Tetra Tech EM Inc.

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January 28, 2004

Mr. Derek Matory
Remedial Project Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street, S.W., 11th Floor
Atlanta, Georgia 30303

Subject: **Dickson County Landfill Reassessment Report (Revision 3)**
Dickson, Dickson County, Tennessee
Contract No. 68-W-00-120 (START)
TDD No. 4T-01-11-A-004

Dear Mr. Matory:

The Tetra Tech EM Inc. Superfund Technical Assessment and Response Team (START) is submitting one electronic copy of the Dickson County Landfill Reassessment Report. Also included with this submittal are the references, attachments and appendices for the report. This report was revised, reorganized and updated to include the most recent investigative information for the site in accordance with comments received from you on January 9, 2004.

If you have any questions regarding this submittal, please contact me at (678) 775-3081.

Sincerely,

David L. Brown
START Project Manager

Enclosure

cc: Matthew Monsees, EPA Project Officer (letter only)
Steve Pierce, START Program Manager (letter only)
Paul Moisan, START Site Assessment Coordinator (letter only)
START File

DICKSON COUNTY LANDFILL REASSESSMENT REPORT

Revision 3

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY

Prepared by

TETRA TECH EM INC.

JANUARY 28, 2004

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EXECUTIVE SUMMARY

The scope of this Tetra Tech EM, Inc. (TtEMI) investigation was to summarize work completed by multiple local, state, and federal agencies relative to environmental permitting and site cleanups and the work performed relative to evaluating the potential cause and effect of environmental exposures and orofacial clefts (cleft palate and/or cleft lip). The investigation was designed to result in recommendations for responses appropriate to protect human health and the environment. Specifically, the investigation focused on (1) the use of a municipal groundwater well that has been used to supply potable water not only to the residents of the City of Dickson, but to others throughout Dickson County and (2) the operation of the Dickson County Landfill.

The City of Dickson, Dickson County, Tennessee, and the surrounding area contains numerous manufacturers, some of which have been in operation for 30 years or more. Printing, boat building, and metal fabrication industries have historically been prevalent in the area. Each of these industries used, and continues to use, various types of industrial solvents. A number of these types of facilities in Dickson County have had documented releases of such chemicals to the environment. In addition to the presence of manufacturing facilities, the City of Dickson and Dickson County operated a Class I landfill (Dickson County Landfill) that reportedly received industrial wastes, including solvents. A municipal well field located adjacent to the landfill has been contaminated with trichloroethene (TCE). Investigations by state and federal agencies have been performed in an effort to link the landfill with documented TCE contamination in both private water supplies and the municipal water system.

Dye trace efforts by the county and the U.S. Geological Survey (USGS) in connecting the Dickson County Landfill with the municipal well field were unsuccessful and the results inconclusive. The continued reliance on groundwater for private, commercial, recreational, and public water supply uses and the sensitive nature of the geology and hydrogeology only enhance the possibility of exposures to groundwater that might be contaminated. The extreme karst nature of the geology, which is largely undefined in the area, complicates the ability to protect the groundwater resource and to provide reliable, uncontaminated groundwater as a potable water source. The area geologic conditions and the location of the municipal well field adjacent to the Dickson County Landfill require a clear understanding of the geologic conditions of the area in the event groundwater is relied upon as a potable water source. Investigations performed by the USGS indicate those wells installed in conduits up to approximately 20 feet in height, produce the most water.

Information in this report indicates that portions of the landfill are unlined and industrial wastes including solvents were disposed of in the landfill. Recent investigations at the landfill confirm that the landfill is a source that is contributing contaminants to the underlying groundwater. Therefore a well planned hydrogeologic investigation should be conducted at the Dickson County Landfill.

1.0 INTRODUCTION

This report has been prepared under provisions of Technical Direction Document (TDD) No. 4T-01-11-A-004, which the U.S. Environmental Protection Agency (EPA) assigned to the Tetra Tech EM Inc. (TtEMI) Superfund Assessment and Response Team (START). The overall scope of the TDD was to assist in preparing a reassessment report for the Dickson County Landfill that would summarize work performed to date regarding the potential sources of contaminants documented in private and public potable water supplies in Dickson, Dickson County, Tennessee.

1.1 BACKGROUND

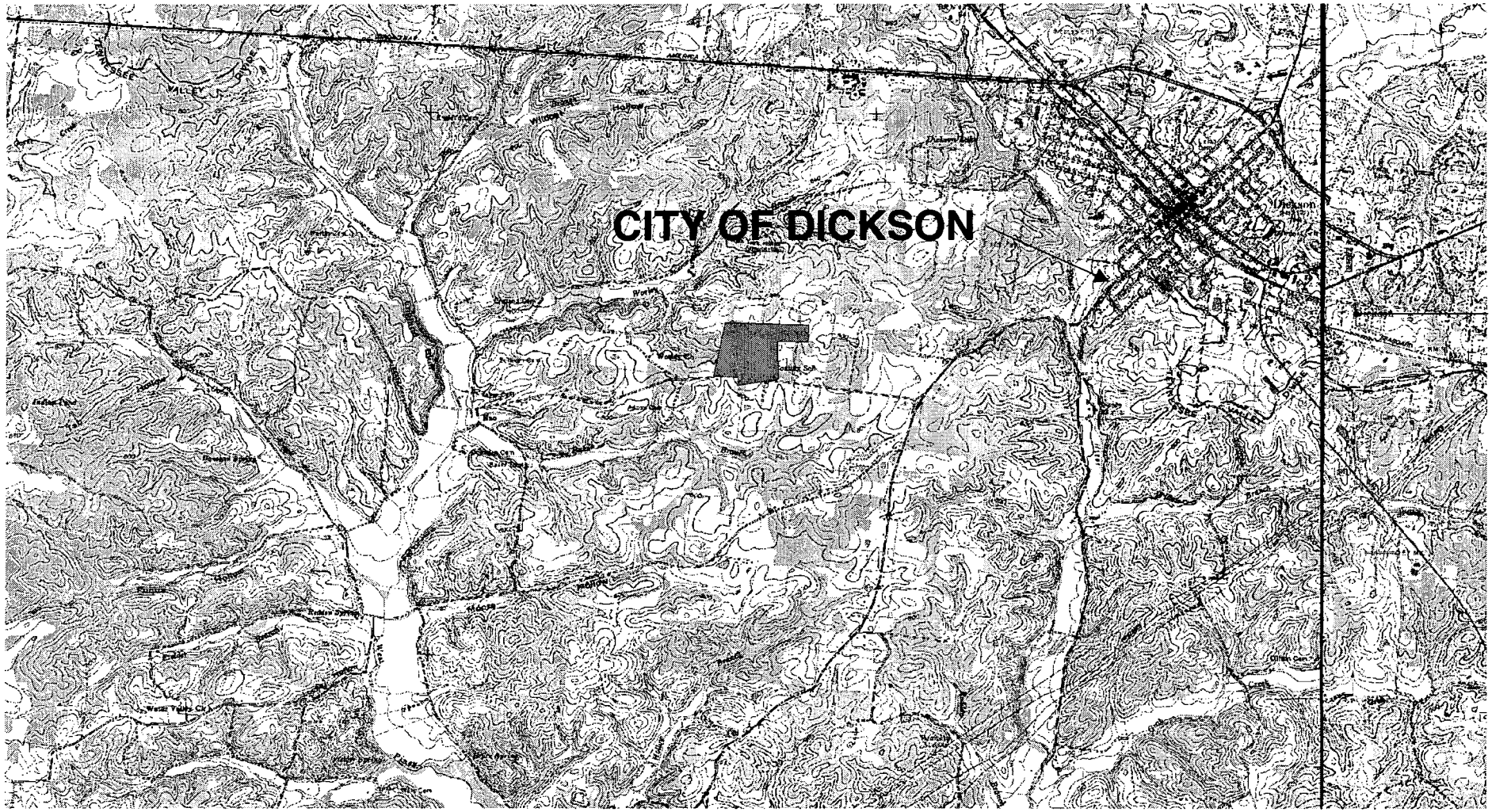
The City of Dickson and the surrounding area have been home to manufacturing facilities that conducted metal cleaning operations using various solvents, degreasers, and other volatile organic compounds (VOCs). Boat building, printing, and metal fabrication facilities have operated in Dickson County dating back at least to the 1960s. Some of these manufactures, particularly metal fabricators and printers, were known to have used trichloroethene (TCE), and at least one manufacturer is implementing corrective actions for a release of TCE to the soil and groundwater. Several of these facilities operated both permitted and unpermitted sites for the disposal of industrial wastes. The Tennessee Department of Environment and Conservation (TDEC) and EPA have completed investigations that identified several possible contaminant sources or areas, including the Dickson County Landfill and manufacturing facilities that may have contributed VOCs to the potable water supply. However, VOCS detected in the City of Dickson treated drinking water supply have not exceeded their EPA established maximum contaminant levels (MCL).

VOCs have been detected in private residential wells, as well as one spring, and one municipal water supply well (well DK-21) that has been used by the City of Dickson for its potable water supply. The results of groundwater sampling and analysis for private residential wells and springs indicated the presence of one or more VOCs, including trichloroethene (TCE) and cis-1, 2-dichloroethene (DCE) for a short period of time between December 9, 1996 and April 21, 1997. Potable water sampling by the City of Dickson has also indicated the presence of TCE in the public potable water distribution system on two occasions: February 24, 1997 at 1.3 parts per billion (PPB), and April 7, 1997 at 2.1 ppb which are below the EPA established MCL for TCE (5 ppb).

The Dickson County Landfill, which is located near impacted private wells, springs, and the municipal well field that includes well DK-21, has been identified as a potential source of these contaminants. The landfill property includes an active Class IV landfill, an active Subtitle D balefill, and areas considered closed that have not received wastes in recent years. These closed areas include the portions operated by the city and county, as illustrated on Figure 1. The city operated the landfill from 1968 to 1977, and the county assumed operations in 1977.

1.2 PURPOSE AND SCOPE

Based on investigative work performed by federal and state regulatory agencies, the known presence of contaminants in groundwater, and the possible increased occurrence of orofacial cleft cases, EPA is

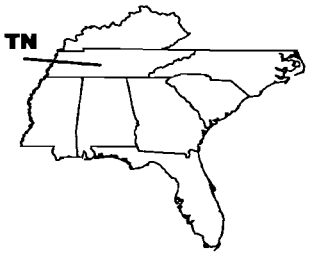


REF. USGS 7.5-MIN TOPOGRAPHIC MAP, DICKSON AND BURN, TENNESSEE QUADRANGLE, DATED 1956, PHOTOREVISED 1987

Note: All locations are considered to be approximate.

Legend

Landfill Boundary



0 2 Miles

U.S. ENVIRONMENTAL PROTECTION AGENCY

DICKSON COUNTY LANDFILL REASSESSMENT REPORT
DICKSON, DICKSON COUNTY, TENNESSEE
U.S. EPA ID No. TND981467673
EPA Contract No. 68-W-00-120
TDD No. 4T-01-11-A-004

FIGURE 1 - CITY OF DICKSON

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reevaluating industrial activities in the Dickson area and their effect on local water supplies. EPA requested that TtEMI assist by preparing the reassessment report and summarizing work performed to date.

The approved project approach was developed so that relevant facts from various regulatory agencies, knowledgeable individuals, and other sources could be combined into a single summary document. The major tasks associated with the TtEMI project included regulatory file reviews concerning the Dickson County Landfill and other industrial facilities in the Dickson area; interviews of persons knowledgeable of the water distribution system; interviews with TDEC officials; an assessment of available information regarding the occurrence of orofacial cleft birth defects; an evaluation of regulatory actions for assessment and corrective actions; a review of the area geology and hydrogeology; and an assessment of potential sources of contaminants in the public and private water supply.

This report presents the results for the reassessment activities conducted. Section 2.0 summarizes information on the environmental setting of Dickson County, including the area geology and hydrogeology, groundwater studies, surface water conditions, water use and supply, and operations of the public water system. Section 3.0 summarizes the Dickson County Landfill. Section 4.0 summarizes studies conducted concerning the occurrence of orofacial defects in the Dickson area. Section 5.0 summarizes the results of the regulatory file review, and Section 6.0 presents a summary and recommendations for further assessment. References are provided at the end of the report.

Also included in this document are three appendices and several attachments. Appendix A summarizes documents regarding the City of Dickson public water system; Appendix B provides a list of files reviewed and a chronology of events for the Dickson County Landfill; and Appendix C summarizes regulatory files reviewed for sites identified through TtEMI's regulatory database review.

2.0 DICKSON COUNTY ENVIRONMENTAL SETTING

The following sections summarize the environmental setting of Dickson County, Tennessee, including general information, published geology and hydrogeology information, information obtained from groundwater studies, information on surface water conditions, water use and supply, and water system operations.

2.1 GENERAL INFORMATION

Dickson County is located in the central part of Tennessee. Based on the Dickson, Tennessee USGS topographic quadrangle map, elevations within the county appear to range from 600 feet above mean sea level (amsl) along river and creeks to 900 feet amsl at ridge tops. The major surface water drainage feature in the county is the West Piney River, which flows south. The Tennessee Valley Divide, which is a local drainage divide, bisects the region. Surface drainage north of the divide generally flows north to northeast, while surface drainage to the south of the divide generally flows south.

2.2 PUBLISHED GEOLOGY AND HYDROGEOLOGY SUMMARY

TtEMI reviewed available geologic information to define the regional geology and hydrogeology.

Available sources included published information from the USGS, the TDEC DWS, and consultants. The sections below describe the area geology and hydrogeology. A copy of the USGS document, "Ground Water in the Dickson Area of the Western Highland Rim of Tennessee," is included in Attachment E.

2.2.1 Geologic Conditions

Dickson County and the surrounding area lie on the rolling plateau of the Western Highland Rim, a section of the Interior Low Plateau physiographic province (USGS 1984). The Dickson area also lies along the drainage divide below the Tennessee and Cumberland River Basins and is characterized by rolling terrain that has been cut by numerous streams.

Formations exposed on the northwestern Highland Rim in the Dickson area include, in descending order, the Tuscaloosa Gravel of the Cretaceous Period, and the St. Louis Limestone, the Warsaw Limestone, and the Fort Payne Formation of the Mississippian Period. According to the USGS, the regional dip of the formations is toward the northwest. Local structural features include lows to the southwest and northeast parts of the study area, separated by an east-west trending anticline under the City of Dickson (USGS 1984).

The Tuscaloosa Gravel consists of chert gravel, sand, silt, and clay. The chert gravel is composed of well-rounded fragments up to 6 inches in diameter derived from the Camden Chert of Devonian age or locally from the St. Louis, Warsaw, and Fort Payne Formations. Because of its isolated nature and limited distribution, the Tuscaloosa Gravel is not a significant source of groundwater (USGS 1984).

The St. Louis Limestone, which caps most of the uplands, is generally represented at land surface by a residual clay soil containing blocks and nodules of chert. The St. Louis formation is a yellowish-brown fine-grained cherty limestone that locally includes beds of medium- to coarse-grained fossil-fragmental silty limestone similar to the underlying Warsaw Limestone. The St. Louis regolith contains chert that is dark, very dense, and brittle, and in places is characterized by round chert "cannonballs." Regolith is the mantle of unconsolidated material that overlays the bedrock. The regolith in the uplands is generally 50 to more than 150 feet thick, and in the valleys of major streams, the regolith is less than 50 feet thick (USGS 1984).

The Warsaw Limestone is typically a thick-bedded, light colored, medium- to coarse-grained, fossil-fragmental limestone. In the Dickson area, it is approximately 100 feet thick. The sand-size fossil fragments were derived primarily from crinoids and bryozoans. Quartz and calcite are the main minerals present, but glauconite and pyrite occur locally in very small amounts. Locally, the Warsaw Limestone contains fine-grained, cherty beds that are typical of the underlying Fort Payne Formation. The Warsaw-Fort Payne contact is generally conformable with gradation and possible intertonguing occurs between the two formations (USGS 1984).

The Fort Payne Formation is typically a calcareous, dolomitic, very cherty siltstone. The maximum thickness in the Dickson area is approximately 250 feet. Chert occurs throughout the formation in distinct beds, as irregular discontinuous beds or nodules, and within the matrix of the limestone and dolomite. Small cavities (less than 2 inches in diameter) contain quartz or calcite. Gypsum occurs in the lower part

of the Fort Payne Formation, with glauconite and pyrite also occurring in small quantities. Some beds in the Fort Payne are medium- to coarse-grained, fossil fragmental limestone similar to the typical Warsaw Limestone (USGS 1984).

2.2.2 Hydrogeologic Conditions

Groundwater primarily occurs in the Warsaw Formation, which is characteristically reliant upon secondary permeability (fractures and joints in the bedrock) to produce varying amounts of groundwater discharge. The Fort Payne Formation is regarded as the base of the aquifer. The regolith thickness and lithology of the bedrock are the main factors influencing the development of high-yielding solution-enlarged bedrock openings. High-yielding openings are more likely to occur in areas where a thick regolith and fine-grained limestone is present at the top of bedrock (USGS 1984).

The St. Louis Limestone and the upper part of the Warsaw Formation have weathered to a clay regolith. The regolith has a low permeability but stores a large amount of water and slowly releases it to the solution openings in the underlying limestone. Springs in the area, except Payne Spring, discharge from the Warsaw Limestone Formation (USGS 1984).

A review of the geologic maps and documents indicates several springs in the Dickson area. The following springs were identified by the USGS as Grassy Spring, Walnut Grove Spring, Tide Spring, Payne Spring, Donegan Spring, Redden Spring, Bruce Spring, and Fielder Spring (USGS 1984).

TtEMI reviewed county information on well yields, groundwater elevations and groundwater flow directions from "Ground Water in the Dickson Area of the Western Highland Rim of Tennessee" (USGS 1984). Well yields in the county range from less than 1 gallon per minute (gpm) to approximately 100 gpm. Groundwater elevations in the county range from approximately 600 to 900 feet amsl. A groundwater drainage divide runs generally east to west through Dickson County. The highest groundwater elevations occur in the northwest portion of the county, north of the drainage divide. Groundwater flow north of the drainage divide is generally north to northeast, with minor components of flow to the south and west. Groundwater flow south of the drainage divide is generally south to southwest.

TtEMI obtained site-specific groundwater flow information from "Construction, Lithologic, and Water-level Data for Wells Near the Dickson County Landfill, Dickson County, Tennessee, 1995" (USGS 1996). Groundwater elevations at the site range from 750.04 to 800.17 feet amsl.

A recent on-site groundwater monitoring event took place at the landfill from March 31 through April 2, 2003. The water level data collected from the wells from around and on the landfill were used to develop potentiometric surface maps. The shallow groundwater potentiometric surface map indicates that groundwater flow is generally to the northwest; the deep groundwater potentiometric surface map indicates that groundwater flow is generally to the southwest. Groundwater elevations at the site ranged from 750.44 to 806.17 feet amsl.(ENSAFE 2003a).

2.3 GROUNDWATER STUDIES

TtEMI reviewed two reports by the USGS (USGS 1984, 1996) and one report by Griggs and Maloney (1994), consultant for the City of Dickson, on groundwater within the county. The reports are summarized below.

2.3.1 Groundwater in the Dickson Area of the Western Highland Rim of Tennessee- 1984 USGS Study

The USGS installed 26 wells in the Dickson area in the 1980s. The wells, identified as DK1 through DK26, were installed in cooperation with the City of Dickson and the Tennessee Division of Water Resources as Phase 2 of a groundwater evaluation of the area. Phase 1 described the groundwater hydrology, and Phase 3 evaluated the quantity and quality of groundwater in the study area of Dickson County. According to the well logs, the depths of the 26 wells ranged from 21 to 400 feet, and the observed regolith thickness ranged from 4 feet in the valleys to 331 feet in the uplands. The wells were drilled west of the City of Dickson and east of the Dickson Landfill (USGS 1984).

As part of Phase 3, the USGS performed pumping tests on 10 of the 26 wells to determine well yield characteristics. Test data for the wells indicated that well DK-21 had a specific capacity of 12.7 gallons per minute per foot [(gal/min)/ft] of drawdown compared to the average specific capacity of 4.1 (gal/min)/ft; thus well DK-21 is able to transmit water more readily than the other wells. Additional pumping tests were performed by the USGS on wells DK-17 and DK-21 in 1980 and 1981. The pumping test for well DK-17, pumped at a rate between 140 and 150 gal/min, indicated a drawdown of up to 75 feet in a well located approximately 200 feet from well DK-17; the total distance of influence (where at least some amount of drawdown was recorded at 10 feet) was at least 850 feet from the pumping well (USGS 1984).

The pumping test for well DK-21, pumped at 350 gal/min, indicated a drawdown response (20.52 feet) at least 552 feet from the pumping well. Well DK-21 reportedly intersects a 17-foot-high solution-enlarged, water-bearing zone in the bedrock that is reported to be 4 feet thick at a well 330 feet away. Wells that are poorly connected to well DK-21 are believed to intersect thin water-bearing fractures in the bedrock (USGS 1984).

2.3.2 1996 USGS Study

A USGS study was conducted in 1995 in cooperation with the Dickson County Solid Waste Management authority to determine local groundwater altitudes and determine if the spring located northwest of the landfill is hydraulically downgradient of the Dickson County Landfill. Five monitoring wells (MW-6 through MW-10) were installed at the northwest corner of the landfill at points between the landfill and Sullivan Spring (USGS 1996).

The following summarizes the activities and findings of the USGS study (USGS 1996):

- Two wells were screened in the first water-bearing zone in the regolith (wells MW-7 and MW-9

of the on-site monitoring system) to a depth of 103 and 84 feet below ground surface (bgs), respectively.

- Three wells (MW-6, MW-8, and MW-10), were screened in a water-bearing zone in the bedrock and had total depths of 183, 174, and 162 feet bgs, respectively.

- According to the well records from the USGS study, the surface casing in MW-6 was not sealed at the bedrock-soil interface to the ground surface.

- The water-bearing intervals for wells MW-6 and MW-10 were undetermined, and the yields were less than or equal to 1 gpm.

- Fine-grained limestone was the uppermost bedrock unit at each bedrock well location.

- The spring located northwest of the landfill, was determined to be at a lower altitude than and hydraulically downgradient of the water-level altitudes of the landfill monitoring wells.

- Groundwater levels in the eastern portion of the study area were higher than those in the western portion (USGS 1996).

2.3.3 Groundwater Quality Assessment Plan-Griggs and Maloney

Griggs and Maloney completed a Groundwater Quality Assessment Plan of the Dickson County Landfill for the City of Dickson in November 1994. The document included information on the regional geology and hydrogeology of the Dickson area, as well as more specific information related to the Dickson County Landfill and the spring located to the northwest. A copy of the report is provided as Attachment F.

2.3.3.1 Regional Information

The groundwater system in the Dickson area is primarily recharged from precipitation in the uplands where the regolith is thick. Recharge enters the regolith, which stores the water and transmits it slowly downward to points where it can enter the bedrock system or flow along the bedrock-residuum contact. Groundwater flow within the regolith may be discontinuous across the site and controlled by the presence of pinnacles, regolith thickness, or variable rates of recharge to solution openings in bedrock. Although the regolith stores large quantities of water, in most cases it will yield little water due to the low permeability of the clay (Griggs & Maloney 1994).

The groundwater quality assessment plan included a regional water level contour map, which indicated water levels in the Dickson area based on 1960 measurements in wells and springs. Based on TtEMI's review of the regional water level contour map, it appears that groundwater flow patterns are similar to surface flow patterns, as groundwater generally flows from the uplands toward the valleys. In the valleys, groundwater is discharged at springs or seeps. Based on the map, the general groundwater flow in Dickson County is west-southwesterly.

2.3.3.2 Dickson County Landfill Information

Existing monitoring wells at the landfill are screened immediately above the bedrock surface and show widely varying water levels, and 2 of the 10 wells are periodically dry. The direction of groundwater flow cannot be determined based on information from the existing wells (Griggs & Maloney 1994).

Based on the thickness of regolith, the primary aquifer beneath the landfill should occur in solution-enlarged openings in the Warsaw Limestone. When test wells were drilled into the Warsaw Limestone in the Dickson area, solution openings were noted ranging from less than 1 foot to more than 40 feet thick. In general, the smaller openings were clean, water-bearing zones, while the larger openings were partially or completely filled with clay. Solution openings that occurred below fine-grained "cap rock" near the top of bedrock were more likely to yield large amounts of water. The size and number of the solution openings decreased with depth (Griggs & Maloney 1994).

Sullivan Spring appears to be recharged from the Warsaw Limestone, which outcrops along the valley wall of Worley Furnace Branch. The bedrock solution openings that recharge this spring would most likely be at altitudes above or equal to the altitude at the spring. Surface water from landfill drains primarily to the southwest, west, and northwest toward Worley Furnace Branch and its tributaries, including the spring. Worley Furnace Branch is located approximately 0.3 mile north-northwest of the landfill. The altitude of the spring is near the 720-foot elevation. The spring appears to issue from the limestone bedrock that outcrops along the valley wall of Worley Furnace Branch (Griggs & Maloney 1994).

The regolith in the uplands of the Dickson area is generally from 50 to more than 150 feet thick. A comparison of depths to bedrock for residential wells and test wells in the area near the landfill found the actual regolith thickness to be highly variable within short distances, which indicates that the bedrock surface is likely pinnacled. One test well drilled at the southeastern corner of the landfill was drilled to 331 feet before bedrock was encountered. The top of the Warsaw Limestone was estimated to be near the 740-foot contour in the area of the landfill. This would place the top of the Warsaw Limestone at about 60 to 130 feet beneath the landfill site. Locally, the upper part of the Warsaw may be weathered to clay regolith at some locations in the landfill vicinity. The unit is approximately 100 feet thick in the area. The Fort Payne Formation is typically a calcareous, dolomitic, very cherty siltstone. It is estimated to have a maximum thickness of approximately 250 feet in the Dickson area (Griggs & Maloney 1994).

2.4 SURFACE WATER CONDITIONS

Surface water in Dickson County includes lakes, ponds, springs and rivers. The area surface water drains primarily to the southwest, west, and northwest. Large tributary streams of the Piney River enter the main stream at nearly right angles, suggesting a fracture origin for the stream bed. Fractures along the regional surface water divide are not easily observed due to the lack of stream incision and the masking of fracture patterns by a thick residuum overburden (IT Group 2001).

2.5 WATER USE AND SUPPLY

The primary aquifer and the source of drinking water in the Dickson area occurs in the solutionally-enlarged fractures and bedding plane openings in the St. Louis and Warsaw Limestones. Most wells in the area are screened in the Warsaw Limestone, and, with one exception, all springs recharge from the Warsaw. The dense cherty Fort Payne Formation is generally an underlying confining layer, but does yield water in some wells (Griggs & Maloney 1994).

Potable water supplies in Dickson County are obtained from surface water or bedrock wells through either public utilities or private wells. Five public utilities were identified, including the Harpeth Utility District, Harpeth/Charlotte Water District, Dickson Water District, Turnbill/White Bluff Utility District, and the Sylvia-Tennessee City Utility District. The following summarizes information obtained by TtEMI from the TDEC DWS, which regulates drinking water supplies.

2.5.1 Division of Water Supply Database

TtEMI reviewed and summarized information regarding public and private water wells identified by the TDEC DWS for the Dickson Quadrangle, in which the landfill and well DK-21 are located. The USGS Dickson, Tennessee, topographic quadrangle map includes wells registered with the DWS by the responsible installer or owner. The list may not be complete for the area given that some owners or installers may not have registered their wells. Wells were required to be registered by the driller as of 1963 (USGS 1984). The database obtained from the TDEC DWS in April 2001, sorted by well use, is included as Attachment G. The estimated well locations, plotted by latitude and longitude coordinates provided within the database are shown on Figure 2.

An analysis of the DWS data by 5-year periods indicates that 17 percent of the wells (58 of 334) included on the list were logged since 1995. The data indicated that 282 (84%) of the registered wells were greater than 100 feet deep and that 52 wells (16%) were 100 feet or less.

2.5.2 Private Groundwater Wells

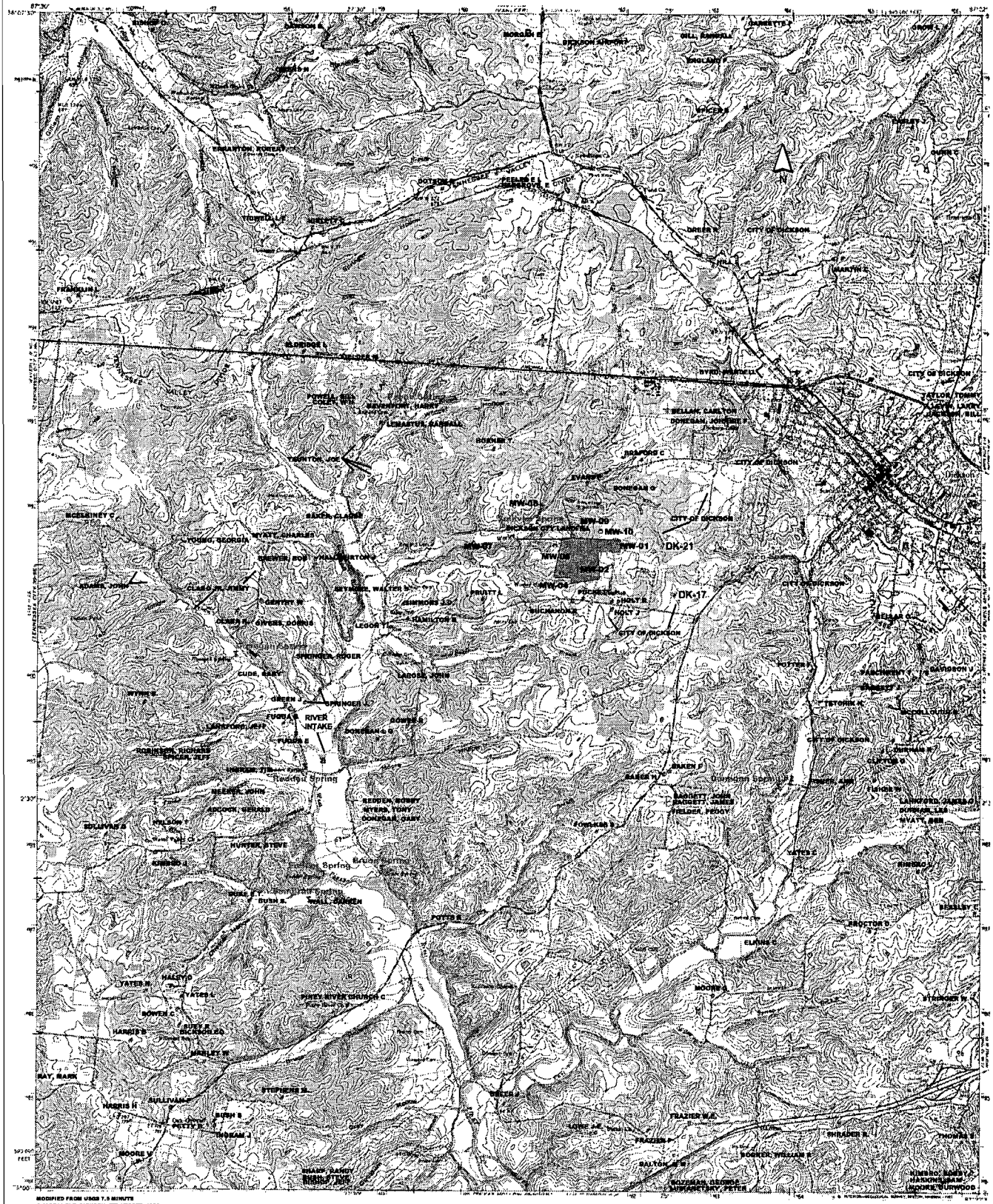
A review of the DWS database indicated that 274 (82%) of the 334 registered wells on the Dickson Quadrangle were reportedly used for residential purposes.

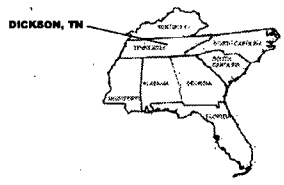
2.5.3 Commercial Groundwater Wells

The DWS database included one well listed for commercial use. The owner for the well was listed as the Mt. Sinai Community.

2.5.4 Irrigation Wells

Private individuals, the Dickson County Landfill, and the Goodlark Hospital were listed as owners of seven irrigation wells. It is assumed that the irrigation wells are primarily used for agricultural purposes and landscaping maintenance.





LEGEND

- Vital wells.shp
- Monitoring Wells
- Springs

Dickson County Wells

- 2001 - 1992
- 1991 - 1982
- Pre 1982
- Landfill Boundary

0.3 0 0.3 Miles

U.S. ENVIRONMENTAL PROTECTION AGENCY

DICKSON COUNTY LANDFILL REASSESSMENT REPORT
DICKSON, DICKSON COUNTY, TENNESSEE
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FIGURE 2 - WATER SUPPLY WELLS - DICKSON QUADRANGLE

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2.5.5 Municipal Wells

Eighteen wells were listed for municipal use. The City of Dickson, Dickson County, and the Dickson County Airport were listed as owners of the municipal wells.

2.5.6 Miscellaneous Listing

Three wells owned by the City of Dickson were listed as used for "other" purposes, and two additional wells did not note a use. The Tanbark Campground located on Highway 48 South was also listed as an owner of a well, with no purpose indicated.

2.6 PUBLIC WATER SYSTEM OPERATION

TtEMI reviewed and summarized information in DWS files to obtain information about the City of Dickson public water system. TtEMI also reviewed the wellhead protection plan developed by the City of Dickson, which is included in this report as Attachment H. The purpose of the review was to identify the location of public water supply wells and springs, determine well construction specifics, locate potential contaminant sources, estimate groundwater flow patterns under pumping and baseline conditions, and estimate well pumping rates and the zones of influence. City of Dickson officials were interviewed to discuss the City of Dickson water supply and distribution system. Interviews were also conducted with former and current City of Dickson public works officials and a representative from their consultant, James C. Haley & Co. Consulting Engineers to discuss the City of Dickson water supply and distribution system. The DWS files for the City of Dickson were reviewed at the NEAC and the TDEC Central Office. The documents that pertain to the City of Dickson public water system are summarized in Appendix A.

The following summarizes significant operational information regarding the City of Dickson public water supply system:

- A hydrologic study of the Dickson area was performed by the USGS in the early 1980s, in cooperation with the City of Dickson and the TDEC Division of Water Resources. Twenty-six wells were drilled in the area to identify potential sources of water to supplement existing sources. Eight wells yielded more than 100 gpm. Aquifer tests were conducted on wells DK-17 and DK-21 (USGS 1984)

- City Lake was reportedly used as a primary source of water from November to May each year (TtEMI 2001b). Well DK-21 was formerly used to supplement that source from November to May, and water from the well was mixed with raw water from City Lake (TtEMI 2001b). Mixed, the lake supply was 0.90 million gallons per day (MGD) and DK-21 supplied 0.25 MGD (City of Dickson Water Department 1992, Attachment I). However, as of 2003, City Lake is no longer used as a potable water source by the City of Dickson Water Department (TtEMI 2003a). Well DK-21 was used from 1984, its date of installation, until April 1997, when sampling indicated the presence of TCE in the well. According to a city official, the well

was turned off on April 18, 1997, after TCE was detected during sampling events in December 1996, February 1997, and April 1997 (TtEMI 2001d). The city stopped using the well that April and acquired an aeration system as required by the state. From April 1997, to March 2000, while the well was shut down, ground water tests were conducted regularly, according to City of Dickson and state records. From the period of 1998 through the fall of 1999, ground water samples were collected from well DK-21, and no VOCs were detected. In March 2000, the well was turned back on as a supplemental water source, with the new aeration system operational. However, the pump failed after 13 days. Although there were not any ground water samples collected during that time the well was operating, ground water samples collected from the well shortly thereafter, did not reveal any VOCs (The Dickson Herald 2003 a). The well was turned off at the request of the DWS upon its review of the monthly monitoring report (TtEMI 2001c, TDEC 2000, Attachment J). Well DK-17 reportedly produced large quantities of sand that caused pump shaft bearing failures, which led to terminating its use in approximately 1989 (City of Dickson, Water Department 1992).

- The city has supplemented supply by obtaining water from the Turnbull Utility District, and began purchasing approximately 250,000 gpd from Turnbull Utility District in 1964. Although the city paid for the water, it did not actually start receiving water until 1978, after which the city used the source when the water demand increased and when filters at the city water plant were repaired. The Turnbull Utility District can reportedly supply up to 1.0 MGD on a continuous basis (City of Dickson, Water Department 1992).

- The West Piney River surface water intake was brought on-line in 1986, and most of the river flow at the intake point, which is located at the confluence of the East and West Piney Rivers, is due to spring discharges along the rivers. The Piney River intake pump capacity was reported as 2.1 MGD with a safe yield of 4.4 MGD (City of Dickson, Water Department 1992).

- The city sold treated water to the West Piney Utility District located south of the city (3.5 MG per month) and to the Sylvia-Tennessee City-Pond Utility District northwest of the city (5.0 MG per month). Other county utility districts supplying water to county residents included the Harpeth Utility District (serving Charlotte and Northeast Dickson County by spring and water supplied by the Turnbull Utility District); the White Bluff Utility District (serving White Bluff and areas north of town with water purchased from Turnbull), and the Town of Vanleer (serving Vanleer and areas nearby from a spring with lines linked to Sylvia-Tennessee City-Pond Utility District for emergency supply). The City of Dickson purchased the West Piney Utility District in 1998. In addition, the city currently provides potable water to the Harpeth Utility District. As a result, water produced by the city is distributed throughout most of Dickson County (City of Dickson, Water Department 1992).

- The wellhead protection plan reviewed by TtEMI identified three wells as being used as potable water supplies for the City of Dickson. These wells are DK-21 located northeast of

the Dickson County Landfill, DK-17 located southeast of the landfill, and well DK-1 located at the Water Treatment Plant. Potential contaminant sources that were identified in the plan consisted of the landfill, the Brannon Trailer Park to the east, a sludge-spreading site located between the landfill and well DK-21, and urbanized residential and commercial areas to the north (City of Dickson, Water Department 1996). However, well DK-17 was turned off in approximately 1989 due to pump failures (City of Dickson Water Department 1992). In addition, well DK-21 was turned off on April 18, 1997 after TCE was detected during sampling events in December 1996, February 1997, and April 1997 (TtEMI 2001 d).

- In a June 7, 2001 meeting with TtEMI, City of Dickson officials and their consultants discussed operational plans for the municipal water system. Specific portions of the proposed plans include the following (TtEMI 2001b):

  The city did not expect to use City Lake as a water source until a 4.0 MGD upgrade of the existing treatment plant was completed. Water from the lake is reportedly high in iron and manganese and is difficult to treat without dilution. Previously, when well DK-21 was operational, water from the well was used to dilute the water obtained from City Lake.

  The city had installed a well near the West Piney River intake and was considering using the well as a raw water source.

  The city considered using well DK-15, located southeast of the landfill, as a potable water source. The well is reportedly installed in a sand aquifer.

  The city considered joining other utility districts in developing a new utility district to obtain raw water from the Cumberland River, located along the northern portion of the county.

As of December 2003, the city had joined with other utility districts in developing a new utility district (Water Authority of Dickson County [WADC]) which is operating a state-of-the-art water plant on the Cumberland River in northern Dickson County (The Dickson Herald 2003 b).

2.6.1 Public Water System Treatment

The following section is based primarily on verbal information provided to TtEMI through interviews and meetings. According to the information, the City of Dickson water treatment plant was upgraded in 1986 with the addition of two filters. The total filtration capacity prior to the upgrade was 1,400 GPM. In 1999, the city installed an aerator to provide the capability to treat TCE-contaminated water from well DK-21.

Recent information collected from the TDEC file indicates that the city provides approximately 2 MGD to city and county residences. Currently, the plant is reportedly operating near the 2.0 MGD design capacity. The water treatment plant is classified as "Water Treatment –4" by the TDEC based on the design capacity, the nature of the raw water, the treatment operations, chemical feed operations, and laboratory practices (TDEC 2001). The city applied for and received approval from the TDEC on April 14, 1999, to expand the water plant to 4 MGD, upgrade the West Piney River intake to 4.0 MGD, and develop an additional well supply (TDEC 1999). The current, pre-expansion design filter rate is 4.0 GPM per square foot, with an anticipated increase to 6.0 GPM per square foot. The filter rate was approved during repair periods in 1996 and 1997 to operate at up to 6.0 gallons per minute (GPM) even though its design capacity was 4.0. The facility uses chlorine to disinfect the raw water; as a result, trihalomethanes (THMs) are produced and monitored at perimeter locations in the system.

The treatment processes include chemical feed to initiate flocculation, and a coagulation chamber, sedimentation basins, and sand filtration. When well DK-21 was used, the raw water was passed through a draft-induced aerator before chemicals were added for flocculation. The TDEC DWS approved the aerator for installation in October 1998 (TDEC 1998); prior to that, the system had no treatment capability designed to remove VOCs from the water supply. Disinfection with chlorine gas was the last process before the treated water entered the distribution system. The aerator was reportedly tested for a 2-week period in March 2000 when well DK-21 was pumped continuously 24 hours a day. This is reportedly the last time well DK-21 was used by the city for a water source. City representatives stated that no analytical testing was performed on the raw water obtained from the well, nor were samples collected to indicate the ability of the treatment system to remove TCE or other VOCs (TtEMIc; TtEMId; TDEC 2000).

2.6.2 Public Water System Sampling

The City of Dickson Water Utility has routinely collected and analyzed for VOCs or other parameters during the operation. The following summarizes available information and analytical results for samples collected.

2.6.2.1 Well Sampling

Analytical data for various well points and locations throughout Dickson County were obtained from the TDEC DWS for sampling events occurring in 1994 and 1996 to 2001. Copies of data are included in Attachment K. Analytical results for raw water from City Lake and well DK-21 were obtained for the period April 1997 to May 2001. TCE was detected at 0.032 milligrams per liter (mg/L) in well DK-21 on April 21, 1997, and methyl ethyl ketone was detected at 18 micrograms per liter (µg/L) on October 9, 2000. No information was available for other wells and water supply sources (DK-1, DK-17, West Piney River).

2.6.2.2 Treated Water Sampling

Analytical results were obtained for groundwater samples collected in 1996 through 2000. A finished water sample (treated and entering the distribution system) collected on February 24, 1997, indicated the presence of TCE at 0.0013 mg/L. Analysis of a sample identified as City Lake "A," collected on April 7, 1997, detected TCE at 0.0021 mg/L. Both of these concentrations are below the EPA established MCL for TCE. The EPA MCL for TCE is 0.005 mg/L. Because groundwater flow patterns in the vicinity of the landfill were not fully defined, the potential source or sources for the contamination could not be determined or identified.

3.0 DICKSON COUNTY LANDFILL

The Dickson County Landfill consists of approximately 74 acres off Eno Road, 1.5 miles southwest of the City of Dickson, Dickson County, Tennessee. The landfill is described as containing four parts, the City of Dickson Landfill, the County Landfill Expansion, and the Balefill; which are all now closed (see Figure 1). The Balefill was a portion of the landfill that disposed of solid waste that was compressed or bound. The fourth part consists of a construction debris section and is currently active. The City of Dickson Landfill consists of approximately 5 acres located on the eastern portion of the landfill and was operational from 1968 to 1977. The County Landfill initially started as a 41.6-acre expansion to the original City of Dickson Landfill, of which 28.6 acres was to be used for waste disposal. The expansion occurred after the county purchased the original City of Dickson Landfill, as well as 45 additional acres in 1977. The balefill was established as part of the 1987 expansion.

According to a site description in an EPA site inspection report (SIR), the entire landfill property includes a steep hill at the northern end of the property that slopes to a perimeter road and a pond. The property slopes gently toward the southern end of the landfill, and a drainage ditch is constructed through the eastern portion of the landfill. The drainage ditch was constructed by the U. S. Department of Agriculture (USDA) Soil Conservation Service (SCS) to control erosion of cover soil. The north end of the property includes a small wetland area and pond. A retention pond located on the western edge of the landfill drains into an unnamed creek west of the landfill and feeds into Worley Furnace Creek (Haliburton 1991).

The landfill has been identified by the TDEC and EPA as a potential source of TCE in groundwater because of its location relative to impacted springs and groundwater supply wells. As part of this investigation, TtEMI reviewed available information regarding the landfill, including construction and operational data, results of environmental investigations, and information from dye trace studies and groundwater sampling conducted at the site. The following describes the landfill, summarizes investigations, and presents a regulatory timeline of significant events associated with the landfill. A full listing of the files reviewed and chronology of events is included in Appendix B.

3.1 CONSTRUCTION, OPERATION AND HISTORY, AND ACCEPTED WASTE STREAMS

The following summarizes available information on the construction and operation of the landfill.

3.1.1 Construction

The landfill is situated at an approximate elevation of 840 feet amsl, with topography within the area ranging from 700 to 900 feet amsl. The City of Dickson Landfill was originally a dumpsite starting in 1968, prior to the development of Solid Waste Regulations. Construction details for the City of Dickson Landfill and county-operated landfill were not available. However, an environmental assessment plan prepared by Gresham, Smith and Partners references the original 5- and 45-acre portions of the landfill as unlined. No information was available on construction of the balefill, a portion of the landfill that disposed of solid waste that was compressed or bound.

The 1991 EPA SIR for the landfill indicated that runoff collected in a pond at the northern end of the property. Runoff was reported as flowing from the property through the drainage ditch and a small potential wetland at the southern end of the landfill.

In 1987, the SCS designed and supervised the construction of a sediment basin located in a drain below the Dickson County Landfill. The sediment basin was designed to drain the Dickson County Landfill and the 1987 expansion of the landfill.

3.1.2 Operation and History

Information collected from the TDEC file indicates that the landfill property first operated as a formal city dump in 1968. The initial area of filling was in the southeast portion of the property, as illustrated on Figure 1. The landfill operated as an unregulated disposal area until 1972, when the state accepted its construction and operation plan (Dynamac 1992).

The approximately 5-acre landfill was originally operated by the county and owned and used by the city until it reached capacity in 1977 and was closed. The county purchased the landfill property and an additional 45 acres in 1977 to continue using the facility as a sanitary landfill. After the sanitary landfill was opened, the landfill reportedly accepted only domestic wastes and industrial wastes permitted by the TDEC Division of Solid Waste Management (DSWM).

In 1987, the county considered expansion plans for the landfill. The TDEC approved the request for the expansion in October 1987. The approval included a requirement for sampling of wells for pH, specific conductance, total organic carbon (TOC), nitrate nitrogen, chloride, lead, chromium (total), cadmium, iron, and manganese.

In 1988, the TDEC issued a permit to Dickson County for the operation of a sanitary landfill. The general terms of the operation of the sanitary landfill included the following:

- No liquids, industrial special wastes or wastes requiring special handling shall be accepted at the facility unless prior approval for each individual waste is obtained from the Division of Solid Waste Management.

- Groundwater monitoring shall be conducted at the frequency and for the parameters specified by the Division of Waste Management. The location of groundwater monitoring wells shall be approved by a Division geologist.

- No hazardous waste, as regulated by the Tennessee Hazardous Waste Management Act and the Rules adopted pursuant to that Act, shall be accepted at the facility.

In 1988 and 1990, a balefill permit was granted, and the fill area was operated until October 1996 (Griggs & Maloney 1996). The county submitted a revised closure and post-closure plan to the TDEC in June 30, 1997, describing the anticipated closure and post-closure care activities for the balefill. The balefill was reported by county officials to have been capped beginning in the summer of 1997, with borrow soils obtained from an adjacent property to the east. According to 1992 plans, the landfill and the balefill operations consisted of approximately 14 acres of the site.

3.1.3 Accepted Waste

Waste identified as being accepted and disposed of at the landfill included industrial waste such as solvents and paint residues, special wastes, and domestic wastes. Information gathered from the landfill operations manual prepared in 1988 indicate that disposal volume was approximately 1,572 tons per week and that the filling was initially done in trenches, with three additional lifts added. The following summarizes available information regarding materials disposed of at the landfill. No information was available on wastes received when the property was used as a city dump.

Industrial Wastes, Solvents and Paints: According to a potential hazardous waste site preliminary assessment, the Ebbtide Corporation (Ebbtide) located in the area reportedly disposed of trailer loads of drums containing industrial wastes. According to the report, Ebbtide disposed of drummed wastes every week for 3 to 4 years (Dynamac 1992). The contents of the drums were suspected to be spent solvents used to harden fiberglass.

Special Waste-State Supervised-Cleanup: According to the Tennessee potential hazardous waste site preliminary assessment and the review of TDEC files, Ebbtide removed material from an on-site dump and transferred it to the Dickson County Landfill for disposal (Black & Veatch 1994). Additional information obtained from files specific to Ebbtide is included in Appendix B.

Schrader Automotive Group (Schrader) also reportedly disposed of drums containing waste solids used to degrease automotive parts and wastes generated from a state-enforced cleanup at the facility. (Haliburton 1991)

In 1988, the Tennessee Department of Health and the Environment (TDHE) approved the disposal of 275 to 300 cubic yards of solid waste from the CSX White Bluff derailment cleanup (TDHE 1988).

In 1990, the TDHE approved the disposal of soil excavated during an underground storage tank (UST) removal at the National Convenience Store 1356 and Smith & Whitfield Phillips 66 on Highway 70 West. (TDHE 1990).

In 1990, the TDHE approved the disposal of waste powder coatings from the Tennsco Corporation. According to the material safety data sheets, the powder coatings were primarily calcium carbonate, titanium dioxide, and acrylic oligomer. The powder coating was used to coat various metal shelving and related items. According to the Special Waste Approval Form, the powder coating was generated when color changes were made. The estimated disposal was 50 to 100 pounds per month with up to 600 pounds per month being generated twice per year.

In 1991, the TDHE approved the disposal of waste material and filters generated from the paint line at Tennsco Plant and dried sludge from the White Bluff wastewater treatment facility.

3.1.4 Leachate Issues

Leachate outbreaks at the landfill have been identified as early as 1983 (Dynamac 1992). To date, several consultants (Gardiner Engineering, Gresham, Smith and Partners, Griggs and Maloney, and Ferguson Harbor) have assisted Dickson County in evaluating leachate problems and providing alternative treatment options. Analytical results are available for leachate samples collected during a 1991 EPA site inspection and on September 6, 1994. The leachate samples collected during the EPA site inspection identified zinc, potassium, magnesium, lead and aluminum and numerous unidentified extractable organics.

In 1992, Gardiner Engineering prepared a report discussing the specifications of the liner and leachate collection system at the balefill portion of the landfill. Limited information was available about the leachate systems. Maps indicated up to five leachate withdrawal wells were installed ranging from 4 inches to 16 inches in diameter.

An inspection by DSWM on December 17, 1993, identified numerous major and minor leachate seeps and flow on both the closed and active portions of the landfill. A notice of violation was issued on December 29, 1993, with required compliance by January 18, 1994. Follow-up inspections by the DSWM in March, April, and May 1994 indicated continued leachate and erosion problems at the landfill. The county submitted a remediation plan to address the leachate issues to the TDEC during a show-cause meeting in July 1994. The TDHE approved the plan for implementation.

In January 1996, Gresham, Smith and Partners, consultants for the landfill, conducted leachate treatment pilot tests to examine alternatives to the pump and haul method. The proposed approach for treating leachate included the use of a dual-phased extraction system to withdraw and aerate the leachate from leachate sumps and wells. The system would include ultraviolet treatment of the water and discharge to a constructed wetland area. According to the proposed approach, the system was expected to treat 14,000 gallons per day.

In March 1996, Ferguson-Harbor was contracted to perform a second treatability study. The response from the DSWM indicated full support of the proposed leachate system. In November 1996, the county requested additional time to comply with the DSWM requirement to terminate leachate outbreaks. In

June 1997, the DSWM provided a "formal request" inquiring about the status of the remedial activities to address the landfill leachate problems.

In August 1997, the proposed leachate treatment was revised by the county, which requested approval to conduct a pilot-scale wetland treatability study. In April 1998, the county received a notice of violation for discharge of leachate at one of the landfill outfalls (Outfall 003) without a permit. The violation also indicated a failure to implement and modify the facility's Stormwater Pollution Prevention Plan. The county was requested to provide an outline of the corrective actions to fully comply with the regulations.

The remedial approach for leachate collection and treatment was revised in March 1999 when plans were made to dispose of the leachate into the City of Dickson sewer system. In June 2000, an industrial user permit application was submitted to the City of Dickson sewer department requesting approval for leachate discharge into the sewer system. Documentation in the TDEC files includes correspondence with contractors concerning easement issue for the installation of the leachate system discharge line. Leachate is presently discharged into the city sewer system for treatment and discharge.

3.1.5 Notices and Violations

Available information indicates that the landfill received numerous unsatisfactory operational notices during 1983 and 1991. The results for solid waste management sanitary landfill evaluations conducted at the landfill are summarized in Attachment M.

Available information indicates that five notices of violation (NOV) have been issued to the Dickson County Landfill. The NOVs include the following:

Date	Notice of Violation
July 18, 1988	Inadequate daily cover.
September 9, 1994	Violation of Groundwater Protection Standards.
August 19, 1996	Inadequate daily cover.
October 14, 1996	Violation of Groundwater Protection Standards Cadmium detected in groundwater and springs at concentrations exceeding MCLs.
April 12, 1999	Violation for inadequate depth of cover and pooling of water on landfill cover.

3.2 ENVIRONMENTAL INVESTIGATIONS

During the operation of landfill, various environmental investigations were conducted to evaluate the geologic and hydrogeologic conditions related to construction and expansion of the landfill, required landfill monitoring as part of the solid waste permit, and potential sources of contamination in identified wells and springs adjacent to the landfill. The following summarizes available information on these investigations.

3.2.1 Landfill Expansion Investigations

The landfill has undergone three expansions since the city dump was originally approved as a landfill in 1972. The initial expansion was in 1977, when the county took over operations of the city-run landfill and added an additional 45 acres to the property. The next expansions were conducted in 1987 and 1992. The county has obtained assistance from several consultants (Law Engineering, ATEC Engineers, and Gardiner Engineering) in the investigations related to expansion projects.

As part of its initial geologic evaluation of the site for expansion, the TDHE reported, "most of the site appears suitable for use as a sanitary landfill" (TDEC 1975). The 1975 report recommended landfilling under the following conditions:

- No liquid wastes were to be disposed of.
- No cuts were to be made below 820 feet amsl until the possibility of perched groundwater was disproved.
- The maximum cut depth was not to exceed 20 feet due to an increase of chert content in the soil.
- Water wells within a 0.5-mile radius were to be sampled to determine background quality.
- Wastes were to be covered and compounded; drainage control was to be maintained; cuts were allowable to 800 feet amsl if no perched groundwater was present.
- A 20-foot soil buffer was to be maintained above any perched groundwater (TDEC 1975).

A geologic evaluation of the site was completed in 1987, when the county was considering expanding the landfill. The evaluation included the advancement of six borings using hollow-stem augers and mud-wash drilling techniques. The reports indicated groundwater at less than 50 feet bgs in all cases. Sand or gravelly chert was prevalent in all borings, and the borings were terminated prior to refusal on bedrock. A report summarizing the investigation stated that the first water-bearing zone was a perched zone that "could be from a large perched system over the site." The initial review by the DSWM concluded "the water levels at present rule out the use of this site for a landfill" unless further investigations distinguish between a perched system and "actual groundwater conditions." The SCS conducted a review of soil types and submitted information to the DSWM. In 1987, the TDHE approved the expansion of the landfill with restrictions.

In preparation for an additional expansion of the landfill (the proposed balefill), a geotechnical and hydrogeological investigation report was prepared by ATEC Associates. The landfill was proposed as a Class I balefill as defined by DSWM rules. The report discusses the results of six borings installed on a 35-acre site and concludes the following:

1. Soil was suitable as the landfill buffer zone.

2. The uppermost aquifer occurred within 20 to 50 feet of the Warsaw Limestone Formation.

3. Three existing wells on site were suitable to monitor the water moving through the overburden recharging the underlying bedrock.

4. Existing groundwater monitoring wells indicate an indefinable groundwater flow in the overburden.

5. Private well and stream monitoring points should be added to the monitoring scheme.

The report concluded that the site was suitable for expansion. No wells or borings advanced during the investigation penetrated into the bedrock (ATEC 1992). In 1990, the TDHE granted a permit for operation of the balefill, which has subsequently been closed and is no longer in operation.

3.2.2 Required Landfill Monitoring

The following summarizes available data on groundwater and other sampling required during the operation and closure of the landfill.

3.2.2.1 Groundwater Monitoring

In 1989, four monitoring wells (MW-1 through MW-4) were installed at the landfill. MW-1 is located at the northeast corner of the landfill, and MW-2, MW-3, and MW-4 are located along the southwest corner. In 1995, an additional five monitoring wells (MW-6, MW-7, MW-8, MW-9, and MW-10) were installed in the northwest corner of the property, topographically between the landfill and off-site springs. Of the five wells, three were installed to bedrock, and two were identified as "shallow".

According to a groundwater assessment plan, the site was using the existing 10 monitoring wells (MW-1, MW-1A, MW-2, MW-4, MW-6, MW-7, MW-8, MW-8A, MW-9, and MW-10), three private wells, two USGS wells (DK-9 and DK-21), and one spring located northwest of the landfill (Griggs & Maloney 1994). The additional wells were installed on the property as previously discussed in USGS investigations (DK-9 and DK-21) and other investigations. Monitoring well MW-8A was installed in 1997 for use in groundwater pumping tests at the landfill. No information is available on the installation of well MW-1A.

Sampling and analysis of the groundwater monitoring wells has been performed on a sporadic basis from 1989 to 2000. Groundwater samples were initially collected from wells MW-1, MW-2, MW-3, and MW-4; well MW-3 eventually was removed from the sampling scheme due to insufficient quantity of water. Additional monitoring wells were added to the sampling scheme as they were installed.

TDEC files regarding the landfill-related groundwater sampling and analysis included reports describing the results of sporadic sampling events and limited information on potentiometric groundwater surface diagrams. In 1994, the DSWM required the groundwater assessment and monitoring be completed, and in 1996, the DSWM requested that the county outline the steps to be taken to bring the landfill into compliance. In addition, the DSWM requested the following information:

TABLE 1
SUMMARY OF SAMPLING EVENTS FOR LANDFILL MONITORING

Date	Consultant	Wells Sampled	Constituents Analyzed		
			pH, Specific Conductance, TCL, TOC, Nitrates	Metals	VOCs
11/07/89	Gardner Engineering	MW-2 MW-4	Yes	No	No
10/18/90	Gardner Engineering	MW-1	Yes	No	No
11/24/90	Gardner Engineering	MW-1	Yes	No	No
02/08/90	Gardner Engineering	MW-2 MW-4 Donegan Spring	Yes	No	No
03/06/90	Gardner Engineering	MW-1	Yes	No	No
03/16/91	Gardner Engineering	MW-1 MW-2 MW-4	Yes	No	No
03/93 - First Semi-Annual Report for 1993	Gardner Engineering	MW-2 MW-4 Donegan Spring Sullivan Spring	Yes	No	No
03/94 - First Semi-Annual Report for 1994	Gardner Engineering	MW-2 MW-4 Donegan Spring Sullivan Spring	Yes	Yes	Yes
06/27/94	Gardner Engineering	MW-2 MW-4 Donegan Spring Sullivan Spring	No	Yes	Yes

TABLE 1 (Continued)
SUMMARY OF SAMPLING EVENTS FOR LANDFILL MONITORING

09/28/94	Gardner Engineering	MW-2 MW-4 Sullivan Spring	Yes	Yes	Yes
12/26/94	Gardner Engineering	MW-2 MW-4 Sullivan Spring	Yes	Yes	Yes
07/25-26/95	Griggs and Maloney	MW-1 MW-6 MW-7 MW-8 MW-9 MW-10	Yes	Yes	Yes
12/03/96	Griggs and Maloney	Sullivan Well	No	Yes	Yes
02/12,19/97	Griggs and Maloney	MW-2 MW-4 MW-6 MW-7 MW-8 MW-9 MW-10 Sullivan Well	No	Yes	Yes
05/14/97	Griggs and Maloney	Sullivan Spring	No	Yes	Yes
08/99	Gresham, Smith and Partners	MW-1a MW-2 MW-4 MW-6 MW-7 MW-8 MW-9 Sullivan Spring	No	Yes	Yes

TABLE 1 (Continued)
SUMMARY OF SAMPLING EVENTS FOR LANDFILL MONITORING

09/00	Gresham, Smith and Partners	MW-1a MW-2 MW-4 MW-6 MW-7 MW-8 MW-9 Sullivan Spring	No	Yes	Yes
March/April 2003	EnSafe	MW-1a MW-2 MW-4 MW-6 MW-7 MW-8 MW-9 MW-10 MW-DS MW-DD R. Holt Well H. Holt Well L. Holt Well Sullivan Spring	**	Yes	Yes

Notes: VOC = Volatile organic compounds
TCL = Target Compound List
TOC = Total Organic Carbon
** = pH, temperature, dissolved oxygen, specific conductance, oxidation-reduction potential, turbidity parameters were noted during sampling of each well

1 Submit a groundwater monitoring plan
2 Resume Appendix I monitoring
3. Inventory domestic water supply wells within a 1-mile radius of the landfill
4. Sample existing monitoring wells at the landfill and the spring located northwest of the landfill

The first sampling of the monitoring wells in 1996 for Appendix I parameters indicated cadmium at concentrations above the MCLs in all groundwater samples and the spring samples. Based on these results, the DSWM requested a revised monitoring program to include the following:

- Quarterly sampling for Appendix II constituents
- Corrective actions to be initiated within 90 days
- Sampling of wells MW-7, MW-8, and MW-9
- Construction details for wells MW-2 and MW-4

Well MW-1 was eliminated from the sampling because it did not provide adequate sample volume.

Evidence in the file indicates that the county and its consultant recognized shortcomings of the monitoring system in determining the groundwater quality and flow direction. The county consultant at the time, Gresham, Smith and Partners, concluded that two aquifers are present at the landfill: one at the top of the bedrock, and one within the bedrock (Gresham, Smith and Partners 2000b). For the Class I balefill, the report states, "it is unlikely that any of the monitoring wells are upgradient of waste." The report states for the Class IV landfill, "a background monitoring point has not been established." Monitoring well MW-6 continues to be used as a bedrock monitoring point even though the well casing is suspected of leaking water from the upper aquifer. The improper well casing can result in groundwater elevations being artificially high. Information also suggests that the on-site wells are not ideally situated in a triangular manner to determine the direction of groundwater flow.

On February 1, 2001, the City of Dickson and Dickson County were issued a Remedial Action Notice for the Dickson County Landfill by DSWM. The DSWM called for a phased approach to focus the investigation and satisfy the ultimate goals of 1) determining if the former landfill was a source of TCE and, 2) within reason, determining the extent of TCE in groundwater. The first phase was conducted during December 2001 and January 2002, and consisted of a fracture trace analysis in the general area of the landfill and a geophysical study in the area of the drainage ditch separating the former county landfill from the former city dump. The second phase was conducted during May and August 2002, and consisted of advancing seven soil borings at the most likely areas of solutionally enlarged features in the bedrock within the area of the drainage ditch. The soil borings were advanced to refusal and ranged in depth from 78 feet bgs to 307 feet bgs. Analysis of the soil cuttings from the boreholes revealed TCE concentrations ranging from 0.112 mg/kg (321 feet bgs) to 30 mg/kg (217 feet bgs) (EnSafeb). To evaluate the potential impact for VOCs on the groundwater beneath the landfill, a pair of monitoring wells were installed near the drainage ditch in the vicinity of the soil boring which had the soil cuttings with the highest TCE concentration (30 mg/kg). In December 2002, monitoring well (MW-DD) was installed to a depth of 325 feet bgs and completed with an 80 foot screened section. The second monitoring well (MW-DS) was installed to a depth of 150 feet bgs and completed with a 120 foot screened section (see Figures 4 and 5). After the completion and development of these wells, the entire screened section of each well was sampled at 20 foot intervals in April 2003 (EnSafe a). Table 1 summarizes the sampling conducted at the site.

3.2.2.2 Landfill Closure

The city dump landfill was closed in 1977. No information was available on the specifics of the closure activities. A closure/post-closure plan was prepared for the balefill in 1997. The balefill reportedly stopped operations in 1996. The closure plan approach included the following:

- Groundwater monitoring
- Quarterly methane gas monitoring

In June 1997, a closure and post-closure plan was prepared for the landfill and balefill operations. The plan reported that at the landfill's current operation rate, the site would have approximately 15 years of operation and a projected closure of 2011. However, the county discontinued operations of the Class I landfill in October 1996; it is continuing to operate the Class IV landfill. The plan divides the site into areas that received wastes before and after March 1990. The portion that was before 1990 was considered closed, although ponding of water and erosion were reported as problems. As a result, areas will be filled in and a vegetative cover established. The plan proposed closure in accordance with current Tennessee regulations for the post-1990 area of the site. Closure would include placement of a 30-millimeter geomembrane and placement of soil in 6-inch lifts, compacted to a dry density of at least 85 percent of maximum dry density, and the installation of gas vents. No additional information was available on the closure activities (Griggs & Mahoney 1997.

3.2.3 Evaluations of Landfill as a Source of Groundwater Contamination

In 1988, Ms. Ann Sullivan, a resident living near the landfill, requested that TDHE sample a spring on her property. There is no indication in the files of sampling; however, the spring was referenced as being contaminated during a 1988 public meeting on the expansion of the landfill. In 1988, several residents in the area requested sampling of springs and private water supplies. The TDHE sampled three water supplies in October 1988: Dale Donegan Spring, Harry Holt well, and Lavenia Holt well. TCE was detected only in the Harry Holt well.

The next available data for springs and private water supplies in the area is from 1994, when eight residences were sampled. The sampling and analysis of water from kitchen sinks did not indicate concentrations of TCE or DCE. The following summarizes available groundwater analytical results.

3.2.3.1 Spring and Groundwater Sampling

From 1988 through 2003, private springs and groundwater wells near the landfill were sampled by EPA, the TDHE, and landfill consultants. Table 2 lists the dates and the constituents analyzed for during the sampling activities. According to the data, TCE and DCE have been detected at four private well locations northwest and southeast of the landfill. Table 2 summarizes the analytical results for the private wells, and spring. The EPA (MCL is 5.0 µg/L for TCE, and 7.0 µg/L for 1,1-DCE and cis-1,2-DCE.

According to a 2001 environmental assessment plan (EAP), additional sampling of residential wells and springs was conducted in October and November 2000, and January and February 2001. The analytical

results were not provided in the report, but the text indicated that the Holt well located southeast of the landfill contained TCE in October and November 2000, and January 2001; the Sullivan spring located northwest of the landfill contained TCE in February 2001 (See Table 2) (EnSafe a).

R. Holt, Harry and Lavenia Holt Wells, and Donegan Spring Sampling: According to analytical reports from the TDHE laboratory, methylene chloride was detected in a 1988 sample of water from the Donegan Spring (0.003 µg/L) and the Lavenia Holt well (0.5 µg/L) located southeast of the landfill. The reports also indicate TCE was detected in the Harry Holt well southeast of the landfill at 3.5 µg/L. During a March/April 2003 sampling event around the landfill, the R. Holt, Harry Holt, and Lavenia Holt private wells were also sampled. The analytical results for the groundwater samples collected from the R. Holt private well revealed TCE at a concentration of 19 µg/L. In addition cis-1,2 DCE was detected at a concentration of 1.1 µg/L in the Harry Holt private well, and 1.4 µg/L in the R. Holt private well. Additionally, lead was detected at concentrations above the established MCL for lead in the Harry Holt, Lavenia Holt, and R. Holt private wells. None of these wells were being used as a potable water source during the 2003 sampling event (EnSafe a).

Sullivan Spring Sampling: In July 1988, Ms. Ann Sullivan, whose residence is located on Furnace Hollow Road topographically downgradient of the landfill, requested that the DSWM sample the spring on her property used for drinking water and cattle watering. No evidence of spring sampling was located in the TDEC files. However, the spring was sampled on six separate occasions between 1994 and 2000 and an additional four times in late 2000 and early 2001. Concentrations of TCE ranged from 18 to 230 µg/L, and DCE concentrations ranged from < 5 to 39 µg/L based on the 1994 to 2003 data. Because of the September 1994 sampling, TDHE sent a letter to the residents recommending they discontinue use of their spring as their drinking water supply. A new potable water supply was installed at the Sullivan residence. The graph following Table 2 presents historical TCE and DCE concentrations in Sullivan Spring.

TABLE 2
SUMMARY OF TCE AND DCE RESULTS, SPRINGS AND PRIVATE WATER SUPPLIES
DICKSON COUNTY, TENNESSEE

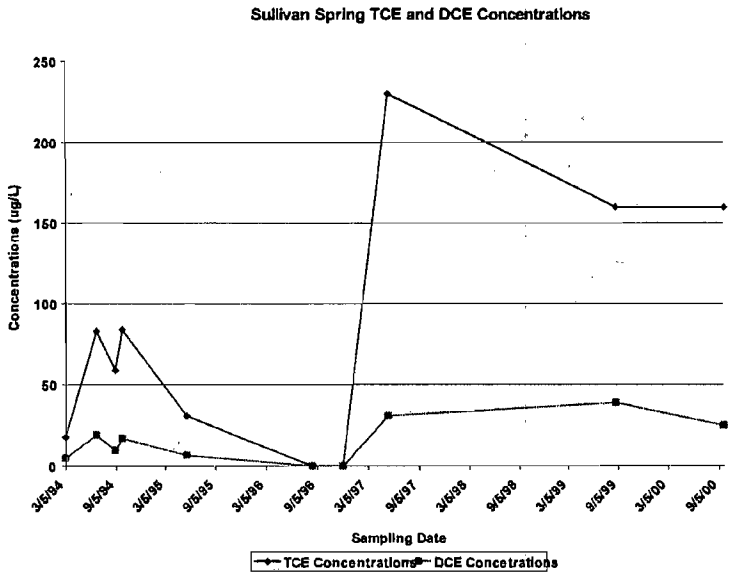
Residence/ Water Supply	Date	TCE (µ/L)	DCE (µ/L)
L. Gorley/ private well	October 25, 2000	0.6	BDL
L. Gorley/ private well	October 31, 2000	0.5J	BDL
H. Holt/private well	October 12, 1988	3.5	BDL
H. Holt/ private well	October 25, 1988	145.0	8.6
H. Holt/ private well	January 28, 1990	26.0	BDL
H. Holt/private well	August 17, 1990	3.9	BDL
H. Holt/ private well	August 23, 1991	3.7	BDL
H. Holt/private well	October 25, 2000	68.0	4.6
H. Holt/private well	January 2001	64.0	2.9
H. Holt/private well	October 2001	160.0	2.0
H. Holt/private well	May 2002	34.0	1.0
H. Holt/private well	April 2003	16.0	1.1
L. Holt/private well	October 25, 2000	0.2 J	BDL
L. Holt/private well	October 2001	BDL	BDL
L. Holt/private well	May 2002	BDL	BDL
L. Holt/private well	October 2002	BDL	BDL
L. Holt/private well	April 2003	BDL	BDL
R. Holt/private well	November 2000	5.0	BDL
R. Holt/private well	January 2001	8.0	BDL
R. Holt/private well	October 2001	3.0	2.2
R.Holt/private well	May 2002	2.0	BDL
R. Holt/private well	October 2002	2.0	BDL
R. Holt/private well	April 2003	9.0	1.4
Sullivan Spring	March 5, 1994	18.0	5.0
Sullivan Spring	June, 25, 1994	83.0	19.0
Sullivan Spring	September 1, 1994	59.0	9.8
Sullivan Spring	September 28, 1994	84.0	17.0
Sullivan Spring	May 22, 1995	31.0	6.8
Sullivan Spring	August 19, 1996	<5	<5
Sullivan Spring	December 3, 1996	<5	<5
Sullivan Spring	May 14, 1997	230.0	31.0
Sullivan Spring	August 26, 1999	160.0	39.0
Sullivan Spring	September 20, 2000	16.0	25.0
Sullivan Spring	May 2002	23.0	1.0
Sullivan Spring	November 2002	110.0	26.0
Sullivan Spring	April 2003	130.0	34.0

TABLE 2 (Continued)

SUMMARY OF TCE AND DCE RESULTS, SPRINGS AND PRIVATE WATER SUPPLIES
DICKSON COUNTY, TENNESSEE

Notes:

TCE = Trichloroethylene (5.0 µg/L EPA MCL)
DCE = Dichloroethene (7.0 µg/L EPA MCL)
µg/L = micrograms per liter
BDL = Below detection limit; laboratory reports no provided
J = Estimate value
< = Less than



Notes:

μg/L = micrograms per liter

3.2.3.2 Dickson County Landfill Dye Trace Summary

A dye trace was proposed by consultants to evaluate a possible hydraulic connection between the landfill and impacted springs. Proposals for dye trace studies associated with the Dickson County Landfill were submitted to the DSWM by Gresham, Smith and Partners in August 1997, and the USGS in December 1997. The proposal prepared by Gresham, Smith and Partners focused on providing a system for managing leachate at the Dickson County Landfill. The proposal stated that a previous study confirmed the presence of a large mound of leachate beneath older sections of the landfill and that the leachate posed a significant potential to impact groundwater and surface water resources (Gresham, Smith and Partners 1997a).

DSWM files included the results of the landfill trace performed by the USGS and Gresham, Smith and Partners. The landfill trace results were provided in Appendix B of the TCE investigation report prepared by Gresham, Smith and Partners on behalf of the county. The report stated that the background phase of the investigation was performed from December 2, 1997, to January 13, 1998. After the background phase was completed, cotton and coal dye detectors were placed at 25 sites in the landfill area. These sites included streams, springs, municipal wells, private wells, wetlands, and ponds. Three dyes were injected on January 13, 1998, and the test was concluded on September 29, 1998 (Gresham, Smith and Partners 2000a). The results of the landfill dye trace study are summarized below.

- The Executive Summary of the Appendix B indicated that DK-21 is upgradient of the landfill, although TtEMI could not find supporting data for this statement.

- Well DK-21 was apparently pumped intermittently during the first half of the study and not pumped during the second half. TtEMI was unable to identify pumping rates, drawdown or other information from the dye trace.

- A positive trace was declared for the optical brightener injection. The dye was reportedly identified in a monitoring well identified as well Di: F-91, located on the west side of the landfill.

- The report indicated that although negative tracer recovery does not conclusively disprove the lack of hydraulic connection between the dye-injection and dye-detection sites, none of the tracer tests provided evidence that the landfill is hydraulically connected to springs and well included in the study.

3.3 FEDERAL AND STATE INVESTIGATIONS

Complaints by local residents have prompted investigations of the landfill by EPA and the State of Tennessee. The following summarizes available information obtained concerning these federal and state investigations.

1986 EPA Preliminary Assessment

EPA completed a preliminary assessment (PA) of the site on January 17, 1986. The report described historical waste disposal practices, geologic conditions, water supplies, and populations served. The report noted that the Turnbull Utilities district sold potable water to the City of Dickson; the City of Dickson which had one active well and one in reserve, also utilized Dickson Lake (also known as City Lake) as a source; the West Piney Utilities served the area around the landfill with potable water. The West Piney Utilities district bought water directly from the City of Dickson. According to a representative of the West Piney Utilities, most of the water supplied to the West Piney Utility district came from Dickson Lake.

1991 Potential Hazardous Waste Site Preliminary Assessment

The 1991 preliminary assessment report was prepared to investigate alleged improper waste disposal at the Dickson County Landfill. Specifically cited in the report is the alleged acceptance of drummed wastes from Ebbtide Corporation, White Bluff, Tennessee. According to the report, the drum was suspected to contain solvents, and the drum "exploded" as an employee tried to remove a top from a drum. The preliminary assessment identified the potential for surface water, groundwater and soil contamination from the disposal of questionable wastes from Ebbtide Corporation.

1991 EPA Site Inspection Report

The 1991 site inspection was conducted to determine the nature of contaminants present and to determine if a release of site substances had occurred or may occur. The inspection also identified the possible pathways for contaminant migration, as well as the population and environment it would affect.

In summary, the inspection identified the following:

Wastes dumped by Ebbtide Corporation (Winner Boats) are known to have contained acetone and paint thinner.

Waste dumped by Schrader Automotive Group was thought to be a degreaser used to clean automotive parts.

Wastes accepted by the sanitary landfill included waste oil and coolants from Tekside Aluminum Foundry.

Empty containers of Spotleak (a mercaptan-sulfur compound mixture) were brought to the landfill.

Soil containing benzene, toluene, ethylbenzene, xylenes, and petroleum hydrocarbons from underground storage tank cleanups were brought to the landfill.

A population within a 4-mile radius of the landfill was estimated at 8,072, primarily residential.

Three surface water drainage patterns were identified on the landfill property. Most of the surface water drains through the swale in the middle of the landfill and travels west to a retention pond, then to an unnamed intermittent stream into Worley Furnace Creek. Worley Furnace Creek eventually flows into the West Piney River. South of the swale, surface water flows to the southwest, where it forms a small wetland, then to Baker Branch before entering the West Piney River. Surface water from the northern end of the property flows north to a small wetland area.

A geophysical study was performed to aid in selecting sampling locations at the old Dickson City Landfill. Electromagnetic "highs" were detected, suggesting that the observed readings were the result of buried waste.

A soil gas survey was also conducted to aid in the selection of sampling locations. The soil gas probes were placed to 3 feet bgs in locations of leachate breaks, suspected disposal areas, and geophysical screened areas. Based on the readings, seven soil samples were collected (three from the drainage pathway, one from the northern edge of the landfill near a leachate outbreak, one from southwest berm of the drainage ditch, and two from the center of the landfill).

A total of 25 samples (soil, surface water, sediment, and groundwater) were collected during the inspection. No municipal wells were sampled during this investigation. The samples were analyzed for all organic and inorganic parameters on the Target Compound List (TCL). The results are as follows:

- One subsurface sample contained pesticide/polychlorinated biphenyl (PCB) compounds
- One leachate sample contained pesticide/PCB compounds
- One groundwater sample from a private well contained trichloroethylene
- One sediment sample contained chloroform, evidence of petroleum hydrocarbons and polyaromatic hydrocarbons

1992 Site Inspection Prioritization (SIP) Report

The 1992 SIP report recommended that a limited further investigation be performed, focusing primarily on the additional characterization of the "possible southern drainage pathway."

3.4 LANDFILL ASSESSMENT ACTIVITIES AND PROPOSED CORRECTIVE ACTIONS

Dickson County developed a plan to address groundwater and leachate concerns at the landfill. The environmental assessment plan (EAP), which describes the proposed approach, was submitted to the DSWM on May 31, 2001, for review and approval. The EAP was prepared "pursuant to the requirements established within the Remedial Action Notice received by the City of Dickson and Dickson County." The plan described proposed groundwater assessment activities and plans for a remedial cap over portions of the landfill, consistent with the cover requirements established in the Resource Conservation and Recovery Act (RCRA) Subtitle D.

The groundwater assessment plan stated that the "site" includes 10 groundwater monitoring wells located on the landfill property, three private wells, two municipal wells (DK-21 and DK-9), and one spring. Well DK-9 is located on the southeast portion of the landfill property, reportedly in a 380-foot plus area of residuum soil cover. The plan states that to date, none of the 10 on-site groundwater wells have indicated the presence of VOCs.

The proposed groundwater assessment approach included the installation of 2-inch piezometer well nests with gas monitoring and groundwater wells at varying depths, installation of bedrock wells located based on lineation patterns, development of a conceptual site model, development of an aquifer characterization plan, and completion of a water use survey. No assessment activities were proposed for the northwest portion of the landfill, nor were any actions proposed to close improperly installed wells.

As part of the EAP, the county also developed a remedial work plan design that included capping the entire City of Dickson/Dickson County Landfill site that received wastes until 1990. The proposed approach to address leachate outbreaks and related issues of noncompliance included installing and enhancing the leachate collection system, installing a geocomposite clay liner (GCL) cap system, and providing passive gas venting. The cap, proposed for a 40-acre area, is to consist of a minimum 6-inch soil layer beneath the GCL, minimum 12-inch soil layer above the GCL, and a 6-inch vegetative support layer. Leachate collected from the landfill will be pumped from the site into the City of Dickson sewage system, pending city approval.

After reviewing the EAP and meeting with representatives of the City of Dickson, Dickson County, and their respective consultants, the DSWM issued a letter dated August 23, 2001 which provided specific guidance for satisfying the Remedial Action Notice. The first phase of the assessment requested in DSWM's August 23 letter consisted of a fracture trace analysis in the general area of the landfill and a geophysical study in the area of the drainage ditch separating the former county landfill from the former city dump. Dickson County contractor (EnSafe) prepared a Phase I Work Plan dated November 2001 to address assessment activities required by DSWM. The field work for this phase of the assessment (fracture trace analysis and geophysical study) was conducted during December 2001 and January 2002.

Based upon the findings of the fracture trace analysis and the geophysical survey, target areas were established for further evaluation and a Phase II Work Plan was submitted to the DSWM in March 2002 (EnSafe b).

The second phase of the assessment consisted of advancing soil borings in the selected target areas to assess the results of the geophysical study. This second phase of the assessment was conducted in May and August of 2002. Seven soil borings were advanced until refusal in the vicinity of the drainage ditch which divides the former county landfill from the former city dump. The soil boring depths ranged from 217 feet bgs to 321 feet bgs. One sample of the cuttings/drill return was collected from one boring in each of the target areas and analyzed for VOCs. The analytical results for the cuttings revealed TCE concentrations ranging from 0.112 mg/kg to 30.0 mg/kg (Ensafe b).

The Phase III investigation consisted of the installation of a pair of wells within the drainage ditch area which revealed the highest TCE concentration (30.0 mg/kg) from the soil cuttings during the advancement of the boreholes during the second phase of the assessment activities. The well installations were completed on December 17, 2002. One well (MW-DD) was advanced to a depth of 325 feet and completed with a 80 foot screened section. The second well (MW-DS) was completed at 150 feet bgs and completed with a 120 screened section (see Figures 4 and 5). During the installation of the deep well (MW-DD), soil samples were collected from five intervals. Soil samples were collected in two foot intervals beginning at 15 feet bgs, 40 feet bgs, 60 feet bgs, and 73 feet bgs. Saturated soil conditions were encountered below 75 feet bgs, and thus soil samples were not collected in the saturated interval. The analytical results for the soil samples collected during the installation of the MW-DD well revealed tetrachloroethene (PCE) concentrations ranging from 0.0117 mg/kg (50 - 52 feet bgs) to 0.0167 mg/kg (73 -75 feet bgs) and TCE concentrations ranging from 7.78 mg/kg (50 - 52 feet bgs) to 41.4 mg/kg (73 - 75 feet bgs) (EnSafe c).

EnSafe personnel mobilized to the landfill on March 31 through April 2, 2003 to perform a groundwater sampling event. Eight monitoring wells around the landfill (MW-1a, MW-2, MW-4, MW-6, MW-7, MW-8, MW-9, MW-10) were sampled for DSWM Appendix I VOCs and metals. The newly installed wells (MW-DS and MW-DD) were analyzed for DSWM Appendix II VOCs, metals, cyanide, sulfides, pesticides, PCBs, herbicides, and base/neutral extractables. In addition one municipal and three private wells were sampled during this sampling event; a Dickson County Municipal well (DK-9), and the private residents Harry Holt, L. Holt, and R. Holt. None of these wells are currently being used as a potable water source. Each groundwater sample was analyzed for DSWM, Appendix I, or Appendix II analytes. The groundwater analytical results for the newly installed wells (MW-DS and MW-DD) revealed TCE at a concentration of 51 mg/L in monitoring well MW-DS, and 2.6 mg/L in monitoring well MW-DD, which exceed the EPA established MCL for TCE . In addition to TCE, analysis of the groundwater from these wells exceeded the established MCLs for cis-1,2- DCE at 11 mg/L and 2.1 mg/L respectively, vinyl chloride at 0.57 mg/L and 0.085 mg/L respectively, and toluene at 100 mg/L in each well. Additionally, TCE was detected in the R. Holt private well at 0.019 mg/L, and in Sullivan Spring at 0.13 mg/L. Cis-1,2 dichloroethene was detected at concentrations of 0.0011 mg/L in the Harry Holt private well, 0.0014 mg/L in the R. Holt private well, and 0.034 mg/L in the Sullivan Spring. Inorganic groundwater analysis for monitoring wells MW-1a and MW-DD revealed antimony at concentrations above the established MCL. In addition, lead was detected at concentrations above the established MCL in the City of Dickson municipal well DK-9, and the Harry Holt, Lavenia Holt, and R. Holt private wells. Also, groundwater analytical results for Lavenia Holt's private well exceeded the established MCLs for selenium, cadmium,

and beryllium (EnSafe a).

3.5 REGULATORY SUMMARY AND TIMELINE

This section provides a timeline of events associated with the Dickson County landfill.

1972-Landfill Receives Approval for Operation

1977-City Landfill Closed

1977-County Landfill Expands

1986-EPA Preliminary Assessment

EPA completed a preliminary assessment (PA) of the site on January 17, 1986. The report described historical waste disposal practices, geologic conditions, water supplies, and population served. The report noted that the Turnbull Utilities district sold potable water to the City of Dickson; the City of Dickson which had one active well and one in reserve, also utilized Dickson Lake (also known as City Lake) as a source; the West Piney Utilities served the area around the landfill with potable water. The PA report concluded that "due to the fact that the city water southwest of Dickson is taken from Dickson Lake and the residents in the area (i.e. the landfill) use groundwater, this site should be given a medium priority" as a potential hazardous waste site.

1987-Soil Boring Investigation for Landfill Expansion-Law Engineering
A soil boring investigation was performed to assess the conditions of the soil and groundwater present for a landfill extension. Six borings were advanced using hollow-stem augers and mud/wash drilling techniques. The reports indicated that groundwater was present at less than 50 feet bgs in all cases. Sand and/or gravelly chert was prevalent in all borings. The borings were terminated prior to refusal

1988-Balefill Expansion Approved by TDHE

1988- Spring and Private Water Supply Sampling
In October 1988, samples were collected from spring and well locations near the landfill. The sampling results indicated that methylene chloride was detected in the Donegan Spring (0.003 ppb); TCE was detected in the Harry Holt private well (3.5 ppb); and methylene chloride was detected in the Lavenia Holt well (0.5 ppb).

The TDHE sampled the Holt well that previously contained TCE and indicated that the water was of good quality. TDHE notes indicate that methylene chloride and TCE were detected but were probably a result of laboratory error.

1989-Landfill First Quarterly Groundwater Sampling
The first quarterly groundwater sampling of the four monitoring wells (MW-1, MW-2, MW-3, and MW-4) at the landfill was conducted and the results reported by Gardiner Engineering to the TDHE.

1989-Landfill Second Quarterly Groundwater Sampling

The second quarterly groundwater sampling of the four monitoring wells (MW-1, MW-2, MW-3, and MW-4) at the landfill was conducted and the results reported by Gardiner Engineering to the TDHE.

1991 Potential Hazardous Waste Site Inspection

EPA completed a potential hazardous waste site inspection in January 1991. The report described known industrial wastes that were reportedly disposed of in the landfill and described leachate outbreak areas that entered the surface water pathway. The report concluded that the total population potentially affected was 30,615 that the dumping of questionable material occurred prior to 1973, that a private well was contaminated with TCE, and that two municipal wells were within 4,000 feet of the landfill. The area was not fenced, and pedestrian traffic was possible. As a follow-up to that inspection, the final report was completed in October 1991. Analytical results indicated that elevated levels of pesticides were detected in a sample collected from the middle portion of the landfill, that numerous unidentified extractable compounds were found in all of the surface soil samples, that pesticides were also detected in a subsurface sample, and that methyl ethyl ketone, chloroform, petroleum products, and polyaromatic hydrocarbons were detected in these samples. Numerous unidentified extractable compounds were found in all sediment samples. An elevated concentration of TCE was detected in a private well sample collected at the home of Mr. Harry Holt. The report recommended that the site be evaluated using the Hazard Ranking System (HRS).

The presence of TCE in the Holt well became a focal point for TDEC and EPA discussions in 1992. These discussions were based on EPA's conclusions in a December 3, 1991, letter to Mr. Harry Holt that discussed the results of well sampling for VOCs. TCE was detected in one sample at a concentration above the MCL (0.26 mg/L) and in a resample at a concentration slightly below the MCL (0.0039 mg/L). The letters are included in Attachment L.

1992 Geotechnical and Hydrogeological Investigation Report- ATEC

A geotechnical and hydrogeological investigation report was prepared for the proposed landfill site. The report discusses the results of six borings on a 35-acre site. The purpose of the investigation and report was to meet the required "Hydrogeologic Report" requirements outlined in TDHE DSWM Rule 1200-1-7-.04(9)(a). Notable report conclusions include the following: the soil was suitable as the landfill buffer zone; the uppermost aquifer occurs within 20 to 50 feet of the Warsaw Limestone Formation; the three on-site existing wells are suitable to monitor the water moving through the overburden recharging the underlying bedrock; and additional private well and stream monitoring points should be added.

1992 Site Inspection Prioritization Report

The SIP report for the landfill was submitted to EPA in August 1992. The report concluded that a limited further investigation should be performed, focusing primarily on the additional characterization of the "possible southern drainage pathway."

1992 Modification for Synthetic Liner and Leachate Collection Report

A report was prepared to discuss the specifications of the liner and leachate collection system at the new balefill. The portion of the design that addresses the geologic buffer references the previous ATEC Geotechnical Report prepared in 1992. A maximum 20-foot cut was included in the design "so that there will be a minimum of 20 feet of soil above the bedrock," based upon ATEC's conclusion that the first water-bearing zone is in the bedrock.

1994 Notification of Groundwater Contamination to Division of Water Pollution Control

On September 2, 1994, the Division of Water Pollution Control received information from Gardiner Engineering, Dickson County consultant, that the landfill was adversely impacting groundwater quality at and around the site (Gardiner Engineering 1994). Sampling data collected in May and June 1994 indicated that organic contamination was detected in Sullivan Spring, and the spring was used as a drinking water supply.

The TDHE issued an NOV on September 9, 1994, and directed the county to initiate an assessment monitoring program and corrective measures. The county was also levied a civil penalty of $34,200. The NOV indicated that the Dickson County Landfill shall immediately institute a monitoring program and that the landfill shall comply with the following rules: Assessment of Corrective Measures; Selection of a Remedy and Implementation of Corrective Action.

1994 Sampling

In September 1994, water samples were collected from private residential kitchen sinks and springs in and around the landfill. In September 1994, a letter was sent from the TDHE to Ms. Sullivan and Ms. Kay Stewart recommending discontinuing use of Sullivan Spring as a drinking water source. Additional sampling events were conducted in March, April, June, July, September, and October of that year.

1994 Groundwater Quality Assessment Plan

A groundwater quality assessment plan was developed to determine if "solid waste constituents have entered the groundwater, and to characterize the concentrations and rate and extent of migration of waste constituents in the groundwater." The work proposed the installation of three wells between the landfill and Sullivan Spring and the identification of springs, streams, and domestic and commercial wells in the area. The report concluded that the direction of groundwater flow in regolith "may be discontinuous." The proposed well installation method was the use of hollow-stem augers through the soil, with split-spoon samples being collected every 10 feet. In the event bedrock drilling was necessary, air rotary drilling would be performed and a surface casing would be placed "in order to seal off the soil aquifer."

1995 Commissioner's Order

Operational issues relative to leachate outbreaks and the county's failure to terminate the discharges resulted in a Commissioner's Order being issued on January 23, 1995. Numerous leachate seeps and flow on both the closed and active portions of the facility were reported by the DSWM. Furthermore, intermediate cover was not being applied every 30 days as required by the permit, rainwater was being allowed to pool on the facility, and erosion on the slopes had exposed wastes.

1995 Groundwater Assessment Report- Griggs and Mahoney and USGS

A groundwater assessment report was submitted to the DSWM in August 1995. The report summarized the sampling results for five new wells (MW-5 through MW-9) installed in the northwest corner of the landfill. The wells were installed as a joint effort between the county, the USGS, and Gresham, Smith and Partners. Three "deep rock" wells were installed into bedrock, and two "shallow" wells are assumed to be in the residuum. The report summarized the monitoring of the five new wells and the results of monitoring well 1 (MW-1), the only previously existing well that was sampled. Wells MW-2 and MW-4 were not sampled. Details of the well installation protocol or boring conditions were not available for review. The report concluded following:

The direction of groundwater flow for the shallow wells was to the southwest and the direction for the rock wells was to the northwest.

1995-Removal of Site From EPA CERCLIS List

EPA issued a memo on August 15, 1995, to Dickson County notifying the county that the landfill had been removed from the EPA CERCLIS list as part of the EPA Brownfields initiative (EPA 1995).

1996 Notice of Violation

An NOV was issued in October 1996 because groundwater data had indicated that the MCL for cadmium had been exceeded. Another letter was issued again requiring that the county establish an assessment-monitoring program, conduct quarterly sampling for Appendix II constituents, and initiate corrective actions within 90 days of having found any constituent with a statically significant increase. Furthermore, the TDEC issued a June 12, 1997, letter inquiring about the status of remedial activities. The letter stated that leachate outbreaks "from time to time" move into the surface water runoff ditch that flows into the silt pond and that a remediation plan should be submitted no later than August 1, 1997.

1997 Groundwater Monitoring Report-Griggs and Maloney

A groundwater monitoring report was received by the DSWM for the February 12 and 19, 1997, sampling event. The report summarized the sampling results for wells MW-2, MW-4, MW-6, MW-7, MW-8, MW-9, and MW-10, and a spring. Water levels and samples were collected on two separate days. The results indicated that five inorganic parameters (Be, Cd, Cr, Pb, and Ni) were detected at concentrations above regulatory limits. The report stated that the groundwater flow direction for the shallow wells is to the northwest and for the bedrock wells is to the southwest.

1997 Dye Trace Work Plan

In 1997, the USGS provided to the DSWM a work plan for a proposed dye study with the dye trace registration form attached. The work plan proposed that the dye trace be conducted in two phases, with the first beginning on December 2, 1997, and the second beginning January 6, 1998. The proposed dye trace suggested the use of three wells: Di: F-86 (unknown well), and two landfill wells (also unknown identification). The study proposed the use of three dyes.

1998 Dye Trace

In January 1998, the USGS began a dye study in cooperation with Dickson County. Three known dyes were introduced into the subsurface at two discreet locations within the footprint of the landfill and in well MW-1A. Monitoring of the study continued for approximately 1 year after the injection of the dyes. Although the USGS claims to have a positive detection of the dyes within monitoring well MW-8, it did not proclaim any proof or disproof of a hydraulic connection between the landfills and Sullivan Spring.

1998 Notice of Violation

An NOV was issued to Dickson County for the violation of the Tennessee Multi-Sector General Permit. The violation was observed during a compliance evaluation inspection and included leachate being discharged through Outfall 003 without a permit. The letter required that Dickson County "immediately take action to terminate the discharge." The facility also was in violation for failing to "properly implement and/or modify the facility Storm Water Pollution Prevention Plan." An outline of corrective actions to meet "full compliance" was due within four weeks of receipt of the letter.

1998 Groundwater Sampling Events

Groundwater and spring sampling was conducted in June 1998. VOCs were not detected in groundwater monitoring wells or the domestic water well. Results for the spring indicated 22 ppb of 1,2-DCE and 140 ppb of TCE.

1999 Notice of Violation

An NOV was given to the City of Dickson in 1999 for inadequate depth of cover and pooling of water on the cover. The violation required the City of Dickson to prepare a plan of corrective actions by June 1, 1999.

1999 Installation of Well MW-8A

Monitor well MW-8A was drilled at the landfill to allow for a pumping test of the aquifer. A video log of the well was taken.

1999 Groundwater Sampling

The groundwater monitoring report for the groundwater sampling event conducted on August 26 and 27, 1999, was submitted to the TDHE. Samples were collected from wells MW-1A, MW-2, MW-4, MW-6, MW-7, MW-8, and MW-9, and a spring. The samples were analyzed for Appendix I parameters. The TCE concentration (0.16 mg/L) in the spring sample exceeded the MCL, and cis-1,2-dichloroethene was detected in the spring sample at 0.039 mg/L. A statistical analysis of the sample results was not performed.

2000 Pumping Test of Well MW-8A

A pumping test of landfill monitoring well MW-8A was conducted in 2000. Groundwater analytical results for samples indicated the presence of TCE below detection limits. The Sullivan Spring sample contained TCE at 130 ppb and cis-1,2-Dichloroethene at 28 ppb. A second pumping test was conducted in February 2000, and samples from well MW-8A indicate TCE below detection limits. The spring sample contained TCE at 81 ppb and cis-1,2-Dichloroethene at 18 ppb.

In April 2000, the results of the dye study for the landfill were included in Appendix B of a report prepared by Gresham, Smith and Partners and USGS. The report states that well DK-21 is used as a municipal water supply from "generally December to April of each year." During that time, there "may be as much as 40 feet of drawdown in the well." Background dye receptors were placed from December 2, 1997, to January 13, 1998, to aid in choosing dyes for injection. Dye detectors were retrieved every 1 to 2 weeks. The dye injection phase was conducted from January 13 to September 29, 1998. Three dyes were injected into three wells at the landfill. Cotton and charcoal detectors placed at 25 sites were initially collected and analyzed "every couple of days," but were collected every 3 weeks at the end of the study. The detection sites generally consisted of the municipal well DK-21, numerous springs, at least one private well, and on-site wet areas and sumps. No receptors were installed at either of the private wells located to the southeast. Tinopal CBS-X (an optical brightener), Rhotamine WT, and Eosine OJ were the three dyes. The three injection points were as follows: Well Di:F-91 (an unknown well location), a county landfill leachate well (LW-4) installed in the waste, and a City landfill leachate well. The USGS reported a positive detection in Site 8 (presumed to be well MW-8) on January 14 from the optical brightener that was injected into Well Di:F-91. No other dyes were detected at the other 24 sites.

2001 - 2003 Soil and Groundwater Investigations

The soil and groundwater investigations conducted to satisfy the Remedial Action Notice issued by DSWM in 2001 are discussed in Section 3.4 of this report. The DSWM is currently the lead agency for ongoing activities at the Dickson County Landfill.

4.0 OROFACIAL STUDIES

The incidence of orofacial defects within Dickson County has been investigated by Tennessee Department of Health (TDH), the CDC, and by the Birth Defect Research for Children Organization. The following are summaries of the information obtained from these sources.

4.1 TENNESSEE DEPARTMENT OF HEALTH/CENTERS FOR DISEASE CONTROL AND PREVENTION OROFACIAL STUDY

The TDH was contacted in June 2000 by a local early intervention center regarding a potential cluster of orfacial clefts in Dickson County, Tennessee. The TDH, in coordination with the CDC, performed a cluster investigation to identify the risk factors contributing to the increased rate of orfacial clefts in Dickson County. The scope of the investigation included a case definition, additional case-finding activities, a case review, and case mother interviews (CDC 2001). A copy of the CDC report is presented in Attachment A.

The investigation defined a case as an "infant with either cleft lip and palate (CLP) or cleft palate only (CPO) born between January 1997 and October 2000 to a mother whose residence was in Dickson County at the time of birth. The diagnosis of CLP or CPO was determined by a medical professional, usually at birth or at the time of surgical repair." Several cases were identified by the local early intervention center. The TDH also requested that the local hospitals search discharge data for ICD-9-CM codes 749.00 through 749.25 and birth certificate records for the period of January 1997 through October 2000. The cluster investigation identified 18 cases in Dickson County, including 11 CLP and 7 CPO cases (CDC 2001).

The CDC report indicated that Tennessee does not have an established statewide birth defects monitoring system. Information from the Department of Energy (DOE)-funded birth defects registry was used to establish statewide baseline rates for 1991 through 1993. Vital statistic data from 1989 through 1996 was also used to determine the rates of orofacial defects for Tennessee. Prior to 1989, clefting defects were not reported on birth certificates in Tennessee. In 1989, a box was added to birth certificates for clefting, but the box does not allow for the differentiation between CPO and CLP. Due to the limitations of the DOE and vital statistic data, the CDC also used information from the Metropolitan Atlanta Congenital Defects Program (MADCP) and the National Birth Defects Prevention Network (NBDPN) was also used. Based on these data resources, the CDC report concluded the following (CDC 2001):

> For the period 1989 through 1996, the Tennessee state average for combined orofacial clefts was 0.97 per 1,000 versus 1.6 per 1,000 reported in Dickson County. The incidence of CPO was higher in Dickson County (0.60 per 1,000 live births versus State of Tennessee rate of 0.30) for the period 1991 to 1993, while rates for CLP were lower (0.60 per 1,000 live births versus 0.76)

over the same time period.

While the rates for orofacial clefts in the state remained relatively constant from 1989 to 1996, the rates for Dickson County varied considerably, with a high of 5.42 per 1,000 recorded in 1989 and a low of 0.0 in 1993, 1995, and 1996. The CDC reported that the variance was expected given the relative low number (500 to 600) of live births per year in the county.

A comparison of county data to the MACDP data indicated that the Dickson County rates from 1997 through October 2000 were five-fold greater than expected for both CLP and CPO.

Interviews were completed for 15 of the 18 case mothers. The information obtained through the maternal interviews indicated that among the 11 infants with CLP, 2 (18%) had other significant anomalies reported; and among the infants with 7 CPO, 3 (43%) had other anomalies reported. None of the infants had a recorded chromosomal abnormality; however only 17% had chromosomal analysis documented. The report indicated that due to the nature of the phenotypes, these types of clefts are likely to be underasertained in both Dickson County and most reference surveillance systems, including MACDP and NBDPN.

The scope of the investigation could not determine whether the drinking water for the case mothers was contaminated with TCE during the first trimester of pregnancies. However, the study noted that most case mothers (87%) used water provided by the City of Dickson, that was monitored and known not to have harmful levels of TCE and was safe for drinking and cooking at home.

The results indicated Dickson County's baseline rates for orofacial clefts may be elevated compared to statewide or national rates. However, baseline rates for Dickson County could not be established with certainty. The report indicated that increased rates for clefting in Dickson County could be due to an undetermined teratogenic exposure, elevated baseline rates, or statistical fluctuation. Further, the report concluded that any one factor examined in the investigation was unlikely to account for the increased rates in the county.

The report indicated that a cluster is a greater-than-expected number of cases in a population for a defined geographic area and period of time, and that the cases described within the report during the period of January 1997 to October 2000 met the definition of a cluster.

The report indicated that the scope of the investigation could not determine the contents of the landfill or how they relate to the cluster of orofacial clefts in Dickson County.

The report recommended continued monitoring to determine if the increased rates were due to elevated baseline rates or statistical fluctuations. In the event they were elevated, the CDC recommended that "more formal case-control study" be conducted to quantify the risks with the known risk factors.

4.2 TENNESSEE DEPARTMENT OF HEALTH FORM LETTER

In February 2001, the TDH sent a form letter to parties interested in the occurrence of orofacial clefts. A TDH representative indicated that one CLP case was identified in Dickson County from November 2000 to November 2001 (Tetra Tech 2001e). The letter enclosed a copy of the CDC report and provided an opinion and summary of the CDC findings. The letter stated that for the period January 1, 1997 to October 31, 2000, the rates of cleft lip and palate had increased, without an identified cause. The letter indicated that most of the case families used water supplied by the cities of Dickson, Charlotte, or Vanleer; that 2 families had private wells; and that sampling of drinking water supplies for 10 families had shown no evidence of contamination. The letter offered to sample drinking water supplies for anyone interested. The letter also stated that the Division of Solid Waste Management had sampled other wells in Dickson County; the well and spring in the immediate vicinity of the landfill were the only areas outside the landfill to have shown any contamination. A copy of the form letter is presented in Attachment B.

4.3 BIRTH DEFECT RESEARCH FOR CHILDREN INVESTIGATION

In obtaining background information on the project, TtEMI contacted the Birth Defect Research for Children organization. The organization became involved around March 2000 when a relative of a child with an orofacial cleft contacted them concerning what they thought was an unusually high occurrence of these birth defects in the area. The organization agreed to investigate the matter; initial efforts included the collection of data from the National Birth Defects Registry (Tetra Tech 2001a and 2001d). The Birth Defect Research for Children organization sent a questionnaire to each of the case families. The interview questionnaire was designed for the National Birth Defects Prevention Study to look at a broad range of factors that might be related to the occurrence of birth defects (see Attachment D).

5.0 REGULATORY FILE REVIEW

TtEMI accessed the EPA Envirofacts Warehouse web database (www.epa.gov/enviro/html/qmr.html) and contacted the TDEC to perform a database search for Dickson County. The following databases were searched for Dickson County information:

- Resource Conservation and Recovery Information System (RCRIS)
- Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)
- Toxic Chemical Release Inventory System (TRIS)
- Biennial Reporting System (BRS)
- TDEC State Remediation Program (SRP)

TtEMI then reviewed TDEC files for the identified facilities to gather information on potential contaminant sources, groundwater investigations, and groundwater corrective actions. Additional facilities were researched based on discussions with the TDEC. Files reviewed included DSWM files at the Central Office, DWS files at the NEAC and Central Office, and DSF files in the NEAC. Given the voluminous files to review, only those portions of the files that discussed contaminant sources, regulatory actions, waste generation and disposal, and significant raw material usage were copied. A summary of

regulatory files reviewed for each facility is provided in Appendix C. Copies of files obtained through TtEMI's regulatory file review are provided in Attachment L. Selected industrial facilities identified through TtEMI's database review are shown on Figure 3.

6.0 SUMMARY AND RECOMMENDATIONS

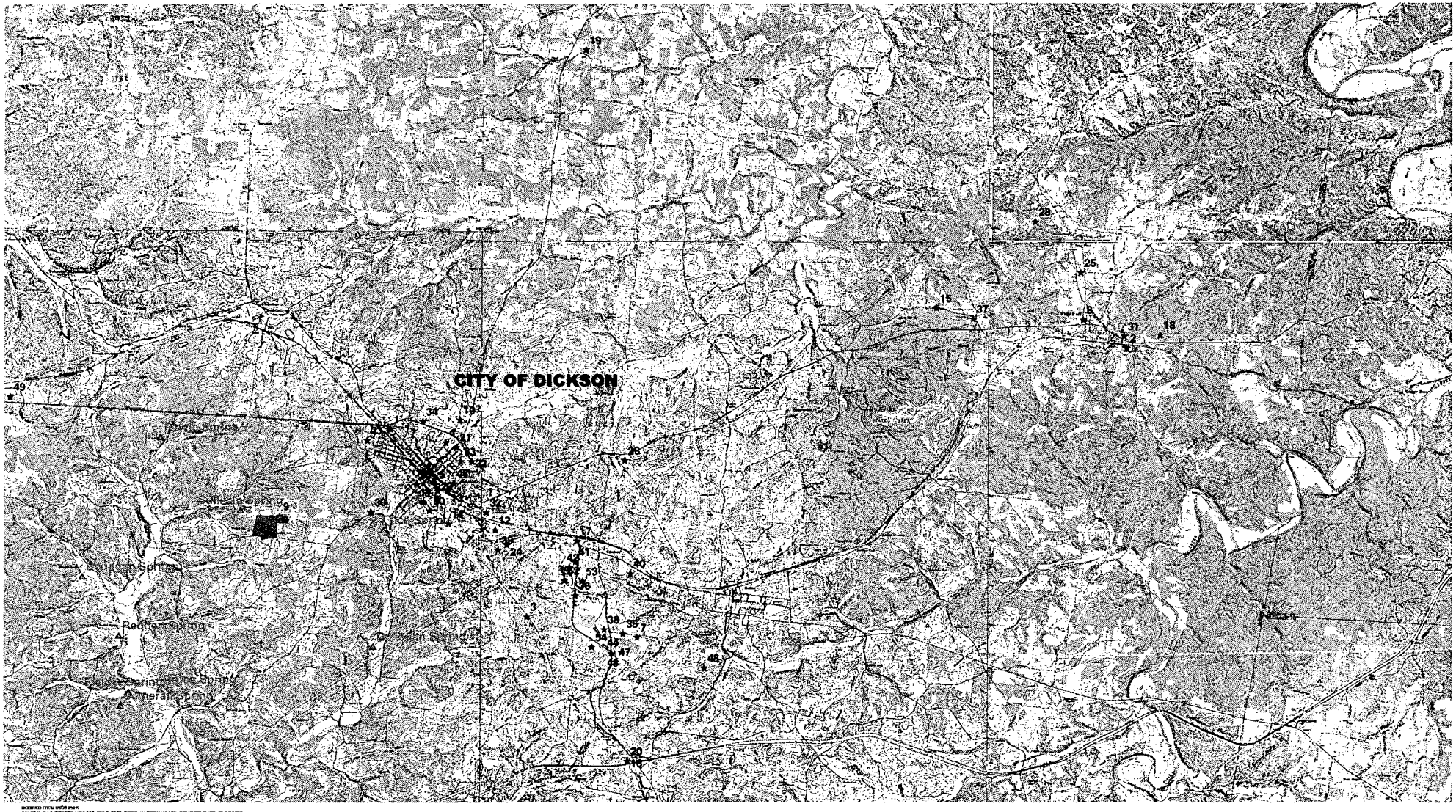
The purpose of this reassessment report was to summarize work that has been completed by multiple local, state, and federal agencies relative to environmental permitting and site cleanups and work performed relative to evaluating the potential cause and effect of environmental exposures and orofacial clefts. Based on information reviewed and summarized herein, the following provides a summary of issues regarding cleft palate/cleft lip occurrence, geologic/hydrogeologic conditions, potable water supply (private and municipal water supplies and sampling), municipal water treatment, wellhead protection, and the Dickson County Landfill. Recommendations regarding key issues are also provided.

6.1 CLEFT PALATE/CLEFT LIP OCCURRENCE

Available information was reviewed for the occurrence of CLP and CPO for Dickson County from January 1997 to October 2000, a period during which 18 residents with orofacial clefts were identified. The investigation performed by the TDH and CDC indicated that the cases identified during that period met the definition of a cluster.

The Birth Defect Research for Children organization has noted the incidence of orofacial clefting for live births is expected to be 1 birth in 1,000. For the period in question, the organization stated that the 18 identified cases were for approximately 1,700 births. This equates to over 10 cases per 1,000 births for an approximate 4-year period.

The CDC defined normal rates of CLP and CPO (based on national averages) to be 1 to 2 and 0.7 per 1,000 live births, respectively. The CDC report noted the high degree of variability in the reported cases in Dickson County. Historical data from 1989 to 1996 indicated 5.42 reported cases per 1,000 births in 1989 and 0 cases reported in 1993, 1995, and 1996.



Note: All locations are considered to be approximate.

Legend

- Springs
- Landfill Boundary
- Facility ID and Location

0 2 Miles

N W E S

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DICKSON COUNTY LANDFILL REASSESSMENT REPORT
DICKSON, DICKSON COUNTY, TENNESSEE
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EPA Contract No. 68-W-00-120
TDD No. 4T-01-11-A-004

FIGURE 3- INDUSTRIAL/COMMERCIAL FACILITY LOCATION MAP

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6.2 GEOLOGIC/HYDROGEOLOGIC CONDITIONS

The karst geologic and hydrogeologic conditions in Dickson County are characteristically sensitive to releases to the environment because of the potential for rapid contaminant migration and the ability for contaminants to travel long distances. The conduit-type flow pattern characteristic of karst settings and the associated jointing and bedding planes of the underlying bedrock can quicken contaminant transport and make source identification more difficult. Information on such conditions was available in the Dickson County Landfill, Dickson Water Department, and Scovill/Schrader Automotive files. Groundwater monitoring programs in the area typically involve many wells (Scovill/Schrader), include dye traces that are sometimes inconclusive (Dickson County Landfill), access conduit-type zones in the bedrock (the 17-foot-tall conduit of well DK-21 and the conduit in well MW-8A at the landfill), and wells in multiple water-bearing zones (Scovill/Schrader). The geology in the Dickson area is further complicated by the existence of a surface drainage divide, the regional structural dip of the rock, and numerous spring discharges that feed most streams in the area. Perennial streams in the area, most notably the East and West Piney Rivers, are all recharged primarily from spring discharges.

The Tuscaloosa Gravel, the St. Louis Limestone, the Warsaw Limestone, and the Fort Payne Formations all have the potential to supply groundwater. The gravel formation is present in the soils above the bedrock, and reports prepared on behalf of Dickson County indicate that the amount of water stored is a function of the soil thickness. More water is available where the soil is the thickest. Griggs and Maloney reported that the top of the Warsaw Limestone Formation is approximately 60 to 130 feet beneath the landfill ground surface. Therefore the soil beneath the landfill would be expected to supply large amounts of recharge to the underlying bedrock.

The USGS concluded that groundwater occurs primarily in the Warsaw Formation, which is characteristically reliant upon fractures and joints in the bedrock to produce varying amounts of groundwater discharge. The report concluded that the regolith thickness and lithology of the bedrock are the main factors influencing the development of high-yielding solution-enlarged bedrock openings. High-yielding openings are more likely to occur in areas with a thick regolith and fine-grained limestone at the top of bedrock. As a result, the area beneath the Dickson County Landfill would be expected to have high-yielding solution openings. The USGS concluded that the Fort Payne Formation is regarded as the base of the aquifer. According to the USGS, the regional dip of the formations is toward the northwest, with local structural features including lows to the southwest and northeast and an east-west trending anticline under the City of Dickson. Most springs in the area reportedly discharge from the Warsaw Limestone Formation. The USGS reports that well yields in the area range from 1 to 100 gpm, and that there is no clear pattern to well yield and location. All of these conditions further complicate environmental investigations in karst areas.

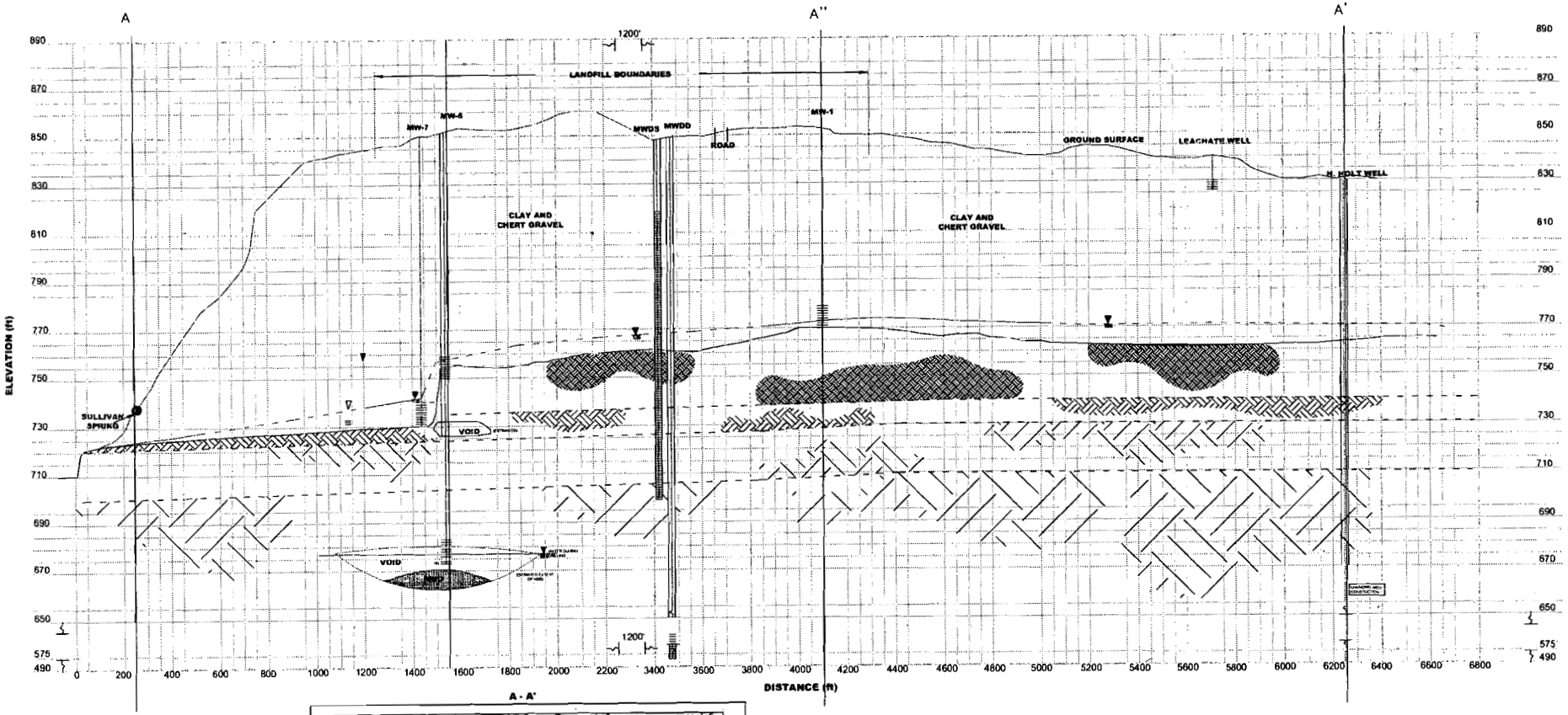
A review of the geologic and hydrogeologic conditions in the area of the Dickson County Landfill indicated substantial karst conditions. Conceptual diagrams that illustrate the localized and regional conditions and wells are included as Figures 4 and 5. Conduit flow conditions were noted in at least two wells located at the landfill and well DK-21 east of the landfill. Although pumping tests indicated a widespread radius of influence, the connection is reportedly poor when a large conduit zone is pumped and compared to residuum or non-conduit zone bedrock wells in the immediate vicinity. This suggests that

preferential pathways exist in the secondary porosity of the bedrock and are most likely related to the joints (lineation) and bedrock dip. As a result, pumping large quantities of water from well MW-8A during well purging, for example, is not guaranteed to evacuate groundwater from well MW-8 or even draw water from the landfill area toward it, as theorized by Gresham, Smith and Partners. Water pumped toward wells MW-8A and DK-21 is drawn from the conduit that extends into undetermined lengths and directions.

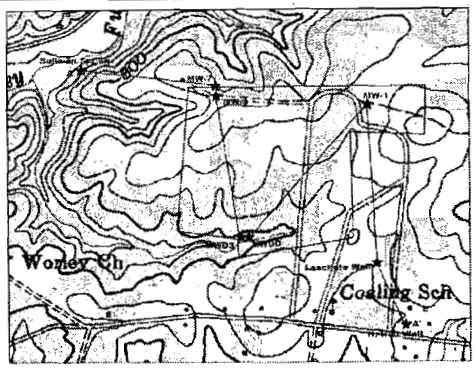
Contaminant fate and transport in such a conduit flow regime is a function of the size of the water-bearing zones, the direction of the bedrock joints, and the dip of the localized bedrock. Groundwater flow is a function of the type of bedrock, with conduit-type flow being more prevalent in coarse-grained limestones. Figures 4 and 5 illustrate the geologic and hydrogeologic conditions based on reported information. As the figures indicate, the conduit conditions are more prevalent in the deeper limestone. Given that these are multiple water-bearing zones in the soil and bedrock, cross-contamination can result in different zones from uncased wells completed at various depths and when well surface casings are not properly grouted into place.

Sullivan Spring, which is reported to be present in the Warsaw Limestone, outcrops along the valley wall of Worley Furnace Branch. The conceptual geologic diagram developed from actual data and illustrated on Figures 4 and 5 indicate that the spring emanates from a coarser limestone layer. Surface water in the landfill area drains primarily to the southwest, west, and northwest toward Worley Furnace Branch. Large tributary streams of the Piney River enter the main stream at nearly right angles, suggesting a fracture origin for the stream bed. As a result, both stream course and groundwater transport are likely related to bedrock jointing and lineation. Joint patterns in the Dickson area are not easy to determine because the soil masks the jointing patterns. A connection of one or more joints is the likely reason that the upper portion of City Lake (north of U.S. 70) cannot be impounded with water and that the water from the upper lake discharges at Payne Spring (a source of water to City Lake). A secondary joint pattern could be the origin of another spring that discharges into City Lake from property to the east with the Tennsco 2 and 3 plants (and former Winner Boat plant).

Hydrogeologic investigations at the Dickson County Landfill and the Scovill and Schrader sites indicate that groundwater occurs at multiple zones. Geologic evaluations of the landfill have indicated that the first groundwater zone is present in the soil at depths less than 50 feet bgs. One report concluded that the first water-bearing zone was a perched zone. As a result, groundwater wells that are required to monitor the first water-bearing zone will most likely be installed in the soil, not bedrock. However, a report prepared for the landfill during planning stages for the now-closed Class I balefill concluded that three existing on-site wells (installed into bedrock) were suitable to monitor water moving through the overburden and recharging the underlying bedrock. However, this is not likely given the conclusions made by the USGS and an understanding of karst transport mechanisms. The existing groundwater monitoring system at the landfill includes several wells; however, most are installed into bedrock. Wells at the Scovill/Schrader site monitor at least two zones in the soil (a perched zone and a zone at the top of bedrock) and various depths within the bedrock.



A - A'



1" = 500'

Note: All locations are considered to be approximate.

LEGEND

- WELL DEPTHS
- POTENTIOMETRIC SURFACE
- TOP OF BEDROCK
- WELL SCREEN
- CASING
- MSL MEAN SEA LEVEL
- ' FEET
- " INCHES
- LANDFILL BOUNDARY
- ROCK TYPE BOUNDARY
- FINE TO MEDIUM-GRAINED LIMESTONE AND CHERT
- MEDIUM TO COARSE-GRAINED LIMESTONE AND CHERT
- MEDIUM GRAINED LIMESTONE
- COARSE TO VERY COARSE-GRAINED LIMESTONE

VERTICAL SCALE
1" = 20'

HORIZONTAL SCALE
1" = 200'

Reference: Construction, Lithologic, and Water-Level Data for Wells Near the Dickson County Landfill, Dickson County, Tennessee, 1995, Prepared by the U.S. Geological Survey 1996.

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EPA Contract No. 68-W-00-120
TDD No. 4T-01-11-A-004

FIGURE 4 - CONCEPTUAL GEOLOGIC PROFILE A TO A'

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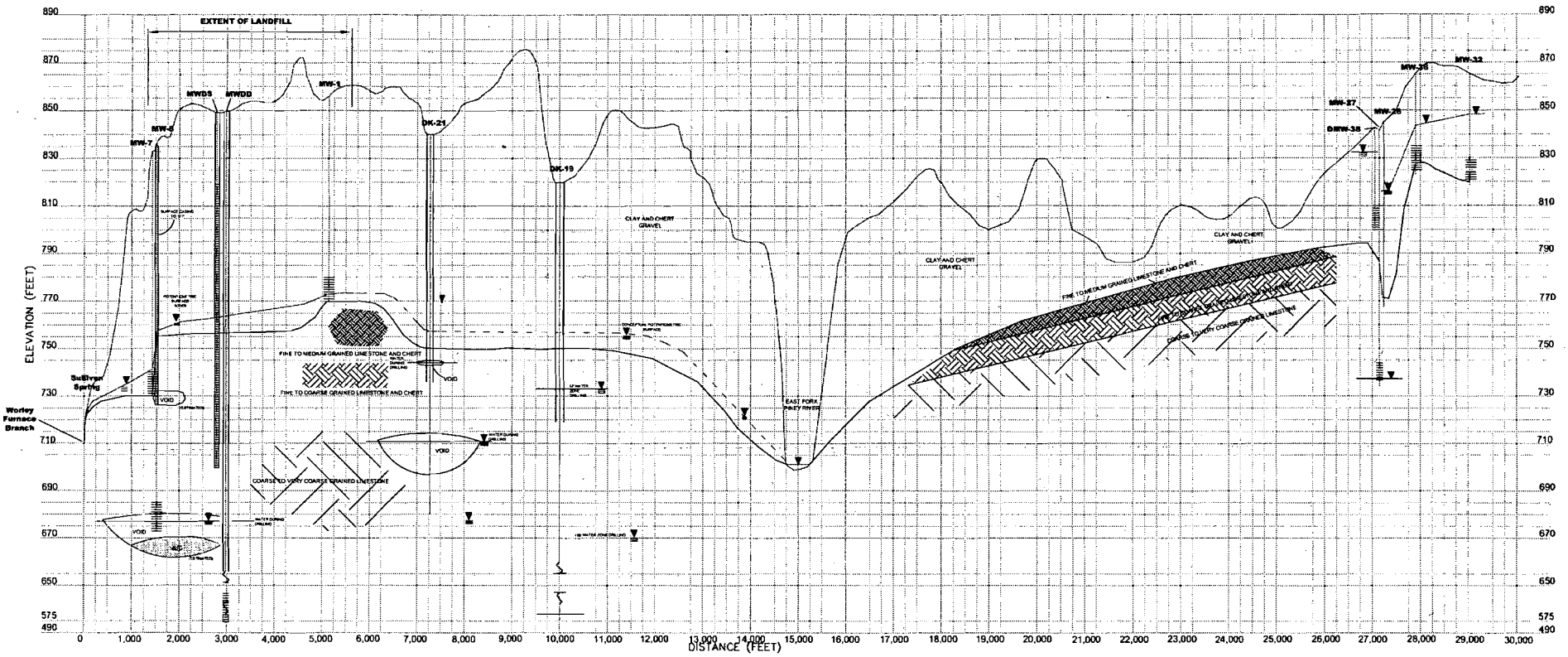
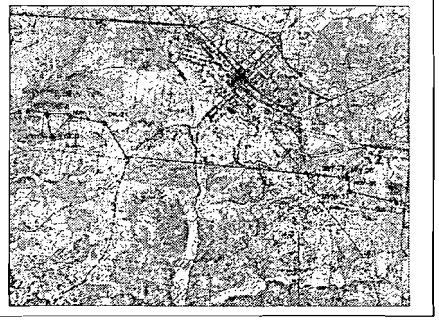


LEGEND

- WELL DEPTHS
- POTENTIOMETRIC SURFACE
- TOP OF BEDROCK
- WELL SCREEN
- CASING
- MSL MEAN SEA LEVEL
- ' FEET
- " INCHES
- LANDFILL BOUNDARY
- MW MONITORING WELL
- ROCK TYPE BOUNDARY
- FINE TO MEDIUM-GRAINED LIMESTONE AND CHERT
- FINE TO COARSE-GRAINED LIMESTONE AND CHERT
- COARSE TO VERY COARSE-GRAINED LIMESTONE
- DK USGS WELL
- DK-21 WATER SUPPLY WELL

B–B'



1" = 4000'

VERTICAL SCALE
1" = 20'

HORIZONTAL SCALE
1" = 1000'

Reference: Construction, Lithologic, and Water-Level Data for Wells Near the Dickson county Landfill, Dickson County, Tennessee, 1995, Prepared by the U.S. Geological Survey 1996.

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EPA Contact No. 68-W-00-120
TDD No. 4T-01-11-A-004

FIGURE 5 - CONCEPTUAL GEOLOGIC PROFILE B TO B'

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6.3 MANUFACTURER CHEMICAL USE

Regulatory files were reviewed for sites previously identified in Section 5.0. As indicated in the files reviewed, boat building, metal fabricating, and printing industries have been prevalent in Dickson County. TtEMI's regulatory file review attempted to identify users of TCE, perchloroethene, toluene, or halogenated solvents. None of the facilities reported using TCE in quantities large enough to trigger TRI reporting. Other solvents noted in the files for numerous facilities included methyl ethyl acetone, methyl isobutyl ketone (MIBK), acetone, and xylene. Lexalite International also reported the use of 1,1,1-trichloroethane and methyl ethyl icetone, which have been reported in well DK-21.

Perchloroethene was noted in the files for the following facilities:

- Classic Cleaners
- Disser Enterprises
- Graham Ford Lincoln Mercury
- Interstate Packaging
- Lexalite International

TCE use was noted in the files for the following facilities:

- Graham Ford Lincoln Mercury
- Scovill/Schrader Automotive
- Ryder Truck Rental

Toluene use was noted in the files for the following facilities:

- Carl's Certified Collision Center
- Gene's Body Shop
- Larry's Body Shop
- Murphy Oil
- Premdor Entry Systems
- Quebecor Printing Corporation
- Tennsco Plant 1
- Tennsco Plants 2 and 3

6.4 POTABLE WATER SUPPLY - PRIVATE WELL USE AND SAMPLING

TtEMI reviewed information on private water wells identified by the DWS from the USGS Dickson, Tennessee, topographic quadrangle. The Dickson Quadrangle was selected because the initial focus of TtEMI's investigation was in the area of the Dickson County Landfill, which is in that quadrangle. Of the 334 wells identified, 274 were listed for residential use. A comparison of the residential wells to the 18 case families indicated that one of the families was included in the database. Information from the CDC interviews indicates four families use private water. As a result, additional private wells may exist that

are not included in the DWS database. The water quality of private wells and other identified water sources (Mount Sinai commercial well, Goodlark Hospital irrigation well), as well as their influence on hydrogeologic conditions, are unknown. Further evaluation of the data indicated that approximately 17 percent of the wells were installed after 1995, indicating that individuals are still installing wells, possibly in areas served with potable water.

TDEC has required for many years that wells and off-site springs be sampled as part of the routine monitoring. Contamination has been documented in Sullivan Spring and the Holt family wells.

6.5 POTABLE WATER SUPPLY – MUNICIPAL WATER SUPPLY AND SAMPLING

Information collected from the TDEC files and from interviews with current and former City of Dickson employees confirmed that groundwater obtained from municipal well DK-21, and at times well DK-17, has been used as a primary water source for potable water to the City of Dickson, the West Piney Utility District, the Sylvia-Tennessee City-Pond Utility District, the Harpeth Utility District, and the Town of Vanleer through its connection with the Sylvia-Tennessee City-Pond Utility District. Dickson municipal well DK-17 was the primary water source when the DK-21 well was out of service due to well pump failure and fitting for the aerator. In addition, water from well DK-21 was also mixed with water from the spring-fed City Lake. As a result, much of Dickson County relied on groundwater as the primary potable water source up until 1986, when the West Piney River surface water intake was installed; the city used the intake as a water source 6 months per year.

Laboratory analytical data for various well points and locations throughout Dickson County was obtained from TDEC DWS for sampling events in 1994 and 1996 to 2001. Correspondence from the TDEC NEAC indicated that chlorinated hydrocarbons, dichloromethane, and trichloroethylene were also detected in well DK-21 in December 1996. However, the analytical concentrations for these constituents were not included in the TDEC NEAC correspondence. TCE was detected at 0.032 mg/L in well DK-21 on April 21, 1997, and methyl ethyl ketone was detected at 12 µg/L on October 9, 2000. A finished water sample (treated and entering the distribution system) collected on February 24, 1997, indicated the presence of TCE at 0.0013 mg/L. A sample identified as City Lake "A," collected on April 7, 1997, contained TCE at 0.0021 mg/L.

6.6 MUNICIPAL WATER TREATMENT

In October 1998, the DWS approved the installation of the draft-induced aerator to treat the water collected from well DK-21. Prior to the installation of the draft-induced aerator, there was no treatment capability to remove VOCs. The DWS stated that treatment of water obtained from well DK-21 is required whenever the well is used for raw water. Furthermore, the city is required to sample raw water quarterly for VOCs if the well is used, and otherwise sampled annually.

Presently, the City of Dickson is no longer utilizing municipal wells as a source for potable water. As of December 2003, the City of Dickson has joined with other utility districts in developing the WADC which is currently operating a state-of-the art water plant with a surface water intake on the Cumberland River in northern Dickson County (Tt EMI 2003b; The Dickson Herald).

6.7 WELL HEAD PROTECTION

TtEMI reviewed the well head protection plan that the city submitted to the DWS most recently on September 4, 1998. Potential contaminant sources identified in the plan included the Dickson County Landfill, the Brannon Trailer Park to the east, a sludge spreading site located between the landfill and well DK-21, and urbanized residential/commercial areas to the north (City of Dickson Water Department 1996). The well head protection plan indicated that the direction of groundwater flow was determined by static water levels measured from numerous municipal wells, industrial monitoring wells, one municipal well at Buckner Park, a well at an "Ice House," and at Tice's Spring. The plan did not state whether these wells were located in the same water-bearing zone or aquifer. Since submittal of the plan and its most recent update, the city has reportedly drilled an additional well near the surface water intake at the West Piney River for use as a potable water source. The city is also reportedly evaluating well DK-15 as a raw water source. Preliminary evaluation reports (PER) for the potential water sources were not obtained through TtEMI's regulatory file review.

6.8 DICKSON COUNTY LANDFILL

Information indicates that portions of the landfill are unlined and industrial wastes including solvents were disposed of in the landfill. As a result, the landfill may be a source of contaminants to groundwater. The following summarizes information obtained for the Dickson County Landfill.

6.8.1 Regulatory Status

The county has a long history of noncompliance related to groundwater and leachate violations since at least 1983. These violations have resulted in fines, Commissioner's Orders, and NOVs. These violations were related to such issues as major and minor leachate seeps and flows, failure to provide intermediate cover, failure to provide erosion control, exceedance of groundwater standards for cadmium and TCE, discharge of leachate from the property without a permit, failure to maintain a storm water pollution prevention plan, and implementation of required corrective actions.

The county was required to implement groundwater assessment and corrective actions starting in September 1994. Remedial actions for leachate violations were required in July 1994. Available information indicates that the county has not met the DSWM requirements for fully assessing the extent of groundwater contamination or for applying corrective actions relative to groundwater and leachate control. The county has employed several consulting firms over time, each with its own idea for addressing leachate and groundwater problems. Relevant conclusions and actions related to groundwater monitoring assessments since 1994 are summarized below:

- The USGS installed groundwater monitoring wells northwest of the landfill in 1995 to assess the potential effect of the landfill on Sullivan Spring. The USGS concluded that the spring was hydraulically downgradient of the landfill. A review of the geologic and groundwater information available for the site indicates that the wells may not monitor the first water-bearing zone (as required by DSWM rules), and at least one well (DK-6) may not be installed correctly.

- Evidence in the file and interviews with the county have indicated that the county and its

consultants Gresham, Smith and Partners, recognize the inadequacy of the monitoring system in determining the groundwater quality and the direction of flow, both of which have been requirements in the DSWM rules since 1994. The downgradient extent of TCE and cadmium have yet to be determined.

- Previous groundwater sampling activities were not conducted in full compliance with EPA protocol. One well for example, is used to represent the groundwater conditions of another well located nearby. The well was purged of almost 25,000 gallons of water rather than purging approximately 40 gallons from the well required to be sampled. The well purge water was discharged to the ground surface without measuring its chemical quality, even though concentrations in samples from the well have exceeded one or more MCL(s) in the past.

- Groundwater monitoring reports have been routinely submitted without Appendix II sampling and reporting, without performing statistical analyses, without determining the direction of groundwater flow from the landfill areas, and without monitoring background conditions for the Subtitle D area.

- An off-site spring (Sullivan Spring) and at least two wells (the Holt wells) are contaminated with TCE. In response to the spring contamination, which was formerly used to supply water to two families, a well was installed; however, that well was later also found to be contaminated. Concentrations in groundwater samples from the area are known to exceed the MCLs for trichloroethene and cadmium.

The county has proposed to mitigate leachate outbreaks and discharges is to construct a geocomposite cap on approximately 40 acres of the old city and county landfills. Leachate will be extracted and pumped to the City of Dickson wastewater treatment plant.

6.8.2 Dye Trace Evaluation

The purpose of the dye trace study performed was to determine whether contaminants could migrate from the landfill to well DK-21. The study attempted to mimic the use of the well as a water supply. The USGS report was inconclusive relative to the hydraulic connection between well DK-21 and the landfill. The trace seems to have been a logical request given the location of the landfill and the municipal well field. The test apparently tried to duplicate pumping rates in 1997 during the test conducted in 1998. The test could not, however, duplicate rainfall and groundwater recharge or possibly groundwater quality that was present in 1997. Past USGS reports suggested that during the pumping of well DK-21, the well was only "poorly" connected to wells installed in soil nearby. Given that the well provides up to 300 gpm (based on pump size), it is located in a 17-foot cavern, and it is most likely in a wide bedrock joint, there is only a slight possibility that dyes injected into wastes at the landfill will be detected in the pumped water. Water pumped from the well will flow along its most preferred pathway, which is the large, unobstructed conduit of unknown direction and origin, and will be less influenced by groundwater in the soil.

Future dye traces in the landfill area should consider the lineation/jointing patterns. A dye trace should consider ramifications of pumping a well for a long period of time, where pumped water of unknown

quality and origin is discharged to the ground surface. The most likely opportunity for a positive trace from the landfill is if dye is injected into a bedrock joint that is linked to the cavern in which well DK-21 is installed.

6.9 RECOMMENDATIONS

Information in this report indicates portions of the landfill are unlined and industrial wastes including solvents were disposed of in the landfill. Recent investigations at the landfill confirm that the landfill is a source that is contributing contaminants to the underlying groundwater. However, previous site investigations at the landfill have been too limited in scope or did not fully account for the hydrogeologic setting. Therefore, Tetra Tech recommends that a comprehensive and well planned hyrdrogeologic investigation for the Dickson County Landfill. Further investigations for the soil and ground water quality in the deeper residuum immediately around the landfill area is needed to establish the geographic distribution of contaminants in deeper soils and to define the mass of contamination potentially available for migration into the underlying bedrock. Further ground water investigations should establish the ground water quality in the bedrock at points downgradient of the two most recently constructed monitoring wells completed in the residuum. This effort may include placement of at least one well in the drainage area extending southwest of the two recently constructed monitoring wells. Once there has been additional confirmation of the deeper soil and ground water contamination at the landfill, another dye trace study may be needed to identify downgradient receptors and discharge locations for site contaminants.

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