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Region 9

Feasibility Study

Tennessee Gas Pipeline Company
Compressor Station 229
at Eden, New York

January 10, 1997

Prepared for

Tennessee Gas Pipeline Company
Houston, Texas

For Submission to

New York State
Department of Environmental Conservation

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EXECUTIVE SUMMARY

In accordance with the Consent Order between the New York State Department of Environmental Conservation (NYSDEC) and Tennessee Gas Pipeline Company (TGPL), a Remedial Investigation/Feasibility Study (RI/FS) has been conducted by TGPL for Compressor Station 229 near Eden, New York. The purpose of the FS is to formulate, evaluate, and select remedial alternatives for appropriate areas associated with Station 229. The scope of this report follows state and federal FS guidance and includes the identification of remedial action objectives and general response actions, and the evaluation and selection of remedial alternatives.

TGPL purchased and used lubricating oil (Pydraul), which contained polychlorinated biphenyls (PCBs), in the lubricating system of the starting air compressors at Station 229 from the 1950s to the 1970s. As a result of historical discharges of condensate from the starting air system, some residual PCBs have been found in the soil, sediments and drainline system. A comprehensive site characterization program was conducted to determine the distribution of PCBs and Target Compound List/Target Analyte List constituents (TCL/TALs) in the areas of potential concern (soils, sediments, drainlines and ground water).

Extensive sampling at Station 229 was performed in several phases between October 1990 and June 1996. Soils, sediment, surface water, ground water and drainlines were sampled for PCBs. The on-site areas sampled included the station operations areas, storage/scrap yard areas, pipeline facilities, a fenceline, a separator pond, ditches, drainlines, and Station Lake. Based on the potential for off-site migration through site drainage to a tributary of Eighteenmile Creek, sampling was conducted in the tributary system including the stream channel, flood plains, farms, residential yards, and a downstream breached pond. Fish were collected for PCB analysis from the Station Lake, the tributary, and the breached pond.

In addition to PCBs, TCL/TAL analyses were performed on samples from station operational areas, drainlines, Station Lake, the separator pond, the tributary, a drainage ditch, and ground water. Toxicity Characteristic Leaching Procedure (TCLP) mercury analysis was performed on samples from three meter buildings on-site; soils impacted by mercury were excavated and disposed off-site in 1995. Volatile organic compounds (VOCs) were present in some of the ground water samples and benzene, toluene, ethylbenzene, and xylenes (BTEX) and chromium were present in limited soil areas; TCL/TALs were not present in other media at levels of potential concern. An extensive soil sampling program was conducted to locate the potential source of the VOCs in the ground water; the results indicated that a continuing source of VOCs to the ground water was not present in soils or upper weathered bedrock.

Analysis of the fate and transport of the constituents identified in the RI for further evaluation included modeling of the erosional transport of PCBs in the tributary system. The model showed that PCBs will not be transported to any downstream receptor at levels of potential concern (ENVIRON 1996). Evaluation of the fate of TCL/TALs in ground water shows that these constituents naturally attenuate and based on the direction of ground water flow and the absence of receptors, TCL/TALs at levels of potential concern will not be transported to receptors.

TGPL performed a two-phase Habitat-Based Assessment (HBA) and an extensive ecological evaluation of the tributary system to assess the quality, diversity, potential receptors and potential ecological exposure pathways in the area. The HBA found the ecosystem to be healthy and diverse. The ecological evaluation found that the exposure pathways are quite limited. PCBs in the system are not adversely impacting plants, fish, wildlife, or natural communities in the tributary area (Woodward-Clyde Consultants 1996). The study also found that intrusive remediation would have no significant effect on PCB levels in biota and would cause a significant amount of disturbance to the currently thriving ecosystem which would not be proportionately justified by any significant benefit to the ecosystem.

TGPL also conducted a study of the potential impact of PCBs on human health with specific assessment of the potential impact, if any, of PCBs in the Station 229 tributary (Terra, Inc. 1996). The human health study reported that the early (1970s) view of PCBs, based on high-dose laboratory studies, did not accurately characterize the actual hazard posed to the human population. Epidemiological studies in the last 10 years have provided more relevant information on the human toxicity of PCBs which tends to dispute the extrapolation of animal studies to human health, alleviating many of the concerns originally raised from the early studies. TGPL's study also showed that years of occupational experience with PCBs at levels orders of magnitude higher than those in the tributary have been remarkably free of adverse health findings. Assessment of the specific site conditions in the tributary corridor results in the conclusion that the current conditions do not represent a health concern to the local population.

On-site soils and drainlines were remediated in 1995 under a NYSDEC-approved Interim Remedial Measure (IRM). Accessible soils containing PCBs above the cleanup goal established for the IRM were excavated and disposed in a chemical waste landfill (Model City, New York); inaccessible soils were capped in place. Sediments containing PCBs exceeding the cleanup goal established for the IRM were removed from the oil/water separators and manholes and were also disposed in the chemical waste landfill. The oil/water separators, manholes and drainlines were grouted. An evaluation of residual PCBs and other chemicals of potential concern showed that no further action is necessary for any constituents in on-site soils or sediments. The site is no longer a source for the off-site migration of PCBs at levels of concern.

To address VOCs in ground water, TGPL has taken numerous actions including a source area characterization and 11 rounds of ground water sampling. TGPL has also determined that there are currently no potential receptors of ground water between the impacted area and the nearest downgradient surface discharge points. VOCs will likely volatilize upon reaching surface waters and will not reach receptors downstream.

Throughout the process of the RI, TGPL actively fostered community dialogue through a variety of means including the preparation and distribution of Community Update newsletters. These newsletters provided area residents, interested citizens, and public officials with the status of TGPL activities at Station 229 and the addresses and phone numbers of state regulators and TGPL representatives. TGPL established public repositories which provided community access to all of the final documents and technical studies. In addition, TGPL prepared a videotape on the tributary and a pamphlet on PCBs for distribution, conducted door-to-door visits with many residents, and participated in public meetings to disseminate sampling results and findings.

This FS summarizes the results of the RI and the IRM and evaluates, where appropriate, remedial action objectives and remedial alternatives for the following areas: (1) on-site soils and drainlines; (2) Station Lake; (3) ground water; and (4) the tributary system.

TGPL has addressed on-site soils and drainlines through implementation of the 1995 Interim Remedial Measure (Section 1.3.4). No further action is necessary for on-site soils, drainlines or sediments as the IRM achieved all of the remedial goals for PCBs in these media.

Based on the results of the RI, no evaluation of remedial alternatives is necessary for Station Lake. Nevertheless, TGPL will remove the fish from the lake to ensure that there is no ecological pathway for bioaccumulation of the PCBs. No further action is warranted to address the low levels of PCBs present in the lake sediment and the lake is not a potential source for the off-site migration of PCBs at levels of concern.

The results of the RI indicate the presence of VOCs in the ground water at levels which warrant further consideration. Remedial alternatives are considered for ground water including *no further action, monitoring, enhanced in situ degradation, air sparging,* and *extraction and treatment.*

Based on the sampling results and the findings of the extensive studies on the tributary system, TGPL believes residual PCBs in the tributary do not present a concern to human health or the environment. However, at NYSDEC's request, this FS evaluates remedial alternatives for the tributary. The alternatives evaluated for the tributary are *no further action, institutional action*, a treatment technology (*in situ bioremediation*), a *multi-component alternative*, and *removal/disposal*.

The evaluation of remedial alternatives presented in this report includes a preliminary screening of the ground water and tributary alternatives developed under general response actions as well as a detailed evaluation of each alternative retained from preliminary screening. The screening and detailed evaluations were conducted based on procedures outlined in the *Technical and Administrative Guidance Memorandum on Selection of Remedial Actions at Inactive Hazardous Waste Sites* (TAGM 4030, May 15, 1990).

The objective of the preliminary screening is to narrow the list of potential alternatives for detailed evaluation. The preliminary screening process is based on the criteria of effectiveness and implementability of the alternatives. The remedial alternatives for ground water that remain after preliminary screening are *no further action, monitoring, enhanced in situ degradation*, and *removal/treatment*. The tributary alternatives that remain following preliminary screening are *no further action, institutional action, the multi-component alternative*, and *removal/disposal*.

A detailed evaluation of the remaining remedial alternatives is performed using the seven criteria outlined in TAGM 4030: compliance with applicable New York State Standards, Criteria and Guidelines (NYS SCGs); overall protection of human health and the environment; short-term impacts and effectiveness; long-term effectiveness and permanence; reduction of mobility, volume, or toxicity; implementability; and cost. Following the detailed evaluation and assessment against these seven criteria, the alternatives that are potentially applicable at Station 229 are subjected to a comparative analysis.

The recommended remedial action for ground water resulting from the detailed evaluation is *monitoring* based on site-specific conditions such as the absence of ground water receptors, the relatively thin zone of low permeability fractured bedrock which contains the impacted ground water, the infeasibility of ground water treatment, and the purchase of an option on the property downgradient from impacted wells MW-6S and MW-6D. The remedial action proposed for the tributary system is the *multi-component alternative*.

1 INTRODUCTION

1.1 Status of the Remedial Investigation/Feasibility Study Program

Tennessee Gas Pipeline Company (TGPL) has conducted a Remedial Investigation (RI) and Feasibility Study (FS) at its Compressor Station 229 near Eden, New York in accordance with the requirements of the Consent Order between the New York State Department of Environmental Conservation (NYSDEC) and TGPL on January 23, 1991 (DO-0003-8903).

The Remedial Investigation and Feasibility Study (RI/FS) was performed in conformance with the *Work Plan for RI/FS at Tennessee Gas Pipeline Compressor Station 229 at Eden, New York* (Work Plan), submitted by TGPL to the NYSDEC in December 1990 and approved by NYSDEC on January 15, 1991. The Work Plan is consistent with New York State's RI/FS process as defined in the following NYSDEC documents:

1) *Technical and Administrative Guidance Memorandum on Guidelines for Remedial Investigation/Feasibility Studies*, TAGM 4025, March 31, 1989; and

2) *Technical and Administrative Guidance Memorandum on Selection of Remedial Actions at Inactive Hazardous Waste Sites*, TAGM 4030, revised May 15, 1990.

The Work Plan also conforms with the U.S. Environmental Protection Agency's (USEPA) October 1988 *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (RI/FS Guidance).

The RI report, which details the methods and findings of the Station 229 RI, was submitted to NYSDEC in phases as site characterization data became available. The following RI reports were submitted to the NYSDEC:

General RI Documents

- *Draft Remedial Investigation, Tennessee Gas Pipeline Company, Compressor Station 229 at Eden, New York, Volume I, Introduction and Summary of Results,* August 2, 1991
- *Remedial Investigation, Tennessee Gas Pipeline Company, Compressor Station 229 at Eden, New York, Volume II, Site Characterization,* August 2, 1991
- *Draft Remedial Investigation, Tennessee Gas Pipeline Company, Compressor Station 229 at Eden, New York, Volume III, Evaluation of Results,* August 2, 1991
- *Addendum, Remedial Investigation Volume II: Site Characterization Report Phase IIC Soil and Sediment Sampling*, February 1992
- *Second Addendum to the Remedial Investigation Volume II - Site Characterization Report Additional Phase IIC - Soil and Sediment Sampling TGPL Compressor Station 229, Eden, New York,* May 1992
- *Data Summary for Residential Water Sampling*, June 1992
- *Third Addendum to the Remedial Investigation Volume II - Site Characterization Report Additional Phase IIC - Soil and Sediment Sampling TGPL Compressor Station 229, Eden, New York,* July 1992

- *Investigation of Soils Adjacent to Drainlines, Tennessee Gas Pipeline Company Compressor Station 229, at Eden New York,* August 1994

- *Phase III Supplemental Site Characterization Report,* February 1995

Ground Water Documents

- *Evaluation of Ground Water Monitoring Data, Station 229, Addendum to Remedial Investigation Report,* July 1993

- *Report on Phase I Additional Groundwater Characterization: Volatile Organic Compounds, Tennessee Gas Pipeline Company Compressor Station 229 at East Eden, New York,* February 1994

- *Ground Water Assessment Report for Tennessee Gas Pipeline Company Compressor Station 229, Eden, New York,* November 1994

- *Report on Phase II Groundwater Characterization - Volatile Organic Compounds for Tennessee Gas Pipeline Company Compressor Station 229, East Eden, New York,* November 1994

- *Tennessee Gas Pipeline Company (TGPC) Phase II Supplemental Groundwater Report Station 229, East Eden, New York,* April 1995

- *Report on VOC Source Characterization at Tennessee Gas Pipeline Company Compressor Station 229, East Eden, New York,* June 1995

Station Lake and Tributary Documents

- *Addendum to Phase IIA and B Sampling, Off-Site Sampling Areas*, March 1991
- *Final Report Phase II Habitat-Based Assessment Verification Work, June 1992*, February 1993
- *Fish Sampling Results from Station Lake, the Breached Pond, and the Tributary Between the Ponds near Tennessee Gas Compressor Station 229, Eden, New York*, March 1994
- *Report: Fish and Sediment Sampling Results from a Tributary and a Breached Pond near TGPL Station 229*, February 1995
- *Station Lake Investigation Report for Station 229*, April 1995
- *Report: Soil and Sediment Sampling Results from a Tributary and a Breached Pond between Tennessee Gas Compressor Station 229 and Highway 62 near Eden, New York, December 1994*, May 1995
- *Ecological Evaluation of a Tributary and Associated Habitats Near Tennessee Gas Pipeline Compressor Station 229 Near Eden, New York*, January 1996
- *A Summary of PCB Toxicology and A Critical Assessment of Its Human Relevance*, February 1996
- *Analysis of Transport of PCB Soils and Sediments in Tributary Near Compressor Station 229*, March 1996

In addition to the RI work, TGPL implemented an Interim Remedial Measure (IRM) in accordance with the NYSDEC-approved *Interim Remedial Measure Work Plan, Tennessee Gas Pipeline Company Compressor Station 229 at Eden, New York*, April 1995. On-site soils and drainline sediments identified in the Work Plan were removed and disposed off-site in a chemical waste landfill. The drainlines were subsequently grouted. The results of this remediation are presented in the *Interim Remedial Measure Report, Soil/Drainline Remediation Activities*, February 1996, and discussed in Section 1.3.4 of this document.

1.2 Scope of the Feasibility Study Report

The purpose of the FS is to formulate, evaluate and select remedial alternatives for appropriate areas of Station 229. This report consists of four major sections, with accompanying tables, figures and appendices. A brief overview of each section is provided below.

Section 1 presents the purpose, scope, and organization of the report as well as a summary of the RI report; the results of the IRM; the nature, extent, fate and transport of, and potential exposure to the constituents of potential concern; and an evaluation of the need for further action for each of the four identified areas of potential concern: on-site soils and sediments, Station Lake, ground water and the tributary system.

Section 2 describes the development of remedial alternatives and discusses the potential remedial alternatives for consideration in this FS. This section includes the development and identification of remedial action objectives and the general response actions for meeting these objectives.

Section 3 describes the preliminary screening of the remedial alternatives. The purpose of this screening is to narrow the list of potential alternatives for detailed evaluation. The screening process is based on the effectiveness and implementability of the technologies, taking into account the constituent(s) of concern and site-specific issues such as the nature of the bedrock underlying the station. A summary of the remedial alternatives retained for detailed evaluation is included in Section 3.

Section 4 consists of a detailed evaluation of the remedial alternatives retained after the preliminary screening. In general, the detailed evaluation is based on technical feasibility, effectiveness, and cost. The factors considered under technical feasibility and effectiveness include compliance with regulatory criteria; impacts to human health and the environment; short-term impacts and effectiveness; long-term effectiveness and permanence; reduction of mobility, volume, and toxicity; and implementability. A comparative analysis is also provided as part of the detailed evaluation of alternatives. Recommended alternatives are presented at the conclusion of the detailed evaluation.

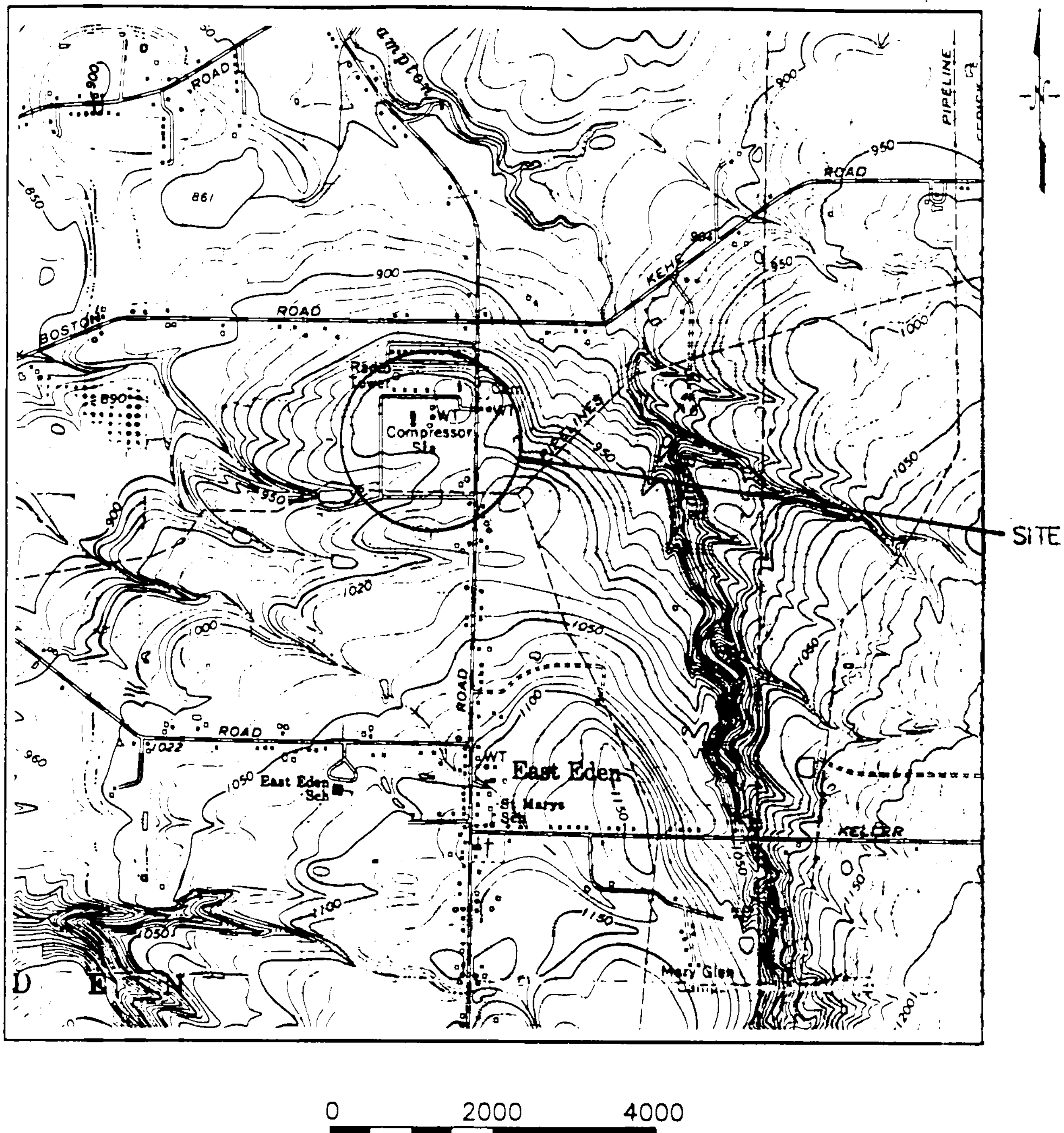
1.3 Summary of the RI

This section summarizes the results of site characterization activities. Site characterization results for polychlorinated biphenyls (PCBs) and Target Compound List/Target Analyte List Substances (TCL/TALs) are summarized for the media sampled including soils, sediments, ground water, and surface water. This section also includes a summary of the fate and transport analysis, the habitat-based assessment and ecological evaluation performed for the site, and the evaluation of potential human health impacts.

1.3.1 Site Description

Station 229 occupies 50.5 acres along East Eden Road, approximately 4 miles south of the Village of Hamburg in the Town of Eden in Erie County, New York (see Figure 1-1). Open woods lie to the west of the station. Former TGPL corporate housing, now a subdivision of privately-owned homes, lies approximately 90 feet north of the facility. A small cemetery, a dairy farm, and a private residence are located to the east of the site. A truck farm is located along the south border of the station. A municipal water system (Erie County Water Authority) provides potable water to the station and the majority of nearby residences. Private ground water wells are used by some owners of property located southeast of the site and along North Boston Road.

The station is situated at an elevation of approximately 1,000 feet above mean sea level. In the immediate vicinity of the Compressor Building and the Auxiliary Building, the topography is flat (Figure 1-2). There is a surface water drainage divide north of the operations area of the station. North of the operations area, the topography slopes steeply from south to north; storm water runoff from this limited portion of the station discharges



SOURCE: USGS TOPOGRAPHIC SERIES, HAMBURG, NEW YORK QUADRANGLE, 1965.

ENVIRON	SITE LOCATION MAP STATION 229 – EDEN ERIE COUNTY, NEW YORK	FIGURE 1–1
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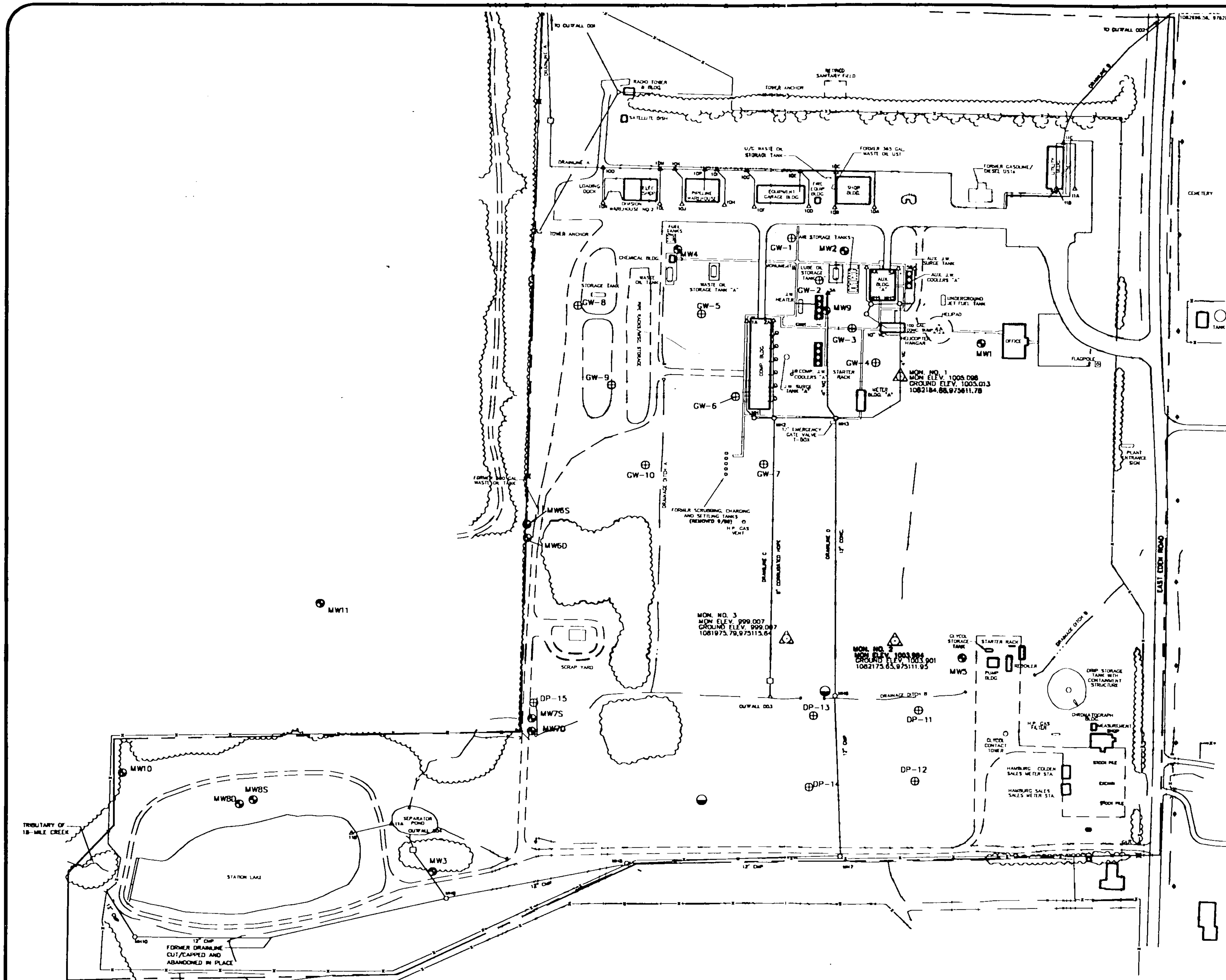

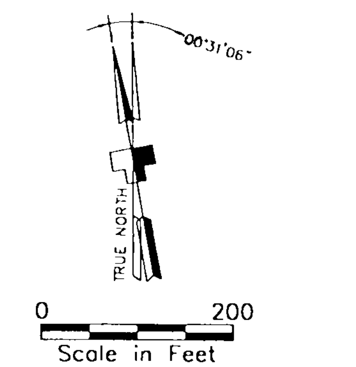

LEGEND

- GROUNDWATER MONITORING WELL
- WATER WELL
- TEMPORARY MONITORING WELL LOCATION (GW/DP)
- GRID MONUMENT
- FENCE
- TREE LINE
- PROPERTY LINE
- PROPERTY CORNER
- MONUMENT
- INTERMITTENT DRAINAGE

NOTES:

1. SITE MAP IS FROM TENNECO GAS (TO-C229-A1-YA101 & TO-C229-A1-YA102) DRAWINGS BASED ON TOBIN SURVEYORS, INC., AERIAL PHOTOGRAPHY AND SURVEY DATA, 11-17-94.
2. LOCATIONS OF MONITORING WELLS DERIVED FROM ECOLOGY AND ENVIRONMENT DRAWING TG5SP229-2-R, AND ROY F. WESTON PHASE II ADDITIONAL GROUNDWATER CHARACTERIZATION REPORT (FIGURE 2-1, DATED 4/11/95).
3. S = SHALLOW WELL IN A WELL PAIR
   D = DEEP WELL IN A WELL PAIR

ENVIRON	SITE PLAN TENNESSEE GAS PIPELINE COMPANY, COMPRESSOR STATION 229 EDEN, NEW YORK	Figure 1-2
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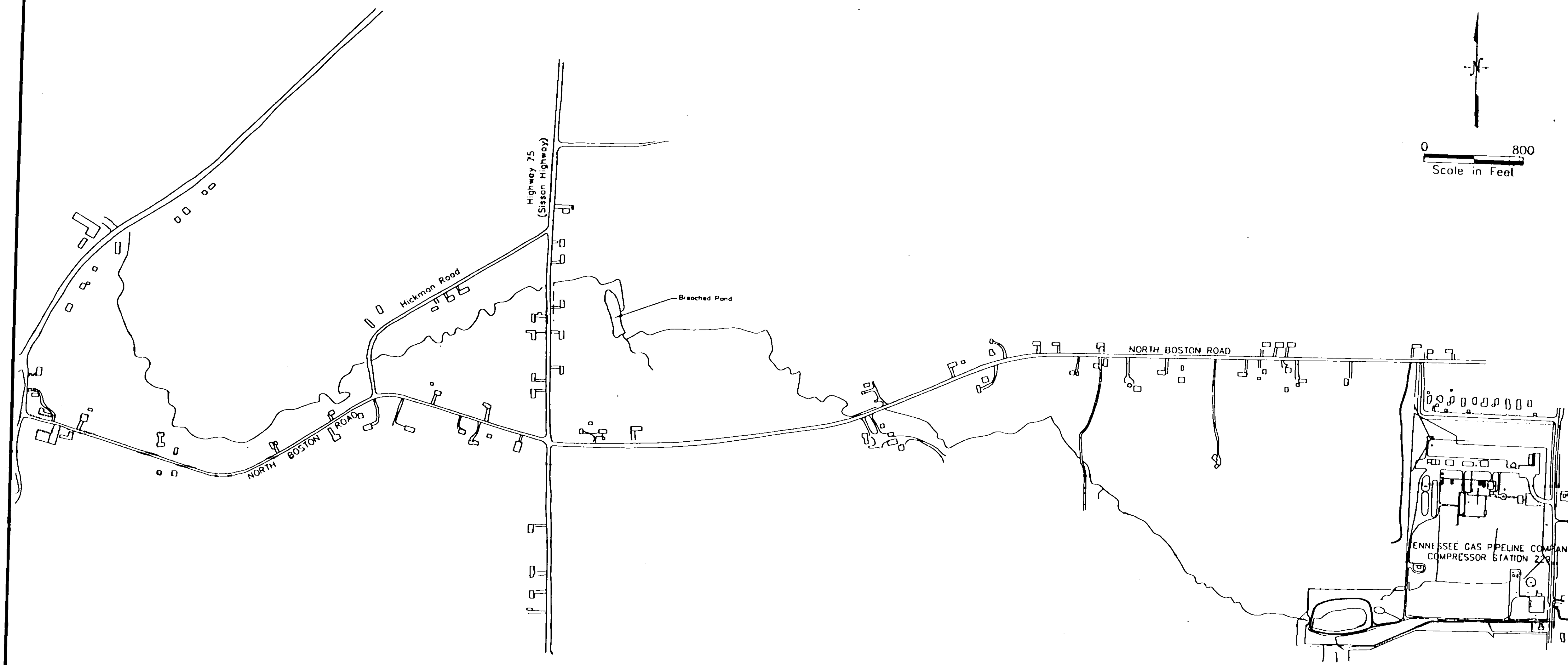
to a roadside culvert near North Boston Road, which eventually discharges to Hampton Brook. All surface water from the operations area and southward flows down moderately steep topography south and west toward Station Lake.

Soil in the area is composed primarily of glacial till with clay and shale. Ground water occurs primarily within the upper, weathered shale bedrock and to a significantly lesser degree in deeper, more competent shale bedrock formation. The topography of the bedrock surface dips to the southwest across the compressor station property. The ground water flow direction is southwest, toward Station Lake, generally following surface topography, although the fractures present in the upper bedrock may result in localized variations in flow direction. There are no apparent potential downgradient receptors of the shallow fractured bedrock water-bearing zone within the approximately 1,500-foot distance between the main portion of the compressor station and the local surface water discharge points (i.e., Station Lake and the tributary described below). The overburden deposits range in thickness from approximately 4 feet in the northwest to approximately 12 feet at Station Lake. Depth to ground water ranges from 10 to 16.5 feet below ground surface (bgs) across the station from the east at MW-2 to the west at MW-11, as measured in August 1994.

All of the surface drainage from the operations area of the site flows to the southwest into Station Lake, a 1-acre lake up to 17 feet in depth, which discharges to an unnamed tributary of Hunt Creek (Figure 1-3). The tributary is typically 3 to 6 feet wide with limited flow in its upper reaches. The tributary flows west-northwest for 1.5 to 2 miles before entering Hunt Creek, which discharges to Eighteenmile Creek, which in turn travels approximately 5 miles before discharging into Lake Erie. A breached farm pond is on the tributary east of Highway 75.

Land use in the vicinity of the station is primarily agricultural and partly residential. Local farmers grow a variety of fruits and vegetables including corn and berries. The tributary is not used for recreational purposes, but Eighteenmile Creek is used for fishing, swimming, and other types of recreation. Hunting of deer, turkey and small game is reportedly common around the facility.



NOTES:

1. Source of base map: Erdman Anthony Consulting Engineers, Eighteenmile Creek Topographic Map, 1993. Produced by photogrammetric methods from 1"=700' photography taken on April 27, 1993. Certain areas obscured by shadows and heavy vegetation may require field verification.

2. Tributary Centerline was prepared using field survey data collected by Labella Associates, January, 1995.

ENVIRON DRAFTED BY: HFZ — DATE: 9/16/96	STATION 229 TRIBUTARY TENNESSEE GAS PIPELINE COMPANY, COMPRESSOR STATION 229 EDEN, NEW YORK	Figure 1-3 1119BB1A

The operations area of the station contains six reciprocal-type natural gas compressor engines in the Compressor Building, which are started with a single air starting system in the Auxiliary Building. The starting air system consists of two starting air compressors and associated air receiver tanks (ARTs) and piping. A single set of seven ARTs is located immediately west of the Auxiliary Building. Other buildings at the station include a pipeline warehouse, a shop, an equipment garage, a utility building, an office, a radio building, a hangar, and three meter station facilities (referred to as Meter Building A, the Colden Meter Station, and the Hamburg Sales Meter Station) which are used to support the gas transmission operation. Buildings associated with dehydration of natural gas from the Colden gas storage field occupy an area in the southeastern corner of property. Pipe racks and a scrap yard are located along the western side of the property. A concrete sump tank is located south of the Auxiliary Building. A waste oil storage tank is located northwest of the Compressor Building. Until 1988, a sanitary system included a leach field located at the northern end of the facility between the shop and former TGPL corporate housing. In 1988, the sanitary system was connected to the Erie County Sewer Authority system.

Condensate generated from the starting air system is currently collected in a steel tank in the basement of the Auxiliary Building, then transferred to 55-gallon drums, tested and disposed appropriately. Prior to 1988, the condensate from the air compressors and ARTs was discharged onto the ground or into the storm water drainline system.

Station Lake and a separator pond are located in the southwestern portion of the site. The main drainage system for the station originally consisted of both floor drains and storm drains, which combined and subsequently discharged around Station Lake near the far western property line. In 1982, the portion of the drainage system adjacent to Station Lake was abandoned, and drainage was rerouted so that storm flows would pass through Station Lake before reaching the tributary. The drainline along the south side of the lake was cut and rerouted with piping to a 1,000-gallon oil/water separator which was piped to a separator pond which, in turn, was piped to Station Lake. The remainder of the drainline along the south side of the lake was left in place until 1995, when, during the IRM, it was filled with grout from the location at which it was cut to the outfall below Station Lake. The oil/water separator and main drainline system were also grouted in 1995 as part of the IRM.

1.3.2 Previous Investigations

TGPL conducted a preliminary sampling program in 1988 to determine if PCBs were present in the starting air system, ART areas, and the drainage system. The sampling results indicated that PCBs were present in crankcase oil, condensate, surface soil and sediment in some areas of the station. A complete description of the TGPL sampling results was presented in the Station 229 RI report; a summary of the locations where PCBs were detected is provided below.

Results of the TGPL sampling showed PCBs to be present at 6 mg/kg in one crankcase oil sample from the starting air compressors. The other crankcase oil sample did not contain PCBs above the detection limit of 1 mg/kg. A PCB level of 75 mg/kg was measured in the condensate sample from the combined ART blowdown valve. Surface soil samples collected from beneath the blowdown valves for the ARTs and near the Auxiliary Building contained PCB levels of 13,000 and 88 mg/kg, respectively. Sediment samples collected from Drainline D contained PCB levels ranging from 2,500 to 5,600 mg/kg. Three of 11 soil and sediment samples taken from the tributary of Eighteenmile Creek contained PCB levels ranging from 3 to 16 mg/kg; the remainder of the tributary samples did not contain detectable levels of PCBs.

1.3.3 Site Characterization

An extensive site characterization program was performed at the station between October 1990 and June 1996. This program consisted of the collection and analysis of soil, sediment, surface water, ground water, and fish samples in order to define the presence of PCBs and to screen for the presence of TCL/TALs. Sampling program results for these media are summarized in this section. A comprehensive description of the field programs and findings are presented in the reports listed in Section 1.1. The following sections describe the sampling conducted and the results of the investigations.

1.3.3.1 PCB Study

Discrete soil, sediment, water and fish samples were collected from targeted areas on- and off-site where site history or drainage pathways indicated the potential presence of residual PCBs. The on-site soils and sediments were collected from areas around the Compressor Building, the Auxiliary Building, the ARTs, the meter buildings, fencelines, the scrap yard, the pipe racks, miscellaneous pipeline facilities, waste oil storage tanks, outfalls, drainage ditches, the separator pond, and Station Lake. In addition, on-site grid sampling was performed to screen the entire station property for the presence of PCBs. Five on-site monitoring wells were sampled for PCBs in ground water. Surface water samples were collected from outfalls, drainage ditch areas, and the tributary. Off-site soil and sediment sampling focused on the tributary, with samples collected in the tributary channel, along its banks and floodplains, and in downstream ponds. Samples were also collected from two off-site farms: one south of the station and one north of the breached pond.

Sampling indicated that on-site soils contained PCB levels up to 2,800 mg/kg and drainline sediments contained a maximum level of 3,300 mg/kg. PCB results for on-site soils and drainlines are presented in Tables 1-1 and 1-2. On-site soils and drainline sediments were addressed through an IRM which included removal of soils, cleaning the drainline manholes and oil/water separators, and grouting the drainlines in accordance with the IRM Work Plan submitted in April 1995 (see Section 1.3.4). The on-site areas addressed in the IRM were the ART area, the Auxiliary Building area, the Compressor Building area, Drainage Ditch B, soils surrounding a former waste oil/solvent tank (Shop Building area), the scrap yard area, the pipe rack area, and Drainline D.

Sampling also included ground water, surface water and sediment (not related to drainlines). Thirty-six samples were collected for PCBs from on-site wells; 10 off-site private wells were also sampled. PCBs were not detected in any on- or off-site ground water samples collected. Four surface water samples were analyzed for PCBs; one contained PCBs at 0.65 μg/L (Outfall 3). No PCBs were detected in other surface water samples. PCBs were present in some of the soils and sediments in Station Lake and the separator pond at levels up to 6.6 mg/kg and 14 mg/kg, respectively. Ground and surface water sampling results are summarized on Table 1-3.

TABLE 1-1
Summary of PCB Results for On-Site Soil Samples Before IRM Implementation
Compressor Station 229

Area	Number of Samples Taken	Number of PCB Detections	Range of PCB Levels (mg/kg)
Air Receiver Tank Area	81	37	1.3 - 2000
Auxiliary Bldg Area	59	27	1.1 - 167
Compressor Bldg Area	107	4	2.7 - 2800
Discrete Grid (Phase II)	112	10	1.4 - 49[1]
Discrete Grid (Phase III)	2	0	NA
Drainage Ditch A	7	1	2.7
Drainage Ditch B	35	6	0.33 - 30
Fenceline	38	21	1.3 - 450
Mainline Valves	6	0	NA
Meter Bldg A	1	0	NA
Meter Bldg Colden	1	0	NA
Meter Bldg Hamburg	1	0	NA
Pipe Racks Area	6	4	1.8 - 13
Scrap Yard Area	4	2	2.9 - 3.9
Vertical Scrubbers	1	0	NA
Waste Oil Storage Tank	8	0	NA
Waste Oil/Solvent Tank	2	2	36.9 - 640

Notes:

Sample count does not include duplicate samples, but duplicate results are included in range of levels.

[1] Two results from Phase II Discrete Grid Sampling exceeded 25 ppm (32 mg/kg and 49 mg/kg). These samples were collected in the scrap yard and northeast of the Compressor Building, respectively.

TABLE 1-2
Summary of PCB Results for Drainline Areas,
Soil and Sediment, Before IRM Implementation
Compressor Station 229

Area	Number of Samples Taken	Number of PCB Detections	Range of PCB Levels (mg/kg)
Drainline A Outfall Area	5	4	0.17 - 1.5
Drainline A Oil/Water Separator	1	0	NA
Drainline B Outfall Area	1	0[1]	0.40[1]
Drainline C Outfall Area	1	1	0.43
Drainline C Soils Adjacent to Drainline	3	2	0.23 - 0.71
Drainline C Oil/Water Separator	1	1	11
Drainline D Manholes #1 & 2[2]	2	2	1.2 - 34
Drainline D Manholes #3, 4 & 5	3	3	21 - 3300
Drainline D Soils Adjacent to Drainline	29	8	0.01 - 1.04
Drainline D Oil/Water Separator	1	1	765
100-Gallon Sump Tank next to Compressor Building[3]	1	1	450

Notes:

Sample count does not include duplicate samples, but duplicate results are considered in ranges.

1 Detection in a duplicate sample. Result is below reporting limit in the original sample.
2 These manholes were previously identified as parts of Drainline C, but during the IRM Drainline C was found to pass through the manholes as a closed conduit; therefore, the sediments are not in Drainline C, and are not representative of PCB levels in that drainline. The manholes actually connect to Drainline D.
3 This tank, previously identified as being on Drainline C, was not connected to any drainlines.

TABLE 1-3
Summary of PCB Results for On-Site Ground and Surface Water
Compressor Station 229

Area	Medium	Number of Samples Collected	Number of PCB Detections[1]	Range of PCB Levels
Drainage Ditch B	Surface Water	2	0	NA
Drainline A Outfall	Surface Water	1	0	NA
Drainline C Outfall	Surface Water	1	1	0.65 μg/L
Tributary	Surface Water	1	0	NA
MW-1	Ground Water	6	0	NA
MW-2	Ground Water	8	0	NA
MW-3	Ground Water	6	0	NA
MW-4	Ground Water	6	0	NA
MW-5	Ground Water	10	0	NA

Notes:

NA - Not applicable.

[1] Detection limit was 0.5 μg/L.

Tributary soils and sediments have been evaluated for the presence of PCBs with extensive sampling programs in 1990/1991 and in 1994. In addition, limited sediment sampling was conducted in conjunction with fish sampling in 1994. Table 1-4 summarizes the tributary system soil and sediment sampling results and sampling results from the on-site water bodies, i.e., the separator pond and Station Lake. Tributary soil and sediment sample locations from the 1994 program are shown in plates accompanying the May 1995 *Report: Soil and Sediment Sampling Results from a Tributary and a Breached Pond between Tennessee Gas Compressor Station 229 and Highway 62 Near Eden, New York.* Levels do not exceed the detection limit (1 mg/kg) in any samples from off-site farms. PCB levels in the tributary system range from non-detect (below 0.1 mg/kg) to 960 mg/kg within the first 1,900 feet of the tributary. Levels decrease rapidly with distance downstream from the station. Beyond 1,900 feet from the station, levels measured in 1994 are all below 10 mg/kg.

Fish were also sampled from Station Lake, the tributary, and the breached pond approximately 7,200 feet from the station along the tributary. Sampling events were conducted in October 1993 and July 1994. Fish sampling was attempted in the separator pond, but fish were not present. A total of 95 fish were collected from Station Lake, the breached pond and the tributary in October 1993. Only those from Station Lake had sufficient numbers and mass for laboratory analysis. The average total PCB level in fillet tissues from largemouth bass and bluegill in Station Lake were 4.34 and 4.63 mg/kg, respectively. The average total PCB level in whole body samples from largemouth bass and bluegill in Station Lake were 16.98 and 20.48 mg/kg, respectively. The maximum PCB level found in any fish whole body sample from Station Lake was 48.09 mg/kg in a largemouth bass.

Fish from the breached pond and a reach of the tributary (between Highways 75 and 62) were collected in July 1994. Due to the small size of the collected fish, only whole body tissue samples were used for sample analyses. A total of 708 fish (5 species) were collected from 20 pools formed in the tributary; 256 of the 708 fish

TABLE 1-4
Summary of PCB Results for Tributary, Separator Pond, and Station Lake, Soils and Sediments
Compressor Station 229

Area	Medium	Range of PCB Levels (mg/kg): Initial[1] RI Data	Range of PCB Levels (mg/kg): Current[2] Data
Off-Site: Upstream of Station Lake	Soil	ND-450	1.3-8.9
Separator Pond	Soil	ND-1.3	NS
	Sediment	ND-14	NS
Station Lake	Soil	ND-1.5	NS
	Sediment	ND-6.6	0.79-3.5
Tributary: From Station Lake to 1,900 feet downstream	Soil	ND-120	ND-960
	Sediment	7.6-760	ND-410
Tributary: 2,000 feet to North Boston Road	Soil	ND-11	ND-8.6
	Sediment	ND-6.9	0.30-1.8
Tributary: North Boston Road to the Breached Pond	Soil	ND-11	ND-6.9
	Sediment	ND-3.3	ND-3.6
Tributary: Breached Pond	Sediment	0.22-0.93	ND-2.3
Tributary: Breached Pond to Highway 75	Soil	NS	ND-0.88
	Sediment	NS	ND-0.25
Tributary: Highway 75 to Hickman Road	Soil	ND	ND-1.2
	Sediment	NS	ND-1.8
Tributary: Hickman Road to Route 62	Soil	NS	ND-0.98
	Sediment	ND-0.186	ND

Notes:
[1] July 1990 - July 1994 data
[2] 1994 data following August 1994 storm event
ND: Not detected
NS: Not sampled

were used to create 22 discrete and 33 composite whole body fish tissue samples. A total of 42 fish (3 species) were collected from the breached pond; all 42 fish were used to create 3 discrete and 7 composite whole body samples. The average total PCB level in all samples was 1.53 mg/kg; the average levels in the tributary and breached pond samples were 1.45 and 1.94 mg/kg, respectively. The maximum levels in the fish samples from the tributary and breached pond were 3.1 and 5.8 mg/kg, respectively.

1.3.3.2 TCL/TAL Study

A total of 46 soil and sediment samples were collected for TCL/TAL analyses during site characterization from 1990 through 1992. These samples were collected from the Compressor Building area, the Auxiliary Building area, the ART area, outfalls from Drainlines A, B, and C, Drainage Ditch B, the separator pond, Station Lake, and the tributary. An additional 22 soil samples from the Jacket Water Cooler area and the Jacket Water Surge Tank area were analyzed for total chromium. The Jacket Water Cooler Area samples were also analyzed for hexavalent chromium. Ten soil samples collected along the station fenceline were analyzed for total petroleum hydrocarbons (TPH). TCL/TAL results for soil and sediment samples are summarized in Tables 1-5 through 1-7. The results of TCL analysis of soil samples indicated the presence of TPHs and benzene, toluene, ethylbenzene and xylenes (BTEX) in soils in the vicinity of the dehydration area in the southeast corner of the station. TAL analysis indicated the presence of 22 TALs in soils.

In addition, eight soil leachate samples from the meter buildings were analyzed for mercury. Mercury levels in the leachate ranged from 0.2 μg/L to 15 μg/L. TGPL implemented a program to further determine the mercury distribution and remediated impacted soils at Station 229 in 1995. A final report on the investigation and remediation of mercury-impacted soils and surfaces will be submitted to the NYSDEC in the near future.

TABLE 1-5
Summary of TCL Results for Soils

	ART Area	AST Former Scrubbing/ Settling Tank	AST Former Waste Oil Tank	Auxiliary Building Area	Compressor Bldg Area	Drainage Ditch B	Fenceline	Former Diesel UST	Former Gasoline UST	Former Waste Oil UST	Monitoring Wells	Oil/Water Separator 1	Oil/Water Separator 3	Separator Pond	Station Lake	Sump Near Compressor Bldg	Station Lake Outfall
Pesticides (mg/kg)																	
alpha-BHC	ND			ND	ND	ND-0.13								ND	ND		ND
Petroleum Hydrocarbons (mg/kg)						ND-44000	ND-200										ND
TCLs - SVOCs (mg/kg)																	
2-Methylnaphthalene	ND		ND	ND	ND	ND		0.092J-0.14J		ND-0.072J		ND	ND	ND	ND	ND	ND
Acenaphthene	ND		ND-0.031J	ND	ND	ND-2.3		ND		0.034J-0.062J		ND-0.13J	ND	ND	ND	ND-0.028J	ND
Anthracene	ND		ND-0.055J	ND	ND	ND-4.5		ND		ND-0.043J		ND-0.46	ND	ND	ND	ND-0.041J	ND
Benzo(a)anthracene	0-0.48		ND-0.22J	ND	ND-0.66J	ND-6.3		0.036J-0.07J		0.097J-0.43J		ND-0.91	ND-0.043J	ND	ND	ND-0.12J	ND
Benzo(a)pyrene	ND		ND-0.098J	ND	ND	ND-4.9		0.053J-0.065J		0.079J-0.68J		ND-0.43J	ND-0.038J	ND	ND	0.021J-0.1J	ND
Benzo(b)fluoranthene	ND		ND-0.19J	ND	ND-0.75J	ND-8.4		0.046J-0.12J		0.15J -1.2J		ND-0.53	ND-0.047J	ND	ND	0.026J-0.17J	ND
Benzo(g,h,i)perylene	ND		ND-0.026J	ND	ND	ND-2.1		ND-0.041J		0.18J-1.5J		ND-0.31J	ND	ND	ND	ND-0.039J	ND
Benzo(k)fluoranthene	ND		ND-0.11J	ND	ND	ND		0.039J-0.11J		0.075J-0.66J		ND-0.42J	0.024J-0.067J	ND	ND	0.027J-0.14J	ND
Carbazole			ND-0.03J					ND		ND-0.037J		ND-0.3J	ND			ND-0.029J	ND
Chrysene	ND-0.42		ND-0.23J	ND	ND-0.67J	ND-5.7		0.076J-0.12J		0.11J-0.56J		ND-0.89	ND-0.062J	ND	ND	0.024J -0.14J	ND
Di-n-butylphthalate	ND		ND-0.076BJ	ND	ND-R	ND		ND		ND		ND-0.026BJ	ND-0.023J	ND	R-0.96B	ND	ND
Dibenz(a,h)anthracene								ND		ND-0.5J		ND-0.21J	ND			ND	ND
Dibenzo(a,h)anthracene	**ND**		**ND**	**ND**	**ND**	**ND-0.51**		**ND**		**ND-0.5J**		**ND-0.21J**	**ND**	**ND**	**ND**	**ND**	**ND**
Dibenzofuran	ND		ND	ND	ND	ND-1.3		ND		ND		ND-0.074J	ND	ND	ND	ND	ND
Diethylphthalate	ND		ND-0.039BJ	ND	ND	ND		ND		ND		ND	0.032BJ - 0.04BJ	ND	ND	ND	ND
Fluoranthene	ND-0.77		ND-0.46	ND	ND-1.3	ND-13		0.09J-0.23J		0.11J-0.17J		0.024J-2.5	0.04J-0.12J	ND-0.46	ND	0.045J-0.33J	ND
Fluorene	ND		ND-0.027J	ND	ND	ND-2.1		ND		0.033J-0.037J		ND-0.18J	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND		ND-0.042J	ND	ND	ND-2.4		ND		0.12J-1.3J		ND-0.3J	ND-0.022J	ND	ND	ND-0.051J	ND
Naphthalene	ND		ND	ND	ND	ND-0.53		0.046J-0.13J		0.042J-0.084J		ND	ND	ND	ND	ND	ND
Phenanthrene	ND		ND-0.25J	ND	ND-0.94	ND-14		0.067J-0.15J		0.087J-0.18J		ND-2.1	ND-0.057J	ND	ND	ND-0.22J	ND
Pyrene	ND-0.77		ND-0.36J	ND	ND-0.89	ND-13		0.094J-0.21J		0.54J-1.3J		ND-3.1	0.034J-0.094J	ND	ND	0.035J-0.21J	ND
bis(2-Ethylhexyl)phthalate	R-5.1B		0.026BJ-0.12BJ	R	ND-R	ND		0.36BJ-1.4J		ND-0.15BJ		0.048BJ-0.055BJ	0.08BJ-0.1BJ	R	ND	0.044BJ-0.095BJ	R
TCLs - VOCs (mg/kg)																	
1,1,1-Trichloroethane	ND		ND	ND	ND	ND		ND		ND	ND	ND	ND	ND	ND	ND-0.003J	ND
2-Butanone	ND		ND	ND	ND	ND-6		ND-0.006J		ND	ND-0.014	ND	ND	ND	ND-0.15	ND	ND

TABLE 1-5
Summary of TCL Results for Soils

	ART Area	AST Former Scrubbing/ Settling Tank	AST Former Waste Oil Tank	Auxiliary Building Area	Compressor Bldg Area	Drainage Ditch B	Fenceline	Former Diesel UST	Former Gasoline UST	Former Waste Oil UST	Monitoring Wells	Oil/Water Separator 1	Oil/Water Separator 3	Separator Pond	Station Lake	Sump Near Compressor Bldg	Station Lake Outfall
4-Methyl-2-pentanone	ND		ND	ND	ND	ND		ND-0.075		ND	ND	ND	ND	ND	ND	ND	ND
Acetone	R		ND	0.019 R	ND-R	ND-R		ND		ND	ND-0.061	ND	ND	R	R-0.98BJ	ND	R
Benzene	ND	ND	ND	ND	ND	ND-18		0.003J	ND-0.088	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ND		ND	ND	ND	ND		ND		ND	ND	ND	ND	ND	ND-0.016	ND	ND
Ethyl Benzene	ND	ND	ND	ND	ND	ND-7.4J		ND-0.002J	ND-0.25	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	R		0.035BJ-0.041B	R	R	ND-R		0.012BJ-0.055B		0.032-0.038BJ	ND	0.014B-0.018B	0.03BJ-0.039B	R	R	0.031BJ-0.042BJ	ND
Toluene	ND	ND	ND	ND	ND	ND-12		ND-0.002J	ND-0.029	ND	ND-0.006	ND	ND	ND	ND	ND	ND
Xylenes (total)	ND	ND	ND	ND	ND	ND-J		0.002J-0.021	ND-0.19	ND	ND-0.0006	ND	ND	ND	ND	ND	ND

Notes:

Soil results for TCLs/TALs detected in at least one soil sample.
Blanks indicate constituent not analyzed for.
VOCs: Volatile organic compounds
SVOCs Semivolatile organic compounds
ND: Constituent not detected.
R: Unreliable result. Analyte may or may not be present.
B: Analyte also detected in blank.
J: Estimated value.

TABLE 1-6
Summary of TAL Results for Soils

	ART Area	AST Former Waste Oil Tank	Auxiliary Building Area	Compressor Bldg Area	Drainage Ditch B	Former Gasoline UST	Former Waste Oil UST	Jacket Water Cooler Area	Jacket Water Surge Tank	Oil/Water Separator 1	Oil/Water Separator 3	Separator Pond	Station Lake	Outfall from Station Lake
TALs (mg/kg)														
Aluminum	8500-12000	10700-14100	9100-9400	10000-14000	12-13000		11900-20600			7730-11300	11100-16700	14000	9000-12000	19000
Arsenic	6-10	3.3J-4.9J	7.7-11	1.4-5J	6.2-24		1.9B-5B			3J-5J	3J-4.3J	0.52-1.9	2.7-3.1	2.5
Barium	68-110	34.6B-52.9	89-94	73-150	26-170		125-212			58-59.1	89.9-104	81-90	5ND-84	120
Beryllium	0.16-0.45	ND	0.18-0.21	0.17-0.72	ND-0.34		ND-2			ND	ND	0.44-0.56	0.22-0.72	0.82
Cadmium	3.4-4.3	ND-1.5	3.8-3.9	2.9-5.9	3.2-5.9		2.8-3.1			2-3	ND	3.7-4	0.96-2.5	10
Calcium	2200-9000	1020B-1770	3400-42000	1600-20000	330-3000		43300-183000			1220-2210	3000-6230	1200-1600	5900-28000J	4400
Chromium (total)	R	15-18.1	R	14-30	10-19		24.6-27	29-910	23J-920	13.5-16	16-21	23-27	24-38	300
Chromium VI	ND-0.79	ND-2	ND	ND	ND			ND-0.79	ND-2					
Cobalt	8.3-16	6.5B-9B	12-13	7-19	3-38		5B-10B			5.8B-11	10-10.1B	13-24	7.7-15	33
Copper	18-26	12.8-20.4	28-29	R-60	15-280		28.8-40			9.7-18.1	20-23	34-40	15-21J	81
Cyanide (total)	ND		ND	ND	ND							ND	ND-9.3	ND
Iron	25-29000	19300-32300	23000-25000	20000-32000B	22000-38000		14500-21900			17600-25100	27200-32200	28000-31000	18000-25000	67000
Lead	19-27	4.8-8.9	43-94	0.11-630	19-44	16.8-30.2	53-158			13.5-27	13-18	17J-26J	10-12J	44J
Magnesium	2800-4700	3720-4220	3200-4500	2500-5600	1200-3900		6680-16300			1560-3810	3980-5670	5600-5700	1900-7000	6800
Manganese	380-540	163J-426J	310-460	200B-630B	86-210		625-3310			145J-302J	371J-732J	210-230	320-400	840
Mercury	ND	ND	ND	ND-1.1	ND-0.79		0.7-5			ND	ND-0.1	ND-4	ND	ND
Nickel	R-28	15-20.4	R	13-33	12-67		26-38			9.9B-23	22.8-30	33-42	18-35	80
Potassium	710-810	593B-964B	700-790	640-860	580-1000		1040B-1290			562B-1040B	705B-1300B	990-1100	1100-1200	1400
Selenium	ND	3.6-5.1	ND	ND	0.12-0.44		3.8-8			3-4	4-5	ND	ND	ND
Sodium	65-100	ND	93-99	ND-170	180-390		ND-685B			ND	ND	66J-88J	ND-R	130J
Thallium	ND-0.28	ND	ND-0.24	ND-0.28	0.24-0.75		ND			ND	ND	ND	ND	ND
Vanadium	14-15	14.8-20.9	11	14-34	10-21		8B-15			10.8B-17	15.6-23	17-18	11-20	27
Zinc	69-81	43.6-67.6	230-450	61B-120	53-190		138-213			49.7-85.2	66.6-70	63-96	74-100	220

Notes:

Soil results for TALs detected in at least one soil sample.
ND: Constituent not detected.
Blanks indicate constituent not analyzed for.
R: Unreliable result. Analyte may or may not be present.
B: Value is between instrument detection limit and reporting limit.
J: Estimated value.

TABLE 1-7
Summary of TCL/TAL Results for Sediment
Compressor Station 229

	Drainline A Outfall Area (Outfall 1)	Drainline B Outfall Area (Outfall 2)	Drainline C Outfall Area (Outfall 3)	Separator Pond	Station Lake
TALs (mg/kg)					
Aluminum	8800	10000-11000	14000	14000	15200-19300
Arsenic	5.8J	3.2J-5.6J	2.7J	0.59	9-11
Barium	100	97-110	48	56	120-142
Beryllium	ND	0.45-0.46	0.25	0.41	ND
Cadmium	5.8	4-4.6	4	4.2	3-4
Calcium	7600	3500-3600	1500	13000	4340-9150
Chromium (total)	49	18-23	42	23	19-23
Cobalt	5.8	14	16	18	18-23
Copper	36	33-53	24	26	21-48
Iron	20000	27000-32000	30000	30000	27000-31600
Lead	150J	39J-42J	33J	20J	46-67J
Magnesium	4900	4200-4600	4300	6000	3120-4150
Manganese	540	420-430	330	280	409-588
Mercury	1.4	0.22-0.27	0.29	ND	ND
Nickel	26	38-43	28	27	32-43
Potassium	830	960-1100	1000	1000	1550-2160
Silver	6.5J	ND	ND	ND	ND
Sodium	120J	85J-110J	140J	86	ND-484
Thallium	ND	ND	ND	0.27	ND-2
Vanadium	13	14-16	19	17	22-28
Zinc	500	88-95	130	74	1764

TABLE 1-7
Summary of TCL/TAL Results for Sediment
Compressor Station 229

	Drainline A Outfall Area (Outfall 1)	Drainline B Outfall Area (Outfall 2)	Drainline C Outfall Area (Outfall 3)	Separator Pond	Station Lake
SVOCs (mg/kg)					
Benzo(a)anthracene	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND-0.05
Benzo(b)fluoranthene	4.3	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
Fluoranthene	4.9	ND	ND	0.46	0.052-0.089
Indeno(1,2,3-cd)pyrene	2.8	ND	ND	ND	ND
Pyrene	3.8	ND	ND	ND	ND-0.088
bis(2-Ethylhexyl)phthalate	ND	R-1.5	R	ND	ND-0.14
VOCs (mg/kg)					
2-Butanone	ND	ND	ND	ND	0.07-0.14
Acetone	ND	R	R	R	0.33J-0.98BJ
Methylene Chloride	R	R	R	R	0.17BJ-0.24BJ

Notes:

TCL/TAL Sediment results for constituents with at least one detection in sediments.
ND: Constituent not detected.
R: Unreliable result. Analyte may or may not be present.
B: Analyte also detected in blank.
J: Estimated value.

In 1993 and 1994 a supplemental characterization was conducted to further characterize the presence of certain TCL/TAL constituents and PCBs in soils and sediments. A total of 81 samples were collected from station soils and sediments for TCL/TAL analysis. The supplemental characterization included sampling of the Station Lake water and sediments.

Soil and sediment results from both the site characterization and the supplemental characterization are included in Tables 1-5 through 1-7. Evaluation of the soil and sediment results indicates that BTEX in the dehydration area and chromium in certain areas on the site are the only TCL/TALs of potential concern at the site.

Two surface water samples were collected from Drainage Ditch B for iron analysis in 1992 and two surface water samples were collected from Station Lake in 1994 for volatile organic compound (VOC) analysis. No constituents were present at levels of potential concern. Table 1-8 presents the constituents detected in these surface water samples.

A total of 59 ground water samples were collected for TCL/TAL and/or VOC analysis during 10 sampling rounds. The specific analyses performed during each round of sampling are listed in Table 1-9. Tables 1-10 and 1-11 summarize results of ground water sampling for TCLs and TALs, respectively. Elevated levels of VOCs were detected in some wells, as shown in Figure 1-4.

A source characterization program was conducted in March and April 1995 in an attempt to locate soils that may be serving as a continuing source of the VOCs measured in ground water. A total of 69 soil samples were collected from 39 borings in the ART area and near monitoring well MW-2 for VOC analysis. Only two samples from one boring contained chlorinated VOCs (1,1,1-trichloroethane, or 1,1,1-TCA) at a maximum level of 0.150 mg/kg of 1,1,1-TCA at 3 to 3.5 feet. These soils were excavated and disposed during the IRM. No VOCs were detected above the detection limit at any other soil sampling location except acetone, a common laboratory contaminant which was detected at low levels in three samples. This extensive sampling program determined that a continuing source of VOCs to the ground water did not exist in the soils sampled.

TABLE 1-8
Summary of TCL/TAL Results for Surface Water
Compressor Station 229

	Drainage Ditch B	Station Lake
TALs (μg/L)		
Iron	2,600-490,000	NA
VOCs (μg/L)		
Methylene Chloride	NA	5-14

Notes:

Results for constituents detected in at least one surface water sample. Iron was the only TAL analyzed for in surface water.

NA - constituent not analyzed for.

TABLE 1-9
Summary of Ground Water Analyses Performed
Compressor Station 229

Sampling Location	Round 1[1] (1/91)	Round 2[1] (4/91)	Round 3[2] (7/92)	Round 4 (8/93)	Round 5 (10/93)	Round 6 (3/94)	Round 7 (4/94)	Round 8 (8/94)	Round 9 (12/94)	Round 10 (1/95)	Supplemental (6/96)
MW-1	TCL/TAL, PCB	TCL/TAL, PCB	TCL/TAL, PCB	VOC	NS	NS	NS	NS	NS	NS	NS
MW-2	TCL/TAL, PCB	TCL/TAL, PCB	TCL/TAL, PCB	VOC	NS	NS	NS	NS	VOC	VOC	VOC
MW-3	TCL/TAL, PCB	TCL/TAL, PCB	TCL/TAL, PCB	NS	NS	NS	NS	NS	NS	NS	NS
MW-4	TCL/TAL, PCB	TCL/TAL, PCB	TCL/TAL, PCB	VOC	NS	NS	NS	NS	VOC	VOC	NS
MW-5	TCL/TAL, PCB	TCL/TAL, PCB	TCL/TAL, PCB	NS	NS	NS	NS	NS	NS	NS	NS
MW-6S	NS	NS	NS	NS	NS	VOC	VOC	NS	VOC	VOC	VOC
MW-6D	NS	NS	NS	NS	NS	VOC	NS	NS	VOC	VOC	NS
MW-7S	NS	NS	NS	NS	NS	VOC	VOC	NS	VOC	VOC	NS
MW-7D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-8S	NS	NS	NS	NS	NS	NS	VOC	NS	VOC	VOC	VOC
MW-8D	NS	NS	NS	NS	NS	NS	VOC	NS	VOC	VOC	VOC
MW-9D	NS	NS	NS	NS	NS	NS	VOC	NS	VOC	VOC	VOC
MW-10	NS	NS	NS	NS	NS	NS	NS	VOC	VOC	VOC	VOC
MW-11	NS	NS	NS	NS	NS	NS	NS	VOC	VOC	VOC	VOC
GW-1	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-2	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-3	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-4	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-5	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-6	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-7	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS

TABLE 1-9
Summary of Ground Water Analyses Performed
Compressor Station 229

Sampling Location	Round 1[1] (1/91)	Round 2[1] (4/91)	Round 3[2] (7/92)	Round 4 (8/93)	Round 5 (10/93)	Round 6 (3/94)	Round 7 (4/94)	Round 8 (8/94)	Round 9 (12/94)	Round 10 (1/95)	Supplemental (6/96)
GW-8	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-9	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
GW-10	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
DP-11	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
DP-12	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
DP-13	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
DP-14	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS
DP-15	NS	NS	NS	NS	VOC	NS	NS	NS	NS	NS	NS

Notes:

1 In rounds 1 and 2, TCL/TAL includes analyses for VOC, BNA (base-neutral analytes [SVOCs]), pesticides, metals, TOC (total organic carbon), TOX (total organic halogens), TDS (total dissolved solids), and TPH (total petroleum hydrocarbons).
2 In round 3, TCL/TAL includes analyses for VOC, BNA, metals and TPH.

NS = Not Sampled.
Sampling locations identified with GW and DP are temporary monitoring locations.

TABLE 1-10
Summary of TCL Results for Ground Water
Compressor Station 229

	Round 01:[2] 1/91	Round 02:[2] 4/91	Round 03:[2] 7/92	Round 04:[3] 8/93	Round 05:[4] 10/93	Round 06:[5] 3/94	Round 07:[6] 4/94	Round 08:[7] 8/94	Round 09:[8] 12/94	Round 10:[8] 1/95	Supp.[9] 6/96
Constituent (µg/L)[1]											
1,1,1-Trichloroethane	ND-12	ND-18	ND-73	ND-26	ND-8400	0.8-150	ND-460	ND	ND-290	ND-640	ND-420
1,1-Dichloroethane	ND	ND	ND-1.5	ND	ND-7	0.6-11	ND-12	ND	ND-17	ND-12	ND-20
1,1-Dichloroethene	ND	ND	ND-6.6	ND-1	ND-1800	0.3-31	ND-83	ND	ND-43	ND-110	ND-100
1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND-2	ND-2	ND-1	ND	ND-16	ND-2	ND-9.6
Benzene	ND-5	ND	ND-22	ND-9	ND-2	ND	ND-24	ND-1	ND-75	ND-10	ND-59
Carbon Tetrachloride	ND	ND	ND-11	ND-0.5	ND	ND	ND	ND	ND-10	ND	ND-4.6
Chloroform	ND-10	ND-30	ND-110	ND-7	ND-22	ND-6	ND-8	ND-0.2	ND-0.1	ND-93	ND-43
Ethylbenzene	ND	ND	ND-2	ND-0.6	ND-0.2	ND-2	ND-5	ND	ND-13	ND-2	ND-4.2
Toluene	ND	ND	ND	ND	ND-2	ND-5	ND-3	ND-0.5	ND-89	ND-12	ND-73
Xylenes (total)	ND-5	ND	ND	ND-0.2	ND-2	ND	ND-14	ND	ND-67	ND-10	ND-43
bis(2-Ethylhexyl)phthalate	ND-140	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA

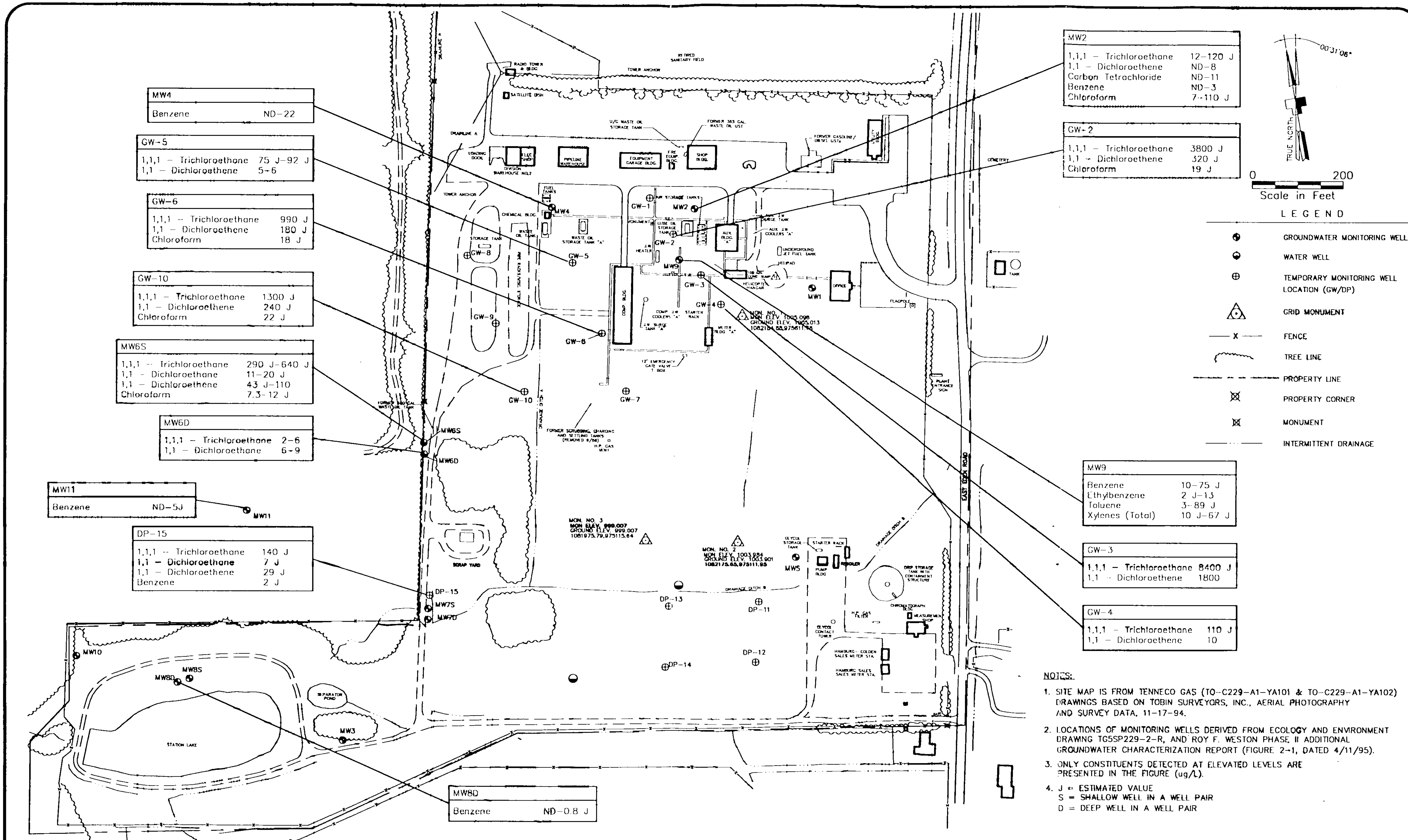
Notes:
ND = Not present above the detection limit.
NA = Not analyzed.

1 All samples are unfiltered. Results for TCLs detected above NYSSGVs in at least one round of sampling are reported. All other TCLs were either ND or were detected below the NYSSGVs for all sampling rounds.
2 Reported by E&E for samples from monitoring wells MW-1, MW-2, MW-3, MW-4, and MW-5.
3 Reported by R.F. Weston for samples from monitoring wells MW-1, MW-2, and MW-4.
4 Reported by R.F. Weston for samples from monitoring wells GW-1 through GW-10 and DP-11 through DP-15.
5 Reported by R.F. Weston for samples from monitoring wells MW-6S and MW-7S. Data are unvalidated and are therefore not considered in the selection of remedial alternatives.
6 Reported by R.F. Weston for samples from monitoring wells MW-6S, MW-7S, MW-8S, MW-8D, and MW-9D.
7 Reported by R.F. Weston for samples from monitoring wells MW-10 and MW-11.
8 Reported by R.F. Weston for samples from monitoring wells MW-2, MW-4, MW-6S, MW-6D, MW-7S, MW-8S, MW-8D, MW-9D, MW-10 and MW-11.
9 Reported by R.F. Weston for samples from monitoring wells MW-2, MW-6S, MW-6D, MW-8S, MW-8D, MW-9D, MW-10 and MW-11.

TABLE 1-11
Summary of TAL Results for Ground Water[1,2]
Compressor Station 229

Chemical (µg/L)	Round 01: 1/91		Round 02: 4/91		Round 03: 7/92	
	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
Aluminum	ND-2000	400-520000	120-220	27000-120000	100-1700	6800-48000
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND-160	ND	ND-15	ND	ND-9
Barium	36-490	55-5200	36-410	660-1600	28-430	240-880
Beryllium	ND	ND-41	ND	ND-6	ND	ND
Cadmium	ND	ND-200	ND	18,933	ND	ND-11
Calcium	21000-180000	100000-1000000	34000-190000	84000-250000	24000-250000	60000-270000
Chromium (total)	ND-13	ND-1000	ND	69-2500	ND-54	12-10000
Cobalt	ND-31	ND-560	ND	37-160	ND-32	20-95
Copper	ND-26	ND-1400	ND-21	68-320	ND	31-120
Cyanide (total)	ND	ND	ND	ND	ND	ND
Iron	ND-6100	930-1000000	68-200	52000-230000	ND-5500	12000-85000
Lead	ND-52	58-1000	ND	19-40	ND-7	11-24
Magnesium	3700-52000	22000-210000	5800-55000	22000-79000	3200-65000	17000-72000
Manganese	120-5400	730-9100	79-5400	1600-8600	ND-5800	510-7300
Mercury	ND	ND-1	ND	ND	ND	ND
Nickel	ND-460	ND-2400	ND-180	100-760	ND-1600	22-2100
Potassium	1200-5500	4400-38000	1500-4600	5900-13000	1500-3700	4800-10000
Selenium	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND
Sodium	17000-150000	16000-150000	11000-87000	11000-85000	15000-160000	14000-180000
Thallium	ND	ND	ND	ND	ND	ND
Vanadium	ND-13	ND-1100	ND	22-71	ND	ND-79
Zinc	ND	ND	ND	ND	ND	ND

Notes:
ND = Not present above the detection limit.
[1] Samples collected from monitoring wells MW-1 through MW-5
[2] No samples were analyzed for TALs during Rounds 4 through 10.



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SUMMARY OF VOC GROUND WATER SAMPLING RESULTS
TENNESSEE GAS PIPELINE COMPANY, COMPRESSOR STATION 229
EDEN, NEW YORK

Figure 1-4

1119DW1A

Elevated levels of iron, manganese, sodium, magnesium, nickel, and lead were present in some wells. There are no historical data to indicate that the presence of these TALs in ground water could have resulted from station activities. Based on the above analysis, the presence of these TALs in ground water is not of potential concern.

Chromium was measured in one well during the third round of sampling at a level of 54 μg/L, which marginally exceeds the New York State standard of 50 μg/L, but is below the U.S. Drinking Water Standard of 100 μg/L. As reflected in the RI document, *Evaluation of Ground Water Monitoring Data, Station 229, Addendum to Remedial Investigation Report* (July 1993), chromium at this level is not of potential concern.

1.3.3.3 Site Characterization Summary

Site characterization data indicated that PCBs were present in operations and drainage areas of the station. PCBs in on-site soils and drainlines were addressed in an Interim Remedial Measure as discussed in Section 1.3.4.

PCBs were also detected in the tributary soils and sediments, the separator pond sediments and Station Lake sediments. The concentration of PCBs in the sediments of the separator pond and Station Lake are low. However, Station Lake contains fish. Therefore, both the tributary and Station Lake are evaluated further below.

The levels of TCL/TALs detected in the soil and sediment samples collected during the RI program indicate that only BTEX and chromium are of potential concern in soil or sediment. The extent of potentially significant BTEX in soils is limited to the dehydration area; sampling in and downgradient of the dehydration area indicates that downgradient soils have not been impacted by BTEX from the dehydration area nor has ground water within or downgradient of the area been affected. The limited extent of BTEX in soils does not warrant further consideration under this program, and will not be evaluated further in this FS. The presence of chromium in certain station soils will be evaluated further in the following sections.

Sampling results for several monitoring wells indicate the presence of VOCs in ground water. Although extensive sampling indicates that a continuing source of VOCs from soils to the ground water does not exist, VOCs in ground water are evaluated further in this report.

1.3.4 On-Site Remedial Activities

TGPL has performed site remediation activities over the past several years. These include cleaning of air compressors and air receiver tanks and cleanup of on-site soils. Cleaning of air compressors and air receiver tanks occurred between 1991 and 1993 as IRMs.

An IRM was performed between July and September 1995 to address on-site soils and drainline sediments containing PCBs. The remediation was conducted in accordance with the NYSDEC-approved *Interim Remedial Measure Work Plan, Tennessee Gas Pipeline Company Compressor Station 229 at Eden, New York*, April 1995. The implementation of the remedial activities is summarized in the *Interim Remedial Measure Decision Document*, NYSDEC, June 1995.

The IRM is a component of the overall remediation of the site. The major elements of the IRM included:

- Acquisition of additional soil samples to delineate the areas targeted for soil removal and to determine if the scope of the IRM should be expanded or additional remedial activities would be required;
- Excavation and off-site disposal of on-site soils and drainline sediments (in oil/ water separators and manholes) containing PCBs in excess of the cleanup goal; and
- *In situ* abandonment of subsurface drainlines by grouting.

The IRM cleanup goal was developed based on a site-specific exposure evaluation, evaluation of promulgated regulatory levels, and site-specific conditions (e.g., restricted access to the site, deed restrictions, no ground water impact) as described in the IRM Work Plan and Decision Document. Based on these factors, a cleanup goal of 25 mg/kg for on-site soils and drainlines was found to be protective of human health and the environment.

Seven areas were identified for soil remediation based on RI and pre-remediation sampling:

- Air Receiver Tank (ART) Area
- Pipe Rack Area
- Scrap Yard Area
- Compressor Building Area
- Shop Building Area
- Auxiliary Building Area
- Drainage Ditch B Area

These areas were delineated and excavated to address soils exceeding the cleanup goals.

A total of 414 cubic yards (cy) of soil was excavated and disposed. Because of subsurface limitations, a low-permeability cap was installed over the excavation area west of the ARTs following the excavation of accessible soils. The areas were restored following remediation with the placement of backfill to within 6 inches of the initial grade, and were covered with topsoil or gravel, depending on the original cover prior to excavation. Areas restored with topsoil were revegetated, fertilized and mulched. Rip-rap was used as backfill for the drainage channel portion of Drainage Ditch B area to limit potential future erosion.

Approximately 4,620 feet of Drainline D were addressed in the IRM. Of that length, approximately 42 feet were considered inaccessible due to the proximity of utilities. The IRM Work Plan called for removal of sediments from the manholes, an oil/water separator from Drainline D, and a sump believed to be on Drainline C, followed by grouting of the lines, separator, and sump with non-shrink cement material. However, subsequent to the preparation of the IRM Work Plan and Design Plan, information was obtained relative to Drainline C indicating that remediation of the drainline was not necessary. Specifically, it was noted that the Compressor Building floor drains are connected to Manholes 1 and 2, which discharge through the Drainline D system, whereas the Compressor Building roof drains are not connected to Manholes 1 and 2 and discharge through the Drainline C system. The roof drain from the east side of the Compressor Building passes through Manhole 2 but does not discharge into it, and the roof drain from the west side of the building bypasses around Manhole 1. Additionally, it was observed that the 100-gallon concrete sump tank adjacent to the Compressor Building was not connected to the drainlines, and there was no indication that it had been previously connected to the roof or floor drains. Subsequent sampling of Drainline C sediments and the oil/water separator indicated that PCBs were not present, so grouting Drainline C was not considered necessary. Therefore, the IRM activities outlined in the original IRM Design Plan for Drainline C were modified as described in the *Interim Remedial Measure Report, Soil/Drainline Activities*, February 1996. The sediments were removed from two identified sumps, from the Drainline D manholes, and from the oil/water separator and the lines and appurtenances were grouted. As a result of the IRM, all impacted drainlines have been closed.

All on-site soils and drainlines exceeding the cleanup goal were addressed by the IRM activities designed to achieve standards developed and presented in the IRM. A letter dated March 28, 1996 from the NYSDEC confirms that the IRM was acceptable.

All criteria presented in the IRM continue to be met at the site and the remediation achieved the cleanup goal determined to be protective of human health and the environment. Therefore no further action is necessary for PCBs in on-site soils and drainlines.

In addition to PCBs in on-site soils and drainlines, PCBs are present in some on-site sediments and other constituents are present on-site. These two potential concerns were evaluated to determine whether the IRM adequately addressed all on-site soil and sediment issues, or whether further remediation may be necessary for these media.

PCBs were measured in the separator pond and Station Lake sediments at levels up to 14 ppm and 6.6 ppm respectively. Levels are low in both areas and, since the sediments are underwater in non-recreational areas, the potential for human exposure is minimal. However, to address potential concerns regarding bioaccumulation of PCBs in fish in

Station Lake, the fish will be removed and the lake will be monitored thereafter to ensure that a fish population does not reappear in the lake.

Other constituents of potential concern on-site are addressed in the following discussion of chemical fate and transport. As demonstrated in the following section, based on evaluation of the TCLs/TALs, there are no on-site contaminants that require further remediation. Therefore, the IRM has sufficiently addressed all on-site contaminants in soil and sediment and no further action is necessary for these media.

1.3.5 Chemical Fate and Transport

Fate and transport analysis examines the physical and chemical processes relating to the transformation and movement of PCBs and TCL/TALs in the environment. This analysis is performed in order to better evaluate whether constituents will reach receptors and assess the potential impacts of these constituents. This section provides a summary analysis of the fate and transport of targeted constituents in the areas identified in the preceding sections of this report (i.e., PCBs in the tributary system and certain TCL/TALs in soils, sediments and ground water). A detailed description of the fate and transport analysis is provided in the RI report.

The fate and transport of PCBs and TCL/TALs depend on the relevant chemical characteristics, the physical characteristics of the site, source characteristics, and distribution of these substances in the environmental media. The pathways relevant to each medium and constituent, specific to the site, are discussed in the following sections. Section 1.3.5.1 presents the properties of PCBs and pathways for migration that were considered in the RI and evaluates the potential for human and wildlife exposure to PCBs in the tributary system. Section 1.3.5.2 presents the properties of specific TCL/TALs, the applicable pathways for their migration, and the potential for exposure to these constituents.

1.3.5.1 PCBs

PCBs are among the more environmentally persistent organic compounds, having low water solubility and high adsorptivity. These characteristics give PCBs a high affinity for soils and sediments, onto which they are readily adsorbed, a process which restricts their mobility in the environment. The process of PCB adsorption to soil is enhanced by the presence of organic carbon, which further reduces the mobility of PCBs in soils and sediments.

The fate and transport of on-site PCBs were discussed in the IRM and are not addressed further in this section. TGPL performed a fate and transport study for Station Lake and the tributary system to determine if residual PCB-containing soils and sediments located in Station Lake and along the upstream reaches of the tributary may have an impact on potential downstream receptors. The results of the study are presented in the report entitled *Analysis of Transport of PCB Soils and Sediments in Tributary Near Compressor Station 229* (ENVIRON, March 1996), which was submitted to the NYSDEC and placed in the public repositories. In the study, the results of two sampling events were evaluated and an erosion and sediment transport model was developed. Comparison of the sampling data sets, collected in 1990/91 and 1994, indicates that following four years of storm events, including a greater than 100-year event, the PCB-containing soils and sediments are not being significantly transported to downstream areas. This conclusion is based on the following observations:

- The maximum PCB levels are observed to be in similar upstream locations in both the 1990/91 and 1994 data sets.
- The storm event (August of 1994) did not cause an increase in downstream PCB levels from accumulation of PCB-containing soils transported from upstream. In fact, average downstream levels in 1994 were less than those observed in 1990/91, indicating a natural attenuation of PCB levels.

The erosion and sediment transport model developed for this site supports the above conclusion that significant downstream transport of PCB-containing soils and sediments is not expected to occur in the tributary system. The model utilized the Universal Soil Loss Equation (USLE) and the results of regional channel erosion field studies to provide estimates of the average PCB level in downstream depositional areas within the tributary. The model was used to provide a comparative assessment of the expected downstream sediment PCB levels under seven theoretical remedial alternatives.

The results of the model indicated that predicted average PCB levels in sediments reaching the "breached pond" (located just over one mile downstream from the compressor station) would be well below 1 ppm, regardless of whether PCBs are removed from the tributary system. A sensitivity analysis conducted as part of the study indicated that even if there is considerable variability among the input parameters, it is unlikely that the predicted average PCB level in sediments reaching the breached pond would exceed 1 ppm even if no PCBs are removed. Consequently, the model showed that the average downstream PCB levels would not be significantly decreased by implementation of any remedial action.

Since the model used is predictive, temporal variations were not considered; thus the model assumed constant PCB levels in the areas serving as a potential source for eroded soil and sediment. PCB levels, however, would generally decrease with time due to the erosion of PCB-containing areas and the influx of non PCB-containing soils and sediments. Thus, the model is conservative in predicting PCB levels in sediments deposited downstream. Despite this conservative assumption, the model predicts that transport will not result in the movement of PCB levels of potential concern to downstream receptors.

Despite these modeling predictions, which indicate that PCBs will not reach potential receptors, PCBs in Station Lake and the tributary system soils and sediments are retained for further evaluation in Section 1.3.6 (ecological evaluation) and Section 1.3.7 (human health evaluation).

1.3.5.2 TCL/TALs

Several TCL/TALs detected in soils, sediments or ground water at Station 229 require further evaluation. The TCLs of potential concern in ground water are BTEX and several chlorinated VOCs. TGPL conducted an extensive source characterization program to locate the continuing source of both chlorinated and non-chlorinated VOCs to the ground water, if such a source existed. Sampling of soils indicated that a continuing source did not exist. Therefore, TCLs are not of concern in on-site soils or sediments. TALs of potential concern in ground water include iron, manganese, sodium, magnesium and chromium. The TAL of potential concern in soil and sediments is chromium. These TCL/TALs are discussed below.

1.3.5.2.1 Ground Water TCLs

The TCLs of potential concern in ground water include BTEX, 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1,-DCA), 1,1-dichloroethene (1,1-DCE), chloroform, and carbon tetrachloride. Bis (2-ethylhexyl) phthalate was detected at an elevated level only in the sample from MW-4 during the first round of sampling; since it was not detected during the subsequent sampling round, bis (2-ethylhexyl) phthalate is not a constituent of potential concern.

Monitoring wells are shown in Figure 1-2 and the VOCs present at elevated levels are shown in Figure 1-4. Ground water flow from the station is generally to the southwest. The absence of the VOC compounds in the downgradient wells, MW-8S and MW-10, indicates that significant VOC transport in ground water has not occurred. Ground water emanating from the property ultimately discharges to surface water, either to Station Lake or the tributary where, if VOCs were present, volatilization would rapidly remove the VOCs from the water. However, no elevated levels of VOCs have been reported in samples from MW-8S, MW-10, or Station Lake. Additionally, no potential receptors exist between the station and the surface water discharge points. Therefore, the localized VOCs from the station will not reach any potential receptors, nor are they anticipated to result in measurable levels of VOCs in surface water.

1.3.5.2.1.1 BTEX Compounds

A summary of the BTEX compounds detected in ground water samples at Station 229 is given above in Table 1-10 and shown in Figure 1-4. Elevated levels of benzene have been detected in ground water wells MW-2, MW-4, MW-9, and MW-11; and at estimated levels in MW-8D and drive point DP-15. MW-9 also contained the other BTEX compounds, ethylbenzene, toluene, and xylenes.

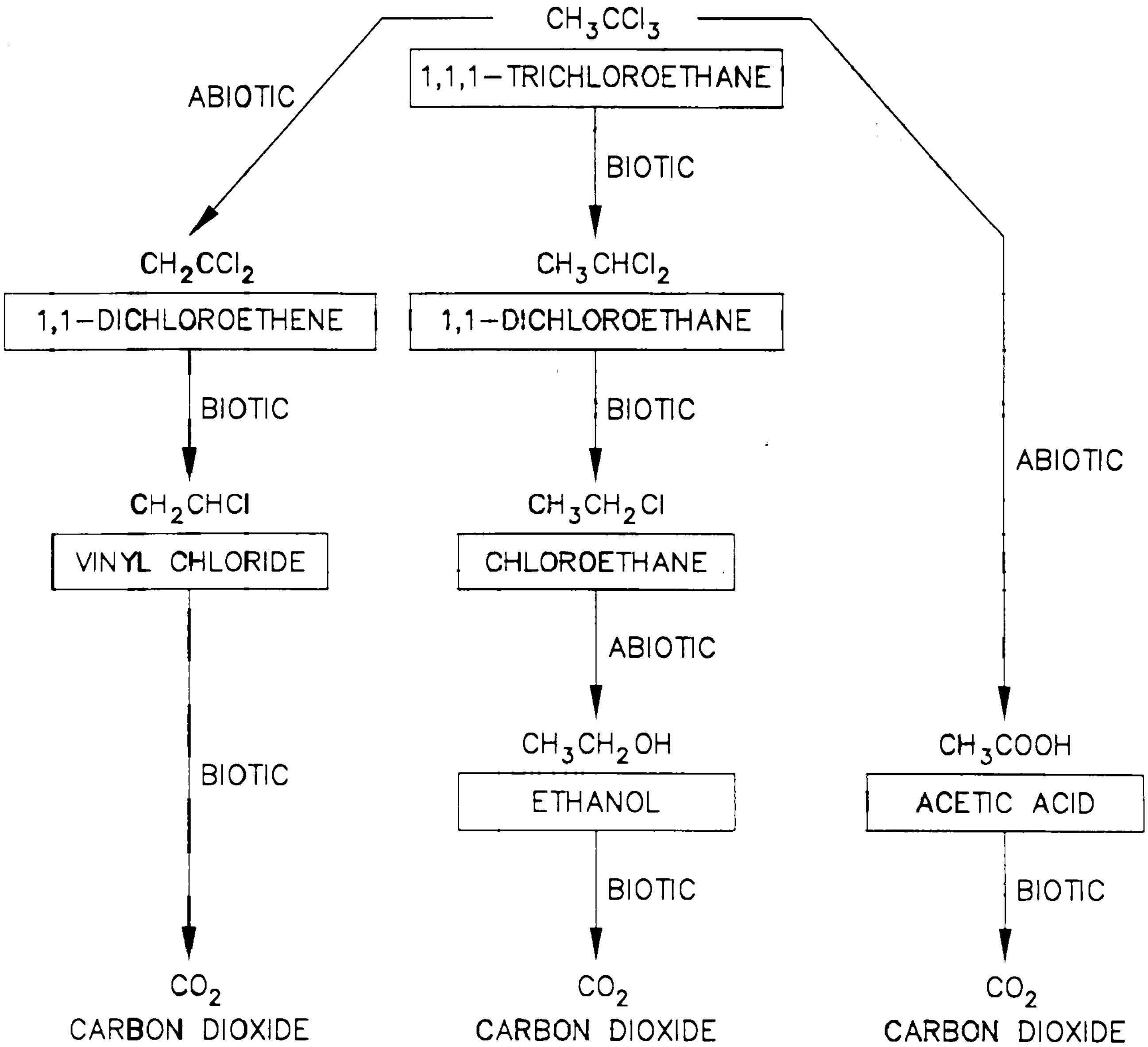
The BTEX compounds are more mobile in ground water than most polynuclear aromatic hydrocarbons (PAHs) or PCBs because they are highly soluble. The BTEX compounds do, however, naturally attenuate in ground water through volatilization, dispersion, and sorption (retardation). The BTEX compounds exhibit varying tendencies for biodegradation. All are biodegradable under aerobic conditions and toluene, ethylbenzene and xylene have been shown to degrade under anaerobic conditions. Benzene is more resistant to anaerobic biodegradation, but some field and laboratory studies demonstrate that benzene biodegrades under denitrifying, sulfate-reducing, and methanogenic conditions (Rifai 1995). The fate and transport of BTEX compounds, including subsurface transport and attenuation via ground water, are considered in the evaluation of remedial alternatives for ground water.

In response to the presence of chlorinated VOCs in MW-6, TGPL installed MW-11 downgradient and west of the facility, in the direction of ground water flow from MW-6. Samples from MW-11 do not indicate the presence of the primary MW-6 constituents (chlorinated VOCs); however, benzene has been identified as a constituent for further evaluation in MW-11. The presence of a gas well on the property between MW-6 and MW-11 suggests that the gas well may be a source of the downgradient benzene levels.

1.3.5.2.1.2 Chlorinated VOCs

A summary of the chlorinated VOCs present at levels warranting further evaluation in ground water is given in Table 1-10. The presence of 1,1,1-TCA at the station is theorized to result from a one-time cleaning of the ARTs in 1979, during which solvents containing 1,1,1-TCA may have been used. The cleaning operations were apparently conducted in close proximity to the ARTs, and only small volumes of residual solvents could have migrated to the adjoining surface soils during the cleaning operations. The VOC source characterization thoroughly investigated this area and located only one limited area where soils contained chlorinated VOCs; these soils were removed during the IRM.

The chlorinated VOCs present in station ground water are relatively soluble and mobile in ground water. In addition, natural attenuation has been shown to be a significant factor in the fate of chlorinated VOCs in ground water. Technical literature indicates that 1,1,1-TCA can be degraded by both abiotic and biotic pathways, as shown in Figure 1-5 (Vogel and McCarty 1987). Abiotic transformation daughter products include 1,1-DCE and acetic acid. Daughter products of biotic transformation occurring under methanogenic conditions include 1,1-DCA and chloroethane. 1,1-DCE has been detected in ground water (1,800 μg/L) at the same location (GW-3) as the maximum detected 1,1,1-TCA concentration (8,400 μg/L) (Figure 1-4). 1,1-DCA was estimated at a maximum of 20 μg/L at MW-6S in the supplemental sampling. The presence of the daughter products, 1,1-DCE and 1,1-DCA, in the absence of any historical usage of these chemicals at the facility, indicates that *in situ* degradation of 1,1,1-TCA is occurring. While the pathway that is most likely to predominate will depend on environmental conditions, the eventual end products of degradation are nonhazardous compounds such as acetic acid and carbon dioxide. Similarly, chloroform and carbon tetrachloride are naturally degraded under abiotic conditions to lower molecular weight compounds (Fetter 1993).



SOURCE: VOGEL AND McCARTY, 1987.

ENVIRON	PATHWAYS FOR THE TRANSFORMATION OF TCA UNDER METHANOGENIC CONDITIONS	FIGURE 1–5
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Thus, these constituents and their subsurface transport via ground water are incorporated into the evaluation of remedial alternatives for ground water.

1.3.5.2.2 Ground Water TALs

As discussed in the RI, several TAL metals have been detected in ground water samples at Station 229. These metals are commonly found in soil and rock in the ground. When a monitoring well is constructed or sampled, soil can enter the well as suspended particles, causing a sample to be turbid. Many of the past ground water samples collected at Station 229 contained suspended soil particles. Turbid ground water samples commonly contain elevated TAL metal concentrations in the form of suspended particles, not as dissolved constituents. It is important to note that ground water is not turbid in its natural state, nor is tap water.

At Station 229, a simple procedure was used to evaluate whether metals detected in samples were dissolved contaminants of concern or simply the result of sample turbidity. Samples were divided into two parts prior to being analyzed. One part was filtered to remove the sediments; the other part was analyzed without filtering. Although the filtered samples had some TAL metal detections, TALs were present in only a limited number of ground water samples at levels exceeding potentially applicable standards. The potentially applicable standards for TALs in ground water are presented in Table 1-12.

Ground water data for TALs in filtered samples were compared with the values in Table 1-12. The basis for using filtered data is that, if the ground water were to be used as a drinking water source, either the well would be constructed in such a manner that the suspended matter would be removed or water would be treated by filtration to remove the turbidity. In addition, issues of chemical transport in ground water are typically limited to the soluble phase.

Potentially applicable standards or guidance values (SGVs) were exceeded for two TALs with secondary Maximum Contaminant Limits [MCLs] (iron in

TABLE 1-12
Potentially Applicable Ground Water Standards
and/or Guidance Value for Select TALs

Constituent	USDWS (µg/L)	NYS SGV (µg/L)
Chromium (total)	100	50
Iron	300[1]	300 (500 w/Mn)
Lead	15	25
Magnesium	--	35,000 (GV)[2]
Manganese	50[1]	300(500 w/Fe)
Sodium	--	20,000

Note:

(1) Secondary Standard
(2) GV = Guidance Value

wells MW-2, 3, and 4 and manganese in MW-1 through MW-5), and for two TALs without primary or secondary MCLs (sodium in MW-1, 2, 4 and 5 and magnesium in MW-1). Among the TALs with primary MCLs, chromium exceeded the NYS SGVs in one well during the third round of sampling (MW-2); however, the U.S. Drinking Water Standard (USDWS) was not exceeded. Lead was detected above the USDWS and the NYS SGVs in one well (MW-5) during the initial round of sampling; lead was not detected in the two subsequent sampling rounds. There are no historical data to indicate that the presence of iron, manganese, sodium, magnesium or lead in ground water could have resulted from station activities. While chromium was used on the station, it was detected in only one sample in one well at a level only slightly exceeding the NYS SGV and below the USDWS. In addition, these metals are naturally occurring ground water constituents. Therefore, based on the above analysis and the station history, none of the metals is considered to be a constituent of concern in ground water.

1.3.5.2.3 Soils and Sediments

As discussed in Section 1.3.3, chromium is the only TCL or TAL in soils warranting further evaluation at the facility. Chromium was detected at elevated levels in soil from the Jacket Water Cooler area, the Jacket Water Surge Tank area, and in a sample from the drainage outfall by Station Lake, and at slightly elevated levels in sediment samples collected from the separator pond, Station Lake and Drainline Outfalls 1, 2 and 3. As discussed below, in all cases levels of chromium in its hexavalent form were much lower than trivalent chromium levels.

Chromium occurs most commonly in its trivalent and hexavalent forms [Cr(III) and Cr(VI)]. Trivalent chromium is considered an essential trace element in humans (USEPA 1980). Hexavalent chromium is a lung carcinogen (USEPA 1990) for which the exposure pathway of concern is inhalation. However, hexavalent chromium is reduced to trivalent chromium rather rapidly in soil, even under alkaline conditions (Bartlet and Kimble 1976, Bodek et al. 1988), so that hexavalent chromium is typically present at only very low levels in soil. Hexavalent chromium, used historically in the Jacket Water Coolers at the station, for example, was only a maximum of 0.2% of the total chromium in the 12 soil samples collected from the area. In general, total chromium detected in soil is likely to be associated with very low levels of hexavalent chromium and migration of hexavalent chromium along any pathway that involves movement through soil is therefore likely to be minor.

The NYS SGV for both total and hexavalent chromium is 50 mg/kg for soils. As shown in Table 1-6, this guidance value is exceeded for total chromium in the Jacket Water Cooler area, the Jacket Water Surge Tank area, and a single sample at the outfall of Station Lake. Levels of hexavalent chromium, the more mobile state of chromium, are much less than the SGV in these samples. The two Jacket Water areas are very limited in extent and are vegetated, which significantly reduces the potential chromium transport by storm runoff. On this basis, chromium is not of concern in the Jacket Water Cooler and Jacket Water Surge Tank areas.

Sediments from the separator pond, Drainline Outfall 1, 2, and 3 areas and Station Lake contain total chromium (Table 1-7). Hexavalent chromium was not detected in Station Lake sediment and was not analyzed for in the other sediment samples. Most of these levels are below the NYSDEC lowest effect level for metals in sediments as defined in the *Technical Guidance for Screening Contaminated Sediment* (November 1993) and all are below the severe effect level defined in that document.

The sample collected in the tributary at the outfall of Station Lake was collected in an isolated pool before the start of an erosional zone composed primarily of exposed shale. This sample is believed to have been collected from a small area of sediment in the pool. Given the limited area represented by this sample, potential downstream impacts are not significant. In addition, a simulation of sediment transport and deposition along the tributary using the

Universal Soil Loss Equation demonstrated that both dispersion of PCB-containing sediment and influx of clean sediment would reduce PCB levels in downstream depositional areas. These same processes also would act to reduce levels of any adsorbed chromium in sediment in the tributary system; therefore, levels of potential concern will not be present in downstream areas.

In addition to the lack of significant transport pathways, the areas containing elevated levels of chromium are limited in extent and there is no continuing source of chromium to site soils, sediments or water. TAL analysis of station ground water has shown that chromium has not significantly impacted this medium. Based on all of these factors, chromium is not a constituent of potential concern at this site and will not be evaluated further in this report.

1.3.6 Habitat Based Assessment and Ecological Evaluation

The Habitat Based Assessment (HBA) was performed in two phases, with additional fish sampling and an extensive evaluation of the ecological health and setting of the tributary following the second phase. Documents related to the HBA and ecological evaluation results include the following:

Remedial Investigation Tennessee Gas Pipeline Company Compressor Station 229 at Eden, New York Volume III Evaluation of Results, August 1991.

Final Report Phase II Habitat Based Assessment Verification Work June 1992, February 1993.

Fish Sampling Results from Station Lake, Breached Pond, and Tributary Between Ponds near Station 229, March 1994.

Final Report: Fish and Sediment Sampling Results from a Tributary and a Breached Pond near TGPL Station 229, February 1995.

Ecological Evaluation of a Tributary and Associated Habitats Near Tennessee Gas Pipeline Compressor Station 229 Near Eden, New York, January 1996.

These documents have been submitted to the NYSDEC and placed in the public repositories.

Phase I of the HBA, performed in April 1991, included the following elements:

- Identification of the natural resources of the site and surrounding areas in terms of the vegetative cover types and their associated fish and wildlife populations, with attention given to special resource areas, such as regulated wetlands, streams, lakes, and other significant habitats;
- Identification, through a literature review, of the fish and wildlife species that would utilize the habitats;
- Assessment of the environmental quality in terms of a habitat's capability to provide for the needs of a native species; and
- Identification of the hazard thresholds for certain fish and wildlife species and comparison of these levels to site characterization data.

The major findings of this HBA included the resource assessment, which concluded that the study area was of good quality and contained a wide range of habitat types capable of supporting a diversity of wildlife and aquatic organisms. Phase I of the HBA did not include direct observation of piscivors in the study area during the field survey; however, the NYSDEC species lists were evaluated in the context of the habitats present to conclude that sensitive mammals and birds could inhabit the area. Fish were not specifically observed in the site area, but downstream classification and the presence of fish-food insects supported an assumption of the presence of fish within a 2-mile radius. Station Lake and portions of the tributary of Eighteenmile Creek were found to be the only potentially affected habitats, based on PCB sampling data. Hampton Brook is not in the PCB migration pathway, based upon site topography and drainage patterns.

The Phase I HBA discussed the sediment criteria for the protection of piscivorous and aquatic wildlife that might be applicable to the tributary system depending on the fraction of organic carbon in the sediment, the presence and size of the populations, the distribution and availability of the sediments, and the validity of the equilibrium partitioning model to predict PCB bioavailability. Further study and sampling were recommended for evaluation of potential aquatic populations in Station Lake and the tributary system and the resulting potential PCB exposure to piscivorous and aquatic species. Two rounds of fish sampling and analysis were conducted to evaluate these populations and their PCB exposure. Results of the sampling are provided in Section 1.3.3.1.

The Phase II HBA was conducted to provide more extensive field evaluation of the habitats, flora, and fauna present within a 0.5-mile radius of the site and within 2 miles of the site along the tributary corridor. This assessment found that the habitats were healthy with few signs of vegetative stress; those noted were due to variation in soil moisture content and to mechanical damage, not to the presence of PCBs. The absence of: (1) state-identified or regulated wetlands; (2) significant habitat units; or (3) rare, endangered, or threatened species was also documented. Limited but healthy populations of benthos and fish species were noted. Limitations in populations were attributable to the limited size and water volume of the tributary, as well as the inability of fish to spawn upstream over a lower portion of the stream which has a steep gradient and shallow water depth.

In addition to the HBA, Woodward-Clyde Consultants conducted an ecological evaluation of issues associated specifically with the off-site tributary near Station 229 (Woodward-Clyde 1996). The evaluation was based on the information provided in site-specific studies and reports, on other site-specific information, on the published scientific literature, on direct site-specific scientific evidence, and on scientific principles. The ecological evaluation of off-site conditions near Station 229 led to the following major observations, considerations, and conclusions.

The existing ecological conditions in the off-station habitats are excellent within the constraints of the physical environment. Site-specific studies have found the natural communities to be healthy, strong, diverse, and in excellent condition without any sign or indication of PCB-related injury or perturbation. More than 200 species of plants and animals thrive in the area, not including microscopic organisms and non-aquatic insects; the presence or absence of species near Station 229 is due to the presence or absence of niche requirements rather than the presence of PCBs.

Invertebrate communities, often employed as sensitive indicators of pollution and pollution impacts, exhibited good condition. The tributary exhibited relatively rich, diverse invertebrate communities within the physical limitations of the intermittent, bedrock-lined stream.

The mere presence of PCBs in the soils and sediments does not imply exposure if plants and animals either do not uptake the PCBs or the pathway for PCB transfer is not available. The potential aquatic exposure pathway from the tributary for PCBs, for example, is limited; and, to the extent the pathway is available, it is only on an intermittent basis.

The numbers and biomass of fishes in the tributary off-site at Station 229 were so limited as to provide an insufficient food supply for any piscivorous predators that may reside in the area; this situation is expected to continue. The restricted food supply could provide only an occasional meal for an occasional predator and not a continuous food supply for any species. Further, only a portion of the PCBs in the food item(s) is bioavailable to the consuming organism and uptake of the bioavailable PCBs by the consuming organism is not 100 percent efficient. As a result, potential exposure to PCBs through the food web is necessarily quite low. In addition, the predators living in the area are too large to efficiently utilize the small prey that are present in the tributary. Thus, biota in the tributary do not provide a significant pathway for exposure to PCBs because they do not provide a significant source of food to higher trophic levels.

The evaluation of individual species living near the tributary system draining Station 229 indicated that PCB uptake by those animals is lacking or negligible, based on site-specific conditions and the biology of the potential receptor species including their diets, life spans, and sizes of their home ranges. As a result, the ingestion of fish, wildlife, or water does not provide an exposure pathway for PCBs to reach humans in the vicinity of Station 229.

A physically intrusive effort to remove PCBs from the natural communities in the tributary would necessarily result in considerable physical damage to these biologically and aesthetically desirable communities. Such damage from remediation would outweigh any alleged potential benefits from the removal of PCBs.

The ecological evaluation did not identify any measurable, quantifiable, scientifically-based benefits to human health and the environment for the considerable financial and environmental costs which would be expended for a physically intrusive remediation of the Station 229 off-site tributary. Remediation will not result in any measurable changes in PCB levels in downstream fish or, as shown in the sediment transport modeling, in PCB levels in downstream sediments.

Reestablishment of the natural communities following remediation would be very difficult and would require extended periods of time (decades or centuries). In addition, restoration techniques currently cannot replicate the microorganism communities (e.g., bacteria, algae) which are critical to the nutrient dynamics of any ecosystem. In other words, current restoration practices cannot recreate the natural communities with the same attributes, complexities, and characteristics that currently exist. The natural communities associated with the tributary are expected to continue to thrive, unless they are physically disturbed.

The current NYSDEC guidelines are based on an equilibrium partitioning approach and the bioaccumulation of PCBs. However, many of the underlying assumptions of the equilibrium partitioning approach are not proven, and some or all of the assumptions may not be true under site-specific conditions. Actual tissue levels of PCBs at different trophic levels may be quite different (usually much lower) than predicted by an equilibrium partitioning approach. The prediction of PCB levels in higher trophic level biota tissue (and hence prediction of adverse effects based on those predicted levels) based on sediment PCB levels is not accurate and involves great uncertainty. Indeed, the published literature indicates that bioconcentration factors in fish from actual feeding studies are extremely low. PCB levels in fish tissues are a fraction of the level found in their food.

The purpose of the HBA was to determine the effects of the presence of PCBs in the off-site ecosystem. The HBA results and the ecological evaluation indicate that PCBs have not adversely impacted the natural communities, nor is there any reason to anticipate adverse downstream impacts from the presence of PCBs in the tributary either now or in the future.

A careful ecological evaluation of the complex issues associated with the off-site tributary near Station 229, as described above, leads to the overall conclusions that PCBs are not adversely impacting the natural communities, which are healthy and diverse. Based on the many observations and conclusions of this evaluation, remedial action in the tributary is not warranted, nor would theoretical benefits justify the damage that would be done to the ecosystem.

1.3.7 Human Health Evaluation

TGPL requested Terra, Inc. to review and summarize the available toxicological literature on PCBs to combine the knowledge recently gained by the scientific community with the understanding of the characteristics of PCBs found in the vicinity of Compressor Station 229. This effort was undertaken to provide a state-of-the-science human health assessment of the conditions found near Compressor Station 229 for those individuals residing near this site. The report entitled *A Summary of PCB Toxicology and A Critical Assessment of Its Human Relevance* (Terra, Inc., February 1996) was submitted to the NYSDEC and placed in the public repositories for review. The major findings of this report are outlined below.

A historical review of both the regulatory perspective of PCBs and the development of a scientific understanding of PCB toxicology reveals a significant dichotomy between how PCBs were perceived in the 1970s and how they are currently recognized within the scientific community. The early view of PCBs was developed based on findings derived from high-dose laboratory animal studies, which did not accurately characterize the actual hazard to the general human population. In the last 10 years, epidemiological studies of

PCB-exposed workers that were completed in the 1980s have provided more relevant information on the potential human toxicity of PCBs, and have tended to alleviate many of the concerns originally raised from the animal studies.

For example, a number of mortality studies have been published to date and indicate that occupational PCB exposures are not causally associated with cancer of any kind or with any other serious chronic disease. Also, a considerable number of morbidity studies have been published; to date, the only adverse health conditions attributable to occupational PCB exposures are skin conditions, including a condition known as chloracne. In contrast to the sometimes negative view of PCBs that is extrapolated from animal studies, the rather lengthy occupational experience with PCBs has been remarkably free of adverse health findings. In fact, the general health of PCB-exposed workers has been described by one group of researchers as being very good despite the presence in their study population of such known risk factors as smoking and obesity.

Animal studies have shown that chronic high-dose exposures to PCBs can produce liver tumors in rodents. The current human relevance of this finding is limited, however. In spite of the observed elevation in liver tumor incidence, these animal studies have also shown that the total cancer risk of the animals is either reduced or not elevated (i.e., other types of tumors are reduced). The animal tumors also do not resemble human cancer; that is, they do not metastasize or behave like malignant tumors. Given the two findings concerning the number and characteristics of the tumors, it is perhaps not surprising to find that the life expectancy of PCB-exposed animals was not shortened by chronic PCB exposure. In fact, life expectancy was typically increased over that experienced by the control or untreated animals. Considering the preceding observations, the well-known limitations of making animal-to-man extrapolations in general, and the failure to observe cancer in those human populations receiving the highest PCB doses, the conservative regulatory presumption of PCB carcinogenicity, even at low environmental doses, should not be viewed as representative of the true human health risk.

The current USEPA toxicity constants used to estimate cancer and noncancer risks have been derived from animal data. An analysis shows that these toxicity constants overstate PCB-associated risks for a variety of reasons, some of which include the use of doses or animal species that are inappropriate for assessing human risks. Because occupational PCB exposures were probably two to four orders of magnitude greater than environmental PCB exposures, the relative lack of adverse human effects observed in these human studies contradicts any health concerns that might be suggested from risk assessments attempting to use these toxicity constants.

The possible development and use of toxic equivalency factors (TEFs) for PCBs have been discussed by scientists for a number of years. However, all TEF schemes proposed to date are seriously flawed because none are able to take into consideration the antagonistic potential of a number of other PCB congeners. Consistent with these flaws, empirical evidence has repeatedly shown that TEF schemes do not accurately portray PCB hazards, and their utility in the current risk assessment process has never been demonstrated.

Some scientists have attempted to suggest that PCB mixtures may exhibit some estrogenic activity. However, the estrogenic potential of PCB mixtures is so small, especially when balanced against the far greater potency and biological effects of natural estrogens, that the potential impact of PCBs on estrogen-mediated effects becomes insignificant, if not zero.

Developmental studies following exposure to environmental levels of PCBs have been reported by two independent groups of investigators. As summarized in the Terra, Inc., February, 1996 report, the results reported by researchers in Michigan have not been internally consistent, do not agree with studies of other environmentally exposed women, and have never been substantiated by any other group of scientists; in addition, the few changes noted were subclinical in nature. The one study of occupationally exposed women, women with tissue levels orders of magnitude higher than those in environmentally exposed women, did not confirm the initial findings of the Michigan studies. Also, there are many flaws in the basic study design of these studies, primarily in regard to the methods used to estimate and characterize exposure to PCBs. The overall flaws of these studies are so significant that the Agency for Toxic Substances and Disease Registry has concluded these potentially interesting studies provide equivocal results at best.

Several studies have shown that the presence of PCBs in soil does not translate into a measurable dose of PCBs for residents living on or near the affected soil. Because a measurable dose cannot be demonstrated, it cannot realistically be argued that persons exposed to such soils are at any greater risk than the average U.S. resident. Likewise, it is misleading to calculate any theoretical risk based on the presence of PCBs, if exposure and resulting dose are not occurring.

The conclusions reached from the extensive review of the current scientific information on PCBs have particular relevance to the residents living near Compressor Station 229. This scientific information was considered during a review of the site history and available analytical data in order to assess the potential effects of these conditions on the health of the surrounding community. Based on a thorough review of this information, Terra concluded that the current site conditions cannot result in a dose of PCBs above that which is experienced by the general population. The primary reason that an increased dose would not be expected is that the off-site areal distribution of PCBs is confined to the sediments of the small tributary and to soils adjacent to the stream that have been affected by highwater overflows. In all, the impacted area is a relatively narrow corridor of stream and land that is few thousand yards long. These conditions found at the unnamed tributary result in (1) a lack of substantial edible fish population to serve as a continual human food source; and (2) only limited access to PCB-containing soil. As previously discussed, this latter environmental medium (i.e., soils) has been shown to pose little risk of an increased dose of PCBs, even when found in an individual's personal environment, a condition that clearly does not exist near Station 229. Terra concluded that with regard to the PCBs found in the vicinity of Compressor Station 229, the current site conditions do not present a health concern to the local population.

1.4 Areas of Potential Concern

Based on the RI, four areas associated with Station 229 have been identified as areas of potential concern: on-site soils, drainlines and sediments, Station Lake, ground water and the tributary system. This section briefly describes each area and presents the actions TGPL has taken to date to characterize and/or remediate each area, and includes an evaluation of the need to develop remedial action objectives (RAOs) and remedial alternatives for each area based on the site-specific risk, if any, posed by the constituents present.

1.4.1 On-Site Soils, Drainlines and Sediments

On-site soils and drainline sediments were remediated under the 1995 IRM, as described in Section 1.3.4. The site-specific cleanup goals for the IRM were established to be protective of human health and the environment. The IRM achieved its cleanup goals therefore, no further development of RAOs or evaluation of remedial alternatives is necessary for these media.

Other on-site sediments include those in the separator pond and Station Lake. As discussed in Section 1.3.4 and shown in Table 1-4, PCB levels in sediments in these two areas are low. A comparison of the levels in the pond with those in Station Lake indicates that PCBs are not being transported into the lake from the pond to accumulate in the lake. There is no significant potential for human exposure and the fish will be removed from Station Lake, eliminating the potential for ecological exposure via bioaccumulation. Therefore, these areas are not areas of concern.

Other on-site soils and sediments of potential concern are those containing TCL/TALs at elevated levels. Chromium was identified as the only TAL of potential concern in on-site soils or sediments. No TCLs were measured at levels of potential concern. As discussed in Section 1.3.5.2.2, the on-site soil and sediment areas containing elevated chromium levels are limited in extent and have not significantly impacted ground water. In addition, a continuing source of chromium to any medium on the station does not exist. Based on these considerations, chromium is not a constituent of concern on the station. There are, therefore, no TCL/TALs of concern in on-site soil or sediments.

Since (1) on-site soils and sediments do not contain TCL/TALs of potential concern, (2) the IRM addressed all of the on-site soils and sediments in accordance with its cleanup goals, and (3) conditions that make the IRM cleanup goal protective of human health and the environment do and will continue to exist on the station, the IRM has addressed all soils and sediments of potential concern on-site and no further action is necessary.

Therefore, remedial alternatives are not developed and these media are not discussed further in the FS.

1.4.2 Station Lake

Station Lake is a one-acre impoundment located on the southwestern portion of the Station 229 site. The lake lies within the fenced boundary of the station site, and the fence is posted with "No Trespassing" signs. The lake has been fenced and posted for many years. Most of the surface drainage from the Station 229 site is received by Station Lake, which discharges through overflow pipes into the tributary. Station Lake ranges to 17 feet in depth. Sampling activities indicate that Station Lake supports populations of largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), and bluegill/ pumpkinseed hybrids. The small tributary draining Station Lake supports a very limited fish population. Analysis of fish samples indicated the presence of PCBs in some lake and tributary fish, as described in Section 1.3.3.

Levels of PCBs in the Station Lake sediment are low (maximum of 6.6 mg/kg). In addition, modeling of the potential transport of sediments in Station Lake to downstream receptors shows that significant levels will not be transported to downstream receptors. The model, based upon the USLE, calculates the potential levels of PCBs if sediments are transported from their current location via erosion and storm water runoff (ENVIRON 1996). Based on the low levels present in the lake and the findings of the model, the lake poses no potential threat to human health or the downstream environment. Accordingly, development of RAOs or remedial alternatives is not necessary for the lake. However, TGPL will remove the fish from Station Lake to address any potential concerns regarding bioaccumulation. Station Lake will be screened periodically thereafter to ensure that fish are not reintroduced.

1.4.3 Ground Water

Eleven ground water sampling events have been conducted, as presented in Section 1.3.3.2. Due to the presence of VOCs in on-site wells, TGPL conducted a study to locate the potential source of the VOCs in ground water. Extensive sampling of the soils, suggested by historical data to be the potential source, showed that a continuing source of VOCs to ground water is not present. In the absence of a source of VOCs, natural attenuation, as discussed in Section 1.3.5.2, will result in decreasing VOC levels over time.

As discussed in Section 1.3.1, there are currently no downgradient receptors of the shallow fractured bedrock water-bearing zone within the approximately 1,500-foot distance between the main portion of the compressor station and the local surface water discharge points. However, based on the presence of volatile organics in some wells, ground water has been retained for further discussion and evaluation of remedial alternatives in the following sections.

1.4.4 Tributary System

The primary feature of the tributary system is an approximately 3-mile long stream which begins at Station Lake and flows west into Hunt Creek. Hunt Creek is one of many tributaries to the South Branch of Eighteenmile Creek. Also included in the tributary system are floodplain soils and the breached pond between North Boston Road and Highway 75. The results of sampling of tributary media are presented in Section 1.3.3.1.

TGPL has completed numerous actions in response to the tributary system sampling results with the goal of protecting the health of the community residents and the environment while developing a logical, scientifically-based response to the presence of PCBs. To that end TGPL has completed multiple rounds of sampling, technical studies, and extensive dialogues with area residents and local officials. The activities conducted to date include the following:

- TGPL performed comprehensive studies of the issues associated with the presence of PCBs in the tributary system including (1) the impact, if any, on human health; (2) potential impacts, if any, to plants, fish, wildlife and natural communities in the tributary area; and (3) potential transport of PCB-containing soils and sediments through the tributary system. The scope and results of these studies are presented in the previous sections.

- TGPL completed multiple rounds of sampling of tributary system soils and sediments to evaluate the presence and distribution of PCBs in the system and to assess whether PCBs in the system were transported via erosion or storm-related runoff, including a major storm event in August 1994.

- TGPL conducted sampling of 10 private ground water wells to evaluate the potential presence of PCBs. PCBs were not detected in any of these wells.

- TGPL actively pursued means to inform town residents, property owners, and local officials of the presence of PCBs in the tributary and their potential impacts, and to initiate a dialogue with residents regarding the results of sampling and potential actions to be taken. To achieve these goals, TGPL took a number of actions including:

  (1) Establishment of public repositories at the Eden Town Hall and Eden Public Library to allow concerned citizens access to all final documents provided to the state;
  (2) A public meeting to present sampling results and solicit input from area residents;
  (3) Establishment of an 800 number which enables any concerned person to present any questions on the company or the site directly to TGPL management;
  (4) Preparation and distribution to a mailing list of over 400 people of newsletters that contained information on sampling results, the progress of the IRM, the results of the technical studies, TGPL's 800 phone number created to allow the public direct access to TGPL management, and numbers and addresses of relevant regulatory agencies, regulators, and TGPL representatives;
  (5) Creation of a videotape depicting the tributary system and presenting the issues related to the tributary titled "Unnamed Tributary to Hunt Creek"

which was placed in the public repository, submitted to the NYSDEC, and provided to residents with tributary property nearest to the station; and

(6) Door-to-door personal visits with residents along the tributary corridor to hear their concerns, provide them with relevant new results, and solicit suggestions for action to be taken.

- TGPL purchased portions of the properties along the tributary corridor that contained the highest levels of PCBs. This form of institutional action ensures that the highest levels of PCBs are not on private property and allows TGPL access to impacted areas.

As a result of these activities, TGPL believes that no further action is necessary for the tributary system. However, at the request of the NYSDEC, the tributary is retained for further discussion and evaluation of remedial alternatives.

2 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The objective of this section is to develop an appropriate range of management/remedial options to be analyzed more fully in the detailed analysis phase. Consistent with TAGM 4030, the process of developing, selecting, and assembling alternatives involves the following steps:

- Development of remedial action objectives and cleanup levels specifying the constituents of concern and areas to be addressed;
- Development of general response actions;
- Identification and estimation of quantities and/or system components to which general response actions might be applied;
- Identification and screening of the technologies applicable to the areas of interest to eliminate those technologies that cannot be implemented technically at the site for that medium; and
- Assembly of the selected representative technologies into appropriate alternatives, if applicable.

Due to the complexity of the issues associated with remedial action in the tributary, a traditional screening of technologies will be replaced by a screening of potential remedial approaches which may incorporate a number of technologies to address the tributary system.

This section presents the remedial action objectives and general response actions associated with ground water and the tributary system and identifies applicable remediation alternatives. The subsequent sections of this report describe the screening of remedial alternatives (Section 3) and the detailed evaluation of the alternatives retained from the screening process (Section 4).

2.1 Remedial Action Objectives

Remedial action objectives (RAOs) provide a general description of the goals of remediation for the media and constituents of potential concern to address the specific potential exposure pathways described in Section 1. The areas to be addressed at Station 229 are ground water and the tributary system.

2.1.1 RAOs for VOCs in Ground Water

Ground water at the station contains some chlorinated and aromatic VOCs. Since the ground water from the station area is not used for drinking water purposes, the remedial action objective is to minimize the potential for exposure of off-site receptors to these VOCs at levels exceeding the potentially applicable standards and guidance values, which are listed in Table 2-1. NYS SGVs (right column of Table 2-1) are used to evaluate ground water sample results.

2.1.2 RAOs for PCBs in the Tributary System

As described in Section 1, some soils and sediments in the tributary system contain PCBs, with levels decreasing rapidly with distance from the station. The RAOs for these soils and sediments are to minimize the potential for (1) exposure/direct contact, and (2) migration of PCBs. Through the extensive studies described in Section 1, TGPL believes these RAOs are currently being met. However, TGPL will evaluate whether there is a feasible and cost-effective way to further address the presence of PCBs.

2.2 General Response Actions

The purpose of this section is to develop the general response actions that will satisfy the remedial action objectives described above. General response actions considered for ground water are no further action and remedial action; general response actions for the tributary

TABLE 2-1
Drinking Water Standards for VOCs in Ground Water

TCL	USDWS (μg/L)	NYS SGVs (μg/L)
1,1-Dichloroethane	NA	5
1,1-Dichloroethene	7	5
1,1,1-Trichloroethane	200	5
1,2,4-Trimethylbenzene	NA	5
Benzene	5	0.7
Carbon Tetrachloride	5	5
Chloroform	NA	7
Ethylbenzene	700	5
Toluene	1,000	5
Xylenes, total	10,000	5

Notes:

NA = Not available.
USDWS = U.S. Drinking Water Standard
NYS SGVs = New York State Standards/Guidance Values for Class GA ground water aquifers

system are no further action, institutional action, a treatment technology (*in situ* bioremediation) and removal/remedial actions; a removal/disposal alternative and a multi-component alternative that incorporates removal as part of a multifaceted remedial approach are the removal/remedial actions considered.

2.2.1 Delineation of VOC Distribution in Ground Water

VOCs have been detected in ground water samples collected during 11 rounds of ground water sampling. The types of VOCs were consistent throughout the sampling and consisted of benzene, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, and chloroform. Ethylbenzene, toluene, xylenes, and carbon tetrachloride were also present, but were measured at levels warranting further evaluation in only one monitoring well on the station. The monitoring well locations and VOCs detected at levels warranting further evaluation are presented in Figure 1-4. The highest levels of individual VOCs were measured primarily in shallow drivepoint locations within the station operations area.

Sampling of MW-11 has previously indicated levels of benzene that exceed the NYS guidance value, but not the federal standard. The most recent sampling, however, reported measured levels below both the federal standard and NYS guidance value. The source of the benzene is currently unknown, but may be a private gas well on the property containing MW-11.

Ground water is present in the shallow fractured bedrock underlying the station and has been determined to flow in a generally southwestern direction. Therefore, MW-8S and MW-10 serve as the downgradient wells at this station. In the unlikely event that ground water were to transport VOCs to or beyond these wells, the ultimate release point would be in the surface waters of either Station Lake or the tributary, at which point the VOCs would rapidly volatilize, removing them from the water bodies.

TGPL has conducted an extensive source characterization program which has confirmed that soils in the station operations area are not serving as a continuing source of VOCs to the ground water. The absence of VOCs from these soils indicates that it is unlikely that a continuing source of VOCs to the ground water exists at the station.

2.2.2 Delineation of PCB Distribution in the Tributary System

PCBs were detected in soil and sediment samples in the tributary system. PCB levels decrease rapidly with distance from the station; within 2,000 feet, PCB levels decrease to below 10 mg/kg. PCBs have not been detected in soil samples from farms adjacent to the tributary system.

2.2.3 General Response Actions for Ground Water

2.2.3.1 No Further Action

TGPL has already rejected the no action alternative by conducting a VOC source characterization and by purchasing an option on the property directly west of MW-6S and MW-6D. Therefore, no further action is the baseline against which other response actions may be compared.

2.2.3.2 Remedial Action

As discussed in Section 1, TGPL has conducted an extensive VOC source characterization to locate a source of target organic compounds in soils. Although no source was identified, several options exist for remediation of ground water. These include passive remediation techniques such as monitoring of VOC levels and natural attenuation processes that may be occurring, or active remediation methods, which could be performed either *in situ* or *ex situ*. Examples of *in situ* treatment technologies for VOCs in ground water include air sparging and enhanced biodegradation. *Ex situ* treatment would consist of ground water extraction followed by air stripping, biotreatment or other methods of VOC reduction.

2.2.4 General Response Actions for the Tributary System

2.2.4.1 No Further Action

TGPL has already rejected the no action alternative by purchasing options along the tributary corridor and conducting extensive technical studies and significant community outreach. This alternative satisfactorily meets the RAO, but will, for purposes of evaluation, be utilized as a baseline for comparison to the other alternatives.

2.2.4.2 Institutional Action

Institutional action would include access restriction (i.e., fences) along with purchase of the optioned properties along the tributary corridor.

2.2.4.3 Treatment

The potentially applicable response action identified under treatment is the application of *in-situ* bioremediation.

2.2.4.4 Removal/Remedial Action

The general response actions identified under removal/remedial action include a removal/disposal alternative and removal as part of a multi-component alternative which also includes access restriction, containment, monitoring, tributary and sediment control measures, property purchase, and covering of certain residential soils in addition to removal.

2.3 Remedial Alternatives

In this section, one or more remedial alternatives are identified for each of the general response actions developed for ground water and the tributary system.

2.3.1 Ground Water

2.3.1.1 No Further Action

The no further action alternative would involve performing no additional remedial action at the site with respect to VOCs in ground water (including monitoring activities), and is carried through the remedial alternative selection process to provide a base case for comparison with other alternatives.

2.3.1.2 Remedial Action

Several ground water remediation alternatives exist under this general response action. Potential ground water remediation alternatives under consideration are described below, and include *monitoring*, *enhanced in situ degradation*, *air sparging*, and *ground water extraction and treatment.*

Each of these alternatives would involve ground water monitoring of wells MW-2, MW-4, MW-6S, MW-6D, MW-8S, MW-8D, MW-9, and MW-10, and MW-11 for five years, with sampling in the first, third and fifth year following baseline sampling. The need for further sampling would be determined by evaluating the five years of results. Monitoring well MW-6D, which was drilled to solid bedrock, has not yielded sufficient water volume for a sample after purging during some previous sampling rounds. However, an attempt will be made during each monitoring event to collect a sample for analysis. If insufficient water is available, a sample will not be collected.

In the event that VOCs were to be detected at levels exceeding promulgated standards near the Station Lake (i.e., monitoring wells MW-8S, MW-10), a contingency measure would be implemented as needed based on an assessment of the potential impact to human health and the environment and an evaluation of the presence of potential receptors. This measure could involve one or more actions and would depend on the potential impact to human health and the environment, implementability and cost-effectiveness. Possible examples include additional sampling (ground water or lake water/sediment), engineering controls or other actions, as necessary.

2.3.1.2.1 Monitoring

Under this alternative, data generated from the ground water monitoring program described above would be evaluated after approximately five years to determine the need for continued monitoring. Should further monitoring be warranted, a schedule of sampling would be proposed.

2.3.1.2.2 Enhanced *In Situ* Degradation

This alternative involves the engineered stimulation of *in situ* anaerobic degradation. The process would require the *in situ* delivery of an electron donor (e.g., sodium benzoate), nutrients or other additives, as necessary, to accelerate biological activity. In order to facilitate design of the *in situ* bioremediation system in a fractured bedrock system, it is likely that treatability testing would be required. It may also be necessary to evaluate subsurface flow conditions through tracer testing to assist in the design of the delivery system to ensure that the electron donor/other necessary additives can be adequately distributed within the subsurface. This alternative would also be accompanied by ground water monitoring to determine the effectiveness of the system.

2.3.1.2.3 Air Sparging

This alternative involves the active injection of ambient air or nitrogen into the subsurface to volatilize VOCs and application of a vacuum to induce an air flow to vapor extraction wells. The extracted air/vapor stream would be treated, if necessary, and discharged to the atmosphere. As with the *enhanced in situ degradation* alternative, pre-design tracer testing may be required. Monitoring of downgradient wells would be continued over the remediation period to determine the effectiveness of the system.

2.3.1.2.4 Ground Water Extraction and Treatment

Under this alternative, ground water would be extracted from the aquifer for treatment in an aboveground treatment unit. Extraction of ground water could be accomplished via a system of recovery wells or interceptor trenches. Containment of the plume using a ground water flow barrier, such as fracture grouting, could be considered to facilitate ground water extraction through improved hydraulic control of the aquifer.

Aboveground treatment of VOCs could consist of biotreatment through the use of either a suspended-growth or fixed-film bioreactor; chemical or photochemical oxidation, such as UV/hydrogen peroxide/ozone treatment; or air stripping. The VOCs removed by the air stripper would be treated, if necessary, by vapor phase carbon or catalytic combustion. Residual liquid phase VOCs of concern from any of these operations could be polished with activated carbon, if required. Treated ground water would be discharged as appropriate. Downgradient wells would be monitored for VOCs during the remediation period.

2.3.2 Tributary System Soils and Sediments

2.3.2.1 No Further Action

The no further action alternative would involve performing no additional remedial action at the site with respect to PCBs in the tributary system.

2.3.2.2 Institutional Action

Institutional action would involve restriction of access to soils and sediments containing the highest PCB levels through the construction of a fence surrounding these soils and sediments. To this end, soils surrounding the first 2,000 feet of the tributary would befenced with a combination of chain link, three-strand wire fence and/or vegetative barrier. The width of the fenced area is dependent on the distribution of the PCBs, which is up to 100 feet. The purchase options on certain tributary corridor properties would be exercised.

2.3.2.3 Treatment

The application of a treatment technology would involve the implementation of *in situ* bioremediation over the first 2,000 feet of the tributary corridor soils and sediments containing PCBs. Following a pilot study to determine the applicability of bioremediation in these soils given the PCB congeners present, "bio plugs" would be inserted through the top vegetative layer in the soil and sediment, passively delivering bacteria and nutrients to the PCB-containing soil. Monitoring and system readjustment would be conducted to determine and optimize the bioremediation rate and effectiveness.

2.3.2.4 Removal/Remedial Action

2.3.2.4.1 Multi-Component Alternative

A variety of actions would be implemented in combination in this alternative:

- Purchase options on certain properties along the tributary corridor would be exercised by TGPL;
- Deed restrictions would be placed on the tributary corridor purchased by TGPL (up to approximately 150 feet from the stream);
- Soils and sediments would be addressed with removal (in erosional areas) or covering (in non-erosional/depositional areas) as shown on Plate 1;
- Access to the first 2,000 feet of the tributary would be restricted by the construction of a fence (combination chain link, wire, and/or vegetative barrier);
- Tributary flow would be channelized through the bog and the channel and its banks would be stabilized with geotextile matting, geogrid, and rip-rap;
- Sediment transport would be further reduced by the construction of a sediment trap 2,400 feet downstream of the station at an existing farm road;
- Certain PCB soils in residential areas that border North Boston Road would be covered and the areas restored;
- Excavated and covered areas would be restored to the extent feasible;
- A comprehensive operations and maintenance plan would be implemented to ensure the structural integrity of the trap, to remove accumulated sediment from the trap as necessary, and to maintain the covered and restored areas;

- The hydrogeology of the tributary would be evaluated and ground water monitoring conducted, as appropriate;
- Fish from the breached pond and the tributary near Hickman Road would be sampled regularly; and
- Sediment monitoring would be conducted from the sediment trap (for disposal purposes) and from three additional points between the trap overflow and North Boston Road.

2.3.2.4.2 Removal/Disposal

In this alternative, all identified soils and sediments containing PCB levels exceeding 1 mg/kg would be removed. These soils and sediments extend to 9,300 feet downstream of Station Lake, and include sediments in Station Lake. The widths to be removed range from zero (no removal in a given portion of the tributary) to over 100 feet and depths of removal range from 0 to 3 feet. Approximately 30,000 cubic yards (cy) of soil and 1,400 cy of sediment would be removed under this scenario. Approximately 13 acres of woods would be cleared to implement this alternative.

3 PRELIMINARY SCREENING OF REMEDIAL ALTERNATIVES

3.1 Introduction

The objective of the preliminary screening of remedial alternatives is to narrow the list of potential alternatives (identified and described in Section 2) before conducting a detailed evaluation of each alternative. Therefore, the screening process is more general than the detailed analysis process presented in Section 4.

Preliminary screening of the remedial alternatives focuses on their effectiveness and their implementability, as set forth in TAGM 4030 and described below. The remedial alternatives that cannot be implemented technically at the site or cannot meet the appropriate RAO are eliminated from further consideration. Ranking the alternatives is not an objective in the preliminary screen. To the extent practicable, consideration is given in the preliminary screening to the preference, under TAGM 4030 and the Superfund Amendments and Reauthorization Act (SARA), for treatment technologies that will result in a significant decrease in the mobility, volume, or toxicity associated with the constituents of concern.

TGPL does not necessarily endorse the underlying risk assessments and assumptions that may have served as the basis for establishing the toxicity of PCBs. Therefore, TGPL evaluates the ability of a technology to reduce mobility or volume, or to alter the chemical nature of the PCBs present. However, in recognition of "reduction in mobility, volume or toxicity" as standard terminology, and in an effort to present a technology evaluation consistent with NYSDEC guidelines, the screening and detailed evaluation will utilize this terminology.

Each of the evaluation criteria used in the preliminary screening of alternatives is described below. In the following sections, a comparative evaluation of each remedial alternative is presented, followed by a summary of the preliminary screening results.

3.1.1 Effectiveness

During the preliminary screening, each alternative is evaluated for its ability to meet the RAO, considering short-term and long-term effectiveness. The short-term effectiveness criterion involves consideration of the impacts that implementation of the remedial action may have on the community and the environment. Factors considered in evaluating long-term effectiveness include:

- The effectiveness of the remedy based on reduction in mobility, volume, or toxicity of VOCs of concern;
- The quantity and nature of untreated waste or treatment residuals to be left at the site after remediation; and
- The adequacy and reliability of controls or monitoring requirements.

3.1.2 Implementability

The implementability of a remedial alternative is evaluated in the preliminary screen on the basis of its technical and administrative feasibility, and the commercial availability of equipment and services. Avoidance of impacts on the pipeline, on the community, on compressor safety, and on business operations is also considered.

Technical feasibility considerations include the ability to construct the technology or implement the actions proposed, the alternative's ability to meet RAOs, the probability of encountering delays, and the potential need for further remedial action at a later date. Administrative feasibility is based on the degree to which agency and community coordination will be required. Technologies that may require significant time periods to obtain applicable federal and state permits may not be retained for detailed analysis. The commercial availability of the technology, supplies and specialists to implement the remedial alternative is also considered under the implementability criterion.

Alternatives that are not technically or administratively feasible, or that would require equipment, specialists, or facilities that are not available within a reasonable period of time, may be eliminated from further consideration.

3.2 Screening of Remedial Alternatives for Ground Water

The remedial alternatives for ground water identified in Section 2 are listed below:

(a) *no further action*

(b) *monitoring*

(c) *enhanced in situ degradation*

(d) *air sparging*

(e) *ground water extraction and treatment*

In the following sections, the effectiveness and implementability of each alternative are discussed, and the decisions to accept or reject an alternative for further evaluation are described. Table 3-1 summarizes the preliminary screening results for all remedial alternatives for ground water.

3.2.1 Effectiveness

The principal elements of effectiveness that were evaluated are risks during implementation; reduction in mobility, volume, or toxicity; and permanence. The *no further action, monitoring* and *enhanced in situ degradation* alternatives essentially present no short-term impacts to the community or environment related to their implementation. *Air sparging* and *ground water extraction and treatment* could potentially have a short-term impact on the community and the environment due to atmospheric emissions (e.g., emissions from an air stripper). Appropriate engineering controls (e.g., vapor phase carbon treatment or catalytic combustion for an air stripping system) could be used to capture emissions in the event that they were determined to be of potential concern. By providing engineering controls, implementing a health and safety plan during site activities and complying with applicable federal and/or state regulations, it is expected that potential short-term impacts to the community and environment could be controlled for all of the remedial alternatives under consideration.

All of the proposed alternatives may offer some degree of long-term effectiveness based on reduction of toxicity resulting from natural attenuation. However, since

TABLE 3-1
Preliminary Screening Summary of Remedial Alternatives for VOC-Bearing Ground Water

Alternative	Screening Criteria: Effectiveness[1]	Screening Criteria: Implementability	Screening Results (Retained for Detailed Analysis?)
1. No Further Action	Probable reduction in toxicity due to natural degradation	Limitations in administrative implementability	Yes (retained as the baseline alternative)
2. Monitoring	Probable reduction in volume and toxicity due to natural degradation	Expected to be technically and administratively feasible	Yes
3. Enhanced *In Situ* Degradation	Probable reduction in volume and toxicity due to enhanced degradation	Potential limitations in technical implementability	Yes
4. Air Sparging	Probable reduction in volume and toxicity due to natural degradation. Reduction in volume by volatilization and carbon adsorption. Additional reduction in toxicity by incineration of VOC-bearing carbon	Limitations in implementability in bedrock	No
5. Ground Water Extraction and Treatment	Reduction in toxicity (biodegradation or oxidation) or volume (air stripping)	Potential limitations in extracting ground water for *ex situ* treatment; if the ground water extraction is intermittent due to low yielding nature of the bedrock aquifer, aboveground treatment alternatives may be limited to those that can be operated in batch mode	Yes

Notes:

[1] The short-term effectiveness criterion is met for all alternatives except alternatives 4 and 5. Appropriate engineering controls could be implemented to meet the short-term effectiveness criterion for these alternatives, as needed. The information presented in this column refers to long-term effectiveness.

the *no further action* alternative does not involve ground water monitoring, the extent to which ongoing natural processes attenuate the constituents of concern cannot be quantified. The *monitoring* alternative offers a degree of long-term protection by detecting potential changes in the chemical profile of ground water over time and evaluating the extent to which attenuation is occurring. The *air sparging, enhanced in situ degradation*, and *ground water extraction and treatment* alternatives are anticipated to result in the permanent reduction of the waste volume in ground water, as might *monitoring*. *Enhanced in situ degradation* and some of the potential *ex situ* treatment alternatives under consideration (i.e., air stripping with off-gas combustion, biodegradation and oxidation) are destructive remedies that are anticipated to result in permanent reduction in waste toxicity. In summary, the *air sparging, enhanced in situ degradation*, and *ground water extraction and treatment* alternatives are permanent remedies that could potentially satisfy the preference for destructive technologies, as stated in TAGM 4030. The *no further action* and *monitoring* alternatives also provide long-term effectiveness through natural attenuation.

3.2.2 Implementability

The *no further action* alternative is technically feasible, but does not provide for any mechanism, such as ground water monitoring, that would ensure that the RAO will continue to be met. The *monitoring* alternative is expected to be both technically and administratively feasible.

The *enhanced in situ degradation* alternative is considered to be administratively feasible as it also provides for ongoing ground water monitoring. However, the alternative may have some technical limitations associated with the delivery of electron donors, nutrients or other necessary additives to areas of concern within the bedrock system. *Air sparging* is expected to be technically infeasible due to channeling of air within the fractured bedrock that results in inefficient contact with ground water containing VOCs and concerns associated with the spreading of VOCs into unaffected areas as a result of overpressurizing the area of concern. The low yield of the shallow aquifer (estimated to be less than 1 gallon per minute) suggests that the feasibility of operating a system of recovery wells as part of the *ground water extraction and treatment* alternative is limited. An alternative method of withdrawing ground water, such as passive interception trenches, may prove to be more effective than active pumping of the aquifer system. A further complication of the *ground water extraction and treatment* alternative is that the aboveground treatment unit will likely have to be operated in a batch mode, as it appears that ground water has to be pumped from a trench intermittently and operation of a continuous flow system is typically not feasible under intermittent pumping conditions. Both the *air sparging* and *ex situ* treatment alternatives, however, are generally well-established and it is not expected that it would be difficult to meet the substantive requirements of associated construction and operation permits. Hence, they are considered to be administratively feasible.

In summary, the *no further action and monitoring* alternatives are expected to be both technically and administratively feasible. Although *enhanced in situ degradation* and *ground water extraction and treatment* are expected to be administratively feasible, they are likely to have limitations due to the nature of the subsurface conditions. *Air sparging*, which is also expected to be administratively feasible, is not considered technically feasible within the fractured bedrock system.

3.2.3 Results

The following alternatives offer adequate effectiveness and implementability, and have been retained for detailed analysis: *no further action, monitoring, enhanced in situ degradation* and *ground water extraction and treatment.*

The *air sparging* alternative is not retained for detailed analysis since it did not meet the implementability criteria.

This preliminary screening was based on the currently available data and TGPL may evaluate other alternatives as the results of continuing monitoring activities become available.

3.3 Screening of Remedial Alternatives for the Tributary System

The remedial alternatives for the tributary system identified in Section 2 are:

(a) *no further action*

(b) *institutional action*

(c) *in situ bioremediation*

(d) the *multi-component alternative*, and

(e) *removal/disposal*

In the following sections, the effectiveness and implementability of each alternative are discussed, and the decisions to accept or reject an alternative for further evaluation are described. Table 3-2 summarizes the preliminary screening results for all remedial alternatives for the tributary system.

3.3.1 Effectiveness

As discussed in Section 2.1.2, evaluations performed by TGPL indicate that the PCB levels in the tributary do not present a significant human health or ecological risk, so all alternatives offer long-term effectiveness. *Institutional action*, *in-situ bioremediation,* and the *multi-component* and *removal/disposal* alternatives may further address the presence of PCBs (long-term effectiveness) by further minimizing the potential for exposure/direct contact and/or the potential for migration of PCBs. Evaluation of the short-term effectiveness indicates that there may be a greater potential for exposure during implementation of the alternatives that include removal of soils or sediments, due to potential erosion of these soils from areas when they are cleared prior to excavation. These may be minimized, however, through the use of silt fences downstream of the remediation area. The short-term effectiveness of the *removal/disposal* alternative presents concerns because it would require control of erosion during the extensive remedial duration (engineering estimates show that remediation would extend over

TABLE 3-2
Preliminary Screening Summary of Remedial Alternatives for the Tributary System

Alternative	Screening Criteria: Effectiveness[1]	Screening Criteria: Implementability	Screening Results (Retained for Detailed Analysis?)
1. No Further Action	Site currently poses low potential for exposure/direct contact and migration. Alternative offers long-term effectiveness.	Expected to be technically and administratively feasible	Yes
2. Institutional Action	Further reduces potential for exposure/direct contact.	Expected to be technically and administratively feasible	Yes
3. In situ Bioremediation.	May reduce potential for exposure/direct contact and migration if PCB levels are reduced.	Not expected to be technically feasible.	No
4. Multi-Component Alternative	Further reduces potential for exposure/direct contact and migration.	Expected to be technically and administratively feasible	Yes
5. Removal/Disposal	Further reduces potential for exposure/direct contact and migration.	Potential implementation concerns including: access, duration, erosion control, and impact on ecosystem and community	Yes

Notes:

[1] The short-term effectiveness criterion is met for alternatives 1, 2 and 3. Appropriate engineering controls could be implemented to meet the short-term effectiveness criterion for alternatives 4 and 5, as needed. The information presented in this column refers to long-term effectiveness.

approximately 250 days, or 2 working seasons), during which storms, spring melt, and flooding would occur. The long-term effectiveness of the *insitu bioremediation* may not be greater than that of *no further action* due to the relatively recent development of bioremediation for PCB reduction, the uncertainty associated with the suitability of the bacteria for the PCB congeners present, and the difficulties associated with the distribution of the bacteria throughout the soils.

3.3.2 Implementability

No further action, *institutional action*, and the *multi-component alternative* are technically and administratively implementable. The *in situ bioremediation* alternative, although the least intrusive of the treatment technologies, is not expected to be technically implementable. Bioremediation has limited effectiveness on PCBs and the ability of *in situ* delivery systems to deliver bacteria evenly throughout the impacted soils and sediments is currently unproven . In addition, storm flows may affect placement of bioplugs. The *removal/disposal* alternative presents potential implementation concerns including access to residential properties, implementation of remediation over 2 years, erosion control of sediment during excavation of almost 2 miles of tributary, and impacts of the woods destruction and remedial action on the community.

3.3.3 Results

All of the remedial alternatives are retained for detailed analysis except *in situ bioremediation* due to the uncertainty in that alternatives effectiveness and implementability. *Removal/disposal* may result in difficulties related to implementability, but will be retained for further analysis and discussion.

3.4 Summary of Preliminary Screening

3.4.1 Ground Water

No further action, *monitoring*, *enhanced in situ biodegradation*, and *ground water extraction and treatment* are retained for detailed analysis.

3.4.2 Tributary System

No further action, *institutional action*, the *multi-component alternative* and *removal/disposal* are retained for detailed analysis.

4 DETAILED EVALUATION OF ALTERNATIVES

4.1 Introduction

The purpose of this section is to examine in detail the remedial alternatives that were retained from the preliminary screening, and to select the alternatives most appropriate for this site. The detailed evaluation follows the procedures outlined in NYSDEC's TAGM 4030. Each alternative is examined to determine the degree to which it can (a) be protective of human health and the environment, (b) attain the RAOs and New York State Standards, Criteria and Guidelines (SCGs), (c) satisfy the preference for permanent treatment, and (d) be cost-effective. TAGM 4030 presents seven evaluation criteria that address the requirements and conditions listed above. The seven evaluation criteria are discussed in the following sections.

In this analysis, TGPL has adopted an approach to evaluating alternatives for Station 229 which takes into account chemical properties, site-specific conditions, and cost effectiveness. This approach is consistent with the mandate of the *National Oil and Hazardous Substances Pollution Contingency Plan--Final Rule* (40 CFR 300, March 8, 1990) and NYSDEC guidance (TAGM 4030) favoring flexibility and the tailoring of specific remedial approaches to the actual site conditions.

4.2 Evaluation Criteria

The seven evaluation criteria developed by NYSDEC are described in the following sections.

4.2.1 Compliance with Applicable New York State Standards, Criteria and Guidelines

This criterion, as set forth in regulatory guidelines, assesses the ability of an alternative to comply with all applicable or relevant and appropriate requirements (ARARs) and applicable New York State SCGs. Three categories of compliance criteria are addressed:

chemical-specific (e.g., ground water standards), action-specific (i.e., performance goals for the technologies under consideration), and location-specific (e.g., wetlands requirements).

Below is a list of potentially applicable or relevant federal requirements and SCGs:

40 CFR 761	-	Toxic Substances Control Act (TSCA) - Federal regulations which govern how PCBs are handled
6 NYCRR Part 373	-	Regulation governing the management of hazardous waste
6 NYCRR Part 375	-	Regulation directing the investigation/cleanup of inactive hazardous waste sites
6 NYCRR Part 376	-	Land disposal regulation
6 NYCRR Part 212 and Air Guide 1	-	Requirements and guidance regarding the control of air contaminants
6 NYCRR Parts 700-705	-	Water quality regulations for surface water and ground water
TAGM HWR-4031	-	Fugitive dust suppression and particulate monitoring
TAGM HWR-4036	-	Guidance regarding soil cleanup objectives and cleanup levels
Technical Guidance for Screening Contaminated Sediments		
Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (FWIA)		
6 NYCRR Part 608	-	Use and protection of waters
6 NYCRR Part 663	-	Procedural requirements in and adjacent to wetlands.

4.2.2 Overall Protection of Human Health and the Environment

This criterion, as set forth in regulatory guidelines, assesses how the alternative achieves and maintains protection over time and how potential site risks are reduced. It applies to conditions at the site after remediation is complete.

4.2.3 Short-Term Impacts and Effectiveness

This criterion evaluates the potential for impacts to the community or the environment during implementation of the remedial measures. The effectiveness and reliability of proposed measures to mitigate potential short-term impacts are also considered. TAGM 4030 requires that each alternative be evaluated based on the following components: (a) potential impacts to the community, (b) potential impacts to the environment, (c) potential impacts to workers during remediation, and (d) time for implementation of the remedy or time until the protection is achieved.

4.2.4 Long-Term Effectiveness and Permanence

This criterion addresses the following elements of long-term effectiveness: (a) residuals remaining in place after completion of remediation, (b) the permanence of the remedial measures, (c) the preference for alternatives that provide destructive treatment, and (d) the adequacy and reliability of controls and monitoring to manage constituents of concern remaining in place.

4.2.5 Reduction of Mobility, Volume, or Toxicity

Specific factors to be considered in this criterion are the extent of destruction of target constituents; the expected degree of reduction in mobility or volume; the degree to which the remedy will be irreversible; and the nature and quantity of treatment residuals that will remain on-site.

4.2.6 Implementability

The principal objective of this evaluation criterion, as set forth in guidance, is to assess the technical feasibility of the remedial alternative, considering ease of construction, reliability of the technology, expected delays, and where appropriate, any constraints the remedial alternative may place on future activities at the site. Secondary objectives are to assess the administrative feasibility and availability of services and materials.

4.2.7 Cost

This criterion, as set forth in regulatory guidelines, evaluates and compares the capital costs and treatment costs associated with the various remedial alternatives.

4.3 Detailed Evaluation of Remedial Alternatives for Ground Water

The detailed evaluation of ground water remedial alternatives presented below follows the evaluation process set forth in TAGM 4030. In the following discussion, a comparative analysis of the short-listed alternatives (*no further action, monitoring, enhanced in situ degradation* and *ground water extraction and treatment*) is presented. The *no further action* alternative is retained in the detailed analysis to provide a base case for comparison with the other alternatives.

The detailed evaluation of remedial alternatives is summarized in Table 4-1.

4.3.1 Compliance with Applicable New York State Standards, Criteria and Guidelines

As discussed previously, action levels for VOCs in ground water at the site boundary will be based on NYS promulgated standards for ground water. Table 2-1 lists federal standards (USDWS) and state guidelines (NYS SGVs). Other chemical-specific criteria could include air and water discharge standards associated with alternatives that involve treatment.

All of the alternatives under consideration may meet the chemical-specific criteria through natural attenuation of VOCs of potential concern as well as, in some cases, more active treatment methods. In the event these criteria cannot be attained, alternative criteria will be evaluated. Unlike the other alternatives which incorporate monitoring, the *no further action* alternative does not provide any mechanism that would demonstrate that chemical-specific criteria have been satisfied.

For the *no further* action and *monitoring* alternatives, an estimate of time for natural attenuation to meet NYS SGVs has been made. Using a range of biodegradation rates from the literature (Howard et al. 1991), the time required for the most conservative

TABLE 4-1
Detailed Evaluation Summary Table - Ground Water Remediation: Station 229

Alternatives	Description	Compliance with Regulatory Criteria			Protection of Human Health & Environment			Short-Term Effectiveness			
		Compliance with Chemical-Specific Regulatory Criteria	Compliance with Action-Specific Regulatory Criteria	Compliance with Location-Specific Regulatory Criteria	Use of Site After Remediation	Protection of Human Health	Protection of Environment	Protection of Community During Remediation	Control of Environmental Impact during Remediation	Field Implementation Time (months)	Total Cost
1. No Further Action	No remedial action implemented	Compliance with chemical-specific criteria probable as a result of natural attenuation of VOCs. However, no mechanism for confirming that cleanup goals are met	N/A	Yes	Continued access and use of site without restriction, ground water use may be restricted	No receptors, therefore no human health impact. Protection also provided by VOC attenuation; however, attenuation is not confirmed with monitoring.	Protection provided by VOC attenuation; however, attenuation is not confirmed with monitoring	No adverse effects	N/A	N/A	$0
2. Monitoring	Ground water monitoring	Compliance with chemical-specific criteria via natural attenuation probable	N/A	Yes	Continued access and use of site without restriction, ground water use may be restricted	No receptors, therefore no human health impact. Protection also provided by VOC attenuation and long-term monitoring.	Protection provided by VOC attenuation and long-term monitoring	No adverse effects	Protection provided by ground water monitoring	2 months to install monitoring wells	$40,200
3. Enhanced *In Situ* Degradation	Delivery of biostimulant to ground water to accelerate biological degradation	Compliance with chemical-specific criteria expected. Active reduction of VOCs depends on ability to uniformly deliver biostimulants to aquifer	N/A	Yes	Continued access and use of site without restriction, ground water use may be restricted	No receptors, therefore no human health impact. Protection provided by VOC degradation and long-term monitoring.	Protection provided by VOC degradation and long-term monitoring	No adverse effects	Protection provided by ground water monitoring	12 months including treatability studies and delivering system	$1,023,200
4. Ground Water Extraction and Treatment	Ground water extraction by interceptor trenches followed by air stripping or oxidation followed by activated carbon polishing of eluting water as necessary	Compliance with chemical-specific criteria expected. Active reduction of VOCs depends on yield from aquifer. Applicable emissions and discharge standards can be met	N/A	Yes	Continued access and use of site without restriction, ground water use may be restricted	No receptors, therefore no human health impact. Protection provided by VOC attenuation, ground water extraction, *ex situ* treatment, long-term monitoring.	Protection provided by VOC attenuation, ground water extraction, *ex situ* treatment, long-term monitoring	Protection provided by controlling releases during treatment	Protection provided by controlling releases during treatment and ground water monitoring	6 months using a mobile treatment system	$513,000

TABLE 4-1 (continued)
Detailed Evaluation Summary Table - Ground Water Remediation: Station 229

		Long-Term Effectiveness					Reduction of Volume, Mobility, or Toxicity				Implementability						
Alternatives	Description	Alternative Employs Waste Treatment	Permanence of Remedy	No Untreated Waste Remaining	No Treatment Residuals Remaining On-Site	Proposed Controls and Monitoring Reliable and Adequate	Reduction of Waste Volume	Reduction of Waste Mobility	Reduction of Toxicity	Irreversibility of Volume, Mobility, or Toxicity Reduction	Ease of Construction	Application of Demonstrated Technology	No Anticipated Delays	Impact on Potential Further Remediation	Need for Administrative Coordination	Use of Available Technology	Equipment & Staff Available
1. No Further Action	No remedial action implemented	Yes; by natural attenuation	Possible destruction of VOCs via natural attenuation	VOC attenuation expected	Attenuation processes are expected to go to completion	No controls or monitoring proposed	Probable	No	Probable	Irreversible	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Monitoring	Ground water monitoring	Yes, by natural attenuation	Possible destruction of VOCs via natural attenuation	VOC attenuation expected	Attenuation processes are expected to go to completion	Adequate monitoring	Probable	No	Probable	Irreversible	No construction difficulties anticipated	Yes	No delays are expected	Would not constrain potential future remediation	Anticipated need for minimal administrative coordination	Yes	Yes
3. Enhanced *In Situ* Degradation	Delivery of biostimulant to ground water to accelerate biological degradation	Yes	Destruction of VOCs expected if pilot testing shows this alternative to be implementable and effective	Ground water VOCs treated to the extent practicable if this alternative can be effectively implemented	Attenuation processes are expected to go to completion	Adequate monitoring, controls employed if required	Expected	No	Expected	Irreversible	No construction difficulties anticipated; pilot testing may show this alternative to be ineffective	Successful full scale applications, but pilot testing required to determine if alternative is implementable or effective in this setting	No delays are expected	Would not constrain potential future remediation	Need to obtain applicable permits; moderate administrative coordination may be required	Yes	Equipment available for use. More than one vendor available.
4. Ground Water Extraction and Treatment	Ground water extraction by interceptor trenches followed by air stripping or oxidation followed by activated carbon polishing of eluting water as necessary	Yes	Destruction of VOCs expected if extraction can be achieved	Ground water VOCs treated to the extent practicable if extraction can be achieved	No treatment residuals would remain on-site	Adequate monitoring, controls employed if required	Expected	Yes	Expected	Irreversible	No construction difficulties anticipated if extraction can be achieved	Well established technology, but may not work in low permeability fractured bedrock	No delays are expected	Would not constrain potential future remediation	Need to obtain applicable permits; moderate administrative coordination may be required	Yes	Equipment available for use. More than one vendor available.

VOCs of potential concern to reach NYS standards is estimated to range from 4 to 20 years with an average of about 10 years. The enhanced *in situ* degradation is expected to be near the lower end of this range, about 4 years for the most conservative VOCs in the ground water. The *enhanced in situ degradation* and *ground water extraction and treatment* alternatives may not be expected to significantly enhance the ability to meet applicable levels as compared to natural attenuation because of limitations associated with delivery of biostimulants to ground water and extracting water from this low-yielding aquifer, respectively. An estimate of time to reach standards has also been made for the ground water extraction to treatment alternatives. Assuming the fractured shale on the station behaves like a porous medium and the compounds degrade at the rates referenced above, the time required for the most conservative VOCs of concern to reach NYS standards ranges from 3 to 10 years with an average of about 6 years. Time estimates are made using methods developed by Yim et al. (1991).

Other chemical-specific SCGs for the *ground water extraction and treatment* alternative may include emissions and effluent standards. Since this alternative would include provisions for off-gas treatment, as necessary, and it is assumed that treated ground water would either be reinjected into ground water or discharged to surface water after satisfying applicable discharge limits, it is expected that these chemical-specific criteria would be met for this alternative.

All of the alternatives under consideration are expected to achieve appropriate location-specific criteria, including federal and state wetlands permitting requirements, if any.

4.3.2 Overall Protection of Human Health and the Environment

This site will remain an industrial facility and ground water from the site will not be used as a drinking water source. In addition, no potential off-site receptors have been identified. Therefore, all of the alternatives achieve protection of human health and the environment. Furthermore, with the exception of the *no further action* alternative, ground water monitoring would be conducted to monitor the performance of the remedy and provide for the overall protection of human health and the environment.

4.3.3 Short-Term Impacts and Effectiveness

The criterion of short-term impacts and effectiveness addresses any impacts to the community or the environment that may result from implementation of the remedial alternative. The *no further action, monitoring*, and *enhanced in situ degradation* alternatives essentially present no short-term impacts to the community or environment related to their implementation. Air emissions potentially resulting from the *ground water extraction and treatment* alternative (e.g., air stripping) would be controlled by employing demonstrated off-gas treatment technologies such as vapor-phase carbon adsorption or catalytic combustion, as necessary.

4.3.4 Long-Term Effectiveness and Permanence

Natural attenuation and biodegradation are anticipated to occur under the *no further action* and *monitoring* alternatives. Stimulated biodegradation may occur in the *enhanced in situ degradation* alternative. *Extraction and treatment* may destroy the VOCs or remove them from the ground water to another medium(e.g., air stripper). *Enhanced in situ degradation* and *extraction and treatment* are considered permanent because they include active destruction. The effectiveness of each alternative in reducing ground water VOC levels, except *no further action*, would be established by monitoring.

4.3.5 Reduction of Mobility, Volume, or Toxicity

The *no further action* alternative may result in toxicity reduction through *in situ* natural attenuation of ground water VOCs; however, this effect would not be demonstrated as this alternative does not include ground water monitoring. The *monitoring* alternative is expected to confirm toxicity reduction through natural biodegradation. The *enhanced in situ degradation* alternative may provide for toxicity reduction via the abiotic and/or biotic transformation of target VOCs to end products that do not pose potential concerns. Extraction of ground water in the *ground water extraction and treatment* alternative may also reduce the mobility of VOC-containing ground water. In addition, depending upon the particular *ex situ* VOC treatment technology used, the alternative may provide for volume reduction (e.g., air stripping followed by vapor phase carbon adsorption) or toxicity reduction (e.g., air stripping followed by off-gas combustion or oxidation).

4.3.6 Implementability

All of the remedial alternatives under consideration in the detailed evaluation are expected to be administratively feasible. The *no further action* and *monitoring* alternatives are also expected to be technically feasible, but the remaining alternatives retained for the detailed analysis may be associated with potential technical limitations. For example, the *enhanced in situ degradation* alternative may be difficult to implement due to the difficulty of delivering biostimulants to VOC-containing ground water within the fractured bedrock. The low yield of the aquifer may not permit adequate flushing of the aquifer for the *ground water extraction and treatment* alternative to be successful. The presence of metals in ground water may also cause operational difficulties in aboveground treatment units.

4.3.7 Cost

The elements considered under cost of implementing the remedial alternatives included, as appropriate, (a) treatability testing; (b) mobilization/demobilization; (c) aboveground treatment capital and operating and maintenance (O&M) costs; (d) site restoration; (e) ground water monitoring; (f) health and safety contingency; and (g) engineering/field services. Aboveground treatment technologies under consideration for removal of VOCs as part of the *ground water extraction and treatment* alternative are air stripping followed by carbon adsorption polishing or oxidation. For the purposes of this evaluation, it was assumed that the *ground water extraction and treatment* alternative would consist of collection of ground water via interceptor trenches and aboveground treatment by air stripping followed by activated carbon polishing, as necessary. This technology is common for treatment of aqueous-phase VOCs. A detailed breakdown and present-worth cost for each alternative are provided in Table 4-2. The total cost of each alternative is as follows:

TABLE 4-2
Costs for Remedial Alternatives for Ground Water at TGPL Compressor Station 229

Remediation Costs	No Further Action	Monitoring	Enhanced Degradation (In-Situ)	Ground Water Extraction and Carbon Treatment (Ex Situ)
1. Ground Water Extraction System				
1a. Extraction Well Installation	$0	$0	$0	$10,500
1b. Trench Installation	$0	$0	$0	$170,200[1]
2. Engineering Analysis[2]	$0	$10,000	$30,000	$30,000
3. Ground Water Treatment				
3a. Laboratory Tests	$0	$0	$60,000	$0
3b. Field Tests	$0	$0	$100,000	$0
3c. Treatment System Installation	$0	$0	$250,000[3]	$41,500[4]
SUBTOTAL, remediation cost	$0	$10,000	$440,000	$252,000
Health & safety contingency, 10%[5]	$0	$0	$35,000	$22,200
Scope contingency, 20%[6]	$0	$2,000	$88,000	$50,400
TOTAL, direct cost	$0	$12,000	$563,000	$324,800
Engineering and design	$0	$0	$50,000	$50,000
Field services & supervision	$0	$0	$40,000	$40,000
TOTAL, capital cost	$0	$12,000	$653,000	$414,800

TABLE 4-2
Costs for Remedial Alternatives for Ground Water at TGPL Compressor Station 229

Remediation Costs	No Further Action	Monitoring	Enhanced Degradation (In-Situ)	Ground Water Extraction and Carbon Treatment (Ex Situ)
Operation and Maintenance Costs (present worth)[7]				
Ground Water Monitoring	$0	$28,200[8]	$28,200[8]	$50,100[10]
Treatment	$0	$0	$342,000[9]	$48,600[11]
TOTAL REMEDIATION COST (rounded)	$0	$40,200	$1,023,200	$513,000

Assumptions:

* The costs presented above are best-estimate costs, based on non-binding vendor quotes and engineering experience. Remediation costs approximated to 3 significant figures.
1 Based on installation of two extraction trenches.
2 Includes evaluation of ground water data to demonstrate effectiveness of alternative.
3 Includes pipe manifold, pumps, injection wells, controls.
4 Assumes 2.6 gpm system; includes piping, building, pumps, and initial carbon units.
5 Not applied to activities 2 and 3a.
6 Applied to Subtotal Remediation Cost.
7 Assumes an annual interest rate of 10% and inflation rate of 5% for 5 years.
8 Assumes four rounds of monitoring (i.e., baseline, 1, 3 and 5 years) of MW-2, MW-4, MW-6S, MW-6D, MW-8S, MW-8D, MW-9, MW-10, and MW-11.
9 Assumes a five-year period of treatment.
10 Assumes monitoring as described in note 8 plus two samples every quarter for 5 years to monitor system performance.
11 Assumes replacement carbon, disposal, electrical usage and system maintenance.

Remedial Action	Total Cost
Monitoring	$40,200
Enhanced In Situ Degradation	$1,023,200
Ground Water Extraction and Treatment	$513,000

The above cost estimates are provided for comparative purposes only. The cost estimates include costs expected to be incurred during the various phases of implementation of the remedial alternatives and are based on vendor quotes. The cost estimates do not include project costs of $6.1 million already expended for investigation and remediation.

4.3.8 Summary of Comparative Analysis

The detailed evaluation of remedial alternatives for VOCs in ground water is summarized in Table 4-1. While all of the remedies are expected to satisfy the RAO established for ground water, the *no further action* alternative does not provide a mechanism such as ground water monitoring that would demonstrate that the RAO will continue to be achieved. No significant concerns related to potential short-term impacts or effectiveness were identified for any of the alternatives under consideration. Natural attenuation, occurring under all of the remedies, would result in a permanent reduction in the volume and toxicity of ground water VOCs. *Enhanced in situ degradation* and *ground water extraction and treatment* are considered the two permanent remedies since they involve active destruction of VOCs. The long-term effectiveness of each alternative in reducing ground water VOC levels, except *no further action*, would be established by monitoring. The significant differences among the alternatives are implementability and cost. The low permeability and fractured nature of the bedrock containing the impacted ground water may make *enhanced in situ degradation* and *ground water extraction and treatment* unimplementable.

No further action is rejected from further consideration because it does not demonstrate continuing compliance with the ground water RAO. All of the remaining alternatives are expected to meet the RAO and be protective and permanent. Of the remaining alternatives, *monitoring* is the most cost-effective remedy. Given the lack of off-site receptors at Station 229, the increased costs associated with *enhanced in situ* *degradation* or *ground water extraction and treatment* are not justified since there is no associated incremental gain. Consequently, taking cost and implementation into consideration, TGPL proposes to address ground water at Station 229 by *monitoring*. This remedy involves evaluation of ground water data generated over five years. After five years, the need for continued monitoring and/or a more active remedial approach for ground water would be evaluated based on the monitoring results.

The monitoring alternative was selected in response to site-specific conditions which include the following:

- The presence of the degradation products 1,1-DCA and 1,1-DCE which indicate that natural biodegradation is occurring;
- Decreases in levels of benzene at MW-11;
- The fact that the site is an industrial facility and ground water is not used for drinking water purposes;
- The absence of downgradient receptors;
- The absence of a continuing source of VOCs to the ground water;
- The limited transport of VOCs (none seen in downgradient wells MW-8S and MW-10; no chlorinated VOCs in MW-11);
- The technical impracticability of remediation in the fractured bedrock underlying the station; and
- The limited flow of the ground water and the availability of public water, which discourage future private well installation in the area.

4.4 Detailed Evaluation of Remedial Alternatives for the Tributary System

The detailed evaluation of remedial alternatives presented below follows the evaluation process set forth in TAGM 4030. In the following discussion, a comparative analysis of the short-listed alternatives (*no further action*, *institutional action*, *multi-component alternative* and *removal/disposal*) is presented. The detailed evaluation of remedial alternatives is summarized in Table 4-3.

TABLE 4-3
Detailed Evaluation Summary Table - Tributary System Remediation: Station 229

Alternatives	Description	Compliance with Regulatory Criteria			Protection of Human Health & Environment			Short-Term Effectiveness			
		Compliance with Chemical-Specific Regulatory Criteria	Compliance with Action-Specific Regulatory Criteria	Compliance with Location-Specific Regulatory Criteria	Use of Site After Remediation	Protection of Human Health	Protection of Environment	Protection of Community During Remediation	Control of Environmental Impact during Remediation	Field Implementation Time (months)	Total Cost
1. No Further Action	No remedial action implemented	Yes	N/A	Yes	Continued access and use of site without restriction.	Yes	Yes	No adverse effects	N/A	N/A	$0
2. Institutional Action	Property purchase and fencing areas with highest levels.	Yes	N/A	Yes	Restricted access	Yes	Yes	No adverse effects	Limited impact	0.5	$810,000
3. Multi-Component Alternative	Property purchase, fencing, removal, capping, channelization, residential covering, sediment trap, restoration, and monitoring	Yes	N/A	Yes	Restricted access	Yes	Yes	No adverse effects Further protection provided by controlling erosion during implementation	Impact may be significant. Protection provided by erosion control	2+	$2,200,000
4. Removal/ Disposal	Removal of soils and sediments with PCBs > 1 mg/kg, including Station Lake sediments.	Yes	N/A	Yes	Continued access and use of site without restriction	Yes	Yes	No adverse effects Further protection provided by controlling erosion during implementation	Impact may be significant Protection provided by erosion control	7+	$14,000,000

TABLE 4-3 (continued)
Detailed Evaluation Summary Table - Tributary System Remediation: Station 229

		Long-Term Effectiveness					Reduction of Volume, Mobility, or Toxicity				Implementability						
Alternatives	Description	Alternative Employs Waste Treatment	Permanence of Remedy	No Untreated Waste Remaining	No Treatment Residuals Remaining On-Site	Proposed Controls and Monitoring Reliable and Adequate	Reduction of Waste Volume	Reduction of Waste Mobility	Reduction of Toxicity	Irreversibility of Volume, Mobility, or Toxicity Reduction	Ease of Construction	Application of Demonstrated Technology	No Anticipated Delays	Impact on Potential Further Remediation	Need for Administrative Coordination	Use of Available Technology	Equipment & Staff Available
1. No Further Action	No remedial action implemented	No	No	No. However, studies and sampling show no impact to human health and the environment	N/A	No controls or monitoring proposed	No	No	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Institutional Action	Property purchase and fencing areas with highest levels.	No	No	No. However, studies and sampling show no impact to human health and the environment	N/A	No controls or monitoring proposed	No	No	No	N/A	No construction difficulties anticipated	Yes	No delays are expected	Would not constrain potential future remediation	Anticipated need for minimal administrative coordination	Yes	Yes
3. Multi-Component Alternative	Property purchase, fencing, removal, capping, channelization, residential covering, sediment trap, restoration, and monitoring	No	No	Some. However, this will be controlled and/or covered and studies and sampling show no impact to human health and the environment	N/A	Adequate monitoring and controls employed	No	Yes	No	Irreversible	Some construction difficulties anticipated	Yes	No delays are expected	Would not constrain potential future remediation	Need to obtain applicable permits; moderate administrative coordination may be required	Yes	Yes; More than one vendor available for equipment and supplies.
4. Removal/Disposal	Removal of soils and sediments with PCBs > 1 ppm, including Station Lake sediments.	No	No	Complete removal	N/A	Adequate controls	No	Yes	No	Irreversible	Significant construction difficulties anticipated	Yes	No delays are expected	Would not constrain potential future remediation	Need to obtain applicable permits; moderate administrative coordination may be required	Yes	Equipment available for use. More than one vendor available for equipment and supplies.

4.4.1 Compliance with Applicable New York State Standards, Criteria and Guidelines

There are no applicable federal standards. The SCGs provide no regulatory levels for PCBs in soil, but NYSDEC has potentially relevant guidance levels which provide a starting point for evaluation of soil remediation alternatives. NYSDEC has previously utilized guidance levels of 1 mg/kg for non-restricted access (surface) soils and 10 mg/kg for soils at depth. The NYSDEC has also suggested that a level of 1.4 μg/g organic carbon be utilized as a starting point for sediments for evaluating wildlife bioaccumulation.

TGPL does not endorse the underlying risk assessments and assumptions that may have been utilized to derive the guidance described above. In particular, for PCBs, the company addressed issues of toxicity in two reports entitled *A Review and Evaluation of the Potential Carcinogenicity of Polychlorinated Biphenyls* (Tennessee Gas Pipeline Company 1990) and *A Summary of PCB Toxicology and A Critical Assessment of Its Human Relevance* (Terra 1996), both previously provided to NYSDEC. In addition, as shown by the studies and discussions presented in Section 1, these guidance levels are not supported by the site-specific data collected by TGPL.

Specifically, TGPL's human health, ecological evaluation, and fate and transport evaluations discussed in Section 1 show that: (1) all the alternatives achieve the criteria or an equivalent standard of performance (e.g., protection of human health and the environment) and (2) direct compliance with the SCGs (e.g,. implementation of *removal/ disposal*) would result in greater risk to human health and the environment than the other alternatives. Both of these factors are considered in the National Contingency Plan (*Fed. Reg.* 55(46); 8850, March 8, 1990, 40 CFR 300.430(f)(ii)(C)) as circumstances under which an alternative may be selected.

4.4.2 Overall Protection of Human Health and the Environment

TGPL's human health, ecological evaluation and fate and transport evaluations indicate that the PCBs in the tributary soils and sediments do not pose a significant threat to human health or the environment. *No further action, institutional action*, and *removal/disposal,* however, do not provide monitoring to confirm continued protection. *Institutional action* provides access control to further limit human access to the soils present. The *multi-component* and *removal/disposal* alternatives include the removal of PCB-containing soils and sediments and the *multi-component alternative* additionally controls access and sediment transport, channelizes flow, and confirms continued protection through monitoring.

4.4.3 Short-Term Impacts and Effectiveness

No further action would have no short-term impact nor would it change the current status of the system. The existing natural communities are healthy, robust and diverse and will be perpetuated intact under the *no further action* alternative.

Institutional action is anticipated to have few short-term impacts. Access to the tributary would be controlled by the installation of a boundary system of fences and vegetative barriers which may result in minor disturbance to the upland slopes from the use of light weight vehicles. This limited disturbance would be temporary and is offset by the habitats provided, and cover created, by the vegetative barriers installed as part of this alternative.

The *multi-component alternative* is anticipated to have some short-term impacts during soil and sediment removal, channelization, and construction of the sediment basin. These include erosion during clearing and excavation of soils and sediments. Erosion would be controlled through the use of silt fences and a sediment basin to trap sediment. Temporary tributary diversion may also result in short-term erosion and other impacts on the stream. Clearing and removal activities may disturb and/or eliminate resident natural communities in the sediments and soils including the existing benthic community and micro-organism communities (e.g., bacteria, fungi, algae). In addition, some hardwood trees would be removed in the upper and lower tributary areas. Stream channelization in the bog area may alter some ecological characteristics including wetland areas; the resulting bog community may be less conducive to wildlife propagation in the short-term. These impacts are limited to the specific removal areas along the tributary and will not affect the wooded slopes and upland areas. Also, fence installation proposed under the *multi-component* alternative will have minor short-term impacts described under *institutional action* above.

Removal/disposal is anticipated to have significant short-term impacts including clearing and removal of soil and sediment from approximately 13 acres of wooded property including wetlands areas. Significant soil erosion is expected from a removal activity of this magnitude. Extensive physical removal of soils and sediments using heavy equipment would damage the natural, biologically desirable communities present in and along the creek. Further, current restoration practices cannot recreate the natural communities with the same attributes, complexities, and characteristics which currently exist. Therefore, the effects from the implementation of the *removal/disposal* alternative are both short-term physical destruction and ecological impacts.

4.4.4 Long-Term Effectiveness and Permanence

Technical studies performed by TGPL indicate that PCBs in the tributary system do not pose a significant threat to human health and the environment. Therefore, all the alternatives would be effective in the long-term. The *institutional action, multi-component, and removal/disposal* alternatives each include additional measures beyond the *no further action* alternative.

With regard to potential impacts, the *no further action* and *institutional action* alternatives are expected to have no long-term impacts. The removal and construction activities of the *multi-component* alternative may have some long-term impacts on the tributary ecosystem and its associated habitats. This alternative may alter the features and characteristics of the tributary system so that succeeding communities may differ from those currently present.

The *removal/disposal* alternative, which requires an extensive removal and construction effort, is expected to have extensive long-term impacts. The physical removal of large volumes of sediment and soils to bedrock in many locations may result in long-term elimination of natural communities, including the tributary benthic community and many of the established hardwood trees in approximately 13 acres of woodland. In addition, since current restoration practices cannot recreate the natural communities with the same attributes, complexities, and characteristics which currently exist, impacts are expected in the long-term.

4.4.5 Reduction of Mobility, Volume, or Toxicity

The *no further action* and *institutional action* alternatives may result in toxicity reduction through *in situ* natural attenuation of PCBs in soils and sediments; however, this effect would not be demonstrated as these alternatives do not include monitoring.

The *multi-component alternative* provides mobility reduction via soil and sediment removal and off-site disposal, construction of a sediment basin, and channelization (including covering) of a portion of the tributary; this alternative also includes monitoring to confirm the mobility reduction.

The *removal/disposal* alternative would remove the soil from the site and provide long-term off-site containment, resulting in reduced mobility of PCBs.

4.4.6 Implementability

No further action, *institutional action*, and the *multi-component alternative* are technically and administratively implementable. Implementation of the *removal/disposal* alternative is anticipated to be difficult due to factors including the following: access to residential properties, implementation of remediation over 2 years, erosion control of sediment during excavation of almost 2 miles of tributary, and impacts of the woods destruction and remedial action on the community.

4.4.7 Cost

The elements considered in the cost of implementing the remedial alternatives included: (a) mobilization/demobilization; (b) site preparation; (c) remediation support; (d) excavation and covering of soil and sediment, as appropriate; (e) erosion control; (f) liquids collection and disposal; (g) restoration; (h) long-term sediment control; (i) landscaping; (j) monitoring; (k) sampling, as appropriate; (l) fencing; (m) transport and disposal; (n) contingency, operations and maintenance, and engineering design/field services; and (o) property purchase. A detailed breakdown for each alternative is provided in Table 4-4.

Remedial Action	Total Cost
No action	$0
Institutional action	$810,000
Multi-component Alternative	$2,200,000
Removal/Disposal	$14,000,000

The above cost estimates are provided for comparative purposes only. The cost estimates above are based on cost estimating references and vendor quotes and include the costs expected to be incurred during many phases of implementation. The cost estimates do not include project costs for investigation and remediation of $6.1 million already expended.

4.4.8 Summary of Comparative Analysis

.The tributary system currently has a low potential for exposure/direct contact or migration. Therefore, TGPL believes that all of the alternatives are acceptable (i.e., pose no significant human health or environmental concerns). The *institutional action*, *multi-component alternative*, and *removal/disposal* alternatives include additional efforts to further minimize the potential for exposure/direct contact and for migration. The *multi-component alternative* provides monitoring to demonstrate that the RAO will continue to be achieved. The *multi-component alternative* and *removal/disposal* alternatives present potential short-term impacts; the short-term impacts of *removal/disposal* are potentially significant. All of the remedies would result in a permanent reduction in the mobility and/or toxicity of the PCBs, although attenuation under the *no further action* and *institutional action* would not be confirmed. All of the alternatives are anticipated to achieve long-term reductions through natural attenuation although none of these alternatives includes active, permanent destruction of PCBs. *Removal/disposal* may present long-term impacts due to the uncertainty associated with the success of restoration.

TABLE 4-4
Costs[1] for Remedial Actions for Station Lake and the Tributary System at TGPL Compressor Station 229

Remedial Component	Cost Units	No Further Action	Institutional Action	Multi-Component Alternative	Removal/Disposal
1. Mobilization/Demobilization	15%	$0	$20,800	$117,600	$868,800
2. Site Preparation - Support Areas[2]	$/alternative	$0	$39,900	$74,100	$276,600
3. Site Preparation - Remediation Areas[3]	$/alternative	$0	$0	$159,000	$1,266,700
4. Daily Remediation Support - Contractor[4]	$/alternative	$0	$1,000	$78,000	$581,200
5. Remediate Affected Soil/Sediment[5]					
a. Excavation - Soil/Sediment	$/alternative	$0	$0	$12,900	$1,122,300
6. Erosion Control	$2/lf	$0	$0	$5,200	$44,200
7. Liquids Collection/Transportation /Disposal	$1.25/gal	$0	$0	$9,400	$119,100
8. Support Area Restoration[6]	$/alternative	$0	$2,200	$98,900	$528,500
9. Remediation Area Restoration					
a. Backfilling	$24/cy	$0	$0	$7,300	$529,400
b. Restoration/Cover[6]	$/alternative	$0	$0	$67,600	$621,700
c. Fencing[7]	$/alternative	$0	$95,400	$95,400	$0
10. Sedimentation Control					
a. Detention Basin	$/station	$0	$0	$67,000	$0
b. Stream Restoration and/or Channelizing[8]	$/alternative	$0	$0	$37,800	$573,300
11. Residential Covering and Landscaping	$/alternative	$0	$0	$64,800	$0
12. Station Lake Sediment Removal	$/alternative	$0	$0	$0	$128,600
13. Monitoring and Reporting[9]	$/alternative	$0	$0	$6,300	$0
SUBTOTAL	$/alternative	$0	$159,300	$901,300	$6,660,600
Pre-remediation sampling (Lab & EnSys)	$/alternative	$0	$0	$0	$187,100
Waste Characterization Sampling	$154/300cy	$0	$0	$500	$15,800
Transportation[10]	$/station	$0	$0	$15,900	$745,600

TABLE 4-4
Costs[1] for Remedial Actions for Station Lake and the Tributary System at TGPL Compressor Station 229

Remedial Component	Cost Units	No Further Action	Institutional Action	Multi-Component Alternative	Removal/Disposal
Disposal[10]	$/station	$0	$0	$109,700	$2,576,900
O&M Net Present Value		$0	$28,600	$112,200	$238,800
SUBTOTAL			$187,800	$1,139,600	$10,424,500
Contingency	20%	$0	$37,600	$227,900	$2,085,000
Engineering Design		$0	$10,000	$135,200	$333,000
Construction Oversight		$0	$10,000	$90,100	$666,100
Property Purchase		$0	$570,000	$570,000	$0
Total Remedial Action Cost		$0	$810,000	$2,200,000	$14,000,000

Notes:

(1) The costs presented above are best-estimate costs based on nonbinding vendor quotes. Cost items are rounded to the nearest one hundred dollars. Total remediation costs is rounded to two significant figures.
(2) Site preparation-Support areas includes clearing for and construction of remediation area access roads and staging areas.
(3) Site preparation-Remediation areas includes clearing and grubbing remediation areas, transporting and disposing of cleared material and tributary diversion.
(4) Daily remediation support costs are dependent on the scope of work in an alternative.
(5) 304 cy of soil and sediment are targeted for excavation and disposal under the multi-component alternative. 30,815 cy of soil and sediment are targeted for excavation and disposal under the removal/disposal alternative. Costs are $36/cy for soil and $45/cy for sediment excavation.
(6) Restoration includes restoring open and wooded areas and removing access roads and cover includes covering designated areas under the multi-component alternative.
(7) Fencing includes the combination chain link, vegetative, and barbed wire fence and moving a portion of the station fence.
(8) Stream restoration and/or channelizing includes placement of geotextile, geogrid, and rip-rap for bank stabilization and tributary restoration.
(9) Monitoring and reporting assumes the collection of sediment samples and fish samples during 5 sampling events.
(10) Transportation and disposal includes regulated and non-regulated soil and sediment.
(11) Cost based on existing purchase options on portions of select properties along the upper-most portion of the tributary currently being purchased by TGPL.

No further action does not present a potential risk to human health or the environment based on studies performed by TGPL. *Institutional action* further limits any potential exposure. *Removal/disposal* is effective, but destroys the existing habitat and has a cost which is not justified since there is no incremental gain over the *multi-component alternative*. Consequently, taking all of the above factors into consideration, and to address potential NYSDEC and community concerns regarding the presence of PCBs, TGPL proposes to implement the *multi-component alternative*.

4.5 Summary of Proposed Alternatives

TGPL proposes to address VOCs in ground water with *monitoring* to be conducted in the first, third, and fifth year following baseline sampling. Monitoring wells MW-2, MW-4, MW-6S, MW-6D, MW-8S, MW-8D, MW-9, MW-10, and MW-11 would be sampled on this schedule and the results evaluated after the fifth year to assess the need for continued monitoring.

PCBs in the tributary system would be addressed through implementation of the *multi-component alternative* which includes the following:

- Exercising purchase options on certain properties along the tributary corridor;
- Deed restrictions on the tributary corridor owned by TGPL (up to 150 feet on either side of the tributary);
- Removal (in erosional areas) of some PCB soils and sediments and covering (in non-erosional/depositional areas) of others as shown in Plate 1;
- Restricting access to the first 2,000 feet of the tributary corridor through the construction of a multi-component fence;
- Channelizing tributary flow through the bog;
- Stabilizing channel slopes and banks with geotextile matting, geogrid, and rip-rap;
- Constructing a sediment trap at an existing farm road between the station and North Boston Road;
- Covering certain PCB soils in residential areas that border North Boston Road;
- Restoring excavated and covered areas to the extent feasible;

- Conducting a comprehensive operations and maintenance plan to ensure the integrity of the sediment trap and the capped, restored, and stabilized areas along the tributary;
- Monitoring or fish from the breached pond and from the tributary near Hickman Road; and
- Monitoring of sediments from the sediment trap (for disposal purposes) and from three additional locations between the trap overflow and North Boston Road.

This alternative is selected because it addresses potential NYSDEC and community concerns regarding the presence of PCBs in the system.

Based on the selection of these alternatives, the cost incurred by TGPL for investigating and remediating this station are projected to be as follows:

- Comprehensive RI/FS: $4.8 million;
- On-Site Soils and Drainlines Remediation (IRM): $1.3 million;
- Ground Water Remediation: $40 thousand; and
- Tributary Remediation: $2.2 million;

for a total cost of $8.3 million.

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