ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

Initial Release

LIBERTY HILL ROAD SITE
GILFORD, NEW HAMPSHIRE
MARCH 24, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
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THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

Section 104 (i) (7) (A) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, states "…the term 'health assessment' shall include preliminary assessments of potential risks to human health posed by individual sites and facilities, based on such factors as the nature and extent of contamination, the existence of potential pathways of human exposure (including ground or surface water contamination, air emissions, and food chain contamination), the size and potential susceptibility of the community within the likely pathways of exposure, the comparison of expected human exposure levels to the short-term and long-term health effects associated with identified hazardous substances and any available recommended exposure or tolerance limits for such hazardous substances, and the comparison of existing morbidity and mortality data on diseases that may be associated with the observed levels of exposure. The Administrator of ATSDR shall use appropriate data, risk assessments, risk evaluations and studies available from the Administrator of EPA."

In accordance with the CERCLA section cited, ATSDR has conducted this health assessment on readily available site data. Additional public health assessments may be conducted for this site as more information becomes available to ATSDR.

The conclusions and recommendations presented in this public health assessment are the results of site-specific analyses and are not to be cited or quoted in other evaluations or public health assessments.

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INITIAL RELEASE PUBLIC HEALTH ASSESSMENT

LIBERTY HILL ROAD SITE

GILFORD, NEW HAMPSHIRE

Prepared by:

New Hampshire Department of Environmental Services
Environmental Health Program
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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I. SUMMARY

The US Agency for Toxic Substances and Disease Registry (ATSDR) is a non-regulatory federal agency mandated by Congress to assess human health effects from exposure to hazardous substances at Superfund and other hazardous waste sites. To fulfill its mandate, ATSDR enters formal partnerships with state agencies throughout the nation to carry out site-related evaluations on environmental exposures and public health. For 17 years, ATSDR and New Hampshire's Environmental Health Program (EHP) have maintained a cooperative agreement to conduct these evaluations in the state. EHP is a non-regulatory program within the New Hampshire Department of Environmental Services (DES). It functions independently of regulatory programs within DES to assess the human health implications of hazardous chemical releases, and to make recommendations to protect public health.

In 2007 the Environmental Health Program was asked to investigate local residents' concerns of cancer and other illnesses in relation to a coal tar waste deposit in the Liberty Hill Road area of Gilford, NH. In 1952, the Messer Street Manufactured Gas Plant (MGP) in Laconia ceased operation as a result of an explosion (Note: KeySpan is a successor owner to the company that operated the Messer Street MGP). During the decommissioning of the Messer Street MGP circa 1952-3, a third party contractor reportedly obtained permission from the owner of a gravel pit on Liberty Hill Road to dispose of liquid byproducts removed from equipment at the Messer Street facility. An unknown quantity of MGP byproducts was disposed at the gravel pit. Some time during the 1970s, the former gravel pit was developed into house lots, currently known as Liberty Hill Road.

Information regarding the off-site disposal of liquid byproducts from the former Messer Street MGP came to light in 2004 during the course of insurance coverage litigation. KeySpan notified DES that based on information developed during the aforementioned litigation it believed waste from the former Messer Street MGP was disposed at an off-site location. KeySpan notified DES in November 2004 that it believed the disposal occurred along Liberty Hill Road in the vicinity of a former gravel pit.

All potentially affected property owners were notified. The sampling and testing of drinking water wells was initiated in mid-December 2004. Since then, KeySpan has sampled the drinking water wells of any property owner in the neighborhood who has requested it.

From 2004 to mid-2006 KeySpan conducted a comprehensive site investigation of the impacted properties focusing on 69, 77, 83 and 87 Liberty Hill Road and Jewett Brook which borders these properties to the southwest. It is noted that KeySpan acquired the aforementioned properties in 2006. The work performed as part of the site investigation included groundwater monitoring, soil sampling, soil gas testing and indoor air monitoring to determine the nature and extent of contamination. A Site Investigation Report was submitted to DES in 2006. In conjunction with the receipt of this report, DES hosted a Public Information Meeting on August 10, 2006 at Gilford Town Hall to present findings of the Site Investigation Report to the community. The general findings of the report were that coal tar product and constituents associated with coal tar have impacted soil and groundwater at the aforementioned residential

properties. Contaminants attributable to coal tar were not detected in any drinking water wells. With the exception of a small side channel adjacent to Jewett Brook, no other potential exposure pathways (e.g., oral, inhalation, direct contact) have been identified. Another Public Information Meeting was held on October 11, 2006 at Gilford Town Hall to provide an update of the site investigation work that had been completed since the last meeting. Information on the health investigation and cancer analysis was also presented.

Since these initial findings EHP has reviewed all of the environmental data collect at the Site to determine if area residents were at health risk from exposure to coal tar wastes. EHP found the only completed exposure pathway for the Site is for individuals who may recreate in Jewett Brook in the area of the side channel where Site related contaminants have been detected in surface water. According to ATSDR's methodology, current exposure to surface water in the side channel poses no apparent public health hazard. This category is used when individuals at a site may be exposed to contamination but the exposure is not expected to result in harm or health problems to the individuals. The concentrations of the contaminants are not at levels that would be considered a public health hazard. Unfortunately there are no data available prior to 2005 which makes it impossible to determine if residents of Liberty Hill Road were exposed to coal tar contaminants in the past.

EHP has also conducted one of the most detailed cancer analyses ever done in the State of New Hampshire. Based on these analyses EHP has determined that there is not an elevated rate of cancer in the Liberty Hill Road area. Comparison of the Liberty Hill Road population to statewide cancer statistics found that the cancer cases reported since 1951 are substantially lower than would be expected in an average neighborhood of this type.

Based on the conclusions of this report, EHP has developed the following recommendations that will be implemented:

• EHP should offer to meet separately with concerned individuals and families to further discuss their health concerns related to possible exposure to site related contaminants.

• Surface water in Jewett Brook, especially the side channel area, should continue to be sampled.

• EHP will evaluate any new environmental data for the Site to determine if there is a health concern.

II. PURPOSE

Due to the nature and number of health concerns that community members have raised about potential past exposure and health risk, DES' Environmental Health Program prepared this Public Health Assessment for the Liberty Hill Road Site.

A Public Health Assessment is a triage tool used by public health agencies to determine if actions are needed to protect the community surrounding a hazardous waste site, and to determine if follow-up health activities (e.g., health education, medical surveillance) should be undertaken. To achieve this

goal, this assessment contains three types of evaluations: (1) the identification of pathways of exposure to site contaminants and an evaluation of their public health implications; (2) a discussion of relevant and available health outcome data; and (3) an evaluation of specific community health concerns about the site.

The New Hampshire Department of Environmental Services, Environmental Health Program (EHP) prepared this Public Health Assessment under a cooperative agreement with the U.S. Agency for Toxic Substances and Disease Registry (ATSDR).

III. BACKGROUND AND STATEMENT OF ISSUES

A. Site Description and History

The Liberty Hill Road Site (known as "Site") is located in a predominantly residential area along lower Liberty Hill Road in Gilford, New Hampshire (Figure1). The Site is comprised of four properties on which coal tar-impacted soils have been identified (69, 77, 83, and 87 Liberty Hill Road), the western portion of 63 Liberty Hill Road and an adjacent golf course property where dissolved phase product has been detected in groundwater (1). Tar impacted soils have not been found at 63 Liberty Hill Road; part of this property will be included in the Groundwater Management Zone that DES will require for the Site.

Topographically, the eastern half of the Site, along Liberty Hill Road, is relatively flat and contains the four properties referenced above (2). The ground surface slopes steeply toward Jewett Brook. A cleared area, near Jewett Brook, exists on the 83 and 87 Liberty Hill Road properties. The remainder of the Site is wooded (2).

The overburden at these properties reportedly consist of some 5-8 ft. of sand or fill material, underlain by 50 ft. to 150 ft. of glacial till, which overlies bedrock. Shallow groundwater in this area appears to be perched above the till layer. Depth to groundwater averages from 3 to 8 feet below the ground surface. Shallow groundwater flows to the northwest in the area of the residences and to the west toward Jewett Brook on the southern portion of the Site (2).

From the late 1800s until 1952, a manufactured gas plant, owned by Gas Service, Inc. operated on Messer Street in Laconia, NH. In 1952, an explosion occurred at the Messer Street facility that left it inoperable. The explosion, coupled with the introduction of a natural gas pipeline to New Hampshire during this period, ultimately led to the decision to decommission the facility. During the decommissioning of the plant, a demolition contractor removed liquid wastes from a former gas holder. They also received permission from the owner of a gravel pit on Liberty Hill Road in Gilford to transport and dispose of the wastes to that location. The actual disposal of coal tar wastes on Liberty Hill Road is thought have occurred in 1953 or 1954 (2).

Information about the disposal of coal tar wastes was discovered during the course of insurance company litigation involving Energy North Natural Gas, Inc., the successor to Gas Service, Inc., and by KeySpan which acquired Energy North Natural Gas, Inc. in 2000 (2). In a letter to DES dated October 19, 2004, KeySpan notified DES of the possibility that coal tar wastes from the former manufactured gas plant in Laconia were disposed at an off-Site location (1).

KeySpan subsequently notified DES that it believed that the wastes had been disposed on Liberty Hill Road in the area of a former gravel pit. Based on discussions with Liberty Hill Road residents, it was initially believed that the contaminants were disposed on the properties now known as 63 and 69 Liberty Hill Road. Follow up discussions with local residents indicated that the disposal of coal tar wastes occurred on 77 and 83 Liberty Hill Road (1).

KeySpan reviewed historical aerial photographs of the Site and surrounding area. An aerial photograph taken of Liberty Hill Road in 1953 shows portions of the Site partially cleared with disturbed surface soil (Figure 2). A bermed area appears near the current location of the 83 Liberty Hill Road residence. An aerial photograph taken the following year shows the same bermed area that appears black and may represent the presence of coal tar at the ground surface (Figure 3). A photograph taken in 1964, show the formerly cleared areas to be partially re-vegetated with residences present on the northern side of Liberty Hill Road opposite the Site. Subsequent photographs, taken during the 1970s, show development of the properties at 77, 83 and 87 Liberty Hill Road (Figure 4). The residence at 69 Liberty Hill Road appears on an aerial photograph taken in 1986.

Following site discovery, all potentially affected property owners were notified. Sampling and testing of drinking water wells was initiated in mid-December 2004. Since then, KeySpan has sampled the drinking water wells of any property owner in the neighborhood who has requested it.

From late 2004 to mid-2006, KeySpan conducted a comprehensive Site investigation of the impacted properties focusing on 69, 77, 83 and 87 Liberty Hill Road and Jewett Brook, which borders these properties to the southwest. In order to gain control of the site and facilitate further site investigation, KeySpan acquired these aforementioned properties in 2006. The work performed as part of the Site investigation included groundwater monitoring, soil sampling, surface water and sediment sampling, soil gas testing and indoor air monitoring to determine the nature and extent of contamination.

A Site Investigation Report was received by DES on July 3, 2006. In conjunction with the receipt of this report, DES hosted a Public Information Meeting on August 10, 2006 at Gilford Town Hall to present the findings of the report to the community. The general findings were that coal tar product and constituents associated with coal tar have impacted soil and groundwater at the aforementioned residential properties. Contaminants attributable to coal tar were not detected in any drinking water wells. With the exception of a small groundwater fed side channel adjacent to Jewett Brook, no other potential exposure pathways (e.g., oral, inhalation, direct contact) have been identified. A second Public Information Meeting was held on October 11, 2006 at Gilford Town Hall to provide an update of the Site investigation work that had been completed since the first meeting.

B. Site Visit

On March 22, 2007, representatives of EHP, accompanied by other DES staff conducted a Site visit at the Liberty Hill Road Site. During the Site visit, staff viewed the four properties (69, 77, 83 and 87 Liberty Hill Road) which comprise the Site, Jewett Brook and residential areas

adjacent to the Site (Figure 5). The four properties comprising the Site have been purchased by KeySpan Inc. The former residential dwellings located on 77 and 83 Liberty Hill Road had been demolished. EHP representatives observed the side channel at Jewett Brook where naphthalene and benzene had been detected in surface water and sediment.

C. Demographics and Land Use

Gilford is a town with a population of 6803 (3) located in Belknap County in central NH. The two Census Blocks of which Liberty Hill Road is a part contain 89 households with a population of 245 (2000 US Census enumeration).

The main population of interest includes those who resided in any of the 22 households located downhill from the Site on lower Liberty Hill Road between the 1950s and the present day. According to a population history compiled by a former resident, there were 180 individuals who lived in the neighborhood at some time between 1950 and 2007. The following table presents the number of current or former residents living in 1970, 1980, 1990, and 2000 by selected age categories.

Estimated number of current and former residents (living) of lower Liberty Hill Road by year and age group: 1970 to 2000

	1970	**1980**	**1990**	**2000**
Total Population	135	156	162	153
Age <15	39	33	18	6
Age 55+	13	26	31	39

D. Environmental Health Program Involvement

To date, the Environmental Health Program staff of DES have participated in two Site visits and several public meetings and other meetings with community residents. A summary of these activities are provided below:

- **February 15, 2007 –** Staff participated in a Site visit and later that evening a public meeting that DES sponsored in the Gilford Town Hall. The DES Epidemiologist presented a preliminary evaluation of cancer rates for the Liberty Hill Road area.

- **March 22, 2007** – Staff participated in a follow up public meeting held in the Gilford Town Hall. The purpose of the meeting was to discuss remedial alternatives for the Site and to provide an update to the cancer cluster analysis.

- **April 4 and April 23, 2007 –** Staff conducted two public availability sessions at the Gilford Town Hall to allow local residents the opportunity to meet one-on-one with Environmental Health Program staff to ask questions and to discuss their individual health concerns in a confidential setting.

- **October 9, 2007 –** Staff provided an additional update on the cancer cluster investigation at a public meeting at the Gilford Town Hall.

- **October 30, 2007 –** DES met with former residents on-site to view areas of Jewett Brook where they had played as children.

E. Quality Assurance/Control (QA/QC)

In preparing this document, DES relied on the information provided in the referenced documents. Only data collected using appropriate sampling and laboratory methods were considered in this analysis. All data and analyses were collected and performed with certified laboratories. Measurements of exposure point concentrations were taken directly from laboratory data sheets.

IV. DISCUSSION

A. Assessment Methodology

To determine whether local residents are exposed to contaminants from the Site, it is necessary to evaluate the environmental and human components that lead to human exposure. This pathways analysis consists of five elements: (1) a **source** of contamination; (2) transport of contaminants through an **environmental medium**; (3) a **point** of human exposure; (4) a **route** of human exposure; and, (5) a **receptor population**. Exposure pathways can be classified into three groups: (1) **completed pathways**; i.e., those in which exposure is reasonably likely to have occurred, to occur, or to occur in the future; (2) **potential pathways**; i.e., those in which exposure might have occurred, may be occurring, or may yet occur; and, (3) **eliminated pathways**; i.e., those that can be eliminated from further analysis because one of the five elements is missing and will never be present, or in which no contaminants of concern can be identified.

After the pathways are designated as completed, potential, or eliminated, the health risk assessor follows a two-step process to comment on public health issues related to exposure pathways at hazardous waste sites. First, the health risk assessor obtains representative environmental monitoring data for the site and compiles a list of site-related contaminants. The health risk assessor compares this list of contaminants to health-based comparison values (CVs) to identify those contaminants that do not have a realistic possibility of causing adverse health effects. These comparison values are conservative, because they include ample safety factors that account for the most sensitive populations. The health risk assessor typically uses CVs as follows: if a contaminant is never found at levels greater than its comparison value, then the health risk assessor concludes that the levels of corresponding contamination are not at levels of public health concern. If, however, a contaminant is found at levels greater than its CV, the health risk assessor designates the pollutant as a contaminant of concern and examines it further in the assessment. Because CVs are based on conservative assumptions, the presence of concentrations greater than a CV does not necessarily suggest that adverse health effects will occur among the exposed population.

For the remaining contaminants, the health risk assessor evaluates site-specific conditions to determine what exposure scenario is realistic for a given exposure pathway. Given this exposure scenario, the health risk assessor determines a dose and compares this dose to scientific studies to determine whether the extent of exposure indicates a health hazard.

B. Environmental Contamination

The initial step in the assessment process is a review of environmental contamination at the Site. The following represents a brief overview of the chemical contaminants identified in different environmental media at the Liberty Hill Road Site.

Chemical contaminants associated with the coal tar release consist of **semi-volatile organic compounds** (primarily polycyclic aromatic hydrocarbons, or PAHs) and **volatile organic compounds** (VOCs) such as benzene, toluene, ethylbenzene and xylenes (BTEX). Coal tar, because it exists as a mixture of a number of chemical substances, has a wide range of physical properties. Generally it has high viscosity (does not flow easily) and binds strongly to soil surfaces. Coal tar is relatively insoluble in water, is not very volatile, attaches readily to organic materials and breaks down slowly.

Semi-volatile organic compounds (SVOCs) have a tendency to attach to soil and sediment rather than dissolve into groundwater and do not volatilize (pass off into air) readily to soil gas or groundwater. The tendency to attach to soil particles increases with the molecular weight of the compound. This tendency is evident in that lower molecular weight compounds like naphthalene have been found throughout the Site in groundwater; heavier SVOCs have been detected in soils where coal tar wastes had been deposited in the past. PAHs are a subgroup of SVOCs and are a concern at the Liberty Hill Road Site because they are present in high concentrations in coal tar.

Volatile Organic Compounds (VOCs), such as BTEX compounds, are less dense than water and tend to be more soluble in it than SVOCs. VOCs tend to attach to organic matter in soil which slows the rate at which these compounds migrate in soil and groundwater. The soil at the Site consists largely of sand and till with little organic matter present. VOCs have been transported significant distances as shown by groundwater sampling where BTEX has been detected at sampling locations at the Site where there were no visible indications of coal tar (1).

1. Subsurface Soil Soil samples were collected in July 2005 for chemical analysis for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and other analytes (metals, polychlorinated biphenyls (PCBs), and total cyanide). PCBs and cyanide were not detected in concentrations above laboratory detection limits while metals were not detected at levels above background concentrations. Samples collected after July 2005 therefore were analyzed only for VOCs and SVOCs (2).

Site investigation activities were conducted August through November 2006 to determine the extent of SVOCs (primarily polycyclic aromatic hydrocarbons) and VOCs (primarily benzene, toluene, ethylbenzene, and xylene; also known as BTEX) in subsurface soil. These contaminants of concern were not found in soil on properties to the east of Liberty Hill Road.

Coal tar contaminated soils were found in the four principal properties (69, 77, 83 and 87 Liberty Hill Road) that comprise the Site (2).

Visual observation of coal tar wastes were observed in subsurface soil in a number of test borings throughout the Site; the extent of contamination exceeding the DES S-1 soil standards coincided with areas of visible coal tar. The area impacted by coal tar wastes is primarily located on the central portions of 77 and 83 Liberty Hill Road, extending to the western portion of the 97 Liberty Hill Road property. A smaller area where coal tar contamination exists is near the boundary of the 69 and 77 Liberty Hill Road properties. Benzene, naphthalene and toluene were detected in subsurface soil samples collected at 77 Liberty Hill Road. Of these contaminants, only benzene was detected at a concentration exceeding its DES S-1 soil standard. Likewise at 83 Liberty Hill Road several VOCs were detected in subsurface soil samples but only benzene and naphthalene were found at concentrations exceeding their respective S-1 soil standards (1). The following table represents contaminants in subsurface soil that exceed soil standards at the Site:

Contaminants in Subsurface Soil at the Liberty Hill Road Site

Contaminant	Range of Detected Concentrations (ppm)	Comparison Value (ppm)	Reference
Benzene	<0.019-5.59	0.3	DES S-1
Naphthalene	<0.2-1,870	5	DES S-1

ppm = parts per million
DES S-1 = NH DES Risk Characterization and Management Policy Method 1 Soil Standards

Coal tar contaminants in subsurface soil consist primarily of PAHs and BTEX. Concentrations of contaminants were highest within an area about 100 feet from the rear of the residences at 77 and 83 Liberty Hill Road. The area where tar deposits were observed in the upper 10 ft. of the ground surface is approximately 100 by 320 feet. At greater depth (20-40 feet) tar impacted soil extends over a larger area of some 200 by 400 ft. (1). The extent of coal tar (staining of soil, odors) and locations where coal tar constituents exceed their respective S-1 standards are more fully discussed in the Remedial Action Plan. Figure 6 indicates the estimated lateral extent of coal tar contaminated soil where individual contaminants exceed their respective S-1 standards.

Vertically, coal tar contaminated soils were observed at depths of up to 50 feet from the ground surface (Figures 7, 8). As with the lateral distribution of coal tar wastes, the vertical extent of coal tar contamination was determined by the visual presence of tar. Exceedances of the S-1 standards in samples collected below 40 ft. were limited to benzene and are likely associated with the presence of benzene in groundwater in this area (1).

2. Groundwater Coal tar related contaminants in groundwater consist primarily of PAHs and BTEX. Concentrations of contaminants in groundwater were found to be highest in the area behind the former residences of the properties at 77 and 83 Liberty Hill Road and to extend below and down gradient of areas with visible coal tar (Figure 9). Some of these contaminants exceeded the State's groundwater standards. A brief summary of these contaminants detected

in groundwater at the Site and their respective concentrations are included in the following table:

Groundwater Contamination at the Liberty Hill Road Site

Contaminant	Range of Detected Concentrations (ug/L)	Comparison Value (ug/L)	Reference	Frequency of Detections above the GW- 1 Standard
Benzene	<0.50- 23,400	5	DES GW-1	14/17
Naphthalene	<5- 8,180	20	DES GW-1	15/17
Styrene	<5-2,050	100	DES GW-1	7/17
Toluene	<1- 16,800	1,000	DES GW-1	7/17
1,2,4-trimethyl-benzene	<5- 658	330	DES GW-1	7/17

ug/L = micrograms per liter
DES GW-1 = NH DES Risk Characterization and Management Policy Method 1 Groundwater Standards

The lateral extent of groundwater contamination has been determined for the properties at 69, 77, 83 and 87 Liberty Hill Road and the western portion of 63 Liberty Hill Road. Likewise, the vertical extent of contamination has been determined and appears to be limited to groundwater in the upper 100 ft. of till. The underlying bedrock aquifer has not been shown to be impacted. Upward gradients in the area of Jewett Brook indicate groundwater discharges to the brook. This is borne out by levels of naphthalene and benzene detected in surface water and sediment in the side channel of Jewett Brook (refer Section 8).

3. Surface Soil A total of 20 surface soil samples were collected on the properties at 69, 77, 83 and 87 Liberty Hill Road (Figure 10). Samples were collected from the upper two inches of the ground surface in areas considered to have the highest likelihood of high intensity use (children's play areas, steps, etc.) (2). PAHs were detected in three surface soil samples from 77 Liberty Hill Road and one surface soil sample from 83 Liberty Hill Road. PAH concentrations of one of the samples from 77 Liberty Hill Road exceeded the S-1 soil standards. Subsequent analysis of the sample revealed that it contained small particles of asphalt. Since the sample was collected within two feet of a driveway it was felt that the source of the PAHs was the asphalt particles (2). The other surface soil samples collected from this property and the sample from 83 Liberty Hill Road were below the S-1 soil standards. Exposure to surface soil is not considered to be a pathway of concern.

4. Drinking Water The four residential properties that primarily comprise the Site (69, 77, 83 and 87 Liberty Hill Road) and most of the immediate surrounding properties are serviced by on-site drinking water wells screened in bedrock. Two properties at 48 and 70 Liberty Hill Road are serviced by shallow dug wells. From late 2004 through 2006, drinking water samples from the wells located at 28, 48, 58, 63, 64, 70, 77, 78, 83, 87 and 90 Liberty Hill Road were analyzed for VOCs and SVOCs (1). Contaminants of potential concern associated with the Site were not detected in the drinking water samples.

Methyl-tert-butyl ether (MTBE) was detected in the drinking water sample taken from 58 Liberty Hill Road at a concentration below the DES GW-1 standard. Acetone was detected in the sample from the drinking water well at 77 Liberty Hill Road, also at a concentration below the DES GW-1 standard for that contaminant. MTBE is an additive that was introduced to gasoline in the mid 1990s to make it burn more cleanly and to reduce air pollution (4). Acetone is a manufactured chemical that is also found naturally in the environment. It is used as a solvent (5). Neither MTBE nor acetone are attributable to coal tar or their byproducts and, therefore, are not considered to be Site related (4).

The Gilford Village West Condominiums, located approximately ½ mile from the Site, at the intersection of Liberty Hill Road and Country Club Lane, are serviced by two public drinking water wells. The wells at this complex are sampled annually for VOCs. Drinking water test results were evaluated for the five year period preceding the initial environmental investigation. Water test reports for samples collected between 2000 and 2005 have been negative for VOCs (1).

Drinking Water Testing Results- Liberty Hill Road (Private Wells)

Chemical	Maximum Detected Concentration (ug/L)	Comparison Value (ug/L)	Source
MTBE	0.65	13	DES GW-1
Acetone	14.3	6,000	DES GW-1

ug/L = micrograms per liter
DES GW-1 = NH DES Risk Characterization and Management Policy Method 1 Groundwater Standards

5. Soil Gas A number of soil gas samples were collected on Site properties to evaluate the potential for coal tar related contaminants to migrate from groundwater and subsurface soil to indoor residences (2).

In 2005 four soil gas sampling points were installed adjacent to each of the residences at 69, 77, 83 and 87 Liberty Hill Road. One sampling point was installed on each side (north, east, south and west) of these four residences. In addition, four sub-slab soil gas sample points were installed at the 83 Liberty Hill Road property (two beneath the basement foundation, two beneath the garage slab (2).

During 2006 soil gas samples were again collected at locations adjacent to the foundations of 77 and 87 Liberty Hill Road. Two sub-slab samples were also collected from beneath the basement foundation of each residence (2).

Results of the soil gas samples collected at all of these properties were compared with the screening values adopted in NH DES' vapor intrusion guidance policy (6). The screening values contained in this policy represent concentrations of specific contaminants in soil gas below which the potential migration to indoor air at significant levels is not expected. Soil gas samples collected at these properties were found to contain a number of compounds associated with coal tar (benzene, naphthalene, trimethylbenzene) (1). Concentrations of these contaminants were found to be orders of magnitude below their respective screening values

indicating that vapor intrusion is not an exposure pathway of concern with respect to indoor air in these residences.

6. Indoor Air To evaluate residents' potential exposure to contaminants in indoor air, samples were collected at the following locations: 77, 83 and 87 Liberty Hill Road. The results, by residence, are as follows:

77 Liberty Hill Road. In August 2006 four indoor air samples (two samples each from the basement and first floor) were collected inside the former residence at 77 Liberty Hill Road. Samples were analyzed for VOCs and SVOCs (1). Compounds attributable to coal tar wastes were not detected in indoor air. Of the remaining compounds, most compounds that were detected were within the range of background concentrations typically found in indoor air (6, 7). Chloroform was detected in the basement area at 1.24 ug/m^3 which is above its New Hampshire indoor air screening level of 1.0 ug/m^3 (6). Methylene chloride was detected at 37.7 ug/m^3 which is above its respective screening level of 5.6 ug/m^3 (8). Methylene chloride is considered a common laboratory contaminant (9). Chloroform is used in the manufacture of a number of chemicals. Neither is associated with coal tar wastes (10).

83 Liberty Hill Road. Indoor air samples were collected at this former residence on August 2005 and February 2006. Samples were collected from the basement, first floor and garage during both sampling rounds (1). Contaminants attributable to coal tar wastes were not detected in indoor air within the home. Benzene was detected in the garage in August 2005 at a concentration of 19 ug/m^3 which exceeds its NH Indoor Air Screening Value of 0.3 ug/m^3 (6). The level of benzene in the garage is thought to be related to the storage of a snow blower and gasoline container at that location. Benzene levels observed in indoor air in the basement and in soil gas during that time were much lower than the level found in the garage (1). Re-testing of the garage in February 2006 showed a decrease in the airborne concentration of benzene after these objects were removed. This indicated that the level of benzene originally found in indoor air within the garage was probably not related to the Site.

87 Liberty Hill Road. Four indoor air samples were collected at this location in November 2006 (two samples each from the basement and first floor) (1). Naphthalene was detected in the first floor living room at a concentration of 8.54 ug/m^3 exceeding its NH Indoor Air Screening Value of 2.6 ug/m^3 (6). The concentration of naphthalene detected in this sample is at least an order of magnitude greater than the levels detected in indoor air in the basement and in soil gas samples collected near the perimeter of the building. Although naphthalene is associated with coal tar, the lower levels found in soil gas and the basement area may indicate that there is another source of naphthalene within the home.

Indoor Air Testing Results

Location	Chemical	Maximum Detected Contamination (ug/m^3)	Comparison Value (ug/m^3)	Source
77 LHR	Chloroform	1.24	.04	CREG
77 LHR	Methylene Chloride	37.7	2	CREG
83 LHR	Benzene	19.3	0.1	CREG
87 LHR	Naphthalene	8.54	4	Chronic EMEG

ug/m^3 = micrograms per cubic meter
LHR = Liberty Hill Road
CREG = Cancer Risk Evaluation Guide (ATSDR)
EMEG = Environmental Media Evaluation Guide (ATSDR)

7. Ambient Air Four ambient air samples each were collected close to the dwellings at the 77 and 87 Liberty Hill Road properties in August 2006 (1). The compound 1,1,2-trichloroethane was detected at a concentration of 31.8 ug/m^3 exceeding its screening value of 1.1 ug/m3 in a sample collected near the front steps of 77 Liberty Hill Road. This compound was not detected in any of the other ambient air samples collected on this property. 1,1,2-trichloroethane is an organic compound used as a chemical intermediate in the production of synthetic fibers, coatings and other products (11, 12). It is not associated with coal tar wastes.

Naphthalene (39.7 ug/m^3) and 1,2,4-trichlorobenzene (9.22 ug/m^3) were detected in an ambient air sample collected near the back porch steps of the residence at 87 Liberty Hill Road (1). The concentrations of both compounds exceeded their respective screening values (see below). 1,2,4-trichlorobenzene is used in the manufacture of pesticides and other organic chemicals and it is a constituent in many wood preservatives (13). 1,2,4-trichlorobenzene is not associated with coal tar wastes. Naphthalene is associated with coal tar. The concentration of naphthalene detected in outdoor air behind the house is approximately 1-2 orders of magnitude greater than the levels found in almost all of the soil gas and sub slab samples collected on the property (1). This difference would indicate that there may be other sources for the naphthalene detected in outdoor air.

Ambient Air Testing Results

Chemical	Maximum Detected Concentration (ug/m^3)	Comparison Value (ug/m^3)	Source
1,1,2-trichloroethane	31.8	0.06	CREG
Naphthalene	39.7	2.6	Chronic EMEG
1,2,4-trichlorobenzene	9.22	3.7	NS

ug/m^3 = micrograms per cubic meter
CREG = Cancer Risk Evaluation Guide (ATSDR)
EMEG = Environmental Media Evaluation Guide (ATSDR)
NS = no standard

8. Surface Water and Sediment In April and May, 2006 a total of 11 sediment samples were collected in Jewett Brook along upstream and downstream locations from the Site (2).

Naphthalene and BTEX (benzene, toluene, ethylbenzene and xylene) were detected in one of the samples (SED 107) which is located in a small side channel of Jewett Brook (Figure 11). Benzene was detected in sediments at a concentration of 0.5 ppm which slightly exceeds the DES S-1 standard of 0.3 ppm. The other compounds were detected at levels below their respective standards. Naphthalene was detected at 1 ppm in sediments at this location. A naphthalene odor was noted in Jewett Brook near this location although it was not detected in other sediment samples (1).

Sediment Testing Results

Chemical	Maximum Detected Concentration (ppm)	Location	Comparison Value (ppm)	Source
Benzene	0.5	SED107	0.3	DES S-1
Naphthalene	1.0	SED107	5	DES S-1

ppm = parts per million
DES S-1 = NH DES Risk Characterization and Management Policy- Method 1 Soil Standards

Surface water samples were collected in Jewett Brook in April and May 2006 at the same locations as the sediment samples (2). Additional surface water samples were collected in November 2006 and July 2007. Naphthalene and BTEX were detected in samples (SW107) collected in the same side channel where contaminants had been discovered in sediments (1). These compounds were also detected in groundwater samples collected near the brook indicating that contaminant migration to surface water in Jewett Brook is by groundwater discharge. Benzene was detected at concentrations exceeding its comparison value. The maximum detected concentration of benzene was 418 ug/L which exceeds the 0.6 ug/L comparison value. Benzene concentrations in surface water at sampling location SW107 increased from 86.5 ug/L in May 2006 to the maximum detected concentration of 418 ug/L in July 2007 (14). Although this level is not considered hazardous, people should avoid this side channel to prevent potential exposure.

Surface Water Testing Results

Chemical	Maximum Detected Concentration (ug/l)	Location	Comparison Value (ug/l)	Source
Naphthalene	10.9	SW107	100	LTHA
Benzene	418	SW107	0.6	CREG

ug/l = micrograms per liter
LTHA = Lifetime Health Advisory
CREG = Cancer Risk Evaluation Guide (ATSDR)

C. Analysis of Exposure Pathways

The pathways analysis section is where health risk assessors evaluate the human and environmental components to determine whether individuals have been exposed to contaminants at the Site. As previously indicated, there are five elements that constitute an exposure pathway. First, there must be a source of contamination. Second, there must be

transport of contamination through an environmental medium, such as soil, air or groundwater. Next, there must be a point of exposure, where individuals come into physical contact with the contaminants. Fourth, there must be a route of exposure such as ingestion, inhalation or dermal contact. Finally, there must be people who can be exposed to the contamination. When all five elements of an exposure pathway exist it is called a *completed exposure pathway*. If at least one of these elements is missing the pathway is considered to be a *potential exposure pathway*.

The significance of considering *exposure pathways* for evaluating a hazardous chemical release and its impact on a community is that it provides the health risk assessor with a method to systematically review all of the possible ways that people can be exposed and potentially be put at risk. For the Liberty Hill Road Site, the following exposure pathways have been identified:

1. Completed Exposure Pathways

Name	Source	Transport and Media	Exposure Point	Route of Exposure	Exposed Population	Time Frame
Jewett Brook- Recreational	Coal Tar Wastes	Groundwater	Surface Water	Ingestion Dermal	Local Residents	Present

At the present time, EHP considers incidental ingestion and dermal exposure to contaminated surface water in Jewett Brook to be a *completed exposure pathway* for the Site. Sampling conducted in 2005 and 2006 in the side channel next to Jewett Brook (69 Liberty Hill Road, bottom of slope) found benzene and naphthalene in surface water at concentrations above their respective comparison values. Individuals who access this area for recreational purposes (children playing, wading) may come into contact with contaminated surface water. EHP has evaluated potential exposure to contaminated surface water and sediment in Jewett Brook in the following section (Section D- Public Health Implications).

2. Potential Exposure Pathways (Present)

Name	Source	Transport and Media	Exposure Point	Route of Exposure	Exposed Population	Time Frame
Drinking Water (Off Site)	Coal Tar Wastes	Groundwater	Tap Water	Ingestion Inhalation Dermal	Local Residents	Present Future
Surface soil (On Site)	Coal Tar Wastes	Soil	Surface soil	Ingestion Inhalation Dermal	Local Residents	Present Future

At present, exposure to coal tar related contaminants does not represent a significant public health concern at the Site. Off site residents of the lower Liberty Hill Road area are not being exposed to contaminants in their drinking water (1). The drinking water wells located on lower Liberty Hill Road and the public water system serving the nearby condominium complex have not been shown to have been impacted by Site contamination. Coal tar constituents have not been detected in surface soils on Site properties at levels of public health concern (2).

3. Potential Exposure Pathways (Past)

Name	Source	Transport and Media	Exposure Point	Route of Exposure	Exposed Population	Time Frame
Site Workers On Site	Coal Tar Wastes	Subsurface Soil	Excavations	Ingestion Inhalation Dermal	Construction Workers	Past
Jewett Brook-Recreational	Coal Tar Wastes	Groundwater	Surface Water And Sediments	Ingestion Dermal	Local Residents	Past
Indoor Air	Coal Tar Wastes	Soil Gas	Indoor Air-Dwelling	Inhalation	Local Residents	Past

Disposal of coal tar wastes on Liberty Hill Road is thought to have occurred in the early 1950s, sometime after the accident at the Messer Street MGP site in 1952. The earliest environmental data that was collected as part of the ongoing Site investigations are from 2004 (2). Although there are no data available prior to this time to evaluate exposure, it is possible that some individuals on Liberty Hill Road may have been exposed to Site related contaminants in the past. There are references from the 1970s to contractors uncovering possible coal tar contaminated subsoil on Site properties while excavating for leaching systems (1). Contractors who were involved in excavating and putting in foundations for residences on the Site may also have been exposed to coal tar contaminated subsoil during the course of their work on these properties. Exposure to Site related contaminants for builders and other contractors who were involved in excavation or construction work is considered to be a *potential exposure pathway.*

Liberty Hill Road residents who lived in homes located on the Site may have been exposed to contaminants in indoor air. Residents who recreated in the past in Jewett Brook may have been exposed to site related contaminants although current data indicate that this has occurred in only one exposure point (sampling location SW 107) in the side channel of the brook (14). Again, there are no data available from this time to determine whether individuals were being exposed and to evaluate the exposure. Residents' past exposure to indoor air and to coal tar related contaminants in surface water in Jewett Brook represent *potential exposure pathways.*

4. Eliminated Exposure Pathways

Name	Source	Transport and Media	Exposure Point	Route of Exposure	Exposed Population	Time Frame
Drinking Water-On Site	Coal Tar Wastes	Contaminated Groundwater	Tap Water	Ingestion Inhalation Dermal	On site Residents	Present Future
Indoor Air On Site	Coal Tar Wastes	Soil Vapor	Indoor Air	Inhalation	On Site Residents	Present Future
Subsurface Soil	Coal Tar Wastes	Subsurface soil	Subsurface Soil	Ingestion Inhalation Dermal	On Site Residents	Present Future

The properties at 69, 77, 83 and 87 Liberty Hill Road were purchased by KeySpan to facilitate Site clean up. The dwellings at 77 and 83 Liberty Hill Road have been demolished. Potential future exposure to coal tar wastes for on Site residents represents an *eliminated exposure pathway*. The environmental investigations conducted to date indicate that coal tar wastes in subsoil and contaminated groundwater have not migrated beyond the Site. It is unlikely that off-Site residents have been directly exposed to coal tar wastes at their properties.

D. Public Health Implications of Exposure

At the present time the only completed exposure pathway that exists for the Site is exposure to coal tar related contaminants in the side channel of Jewett Brook (sampling location SW 107). EHP evaluated potential exposure for an adult and child recreator who frequently visits Jewett Brook and who might theoretically spend all of their time and receive all of their exposure from contact with contaminated surface water and sediments in the side channel where coal tar related contaminants were detected (SW 107). EHP included an assumption that these individuals, besides deriving all of their exposure to surface water at this one location, were exposed to the maximum concentrations of the Site related contaminants that were detected at this location. For both the adult and child, EHP assumed that exposure took place on an average of 80 days per year for a period of 24 years for the adult and 12 years for the child. For both individuals the estimated lifetime cancer risk was very low (less than 1×10^{-6} excess lifetime cancer risk). Cancer risks greater than 1×10^{-6} (or 1 excess cancer case per million individuals exposed over a lifetime) is the level that EHP begins to consider significant. The likelihood that non-cancerous health effects would occur following exposure under these circumstances is also very low. The Hazard Index for non-cancer effects was .06 (a Hazard Index of 1.0 is considered significant and represents the level at which adverse health effects might be expected to occur). Current exposure to contaminants in surface water does not constitute a *significant exposure pathway*.

As previously indicated, there are no environmental sampling data available for the Site from the early 1950s until site investigations began on Liberty Hill Road in 2005. Contractors who were involved with installing leaching systems and constructing the residences on site properties may have been exposed to site related contaminants while engaged in these activities. Residents of these properties may have been exposed to contaminants in indoor air from the potential migration of soil gas from source areas into the dwellings. Residents who recreated in Jewett Brook might also have been exposed to Site contaminants in surface water although recent data indicate that coal tar related contaminants have been detected in only one location.

Several current and former residents of Liberty Hill Road have requested information on the health effects associated with possible exposure to chemical contaminants at the Site (15, 16, 17, 18). Coal tar typically exists as a complex mixture of a number of different chemicals. At Liberty Hill Road the contaminants of concern in coal tar consist primarily of PAHs and BTEX compounds. Toxicological information on PAHs and other constituents of coal tar are summarized in Appendix B. It is important to note that, in general, information about the health effects of coal tar exposure that is contained in the medical and research literature relate

primarily to occupational exposure situations that may be substantially different than what residents are likely to have experienced at Liberty Hill Road in the past.

Benzene

Benzene is a known human carcinogen. Data from both human and animal studies indicate that benzene and/or its metabolites are capable of damaging genetic material in cells. Epidemiological and case studies of occupational exposures consistently correlate benzene exposure with acute non-lymphocytic leukemia (19).

The most noted systemic effect resulting from intermediate and chronic benzene exposure is on the blood. Specifically, a causal relation exists between benzene exposure and aplastic anemia in humans. This disorder is characterized by reduction of all cellular elements in the peripheral blood and bone marrow. Aplastic anemia that results from benzene exposure is also associated with an increased risk of developing acute non-lymphocytic leukemia (19).

Naphthalene

Naphthalene is found naturally in fossil fuels like coal and oil. It is used in the production of a wide range of products such as moth repellents, dyes, leather goods and insecticides. The primary way that individuals can be exposed to naphthalene is through breathing contaminated air. Eating or drinking contaminated foods and water and handling moth repellents, such as mothballs, are also ways that people can be exposed. Exposure to very large amounts of naphthalene may damage or destroy the red blood cells in your body (20). Levels of naphthalene exceeding the state's Groundwater Standards were found in groundwater beneath the Site. As indicated in the Environmental Contamination Section, residents on lower Liberty Hill Road are not using this contaminated groundwater as their source of drinking water. The underlying bedrock aquifer that residents have been using for their drinking water supply has not been shown to be impacted. There is no direct evidence that naphthalene causes cancer in humans (20). The EPA, nevertheless, has classified naphthalene as a possible human carcinogen (Group C) based on limited evidence of cancer in laboratory animals.

V. HEALTH OUTCOME DATA

A. Background

A health outcome data review (HOD) is used to evaluate disease burden in a community. The objective is to determine if rates of certain adverse health effects in an area are higher than expected when compared to a standard reference group. ATSDR includes an HOD as part of a Public Health Assessment if one of two criteria is met: 1) the review of environmental data concludes that a completed exposure pathway exists and may lead to adverse health effects; or 2) residents express concerns about abnormally high incidence or prevalence of disease in the community.

In the case of the Liberty Hill Site, the HOD was initiated in response to concerns expressed by the Town of Gilford, regarding a perceived excess in the number of cancer cases among current

and former residents of 22 households on lower Liberty Hill Road. In January 2007, the Town Administrator received a list from an anonymous citizen that contained the names and addresses of current or former residents with a variety of health problems, including 19 cancer cases. The Town forwarded the list to the New Hampshire Department of Health and Human Services (NH DHHS) Chronic Disease Program, along with a request to review the data to let them know if they should be concerned over what was characterized as "…a high concentration of cancer related illness in the area of Liberty Hill over an extended period of time." (21).

In accordance with the disease cluster protocol of NH DHHS, the request was forwarded to the DES Environmental Health Program (EHP) which carried out the investigation. Preliminary findings of EHP's investigation were presented at a public meeting at the Gilford Town Offices on February 15, 2007. These included cancer statistics for the Town of Gilford as a whole, and for the two Census Blocks of which Liberty Hill Road is part. For each of these levels of analysis, the actual number of cancer cases reported in the New Hampshire State Cancer Registry (NHSCR) was within the range that would be expected based on statewide averages.

Several residents and town officials at the February 2007 meeting expressed concern that the analysis did not focus specifically on the 22 households in question, but rather on larger populations and geographic areas. It was explained by EHP that specific limitations of cancer registry data and Census population data precluded its ability to conduct an analysis based solely on current and former occupants of the 22 households of lower Liberty Hill Road. First, the New Hampshire State Cancer Registry (NHSCR), like the vast majority of cancer registries in the nation, is based on patient's residence at diagnosis, and does not include any history of where patients lived prior to, or subsequent to diagnosis. For this reason, it is not possible to routinely document cancer cases of "former" residents, but only of residents who lived in the neighborhood at the time of diagnosis. The unofficial list of 19 cancer cases submitted anonymously was an attempt to document former and current residents' cancer experiences. According to published newspaper reports (22, 23), the 19 cases span at least a 50-year period and include several different cancer sites. Due to confidentiality rules and incomplete information, these cases cannot be completely verified in this investigation. Nonetheless, the number provides a reference point with which a reasonable estimate of "expected" cancer incidence in the neighborhood can be compared.

Two other factors that limit the ability to carry out neighborhood-level analyses are the absence of both historical population data, and population data for areas smaller than Census Blocks. Population data are used as denominators in the calculation of cancer rates, which provide the basis for comparing one group's cancer burden with another's. Census Blocks are the smallest geographic units for which official population data are routinely available. Furthermore, Census population data are enumerations or estimates for a single point in time – i.e., they do not include historical residential information for an area.

Following this discussion, one former resident of lower Liberty Hill Road volunteered to compile the neighborhood's population history, with the understanding that EHP would then take the information and calculate an estimated number of "expected" or "predicted" cancer cases for both current and former residents of the 22 households of lower Liberty Hill Road. The information on the neighborhood's population history was gathered over the next several

months and the findings were submitted to EHP in three iterations between July and October 2007. The findings based on this population information are presented below.

Presented below are findings of the cancer investigation from the Town of Gilford as a whole (expected and actual number of cancer cases, 1989-2003) and for current and former residents of the 22 households of lower Liberty Hill Road (expected number of cases only, 1987-2003).

B. Summary of Findings

Based on the age and sex characteristics of current and former residents of the 22 households on lower Liberty Hill Road, there is no evidence of elevated cancer rates in the neighborhood. An anonymous list provided to the Town of Gilford identified 19 cancer cases in these 22 households since 1951. A population history of current and former residents compiled by a former neighborhood resident documented 180 individuals who resided in the 22 households at some point between 1949 and 2007. Based on statewide cancer statistics applied to the age and sex of these individuals, 19 cancer cases would have been expected between 1987 and 2004. The statistical range of expected cases for this period of time is between 10 and 28. Therefore, the 19 cancer cases since 1951 documented in the anonymous list is substantially lower than would be expected in an average neighborhood of this type.

Methods:

Cancer Incidence Data Source. Cancer became a reportable disease in New Hampshire in 1985, and since 1986 the NHSCR has been charged with identifying all new cases of cancer occurring among New Hampshire residents. Health Statistics and Data Management (HSDM), within NH DHHS has overall responsibility for the NHSCR, which it funds through a state contract. Dartmouth College has continuously held the contract to operate the NHSCR since its inception. The registry is administratively located in the Norris Cotton Cancer Center. The US Centers for Disease Control and Prevention (CDC) currently provides a grant to NH DHHS, and these funds have been used to help increase the scope of registry information and to assure the quality of the data collected. Cancer data are collected in accordance with NH Administrative Rules. HSDM receives the cancer data set from the NHSCR. NHSCR currently collects reports from hospital registrars operating in all the large hospitals in New Hampshire. Hospitals with relatively smaller caseloads of cancer (fewer than 100 cases per year) generally do not have their own cancer registry, so NHSCR staff assists these hospitals with their reporting duties. NHSCR also receives reports of cases from physician practices, freestanding radiation oncology centers, out-of-state pathology laboratories and other sources, as required by NH Administrative Rules. In addition, the NHSCR receives reports for New Hampshire residents who are diagnosed outside of the state, based on agreements of information exchange with other states.

Study Years and Case Definitions. Multiple years of data are employed in the evaluation of cancer incidence data because they were the most recent data available, and because multiple years of data are needed to provide large enough numbers to yield meaningful statistics for smaller areas such as individual towns, census blocks, or neighborhoods. For town-level analysis, an incident case was defined as an individual residing within the Town of Gilford who

was diagnosed with a new primary malignant cancer during the evaluation period. The variables analyzed included: city/town of residence at time of diagnosis, street address at time of diagnosis, primary cancer type, date of diagnosis, age at diagnosis, and sex. Information on other risk factors, such as health-related behaviors, environmental and occupational exposures, or access to medical care, is not available in the abstracted medical data used in this review.

Population Data Sources. Population estimates for the Town of Gilford for 1989-2003 are from Claritas Corporation (24). Data on the population of current and former residents of lower Liberty Hill Road are based on research carried out by a former resident of the lower Liberty Hill Road neighborhood using deed searches and personal interviews. Summary age and sex statistics from that research were provided to EHP for the calculation of expected cancer incidence.

Standardized Incidence Ratio Methodology. The descriptive epidemiological analyses of cancer incidence in this report were conducted using the Standardized Incidence Ratio (SIR) technique. The SIR is used to analyze disease incidence in small areas, and is the first step in NH's disease cluster investigation protocol. The SIR compares the actual (observed) number of cancer cases in the study population to the number that would be expected to occur if that population had the same age- and sex-specific cancer rates as the State of New Hampshire. An SIR is the ratio of the observed number of cases to the "expected" number of cases in the study population. For the town level analysis, these ratios were calculated for all 24 major cancer types. For the Census Block analysis, they were calculated for total cancers, and for liver, lung, leukemia, and melanoma cancers as a group. For current and former residents of lower Liberty Hill, the analysis was restricted to total cancers only.

The purpose of an SIR study is to identify unusually high (or low) disease rates in an area. Once identified, an assessment is made as to whether the disease in question might be amenable to public health intervention. It is important to emphasize that the term "expected" as used in this study is based only on the characteristics of age and gender. It does not take into account other determinants of disease rates such as health-related behaviors (e.g., tobacco and alcohol use, diet), environmental or occupational exposures, or access to health care (e.g., insurance status, other financial and personal barriers).

The SIR tells us how much higher or lower the study populations' cancer rates are than those of the comparison population (State of New Hampshire) based on age and sex. If the observed number of cases is the same as the age-sex expected number, the SIR will equal 1. If there are more observed cases than would be expected, then the SIR will be greater than 1. If there are fewer observed cases than expected, the SIR will be less than 1. For example, if 10 cases are observed in the study population, but 5 cases were expected, then the SIR = 10/5 = 2.0 and the area has twice number of cancer cases as expected. But if 20 cases were expected, then the SIR = 10/20 = 0.5, meaning that the area has half the expected number.

Caution should be exercised when interpreting the SIR. The interpretation must take into account the actual number of cases observed and expected, not just the ratio. Two SIRs can have the same ratio, but represent very different scenarios. For example, a SIR of 1.5 could mean 3 cases were observed and 2 were expected (3/2 = 1.5). Or it could mean 300 cases were observed and 200 were expected (300/200 = 1.5). In the first instance, only 1 “excess” cancer case occurred, which would most likely have been due to chance. But, in the second instance, 100 excess cancers occurred, which would most likely not be a chance occurrence. This elevated ratio would then be investigated further to determine if it can be linked to any known cause or set of causes.

To help interpret the SIR, the statistical significance of the difference between state and local disease rates is calculated. In other words, the number of observed cases can be determined to be significantly different from the age-sex expected number of cases or the difference can be due to chance alone. "Statistical significance" for this review means that there is less than 5 percent chance (p-value <0.05) that the observed difference is merely the result of random fluctuation in the number of observed cancer cases. If the SIR is found to be statistically significant, then the difference between the expected and observed cases is probably due to some set of factors that influences the rate of that disease. If the lower 95% confidence interval (CI) is over 1.00, then the observed number of cancer cases in the time period is “significantly higher” than expected. If the upper 95% CI is below 1.00, then the observed number is “significantly lower” than expected.

New Hampshire’s average annual age-sex specific cancer incidence rates were used to derive the expected number of cancer cases for the Town of Gilford and the lower Liberty Hill Road neighborhood. SIRs were calculated for each cancer type and reported when 5 cases or more were observed within the reporting period. When there are between one and four cases of cancer they are not reported (for privacy reasons) in accordance with the HSDM data release policy.

Actual and Expected Cancer Incidence: Town of Gilford, 1989-2003

Table 1 presents cancer statistics for the Town of Gilford. The only cancer type that was statistically elevated for this time period was melanoma, which was also elevated for all towns in Belknap County during this time period. Cancer of the Oral Cavity and Pharynx was lower than expected for the Town of Gilford during this period.

Cancer Incidence by type: Gilford NH residents, 1989-2003.

Cancer Type	Observed Number	Age-Sex Expected Number	Observed minus Expected	SIR (Obs/Exp)	95% CI Lower	95% CI Upper
Bladder	38	34	4	1.12	0.79	1.53
Brain & Other CNS	8	8	0	0.95	0.41	1.87
Breast	102	85	17	1.20	0.98	1.46
Cervix Uteri	2	5	-3	0.39	0.04	1.41
Colorectal	60	67	-7	0.89	0.68	1.15
Esophagus	6	7	-1	0.86	0.31	1.87
Hodgkin Lymphoma	1	3	-2	0.33	0.00	1.82
Kidney & Renal Pelvis	14	13	1	1.07	0.59	1.80
Larynx	2	7	-5	0.30	0.03	1.10
Leukemia	13	13	0	0.99	0.53	1.70
Liver	6	4	2	1.45	0.53	3.16
Lung & Bronchus	72	87	-15	0.83	0.65	1.04
Melanoma of Skin	35	22	13	1.62	1.13	2.26
Multiple Myeloma	7	6	1	1.10	0.44	2.27
Non-Hodgkin Lymphoma	28	20	8	1.42	0.94	2.05
Oral Cavity & Pharynx	6	14	-8	0.44	0.16	0.95
Other	31	39	-8	0.79	0.54	1.12
Ovary	6	10	-4	0.58	0.21	1.26
Pancreas	10	12	-2	0.81	0.39	1.50
Prostate	94	90	4	1.04	0.84	1.27
Stomach	3	8	-5	0.39	0.08	1.13
Testis	1	3	-2	0.38	0.01	2.14
Thyroid	1	5	-4	0.19	0.00	1.06
Uterine	20	17	3	1.21	0.74	1.86
TOTAL INVASIVE	566	578	-12	0.98	0.90	1.06

Expected Cancer Incidence: Lower Liberty Hill Road, 1989-2003

In response to concerns that the town-level and Census Block-level investigations were not specific enough, EHP calculated an estimate of the number of cancer cases that would be "expected" or "predicted" for current and former residents of the 22 households on lower Liberty Hill Road from 1989 through 2003. The estimate was made possible by information provided by a former Liberty Hill resident who compiled a complete residential history including gender and estimated dates of birth of the 180 individuals who occupied the 22 households at some point between 1949 and 2007. The residential data were then aggregated into age-sex categories for the years 1987 through 2004 and forwarded to EHP. EHP applied statewide cancer rates to the age-sex categories of current and former lower Liberty Hill

residents and calculated an "expected" number and range of cases for 1989-2003. The primary purpose of the analysis was not to derive a specific number (in part because the residential history is best characterized as an estimate), but rather to provide a reasonable estimate of the number cancer cases that can be expected in a neighborhood with the demographic history of such as that of lower Liberty Hill Road. The table below presents population age breakdowns of living current and former residents of lower Liberty Hill Road by year.

Estimated number of current and former residents (living) of lower Liberty Hill Road by year and age group: 1970 to 2000

	1970	**1980**	**1990**	**2000**
Total Population	135	156	162	153
Age <15	39	33	18	6
Age 55+	13	26	31	39

Applying state cancer rates to the age-sex composition of the lower Liberty Hill population results in an estimated 19 cancer cases for the period 1989-2003. The range of statistically expected cases is between 10 and 28. In comparison, the 19 cancer cases since 1951 submitted by the anonymous citizen and cited in local newspapers is much lower than expected.

Some local residents have expressed an interest to learn more about cancer rates in the community. The State of New Hampshire maintains a cancer registry for cancer incidences. Information from the New Hampshire State Cancer Registry is available at: http://www.dhhs.state.nh.us/DHHS/BHSDM/LIBRARY/Data-Statistical+Report/cancer-mortality98-99.htm

Information can also be obtained by contacting the Bureau of Health Statistics and Data Management at telephone (603) 271-5926 or toll free at 800-852-3345 ext. 5926.

VI. COMMUNITY HEALTH CONCERNS

When performing any public health assessment, EHP gathers information from local residents about health concerns associated with the Site. The health concerns that local residents express are then addressed in the public health assessment. At the Liberty Hill Road Site, EHP accomplished this task through two activities:

- On April 4 and April 23, 2007 EHP held a public availability sessions at the Gilford Town Hall. Town residents had the opportunity to meet with DES staff, in a confidential setting, to discuss their health concerns and questions regarding the Liberty Hill Road Site. The public availability sessions were advertised in the local news media.

- During 2007, EHP staff had several meetings in Gilford with local residents to discuss their health concerns.

The following is a list of questions gathered during the public availability session, private meetings and individual contacts with residents followed by our responses. Since the residents' concerns are considered confidential, all comments have been paraphrased to protect the individual's identity.

1. **Residents who live near the Site were interested in having their well water be tested for chemicals from the Site.**

This concern was forwarded to the DES Project Manager for follow up immediately after the Public Availability Session. Residents whose homes were within the area of potential impact were provided well water analysis at no cost. No wells showed an impact from the coal tar waste.

2. **Certain residents lived on lower Liberty Hill Road (off-site) for many years. Several members of their family have been diagnosed with cancer. They wanted to know if there was a connection between the coal tar and their cancers.**

The estimated number of cancer cases expected among current and former residents of lower Liberty Hill Road was calculated based on a complete residential history provided by a former neighborhood resident. The observed number of cancer cases among current and former residents of lower Liberty Hill Road as reported by an anonymous resident is substantially lower than the estimated expected number. Thus, there is no evidence of an excess number of cancer cases among residents of lower Liberty Hill Road (See Health Outcome Data section.)

3. **Certain families lived downhill from the Liberty Hill Road Site for several decades. They are concerned about their parents who used to work in the soil, drink the well water, and wash their hands with it. Some downhill residents had kidney failure and other serious medical problems. The concerned citizens want the coal tar removed.**

Currently there are no potential routes of exposure from working in the soil or drinking or washing with the well water. Unfortunately we cannot be absolutely sure that there were no exposures in the past, when the coal tar was deposited, left un-covered, or had just been covered. From the data we have gathered from the Site, no drinking water wells have been impacted from the coal tar. We assume that none were impacted in the past either but we do not have data from this time to verify it. It is impossible to know what the exposure scenarios were like during the days when the coal tar was put into the gravel pit or when homes began to be built there. From the currently available data, however, it does not appear that coal tar was in the residential surface soils or the drinking water wells.

4. **The resident wants to be kept aware of developments regarding site clean up and is concerned in general for the health of his family.**

DES has continuously kept the public up-to-date on new information regarding site clean-up and any new developments in the cancer cluster investigation. DES will continue to hold public meetings and provide updates.

5. **Some families used to live on the Site. They are concerned about past exposures when they were children and used to play on the Site and in nearby Jewett Brook. They are also concerned about their children who used to play there when they were visiting their parents. They are also concerned about potential exposure for a young child who may have breathed contaminated air during drilling activities at the Site.**

Unfortunately we cannot be absolutely sure that there were no exposures in the past, when the coal tar was first deposited on lower Liberty Hill Road and when residential development took place there. From the data that's been gathered for the Site, no significant exposure pathways that might result in adverse health effects exist today. We do not have data to assess what exposures may have occurred in the past. It is impossible to know what the exposure conditions were like during the time when coal tar wastes had been trucked to Liberty Hill Road and houses were built. We cannot be sure that there were no exposures in the past. Currently Jewett Brook does not show levels of contaminants that would represent a health concern.

6. **Some residents are concerned about possible kidney effects and other medical conditions such as autoimmune diseases from past exposures at the Site.**

As indicated in the previous response, it is not possible to evaluate exposures that might have occurred in the past because of the lack of data for that period. Coal tar exists as a complex mixture of a number of different chemicals, many of which are capable of causing harm to humans, depending on its chemical form, how an individual may be exposed to it (ingesting it, breathing it in, having it come into contact with your skin), the amount of the chemical and how many times that the person may have been exposed.

It is not possible to demonstrate a cause and effect relationship between exposure to a chemical and the occurrence of a specific health problem. This is especially true when the exposure happened in the past. What complicates the attempt to link exposure to a chemical substance with the appearance of a specific disease or medical condition is that many types of diseases have multiple risk factors associated with them. In addition, many of the health complaints that individuals may experience are non-specific in nature (ex. breathing difficulties, skin irritation, etc.) and are symptomatic of many different diseases.

With respect to autoimmune diseases, the American Autoimmune Related Disease Association identifies some 80 specific diseases where the body's normal immune system loses its ability to protect the body from disease and infection. Autoimmune diseases tend primarily to affect women. It is thought that the use of certain pharmaceuticals, microbial pathogens, and other diseases are risk factors for developing many of the more common types of autoimmune

diseases. Exposure to chemical contaminants in the environment has not been implicated as a significant risk factor for these diseases. Research on the causes of autoimmune diseases is continuing.

The issue of kidney disease is similar to that for autoimmune diseases. Kidney disease is a general term for a number of specific conditions which can result in damage to the kidneys and a decrease in their ability to maintain the balance of bodily fluids. Kidneys also function to remove wastes from the human body. The major risk factors associated with kidney disease and kidney failure are diabetes and hypertension (high blood pressure).

As indicated elsewhere in this public health assessment, there are no environmental sampling data available for the period before 2004 that would allow us to evaluate the actual or potential exposure of Liberty Hill Road residents prior to that time. There will always be uncertainty regarding this issue.

7. **Some people were concerned about the potential exposure to coal tar wastes while they were doing excavation work and building the houses on Liberty Hill Road.**

There were reports that individuals who were excavating for the installation of septic systems on Lower Liberty Hill Road in the early 1970s observed coal tar stained soils and detected odors. Septic system installers and building contractors who were engaged in building the houses at this location may have come into contact with site related contaminants during the course of their work. There are no environmental data available from this time that could be used to evaluate the actual airborne and other exposures of these workers. Given this lack of information, however, it is still possible to make some assumptions based on a review of the occupational literature involving PAH (major component of coal tar wastes) and other contaminant exposures.

Occupational studies that have documented adverse health problems often involve workers in industries that process or extensively use coal tar (petroleum refining, coal tar and asphalt production plants, pigment and dye processing). Workers in these occupations may be exposed to these substances at very high concentrations, on a daily basis, and for periods lasting years (or sometimes decades). The occurrence and severity of health effects that have been documented in these occupational studies are usually not found in the environment where individuals may be exposed to contaminants at much lower concentrations, with limited potential for actual contact with the contaminants and where exposure may be of much shorter duration.

VII. CHILDREN'S HEALTH CONSIDERATIONS

This Public Health Assessment has been prepared under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). EHP has included the following information in accordance with the ATSDR's Child Health Initiative.

Children may be at greater health risk than adults from exposure to hazardous substances released into the environment. Children spend a good deal of time outdoors and, therefore,

may have an increased likelihood of coming into contact with harmful chemicals that may be present in soil, air and water. Children are shorter in stature than adults and their breathing zones are closer to the ground (increasing the likelihood that may breathe dust, soil, and heavy vapors). Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if certain toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, where they live, and access to medical care.

There are no environmental data available for the Site for the time when houses where first built and people, including children, began to live on lower Liberty Hill Road. The environmental investigations that have been conducted beginning in 2005 have not identified any significant exposure pathways for the Site. Site related contaminants have been detected in a side channel of Jewett Brook. Individuals, including children, who access the side channel of Jewett Brook, may have come into contact with contaminated surface water.

VIII. CONCLUSIONS

EHP evaluated the environmental information available for the Liberty Hill Road Site to determine if area residents were at health risk from exposure to coal tar wastes. Environmental investigations have been conducted at the Site since 2005. EHP's review of the existing environmental data and other information for this Site indicates the following:

Currently, the only one *completed exposure pathway* for the Site is for individuals who may recreate in Jewett Brook in the area of the side channel where Site related contaminants have been detected in surface water. EHP evaluated the potential health risk for individuals who might be exposed to surface water at this location. According to ATSDR's methodology, current exposure to surface water in the side channel of Jewett Brook poses *no apparent public health hazard.* This hazard category is used when individuals at a site may be exposed to contamination but the exposure is not expected to result in harm or health problems to the individuals.

Coal tar wastes have contaminated subsurface soil and groundwater within the Site. Coal tar moves very slowly in soil and groundwater. Local residents are not being exposed to contaminants in these media. In addition, local residents are not being exposed to contaminants in surface soil, indoor air, ambient air or drinking water. Currently, drinking water data for private wells and the condominium water system in the area of lower Liberty Hill Road show no evidence of contamination. It is possible, given the hydrology and physical conditions at the Site, that the drinking water supplies of residents may not have been impacted by contamination.

It is possible that building contractors and septic installers may have been exposed to Site related contaminants in subsurface soils and ambient air while doing excavation and other work at the Site in the past. Unfortunately, there are no environmental data available from this time (1970s, 1980s) which would allow EHP to evaluate actual exposure for these workers. For this

reason, past exposure for contractors who were involved in building the homes at the Site represents an *indeterminate health hazard*.

It is possible that former residents of the Site may have been exposed to coal tar contaminants if they engaged in activities such as gardening, landscaping or if they recreated in Jewett Brook. Again, there are no available environmental data from before 2005 that would allow EHP to evaluate exposure for residents of the Liberty Hill Road Site in the past. Potential exposure to Site related contaminants for people who resided on the Site in the past represents an *indeterminate health hazard*.

Local residents have expressed a concern for the number of cancer cases that have been reported on Liberty Hill Road. EHP conducted a cancer cluster investigation of the lower Liberty Hill Road area to respond to this concern. The EHP investigation focused on 22 households that comprise the lower Liberty Hill Road area. EHP found no evidence of elevated cancer rates in this neighborhood.

IX. RECOMMENDATIONS

EHP should offer to meet separately with concerned individuals and families to further discuss their health concerns related to possible exposure to site related contaminants.

Surface water in Jewett Brook, especially the side channel area, should continue to be sampled.

EHP will evaluate any new environmental data for the Site to determine if there is a health concern.

X. PUBLIC HEALTH ACTION PLAN

The purpose of the Public Health Action Plan is to ensure that this document not only identifies any current or potential human health hazards, but also provides a plan of action to mitigate and prevent injuries or human health effects resulting from exposures to hazardous substances at the Site. The first section of the Public Health Action Plan contains a description of completed or ongoing actions to mitigate exposures to environmental contamination. In the second section, there is a list of additional public health actions that should be implemented in the future.

Completed or Ongoing Actions

- Since 2005, a series of environmental investigations have been conducted by GEI Consulting, the firm working for KeySpan Inc., to characterize the nature and extent of contamination at the Site.

- DES has held several public meetings for the Liberty Hill Road Site to provide information and update local residents on efforts to clean up contamination at the Site.

- EHP evaluated environmental and health outcome data for the Site and the lower Liberty Hill Road area. This information has been included and forms the basis of this Public Health Assessment.

- DES is evaluating the remedial alternatives for Site clean up.

Planned Actions

- DES will finalize its decision on an appropriate Site clean up.

- EHP will continue to respond to local residents' health concerns about possible site related exposures.

- EHP will offer to meet with individuals and families to discus their health concerns about potential past exposures at the Site.

- EHP will evaluate any new environmental sampling information for the Liberty Hill Road Site that may indicate a future hazard to the community.

XI. PREPARERS OF REPORT

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Sherry Godlewski, Environmental Health Educator

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Bureau of Permitting and Environmental Health
Environmental Health Program
29 Hazen Drive P.O. Box 95
Concord, NH 03302-0095

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XIII. APPENDICIES

APPENDIX A: FIGURES

Figure 1

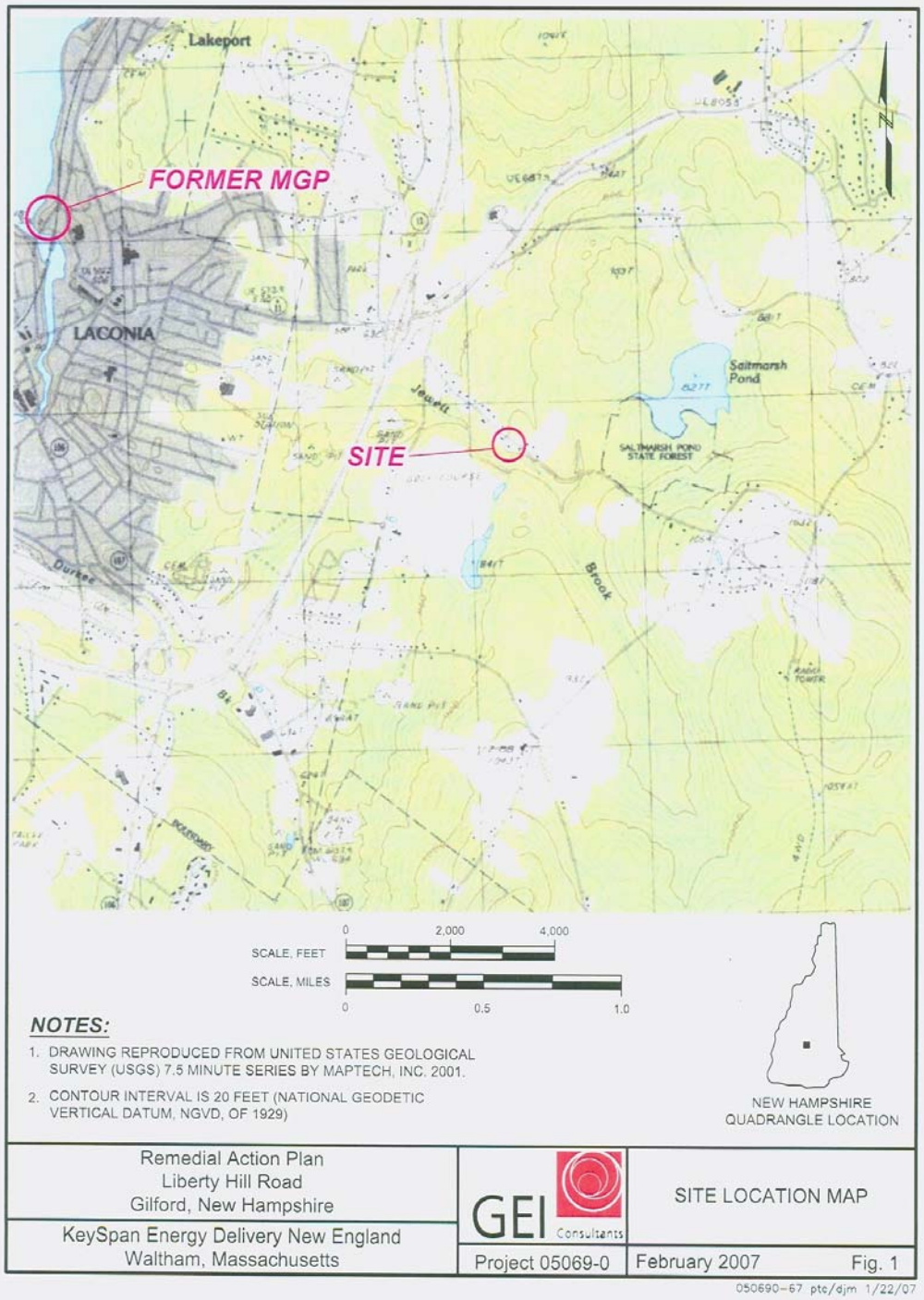


Figure 2

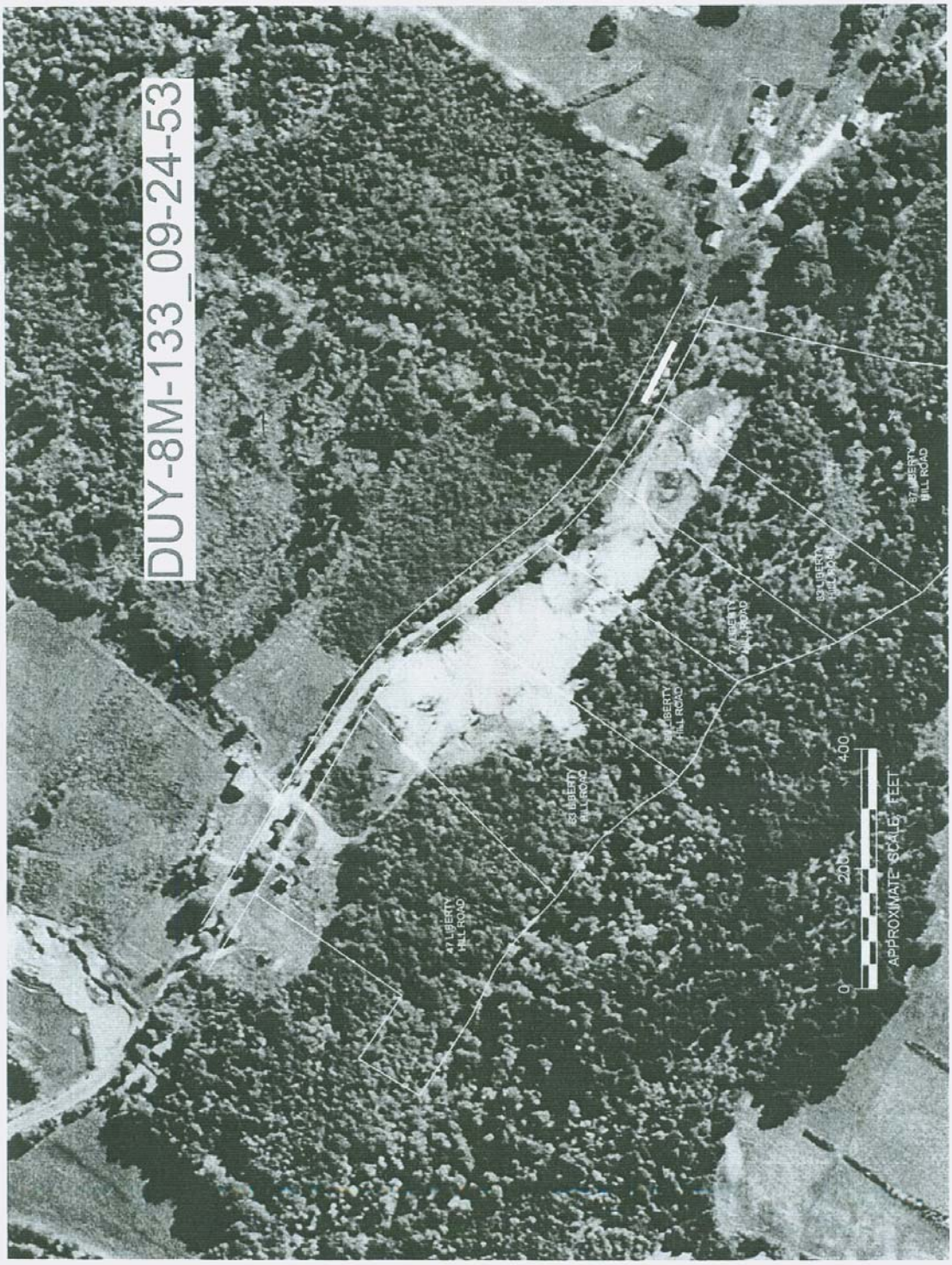

DUY-8M-133_09-24-53
47 LIBERTY HILL ROAD
63 LIBERTY HILL ROAD
69 LIBERTY HILL ROAD
77 LIBERTY HILL ROAD
87 LIBERTY HILL ROAD
87 LIBERTY HILL ROAD
0
200
400
APPROXIMATE SCALE FEET

Figure 3

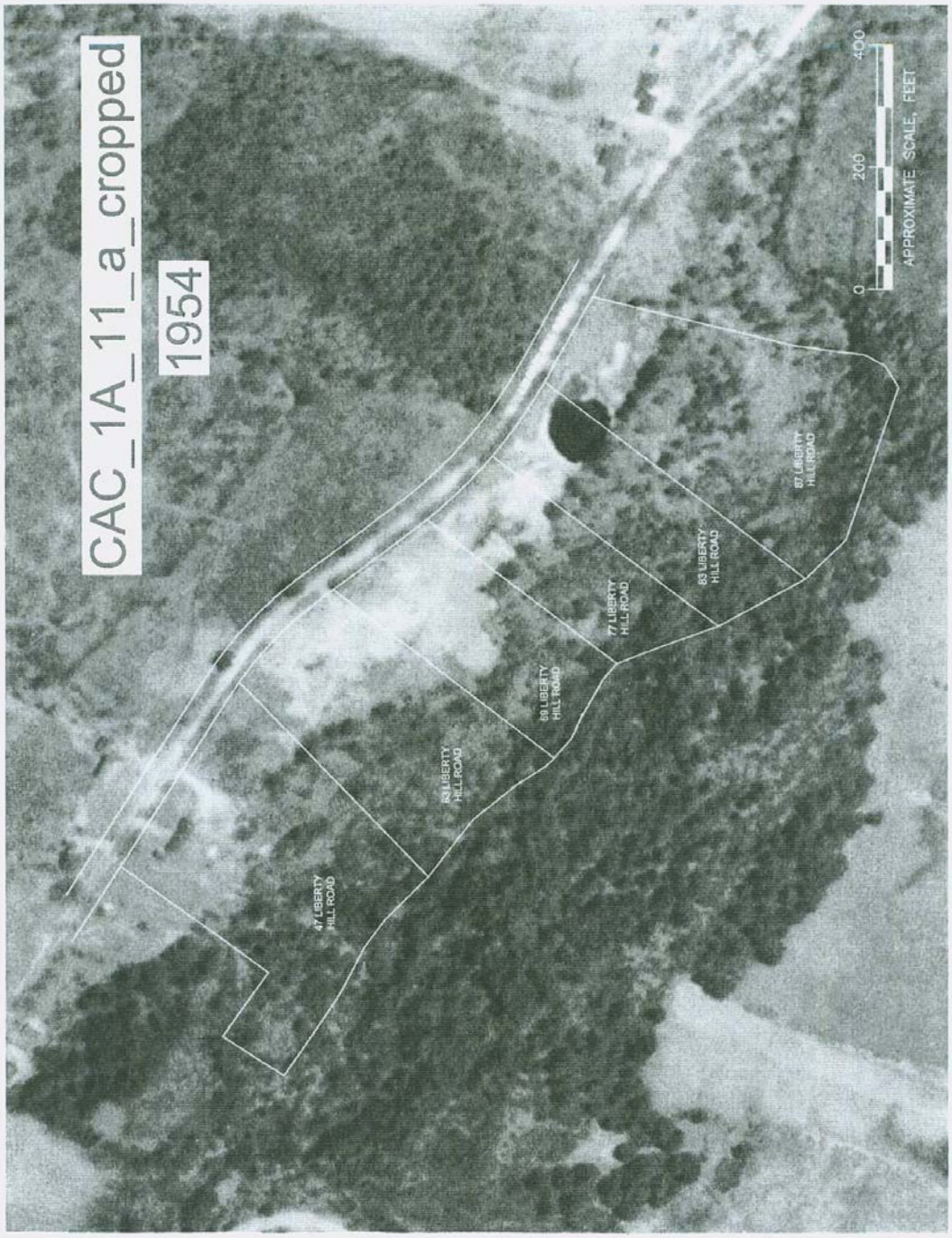

CAC_1A_11_a_cropped
1954
47 LIBERTY HILL ROAD
63 LIBERTY HILL ROAD
69 LIBERTY HILL ROAD
77 LIBERTY HILL ROAD
83 LIBERTY HILL ROAD
87 LIBERTY HILL ROAD
0
200
400
APPROXIMATE SCALE, FEET

Figure 4

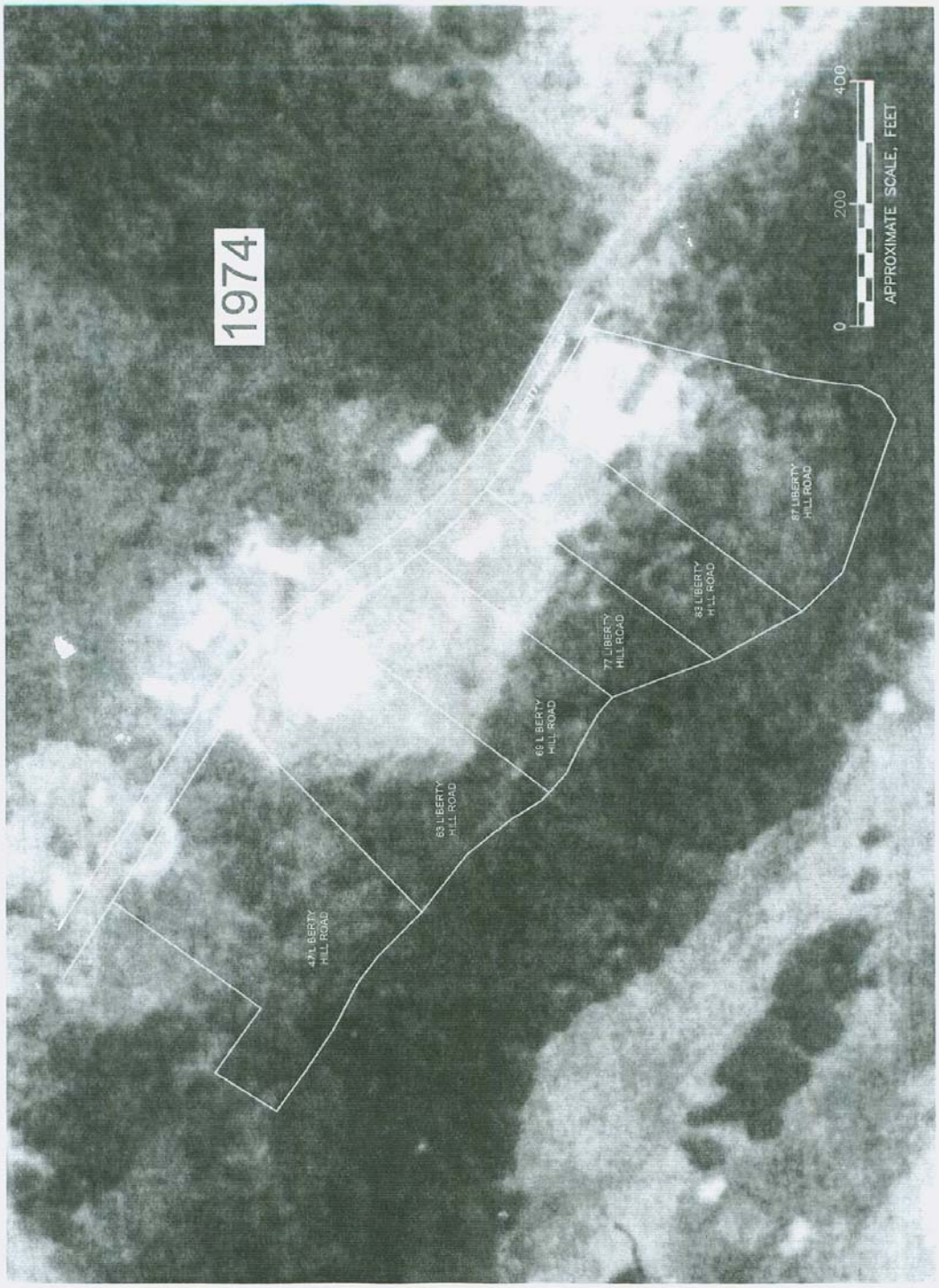

1974
47 L BERTY HILL ROAD
63 LIBERTY HILL ROAD
69 L BERTY HILL ROAD
77 LIBERTY HILL ROAD
83 LIBERTY HILL ROAD
87 LIBERTY HILL ROAD
0
200
400
APPROXIMATE SCALE, FEET

Figure 5

LEGEND:
PROPOSED MONITORING WELL CLUSTER
MONITORING WELL
BORING
GEOPROBE BORING/MONITORING WELL
GEOPROBE BORING
SURFACE SOIL SAMPLE
SUB SLAB SOIL-GAS SAMPLE
SOIL-GAS SAMPLE
AMBIENT AIR SAMPLE
INDOOR AIR SAMPLE (SEE NOTE 3)
SEDIMENT/SURFACE WATER SAMPLE
SUBSURFACE PROFILE LOCATION (SEE FIGs. 7 & 8)
LIBERTY HILL ROAD
SEPTIC TANK
WATER SUPPLY WELL
AREA OF LEACH FIELD (Approx.)
FLOW
SCALE, FEET
0
60
120
NOTE:
1 BASE PLAN FROM PLAN TITLED "BOUNDARY PLAN PREPARED FOR GEI CONSULTANTS" BY RICHARD D. BARTLETT & ASSOCIATES, LLC DATED JAN. 20, 2006
2 GEOPROBE BORINGS ARE BASED ON MEASUREMENTS FROM EXISTING FEATURES. OTHER BORINGS AND ALL MONITORING WELL LOCATIONS WERE SURVEYED.
3 AT #3, MW AND MW2 WERE COLLECTED FROM THE BASEMENT, MW3 WAS COLLECTED FROM THE GARAGE, AND MW4 AND MW5 WERE COLLECTED FROM THE FIRST FLOOR
4 AT #7, MW6 AND MW7 WERE COLLECTED FROM THE BASEMENT, AND MW8 AND MW9 WERE COLLECTED FROM THE FIRST FLOOR
5 AT #17, MW10 AND MW11 WERE COLLECTED FROM THE FIRST FLOOR, AND MW12 AND MW13 WERE COLLECTED FROM THE BASEMENT.
Remedial Action Plan
Liberty Hill Road
Clifford, New Hampshire
KeySpan Energy Delivery New England
Waltham, Massachusetts
GEI
Project 05069-0
February 2007
SITE PLAN
Fig 2

Figure 6

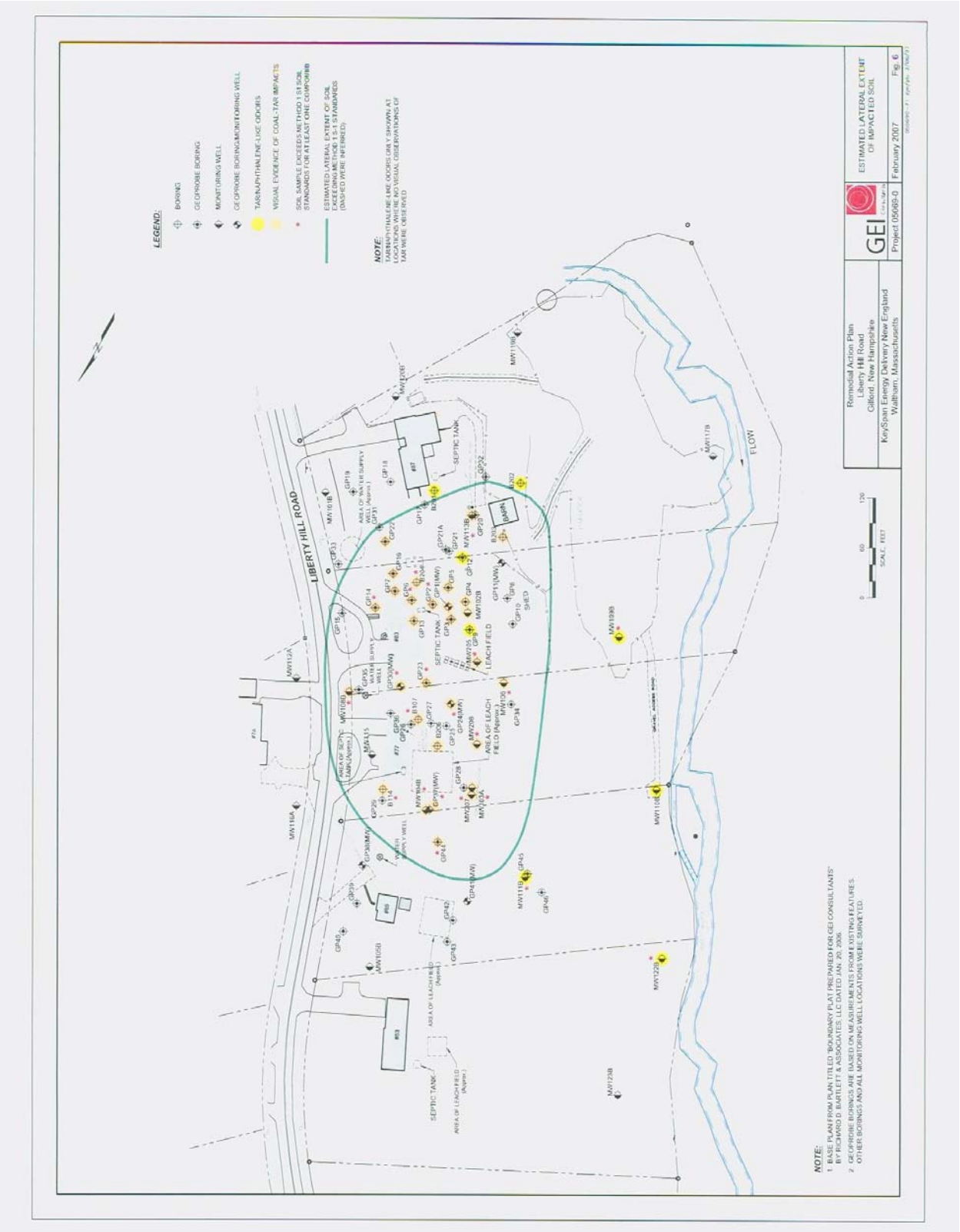

LEGEND:
BORING
GEOPROBE BORING
MONITORING WELL
GEOPROBE BORING/MONITORING WELL
TARNAPHTHALENE-LIKE ODORS
VISUAL EVIDENCE OF COAL-TAR IMPACTS
SOIL SAMPLE EXCEED METHOD 1 S1 SOIL STANDARDS FOR AT LEAST ONE COMPOUND
ESTIMATED LATERAL EXTENT OF SOIL EXCEEDING METHOD 1 S-1 STANDARDS (DASHED WERE INFERRED)
NOTE:
TARNAPHTHALENE-LIKE ODORS ONLY SHOWN AT LOCATIONS WHERE NO VISUAL OBSERVATIONS OF TAR WERE OBSERVED
LIBERTY HILL ROAD
FLOW
SEPTIC TANK
AREA OF LEACH FIELD (Approx.)
SCALE: FEET
Remedial Action Plan
Liberty Hill Road
Gilford, New Hampshire
KeySpan Energy Delivery New England
Waltham, Massachusetts
GEI
Project 05069-0
February 2007
ESTIMATED LATERAL EXTENT OF IMPACTED SOIL
Fig. 6
NOTE:
1 BASE PLAN FROM PLAN TITLED "BOUNDARY PLAT PREPARED FOR GEI CONSULTANTS" BY RICHARD D. BARTLETT & ASSOCIATES, LLC DATED JAN. 20, 2006.
2 GEOPROBE BORINGS ARE BASED ON MEASUREMENTS FROM EXISTING FEATURES. OTHER BORINGS AND ALL MONITORING WELL LOCATIONS WERE SURVEYED.

Figure 7

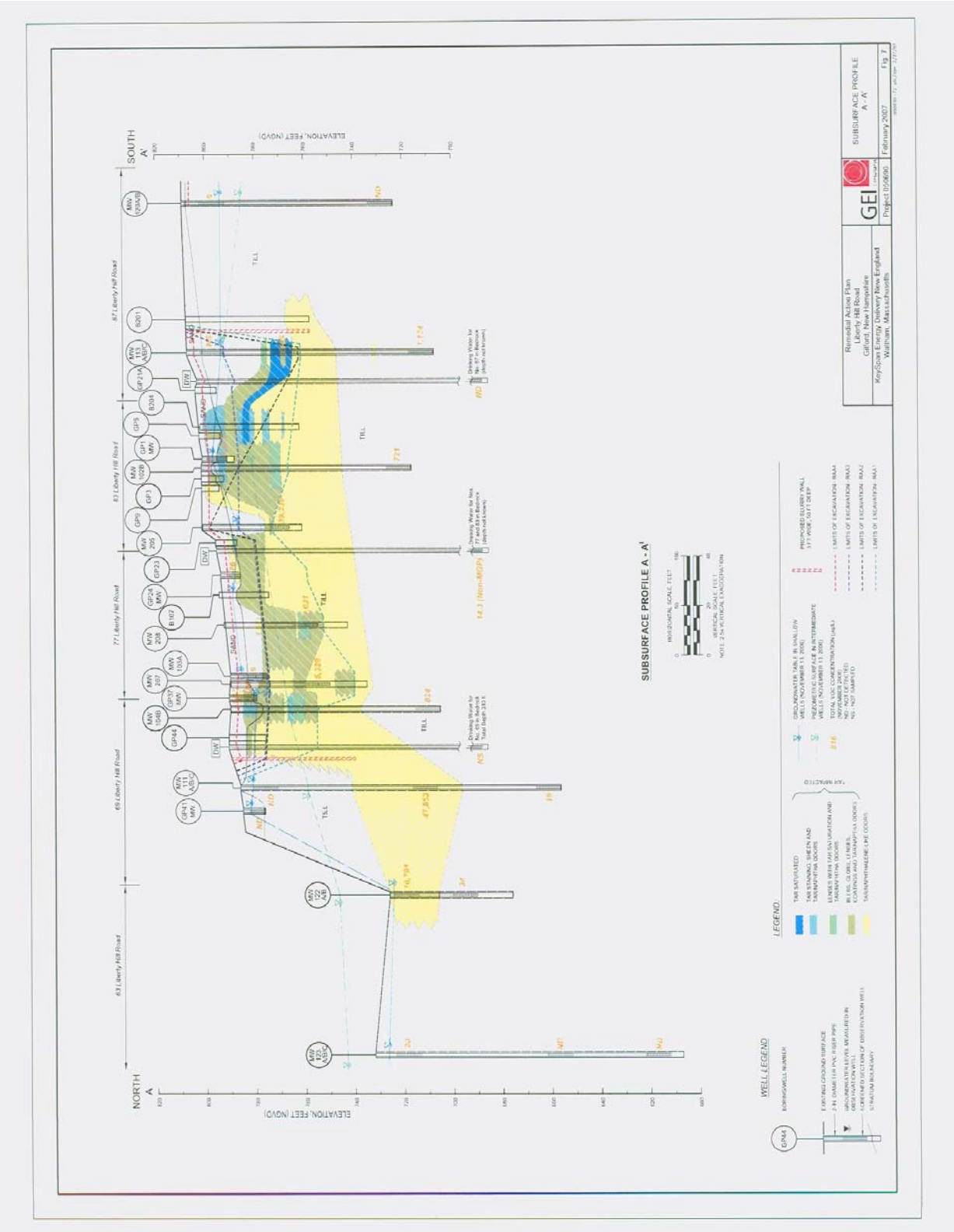

NORTH
A
SOUTH
A'
ELEVATION, FEET (NGVD)
63 Liberty Hill Road
65 Liberty Hill Road
77 Liberty Hill Road
83 Liberty Hill Road
87 Liberty Hill Road
TILL
SAND
SUBSURFACE PROFILE A - A'
HORIZONTAL SCALE, FEET
VERTICAL SCALE, FEET
NOTE: 2.5x VERTICAL EXAGGERATION
WELL LEGEND
LEGEND
Remedial Action Plan
Liberty Hill Road
Gilford, New Hampshire
KeySpan Energy Delivery New England
Waltham, Massachusetts
GEI
Project 050690
February 2007
SUBSURFACE PROFILE
A - A'
Fig. 7

Figure 8

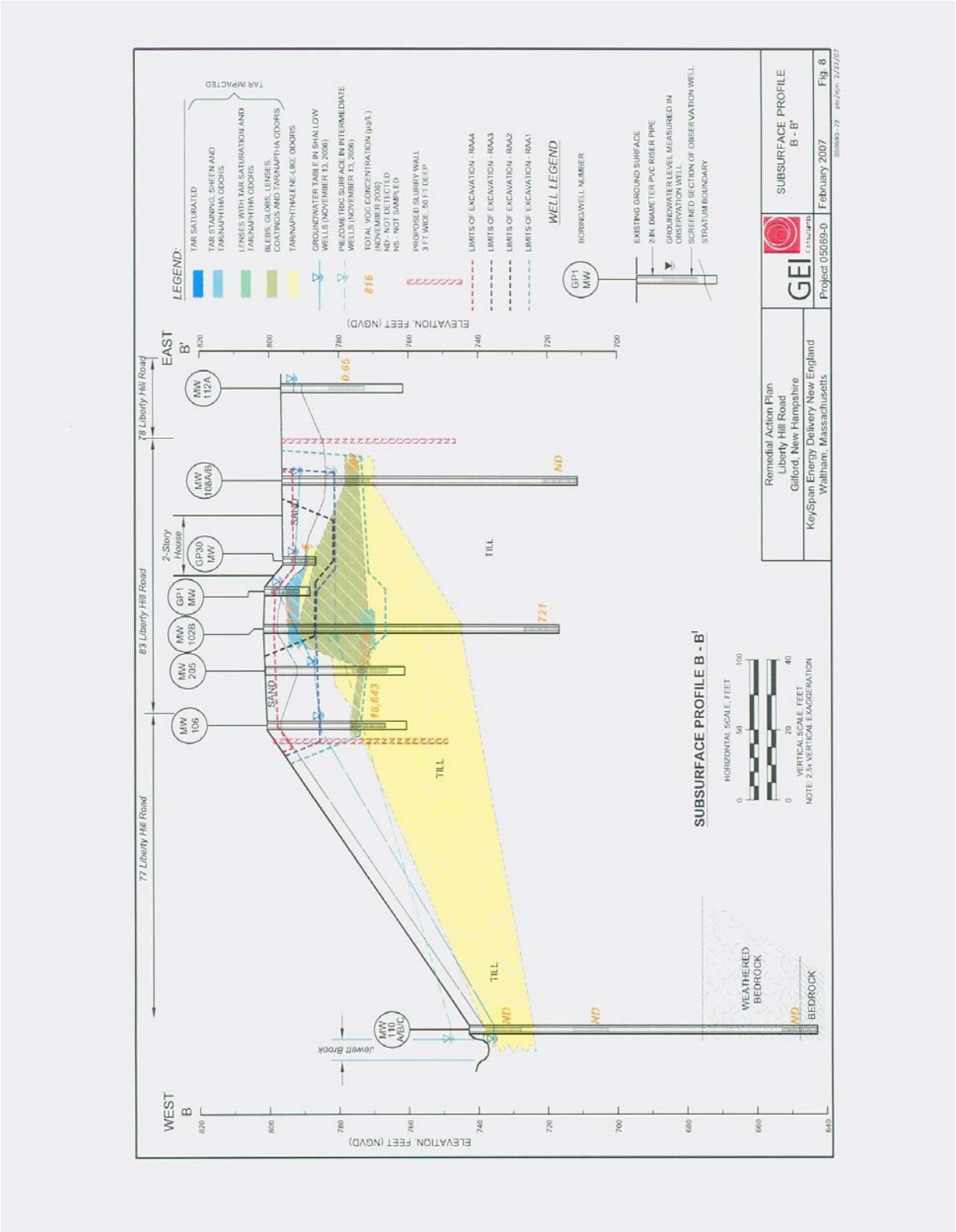

LEGEND:
TAR SATURATED
TAR STAINING, SHEEN AND TAR/NAPHTHA ODORS
LENSES WITH TAR SATURATION AND TAR/NAPHTHA ODORS
BLEBS, GLOBS, LENSES, COATINGS AND TAR/NAPTHA ODORS
TAR/NAPHTHALENE-LIKE ODORS
TAR IMPACTED
GROUNDWATER TABLE IN SHALLOW WELLS (NOVEMBER 13, 2006)
PIEZOMETRIC SURFACE IN INTERMEDIATE WELLS (NOVEMBER 13, 2006)
816 TOTAL VOC CONCENTRATION (µg/L) (NOVEMBER 2006) ND - NOT DETECTED NS - NOT SAMPLED
PROPOSED SLURRY WALL 3 FT WIDE, 50 FT DEEP
LIMITS OF EXCAVATION - RAA4
LIMITS OF EXCAVATION - RAA3
LIMITS OF EXCAVATION - RAA2
LIMITS OF EXCAVATION - RAA1
WELL LEGEND
GP1 MW BORING/WELL NUMBER
EXISTING GROUND SURFACE
2-IN. DIAMETER PVC RISER PIPE
GROUNDWATER LEVEL MEASURED IN OBSERVATION WELL
SCREENED SECTION OF OBSERVATION WELL
STRATUM BOUNDARY
ELEVATION, FEET (NGVD)
WEST B
EAST B'
77 Liberty Hill Road
83 Liberty Hill Road
78 Liberty Hill Road
2-Story House
MW 106
MW 205
MW 102B
GP1 MW
GP30 MW
MW 106A/B
MW 112A
MW 110 A/B/C
Jewett Brook
SAND
TILL
WEATHERED BEDROCK
BEDROCK
ND
721
16,643
0.65
SUBSURFACE PROFILE B - B'
HORIZONTAL SCALE, FEET
VERTICAL SCALE, FEET
NOTE: 2.5x VERTICAL EXAGGERATION
Remedial Action Plan
Liberty Hill Road
Gilford, New Hampshire
KeySpan Energy Delivery New England
Waltham, Massachusetts
GEI
Project 05069-0
February 2007
SUBSURFACE PROFILE B - B'
Fig. 8

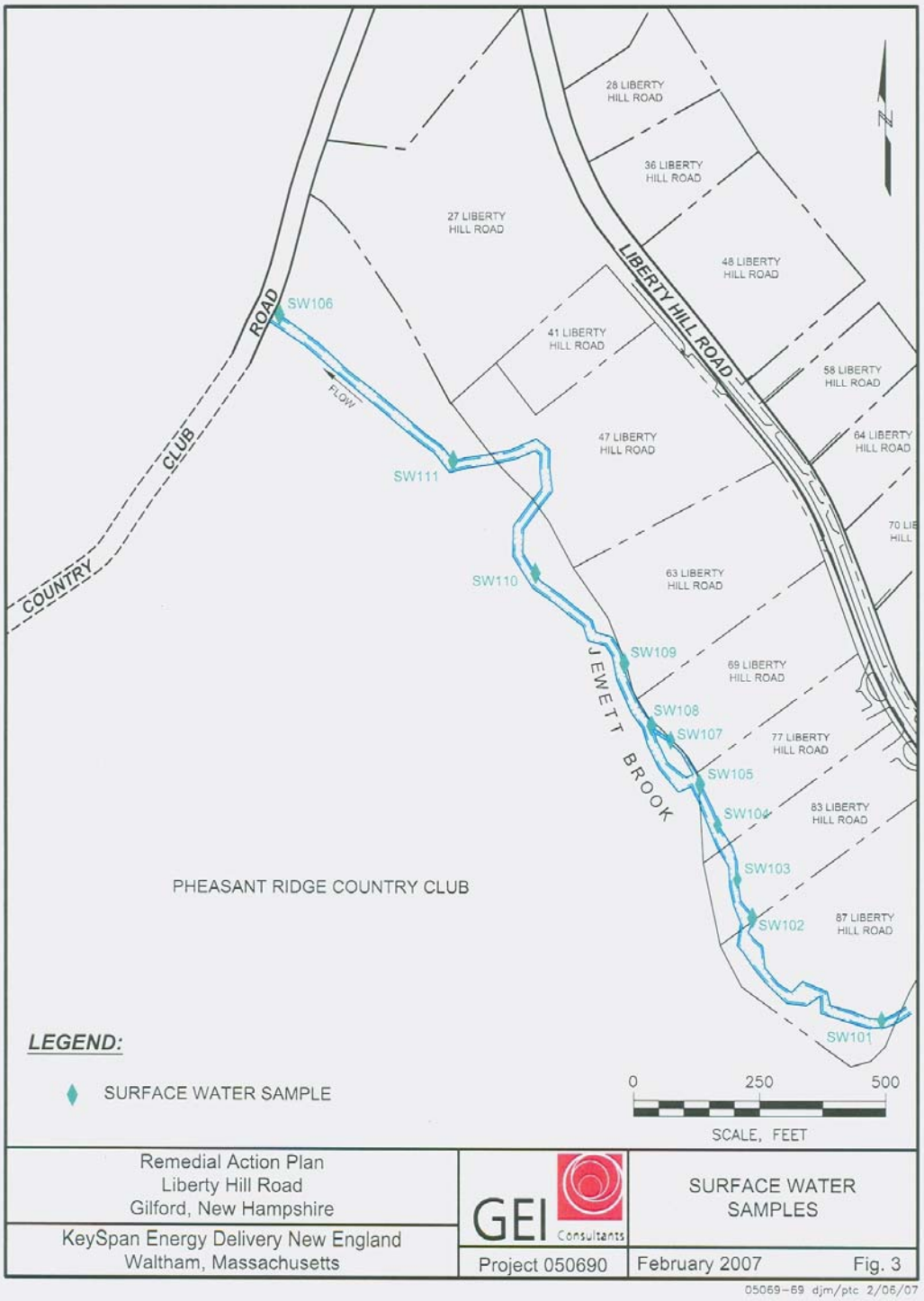
Figure 9

LEGEND:
MONITORING WELL
GEOPROBE BORING/MONITORING WELL
NH GW1 STANDARD (ug/L)
BENZENE
NAPHTHALENE
STYRENE
TOLUENE
1,2,4 TRIMETHYLBENZENE
ESTIMATED EXTENT OF GROUNDWATER WITH CONCENTRATIONS GREATER THAN GW-1 STANDARDS (DASHED WERE INFERRED)
PRELIMINARY GROUNDWATER MANAGEMENT ZONE
NOTES:
1. VALUES SHOWN ARE CONCENTRATIONS DETECTED IN SAMPLES COLLECTED IN NOVEMBER 2006
2. * = CONCENTRATIONS EXCEEDS THE GW1 STANDARDS.
3. WELL TRIPLETS
A = SHALLOW
B = DEEP
C = INTERMEDIATE
4. ND = ANALYTE NOT DETECTED. A RESULT OF JUST ND FOR A WELL INDICATE THAT NEITHER BENZENE, NAPHTHALENE, STYRENE, TOLUENE, NOR 1,2,4-TRIMETHYLBENZENE WERE DETECTED
5. NS = WELL NOT SAMPLED.
LIBERTY HILL ROAD
SCALE, FEET
NOTE:
1. BASE PLAN FROM PLAN TITLED "BOUNDARY PLAT PREPARED FOR GEI CONSULTANTS" BY RICHARD D. BARTLETT & ASSOCIATES, LLC DATED JAN. 20, 2006.
Remedial Action Plan
Liberty Hill Road
Gilford, New Hampshire
KeySpan Energy Delivery New England
Waltham, Massachusetts
GEI
GROUNDWATER CONCENTRATIONS EXCEEDING GW1 STANDARDS
Project 050603-0
February 2007
Fig. 9

Figure 10

LEGEND:
PROPOSED MONITORING WELL CLUSTER
MONITORING WELL
BORING
GEOPROBE BORING/MONITORING WELL
GEOPROBE BORING
SURFACE SOIL SAMPLE
SUB SLAB SOIL-GAS SAMPLE
SOIL-GAS SAMPLE
AMBIENT AIR SAMPLE
INDOOR AIR SAMPLE (SEE NOTE 3)
SEDIMENT/SURFACE WATER SAMPLE
SUBSURFACE PROFILE LOCATION (SEE FIGs. 7 & 8)
LIBERTY HILL ROAD
SEPTIC TANK
LEACH FIELD
FLOW
SCALE, FEET
NOTE:
1. BASE PLAN FROM PLAN TITLED "BOUNDARY PLAN PREPARED FOR GEI CONSULTANTS" BY RICHARD D. BARTLETT & ASSOCIATES, LLC DATED JAN. 20, 2006
2. GEOPROBE BORINGS ARE BASED ON MEASUREMENTS FROM EXISTING FEATURES. OTHER BORINGS AND ALL MONITORING WELL LOCATIONS WERE SURVEYED.
3. AT # 83, (M01 AND (M02 WERE COLLECTED FROM THE BASEMENT. (M03 WAS COLLECTED FROM THE GARAGE. AND (M04 AND (M05 WERE COLLECTED FROM THE FIRST FLOOR
4. AT # 77, (M06 AND (M07 WERE COLLECTED FROM THE BASEMENT. AND M08 AND (M09 WERE COLLECTED FROM THE FIRST FLOOR.
5. AT # 87, AND (A10 AND (A11 WERE COLLECTED FROM THE FIRST FLOOR. AND (A12 AND (A13 WERE COLLECTED FROM THE BASEMENT.
Remedial Action Plan
Liberty Hill Road
Gilford, New Hampshire
KeySpan Energy Delivery New England
Waltham, Massachusetts
GEI
Project 05169-0
SITE PLAN
February 2007
Fig. 2

Figure 11


28 LIBERTY HILL ROAD
36 LIBERTY HILL ROAD
27 LIBERTY HILL ROAD
48 LIBERTY HILL ROAD
LIBERTY HILL ROAD
41 LIBERTY HILL ROAD
58 LIBERTY HILL ROAD
64 LIBERTY HILL ROAD
47 LIBERTY HILL ROAD
63 LIBERTY HILL ROAD
69 LIBERTY HILL ROAD
77 LIBERTY HILL ROAD
83 LIBERTY HILL ROAD
87 LIBERTY HILL ROAD
COUNTRY CLUB ROAD
FLOW
SW106
SW111
SW110
SW109
SW108
SW107
SW105
SW104
SW103
SW102
SW101
JEWETT BROOK
PHEASANT RIDGE COUNTRY CLUB
LEGEND:
SURFACE WATER SAMPLE
0 250 500
SCALE, FEET
Remedial Action Plan
Liberty Hill Road
Gilford, New Hampshire
KeySpan Energy Delivery New England
Waltham, Massachusetts
GEI Consultants
Project 050690
SURFACE WATER SAMPLES
February 2007
Fig. 3
05069-69 djm/ptc 2/06/07

APPENDIX B: POLYCYCLIC AROMATIC HYDROCARBONS AND COAL TAR

(a) Polycyclic Aromatic Hydrocarbons

PAHs constitute a class of over 100 different compounds that are typically found in and formed during the incomplete combustion of coal, oil, wood, or other organic substances. In the environment, PAHs are rarely found as single chemicals, they almost always exist as complex mixtures of many different compounds. Uses for PAHs include the widespread manufacture of medicines, dyes, plastics, and pesticides. More typically they are found in petroleum based products such as coal tar, asphalt, creosote, and roofing tar (25).

The greatest exposures to PAHs for the general population are from inhaling tobacco smoke, wood smoke, and contaminated air, as well as eating contaminated foods. For non-smokers, diet is the largest background exposure to PAHs. Food preparation methods that involve combustion, such as charbroiling or smoking meats or fish, increase exposures to PAHs in food. Occupations where there are significant opportunities for exposure to PAHs include: working with coal tar, asphalt, or roofing materials; foundry workers; miners; and chimney sweeps (25).

The available evidence indicates that mixtures of PAHs can cause cancer in humans. The evidence in humans comes primarily from occupational studies of workers exposed to mixtures containing PAHs as a result of their involvement in such processes as coke production, roofing, oil refining, or coal gasification (e.g., coal tar, roofing tar, soot, coke oven emissions, soot, and crude oil). However, PAHs have not been clearly identified as the causative agent. Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lung and skin following inhalation and dermal exposure, respectively (19). The mechanism of action for PAH carcinogenicity is thought to be that breakdown products formed when PAHs are metabolized by the body are highly reactive with DNA macromolecules, potentially resulting in genetic damage (26).

Non-cancer adverse health effects associated with PAH exposure has been observed in animals but generally not in humans. For skin contact with PAHs, the main concern is for adverse reactions of the skin. For example, benzo(a)pyrene, the most toxic and best studied of the PAHs, was found to irritate skin lesions for people with pre-existing skin conditions and to make the skin of animals more sensitive to ultraviolet light (25).

A recent study found that PAHs can pass through the placental barrier between a pregnant woman and the developing fetus (27). There is also some evidence from experiments with animals that exposures to certain PAHs *in utero* can affect reproduction and development; however, the available studies show contradictory results. In Mackenzie and Angevine (28), pregnant mice were exposed to benzo(a)pyrene by the oral route during gestation. At the highest dose level, the number of mice giving birth was significantly decreased. Progeny (i.e., offspring) of mice from all the dose levels experienced reproductive problems ranging from decreased fertility to sterility. These results were contradicted by a study performed by Rigdon and Neal (29) in which mice were exposed to benzo(a)pyrene in their diet during mating, gestation, and childbirth at levels comparable to the first study, but no effects were observed.

Certain people are more susceptible to the toxic effects of PAHs than the general population. Of primary concern are developing fetuses, children, and the elderly, because the detoxification mechanisms used by the body to mitigate the effects of exposure are either immature or declining in function. People with nutritional deficiencies, pre-existing skin or liver disease, genetic diseases that inhibit DNA repair, or compromised immune systems may also be at increased risk. Finally, anyone who is exposed to PAH from other sources than exposures at the Site (e.g., smoking, working with asphalt or coal tar) would be more susceptible because exposures to PAHs are cumulative (25).

(b) Coal Tar

Coal tars are byproducts of the carbonization of coal to produce coke and/or natural gas. Physically, they are usually viscous liquids or semi-solids that are black or dark brown with a naphthalene-like odor. Coal tars are complex combinations of polycyclic aromatic hydrocarbons, phenols, heterocyclic oxygen, sulfur and nitrogen compounds (30). Coal tar can be refined to form creosote for preserving wood products. It is also used as a pesticide, a pharmaceutical agent for the treatment of psoriasis, and as a component of some anti-dandruff shampoos. Because the composition of coal tar is variable, there is little information on the rates of degradation for coal tar in the environment (30).

Aside from exposures to coal tars at hazardous waste sites, people can come into contact with coal tars or creosotes by handling creosote-treated wood products or using anti-dandruff shampoos that contain coal tar. Workers that manufacture coal tar creosotes, use creosotes to preserve wood, or handle creosote-treated wood products have the potential to be exposed to coal tars through their work and are more likely to be at health risk as a consequence of these exposures (30, 31).

The major chemicals of health concern in the coal tar wastes at the Site are PAHs (1). Therefore, the health effects previously discussed for PAHs are also of concern for coal tars. Coal tar, however, has a far greater capacity to produce dermal and ocular effects than PAHs alone. Effects on the skin range from mild to severe and include burns, rashes, and lesions. Coal tar products are also capable of making the skin sensitive to ultraviolet light. Conjunctivitis and other eye irritation (e.g., burning, redness, swelling, watering) have been observed in humans and animals after exposures to coal tars and their volatile components (24).

APPENDIX C: GLOSSARY OF ENVIRONMENTAL HEALTH TERMS

Adverse Health Effect:
A change in body function or the structures of cells that can lead to disease or health problems.

ATSDR:
The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Background Level:
An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.

Cancer:
A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control

Carcinogen:
Any substance shown to cause tumors or cancer in experimental studies.

Chronic Exposure:
A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

Completed Exposure Pathway:
See **Exposure Pathway**.

Comparison Value (CVs):
Concentrations or the amount of substances in air, water, food, and soil that is unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

Concern:
A belief or worry that chemicals in the environment might cause harm to people.

Concentration:
How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant:
See **Environmental Contaminant**.

Dermal Contact:
A chemical getting onto your skin. (see **Route of Exposure**).

Duration:
The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant:
A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

Environmental Media:
Usually refers to the air, water, and soil in which chemical of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

Epidemiology:
The study of the different factors that determine how often, in how many people, and in which people will disease occur.

Exposure:
Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Assessment:
The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway:
A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure; and,
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency:
How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste:
Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect:
ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard:
The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion:
Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation:
Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

No Apparent Public Health Hazard:
The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard:
The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA:
Public **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Plume:
A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure:
The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). For examples: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population:
A group of people living in a certain area; or the number of people in a certain area.

Public Health Assessment(s):
See **PHA**.

Public Health Hazard:
The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each is defined in the Glossary. The categories are:

- Urgent Public Health Hazard
- Public Health Hazard
- Indeterminate Public Health Hazard
- No Apparent Public Health Hazard
- No Public Health Hazard

Reference Dose (RfD):
An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Route of Exposure:
The way a chemical can get into a person's body. There are three exposure routes:
- breathing (also called inhalation),
- eating or drinking (also called ingestion), and
- or getting something on the skin (also called dermal contact).

Source (of Contamination):
The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Statistics:
A branch of the math process of collecting, looking at, and summarizing data or information.

Survey:
A way to collect information or data from a group of people (**population**).

Toxic:
Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology:
The study of the harmful effects of chemicals on humans or animals.

Urgent Public Health Hazard:

This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

APPENDIX D: ATSDR PUBLIC HEALTH HAZARD CATEGORIES

CATEGORY / DEFINITION	DATA SUFFICIENCY	CRITERIA
A. Urgent Public Health Hazard This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.
B. Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or to support the decision.	Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.
C. Indeterminate Public Health Hazard This category is used for sites in which *critical* data are *insufficient* with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.	This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to make a decision.	The health assessor must determine, using professional judgment, the criticality of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.
D. No Apparent Public Health Hazard This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgment based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
E: No Public Health Hazard This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.	Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future	

*Such as environmental and demographic data; health outcome data; exposure data; community health concerns information; toxicologic, medical, and epidemiologic data; monitoring and management plans.