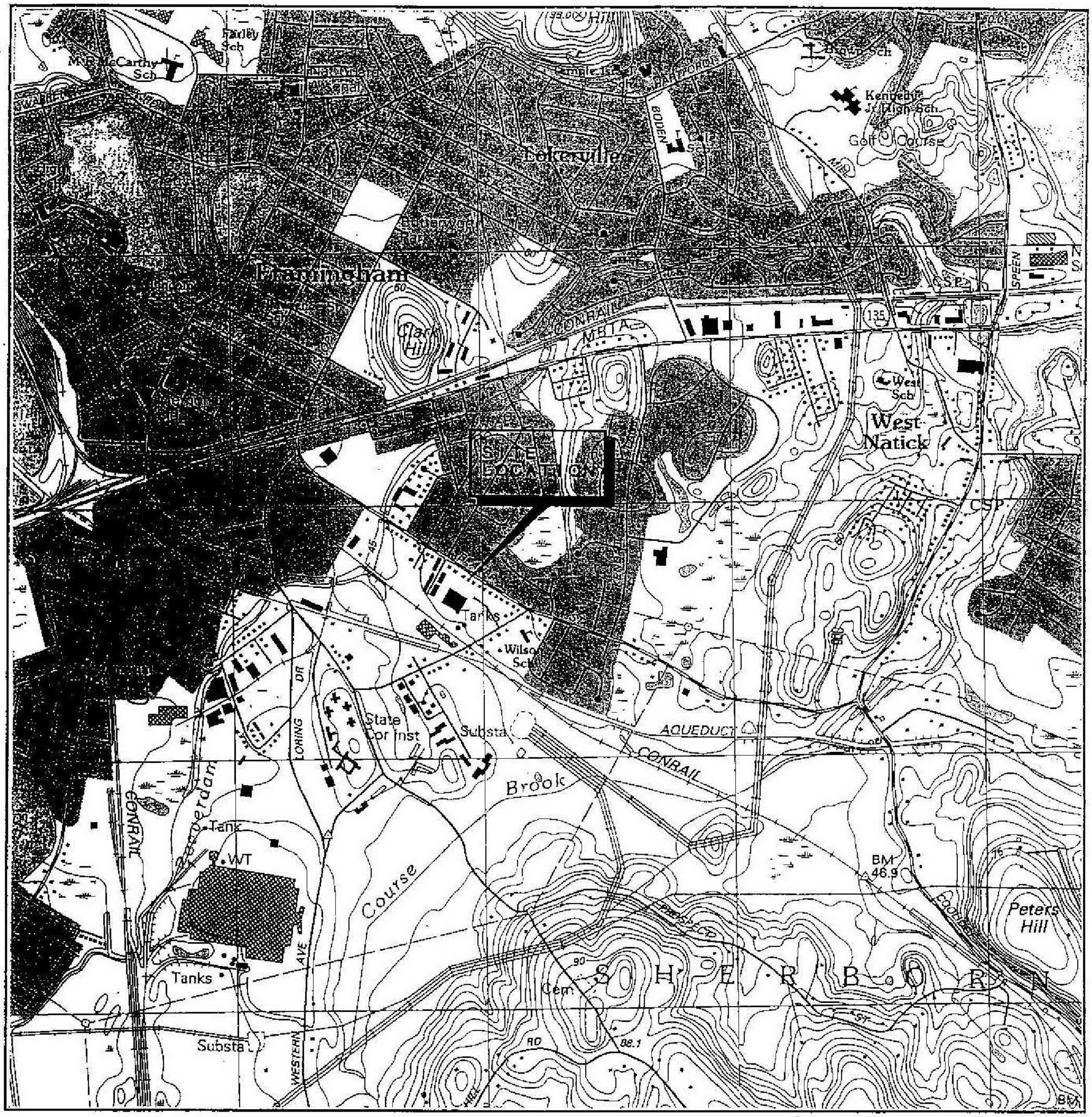
GZA GeoEnvironmental, Inc., "Stabilization Plan, General Chemical Corporation, 133-135 Leland Street, Framingham, Massachusetts, RTN 3-19174, EPA ID # MAD 019371079, Volumes I and II", dated December 14, 2001 (GZA, 2001b).

GZA GeoEnvironmental, Inc., "Semi-annual Assessment Monitoring Report (AMR), General Chemical Corporation, 133-135 Leland Street, Framingham, Massachusetts, RTN 3-19174, EPA ID # MAD 019371079, Volumes I and II", dated November 5, 2001 (GZA, 2003).

Massachusetts Department of Environmental Protection, "Massachusetts Contingency Plan" 310 CMR 40.0000, Commonwealth of Massachusetts Office of the Secretary of State, dated October 31, 1997.

United States Geological Survey, "Topographic Map Series, Framingham 7.5 Minute Quadrangle", dated 1987 (USGS, 1987).

FIGURES



Source: U.S. Geological Survey
1:25000 Quadrangle
Framingham, MA
(1987)

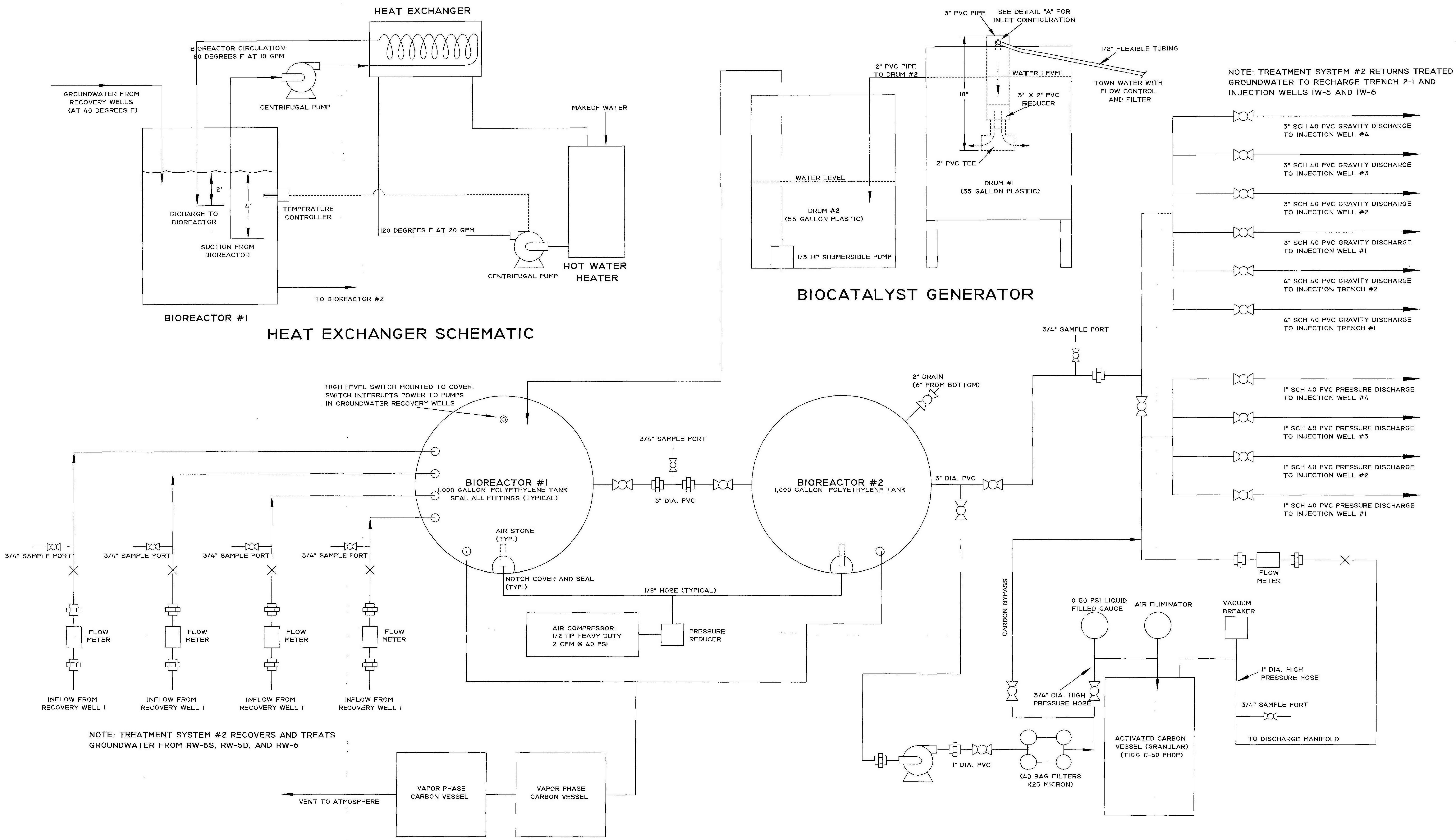
Approximate Scale (feet)

0 1000 2000 3000 4000 5000

North ↑

Web Engineering Associates, Inc. 104 Longwater Drive Norwell, Massachusetts	**SITE LOCATION MAP** GENERAL CHEMICAL CORPORATION 133-135 Leland Street Framingham, Massachusetts	**FIGURE** 1
PROJECT NO. 04-E-005		

LEGEND
MONITORING WELL INSTALLED BY SOIL EXPLORATION CORP. FOR WILSON SCHOOL PROJECT
SOIL BORING / MONITORING WELL INSTALLED BY CDW
SOIL BORING / MONITORING WELL INSTALLED BY GZA, WINTER 2000
PIEZOMETER CLUSTER INSTALLED BY GZA, WINTER 2000
SOIL BORING / MONITORING WELL INSTALLED BY GZA, SPRING 2001
PUMP TEST WELLS INSTALLED BY GZA, SPRING 2001
SURFACE WATER SAMPLING LOCATION
PROPOSED RECOVERY WELL (TO BE INSTALLED BY WEB)
PROPOSED MONITORING WELL (TO BE INSTALLED BY WEB)
PROPOSED INJECTION WELL (TO BE INSTALLED BY WEB)
PROPOSED RECHARGE TRENCH (TO BE INSTALLED BY WEB)
CAR WASH
LELAND STREET
LOCATION OF TREATMENT SYSTEM 1 TO BE DETERMINED
AREA 1
WILSON SCHOOL
GARAGE
WAREHOUSE
GENERAL CHEMICAL FACILITY
APPROXIMATE LOCATION OF GROUNDWATER DIVIDE AS IDENTIFIED BY GZA (2001)
PROPOSED LOCATION FOR TREATMENT SYSTEM 2
COMMONWEALTH OF MASSACHUSETTS AQUEDUCT
GCC PROPERTY
CROSS STREET (PAPER STREET - DOES NOT EXIST)
APPROXIMATE LOCATION OF 55 GALLON DRUMS OF UNKNOWN ORIGIN AND CONTENT
AREA 2
WELD STREET (PRIVATE WAY)
UNIVERSAL STREET (PRIVATE WAY)
POOL
TENNIS COURTS
CENTURY ESTATES CONDOMINIUMS
APPROXIMATE EDGE OF WETLANDS
UNDEVELOPED PRIMARILY WETLANDS OWNED BY CENTURY ESTATES CONDOMINIUMS
BOSTON EDISON PROPERTY LINE
SURFACE WATER DRAINAGE DITCH
BOSTON EDISON ACCESS ROAD
NEW YORK NEW HAVEN & HARTFORD R.R.
COMMONWEALTH OF MASSACHUSETTS AQUEDUCT
SITHE PROPERTY
BOSTON EDISON CO.
TOWN OF FRAMINGHAM PROPERTY
LAWRENCE J. & KATHLEEN GEOGHEGAN
FRAMINGHAM SHERBORN
DRAINAGE DITCH
COURSE BROOK
INJECTION WELL SUMP DETAILS
NOT TO SCALE
24" SQUARE HINGED LOCKING VAULT WITH 4" CHANNEL. RAISE VAULT 1" TO SHED WATER (MORRIS INDUSTRIES OR EQUAL)
W2.9 6" X 6" WIRE MESH
6" MIN. 3/4" CRUSHED STONE BENEATH FILL PADS
1" SCH 40 PVC PRESSURE DISCHARGE FROM TREATMENT SYSTEM WITH BALL VALVE AND HOSE CONNECTION FOR PLUMBERS TEST PLUG
4" SCH 40 PVC GRAVITY DISCHARGE FROM TREATMENT SYSTEM REDUCES TO 2" HOSE
OFFSET SUMP 6" FROM CENTER
6" WELL
SIDE VIEW
REINFORCED CONCRETE PAD SURROUNDING WELL
12" BEVEL (TYP. OF (4) CORNERS
1" ELECTRICAL CONDUIT
1" PRESSURE LINE AND PLUG NOT SHOWN IN PLAN VIEW FOR CLARITY
PLAN VIEW
RECHARGE TRENCH DETAILS
NOT TO SCALE
COMPACTED GRAVEL FILL WITH ASPHALT RESTORED TO ORIGINAL CONDITIONS
GEOTEXTILE FABRIC SILT BARRIER
4" SCH 40 PERFORATED PVC PIPE
3/4" ROAD STONE (WASHED)
RECOVERY WELL DETAILS
NOT TO SCALE
SEE INJECTION WELL DETAILS FOR MANWAY AND PAD SPECIFICATIONS
CHECK VALVE
DISCHARGE LINE (SIZE PVC PIPING TO PUMP)
SAND PACK
DEPTH VARIES
WATER TABLE
APPROX. 7'-0" (OR SELECT DEPTH FOR SITE CONDITIONS)
SUBMERSIBLE PUMP: SIZED FOR SITE CONDITIONS (EXTEND ELECTRICAL CORD BASED ON DEPTH OF WELL)
6" MINIMUM WELL DIAMETER
EXISTING CONDITIONS WERE OBTAINED FROM PLANS PROVIDED BY GZA (GZA 2001A, 2001B, 2003)
THE NORTHEAST BOSTON EDISON PROPERTY LINE IS SHOWN AS PROVIDED BY GENERAL CHEMICAL CORP.
SCALE
WEB ENGINEERING ASSOCIATES, INC.
104 LONGWATER DRIVE, NORWELL, MA 02061
DATE: 2/19/04
FILE: FIGURE 2
DRAWN BY: JAS
SCALE: 1" = 120'
JOB #: 04-E-005
GENERAL CHEMICAL CORPORATION
133-135 LELAND STREET, FRAMINGHAM, MASSACHUSETTS
DRAWING No: 0405
FIGURE 2: SITE PLAN



GROUNDWATER RECOVERY AND TREATMENT SYSTEM

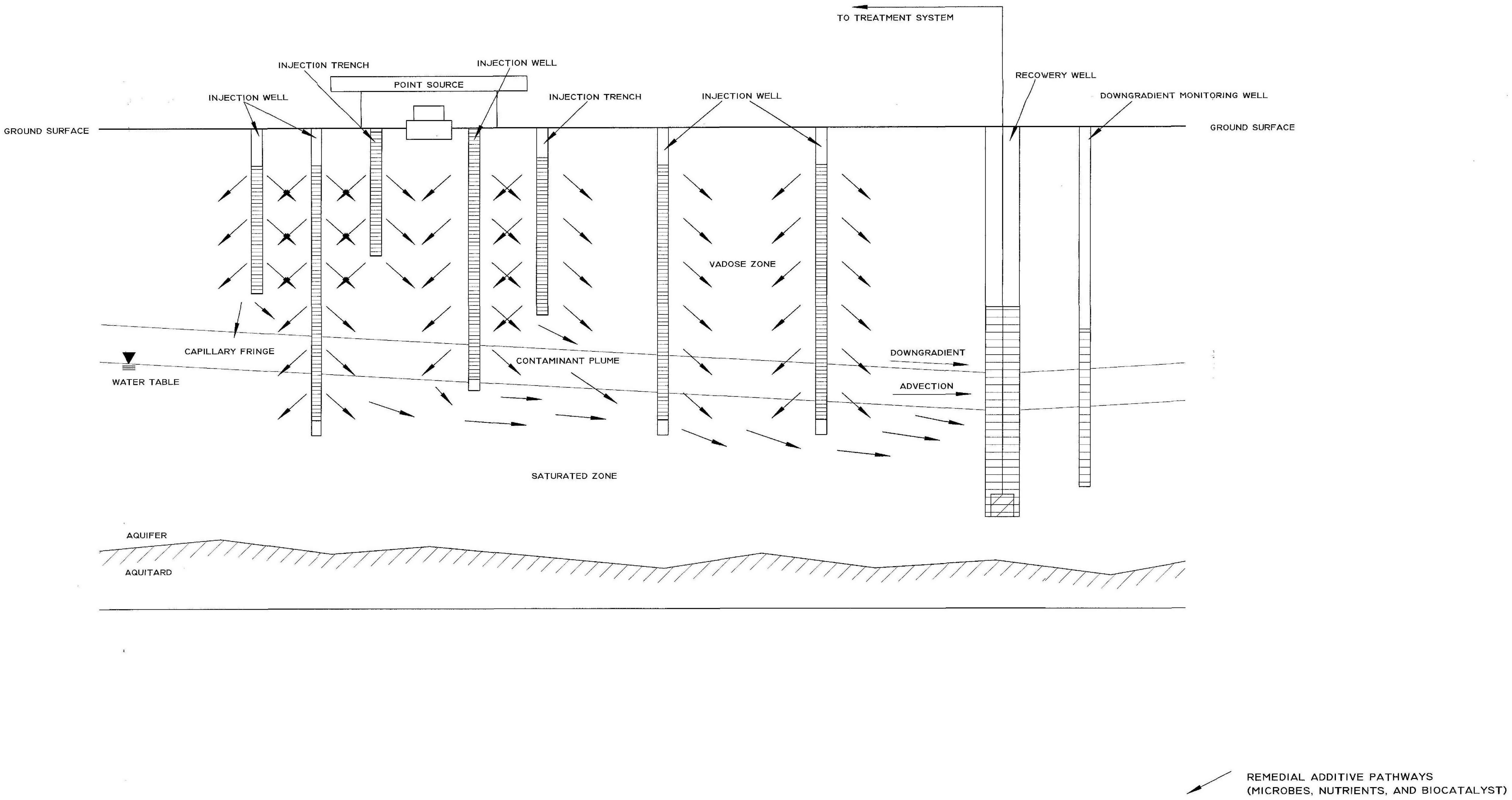
(TYPICAL OF 2 SYSTEMS)

BALL VALVE

FLOW CONTROL VALVE (GLOBE)

UNION

WEB ENGINEERING ASSOCIATES, INC. 104 LONGWATER DRIVE, NORWELL, MA 02061	
DATE: 4/10/03 FILE: FIGURE 3	DRAWN BY: JAS
SCALE: NONE	JOB #: 04-E-005
GENERAL CHEMICAL CORPORATION 133-135 LELAND STREET, FRAMINGHAM, MASSACHUSETTS	
FIGURE 3: CONCEPTUAL REMEDIAL DESIGN - GROUNDWATER RECOVERY & TREATMENT	DRAWING No: 0406



THIS DRAWING TAKEN FROM:
MACKEY, ET AL: 1985
SCHWENDEMAN, ET AL: 1987
VOGEL, ET AL: 1987
CALABRESE AND KOSTECKI, 1988

WEB ENGINEERING ASSOCIATES, INC.
104 LONGWATER DRIVE, NORWELL, MA 02061

DATE: 2/18/04	FILE: FIGURE 4	DRAWN BY: JAS
	SCALE: NOT TO SCALE	JOB #: 04-E-005

GENERAL CHEMICAL CORPORATION
133-135 LELAND STREET, FRAMINGHAM, MASSACHUSETTS

FIGURE 4: CONCEPTUAL REMEDIAL DESIGN - IN SITU BIOREMEDIATION SCHEMATIC

DRAWING No: 0407

APPENDIX A

About MicroSorb Environmental Products, Inc.

What is MicroSorb Environmental Products, Inc.?

MicroSorb Environmental Products, Inc. was incorporated in 1996 to market a superior blend of naturally occurring, non hazardous, nonpathogenic microbes and microbe "enhancers" that are utilized to break down a wide assortment of organic materials. These materials include petroleum hydrocarbons, chlorinated compounds, and animal and vegetable wastes (fats, oils, and grease).

In order for MicroSorb microbes to live, multiply, and attack organic wastes, they must have available: water, reasonable temperatures (29°F - 130°F), and oxygen. The "enhancers" mentioned above are various products provided by MicroSorb products, which help our microbes access and utilize oxygen and water.

Advantages of MicroSorb Environmental Products

MicroSorb products are highly concentrated numbers of microbes housed in a bentonite clay matrix. Some of these products have as many as 100 billion microbes per gram – more than any other currently known microbial product. This allows for lower volumes of product to treat areas where the competition must provide large doses of product with inferior microbial counts. In addition, MicroSorb microbial products have a broad variety of microbial species – capable of dealing with and destroying a large variety of contaminants.

MicroSorb products also have a long shelf life – up to five years. This permits easy shipment and lower costs compared to competitive products that often are in liquid form with limited shelf life and that often cost hundreds of dollars to ship.

MicroSorb Product Applications

The release to the environment of petroleum hydrocarbons and other organic wastes can require an expensive cleanup effort. In the past, most solutions called for digging out or pumping and treating contaminated media at huge costs to the owner. With most governmental regulations, the burden of clean up falls on the landowner. This means that not only are industry and commercial property owners impacted, but residential properties and individuals as well. The use of microbes for treating contamination in place (*in situ*) at considerably lower costs therefore should be carefully considered in most contaminated site clean-up efforts.

What types of contamination can be treated with MicroSorb Environmental Products?

Listed below is a partial list of different products/contaminants that have been successfully treated with MicroSorb microbial products:

Acenapthene
Alkylamine Oxides
Animal Wastes
Biphenyl
Chlorinated Phenols
Chloroform
Cyanide
Diethyleneglycol
Fuel Oils #1-6
Hydraulic Oils
Jet Fuels
Lubricating Oils
Methylene Chloride
Napthalenes
Oil Based Fluids
Organic Pesticides
Phenylureas
Pulp By-Products
Trichloroethylene
Xylene
Acrolein
Aromatics

Brake Fluids
Chloro Napthalene
Crude Oil
Dichlorobenzene
Ethylbenzene
Gasoline
Heptane
Kerosene
Marine Fuels
Monoalkylbenzenes
Nitrated Phenols
Oil Based Inks
Pentane
Phthalate Esters
Secondary Alkylbenzene
Sewage
Varsol

Acrylonitrile
Benzene
Chlorobenzene
Cutting Oils

Diesel Fuels
Fluoranthene
Grease
Hexane/Hexene
Isoprene
Long Chained Alkenes
Mercaptan
Motor Oils (not synthetic)
Oil Based Paints
Organic Herbicides
Phenoxyacetates
Polycyclic Aromatics
Toluene
Vegetable Oils

MicroSorb Products

The following is a brief description of the MicroSorb line of products and examples of under what conditions each product is applied. Following product application discussions are references to completed projects found in the "Projects" section of this brochure. In addition, Material Safety Data Sheets for MicroSorb products are found at the end of this section.

MicroSorb® ER (Emergency Response):
Oil & chemical surface spill treatment for virtually any hydrocarbon or oxygenated hydrocarbon product.

MicroSorb® IS (Industrial Strength):
A powerful microbial consortium which reduces organic matter.

MicroSorb® SC: (Super Concentrate):
An extra strength microbial consortium – used in oxygen limiting environments, particularly in *in-situ* bioremediation.

MicroSorb® DC: (De-Chlorinator Product)
Specifically designed to break down chlorinated hydrocarbons.

MicroSorb® Biocatalyst:
An oxygen-enriching water mixed with MicroSorb® microbes and enzymes, and applied to contaminants in oxygen limiting environments.

MicroSorb® OW (Oxygenated Water):
A hydrated nitrogen liquid that destroys organic wastes, reduces odors, and eliminates grease.

MicroSorb® Nutrients:
A blend of nutrients and trace elements designed to be immediately available for use by microbes.

MicroBlue®:
An emulsifier designed to work with MicroSorb®ER to break up heavy oils and grease and provide more surface area for the microbes to attack.

MicroSorb® Natural Degreaser
A non-flamable solvent made from plant extracts that solubilize fats, oils and grease and provides natural sugars to enhance microbial activity.

Before using MicroSorb products be sure to:

Rule # 1: Comply with Federal and State Regulations. All spills creating a sheen or discoloration of the surface waters of the United States must be reported except for specific exemptions.

Rule #2: For any chemical spill, use caution, and if unfamiliar with the product, call for professional help, i.e., Fire Department and/or a Hazardous Materials Contractor. Always approach a spill from upwind with proper safety equipment. Never smoke, use matches or open flames. Comply with OSHA requirements.

MicroSorb® ER (Emergency Response)

For oil and chemical surface spill treatment

How it works

MicroSorb® ER is a consortium of over 140 billion hydrocarbon digesting microbes per ounce contained in a bentonite clay carrier. The bentonite absorbs the spill and the microbes bioremediate the spill when water is added. MicroSorb® ER may be used to attack any petroleum based liquids (i.e. gasoline, fuel oil, hydrocarbon solvents) and virtually any hydrocarbon or oxygenated hydrocarbon. As in all MicroSorb microbial products, water and oxygen must be present to allow the microbes to break down oils into carbon dioxide, water, and soluble fatty acids. Fatty acids are a water soluble food for fish and plants.

Applications

MicroSorb® ER is utilized to:

1) Contain (absorb) and treat sudden surface spills or low level historical releases (weeping) on natural surfaces (i.e. soil).
2) Treat oily buildup or sudden spills on concrete or other man-made surfaces to eliminate oil and oil odors, reduce slippery conditions, or for repainting surfaces. (See projects D-1 and D-2)
3) Treat oily sheens on surface water.
4) Initially treat open contaminated trenches, pits, or excavations for "on the spot" cost effective remediation.

Additional product information

For spills on soils, loosen the soils with a rake. Spread MicroSorb® ER on the contaminated soil. Use one to two pounds of MicroSorb® ER per 100 square feet. Apply water and keep the soils wet. Should the soils become dry, the degradation will cease, however, the microbes will become active when more water is applied. If a spill has penetrated the ground more than 18 inches, there is not enough oxygen in the soils to support aerobic bioremediation. The soils must be cultivated to ensure bioremediation will completely destroy the spill.

MicroSorb® IS (Industrial Strength)

A powerful microbial consortium which reduces organic matter

How it works

MicroSorb® IS is a consortium of over 560 billion hydrocarbon digesting microbes per ounce contained in a bentonite clay carrier. It may be used to attack any petroleum based liquids (i.e. gasoline, fuel oil, hydrocarbon solvents, organic wastes) and virtually any hydrocarbon or oxygenated hydrocarbon. As in all MicroSorb microbial products, water and oxygen must be present to allow the microbes to break down oils into carbon dioxide, water, and soluble fatty acids. MicroSorb® IS contains a greater number of microbes per volume than MicroSorb® ER and therefore has the capability to attack hydrocarbons, oils, and grease more quickly than MicroSorb® ER when clean-up time or organic waste reduction is a significant factor.

Applications

MicroSorb® IS is utilized:

1) In the treatment of poultry grow-out houses for reduced odor, reduced wastes, and healthier, quicker grow-out conditions. (See project F-1)
2) For the more rapid cleanup of surface releases (versus MicroSorb® ER) when time is of the essence.
3) In the treatment of septic tanks and leaching fields. MicroSorb® IS helps reduce organic waste buildup in the tank and helps prevent grease and other fouling agents from entering the leaching field. (See project E-2)
4) In the treatment of surface water spills to contain and break down floating hydrocarbons.

Additional product information

MicroSorb® IS is a competitively priced, powerful blend of microbes at a concentration many times greater than any similarly priced microbial product. Typically 1/3 the amount of MicroSorb® IS is required to that of any competitive bioremediation product. MicroSorb® IS is adapted to breaking down organic wastes and grease buildup in treatment works without transferring the problem "downstream."

MicroSorb® SC (Super Concentrate)

An extra strength microbial consortium used in oxygen-limiting environments

How it works

MicroSorb® SC is a consortium of over 21/2 trillion hydrocarbon digesting microbes per ounce contained in a bentonite clay carrier. MicroSorb® SC may be used to attack any petroleum based liquids (i.e. gasoline, fuel oil, hydrocarbon solvents, organic wastes) and virtually any hydrocarbon or oxygenated hydrocarbon. As in all MicroSorb microbial products, water and oxygen must be present to allow the microbes to break down oils into carbon dioxide, water, and soluble fatty acids. However, MicroSorb® SC, because of its high microbe content and when used with MicroSorb® Biocatalyst, has the ability to attack hydrocarbons in oxygen limited environments (e.g. below grade and in groundwater). As such, it augments natural biodegradation and significantly assists existing microbes in breaking down the contaminant.

Applications

MicroSorb® SC is utilized:

1) For subsurface *in situ* soil and/or groundwater contamination treatment through subsurface bio-injection well applications, through subsurface leaching galleries, or through injection and recovery trench applications. The above applications are ideal for treating poor access areas (e.g. under basement floors, wetland areas, etc.) where destruction of property or natural resources used to be the only option. MicroSorb® SC is also ideal for treating contamination near building foundations, tanks, or utilities where contamination removal may damage structures. (See projects A-1 through A-9)
2) For treating stockpiled (*ex situ*) contaminated soil. (See projects B-1 and B-2)
3) For direct application to septic systems and grease traps to lower solids buildup, reduce odors, and break down fats, oil, and grease. (See project E-1)
4) In sewerage lift stations, piping, and wastewater treatment plants to reduce odors, limit corrosion, and lower solids disposal costs. (See projects C-1 and C-4)
5) In manure treatment (chickens, hogs, and cattle) to reduce solids, eliminate odors, and improve livestock health and grow-out.

MicroSorb® DC (De-Chlorinator Product)

Designed to break down chlorinated solvents

HOW IT WORKS

MicroSorb® DC is a consortium of over 21/2 trillion hydrocarbon digesting microbes per ounce contained in a bentonite clay carrier. MicroSorb® DC contains microbes specifically designed to breakdown chlorinated hydrocarbons. As in all MicroSorb microbial products, water and oxygen must be present to allow the microbes to break down the chlorinated hydrocarbons to water, carbon dioxide, and free chlorine. MicroSorb® DC, because of its high microbe content, and when used with MicroSorb® Biocatalyst, has the ability to attack hydrocarbons in oxygen limited environments (e.g. below grade and in groundwater). As such, it augments natural biodegradation and significantly assists existing microbes in breaking down the contaminant.

APPLICATIONS

MicroSorb® DC is utilized for subsurface *in-situ* soil and/or groundwater contamination treatment through subsurface bio-injection well applications, through subsurface leaching galleries, or through injection and recovery trench applications. (See project A-7)

MicroSorb® Biocatalyst

An oxygen enriching water that is mixed with microbes and applied in oxygen limiting environments to break down hydrocarbons

How it works

MicroSorb® Biocatalyst is processed from naturally occurring organic materials. It is oxygen enriched water with enzymes, which is mixed with microbes to attack hydrocarbon contamination in oxygen deficient conditions (i.e. subsurface soil and groundwater). Microbial activity is frequently limited by insufficient oxygen due to low rates of oxygen and carbon dioxide diffusion in subsurface soils. MicroSorb® Biocatalyst helps reduce this limiting factor. The greater the mass of oxygen available, the more rapid the clean-up.

Applications

MicroSorb® Biocatalyst is used:

1) For subsurface *in-situ* soil and/or groundwater contamination treatment through: subsurface bio-injection well applications, subsurface leaching galleries, or through injection and recovery trench applications. (See projects A-1 through A-9)
2) For increased plant growth.

Additional product information

MicroSorb® Biocatalyst is processed from naturally occurring materials; it is nontoxic, nonpathogenic, and nonflammable. MicroSorb® Biocatalyst increases microbe performance dramatically in the absence of free oxygen and it also increases microbe tolerances in salt-damaged soils.