Public Health Assessment for

FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, MANATEE COUNTY, FLORIDA
EPA FACILITY ID: FLD004100731
SEPTEMBER 30, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

FORMER AMERICAN BERYLLIUM COMPANY

TALLEVAST, MANATEE COUNTY, FLORIDA

EPA FACILITY ID: FLD004100731

Prepared by:

Florida Department of Health
Division of Environmental Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Contents

Foreword

This document summarizes the Florida Department of Health's health assessment from exposure to the contaminants in the environment around the former American Beryllium site. The Florida Department of Health (DOH) evaluates site-related public health issues through the following processes:

- Evaluating exposure: Florida DOH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is on the site, and how human exposures might occur. Usually, the Florida DOH does not collect its own environmental sampling data. The Florida Department of Environmental Protection (DEP) provided the information for this public health assessment.
- Evaluating health effects: If we find evidence that exposures to hazardous substances are occurring or might occur, Florida DOH scientists will determine whether that exposure could be harmful to human health. We focus this report on public health; that is, the health impact on the community as a whole, and base it on existing scientific information.
- Developing recommendations: In this evaluation report, the Florida DOH outlines its conclusions regarding any potential health threat posed by the former American Beryllium site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of the Florida DOH in dealing with hazardous waste sites is primarily advisory. For that reason, the evaluation report will typically recommend actions for other agencies, including the US Environmental Protection Agency (EPA) and the Florida DEP. If, however, an immediate health threat exists or is imminent, the Florida DOH will issue a public health advisory warning people of the danger, and will work to resolve the problem.
- Soliciting community input: The evaluation process is interactive. The Florida DOH starts by soliciting and evaluating information from various government agencies, individuals or organizations responsible for cleaning up the site, and those living in communities near the site. We share any conclusions about the site with the groups and organizations providing the information. Once we prepare an evaluation report, the Florida DOH seeks feedback from the public.

If you have questions or comments about this report, we encourage you to contact us.

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1.0 Summary and Statement of Issues

1.1 Summary

This report assesses the public health threat from exposures to contaminated soil, groundwater, and surface water on and around the former American Beryllium facility in Tallevast, Florida. It considers Tallevast residents' health concerns and explores possible associations with site related contaminants. This assessment requires the use of assumptions, judgments, and incomplete data. These factors contribute to uncertainty in evaluating the health threat. Assumptions and judgments in this assessment error on the side of overestimating the risk. This assessment does not represent an absolute estimate of the risk.

In 1962, the American Beryllium Company began manufacturing ultra-precision machine parts from beryllium-containing metals at 1600 Tallevast Road. Disposal of solvents, including trichloroethylene, resulted in groundwater contamination. In 1996, Lockheed Martin Corporation purchased American Beryllium and ceased operations. In 2004, the Manatee County Health Department and the Florida Department of Environmental Protection discovered trichloroethylene and other solvents in 13 nearby private drinking water wells. Some nearby Tallevast community residents were exposed to these solvents via drinking, showering, and other household water uses. Since 2004, all nearby residents have been using municipal water.

Contaminated groundwater under the former American Beryllium site and Tallevast community was a public health hazard. Past long-term use of groundwater with the highest measured trichloroethylene concentrations for drinking and showering by Tallevast residents could have resulted in anywhere from a "low" to a "very high" increased theoretical risk of kidney cancer, liver cancer, leukemia, and lymphoma. Past long-term ingestion of groundwater from an on-site well by former workers could have resulted in a "moderate" to "high" increased theoretical risk of these same cancers.

Although trichloroethylene and other solvents may be more toxic together than individually, too little is known to estimate the risk of illness from multiple chemical exposure.

Currently, Tallevast residents do not use groundwater for drinking, showering, or other household uses. As long as they do not use the groundwater there is no apparent current or future public health hazard. The Florida Department of Environmental Protection, however, will require groundwater cleanup to restore the resource and protect the public.

Soil and surface water on the former American Beryllium site and in the surrounding Tallevast community poses no apparent public health hazard. Except for elevated lead concentrations in one yard, pica behavior (unusual eating or swallowing of large amounts of soil) by some Tallevast children is not expected to cause illness.

Tallevast residents should not use contaminated groundwater for drinking, showering, or other household uses. Installation of new wells in the area of contaminated groundwater should be restricted. Any Tallevast children who eat unusually large amounts of soil (pica behavior) should have a blood lead test. Florida DOH epidemiologists will discuss with community leaders the possibility of additional health investigations. Because of questions about the reliability of health outcome data, Florida DOH epidemiologists will reexamine cancer data from the Florida Cancer Data System. They will report on their findings separately from this public health assessment report.

1.2 Statement of Issues

In January 2000, Lockheed Martin identified on-site contamination during an environmental assessment to sell the former American Beryllium Company site. In 2003, Lockheed Martin discovered that contamination had spread off-site. In June 2004, the Manatee County Health Department (CHD) requested the Florida Department of Health (DOH) review environmental data from the Tallevast community around the former American Beryllium facility.

In this public health assessment, the Florida DOH evaluates past, current and future exposures to chemicals on and around the former American Beryllium site. Specifically, this report evaluates drinking water from private wells, groundwater, soil, and surface water data collected by the Florida DOH, the Florida Department of Environmental Protection (DEP), and contractors for Manatee County, Lockheed Martin, and the Tallevast community group, Family Oriented Community United Strong (FOCUS). Florida DOH then discusses the likelihood of exposures to cause illnesses and actions needed to protect public health.

Because of the inherent uncertainties, this public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the former American Beryllium site. The assumptions, interpretations, and recommendations made throughout this public health assessment, however, tend to error on the side of protecting public health and may overestimate the risk.

This public health assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. This assessment, however, does not apply equally to all Tallevast residents. Most Tallevast residents with wells were exposed to less than the highest contaminant levels. The health risk for these individual would be less than the health risk estimated in this report. For those Tallevast residents whose wells were not contaminated, the health risk from ground water is essentially zero.

This is the first comprehensive public health assessment (PHA) of the former American Beryllium site by either the Florida DOH or the US Agency for Toxic Substances and Disease Registry (ATSDR). Florida DOH evaluates the public health significance of hazardous wastes sites through a cooperative agreement with ATSDR.

Previously, the Florida DOH prepared a health consultation report regarding indoor air quality (ATSDR 2005a) and a health consultation report regarding beryllium sensitivity testing (ATSDR 2005b). In 2006, ATSDR published a follow-up health consultation report on beryllium sensitivity testing (ATSDR 2006a) and a health consultation on fruits and vegetables testing (ATSDR 2006b).

2.0 Background

2.1 Site History

In 1962, American Beryllium relocated from a nearby building to a new five building facility at 1600 Tallevast Road. This is just east of its original location in the former Spindrift facility. From 1962 until 1996, the Loral Corporation, the parent company of American Beryllium, owned the property.

American Beryllium operated an ultra-precision machine parts manufacturing plant, where beryllium-containing metals were milled, lathed, and drilled into various components. These operations created beryllium dust. Finishing of the components included electroplating, anodizing, and ultrasonic cleaning. American Beryllium used and generated oils, petroleum-based fuels, solvents (including trichloroethylene), acids, and metals. American Beryllium stored fuel and solvents in aboveground and underground storage tanks. They had sumps and a hazardous materials storage yard southeast of Building 5 (DEP 2004).

Before 1984, Tallevast residents around American Beryllium relied on private wells for potable water. In 1984 and 1985, Manatee County Utilities Department extended municipal water lines along most Tallevast streets. Manatee County did not, however, extended water lines along 16th Street, 18th Street, 19th Street, and parts of Tallevast Road. Those residents continued to use water from their wells for drinking, showering, and other household uses.

In 1986, approximately 50 tons of sediment were removed from the location of an evaporation pond behind the former American Beryllium site. The sediment was transported to a processor in Amelia, Louisiana and incinerated (BBL 2006 – Appendix I).

Lockheed Martin acquired American Beryllium in 1996 and ceased operations. In 1997, Lockheed Martin paid for a preliminary site investigation to determine if chemicals were present in subsurface soils at the site. A contractor collected samples from 21 locations at depths ranging from one to four feet. Only beryllium exceeded the Florida Department of Environmental Protection's (FDEP) soil cleanup guidelines. In 1999, the sample results were compared to updated FDEP soil cleanup guidelines and the levels exceeded guidelines for total petroleum hydrocarbons (TPH) at four sumps located within Building #5. Based on the concentrations of TPH, the four sumps were removed as well as approximately 31 cubic yards of soil. The contaminated soils were transported to a processor in Mulberry, FL (Tetra Tech 2004).

In January 2000, Lockheed Martin discovered groundwater contamination under the site and retained Tetra Tech to perform a contamination assessment to delineate the extent of pollution. When groundwater contamination began is unknown. Initially, it appeared that groundwater contamination was contained on site. In 2001, Lockheed Martin removed 538 tons of contaminated soil from the site.

Lockheed Martin sold the property to BECSD, LLC that operates Wire Pro, Inc (WPI). WPI makes cable harnesses and assemblies, connectors, and board-level components (Tetra Tech 2004). Lockheed Martin retained the responsibility for the environmental contamination.

In late 2003, Tallevast community leaders informed Lockheed Martin that some residents were still using their own wells for drinking, showering, and other indoor uses. In May 2004, Florida DEP and the Manatee CHD located and tested 17 private drinking water wells. They found trichloroethylene and other volatile organic compounds (VOC) or "solvents" in 13 wells. In five of these wells, the contaminant levels were above drinking water standards (DEP 2004). How long these wells were contaminated is unknown. In June 2004, the Manatee County Utilities Department connected to a public water supply all the homes still using private drinking water wells thus eliminating exposure to contaminated groundwater. Tallevast residents also reported that soil from the former American Beryllium site had been distributed to several residential properties in Tallevast to fill in low areas (Tetra Tech 2004).

Beginning in May 2004, Florida DOH and Manatee CHD participated in numerous meetings and conference calls with Tallevast residents and other agencies. In a July 2004 fact sheet, the Florida DOH informed nearby residents that except for lead in one surface soil sample, the levels of chemicals found in Tallevast surface soil samples are not likely to cause illness.

In August 2004, at the request of Tallevast residents, the Florida DOH tested air in four Tallevast buildings above the most contaminated groundwater. This testing took place two months after the last Tallevast residents switched to municipal water. The purpose of this indoor air testing was to look for possible intrusion of vapors directly up from groundwater into buildings. It was not intended to measure vapors from showering or other household uses of the contaminated well water that had ceased two months earlier. Florida DOH did not find trichloroethylene or other solvents associated with the former American Beryllium site in these four buildings. Florida DOH and ATSDR detailed this testing in a health consultation report (ATSDR 2005a).

In August 2004 and December 2005, Florida DOH tested corn, oranges, grapefruit, and tangerines from two Tallevast properties and found the levels of metals are not likely to cause illness. Florida DOH and ATSDR detailed this testing in a health consultation report (ATSDR 2006b).

In December 2004, Florida DOH prepared separate preliminary draft health consultation reports for soil and groundwater. At the request of FOCUS leaders, Florida DOH delayed finalizing these two reports pending additional soil and groundwater testing. Subsequently, Florida DOH decided to combine these two draft reports into this comprehensive public health assessment.

Between January 2005 and April 2005, the Florida DOH, in cooperation with the Manatee and Sarasota County Health Departments, tested the blood of 359 former American Beryllium workers, household members, and nearby Tallevast residents. Five individuals, who were either former workers or household members of former workers, tested positive for beryllium sensitivity. Florida DOH and ATSDR detailed the results in two health consultation reports (ATSDR 2005b, 2006a). In a separate program, the US Department of Energy also tested former workers and found some were positive for beryllium sensitivity.

In February 2006, Lockheed Martin initiated a program to close 55 irrigation and private wells. As of September 2006, 34 wells have been capped.

In June and October 2006, Lockheed Martin tested soil gas a few feet below land surface at 21 locations in the Tallevast community. Assuming soil gas could enter houses undiluted, Florida DOH determined the highest levels of tetrachloethylene were not likely to cause illness. Florida DOH also determined the highest levels of trichloroethylene were no more than a "low" (<2 in 10,000) increased theoretical risk from lifetime exposure. Too little is known about the toxicity of 1,1-dichloroethane and *cis*-1,2-dichloethene to determine the risk of illness (DOH 2007).

2.2 Site Description

The Tallevast community is in southern Manatee County between Sarasota and Bradenton (Figure 1). The neighborhood is a blend of single-family homes, and light commercial and industrial development. For the purpose of this public health assessment report, the Tallevast community is defined by the people living on 16th Street East, 16th Street Court East, 17th Street East, 17th Street Court East, 17th Court Street East, 18th Street East, 18th Street Court East, 19th

Street East, 76th Avenue East, and Tallevast Road between 16th Street East and 19th Street East. The Tallevast community surrounds the former American Beryllium site (Figure 2).

The former American Beryllium site is on 5 acres at 1600 Tallevast Road. The buildings, landscaping, and surface features of the property are essentially the same today as they were when Lockheed Martin purchased the property in 1996 (Tetra Tech 2004).

2.2.1 Demographics – The Tallevast community surrounding the former American Beryllium site consists of about 85 homes in a one mile by half-mile area. In 2000, about 200 people lived within a 0.5-mile radius of the site. Most are black (BOC 2000).

2.2.2 Land Use - The Tallevast community is in an unincorporated section of southern Manatee County. Mixed residential, agriculture, light commercial and industrial developments surround the former American Beryllium site. Tallevast Road and homes border the former American Beryllium site on the north. The former Spindrift facility, a fiberglass boat manufacturer, is west. The Sarasota-Bradenton International Airport is southwest. The Tallevast Community Center, a golf course, and more residences are to the south. More residences and undeveloped land lie to the east of the facility. Until recently, some nearby residents grew fruits and vegetables.

2.3 Site Geology and Hydrogeology

In this area of Manatee County, surficial deposits are generally less than 30 feet thick and tend to be comprised of quartz sand. Below the surficial deposits lays a layer of clay known as Venice Clay. The clay layer's thickness averages approximately 18 feet. Below the clay lays an undifferentiated deposit of sandy and silty clay with varying amounts of carbonates, phosphate, clay, and sand. These deposits extend to approximately 350 feet below ground surface. The next layer of sediments consists primarily of quartz sandy limestone and dolomitic sediments (BBL 2006).

Below the Tallevast community lie three groundwater aquifer systems: the surficial aquifer system, the intermediate aquifer system, and the Floridan aquifer system. The surficial aquifer system is unconfined in undifferentiated surficial deposits. The intermediate aquifer system is a confined aquifer in varying thicknesses of sand, phosphate, silt, clay, and carbonate, and layers of various combinations of these materials. The Floridan aquifer system is a confined system in an upper and lower unit divided by a confining layer. The upper Florida aquifer system is limestone.

Trichloroethylene and other solvents have been found in both the surficial and intermediate aquifer systems under the site and in parts of the Tallevast community. Groundwater in the surficial and intermediate aquifers appear to flow radially away from the site. The highest levels of groundwater contamination are found in wells screened in the surficial aquifer system.

2.4 Site Visit

Representatives of the Florida DOH have visited the area around the former American Beryllium site several times since May 2004. A well-maintained fence currently surrounds the site. Community leaders report, however, that children occasionally play in the on-site pond when the gate is inadvertently left open.

3.0 Discussion

In this section, Florida DOH reviews the available site information (groundwater, surface water, sediment, and soil). In four previous reports, Florida DOH and ATSDR addressed indoor air quality, beryllium sensitivity, and homegrown fruits and vegetables. Florida DOH reviews how people can contact chemicals. Florida DOH predicts whether, if people were to contact these chemicals, those chemicals could affect their health.

The public health assessment process has inherent uncertainties because:

- The risk assessment process is inexact,
- Information on the site and on actions (and interactions) of chemicals is never complete, and
- Opinions on the implications of known information differ.

All risk assessments, to varying degrees, require the use of assumptions, judgments, and incomplete data. These contribute to the uncertainty of the final risk estimates. Important sources of uncertainties include environmental sampling and analysis, exposure parameter estimates, use of modeled data, and present toxicological knowledge (Appendix E). These uncertainties can cause risk to be overestimated or underestimated. The assumptions, interpretations, and recommendations made throughout this public health assessment, however, tend to error on the side of protecting public health and may overestimate the risk. Because of the inherent uncertainties, this public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the former American Beryllium site.

This public health assessment is a deterministic style risk assessment. For each variable in the risk equation (such as exposure concentration or exposure duration) this assessment selects one value. The result is a single estimate of the risk. In contrast, probabilistic risk assessments use a range of values for each variable. The result of probabilistic risk assessments is a range of risk. Both deterministic and probabilistic style risk assessments are useful in describing the risk.

3.1 Environmental Contamination

The Florida DOH used the following screening guidelines in order of priority to select contaminants of concern:

1. Cancer Risk Evaluation Guide (CREG). A CREG is the contaminant concentration estimated to result in no more than one excess cancer per 1 million persons exposed during a lifetime (i.e., 70 years). ATSDR calculates CREGs from EPA-established cancer slope factors (ATSDR 1992).
2. Environmental Media Evaluation Guide (EMEG). ATSDR derives an EMEG from a Minimal Risk Level (MRL), using standard exposure assumptions (e.g., ingestion of 200 milligrams of soil per day and body weight of 30 kilograms (kg) for children). ATSDR establishes MRLs: levels of daily human exposure to a chemical for a period of 1 year or longer which is likely to be without any appreciable risk of noncancerous illnesses.
3. Maximum Contaminant Levels (MCL). The Florida DEP derives MCLs from U.S. Environmental Protection Agency (EPA) standards or from health data complied from state and federal resources. MCLs are fully enforceable standards and must be equal to or more stringent (i.e., lower) than federal MCLs (such as the EPA's).

4. Health Advisory Levels (HALs). The Florida DEP and the Florida DOH set HALs based on U.S. EPA standards or from health data compiled from state and federal agencies. While not enforceable, the state agencies use HALs to protect human health.

The screening guidelines are conservative estimates of levels at which no health effects would be expected. The Florida DOH utilizes the above criteria to screen all data. Any sample results that exceed the levels established by the guidelines are then selected for further evaluation. The next step in the process for toxicological review is to compare an estimated dose or concentration that has been calculated from known concentrations to health studies in ATSDR's toxicological profiles. The health studies establish no observable adverse effect levels (NOAELs) and lowest observable adverse effect levels (LOAELs) that can be compared to estimated doses and concentrations.

Using the criteria listed above, the Florida DOH selected, 1,1-dichloroethane, 1,1-dichloroethene, *cis*-1,2-dichlorothene, *trans*-1,2-dichloroethene, 1,4-dioxane, tetrachloroethylene and trichloroethylene as groundwater contaminants of concern. We selected each chemical because it occurred in the groundwater at levels equal to or greater than the screening guideline (Tables 1 and 3). The 1,1-dichloroethane, 1,1-dichloroethene, *cis*-1,2-dichloroethene, and *trans*-1,2-dichloroethene may be breakdown products of trichloroethylene. The 1,4-dioxane may have originated as a stabilizer for commercial grade trichloroethylene.

Using the above criteria and Florida DEP soil cleanup target levels (SCTL), the Florida DOH selected inorganic arsenic, barium, lead, polycyclic aromatic hydrocarbons (PAHs), and total recoverable petroleum hydrocarbons (TRPH) as surface soil contaminants of concern. We selected each chemical because it occurred in the surface soil at levels equal to or greater than the screening guideline (Tables 5 and 7). While beryllium in soils did not exceed screening values, the Florida DOH also selected it as a contaminant of concern because of community concerns.

Identification of a contaminant of concern in this section of the report does not necessarily mean that exposure to the contaminant will cause illness. To be protective of health, ATSDR screening guidelines are usually set hundreds or thousands of times below levels that actually cause illness. Identification of contaminants of concern helps narrow the focus of the public health assessment to those contaminants that require further evaluation for potential public health risk.

3.1.1 On-Site Contamination

We define "on-site" as the area within the former American Beryllium property boundary (Figure 3).

3.1.1.1 On-Site Surface Soil - In 2004, Lockheed Martin contractor Tetra Tech collected 32 on-site surface soil samples (discrete intervals 0-6 and 6-12 inches below land surface) and 16 on-site subsurface soil samples (12-24 inches below land surface). In August 2005, FOCUS consultant, Environmental Services and Technologies, Inc. (EST), collected one on-site soil sample. Tetra Tech analyzed their samples for VOCs, PAHs, TRPH, and metals (Tetra Tech 2005). The EST sample analyses included VOCs, 1,4-dioxane, semi-VOCs, metals, PAHs and Florida Residual Petroleum Organic Method (FL-PRO) (EST 2005). Table 8 summarizes results of on-site soil testing. For the purpose of this report, on-site surface soil quality has been adequately characterized.

3.1.1.2 On-Site Groundwater – In 2004 and 2005, Lockheed Martin's contractor Tetra Tech installed and tested approximately 36 monitoring wells on the former American Beryllium site: 26 in the surficial aquifer system, eight in the intermediate aquifer system, and one in the Floridan aquifer system (BBL 2006). Groundwater samples were analyzed for VOCs and 1,4-dioxane. Table 1 summarizes the results of the on-site groundwater testing. For the purpose of this report, on-site groundwater quality has been adequately characterized.

3.1.1.3 On-Site Surface Water - In May 2005, Lockheed Martin's contractor Tetra Tech collected one surface water sample from the pond on the former American Beryllium site. They analyzed their sample for VOCs, and 1,4-dioxane (Tetra Tech 2005). In August 2005, FOCUS consultant EST sampled the on-site pond and standing water in a drainage ditch on the south side of the former American Beryllium site. EST analyzed the samples for VOCs, 1,4-dioxane, semi-VOCs, metals, PAHs and FL-PRO (EST 2005). For the purpose of this report, on-site surface water quality has been adequately characterized.

3.1.1.4 On-Site Sediment - In June 2004, Lockheed Martin's consultant Tetra Tech collected four sediment samples from the pond on the former American Beryllium site. They collected one sample from the center of the pond and the other three from the perimeter. They analyzed the sediment samples for VOCs and metals (Tetra Tech 2005). For the purpose of this report, on-site sediment quality has been adequately characterized.

3.1.2 Off-Site Contamination

We define "off-site" as the area outside the former American Beryllium property boundary (Figure 3).

3.1.2.1 Off-Site Surface Soil - In 2004, the Florida DEP and contractors for Lockheed Martin and Manatee County Utilities Department collected 100 off-site surface soil samples (0-3, 9-12 and 0-12 inches below land surface) and 40 off-site subsurface soil samples (21-24 inches deep) in the Tallevast community (Figures 4 and 5). In late 2004, Lockheed Martin contractor Tetra Tech collected another 270 off-site soil samples 0-12 inches below land surface and 135 soil samples 12-24 inches below land surface (Figure 6) (Tetra Tech 2005). In the summer of 2005, FOCUS consultant EST collected samples at 27 locations throughout the Tallevast community. At each location, EST collected soil from three or four locations at approximately 12 inches below ground surface, and then mixed each sample to create a composite sample for each location (EST 2005).

Table 5 summarizes the results of the off-site surface soil testing. For the purpose of this report, off-site surface soil quality has been adequately characterized.

3.1.2.2 Off-Site Groundwater - In May 2004, the Florida DEP and the Manatee CHD collected samples from 17 off-site private drinking water wells in the Tallevast community (Figure 7). The Florida DOH laboratory analyzed each sample for inorganic compounds and volatile organic chemicals (VOCs). Lockheed Martin's consultant Tetra Tech collected samples from 22 wells in May 2004 and seven in July 2004 (Figure 8). These included the original 17 private drinking water wells, 11 irrigation wells, and a private drinking water well not previously sampled. The laboratory used by Tetra Tech analyzed for VOCs. In August 2005, FOCUS contractor EST sampled 30 wells and analyzed for VOCs, 1,4-dioxane, metals, base neutral extractables, and petroleum range organics.

In November 2004, Lockheed Martin consultant Tetra Tech began installing additional monitoring wells to determine the extent of the contaminated groundwater. They collected discrete samples at 5-foot intervals from 114 locations within the surficial aquifer system and at select intervals from 23 locations within the intermediate aquifer system. Tetra Tech installed 53 monitoring wells in the surficial aquifer and 24 monitoring wells in the intermediate aquifer (Tetra Tech 2005).

In 2006 and early 2007, contractors for Lockheed Martin installed more than 100 new monitoring wells (Figure 9). They tested these wells and many existing monitoring wells for VOCs including 1,4-dioxane (BBL 2006, Arcadis 2007).

In October 2007, FOCUS contractor EST sampled four additional off-site wells and analyzed for VOCs and 1,4-dioxane (EST 2007).

Table 3 summarizes the results of the off-site groundwater testing. For the purpose of this report, off-site groundwater quality has been adequately characterized.

3.1.2.3 Off-Site Surface Water - In August 2005, FOCUS contractor EST, sampled 11 off-site surface water bodies in the Tallevast community. The sampling locations included five ponds, four locations with standing water, and two ditches with standing water. EST analyzed the samples for VOCs including 1,4-dioxane, semi-VOCs, metals, PAHs and FL-PRO, Petroleum Range Organics (EST 2005). For the purpose of this report, off-site surface water quality has been adequately characterized.

3.1.3 Quality Assurance and Quality Control - This PHA uses existing environmental data. Florida DOH assumes these data are valid because government consultants or consultants overseen by government agencies collected and analyzed the environmental samples. Florida DOH also assumes that consultants who collected and analyzed these samples followed adequate quality assurance and quality control measures concerning chain-of-custody, laboratory procedures, and data reporting.

3.2 Pathways Analyses

Chemical contaminants in the environment can harm people's health, but only if people have contact with those contaminants at a high enough concentration (dose) to cause a health effect. Knowing or estimating the frequency with which people could have contact with hazardous substances is essential to assessing the public health importance of these contaminants. To decide if people can contact contaminants at or near a site, Florida DOH looks at the human exposure pathways. An exposure pathway has five parts. These parts are:

1. a source of contaminants, like a hazardous waste site,
2. an environmental medium like air, water or soil that can hold or move the contamination,
3. a point where people come in contact with a contaminated medium, like drinking water or soil in a garden,
4. an exposure route like drinking contaminated water from a well or eating contaminated soil on homegrown vegetables, and
5. a population who could be exposed to the contaminants.

Florida DOH eliminates an exposure pathway if at least one of the five parts referenced above is missing and will not occur in the future. Exposure pathways not eliminated are either completed or potential. For completed pathways, all five pathway parts exist and exposure to a contaminant has occurred, is occurring, or will occur. For potential pathways, at least one of the five parts is missing, but could exist. Also for potential pathways, exposure to a contaminant could have occurred, could be occurring, or could occur in the future.

3.2.1 Completed Exposure Pathways – The following subsection lists completed human exposure pathways.

3.2.1.1 On-Site Surface Soil – On-site soils are a completed pathway for former American Beryllium workers and current WPI workers. Exposure might occur by accidental ingestion of surface soil or inhalation of contaminated dust.

3.2.1.2 Off-Site Surface Soil – Currently off-site soils are a completed pathway for some nearby residents. Exposure might occur by accidental ingestion by nearby residents, pica ingestion by children who eat an abnormally large amount of soil, or by inhalation of contaminated dust.

3.2.1.3 Off-Site Groundwater – Prior to 2004, Tallevast residents in at least 13 homes who used private wells were exposed to groundwater contamination. How long they were exposed is unknown.

3.2.1.4 Off-Site Surface Water – Tallevast residents may have contacted surface water in ponds near the former American Beryllium site. Residents who swam or waded in the pond may have been exposed via dermal absorption.

3.2.1.5 Fruits and Vegetables – Tallevast residents may have been exposed via their homegrown fruits and vegetables. The levels of metals in corn, oranges, grapefruit, and tangerines from two Tallevast properties, however, are not likely to cause illness (ATSDR 2006b).

3.2.2 Potential Exposure Pathways – The following subsection lists potential human exposure pathways.

3.2.2.1 On-Site Groundwater – Information from the Manatee County Utilities Department shows that in 1980 they connected the former American Beryllium Company to municipal water. No drinking water well has been found on the former American Beryllium site, but one likely existed for water supply before 1980. No historical sampling data exists to indicate when contamination of the groundwater began after American Beryllium moved to this location in 1962. If an on-site well was in use and groundwater contamination existed before 1980, worker exposure might have occurred by ingestion of the groundwater.

3.2.2.2 Groundwater to Indoor Air Vapor Intrusion – Tallevast residents may have breathed vapors intruding directly from contaminated groundwater into their homes. Testing of air in four Tallevast homes above the most contaminated groundwater, however, did not find trichloroethylene or other solvents associated with groundwater contamination from the former American Beryllium site (ATSDR 2005a).

3.2.2.3 On-Site Surface Water – Community leaders report that in the past, some Tallevast residents swam in, and ate fish from, the on-site pond. Community leaders also report children occasionally play in the on-site pond when the gate is inadvertently left open.

Currently, contaminant concentrations in the on-site pond water are very low.

3.2.2.4 On-Site Sediment – Community leaders report that in the past, some Tallevast residents swam in the on-site pond. Currently, contaminant concentrations in the on-site pond sediments are very low.

3.3 Public Health Implications

In the following sections, we discuss exposure levels and possible health effects that might occur in people exposed to the contaminants of concern at the site. Results of previous indoor air, fruit/vegetable, and beryllium sensitivity testing are discussed in the Background section.

3.3.1 Toxicological Evaluation The Florida DOH evaluates exposures by estimating daily doses for children and adults. Kamrin (1988) explains the concept of dose in the following manner:

> . . .all chemicals, no matter what their characteristics, are toxic in large enough quantities. Thus, the amount of a chemical a person is exposed to is crucial in deciding the extent of toxicity that will occur. In attempting to place an exact number on the amount of a particular compound that is harmful, scientists recognize they must consider the size of an organism. It is unlikely, for example, that the same amount of a particular chemical that will cause toxic effects in a 1-pound rat will also cause toxicity in a 1-ton elephant.
>
> Thus instead of using the amount that is administered or to which an organism is exposed, it is more realistic to use the amount per weight of the organism. Thus, 1 ounce administered to a 1-pound rat is equivalent to 2,000 ounces to a 2,000-pound (1-ton) elephant. In each case, the amount per weight is the same; i.e., 1 ounce for each pound of animal.

This amount per weight is the *dose*. Toxicology uses dose to compare the toxicity of different chemicals in different animals. We use the units of milligrams (mg) of contaminant per kilogram (kg) of body weight per day (mg/kg/day) to express doses in this public health assessment. A milligram is 1/1,000 of a gram; a kilogram is approximately 2 pounds.

To calculate the daily dose of each contaminant, the Florida DOH uses standard assumptions about body weight, ingestion and inhalation rates, duration of exposure (period of time), and other factors needed for dose calculation (ATSDR 2005c, EPA 1997). The Florida DOH uses Risk Assistant, a software model that uses EPA risk assessment guidelines, to calculate estimated ingestion doses (Table 10). We assume that people are exposed daily to the maximum concentration measured. Because of uncertainty in the maximum trichloroethylene groundwater concentration Tallevast residents were exposed to, we consider two possibilities. First, we estimate exposure for Tallevast residents using the maximum trichloroethylene concentration found in a private drinking water well (240 ug/L). Second, we estimate exposure for Tallevast residents using the maximum trichloroethylene concentration found in an irrigation well (6,000 ug/L). This "irrigation well" was likely a potable well before 1984/1985 when Manatee County extended municipal water lines to most of Tallevast.

ATSDR's toxicological profiles on contaminants discuss toxicity from three exposure routes - inhalation, ingestion, and dermal (skin) exposure. For each of these exposure routes, ATSDR also groups health effects by duration (length) of exposure. Acute exposures are those with duration of 14 days or less; intermediate exposures are those with duration of 15 - 364 days; and chronic exposures are those that occur for 365 days or more (or an equivalent period for animal exposures). ATSDR Toxicological Profiles also provide information on the environmental transport and regulatory status of contaminants.

To estimate exposure from ingestion of contaminated water, Florida DOH used the following assumptions:

1) children 1 - 4 years of age ingest an average of 1 liter of water per day,
2) adults ingest an average of 2 liters per day,
3) children 1 - 4 years of age weigh an average of 15 kg,
4) adults weigh an average of 70 kg.

To estimate exposure from incidental ingestion of contaminated residential soil, Florida DOH used the following assumptions:

1) children 1 - 4 years of age ingest an average of 200 mg of soil per day,
2) adults ingest an average of 100 mg of soil per day,
3) children 1 - 4 years of age weigh an average of 15 kg,
4) adults weigh an average of 70 kg,
5) children and adults ingest contaminated soil at the maximum concentration measured for each contaminant.

To estimate exposure to children with soil pica behavior, Florida DOH used the following assumptions:

1) children 1 - 3 years of age ingest an average of 5000 mg of soil per day,
2) children 1 - 3 years of age weigh an average of 10 kg,
3) children ingest contaminated soil at the maximum concentration measured for each contaminant.

To estimate exposure from skin absorption and inhalation of vapors during/following showering, Florida DOH used an ATSDR model (Mellard 2007). The model used background indoor air concentrations cited in the ATSDR toxicological profiles or the 1987 EPA TEAM study (Wallace 1987). Florida DOH used the model output for adults (male) and children (preschool 3.1 to 5 years old).

3.3.1.1 On-Site Surface Soil

The highest levels of chemicals in the soil found on the site are not likely to cause illness in current or former workers. Tables 13 and 14 summarize the non-cancer and cancer risk for each contaminant of concern.

Current and former workers may have been exposed to contaminants in the soil on the former American Beryllium site. Their exposure may have been via incidental ingestion (accidentally swallowing small amounts of soil) or by inhalation (breathing dust created from the contaminated soil). They may have been exposed for up to 34 years. During sampling performed between 2004 and 2006, inorganic arsenic and polycyclic aromatic hydrocarbons were the only two contaminants in on-site surface soil at levels above ATSDR health-based screening values.

Arsenic

Incidental ingestion of inorganic arsenic measured in on-site surface soils on the former American Beryllium site is not expected to cause illness in current or former workers. We assumed the arsenic was in the more toxic inorganic form. The highest estimated average daily inorganic arsenic dose, 0.000005 mg/kg/day (Table 9), is 360 times lower than the dose (0.0018 mg/kg/day) that caused pigmentation changes in the skin. Studies show no adverse effect levels for inorganic arsenic in humans range from 0.0004 – 0.1 mg/kg/day (ATSDR 2005d).

Inhalation of dust from the highest on-site inorganic arsenic surface soil concentration measured in the soils on the former American Beryllium site is not expected to cause illness in current or former workers. The highest estimated concentration of inorganic arsenic dust in the air is 0.000001 milligrams per cubic meter (mg/m^3) (Table 9). This concentration is 700 times lower than the lowest concentration that increased the risk of stillbirth in humans (0.0007 mg/m^3) (ATSDR 2005d).

To evaluate a theoretical cancer risk from incidental ingestion of inorganic arsenic, the US EPA developed a cancer slope factor based on a human study where subjects developed skin cancer. We multiply the cancer slope factor (1.5 per mg/kg-day) by a lifetime average daily dose (0.000001 mg/kg/day). We adjust the highest estimated ingestion dose for workers to create the lifetime average daily dose for a 70-year life expectancy. The maximum theoretical excess cancer risk for lifetime exposure of incidental ingestion of inorganic arsenic contaminated soil is 0.2 in 100,000, which is an extremely small increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in former workers.

While studies link inorganic arsenic to skin, lung, bladder and liver cancer, the lowest dose in any human study that caused cancer was 0.0011 mg/kg/day (ATSDR 2005d). Given the relatively low level of the estimated dose in comparison to studies that associated inorganic arsenic to cancer, and given intermittent exposure, it is unlikely that the estimated incidental ingestion of inorganic arsenic in soil would result in an increased rate of cancer in former workers.

To evaluate a theoretical cancer risk from inhalation of inorganic arsenic contaminated dust, the US EPA developed an inhalation risk unit, from a human study where subjects developed lung cancer. We multiply the unit risk (4.3×10^{-3} ug/m^3) by an inhalation concentration that we have adjusted for a 70 year lifetime exposure (0.00007 ug/m^3). The estimated maximum theoretical excess cancer risk for lifetime inhalation of inorganic arsenic contaminated dust in workers is 0.03 in 100,000, which is an extremely small increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in former workers.

Polycyclic Aromatic Hydrocarbons (PAHs)

Incidental ingestion of PAHs measured in on-site surface soils on the former American Beryllium site is not expected to cause non-cancer illness in current or former workers. The highest estimated average daily dose, 0.0000007 mg/kg/day (Table 9), is millions of times lower than the lowest dose in an animal study that caused adverse health effects (120 mg/kg/day) (ATSDR 1995).

Inhalation of dust contaminated with PAHs on the former American Beryllium site is not expected to cause non-cancer illness in current or former workers. The highest estimated air concentration of PAH dust from the soils is 0.00000008 mg/m^3 (Table 9). This level is thousands of times lower than the level in a human study that caused decreased lung function, cough, bloody vomit, and chest and throat irritation (0.0001 mg/kg/day) (ATSDR 1995).

Certain PAHs cause cancer in humans and animals. The evidence in humans comes mostly from studies of workers in oil refining, roofing, coal gasification, or coke production. Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lungs following inhalation and skin following skin contact. Route of exposure influences incidence of cancer in animal studies, stomach cancer follows ingestion, lung cancer follows inhalation and skin cancer follows dermal contact (ATSDR 1995).

To estimate a theoretical increased cancer risk from ingestion of PAHs, the US EPA developed a cancer slope factor from an ingestion study of squamous cell papillomas and carcinomas in mice. We multiply the cancer slope factor (7.3 per mg/kg-day) by the lifetime average daily dose that is adjusted for a 70-year life expectancy (0.0000002 mg/kg/day). The estimated maximum theoretical excess cancer risk for lifetime exposure of incidental ingestion of PAHs is 0.1 in 100,000, which is an extremely small increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in former workers.

3.3.1.2 On-Site Groundwater

Former American Beryllium workers could have been drinking contaminated groundwater five days a week, 50 weeks a year, for up to 18 years. If they were, ingestion was the major route of exposure to contaminated groundwater since former workers most likely limited hand washing to a few times a day (dermal) and did not frequently shower at work (inhalation). Prior to 1985, the American Beryllium plant received water from an on-site well. The location of the well has not been identified and no known data exists for the well. The Florida DOH used on-site monitoring wells to evaluate formers workers potential exposure to contaminants.

If every day for 18 years, former American Beryllium workers drank contaminated groundwater from an on-site well with the highest measured trichloroethylene concentration (13,000 ug/L), they would be at a “moderate” (60 in 100,000) to “high” (1,000 in 100,000) increased theoretical risk of cancer including kidney, liver, leukemia, and lymphoma. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in former workers. If they drank this groundwater, the concentration likely varied over time and they may have been exposed for less than 18 years.

The concentrations of 1,1-dichloroethene, 1,4-dioxane, and tetrachloroethylene in on-site groundwater are not likely to cause illness. Too little is known about the toxicity of 1,1-dichloroethane and *cis*-1,2-dichloroethene to determine the public health threat. The toxicity of 1,1-dichloroethene, 1,4-dioxane, tetrachloroethylene, and trichloroethylene in a mixture may be additive. Too little is known, however, to quantify the public health risk from exposure to multiple chemicals. Tables 13 and 14 summarize the non-cancer and cancer risk for each contaminant of concern.

1,1-Dichloroethane (1,1-DCA)

Too little is known about the toxicity of 1,1-dichloroethane to determine the risk of illness if former workers drank contaminated groundwater. Reliable information on how 1,1-dichloroethane affects the health of humans is not available. Two studies investigated the health effects associated with oral exposure to 1,1-dichloroethane in rats and mice. With the exception of decreased body weight in one study, neither one provided any conclusive evidence of adverse toxic effects associated with oral exposure to 1,1-dichloroethane (ATSDR 1990).

1,1-Dichloroethene (1,1-DCE)

1,1-Dicloroethene levels are not likely to cause non-cancer illness if former workers drank on-site groundwater. The highest estimated average daily dose for former workers who drank on-site groundwater (0.009 milligrams per kilogram per day; mg/kg/day) (Table 2) is about a thousand times less than the no observable adverse effect level (NOAEL) in rats for liver effects (10 mg/kg/day) and for kidney effects (19.3 mg/kg/day) (ATSDR 1994).

Cis-1,2-dichloroethene (cis-1,2-DCE)

Too little is known about the toxicity of *cis*-1,2-dichloroethene to determine the risk of illness if former workers drank contaminated groundwater (ATSDR 1996).

1,4-Dioxane

The highest estimated average daily dose of 1,4-dioxane in on-site groundwater (0.009 mg/kg/day) for former workers is less than the ATSDR chronic minimal risk level (0.1 mg/kg/day) (Table 2). Therefore, there is little risk of non-cancer illness for former workers from ingestion of 1,4-dioxane in the on-site groundwater (ATSDR 2004).

To estimate a theoretical increased risk of cancer from oral exposure of 1,4-dioxane, the US EPA developed a cancer slope factor from an ingestion study of squamous cell carcinoma of the nasal turbinates in rats. We multiply the cancer slope factor (0.011 mg/kg-day) by the lifetime average daily dose (0.002 mg/kg/day). The theoretical increased risk of cancer for former workers who drank the highest level of 1,4-dioxane measured in groundwater is an increase of 2 in 100,000, and is considered a "no apparent" increased risk. No human cancer studies exist for oral exposure of 1,4-dioxane. Several studies in animals, however, examined the carcinogenicity of 1,4-dioxane following oral exposure. The US EPA classifies 1,4-dioxane as a probable human carcinogen. EPA based the human cancer risk on an extrapolation from animal studies.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in former workers.

Tetrachloroethylene (Perchloroethylene, PCE)

Levels of tetrachloroethylene in on-site groundwater are not likely to cause non-cancer illness in former workers. The highest estimated average daily dose of tetrachloroethylene is 0.005 mg/kg/day. This dose is thousands of times less than lowest observable adverse effect level that caused reduced survival and nephropathy (kidney damage) in animal studies (386 mg/kg/day) (ATSDR 1997a).

It is not possible to estimate accurately the human cancer risk from exposure to tetrachloroethylene in the groundwater. There is sufficient evidence that tetrachloroethylene can cause cancer in animals, but the data in humans are inconclusive. The US Department of Health and Human Services has concluded tetrachloroethylene may reasonably be anticipated to be a carcinogen (NTP 2005). Studies of dry cleaning workers suggest a possible association between chronic tetrachloroethylene exposure and increased risk of esophageal cancer, cervical cancer, and non-Hodgkin's lymphoma. These studies are inconclusive, however, because of exposure to other solvents, exposure to tobacco smoke, limited control populations, and incomplete follow-up.

The highest estimated indoor air concentration of tetrachloroethylene vapors in workers may have been exposed to from groundwater use is, however, hundreds of times lower than the air concentrations that cause liver cancer in mice and thousands of times lower than the dose that causes liver cancer in mice (ATSDR 1997a).

Trichloroethylene (Trichloroethylene or TCE)

It is not known if drinking water contaminated with trichloroethylene causes non-cancer illness in humans. Childhood leukemia has been observed after maternal exposure to trichloroethylene-contaminated drinking water during the prenatal period (EPA 2001, NJDHSS 2003). Evidence from animal and epidemiological studies also suggests that exposure to trichloroethylene might be associated with congenital heart defects and poor intrauterine growth. Studies in rats and mice show that trichloroethylene can effect fertility, but the relevance to humans is not clear (NRC 2006). Human epidemiological studies have been limited by difficulties in estimating exposure levels and by the presence of other solvents with similar toxic effects. In rats and mice, trichloroethylene begins affecting the liver, kidney, and developing fetus at doses as low as 1 mg/kg/day (EPA 2001). These studies are limited, however, by inadequate characterization of exposure, inadequate quantification of results, or lack of endpoints suitable for deriving chronic endpoints.

The highest estimated average daily dose for former American Beryllium workers (0.1 mg/kg/day) who every day for 18 years (1962-1980) may have drunk contaminated groundwater from an on-site well with the highest measured trichloroethylene concentration is 500 times less than the lowest doses causing non-cancer effects in rats and mice (50 mg/kg/day) (ATSDR 1997b). Too little information exists, however, to know if drinking trichloroethylene-contaminated groundwater from an on-site well caused liver damage, kidney damage, or other non-cancer illnesses in former American Beryllium workers.

The National Toxicology Program reviewed the carcinogenicity of trichloroethylene (TCE) and concluded:

> "Trichloroethylene (TCE) is reasonably anticipated to be a human carcinogen based on limited evidence of carcinogenicity from studies in humans, sufficient evidence of carcinogenicity from studies in experimental animals, which indicates there is an increase incidence of malignant and/or a combination of malignant and benign tumors at multiple tissue sites in multiple species of experimental animals and information suggesting TCE acts through mechanisms that indicate it would likely cause cancer in humans." (NTP 2005)

In a 2001 draft assessment, EPA also reviewed the risk of cancer from exposure to trichloroethylene (TCE) and concluded:

> "Epidemiological studies, considered as a whole, have associated TCE exposures with excess risk of kidney cancer, liver cancer, lympho-hematopoietic cancer, cervical cancer, and prostate cancer. TCE has been extensively tested in animals, with mice developing liver tumors, lung tumors, and lymphomas, and rats developing kidney tumors and testicular tumors. The epidemiologic evidence is strongest at sites where the animals develop cancer, with site concordance for kidney cancer (in rats and humans), liver cancer (in mice and humans), and lympho-hematopoietic cancer (in mice and humans). TCE is also associated with cervical cancer and prostate cancer in humans, sites for which there are no corresponding animal models." (EPA 2001)

In this 2001 draft risk assessment, EPA also established a range of slope factors (0.02 to 0.4 per mg/kg-day) to estimate the cancer risk from exposure to trichloroethylene. In 2006, the National Research Council (NRC) found that the evidence on carcinogenic risk and other health hazards from exposure to trichloroethylene has strengthened since 2001. The NRC found that enough credible human health information exists and recommended finalizing EPA's 2001 draft risk assessment (NRC 2006).

Based on EPA's 2001 range of cancer slope factors (0.02 to 0.4 per mg/kg-day), if former American Beryllium workers every day for 18 years drank contaminated groundwater from an on-site well with the highest measured trichloroethylene concentration (lifetime average daily dose of 0.03 mg/kg/day), they are at a "moderate" to "high" (60 to 1,000 in 100,000) increased theoretical risk of cancer. Diabetes or chronic alcohol consumption may further increase the cancer risk (EPA 2001).

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in former workers.

This public health assessment makes the health-protective assumption that former American Beryllium workers drank groundwater daily with the highest concentration of trichloroethylene found in an on-site well (13,000 ug/L). If they drank contaminated groundwater, the trichloroethylene concentrations they were actually exposed to in the past likely varied over time. The concentration of trichloroethylene in the groundwater in the past may have been lower or higher than 13,000 ug/L. In addition, former workers may have been exposed for less than 18 years.

3.3.1.3 Off-Site Surface Soils

Tallevast residents may have been exposed to contaminants in off-site soil. Their exposure may have been via incidental ingestion (accidentally swallowing small amounts of soil) or by inhalation (breathing dust created from the contaminated soil).

The highest levels of chemicals found in the surface soil of the Tallevast community are not likely to cause non-cancer illness. The additional theoretical risk of skin or lung cancer for residents from the highest level of inorganic arsenic in Tallevast soil is "no apparent" (0.3 to 6 in 100,000). The additional theoretical cancer risk from the highest levels of beryllium and polycyclic aromatic hydrocarbons (PAHs) in Tallevast soil ranges from "extremely small" (0.5 in 100,000) to "no apparent" (3 in 100,000). However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents. Tables 13 and 14 summarize the non-cancer and cancer risk in Tallevast soil for each contaminant of concern.

Arsenic

Incidental ingestion of inorganic arsenic measured in residential surface soils of the Tallevast community is not expected to cause illness. We assumed the arsenic was in the more toxic inorganic form. The highest estimated inorganic arsenic average daily dose from incidental soil ingestion (0.00007 mg/kg/day)(Table 6) is 26 times lower than the lowest dose (0.0018 mg/kg/day) that caused pigmentation changes in the skin. No observable adverse effect levels (NOAEL) for inorganic arsenic in humans range from 0.0004 – 0.1 mg/kg/day (ATSDR 2005d).

Inhalation of dust from the highest residential inorganic arsenic surface soil concentration measured in the Tallevast community is not expected to cause illness. The highest estimated concentration of inorganic arsenic contaminated dust (0.000002 milligrams per cubic meter, mg/m^3)(Table 6) is 350 times lower than the lowest concentration that increased the risk of stillbirth in humans (0.0007 mg/m^3) (ATSDR 2005d). Skin contact with inorganic arsenic measured in surface soil in the Tallevast community is not expected to cause illness.

To evaluate a theoretical cancer risk from incidental ingestion of inorganic arsenic, the US EPA developed a cancer slope factor based on a human study where subjects developed skin cancer. We multiply the cancer slope factor (1.5 per mg/kg-day) by the lifetime average daily dose (0.00004 mg/kg/day). We adjust the highest estimated ingestion dose in Tallevast to create the lifetime average daily dose for a 70-year life expectancy. The maximum theoretical excess cancer risk for lifetime exposure of incidental ingestion of inorganic arsenic is 6 in 100,000, which is a "no apparent" increased risk.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

To evaluate a theoretical cancer risk from inhalation of inorganic arsenic, the US EPA developed an inhalation risk unit, from a human study where subjects developed lung cancer. We multiply the unit risk (4.3 x 10^{-3} ug/m^3) by an inhalation concentration that we have adjusted for a lifetime of 70 years (0.0006 ug/m^3). The estimated maximum theoretical excess cancer risk for lifetime inhalation of inorganic arsenic contaminated dust in Tallevast is 0.3 in100,000, which is a "no apparent" increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

While studies link inorganic arsenic to skin, lung, bladder and liver cancer, the lowest dose in any human study that caused cancer was 0.0011 mg/kg/day (ATSDR 2005d). Given the relatively low level of the estimated dose in comparison to studies that associated inorganic arsenic to cancer, and given an intermittent residential exposure environment, it is unlikely that the estimated dust inhalation would result in an increased rate of cancer in Tallevast residents.

Barium

Incidental ingestion of barium measured in residential surface soils of the Tallevast community is <u>not</u> expected to cause illness. The highest estimated average daily dose (0.002 mg/kg/day) (Table 6) is hundreds of times lower than the lowest dose that caused increased blood pressure in animal studies (0.8 mg/kg/day) (ATSDR 1992).

Inhalation of dust from the highest residential barium surface soil concentration measured in the Tallevast community is <u>not</u> expected to cause illness. The highest estimated air concentration (0.00006 mg/m^3) is thousands of times lower than the lowest concentration that cause increased blood pressure, difficulty breathing, and irregular heartbeat in animal studies (3.6 mg/m^3) (ATSDR 1992). Skin contact with barium measured in surface soil in the Tallevast community is <u>not</u> expected to cause illness. Barium is not well absorbed through the skin. Barium is not a carcinogen (cancer-causing chemical).

Beryllium

Although beryllium levels in residential surface soils of the Tallevast community do not exceed health-based guidelines, we evaluated health effects because beryllium was the primary component at the former American Beryllium facility and is a community concern.

Incidental ingestion of beryllium measured in residential surface soils of the Tallevast community is <u>not</u> expected to cause non-cancer illness. The highest beryllium average daily dose from incidental soil ingestion (0.0002 mg/kg/day) is thousands of times lower than the lowest concentrations that caused lesions in the stomach, small intestine, and large intestine in animal studies (12 mg/kg/day) (ATSDR 2002).

Inhalation of dust from the highest measured beryllium soil concentrations in the Tallevast community is <u>not</u> expected to cause illness including chronic beryllium disease. The maximum estimated air concentrations resulting from surface soil becoming airborne (dust) (0.000007 mg/m^3) is over 70 times less than the concentrations likely to cause chronic beryllium disease in humans (0.0005 mg/m^3) (ATSDR 2002). Skin contact with beryllium measured in surface soil in the Tallevast community is not expected to cause illness. Beryllium is not well absorbed though the skin (ATSDR 2002).

In two reports, Florida DOH and ATSDR summarized the results of beryllium sensitivity testing of 369 former workers, household members, and nearby residents. During this investigation, the Florida DOH found that only former workers or household members of former workers were sensitized to beryllium. (ATSDR 2005b, ATSDR 2006a).

Studies have not found beryllium to cause cancer in animals after oral (ingestion) exposure. This could be due to the poor absorption of beryllium compounds from the gastrointestinal tract. Inhalation of beryllium dust has been associated with lung cancer, but at concentrations hundreds of times higher than those likely to be found in dust created from Tallevast surface soil (ATSDR 2002).

To estimate a theoretical increased cancer risk from inhalation of beryllium contaminated dust from soil, the US EPA developed an inhalation unit risk based on a human lung cancer study. We multiply the inhalation unit risk (0.0024 ug/m^3) by an inhalation concentration that we have adjusted for a lifetime of 70 years (0.002 ug/m^3). The estimated maximum theoretical excess cancer risk for a Tallevast resident from lifetime exposure of inhalation of beryllium contaminated dust from soil is 0.5 in 100,000, which is an extremely small increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

Studies have not shown an association between cancer and ingested beryllium (ATSDR 2002).

Lead

Except for one location, concentrations of lead in residential surface soil in the Tallevast community are not expected to cause illness. A predictive model estimated blood lead level ranging from 0.7 – 1.4 micrograms per deciliter (ug/dL) (Table 3). These blood lead levels are below any threshold established by human studies for health effects (ATSDR 2005e).

One surface soil sample in the Tallevast community had a lead concentration that could theoretically result in a blood concentration of up to 9 micrograms per deciliter (ug/dL) (Table 3). The US Centers for Disease Control and Prevention's (CDC) level of concern for lead in the blood is 10 ug/dL. Three children live in the home with the yard with the highest lead level. The Manatee CHD tested the children in August 2004. Each child had blood levels below 10 ug/dL.

Polycyclic Aromatic Hydrocarbons (PAHs)

Incidental ingestion of PAHs measured in residential surface soils of the Tallevast community is not expected to cause non-cancer illness. These PAHs include dibenzo(a,h)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, etc. The highest estimated PAH dose (0.000006 mg/kg/day Total Equivalency or TEQ) is millions of times lower than the lowest dose (33 mg/kg/day) that had non-cancer health effects in animal studies (ATSDR 1995).

Inhalation of dust from the highest residential PAH surface soil concentration measured in the Tallevast community is not expected to cause non-cancer illness. The highest estimated air concentration (0.0000002 mg/m^3) resulting from surface soil becoming airborne (dust) is a thousand times lower than the lowest concentration that cause decreased lung function, cough, bloody vomit, and chest and throat irritation in a human study (0.0001 mg/m^3) (ATSDR 1995). Although PAHs are absorbed through the skin, contact with the concentrations of PAHs measured in surface soil in the Tallevast community is <u>not</u> expected to cause illness.

Certain PAHs cause cancer in humans and animals. The evidence in humans comes mostly from studies of workers in oil refining, roofing, coal gasification, or coke production. Cancer associated with exposure to PAH-containing mixtures in humans occurs predominantly in the lungs following inhalation and skin following skin contact. Route of exposure influences incidence of cancer in animal studies, stomach cancer follows ingestion, lung cancer follows inhalation and skin cancer follows dermal contact (ATSDR 1995).

To estimate a theoretical increased cancer risk from ingestion of PAHs, the US EPA developed a cancer slope factor from an ingestion study of squamous cell papillomas and carcinomas in mice. We multiply the cancer slope factor (7.3 per mg/kg-day) by an average daily dose that we have adjusted for a 70-year life expectancy (0.000004 mg/kg/day). The estimated maximum theoretical excess cancer risk for lifetime exposure of incidental ingestion of PAHs is 3 in 100,000, which is a “no apparent” increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents. Given the relatively low level of the estimated dose of PAHs in comparison to studies that associated PAHs to cancer, and given an intermittent residential exposure, it is unlikely that the estimated exposure would result in an increased cancer rate in Tallevast residents.

Total Recoverable Petroleum Hydrocarbons (TRPH)

Total petroleum hydrocarbons are a broad family of several hundred compounds that originally come from crude oil. TRPH measures the total quantity of hydrocarbons without identification of individual constituents. Determining specific health effects of TRPH is not possible without knowledge of specific components (ATSDR 1999).

3.3.1.6 Off-Site Groundwater

Those Tallevast residents who every day between 1961 and 2004 (42 years) drank contaminated groundwater with the highest measured trichloroethylene concentrations are at a “low” (8 in 100,000) to “high” (4,000 in 100,000) theoretical increased risk of cancer including kidney, liver, leukemia, and lymphoma. Those Tallevast residents who every day for 42 years used contaminated groundwater with the highest measured trichloroethylene concentrations for drinking <u>and</u> showering are at a “moderate” (60 in 100,000) to “very high” (20,000 in 100,000) theoretical increased risk of cancer.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents. Tables 13 and 14 summarize the non-cancer and cancer risk for each contaminant of concern.

This section evaluates the health risk for Tallevast residents from past exposure to contaminated groundwater. Exposure to contaminated groundwater may have been through ingestion (drinking), inhalation (breathing) of vapors during showering/other household use, or dermal (skin) absorption. We use the highest concentration in private drinking water wells and off-site irrigation wells to estimate exposure.

This public health assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. This assessment, however, does not apply equally to all Tallevast residents. Most Tallevast residents with wells were exposed to less than the highest contaminant levels. The health risk for these individual would be less than the health risk estimated in this report. For those Tallevast residents whose wells were not contaminated, the health risk from ground water is essentially zero.

How long some Tallevast residents were drinking contaminated groundwater is unknown. Some may have been drinking contaminated groundwater since as far back as 1962. For most Tallevast residents this potential exposure ended in 1984/1985 when they began using municipal water. Approximately 17 families, however, did not start using municipal water until 2004 (potential exposure of 42 years).

The Florida DOH used off-site monitoring and irrigation well data to evaluate potential health effects from exposure to groundwater. Higher levels of contamination were identified in monitoring and irrigation wells, thus providing a worst-case scenario. Private drinking water wells that were in use up to 2004 have been sampled several times since May 2004 and provide data for a more realistic exposure. Due to the lack of private drinking water well data previous to 2004 and not knowing when the on-site contamination began, the Florida DOH chose to use the monitoring and irrigation well data in the first step of the health assessment. If a contaminant of concern appears to have health effects at the levels found in monitoring or irrigation wells, the contaminant of concern is also evaluated using the highest level found in a private drinking water well.

Currently, Tallevast residents do not use groundwater for drinking, showering, or other household uses. As long as they do not use groundwater for drinking, showering, or other household uses, there is no current or future public health hazard from groundwater.

This section first considers the health risk from exposure to individual chemicals. For each chemical we estimate the health risk separately for each route of exposure (drinking, breathing, and skin absorption). For each chemical, we also estimate the health risk from the three routes of exposure combined. Finally, this section considers the health risk from exposure to a mixture of chemicals. Appendix D further discusses evaluation of health risk from exposure to individual chemicals and chemical mixtures in drinking water.

<u>Evaluation of Exposure to the Individual Chemicals in Groundwater</u>

1,1-Dichloroethane (1,1-DCA)

Too little is known about the toxicity of 1,1-dichloroethane to determine the risk of illnesses in Tallevast residents who drank contaminated groundwater. Two studies investigated the health effects associated with oral exposure to 1,1-dichloroethane in rats and mice. With the exception of decreased body weight in one study, neither one provided any conclusive evidence of adverse toxic effects associated with oral exposure to 1,1-dichloroethane (ATSDR 1990).

Too little is known about the toxicity of 1,1-dichloroethane to determine the risk of illness in Tallevast residents who breathed its vapors following indoor water use. The few animal studies that exist on inhalation of 1,1-dichloroethane are inconclusive (ATSDR 1990).

Dermal (skin) absorption of 1,1-dichloroethane is probable. No studies, however, have investigated health effects after dermal exposure (ATSDR 1990).

Cancer studies of 1,1-dichloroethane are limited and inconclusive. Although EPA has classified 1,1-dichloroethane as a possible human carcinogen it is not possible to estimate accurately the human cancer risk from exposure to 1,1-dichloroethane in the Tallevast community. Information exists only from two studies on oral route of exposure in rats and mice. The highest estimated dose from drinking groundwater in Tallevast is hundreds of thousands of times less than the dose that caused precancerous endometrial polyps in mice (ATSDR 1990).

Table 4 estimates the combined dose from ingestion and dermal/inhalation from showering. Too little is known, however, about the toxicity of 1,1-dichloroethane to the determine the risk of illness from the combined exposure.

1,1-Dichloroethene (1,1-DCE)

The highest levels of 1,1-dicloroethene found in Tallevast groundwater are <u>not</u> likely to cause non-cancer illness in residents that drank the water. The highest estimated average daily dose for children who drank from private wells (0.2 milligrams per kilogram per day or mg/kg/day) is about 50 times lower than the no observable adverse effect level (NOAEL) in rats for liver effects (10 mg/kg/day) and for kidney effects (19.3 mg/kg/day) (ATSDR 1994).

Inhalation of 1,1-dichloroethene vapors from showering and other indoor water use is <u>not</u> likely to cause non-cancer illness. The highest estimated indoor air concentrations of 1,1-dichloroethene (five parts per million, ppm) is lower than levels that cause kidney and liver dysfunction in animals (25 ppm). It is also several times lower than the no observable adverse effect level (NOAEL) from a study with mice (ATSDR 1994).

Dermal (skin) absorption of 1,1-dichloroethene is probable. Studies of health effects after dermal exposure are, however, very limited. Pure 1,1-dichloroethene can remove fat from the skin and cause irritation (ATSDR 1994).

It is not known if breathing air or drinking water with 1,1-dichloroethene increases the risk of cancer in humans. The US Department of Health and Human Services has not classified 1,1-dichloroethene with respect to its ability to cause cancer in humans (ATSDR 1994, IRIS 2004). Two worker studies are inconclusive. Only one animal study out of several found any evidence that breathing 1,1-dichloroethene might cause cancer. Although the highest concentration of 1,1-dichloroethene in Tallevast drinking water wells was thousands of times less than the levels that increased malignant and non-malignant tumors in animal studies (ATSDR 1994), it is not possible to accurately estimate the human cancer risk from exposure to 1,1-dichloroethene in the Tallevast community.

Table 4 estimates the combined dose from ingestion and dermal/inhalation from showering. The average daily dose for a child (0.7 mg/kg/day) or adult (0.4 mg/kg/day) showering with the highest levels of 1,1-dichloroethene is 15 to 25 times lower than the no observable adverse effect level (NOAEL) in rats for liver effects (10 mg/kg/day) and for kidney effects (19.3 mg/kg/day)

(ATSDR 1994). Thus showering with the highest concentration of 1,1-dichloroethene found in Tallevast ground water is not likely to cause non-cancer illness.

Cis-1,2-dichloroethene (cis-1,2-DCE)

Too little is known about the toxicity of *cis*-1,2-dichloroethene to determine the risk of illness, including cancer, in Tallevast residents. Human and animal studies are inadequate to determine the risk from breathing *cis*-1,2-dichloroethene, drinking water with *cis*-1,2-dichloroethene, or getting *cis*-1,2-dichloroethere on the skin (ATSDR 1996).

Trans-1,2-dichloroethene (trans-1,2-DCE)

Too little is known about the toxicity of *trans*-1,2-dichloroethene to determine the risk of illnesses in Tallevast residents who drank contaminated groundwater. No human studies exist that discuss cancer or non-cancer effects from exposure to *trans*-1,2-dichloroethene. A limited number of animal studies discuss the non-cancer illnesses related to *trans*-1,2-dichloroethene in acute or intermediate exposure periods. A 16 week study on rats showed slight fatty accumulation in cells lining the liver after breathing *trans*-1,2-dichloroethene at levels hundreds of thousands of times higher than those estimated for Tallevast residents. A 90-day study on mice showed changes in weight of the lung, liver and thymus after drinking water doses of *trans*-1,2-dichloroethene a million times higher than the highest levels estimated for Tallevast residents. Undiluted *trans*-1,2-dichloroethene applied to the skin caused mild to moderate abnormal redness of skin in a 24-hour study on rabbits (ATSDR 1996).

No human or animal studies have been done to determine if *trans*-1,2-dichloroethene increases the risk of cancer (ATSDR1996). Therefore, it is not possible to estimate accurately the human cancer risk from exposure to *trans*-1,2-dichloroethene in the Tallevast community.

1,4-Dioxane

The highest levels of 1,4-dioxane found in Tallevast groundwater were not likely to cause non-cancer illness. The highest estimated child drinking (ingestion) average daily dose in Tallevast groundwater (0.2 mg/kg/day) is about 400 times less than the lowest dose that caused liver and kidney damage in animal studies (80 mg/kg/day) (ATSDR 2004). The highest estimated inhalation concentration from showering (4 ppm) is less than the concentrations German workers breathed for 25 years with no unusual illness (0.006-14.3 ppm) (ATSDR 2004).

Most information on health effects of 1,4-dioxane comes from acute (short-term) exposure of animals to high concentrations. Limited information exists regarding the health effects of 1,4-dioxane in humans. Dermal absorption of 1,4-dioxane is minimal because of the relatively short contact time with bath/shower water and because 1,4-dioxane dissolved in water does not easily penetrate the skin.

To estimate a theoretical increased risk of cancer from drinking (ingestion) exposure of 1,4-dioxane, the US EPA developed a cancer slope factor from an ingestion study of squamous cell carcinoma of the nasal turbinates in rats. We multiply the cancer slope factor (0.011 mg/kg-day) by the lifetime average daily dose (0.02 mg/kg/day). The theoretical increased risk of cancer for Tallevast residents who drank the highest level of 1,4-dioxane measured in groundwater is an increase of 20 in 100,000, and is considered a “low” increased risk. No human cancer studies exist for oral exposure of 1,4-dioxane. Several studies in animals, however, examined the carcinogenicity of 1,4-dioxane following oral exposure. The EPA classifies 1,4-dioxane as a probable human carcinogen. EPA based the human cancer risk on an extrapolation from animal studies. No human or animal studies exist to determine if 1,4-dioxane is associated with cancer via inhalation or dermal routes of exposures.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

Table 4 estimates the combined dose from drinking (ingestion) and showering (dermal/ inhalation). The combined drinking, inhalation, and dermal average daily dose for a child or adult exposed to the highest levels of 1,4-dioxane (0.5 – 0.2 mg/kg/day) is 160 to 400 times lower than doses in animal studies that caused blood and liver problems in animal studies (80 mg/kg/day) (ATSDR 2004). Thus showering with the highest concentration of 1,1-dichloroethene found in Tallevast groundwater is not likely to cause non-cancer illness.

To estimate a theoretical increased risk of cancer from drinking (ingestion) and showering (inhalation and dermal) combined, we multiplied the estimated lifetime average daily dose of 1,4-dioxane (0.1 mg/kg/day) by the EPA cancer slope factor (0.011 mg/kg-day). The theoretical increased risk of cancer for Tallevast residents who drank and showered with the highest level of 1,4-dioxane measured in groundwater is an theoretical increase of 100 in 100,000, and is considered a “moderate” increased risk. No human cancer studies exist for oral exposure of 1,4-dioxane. Several studies in animals, however, examined the carcinogenicity of 1,4-dioxane following oral exposure. The EPA classifies 1,4-dioxane as a probable human carcinogen. EPA based the human cancer risk on an extrapolation from animal studies. No human or animal studies exist to determine if 1,4-dioxane is associated with cancer via inhalation or dermal routes of exposures.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

Tetrachloroethylene (Perchloroethylene, PCE)

Drinking Tallevast groundwater with the highest levels of tetrachloroethylene is not likely to cause non-cancer illness. The highest estimated ingestion dose of tetrachloroethylene for a child (0.3 mg/kg/day) is thousands of times less than the lowest observable adverse effect level that caused reduced survival and nephropathy (kidney damage) in animal studies (386 mg/kg/day) (ATSDR 1997a).

There is not enough information to determine if inhalation of tetrachloroethylene vapors from groundwater use could cause health effects in Tallevast residents. An estimated inhalation concentration from exposure to the highest level of tetrachloroethylene in groundwater was calculated using Risk Assistant, a software model that uses EPA risk assessment guidelines. The highest estimated indoor air concentration of tetrachloroethylene for Tallevast residents (3 ppm) is less than the lowest observable adverse effect levels in human studies (10 to 23 ppm). The highest estimated indoor air concentration of tetrachloroethylene for Tallevast residents is less than the concentration that caused prolonged reaction time in women exposed over a 10-year period (15 ppm) (ATSDR 1997a).

Animal studies suggest tetrachloroethylene is absorbed through the skin. Human skin contact with 99% tetrachloroethylene for 30 minutes caused abnormal redness and irritation (ATSDR 1997a).

It is not possible to estimate accurately the human cancer risk from exposure to tetrachloroethylene in the Tallevast community groundwater. There is sufficient evidence that tetrachloroethylene can cause cancer in animals, but the data in humans are inconclusive. The US Department of Health and Human Services has concluded tetrachloroethylene may reasonably be anticipated to be a carcinogen (NTP 2005). Studies of dry cleaning workers suggest a possible association between chronic tetrachloroethylene exposure and increased risk of esophageal cancer, cervical cancer, and non-Hodgkin's lymphoma. These studies are inconclusive, however, because of exposure to other solvents, exposure to tobacco smoke, limited control populations, and incomplete follow-up.

Table 4 estimates the combined dose from drinking (ingestion) <u>and</u> showering (dermal/ inhalation). The combined drinking/inhalation/dermal average daily dose for a child or adult showering with the highest levels of tetrachloroethylene (0.8 – 0.4 mg/kg/day) is hundreds of times lower than the lowest observable adverse effect level that caused reduced survival and nephropathy (kidney damage) in animal studies (386 mg/kg/day) (ATSDR 1997a). Thus showering with the highest concentration of tetrachloroethylene found in Tallevast ground water is <u>not</u> likely to cause non-cancer illness.

Trichloroethylene (Trichloroethylene or TCE)

It is not known if drinking water contaminated with trichloroethylene causes non-cancer illness in humans. Childhood leukemia has been observed after maternal exposure to trichloroethylene-contaminated drinking water during the prenatal period (EPA 2001, NJDHSS 2003). Evidence from animal and epidemiological studies also suggests that exposure to trichloroethylene might be associated with congenital heart defects and poor intrauterine growth. Studies in rats and mice show that trichloroethylene can effect fertility, but the relevance to humans is not clear (NRC 2006). Human epidemiological studies have been limited by difficulties in estimating exposure levels and by the presence of other solvents with similar toxic effects. In rats and mice, trichloroethylene begins affecting the liver, kidney, and developing fetus at doses as low as one (1) mg/kg/day (EPA 2001). These studies are limited, however, by inadequate characterization of exposure, inadequate quantification of results, or lack of endpoints suitable for deriving chronic endpoints.

The highest estimated average daily dose for children (0.8 mg/kg/day) living in Tallevast who every day for three years drank contaminated groundwater with the highest measured trichloroethylene concentration (6,000 ug/L) is 60 times less than the lowest doses causing non-cancer effects in rats and mice (50 mg/kg/day) (ATSDR 1997b). The highest estimated average daily dose for adults living in Tallevast (0.2 mg/kg/day) who every day for 42 years drank contaminated groundwater with the highest measured trichloroethylene concentration (6,000 ug/L) is 250 times less than the lowest doses causing non-cancer effects in rats and mice (50 mg/kg/day) (ATSDR 1997b). Too little information exists, however, to know if drinking trichloroethylene-contaminated groundwater caused liver damage, kidney damage, or other non-cancer illnesses in Tallevast residents.

Using the highest trichloroethylene concentration found in any off-site well (6,000 ug/L) we used Risk Assistant software to estimate an indoor air trichloroethylene concentration of 12 parts per million (ppm) from showering and other indoor water use. Long-term inhalation studies in mice and rats, as well as human epidemiological studies, find effects on the central nervous system, liver, and endocrine system begin with trichloroethylene air concentrations between 5-16 ppm. Central nervous system effects in people breathing trichloroethylene include poor muscle coordination, drowsiness, fatigue, dizziness, nausea, headache, and eye/nose/throat irritation (EPA 2001). However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause symptoms or illness in Tallevast residents.

Dermal (skin) absorption of trichloroethylene is probable. Direct contact with concentrated solutions of trichloroethylene can result in the desiccation (drying) of the skin due to defatting (ATSDR 1997b). Studies of health effects after dermal exposure, however, are too limited to estimate the health risk for Tallevast residents.

The National Toxicology Program reviewed the carcinogenicity of trichloroethylene (TCE) and concluded:

> "Trichloroethylene (TCE) is reasonably anticipated to be a human carcinogen based on limited evidence of carcinogenicity from studies in humans, sufficient evidence of carcinogenicity from studies in experimental animals, which indicates there is an increase incidence of malignant and/or a combination of malignant and benign tumors at multiple tissue sites in multiple species of experimental animals and information suggesting TCE acts through mechanisms that indicate it would likely cause cancer in humans." (NTP 2005)

In a 2001 draft assessment, EPA also reviewed the risk of cancer from exposure to trichloroethylene (TCE) and concluded:

> "Epidemiological studies, considered as a whole, have associated TCE exposures with excess risk of kidney cancer, liver cancer, lympho-hematopoietic cancer, cervical cancer, and prostate cancer. TCE has been extensively tested in animals, with mice developing liver tumors, lung tumors, and lymphomas, and rats developing kidney tumors and testicular tumors. The epidemiologic evidence is strongest at sites where the animals develop cancer, with site concordance for kidney caner (in rats and humans), liver cancer (in mice and humans), and lympho-hematopoietic cancer (in mice and humans). TCE is also associated with cervical cancer and prostate cancer in humans, sites for which there are no corresponding animal models." (EPA 2001)

In this 2001 draft risk assessment, EPA also established a range of slope factors to estimate the cancer risk from exposure to trichloroethylene. In 2006, the National Research Council (NRC) found that the evidence on carcinogenic risk and other health hazards from exposure to trichloroethylene has strengthened since 2001. The NRC found that enough credible human health information exists and recommended finalizing EPA's 2001 draft risk assessment (NRC 2006).

Based on EPA's 2001 range of cancer slope factors (0.02 to 0.4 per mg/kg-day), Tallevast residents who every day for 42 years drank contaminated groundwater with the highest measured trichloroethylene concentration in any off-site well (6,000 ug/L; lifetime average daily dose 0.1 mg/kg/day) are at a "moderate" (200 in 100,000) to "high" (4,000 in 100,000) increased risk of cancer. Tallevast residents who every day for 42 years drank contaminated groundwater with the highest measured trichloroethylene concentration in a private drinking water well (240 ug/L; lifetime average daily dose 0.004 mg/kg/day) are at a "low" (8 in 100,000) to "moderate" (200 in 100,000) increased risk of cancer. Diabetes or chronic alcohol consumption may further increase the cancer risk (EPA 2001).

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

This public health assessment makes the health-protective assumption that Tallevast residents were exposed to either the highest concentration of trichloroethylene found in any off-site irrigation well (6,000 ug/L) or private drinking water well (240 ug/L). The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher than 6,000 ug/L. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

Table 4 estimates the combined dose from drinking (ingestion) and dermal/inhalation from showering. Too little is known about the toxicity of trichloroethylene to know if the combined exposure from drinking and dermal/inhalation from showering would cause non-cancer illnesses in Tallevast children or adults.

The estimated lifetime average daily dose of trichloroethylene for ingestion and showering combined (0.03 to 0.6 mg/kg/day) multiplied by EPA's 2001 range of cancer slope factors (0.02 to 0.4 per mg/kg-day) results in a "moderate" to "very high" (60 to 20,000 in 100,000) theoretical increased cancer risk.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

Evaluation of Exposure to the Mixture of Chemicals in Groundwater

Some Tallevast residents were exposed to a mixture of contaminants in drinking water from private wells. ATSDR developed guidance for evaluating mixtures (ATSDR 2001a). For evaluating non-cancer health effects, we calculate the hazard quotient (HQ) for each chemical and for each route of exposure as previously described for the evaluation of each contaminant of concern. With mixtures, we add the hazard quotients for each chemical to derive the hazard index (HI) for the mixture as follows:

Oral $HI_{mixture}$ = oral HQ_{TCE} + oral HQ_{PCE} + oral $HQ_{1,1\text{-}DCE}$ + oral $HQ_{1,4\text{-}Dioxane}$

Inhalation $HI_{mixture}$ = inhalation HQ_{TCE} + inhalation HQ_{pce} + inhalation $HQ_{1,1\text{-}DCE}$ + inhalation $HQ_{1,4\text{-}Dioxane}$

Whenever a combined HI for a mixture of chemicals exceeds 1.0, ATSDR evaluates the exposure further to determine if a mixtures effect might be possible. Part of this additional evaluation requires that organ-specific endpoints be determined. ATSDR refers to the organ-specific HQs as a target toxicity doses (TTD). For instance, when two chemicals both cause adverse effects to the lungs, ATSDR derives a lung target toxicity dose for each chemical. As with calculating an MRL, ATSDR then uses the resulting TTD for each chemical to develop an HI for just respiratory (lung) effects. Again, ATSDR calculates the HIs based on organ-specific target toxicity doses for each route of exposure as follows:

Oral HI-TTDingestion = oral HQingestion-TCE + oral HQingestion-PCE + oral $HQ_{ingestion\text{-}1,1\text{-}DCE}$ + oral $HQ_{ingestion\text{-}1,4\text{-}Dioxane}$

Inhalation $HI\text{-}TTD_{respiratory}$ = inhalation $HQ_{respiratory\text{-}TCE}$ + inhalation $HQ_{respiratory\text{-}PCE}$ + inhalation $HQ_{respiratory\text{-}1,1\text{-}DCE}$ + inhalation $HQ_{respiratory\text{-}1,4\text{-}Dioxane}$

Similar to evaluating possible effects of single chemical exposure, when the HI-TTD for a specific organ exceeds 1.0, a comparison of the combined estimated exposure doses for the chemicals to no observed adverse effects levels (NOAELs) and to the lowest observed adverse effect levels (LOAELs) for both chemicals provides a better understanding of which exposures might pose a greater risk of resulting in adverse health effects. In general, experimental studies of chemical mixtures have not documented toxic effects when the chemicals are administered at dose levels below their individual NOAELs. For the former American Beryllium site, the Florida DOH calculated HI-TTDs for several target organs and specific health endpoints. Because of the levels of exposure, some of the values exceeded 1.0, requiring a final comparison of the estimated exposure dose to doses that are known to cause harmful effects in animals and humans.

In addition to the dose comparisons described previously, another important step to consider is the interactions that chemicals might have in causing toxicity. Chemicals can interact in the body resulting in effects that might be additive, greater than additive, or less than additive. If additive, the effect of the mixture can be estimated from the sum of the exposure levels (weighted for potency) or the effects of the individual components. In that case, the combined HI for the two chemicals is an indication of the degree to which possible harmful effects could occur in people. When the chemicals act in a greater than additive manner (synergism), one chemical is enhancing the effect of the other chemical. In that case, the combined HI for the two chemicals underestimates the potential toxicity of the mixture of two chemicals. For chemicals that act in a less than additive manner (antagonistic effect), the combined HI overestimates the potential toxicity of the mixture of two chemicals. In other words, one chemical might be thought of as protecting against adverse effects from the other chemical. In that case, the HI for exposure to that mixture is less than simply adding the individual HQs for each chemical.

To evaluate whether a mixture of chemicals could be acting additively, synergistically, or antagonistically, ATSDR developed an approach known as the binary weight of evidence analysis. The binary weight of evidence analysis consists of three parts:

- reviewing mechanistic information available for the chemicals about how two chemicals in a mixture might interact together,
- evaluating the toxicological significance of two chemicals interacting, and
- determining whether any information is available that might be used to modify their actions.

The results of this analysis provide qualitative information that helps interpret the HI score more accurately. An important note is that additivity and interactions are specific to the route of exposure and target organ. For example, evidence that two chemicals interact at one target organ is not an indicator of how the chemicals would interact at a different target organ or endpoint (Appendix D).

Ingestion

Information about chronic ingestion exposure exists for only five of the contaminants of concern in the drinking water: 1,1-dichloroethane, 1,1-dichloroethene, 1,4-dioxane, tetrachloroethylene, and trichloroethylene. We did not evaluate *cis*-1,2-dichloroethene and *trans*-1,2-dichloroethne as a part of the mixtures due to the lack of information about these two chemicals.

An evaluation of hazard quotients by target organ show that multiple chemicals could potentially act in a mixture (Tables 10). However, after comparing the estimated dose to a known NOAEL or LOAEL for each target organ, it is apparent that the exposure margin for most chemicals is large enough to indicate that the chemicals would not act jointly in a mixture.

Inhalation

Information about chronic inhalation exposure exists for only four of the contaminants of concern in the groundwater: 1,1-dichloroethene, 1,4-dioxane, tetrachloroethylene, and trichloroethylene. 1,1-dichloroethane, *cis*-1,2-dichloroethene and *trans*-1,2-dichlorothene were not evaluated as a part of the mixtures due to the lack of information about these chemicals.

An evaluation of the hazard quotients by target organ show that multiple chemicals could potentially act in a mixture (Tables 11). The comparison of the estimated concentration to a known NOAEL or LOAEL from studies confirms that trichloroethylene, tetrachloroethylene, 1,1-dichloroethene and 1,4-dioxane could act jointly in a mixture. An analysis of the interaction between each pairing of these chemicals indicates that all pairing, except one, would act additively. The Florida DOH determines that there is a potential public health hazard because of the additive nature of the mixture of chemicals residents may have inhaled during showering.

For the pairing of tetrachloroethylene with trichloroethylene, evidence suggests that tetrachloroethylene inhibits the metabolism of trichloroethylene in humans (ATSDR 2004). It is plausible that the interaction may act less than additively for liver and kidney effects from trichloroethylene metabolites (ATSDR 2004).

3.3.1.7 Off-Site Surface Water

The highest levels of chemicals found in off-site surface water are <u>not</u> likely to cause illness. With the exception of inorganic arsenic in one sample, the compounds detected in the surface water are below ATSDR-established health screening values and are not expected to cause illness.

The route of exposure of concern with surface water would be dermal contact. If a child or an adult were to spend time playing in the golf course pond, they could be exposed to the inorganic arsenic in the water via the dermal or skin route. For this exposure, the Florida DOH estimates a resident could possibly be exposed to the water for 2 hours a day, 5 times a week during the summer months. Due to the prolonged warm weather of Florida, it is possible that residents could have waded into the water between April and October when the high temperature averages above 80 degrees.

Arsenic is a metal and the skin does not absorb metals well. The estimated average daily dose to inorganic arsenic from dermal exposure is 0.00001 mg/kg/day for a child and 0.000006 mg/kg/day for an adult. These doses are 600,000 times and one million times, respectively, lower than the lowest observed adverse effect level (LOAEL) of 6 mg/kg/day associated with gross hyperplasia and ulceration for intermediate length exposure in mice (ATSDR 2005d). Therefore, health effects are not expected from dermal exposure to arsenic in the pond.

Residents have raised concerns about the aerator in the pond aerosolizing contaminants into the air. It is unlikely that arsenic, being a metal and the only contaminant identified in the pond, would aerosolize at concentrations likely to cause illness.

3.4 Risk of Illness, Dose Response/Threshold and Uncertainty

Appendix E discusses limitations on estimating the risk of illness, the theory of dose response and the concept of thresholds. It also discusses the sources of uncertainty inherent in public health assessments.

3.5 Health Outcome Data

During the public comment period, community members raised questions about the reliability of the health outcome data previously included in this section. In response to these concerns, Florida DOH epidemiologists will reexamine cancer data from the Florida Cancer Data System including the 34270 ZIP code. They will report on their findings separately from this public health assessment report.

4.0 Child Health Considerations

ATSDR and the Florida DOH recognize the unique vulnerabilities of infants and children demand special attention. Children are at a greater risk than are adults to certain kinds of exposure to hazardous substances. Because they play outdoors and because they often carry food into contaminated areas, children are more likely to be exposed to contaminants in the environment. Children are shorter than adults, which mean they breathe dust, soil, and heavy vapors closer to the ground. They are also smaller, resulting in higher doses of chemical exposure per body weight. If toxic exposures occur during critical growth stages, the developing body systems of children can sustain permanent damage. Probably most important, however, is that children depend on adults for risk identification and risk management, housing, and access to medical care. Thus, adults should be aware of public health risks in their community, so they can guide their children accordingly.

Other susceptible populations may have different or enhanced responses to toxic chemicals than will most persons exposed to the same levels of that chemical in the environment. Reasons may include genetic makeup, age, health, nutritional status, and exposure to other toxic substances (like cigarette smoke or alcohol). These factors may limit that persons' ability to detoxify or excrete harmful chemicals or may increase the effects of damage to their organs or systems.

Trichloroethylene

Childhood leukemia has been observed after maternal exposure to trichloroethylene-contaminated drinking water during the prenatal period (EPA 2001, NJDHSS 2003). Evidence from animal and epidemiological studies also suggests that exposure to trichloroethylene might be associated with congenital heart defects and poor intrauterine growth (NRC 2006).

Pica Behavior

Except for elevated lead concentrations in one yard, pica behavior (unusual eating or swallowing of large amounts of soil) by Tallevast children is not expected to cause non-cancer illness. Table 13 summarizes the health risk for each contaminant of concern.

Some children may have an unusual behavior called "soil-pica", the unusual eating or swallowing of large amounts of soil. Soil-pica behavior is usually limited to preschool children. One and two-year-old children have the greatest tendency for soil-pica behavior. This tendency decreases in children older than two years old.

The exact number of children with this behavior is not known. This behavior is thought to occur in 4% - 21% of children (Barltrop 1966, Robischon 1971, Shellshear 1975, Vermeer and Frate1979). A recent study by ATSDR and the Colorado Department of Health and Environment estimates 20% of preschool children exhibit soil-pica behavior (ATSDR 2005f). Children with soil-pica behavior can eat up to a teaspoon of dirt (or 5,000 milligrams) at a time (Stanek and Calabrese 2000, Calabrese and Stanek 1993, Calabrese et al. 1989, Wong 1988).

Information on the frequency and duration of soil-pica behavior in children is limited. Some preschool children might eat soil once during their preschool years while others might go through a stage of eating soil several times during a week or over several months. Soil-pica behavior might occur for several days in a row, or a child might skip days between eating soil (Calabrese and Stanek 1998; Calabrese and Stanek 1993; Wong 1988, ATSDR 2001b).

FOCUS leaders report at least two Tallevast children had soil pica behavior. To evaluate potential health effects from pica behavior, we estimated a 10 kg child would ingest approximately 5,000 mg of the highest contaminated soil 3 times a week for 2 years (Table 6). We then compared the highest dose to studies where exposure occurred for less than 5 years.

Arsenic

Pica ingestion of inorganic arsenic in residential surface soils of the Tallevast community is not expected to cause illness. The highest estimated inorganic arsenic ingestion dose for a Tallevast pica child (0.01 mg/kg/day) is less than the acute (<14 days) no observable adverse effect levels (NOAEL) (0.05 to 43 mg/kg/day), the intermediate (15-364 day) NOAEL (0.8 to 25 mg/kg/day) and chronic (1- 7 year) human NOAEL (0.06 to 0.1 mg/kg/day). For these studies, lowest observable adverse effect levels range from 0.05 to 0.11 mg/kg/day (ATSDR 2005d).

Barium

Pica ingestion of barium in residential surface soils of the Tallevast community is not expected to cause illness. The highest estimated barium ingestion dose for a Tallevast pica child (0.2

mg/kg/day) is less than the acute NOAEL (66 to 198 mg/kg/day), the intermediate NOAEL (0.21 to 35 mg/kg/day), and the chronic (<3 years) NOAEL (0.17 to 200 mg/kg/day). For these studies, lowest observable adverse effect levels range from 0.8 to 160 mg/kg/day (ATSDR 1992).

Beryllium

Pica ingestion of beryllium in residential surface soils of the Tallevast community is not expected to cause illness. The highest estimated beryllium ingestion dose for a Tallevast pica child (0.03 mg/kg/day) is less than the intermediate NOAEL (0.7 to 345 mg/kg/day) and the chronic (<3.5 years) NOAEL (0.7 to 31 mg/kg/day) (ATSDR 2002).

Lead

Pica ingestion of lead in residential surface soil samples in the Tallevast community is not expected to cause illness. The highest estimated blood lead level for a child exhibiting pica behavior is 23.4 micrograms per deciliter (ug/dL). We estimate this blood lead level using the highest concentration measured, 1114 mg/kg, as an input into the US EPA's IEUBK model. This level is much higher than levels in other samples collected in the Tallevast neighborhood. This particular level could cause illness, but the chance of a child routinely being exposed to this concentration is small. This soil level was detected only one time during sampling and has never been duplicated. The three children that reside in the home where this sample was collected have each had their blood lead level tested and the results were below the CDC action level of 10 ug/dL. The second highest level of lead in a surface soil sample is 240 mg/kg, which could result in a blood lead level of 11.1 ug/dL. Children exhibiting pica behavior are much more likely to be exposed to levels closer to 240 mg/kg and below since the higher level occurred in only one yard. In studies of blood lead levels, children aged 5 years old showed a decline in IQ points with an increase of blood lead level from 1-10 ug/dL (ATSDR 2005e).

Polycyclic Aromatic Hydrocarbons (PAHs)

Pica ingestion of PAHs in residential surface soils of the Tallevast community is not expected to cause illness. The highest estimated PAH ingestion dose for a Tallevast pica child (0.0007 mg/kg/day) is less than the acute NOAEL (10 to 150 mg/kg/day) and intermediate NOAEL (1.3 to 1000 mg/kg/day) (ATSDR 1995).

5.0 Community Health Concerns

Florida DOH collected health concerns at various public meetings, from mailed correspondence, and from phone calls (Appendix C). In this section, Florida DOH gives some background information on each reported health concern and then explores its relationship to contamination from the former American Beryllium site. The studies used for comparison are the studies included in the ATSDR toxicological profile for each contaminant of concern. The toxicological profiles characterize the toxicological and adverse health effects information for a specific chemical.

Acid Reflux:

Acid reflux (esophageal reflux) occurs when stomach acid flows up into the esophagus. The esophagus is the passage down which food moves between the throat and the stomach. The esophageal sphincter is the circular band of muscle that surrounds the passage. If this muscle weakens or does not work properly, it allows acid to move up out of the stomach. The acid inflames the lining of the passage. This causes heartburn and mild pain. Heartburn, a burning sensation in the upper portion of the passage, is the most common symptom of acid reflux. Heartburn is also known as acid indigestion. Sometimes certain foods (such as fatty or spicy foods and alcohol), seem to weaken the response of the passage's muscle, which causes acid reflux. When reflux goes on for a long time, it can lead to problems that are more serious. This includes esophageal stricture (the narrowing of the throat). It can also lead to an increased risk of throat cancer. Mild cases of acid reflux are very common. About one third of Americans have some form of it. The condition is most common when someone is pregnant or overweight (AMA 2003).

Available studies have not shown an association between acid reflux and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Alcoholism:

Alcoholism is a serious chronic disease that lasts a person's lifetime. Research shows that the risk for developing alcoholism runs in families. Genetics partly explains this pattern. Lifestyle is also a factor. Your friends, the amount of stress in your life, and the availability of alcohol are factors that may increase your risk for alcoholism. Alcoholism can lead to an increase in certain cancers, especially those of the liver, esophagus, throat and larynx (voice box). Heavy drinking can increase the risk of liver cirrhosis, immune system problems, brain damage and harm to the fetus during pregnancy (AMA 2003). Currently, 17.6 million US adults abuse alcohol or are alcoholic. There are many different types of treatment programs.

Research shows that, a combination of medications and behavioral therapies have the highest success rates (NIAAA 2004).

Available studies have not shown an association between alcoholism and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Allergies:

An allergy is a very common disorder. It is caused when the immune system wrongly identifies a harmless substance as an illness causing threat. An allergen is a harmless substance that triggers an immune system response. An allergic reaction occurs after the body has been sensitized, after repeated exposures to an allergen. The immune system mistakenly reacts to the allergen as it would to a harmful virus or bacteria. An antibody is then produced to defend the body. When the antibody makes contact with the allergen, chemicals (histamine is the most common) are produced that trigger allergy symptoms. The most common symptoms are itchy, watery eyes, sneezing, runny nose, hives, and inflammation of the nasal passages. In severe cases, allergies can cause anaphylaxis shock. The most common allergens are plant pollens, dust mites, mold, pet dander, medications (like aspirin or penicillin), and certain foods. The cause of allergies is still being investigated. It is known that heredity and environment are risk factors in the development of allergies. Allergies affect a large number of people in the United States. Approximately one in five Americans has a chronic allergy (AMA 2003).

Available studies have not shown an association between allergies and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Arthritis (Rheumatoid and Other Forms):

Arthritis is a common painful disorder that affects mobility. At present, there are at least 100 different forms of the disease. They include osteoarthritis (degenerative joint disorder), rheumatoid arthritis (an autoimmune disorder) and bacterial arthritis. The most common form of the disease is osteoarthritis. Osteoarthritis is a degenerative joint disorder that affects weight-bearing joints because of age or injury. Symptoms often include inflammation, swelling, pain, stiffness and redness. Rheumatoid arthritis is an autoimmune disorder, an immune system failure that causes the body to attack healthy tissue. This form of arthritis is one of the most serious and debilitating forms of the disease. It affects not only the joints but also the heart, lungs and eyes. Symptoms of rheumatoid arthritis can include morning stiffness, fatigue, low-grade fever, and weight loss. Inflammation and pain in the small joints of the fingers, wrists, elbows, hips, knees ankles and feet is common. Arthritis is a very common disease that affects millions of Americans each year (AMA 2003).

Available studies have not shown an association between arthritis and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Asthma and Other Respiratory/Breathing Problems (Including Cough, Wheezing, Phlegm, and Shortness of Breath):

Asthma is a chronic but reversible immunological condition that causes inflammation, excessive mucous secretion (phlegm) and constriction (narrowing) of the lung's airways. Asthma can produce coughing, wheezing, and shortness of breath. A wide variety of environmental factors may trigger an asthma attack. Factors include cold air and allergens (pet dander, dust mites, pollen). It can also be prompted by inhaling an irritant (cigarette smoke, pollution). Strenuous exercise, stress and anxiety can also trigger attacks. The stimuli that trigger asthma attacks are different for each person who has asthma. Asthma attacks can vary widely in how severe they are and how long they last. It affects at least 17 million people in the United States and is becoming more widespread. It can affect people of any age or gender, but tends to begin in childhood. The incidence of asthma is highest in cities where there is more pollution (MERCK 2003, AMA 2003).

Asthma and allergies are the most common causes of respiratory and breathing problems in the United States. Respiratory and breathing problems have also been associated with exposure to trichloroethylene, tetrachloroethylene, 1,4-dioxane, inorganic arsenic and beryllium.

Human epidemiological studies find upper respiratory tract irritation begins with trichloroethylene air concentrations between 5-16 parts per million (ppm) (EPA 2001). Using the highest trichloroethylene concentration measured in an off-site irrigation well (6,000 ug/L), the highest estimated trichloroethylene air concentration in Tallevast homes from showering and other indoor water uses was 12 ppm. However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause asthma in Tallevast residents.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

Respiratory and breathing problems have been associated with exposure to tetrachloroethylene. The lowest concentration of tetrachloroethylene that caused respiratory and breathing problems in a human inhalation study (216 ppm) was over 70 times higher than the highest estimated concentration for Tallevast residents (3 ppm) (ATSDR 1997a). Therefore, the levels in Tallevast groundwater are not expected to cause a higher incidence of respiratory problems.

Respiratory and breathing problems have been associated with both inhalation and ingestion exposure to 1,4-dioxane. The lowest concentration of 1,4-dioxane that caused respiratory and breathing problems in a human inhalation study (300 ppm) was 75 times higher than the highest estimated concentration for Tallevast residents (4 ppm). The lowest dose of 1,4-dioxane that caused respiratory and breathing problems in an ingestion study with rats (103 mg/kg/day) was thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.03 mg/kg/day) (ATSDR 2004). Therefore, the levels 1,4-dioxane in Tallevast groundwater are not expected to cause a higher incidence of respiratory problems.

Respiratory and breathing problems have been associated with inhalation of inorganic arsenic. The highest concentration of inorganic arsenic that did not cause respiratory and breathing problems in a human inhalation study (0.6 mg/m^3) was hundreds of thousands of times higher than the highest estimated concentration for Tallevast residents (0.000001 mg/m^3).

Although respiratory effects are not widely associated with repeated oral ingestion of low inorganic arsenic doses, some studies have reported minor respiratory symptoms such as cough, sputum, rhinorrhea and sore throat, in people with repeated oral exposure to 0.03-0.05 mg /kg/day (ATSDR 2005d). Exposures in these studies was hundreds of times higher than the highest estimated average daily dose for a Tallevast resident (0.00007 mg/kg/day). Therefore, the inorganic arsenic levels in Tallevast soil are not expected to cause a higher incidence of respiratory problems.

Respiratory and breathing problems have been associated with inhalation of beryllium. The lowest concentration of beryllium that caused respiratory and breathing problems in a human inhalation study (0.0005 mg/m^3) was hundreds of times higher than the highest estimated concentration for Tallevast residents (0.000004 mg/m^3)(ATSDR 2002). Therefore, the beryllium levels in Tallevast soil are not expected to cause a higher incidence of respiratory problems.

Attention Deficit Disorder /Attention Deficit Hyperactivity Disorder (ADD/ADHD):

Attention deficit/hyperactivity disorder is a mental condition in which someone is extremely restless, impulsive and has trouble paying attention. Symptoms usually show up before the age of seven and last for at least six months. In some cases, ADD/ADHD goes away by adolescence. More often, it persists into adulthood. Recent studies show factors in someone’s body that affect brain chemistry might cause ADHD. This is especially true in the body’s control of dopamine. Dopamine is a neurotransmitter, which means a chemical that carries messages between the brain and the body. It is estimated that ADD/ADHD affects 5 – 10% of school-aged children. It is found in boys 10 times more often than girls (MERCK 2003).

Available studies have not shown an association between ADD/ADHD and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Body Pain (Arms, Back, Chest, Legs and Joints):

Pain can be the result of many factors. These include injury, disease, fatigue, stress, and mental illness. In most cases, pain is characterized as chronic (over a length of time) or acute (immediate), depending on how long it lasts. Acute pain is often severe. Pain is a sign that a person needs medical help. Chronic pain is usually much less severe. It can accompany many conditions. These include:

- chronic fatigue syndrome (CFS; an illness without a known cause that is characterized by long-term exhaustion, muscle weakness, depression and sleep problems)
- fibromyalgia (a disorder causing many symptoms, the main one being odd levels of the kind of chemicals that transmit nerve signals)
- arthritis (joint pain)
- endometriosis (a condition in which the mucous membrane that normally lines only the womb is present and functioning in the ovaries or elsewhere in the body)
- back problems
- Lyme's disease (which is caused by bacteria passed on to someone by ticks)
- irritable bowel syndrome (IBS) (when pain in the bowel happens repeatedly, along with constipation, diarrhea, or bouts of both (AMA 2003).

Body pain, specifically abdominal pain, has been associated with exposure to inorganic arsenic. The lowest dose of inorganic arsenic that caused abdominal pain in a human ingestion study (0.02 mg/kg/day) was hundreds of times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, inorganic arsenic levels in Tallevast soils are not expected to increase the incidence of body pain in Tallevast residents.

Cancer (Bladder, Breast, Colon, Kidney, Leukemia, Leydig, Liver, Lung, Lymphoma, and Skin):

Cancer is very common. The American Cancer Society estimates that one in four Americans will be diagnosed with some form of cancer during their lifetime and one in three Americans will die of cancer. Cancer is second only to heart disease as a cause of death in the US (ACS 2006). Cancer is not just one disease, but a group of them. Cancer happens when something damages the way the body controls a group of cells. After that, cells grow rapidly and no longer in a normal way. Growths that are cancerous or malignant can form within any tissue or organ system. Malignancies are usually grouped into two categories:

Non-tumor forming - This includes leukemia, which is a type of cancer in which white blood cells displace normal blood. Lymphoma is another type, which starts in the lymph nodes.

Tumor forming - This includes carcinoma, which is kind of tumor that starts in the surface layer of an organ or body part and may spread to other parts of the body. They commonly occur more often in older people. A second kind of tumor-forming cancer is sarcoma. This tumor grows in connective tissue like muscle, bone, fat or cartilage.

Risk factors for cancer include family history, age (60% of all cancers in the US occur in people over 65), environmental factors (cigarette smoking, alcohol consumption, pollution from industrial waste, and radiation), geography, diet (high in saturated fat/high alcohol intake), viral infections, and inflammatory diseases (MERCK 2003).

Excluding nonmelanoma skin cancer, the most common types of cancer in Florida are prostate (men), breast (women), lung/bronchus, colorectal, bladder, head/neck, uterine (women), and non-Hodgkin's lymphoma. Cancer cluster investigations seek to determine if an unexpected number of cases of cancer have occurred. These investigations are limited by a number of factors (DOH 2006).

Bladder Cancer:
Bladder cancer has been associated with exposure to inorganic arsenic. Although there is evidence that long-term ingestion of inorganic arsenic can result in the development of bladder cancer, the data are insufficient to quantify the risk.

Breast Cancer:
Available studies have not shown an association between breast cancer and any of the contaminants of concern identified in groundwater or soils samples collected in the Tallevast neighborhood.

Colon Cancer:
Available studies have not shown an association between colon cancer and any of the contaminants of concern identified in groundwater or soils samples collected in the Tallevast neighborhood.

Kidney Cancer:

Kidney cancer has been associated with exposure to trichloroethylene, 1,1-dichloroethene and inorganic arsenic.

Exposure to trichloroethylene has been associated with kidney cancer in both human epidemiological studies and in studies with rats. Those Tallevast residents who every day between 1961 and 2004 (42 years) drank contaminated groundwater with the highest measured trichloroethylene concentrations are at a "low" (8 in 100,000) to "high" (4,000 in 100,000) theoretical increased risk of kidney cancer. Those Tallevast residents who every day for 42 years used contaminated groundwater with the highest measured trichloroethylene concentrations for drinking <u>and</u> showering are at a "moderate" (60 in 100,000) to "very high" (20,000 in 100,000) theoretical increased risk of cancer.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

This public health assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. This assessment, however, does not apply equally to all Tallevast residents. Most Tallevast residents with wells were exposed to less than the highest contaminant levels. The health risk for these individual would be less than the health risk estimated in this report. For those Tallevast residents whose wells were not contaminated, the health risk from ground water is essentially zero.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

The level of 1,1-dichloroethene that caused kidney cancer in an animal inhalation study was approximately 5 times higher than the highest estimated concentration for Tallevast residents. Animal studies have shown that doses that induce kidney tumors also induce tissue damage to the kidneys. 1,1-dichloroethene is associated with kidney toxicity in humans after chronic, low-level exposure (ATSDR 1994). However, too little is known about 1,1-dichloroethene toxicity to determine if a Tallevast resident's exposure could cause and increased risk of developing kidney cancer. Due to inadequate data, we are unable to calculate a theoretical increase cancer risk for kidney cancer from exposure to 1,1-dichloroethene.

Although the level of inorganic arsenic that caused kidney cancer in an ingestion study was higher than the highest estimated dose for Tallevast residents, the data are inadequate to quantify the risk (ATSDR 2005d).

Leukemia:
Leukemia has been associated with exposure to trichloroethylene and tetrachloroethylene.

Exposure to trichloroethylene has been associated with lympho-hematopoietic cancer, including leukemia, in both human epidemiological studies and in studies with mice. Exposure to trichloroethylene has been associated with leukemia in both human epidemiological studies and in studies with rats. Childhood leukemia has been observed after maternal exposure to trichloroethylene-contaminated drinking water during the prenatal period (EPA 2001, NJDHSS 2003).

Those Tallevast residents who every day between 1961 and 2004 (42 years) drank contaminated groundwater with the highest measured trichloroethylene concentrations are at a "low" (8 in 100,000) to "high" (4,000 in 100,000) theoretical increased risk of leukemia. Those Tallevast residents who every day for 42 years used contaminated groundwater with the highest measured trichloroethylene concentrations for drinking <u>and</u> showering are at a "moderate" (60 in 100,000) to "very high" (20,000 in 100,000) theoretical increased risk of cancer.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

This public health assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. This assessment, however, does not apply equally to all Tallevast residents. Most Tallevast residents with wells were exposed to less than the highest contaminant levels. The health risk for these individual would be less than the health risk estimated in this report. For those Tallevast residents whose wells were not contaminated, the health risk from ground water is essentially zero.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

The level of tetrachloroethylene that caused leukemia in an inhalation study was higher than the highest estimated concentration for Tallevast residents. A study of rats was located that showed an association between exposure to tetrachloroethylene and mononuclear cell leukemia. However, this spontaneous and prevalent neoplasm is specific for Fischer-344 rats, and the control incidences for this study were higher than historical values. Thus, the relevance to humans from this study is unclear (ATSDR 1997a). Not enough is known to determine if tetrachloroethylene can cause leukemia in humans. Due to inadequate data, we are unable to calculate a theoretical increase cancer risk for leukemia from exposure to tetrachloroethylene.

Leydig Cell Tumors:
Leydig cell tumors have been associated with exposure to trichloroethylene.

The data are, however, inadequate to determine if exposure to trichloroethylene could increase a Tallevast resident's risk of developing Leydig cell tumors. Leydig cells tumors are benign (noncancer) growths in the testicles that often produce testosterone causing endocrine symptoms. The level of trichloroethylene that caused Leydig cell tumors in an animal inhalation study was higher than the highest estimated concentration for Tallevast residents. ATSDR located only one animal study and no human studies that discussed Leydig cell tumors (1997b). Therefore, not enough information is known to determine if exposure to trichloroethylene can cause the development of Leydig cell tumors in Tallevast residents.

Liver Cancer:
Liver cancer has been associated with exposure to trichloroethylene, tetrachloroethylene, 1,4-dioxane, and inorganic arsenic.

Exposure to trichloroethylene has been associated with liver cancer in both human epidemiological studies and in studies with mice. Exposure to trichloroethylene has been associated with liver cancer in both human epidemiological studies and in studies with rats. Those Tallevast residents who every day between 1961 and 2004 (42 years) drank contaminated groundwater with the highest measured trichloroethylene concentrations are at a "low" (8 in 100,000) to "high" (4,000 in 100,000) theoretical increased risk of liver cancer. Those Tallevast residents who every day for 42 years used contaminated groundwater with the highest measured trichloroethylene concentrations for drinking <u>and</u> showering are at a "moderate" (60 in 100,000) to "very high" (20,000 in 100,000) theoretical increased risk of cancer.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

This public health assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. This assessment, however, does not apply equally to all Tallevast residents. Most Tallevast residents with wells were exposed to less than the highest contaminant levels. The health risk for these individual would be less than the health risk estimated in this report. For those Tallevast residents whose wells were not contaminated, the health risk from ground water is essentially zero.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

The level of tetrachloroethylene that caused liver cancer in an animal ingestion study was thousands of times higher than the highest estimated dose for Tallevast residents (ATSDR 1997a). Therefore, the estimated ingestion dose of tetrachloroethylene in groundwater is not expected to cause liver cancer in Tallevast residents.

The level of tetrachloroethylene that caused liver cancer in an inhalation study of mice was higher than the highest estimated concentration for Tallevast residents. In this study, mice exposed to tetrachloroethylene developed liver tumors. However, these tumors are common in mice and the relevance of these tumors to humans is not clear. Mice livers react differently from human livers when exposed to tetrachloroethylene and its metabolites. Human studies are confounded by likely exposure to other solvents, smoking, other life-style variables, methodological limitation in choosing control populations, and maintaining compete follow-up (ATSDR 1997a). Therefore, due a lack of quantitative human data and a difference in liver reaction, it is not possible to determine if exposure to tetrachloroethylene vapors could increase a Tallevast resident's risk of developing liver cancer. Due to inadequate data, we are unable to calculate a theoretical increase cancer risk for liver cancer from exposure to tetrachloroethylene vapors.

Although the level of 1,4-dioxane that caused liver cancer in an ingestion study was higher than the highest estimated dose for Tallevast residents, the data are inadequate to quantify the risk (ATSDR 2004).

Although the level of inorganic arsenic that caused liver cancer in an ingestion study was higher than the highest estimated dose for Tallevast residents, the data are inadequate to quantify the risk (ATDR 2005d).

Lung Cancer:
Lung cancer has been associated with exposure to trichloroethylene, inorganic arsenic and beryllium.

The data are inadequate to determine if exposure to trichloroethylene could increase a Tallevast resident's risk of developing lung cancer. There is no clear evidence that trichloroethylene causes lung cancer in humans. ATSDR has compiled data on 4,280 residents of three states who had environmental exposure to trichloroethylene. It found no definitive evidence for an excess of lung cancers from trichloroethylene exposure. The level of trichloroethylene vapors that caused lung cancer in mice following lifetime exposure was higher than the highest estimated air concentration for Tallevast residents (ATSDR 1997b).

Although human studies suggest an association between long-term ingestion of inorganic arsenic and lung cancer, the data are insufficient to quantify the risk.

There is convincing evidence from a large number of human epidemiological studies that inhalation of inorganic arsenic increases the risk of lung cancer. To evaluate a theoretical cancer risk from inhalation of inorganic arsenic, the US EPA developed an inhalation risk unit, from a human study where subjects developed lung cancer. We multiply the unit risk (4.3 x 10-3 ug/m^3) by an inhalation concentration of inorganic arsenic contaminated dust that we have adjusted for a lifetime of 70 years (0.0006 ug/m^3). The estimated maximum theoretical excess cancer risk for lifetime inhalation of inorganic arsenic in Tallevast is 0.3 additional cancer per 100,000 people, which is a "no apparent" increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

To estimate a theoretical increased cancer risk from inhalation of beryllium contaminated dust from soil, the US EPA developed an inhalation unit risk based on a human lung cancer study. We multiply the inhalation unit risk (0.0024 ug/m^3) by an inhalation concentration that we have adjusted for a lifetime of 70 years (0.002 ug/m^3). The estimated maximum theoretical excess cancer risk for a Tallevast resident from lifetime exposure of inhalation of beryllium contaminated dust from soil is 0.5 additional cancer per 100,000 people, which is an extremely small increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

Lymphoma:
Non-Hodgkin lymphoma has been associated with exposure to trichloroethylene.

Exposure to trichloroethylene has been associated with lympho-hematopoietic cancer, including lymphoma, in both human epidemiological studies and in studies with mice. Exposure to trichloroethylene has been associated with lymphomia in both human epidemiological studies and in studies with rats. Those Tallevast residents who every day between 1961 and 2004 (42 years) drank contaminated groundwater with the highest measured trichloroethylene concentrations are at a "low" (8 in 100,000) to "high" (4,000 in 100,000) theoretical increased risk of lymphomia. Those Tallevast residents who every day for 42 years used contaminated groundwater with the highest measured trichloroethylene concentrations for drinking <u>and</u> showering are at a "moderate" (60 in 100,000) to "very high" (20,000 in 100,000) theoretical increased risk of cancer.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

This public health assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. This assessment, however, does not apply equally to all Tallevast residents. Most Tallevast residents with wells were exposed to less than the highest contaminant levels. The health risk for these individual would be less than the health risk estimated in this report. For those Tallevast residents whose wells were not contaminated, the health risk from ground water is essentially zero.

Skin Cancer:
Skin cancer has been associated with exposure to inorganic arsenic.

There is convincing evidence from a large number of epidemiological studies and case reports that ingestion of inorganic arsenic increases the risk of developing skin cancer. Lesions commonly observed are multiple squamous cell carcinomas, which appear to develop from some of the hyperkeratotic warts or corns. In addition, multiple basal cell carcinomas may occur. In most cases, skin cancer develops only after prolonged exposure (ATSDR 2005d).

To evaluate a theoretical cancer risk from incidental ingestion of inorganic arsenic, the US EPA developed a cancer slope factor based on a human study where subjects developed skin cancer. We multiply the cancer slope factor (1.5 per mg/kg-day) by the lifetime average daily dose (0.00004 mg/kg/day). We adjust the highest estimated ingestion dose in Tallevast to create the lifetime average daily dose for a 70-year life expectancy. The maximum theoretical excess cancer risk for lifetime exposure of incidental ingestion of inorganic arsenic is 6 additional cancers per 100,000 people, which is a “no apparent” increased risk.

We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

To evaluate a theoretical cancer risk from inhalation of inorganic arsenic, the US EPA developed an inhalation risk unit, from a human study where subjects developed lung cancer. We multiply the unit risk (4.3×10^{-3} ug/m^3) by an inhalation concentration that we have adjusted for a lifetime of 70 years (0.0006 ug/m^3). The estimated maximum theoretical excess cancer risk for lifetime inhalation of inorganic arsenic in Tallevast is 0.3 additional cancer per 100,000 people, which is a “no apparent” increased risk. We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

While studies link inorganic arsenic to skin cancer, the lowest dose in any human study that caused cancer was 0.0011 mg/kg/day (ATSDR 2005d). Given the relatively low level of the estimated dose in comparison to studies that associated inorganic arsenic to cancer, and given an intermittent residential exposure environment, it is unlikely that the estimated dust inhalation would result in an increased rate of cancer in Tallevast residents.

Cholesterol:

Cholesterol is a basic part of cell membranes, bile, brain and nerve cells.

The body uses it to make hormones. These hormones include estrogen, testosterone and cortisol. An individual's family history and their lifestyle decide their cholesterol level. Doctors test cholesterol to determine total cholesterol, HDL (good cholesterol) and LDL (bad cholesterol). Total cholesterol should be 200 for optimum health. LDL should be less than 100, while HDL level should be 60 or above. A diet high in saturated fat can adversely raise cholesterol levels. Conversely, a diet low in such fat can lower cholesterol levels (AMA 2003).

Available studies have <u>not</u> shown an association between cholesterol and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Circulatory Problems:

The circulatory system is composed of the heart and the blood vessels (arteries and veins). It is also called the cardiovascular system. Arteries carry oxygen-rich blood away from the heart. Veins carry blood that has used up oxygen toward the lungs. The circulatory system supplies oxygen to the body's cells. It also carries nutrients and blood throughout the body. This system also transports and gets rid of waste products. The immune system, which protects the body from infection, is dependent on the cardiovascular system. The health of the circulatory system is vital to keep a person alive. In the United States, cardiovascular disease is the leading cause of death among both men and women. Coronary artery disease is the most common cardiovascular disease in the U.S. Deaths linked with coronary artery disease are more common with age and affects people of all races. The rate of the disease is extremely high among African Americans and Southeast Asians. Coronary artery disease is a condition in which the blood supply to the heart muscle is partly or completely blocked. The common cause of coronary artery disease is when cholesterol and fatty materials collect on the wall of the coronary artery, clogging it (AMA 2003).

Available studies have <u>not</u> shown an association between circulatory problems and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Colon Polyps:

A colon polyp forms when tissue from the wall of the intestines or rectum sticks into the intestine or rectum. Polyps can be non-cancerous or cancerous. They can vary in size. The larger the polyp, the greater chance that it may become cancer or already is cancer. In most cases, colon polyps do not show any symptoms (AMA 2003). If symptoms do occur, the most common is rectal bleeding. While the cause for colon polyps is unknown, family history seems to be a risk factor.

Available studies have <u>not</u> shown an association between colon polyps and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Dementia/Senility:

Dementia is a disorder in which there is a gradual decline in someone's ability to think, solve problems or learn. In most cases, doctors cannot reverse this disorder. People who have this condition have memory loss, are confused and may not know where they are. A slow but steady decline in mental ability causes the patient to be unable to function. They may not be able to care for themselves. This condition occurs when healthy brain cells are damaged. In some cases, a shortage of certain vitamins can cause dementia. It can also occur when someone's thyroid does not work properly. In those cases, vitamins can reverse it. The more common causes of dementia are:

- Alzheimer's disease (a disease that slowly progresses, affects the brain and causes dementia, commonly late in life)
- Multiple strokes (strokes that happen over and over)
- Parkinson's disease (a disease of the nervous system that cannot be cured and is marked by trembling hands, lifeless face, monotone voice, and a slow shuffling walk)
- Huntington Chorea (a rare disease that often starts in middle age and is passed down in a family).

In the United States an estimated 6 million people have dementia. It usually affects people after the age of sixty-five (AMA 2003).

Available studies have <u>not</u> shown an association between dementia/senility and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Dental Problems:

A cavity is an area of a tooth that has decayed due to plaque. Plaque is a mixture of bacteria, food and saliva. It builds up on teeth and in between them and gums. Plaque is the leading cause of tooth decay and gum disease (gingivitis and periodontal disease). Frequent brushing, dental flossing and regular dental cleanings can remove plaque build-up or prevent it (MERCK 2003).

Available studies have <u>not</u> shown an association between dental problems and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Dermatomyositis/Polymyositis:

Dermatomyositis is a rare autoimmune disorder. It involves the body's connective tissue. The most common symptoms are skin rashes, inflammation, muscle weakness, and degeneration of muscle tissue. Viral infections and certain kinds of medicine usually prompt this condition. It most commonly affects adults ages 50 to 60 and children from 5 to 10. This disorder affects twice as many women as men.

Polymyositis is a rare condition that occurs when a person's immune system is disturbed. The voluntary muscles, that govern mobility, are the most affected. The symptoms can include inflammatory swelling, pain, and muscular weakness in the arms and legs. In some cases, it can be related to certain kinds of tumors (AMA 2003).

Available studies have not shown an association between dermatomyositis/polymyositis and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Diabetes and Irregular Glucose Levels:

Diabetes is a group of metabolic (which means it is has to do with how the body changes food into energy) disorders that occur when blood sugar (glucose) levels are not properly controlled. As a result, blood sugar stays in the blood. When that happens, it can damage cells, organs and tissues. Insulin is one of several hormones that control the body's blood sugar level. Insulin allows glucose to move from the blood into the liver, muscles and fat cells where these cells use it for fuel. The most common form of the disorder is diabetes mellitus (Type I and Type II). The most common symptoms of Type I are: frequent urination, excessive thirst, unexplained weight loss and general fatigue. Many times, Type II diabetes shows no symptoms at first. Slowly over time, the affected person begins to show Type I symptoms. In Type I diabetes, the insulin a person's body makes stops or is greatly decreased. People who have this form of diabetes often need daily insulin shots. Type I usually affects children and young people. It can also occur in adults with pancreas damage. In Type II diabetes, the body is insulin-resistant or unable to use the insulin the pancreas makes. Type II diabetes commonly affects adults. In the United States, 90% of diabetics have the Type II form of the disease. Besides a strong sign that diabetes occurs in families, obesity (being overweight for someone's height by 20% or more) is the major risk factor (AMA 2003).

Diabetes mellitus has been associated with exposure to inorganic arsenic. The lowest dose of inorganic arsenic that caused diabetes mellitus in a human ingestion study (0.11 mg/kg/day) was over a thousand times higher than the highest estimated average daily dose from incidental ingestion of Tallevast soils (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, a level of inorganic arsenic in Tallevast soils is not expected to cause diabetes mellitus.

Difficulty Walking Without Walker or Help:

Difficulty walking can be a symptom of an orthopedic problem (to do with bone disorders) or a neurological (nervous system) disorder. Muscle and/or nerve damage may cause unsteady or uncoordinated (or clumsy) gait. Conditions such as cerebral palsy, stroke, multiple sclerosis (an autoimmune disorder that affects the nervous system), ALS (amyotrophic lateral sclerosis, which is also known as Lou Gehrig's disease), Parkinson's disease (see elsewhere in these definitions), head trauma, brain abscess and brain tumors can lead to gait problems. When gait problems occur, it is important to consult a physician (MERCK 2003).

Long-term human epidemiological studies find effects on the central nervous system, including poor muscle coordination, begin with trichloroethylene air concentrations between 5-16 parts per million (ppm) (EPA 2001). Using the highest trichloroethylene concentration measured in an off-site irrigation well (6,000 ug/L), the highest estimated trichloroethylene air concentration in Tallevast homes from showering and other indoor water uses was 12 ppm. However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause difficulty walking in Tallevast residents.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene

Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

Diverticulitis (Diverticular Disease):

Diverticulosis is a condition due to small marble-sized sacs or bulges (called diverticula), found in weak areas of the digestive tract. It is a condition caused by the inflammation or infection of one or more of these sacs in the walls of the lower end of the colon. The presence of diverticula does not always lead to diverticulitis. In fact, only 10 to 25% of people develop the condition. The symptoms of diverticulitis can include severe muscle spasm, pain in the abdomen (commonly on the left side), nausea and fever (AMA 2003). It can lead to serious complications. These include narrowing of the intestine, an abscess and peritonitis (or inflammation of the membrane that lines the abdomen). In the United States and many other nations, diverticulitis is very common. Diets low in fiber and high in processed carbohydrates (foods such as bread, pasta or potatoes) contribute to the greater incidence of diverticulitis. People over the age of 60 are the most likely to suffer from this condition.

Available studies have not shown an association between diverticulitis and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Dizziness/Faintness/Vertigo:

Something minor, such as a cold, a sinus infection or the flu, usually causes dizziness. An inner ear infection, low blood pressure, medicine, alcohol, migraines and injury can also cause dizziness. Someone who is dizzy and lost consciousness (also known as fainting) needs medical attention. Fainting happens when the blood flow and oxygen to the brain is decreased. Heart conditions, exercise, hyperventilation (unusually deep or rapid breathing), injury and certain drugs can cause fainting. Victims of unexplained fainting spells should discuss the problem with a doctor, as they can be symptoms of a serious medical problem. Vertigo is the sensation of movement, along with unsteadiness, disorientation (confusion), dizziness, faintness and loss of balance. There are two distinct kinds of vertigo, objective and subjective. Objective vertigo is the feeling the external world is spinning or moving. Subjective vertigo is the feeling the body is revolving in space. When someone has vertigo they usually also have nausea, vomiting, headache and sweating. Vertigo is a symptom of a disorder of the balance organs located in the inner ear (AMA 2003).

Dizziness has been associated with exposure to trichloroethylene. Human epidemiological studies find effects on the central nervous system, including dizziness, begin with trichloroethylene air concentrations between 5-16 parts per million (ppm)(EPA 2001). Using the highest trichloroethylene concentration measured in an off-site irrigation well (6,000 ug/L), the highest estimated trichloroethylene air concentration in Tallevast homes from showering and other indoor water uses was 12 ppm. However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause dizziness in Tallevast residents.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

Dizziness has also been associated with exposure to tetrachloroethylene. The lowest concentration of tetrachloroethylene that caused dizziness in a human inhalation study (20 ppm) was higher than the highest estimated concentration for Tallevast residents (3 ppm) (ATSDR 1997a). Therefore, the level of tetrachloroethylene in groundwater is not expected to cause dizziness in residents.

Epilepsy/Seizures:

Epilepsy is a neurological (nervous system) disorder, characterized by two or more seizures. Abnormal electrical activity in the brain causes this disorder. A seizure is uncontrolled activity in the brain that happens all of a sudden and goes away quickly. Seizures may cause muscle contractions a person cannot control or a short-term loss of consciousness. In half of all cases of epilepsy, doctors never find the cause. In some cases however, doctors can link the seizures to infection, trauma or other medical problems. Research shows that epilepsy may run in families (MERCK 2003).

Seizures have been associated with exposure to trichloroethylene. The lowest concentration of trichloroethylene that caused seizures in an inhalation study with rats (3,000 ppm) was approximately 250 times higher than the highest estimated air concentration (12 ppm) from showering with Tallevast groundwater. Therefore, levels of trichloroethylene in groundwater are not expected to increase the incidence of seizures in Tallevast residents.

Fatigue and Reduced Energy:

Fatigue is extreme tiredness. It is a normal response to extreme physical activity. Fatigue with no known reason and reduced energy levels could be the sign of physical or psychological problems. Physical disorders that cause fatigue include sleep disorders, heart disease and when a person's thyroid is not acting normally. Psychological disorders that may cause fatigue include depression. Someone who has fatigue should see his or her doctor.

Fatigue has been associated with exposure to trichloroethylene and inorganic arsenic.

Human epidemiological studies find effects on the central nervous system, including fatigue, begin with trichloroethylene air concentrations between 5-16 parts per million (ppm)(EPA 2001). Using the highest trichloroethylene concentration measured in an off-site irrigation well (6,000 ug/L), the highest estimated trichloroethylene air concentration in Tallevast homes from showering and other indoor water uses was 12 ppm. However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause fatigue in Tallevast residents.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

The lowest dose of inorganic arsenic in a human ingestion study that caused fatigue (0.005 mg/kg/day) is approximately 70 times higher than the highest estimated average daily dose for

Tallevast residents (0.00007 mg/kg/day). Reports of neurological effects for exposure at lower levels have been inconsistent, with some studies reporting no effects and others reporting effects, such as fatigue. Ingesting inorganic arsenic can cause decreased production of white and red blood cells that may cause fatigue. The lowest dose causing a decreased number of red and white blood cells in human studies (0.05 mg/kg/day) was hundreds of times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, it is not expected that exposure to inorganic arsenic in soils would cause fatigue in Tallevast residents.

Gallstones:

Gallstones are masses mostly made up of cholesterol that develop in the gallbladder where bile is stored. They can also collect in the bile ducts. Gallstones can range in size from a grain of sand to golf ball size. A chemical imbalance of the bile usually causes gallstones to form. In the United States, 20% of all people over the age of 65 have them. Gallstones appear more often in women than men. The most common risk factors for getting gallstones are being overweight for your height by 20% or more or having too much cholesterol in your diet. In more than half of the cases of gallstones, victims have no symptoms. When a gallstone moves out of the gallbladder and lodges in the bile duct, severe pain can occur in the upper middle or right side of the abdomen (AMA 2003).

Available studies have not shown an association between gallstones and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Gastritis:

Gastritis is a condition defined by inflammation of the stomach lining. There are many factors that can cause gastritis including infection (most commonly from helicobacter pylori bacterial infection), injury or immune system disorders. Doctors also relate this kind of inflammation to the use of non-steroidal anti-inflammatory drugs (NSAIDs). NSAIDs include aspirin and ibuprofen. Gastritis may also result from certain treatments for cancer, heavy smoking and alcohol abuse. It may be chronic (over a long period) or acute (severe but not lasting very long). Gastritis does not always show symptoms. The most common symptoms can include indigestion (trouble digesting food, resulting in burping or heartburn), nausea (feeling sick to your stomach), abdominal pain and vomiting (AMA 2003).

Available studies have not shown an association between gastritis and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Hair Thinning/Alopecia:

Many things can cause hair thinning (hair loss). These include hormonal changes, family history, endocrine disorders, and aging. Certain medicines and medical treatments can prompt hair loss. It can also occur after someone is hurt badly or after burns (AMA 2003).

Hair thinning has been associated with exposure to trichloroethylene. The lowest dose of trichloroethylene that caused hair loss in an ingestion study of rats and mice (549 to 869 mg/kg/day) was thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.2 mg/kg/day)(ATSDR 1997b). Therefore, levels of trichloroethylene in groundwater are not expected to cause hair thinning in Tallevast residents.

Headaches, Including Migraines:

Headaches are very common. Seven out of 10 Americans are affected. Pain can be anywhere in he head and can go down into the neck. Sinus headaches (common with sinusitis or when the membrane lining the sinus is inflamed), rebound headaches and cluster headaches are some less common types. Tension headaches and migraines are the two most common types. A dull pain characterizes tension headaches. Stress, worry, too much caffeine, alcohol, eyestrain, and overexertion can also trigger headaches. Migraines typically include throbbing pain. The pain is usually centered on only one side of the head. Migraines can be prompted by many factors, including changes in hormone levels, reactions to allergies (especially to food), and stress. Family history is a factor in who will likely get migraines. More women than men have migraines (AMA 2003, MERCK 2003).

Headaches have been associated with exposure to trichloroethylene and inorganic arsenic.

Human epidemiological studies find effects on the central nervous system, including headaches, begin with trichloroethylene air concentrations between 5-16 parts per million (ppm)(EPA 2001). Using the highest trichloroethylene concentration measured in an off-site irrigation well (6,000 ug/L), the highest estimated trichloroethylene air concentration in Tallevast homes from showering and other indoor water uses was 12 ppm. However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause headaches in Tallevast residents.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

The lowest dose of inorganic arsenic that caused headaches in a human ingestion study (0.005 mg/kg/day) was approximately 70 times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day). Results from studies of low-level exposure have been inconsistent. Some studies reported various neurological effects, such as headaches, while others have reported no neurological effects. Therefore, not enough information is known to determine if exposure to inorganic arsenic in Tallevast soils can cause headaches (ATSDR 2005d).

Heart Conditions, Disease, and Pain:

In the United States, heart disease (also known as cardiovascular disease, which relates to both the heart and the blood vessels) is the leading cause of death among both men and women. Coronary artery disease is the most common type of this disease in the US. The number of deaths associated with coronary artery disease goes up with age and affects people of all races. The incidence of the disease is extremely high among African Americans and Southeast Asians. Coronary artery disease is a condition in which the blood supply to the heart muscle is partly or completely blocked. A buildup of cholesterol and fatty materials on the wall of the coronary artery most commonly cause coronary artery disease. The symptoms of heart disease include chest pain, shortness of breath, fatigue, irregular heartbeats, dizziness, fainting, and sometimes swelling (legs, ankles, and feet). When the heart does not get enough blood flow, it can cause tightness or a squeezing feeling in the chest. Doctors call this angina. Pain in the chest can also be caused by an inflammation of the sac (pericarditis) surrounding the heart. Pleurisy (inflammation of the membranes covering the lungs) can cause pain that gets worse when someone inhales. Mitral valve prolapse caused by bulging of the left atrium and left ventricle, can cause brief episodes of stabbing pain. Victims usually feel this pain below the left breast. Shortness of breath is a very common symptom of heart failure. Fluid buildup in the spaces of the lungs is a condition called pulmonary congestion. If blood flow to the muscles is not enough for someone's body, feelings of fatigue and weakness result. Palpitations, or irregular heartbeats, when someone also is having shortness of breath and chest pain are usually symptoms of a serious disorder. Lightheadedness and fainting can result when the blood flow to the heart is not enough for a person's body (AMA 2003, MERCK 2003).

Heart disease and other cardiac problems have been associated with exposure to trichloroethylene, *trans*-1,2-dichloroethene, inorganic arsenic, barium and beryllium.

Evidence from animal and human epidemiological studies suggests that exposure to trichloroethylene might be associated with congenital heart defects (NRC 2006).

Too little is known about the toxicity of *trans*-1,2-dichloroethene to determine the risk of heart disease or other cardiac problems in Tallevast residents who used contaminated groundwater (ATSDR 1996).

It is unlikely, that Tallevast residents could experience heart problems from ingestion of inorganic arsenic-contaminated soil. Several human studies have reported heart problems after prolonged exposure to inorganic arsenic. Reported problems range from an increased prevalence of cerebrovascular disease to arterial thickening. The lowest dose of inorganic arsenic that caused heart problems in an ingestion study (0.002 to 0.06 mg/kg/day) was higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day)(ATSDR 2005d). We assumed that Tallevast residents ingest (eat) 100 mg of soil every day at the highest concentration found in any sample. The highest concentration of inorganic arsenic found in one Tallevast soil sample (26 mg/kg), however, is twice as much as the next highest concentration (11 mg/kg). It is more likely that most residents ingest less than 100 mg of soil per day and are exposed to less than the highest inorganic arsenic concentration. Therefore, it is unlikely that some Tallevast residents would ingest 100 mg of soil per day at the highest inorganic arsenic concentration and experience heart problems.

The lowest dose of barium that caused heart problems in an ingestion study of rats (7.2 mg/kg/day) was thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.002 mg/kg/day) (ATSDR 1992). Therefore, levels of barium in Tallevast soils are not expect to cause heart problems in Tallevast residents.

The level of beryllium that caused heart problems in an inhalation study in monkeys (0.2 mg/m^3) is tens thousands of times higher than the highest estimated concentration for Tallevast residents (0.000004 mg/m^3) (ATSDR 2002). Therefore, levels of beryllium in soils are not expected to cause heart problems in Tallevast residents.

High Blood Pressure:

Primary hypertension is high blood pressure with no known cause. When the cause is known (such as heart disease and kidney disease), it is known as secondary hypertension. Ninety percent of all people with high blood pressure have primary hypertension. Blood pressure commonly goes up with age. A blood pressure of 120/80 mmHg is considered normal while a blood pressure of 140/90mmHg is considered high. When the blood pressure is elevated for an extended period, the heart enlarges. The heart's walls also thicken due to increased strain. The heart does not work as well; the thickened walls become stiff making the heart work even harder. Over time, the heart will begin to have abnormal rhythms. This may result in heart failure. Risk factors for high blood pressure include obesity, smoking, stress, diet (high in sodium and saturated fats), drinking too much alcohol and lack of exercise (MERCK 2003).

High blood pressure has been association with exposure to lead.

The lowest blood lead level in studies that reported heart problems is approximately two times higher then the highest estimated blood lead level for Tallevast residents. The point of concern for humans exposed to lead is elevations in systemic blood pressure. The estimated blood lead level is below levels established by human studies (ATSDR 2005e). Therefore, lead in Tallevast soils is not likely to increase a resident's risk of having high blood pressure.

Hysterectomies (at Young Age):

In American women, hysterectomies are the second most common major type of surgery. The number of hysterectomies is slowly going down. Doctors perform hysterectomies for a number of reasons including: early stage cervical cancer, endometrial cancer, ovarian cancer, fibroid tumors, and prolapse of the uterus (when it slips out of its proper place in the body).

Available studies have not shown an association between hysterectomies and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Immune System:

The immune system stops and fights infection. The lymphatic system is the group of organs that make up the immune system. This system is composed of the adenoids, tonsils, lymph nodes, thymus, spleen, appendix, and bone marrow. It makes the body's natural and adaptive immune response work to fight off diseases from bacteria, viruses, and fungi. The immune system also combats cells that are not normal in the body, such as cancer (MERCK 2003).

Immune system problems have been associated with exposure to trichloroethylene, *trans*-1,2-dichloroethene, and beryllium.

The lowest dose of trichloroethylene that caused immune system problems in an ingestion study with mice (400 mg/kg/day) was tens of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.007 mg/kg/day) (ATSDR 1997b). Therefore, levels of trichloroethylene in groundwater are not expected to cause immune system problems in Tallevast residents.

Too little is known about the toxicity of *trans*-1,2-dichloroethene to determine the risk of immune system problems in Tallevast residents who used contaminated groundwater (ATSDR 1996).

The lowest concentration of beryllium that caused immune system problems in a human inhalation study (0.00052 mg/m^3) is approximately 130 times higher than the highest estimated concentration for Tallevast residents (0.000004 mg/m^3) (ATSDR 2002). Therefore, levels of beryllium in soils are not expected to cause immune system problems in Tallevast residents

Infertility:

Infertility is the inability of a man and woman, of childbearing age, to produce a child. Infertility in women goes up as they get older, as part of the natural aging process. Hormonal problems that stop ovulation and endometriosis, a condition when scar tissue grows and blocks the fallopian tubes, are just two of the many conditions that causes infertility in women.. The most common causes of male infertility are prostatis (a bacterial infection), varicocele (sperm damage from increased temperature), pituitary gland dysfunction (which affects sexual maturity) and damage to the testicles (the glands that produce sperm). Sexually transmitted diseases can also cause infertility. This happens due to scarring and permanent damage to both female and male reproductive organs. Many factors can limit a person's ability to conceive. These include drinking too much caffeine, smoking cigarettes, drinking alcohol and using illegal narcotics (AMA 2003, MERCK 2003).

Studies in rats and mice show that trichloroethylene can effect fertility, but the relevance to humans is not clear (NRC 2006).

Irritable Bowel Syndrome (IBS):

Irritable bowel syndrome (IBS) is the most common digestive tract disorder. Doctors characterize IBS by alternating bouts of diarrhea and constipation. Symptoms include indigestion, abdominal pain, pressure and bloating, with no known cause. Stress and anxiety can increase how severe symptoms are. Stress and/or when someone's body cannot put up with some kind of food can bring on this condition. IBS affects twice as many women as men and tends to begin in young adults (AMA 2003).

Available studies have <u>not</u> shown an association between IBS and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Kidney Disease/Problems:

The main function of the kidneys is to filter and cleanse the blood. The kidneys also keep the body's balance of water and filter/rid the body of metabolic wastes and electrolytes (such as sodium and potassium). The kidneys also help control blood pressure by regulating sodium levels in the blood. The kidneys make an enzyme called rennin that controls blood pressure. In addition, the kidneys secrete hormones that help control the production of red blood cells and the growth and upkeep of bones.

When kidneys do not work correctly, it can take many forms including acute/chronic kidney failure, nephritis (or inflammation), blood vessel disorders and tubular/cystic kidney disorders. Acute kidney failure is the sudden inability of the kidneys to filter metabolic waste products from the blood. Acute kidney failure can result from any disease that disrupts kidney function, decreases blood flow to the kidneys or obstructs urine flow. Chronic kidney failure is the slow decline in the kidney's ability to filter metabolic waste. Chronic kidney failure can result from the same disorders that lead to acute kidney failure. The two most common causes of chronic kidney failure are diabetes mellitus and hypertension (high blood pressure). Nephritis is inflammation of the kidneys. In general, this can happen when someone has an infection, has an immune response, or was exposed to a toxin. When the blood vessels in the kidneys are not working as they should, it can lead to kidney damage, blood pressure going up and kidney failure. There are many known causes of these kinds of disorders including: blockages in renal (kidney) arteries, inflammation of blood vessels and injury to kidneys or blood vessels around them. Tubular and cystic kidney disorders get in the way of the kidney's filtration system. When that happens, cysts can form. Most kinds of tubular and cystic kidney problems disorders are genetic and occur in families (AMA 2003, MERCK 2003).

Kidney disease and problems have been associated with exposure to trichloroethylene, tetrachloroethylene, 1,1-dichloroethene, *cis*-1,2-dichloroethene, 1,4-dioxane, inorganic arsenic, barium, beryllium, and lead.

It is not known if drinking water contaminated with trichloroethylene causes kidney problems other than cancer in humans. Human epidemiological studies have been limited by difficulties in estimating exposure levels and by the presence of other solvents with similar toxic effects. The highest estimated average daily dose for Tallevast residents who drank contaminated groundwater with the highest measured trichloroethylene concentration (0.2 mg/kg/day) is less than the lowest doses causing kidney damage in rats and mice (250 mg/kg/day)(ATSDR 1997b). Too little information exists, however, to know if drinking trichloroethylene-contaminated groundwater caused kidney problems other than cancer in Tallevast residents.

The lowest concentration of tetrachloroethylene that caused kidney problems in a human inhalation study (10 ppm) is higher than the highest estimated concentration for Tallevast residents (3 ppm) (ATSDR 1997a). There are data that suggest occupational exposure to hydrocarbon solvents, such as tetrachloroethylene, may contribute to chronic kidney disease. Several studies reported various health effects from different levels of exposure. Only one human study reported kidney toxicity after exposure to tetrachloroethylene vapors. Two animal studies reported kidney effects from inhalation between 100 and 200 ppm. Therefore, estimated inhalation levels of tetrachloroethylene vapors are <u>not</u> expected to cause a higher incidence of kidney problems.

The lowest dose of tetrachloroethylene that caused kidney problems in an ingestion study with mice (386 to 536 mg/kg/day) was thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.05 mg/kg/day)(ATSDR 1997a). Therefore, it is <u>not</u> expected that resident who drank tetrachloroethylene-contaminated water will have higher incidence of kidney problems.

The lowest concentration of 1,1-dichloroethene that caused kidney problems in an inhalation study with mice (10 ppm) is higher than the highest estimated concentration for Tallevast residents (5 ppm). Only a few animal studies were located that reported effects of 1,1-dichloroethene on the kidney. Due to lack of human data, it is not possible to determine if 1,1-dichloroethene vapors could cause kidney problems in humans (ATSDR 1994).

The lowest dose of 1,1-dichloroethene that caused kidney problems in an ingestion study with rats (400 mg/kg/day) is thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.05 mg/kg/day)(ATSDR 1994). Therefore, it is <u>not</u> expected that residents who drank 1,1-dichloroehene-contaminated water will have a higher incidence of kidney problems.

Although the lowest dose of *cis*-1,2-dichloroethene that caused kidney problems in an ingestion study with rats (870 mg/kg/day) is tens of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.01 mg/kg/day), too little is know about its toxicity to determine the risk of kidney problems (ATSDR 1996).

The lowest concentration of 1,4-dioxane that caused kidney problems in animal inhalation studies (1,000 ppm) is hundreds of times higher than the highest estimated concentration for Tallevast residents (4 ppm). The lowest dose of 1,4-dioxane that caused kidney problems in an ingestion study with rats (94 mg/kg/day) is thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.03 mg/kg/day) (ATSDR 2004). Therefore, levels of 1,4-dioxane are not expected to cause kidney problems in Tallevast residents.

The lowest dose of inorganic arsenic that caused kidney problems in a human ingestion study (0.08 mg/kg/day) is over a thousand times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day)(ATSDR 2005d). Therefore, the levels of inorganic arsenic are not expected to cause kidney problems in Tallevast residents.

The lowest dose of barium that cause kidney problems in an ingestion study with mice (160 mg/kg/day) is tens of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.002 mg/kg/day) (ATSDR 1992). Therefore, it is not expected that barium in soils will cause kidney problems in Tallevast residents.

The highest dose of beryllium that did not cause any kidney problems in an ingestion study with rats (31 mg/kg/day) is hundreds of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.0002 mg/kg/day)(ATSDR 2002). Therefore, it is not expected that beryllium will cause kidney problems in Tallevast residents.

Although blood lead level that caused kidney problems in humans (3 to 11 micrograms per deciliter; ug/dL) is within the range of blood lead level for a Tallevast resident (0.7 to 9ug/dL), results of low blood-lead level studies have been mixed (ATSDR 2005e). Therefore, it is not possible to determine if exposure to lead in soils would cause kidney problems in Tallevast residents.

Laryngitis (Chronic):

Laryngitis is a condition that occurs when the mucous membrane of the voice box or larynx becomes inflamed. The most common symptoms of laryngitis are sounding hoarse, throat pain and loss of voice. Allergies, viruses and bacteria can all cause this problem. Overuse or strain of the voice box can cause it. If someone has chronic (ongoing) laryngitis, they should avoid the use of tobacco, things they know they are allergic to, and pollution (AMA 2003).

Available studies have not shown an association between laryngitis and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Liver Disease:

The liver does many things needed to maintain life. These include the breakdown of harmful or toxic substances absorbed from the intestine or made in the body. The liver also takes care of sugar storage, processes drugs, and makes protein and about half of the body's cholesterol.

There are two main types of liver dysfunction. The first group results when the cells in the liver do not work properly. This results in hepatic lipidosis (fatty liver), cirrhosis and hepatitis. The second type of disorder occurs when there is a bile flow blockage resulting in bile stones and cancer. The most common causes of fatty liver are alcoholism, obesity, diabetes and increased serum (blood) triglyceride (a group of organic compounds that occur naturally) levels. Not getting proper nutrition, genetic metabolic problems and drugs can cause fatty liver. Fat builds up in individual liver cells. The buildup can lead to permanent scarring and cirrhosis. Cirrhosis is a chronic degeneration of healthy liver cells that that scar tissue gradually replaces. Scar tissue keeps the liver from working as it should, then toxins buildup and the liver fails. Cirrhosis is the third most common cause of death in the United States among people aged 45 – 65. The most common cause of cirrhosis in the U.S. is alcohol abuse. In other parts of the world, such as Asia and Africa, chronic hepatitis is the major cause of cirrhosis. Hepatitis is inflammation of the liver. Most of the time doctors sort hepatitis by whether or not a virus causes it. Viral hepatitis is the most common form of the disease. At least five viruses cause hepatitis: A, B C, D and E. In the US, hepatitis A, B and C are the most common. Alcohol abuse, certain drugs and exposure to poison commonly cause non-viral hepatitis. The most common symptoms of hepatitis are localized swelling, pain and nausea (feeling sick to your stomach) (AMA 2003, MERCK 2003).

Liver disease and problems have been associated with exposure to trichloroethylene, tetrachloroethylene, 1,1-dichloroethene, *trans*- and *cis*-1,2-dichloroethene, 1,4-dioxane, inorganic arsenic, and beryllium.

It is not known if drinking water contaminated with trichloroethylene causes liver problems other than cancer in humans. Human epidemiological studies have been limited by difficulties in estimating exposure levels and by the presence of other solvents with similar toxic effects. The highest estimated average daily dose for Tallevast residents (0.2 mg/kg/day) who drank contaminated groundwater with the highest measured trichloroethylene concentration is thousands of times less than the lowest doses causing liver damage in rats and mice (400 mg/kg/day) (ATSDR 1997b). Too little information exists, however, to know if drinking trichloroethylene-contaminated groundwater caused liver damage other than cancer in Tallevast residents.

Inhalation studies in mice and humans find effects on the liver other than cancer begin with trichloroethylene air concentrations between 5 and 16 parts per million (ppm) (EPA 2001). Using the highest trichloroethylene concentration measured in an off-site irrigation well (6,000 ug/L), the highest estimated trichloroethylene air concentration in Tallevast homes from showering and other indoor water uses was 12 ppm. However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause liver problems in Tallevast residents.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

The lowest concentration of tetrachloroethylene that caused liver problems in a human inhalation study (16 ppm) is higher than the highest estimated concentration for Tallevast residents (3 ppm). Tetrachloroethylene has been shown to cause hepatotoxic (liver) effects in humans following inhalation exposure. For humans, reports of heptotoxicity consist almost entirely of case studies of accidental exposure in which reliable quantitative exposure information was not available. In most cases, doctors report hepatic effects in humans as transient in nature. Several animal studies show liver effects after exposure to tetrachloroethylene. However, liver damage can occur in humans exposed to tetrachloroethylene, but the mechanism of damage may be different from that occurring in animals. Hepatic effects in humans following exposure to tetrachloroethylene at environmental levels or at a hazardous waste site cannot be ruled out (ATSDR 1997a). However, with no quantitative data to compare the estimated inhalation concentrations in Tallevast to, it is not possible to determine conclusively that exposure to tetrachloroethylene vapors could cause liver problems.

The lowest dose of tetrachloroethylene that caused liver problems in ingestion studies with mice (100 mg/kg/day) was approximately 2,000 times higher than the highest estimated average daily dose for Tallevast residents (0.05 mg/kg/day) (ATSDR 1997a). Therefore, the levels of tetrachloroethylene in Tallevast groundwater are <u>not</u> expected to cause a higher incidence of liver problems.

People who breathe high levels of 1,1-dichloroethene at work or around hazardous waste sites and those with liver problems, may be at risk for 1,1-dichloroethene-induced liver toxicity. The lowest concentration of 1,1-dichloroethene that caused liver problems in a inhalation study with mice (15 ppm) is three times higher than the highest estimated concentration for Tallevast residents (5 ppm). Data are insufficient, however, to determine if levels of 1,1-dichloroethene vapors from Tallevast groundwater could cause liver problems (ATSDR 1994).

The lowest dose of 1,1-dichloroethene that caused liver problems in an ingestion study with rats (9 mg/kg/day) is approximately 180 times higher than the highest estimated average daily dose for Tallevast residents (0.05 mg/kg/day). Information regarding hepatic (liver) effects of 1,1-dichloroethene in humans was limited to a report of increased serum enzymes (indicative of liver injury) in occupationally exposed workers. However, because of the incomplete reporting of the results, a clear relationship between exposure to 1,1-dichloroethene and development of adverse hepatic effects in humans could not be established (ATSDR 1994).

The lowest concentation of *trans*-1,2-dichloroethene that caused liver problems in inhalation studies with rats (200 ppm) is tens of thousands of times higher than the highest estimated concentration for Tallevast residents (0.004 ppm) (ATSDR 1996). Too little is know, however, about the toxicity of either *trans*- or *cis*-1,2-dichloroethene to determine the risk of liver problems in Tallevast residents.

The lowest concentration of 1,4-dioxane that caused liver problems in an inhalation study with animals (1,000 ppm) is hundreds of times higher than the highest estimated concentration for Tallevast residents (4 ppm). The lowest dose of 1,4-dioxane that caused liver problems in an ingestion study (81 mg/kg/day) is thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.03 mg/kg/day)(ATSDR 2004). Therefore, the levels of 1,4-dioxane are <u>not</u> expected to cause liver problems in Tallevast residents.

The lowest dose of inorganic arsenic that caused liver problems in a human ingestion study (0.006 mg/kg/day) is over 85 times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, inorganic arsenic in soils is <u>not</u> expected to cause liver problems in Tallevast residents.

The highest dose of beryllium that did <u>not</u> cause liver problems in an ingestion study with rats (31 mg/kg/day) is approximately 155,000 times higher than the highest estimated average daily dose for Tallevast residents (0.0002 mg/kg/day) (ATSDR 2002). Therefore, beryllium in soils is <u>not</u> expected to cause liver problems in Tallevast residents.

Low Potassium Blood Levels:

Potassium is a key mineral that the body needs for electrical and cellular processes to work. Low potassium blood levels can occur as a part of the normal aging process. They can also occur when someone is sick for a long time. The most common things linked with low potassium levels are hypertension (high blood pressure), congestive heart failure (when the heart builds up too much fluid), cardiac arrhythmias (when the heart beats in an odd way), depression (deep feelings of sadness) and fatigue (being very tired and with no energy) (AMA 2003).

Available studies have not shown an association between low potassium blood levels and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Lupus:

Lupus is an autoimmune disorder. It makes the body's tissues inflamed for a long time. Discoid lupus erythematosus (DLE) affects only the skin. DLE is the less common form of the disease. Systemic lupus erythematosus (SLE) is the most common and is the most severe form. This disorder produces a form of arthritis that affects several tissues and organs within the body. Lupus affects nine times more women than men. Most of the time, the onset of the disease occurs in women ranging in age from 20 to 40. It also affects more black women than white women. The cause of SLE remains unknown. Studies show that risk factors might be hormones, things in someone's environment and their family history. The symptoms of Lupus can vary widely, ranging from mild to severe. The most common symptoms are usually extreme fatigue, painful or swollen joints, unexplained fevers, anorexia (losing weight), anemia (low iron), skin rashes, and kidneys that do not work as they should (AMA 2003, MERCK 2003).

Available studies have not shown an association between lupus and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Menstrual Problems (Heavy Bleeding, Clots, and Frequent Periods):

There are a number of menstrual problems. Some are heavy bleeding, amenorrhea (lack of a period), and not having periods on a regular basis.

Hormones not in balance, problems with blood clots, miscarriage (when a fetus is lost without warning) and uterine cancer (cancer of the womb) can all cause heavy bleeding. When a woman has heavy bleeding, she can get low iron levels (anemia) and feel very tired (fatigue). Women should consult a doctor regarding this disorder.

Many factors can influence changes in the cycle, having periods more often than normal, and lack of a period. Cycles can vary due to hormonal imbalance, weight loss, weight gain, stress, illness, anxiety (worry), and menopause. Pregnancy causes the menstrual cycle to cease (AMA 2003).

Available studies have not shown an association between menstrual problems and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Miscarriage:

Miscarriage is the loss of a pregnancy before the fetus fully develops (usually before 20 weeks). 15 – 20% of all pregnancies end in miscarriage. Vaginal bleeding (with or without pain) is the most common symptom of miscarriage. If bleeding occurs during pregnancy, a woman should consult a doctor immediately. Women past the age of 35 are at a greater risk of miscarriage. Women who smoke or have certain illnesses, such as diabetes, lupus or hormonal imbalance, are at a greater risk of miscarriage. Doctors do not completely understand the causes but they are often times linked with physical problems in the mother. These problems include uterine fibroids (benign growths in the womb), abnormally shaped uterus and scar tissue. In some instances, problems with the genetic material in the fetus may cause miscarriages (AMA 2003).

Miscarriage has been associated with exposure to trichloroethylene and inorganic arsenic.

The lowest dose of trichloroethylene that caused miscarriages in an ingestion study with mice (750 mg/kg/day) was thousands of times higher than the highest estimated average daily ingestion dose for Tallevast residents (0.2 mg/kg/day) (ATSDR 1997b). Therefore, the levels in Tallevast groundwater are not expected to cause a higher incidence of miscarriage. Evidence from animal and epidemiological studies does, however, suggest that exposure to trichloroethylene might be associated with poor intrauterine growth (NRC 2006).

Chronic inorganic arsenic ingestion is associated with excess incidence of miscarriages, stillbirths, preterm births and infants with low birth weights. Similar associations have been made between late fetal mortality, neonatal mortality and post neonatal mortality and exposure to high levels of inorganic arsenic ingestion. The lowest dose of inorganic arsenic that caused miscarriages in animal ingestion studies (1 mg/kg/day) was over ten thousand times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, the levels of inorganic arsenic in Tallevast soil are not expected to cause a higher incidence of miscarriages.

Muscle Cramps:

Muscle cramps are common. They typically include sharp sudden spasms of a muscle. The most common causes of muscle cramps are dehydration (not drinking enough water), muscle stress and overuse. Poor circulation can cause leg cramping at night. Leg cramping might be a sign of a serious condition called arteriosclerosis (narrowing of the arteries) (AMA 2003).

Available studies have not shown an association between muscle cramps and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Night Sweats:

A number of conditions can cause night sweats. Menopause is the most common cause. Changes in hormones during menopause cause hot flashes that make a woman's body temperature go up all of a sudden. Night sweats can also be caused by tuberculosis (a disease that causes small, rounded swellings in mucous membranes such as in the lungs), AIDS (acquired immunodeficiency syndrome), drug withdrawal, lymphomas (a tumor in the lymph node that is likely to spread elsewhere in the body), and bacterial and parasite infections.

Women should report to a doctor night sweats that not linked with any known cause (AMA 2003).

Night sweats are associated with advanced chronic beryllium disease. Night sweats are also associated with lymphoma, which may be caused by exposure to trichloroethylene.

Nosebleeds:

Dryness (low humidity) commonly causes nosebleeds. Injury, colds, allergies and abnormal growths can all prompt nosebleeds. People who get nosebleeds a lot or nosebleeds that are painful should see their doctor.

Available studies have not shown an association between nosebleeds and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Numbness (Feet, Legs, Hands, Fingers, Shoulder, and Back):

Numbness has many causes including: nerve injury, lack of blood supply, diabetes mellitus (types I and II), thyroid problems, or lack of vitamin B-12. Other causes include, carpal tunnel syndrome (a condition of pain and weakness of the hand due to repeated stress on a nerve that passes through the wrist into the hand), transient ischemic attack (also called ministroke), and stroke. Multiple sclerosis, a serious disease that happens mostly to young adults which affects the central nervous system over time and linked with the immune system not working as it should, can cause numbness (AMA 2003). Damage to the spinal cord or brain can also result in numbness. Anyone who has unexplained numbness should see his or her doctor.

Numbness has been associated with exposure to inorganic arsenic. The lowest concentration of inorganic arsenic that caused numbness in a human inhalation study (0.3 mg/m^3) was hundreds of thousands of times higher than the highest estimated concentration for Tallevast residents breathing contaminated dust (0.000001 mg/m^3). The lowest dose of inorganic arsenic that caused numbness in a human ingestion study (0.05 mg/kg/day) was hundreds of times higher than the highest estimated average daily dose for Tallevast residents (0.00007 kg/kg/day) (ATSDR 2005d). Therefore, levels of inorganic arsenic in Tallevast soil are not expected to cause a higher incidence of numbness.

Phlebitis:

Phlebitis (which is when the wall of a vein is inflamed, also called thromophlebitis) occurs when a blood clot forms in a vein. Most of the time, veins on the surface of the body are affected. The common symptoms are usually pain and swelling. When a deep vein is affected, the condition is more serious. When that happens, a broad range of treatment is necessary to keep any more clots from forming (AMA 2003).

Available studies have not shown an association between phlebitis and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Poor Appetite:

Poor appetite can happen due to many reasons. Digestive tract disorders such as constipation, gastritis (inflammation) and gastroenteritis (infection), and obstruction (blockage) can cause pain which leads to having a marked decrease in wanting to eat Thyroid problems, problems with the hunger control center in the brain, cancer, and mental illness can all lead to poor appetite (AMA 2003, MERCK 2003). A decreased or poor appetite can be the sign of a serious medical condition. People with poor appetite should consult a doctor.

Poor appetite has been associated with exposure to *trans*-1,2-dichloroethene. The lowest concentration of *trans*-1,2-dichloroethene that caused poor appetite in an inhalation study with rats (2,000 ppm) was hundreds of thousands of times higher than the highest estimated concentration for Tallevast residents (0.004 ppm). Therefore, levels of *trans*-1,2-dichloroethene in Tallevast groundwater are <u>not</u> expected to cause a higher incidence of poor appetite.

Prostate Infection (Prostatitis):

Many different kinds of germs can cause a prostate infection, or prostatitis. Common signs of prostate infections include sudden onset of fever, muscle aches, pain in lower abdomen, testicle or in the area between the scrotum and the anus. In many cases, there is blood in the urine and semen and a burning feeling when the person urinates (AMA 2003).

Available studies have <u>not</u> shown an association between prostate infection and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Rash (Skin Rash):

Changes in skin color and texture typify a rash. Symptoms of rashes can vary quite a bit from person to person. Common symptoms of rashes include redness, skin eruptions, blisters, itching, swelling and inflammation. The most common causes of rashes are allergic reactions (to a drug, plants or food) and bacterial and viral infections (AMA 2003).

Skin rash has been associated with exposure to beryllium in inhalation studies. The lowest concentration of beryllium that caused a skin rash in an inhalation study with rats and guinea pigs (0.5 mg/m^3) was approximately 125,000 times higher than the highest estimated concentration for Tallevast residents (0.000004 mg/m^3) (ATSDR 2002). Therefore, the levels in Tallevast soil are <u>not</u> expected to cause a higher incidence of skin rash.

Sickle Cell Anemia:

Sickle Cell Anemia is a blood disorder that occurs when someone inherits two abnormal genes (one from each parent). If a child inherits only one gene from sickle cell anemia from his parent, then he will not develop sickle cell anemia. The abnormal genes cause the shape of red blood cells to change from round discs to curved rods. The shape of the red blood cells in people with sickle cell anemia cannot flow through small blood vessels and block blood flow causing tissue and organ damage and pain. There is no cure for sickle cell anemia; however, there are treatments to help control the effects of sickle cell anemia. Doctors advise people with the disease to avoid high altitudes, stress, fatigue, strenuous exercise and dehydration.

Available studies have <u>not</u> shown an association between sickle cell anemia and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Sinus Infections and Sinus Problems:

Sinusitis (sinus infection) is the most common sinus problem. Viral, bacterial, or fungal infections may cause sinusitis. In some cases, allergies can prompt sinusitis. An upper respiratory infection often comes before a sinus infection. When the nasal passages swell, mucous builds up in the sinus cavities and becomes infected. A sinus infection usually occurs along with an intense headache, yellow or green mucous discharge, fever and chills. Pain and tenderness under the eyes and around the nose is also very common (AMA 2003).

Available studies have not shown an association between sinus infections/sinus problems and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Skin Darkening or Lightening:

Melanin is the pigment that controls the color of the skin. Skin that has lower levels of melanin is more likely to get skin cancer. Melanin acts as a sunscreen. Hyperpigmentation (increased melanin production) makes the skin darker. Hypopigmentation (a decrease in melanin production) makes the skin lighter. These changes in the color of skin might last or might not, but does not usually harm a person's health. Changes in hormone levels, family history, injury and radiation treatments can all have an impact in how much melanin the body makes (AMA 2003).

Changes in skin pigmentation have been associated with exposure to inorganic arsenic. The level of inorganic arsenic that caused changes in pigmentation in an inhalation study was approximately 30,000 times higher than the highest estimated concentration for Tallevast residents. The level of inorganic arsenic that caused changes in pigmentation in an ingestion study was approximately five times higher than the highest estimated dose for Tallevast residents.

The most characteristic effect of long-term ingestion of inorganic arsenic is the development of skin lesions: hyperkeratinization (overgrowth of the outermost layer of the skin) and hyper/hypopigmentation (skin darkening/lightening). Numerous human studies of long term, low-level ingestion of inorganic arsenic report these lesions. In general, these lesions occur at doses from 0.002 to 0.02 mg/kg/day. This is 28 to 280 times higher than the highest estimated average daily dose in Tallevast (0.00007 mg/kg/day). (ATSDR 2005d). Therefore, the levels of inorganic arsenic in Tallevast soil are not expected to cause a higher incidence of skin darkening or lightening.

Sleeplessness (Insomnia)/Sleep Apnea/Sleep Disorders:

There are many types of sleep disorders. The most common are insomnia, narcolepsy (when some cannot help falling asleep a lot and may not be able to move), sleep apnea (when a person stops breathing for a moment in their sleep) and restless leg syndrome (when a person's legs ache at night, which causes them to be restless and move their legs to try to get comfortable). Insomnia (or difficulty falling and remaining asleep) is a very common condition. There are many causes of insomnia including stress, depression, anxiety, and pain. The common symptoms of insomnia are trouble falling asleep, waking up a lot during the night, waking early and not being able to fall back asleep, and feeling tired during the day. Sudden fits of extreme drowsiness and being very tired during the day are also common for people who have narcolepsy. Sleep apnea is a potentially life-threatening condition. During sleep, breathing stops for varying amounts of time and then breathing resumes (AMA 2003).

Sleep problems have been associated with exposure to 1,4-dioxane and inorganic arsenic.

The lowest dose of 1,4-dioxane that caused sleep problems in an ingestion study with rabbits (1,034 mg/kg/day) was tens of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.03 mg/kg/day) (ATSDR 2004). Therefore, 1,4-dioxane levels in Tallevast groundwater are not expected to cause a higher incidence of sleep problems.

The lowest dose of inorganic arsenic that caused sleep problems in a human ingestion study (0.005 mg/kg/day) was over 70 times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day). Therefore, inorganic arsenic levels in Tallevast soils are not expected to cause sleep problems in Tallevast residents (ATSDR 2005d).

Sore Throat:

Pharyngitis (sore throat) is a common condition caused by inflammation of the throat lining. The most common symptom is pain when swallowing. A sore throat is usually caused by a viral infection (flu), common cold, mononucleosis (a glandular fever caused by a virus called Epstein-Barr), or a bacterial infection (such as strep or staph). Drinking too much alcohol, smoking, and air pollution can also cause a minor sore throat (AMA 2003).

Human epidemiological studies find upper respiratory tract irritation, including sore throat, begins with trichloroethylene air concentrations between 5-16 parts per million (ppm) (EPA 2001). Using the highest trichloroethylene concentration measured in an off-site irrigation well (6,000 ug/L), the highest estimated trichloroethylene air concentration in Tallevast homes from showering and other indoor water uses was 12 ppm. However, these studies are for exposures lasting 7 to 24 hours. The short duration of trichloroethylene exposure from showering (15-20 minutes) would not be expected to cause sore throat in Tallevast residents.

The trichloroethylene concentrations that Tallevast residents were actually exposed to likely varied over time and likely varied from well to well. The concentration of trichloroethylene Tallevast residents were actually exposed to may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

Sore throats have also been associated with exposure to inorganic arsenic. The lowest dose of inorganic arsenic that caused sore throats in a human ingestion study (0.015 mg/kg/day) was hundreds of times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, the levels of inorganic arsenic found in Tallevast soils are not expected to cause sore throats.

Stomach Bloating:

If a person does not have enough of the digestive enzymes needed to breakdown the sugars found in milk (lactose), it can cause stomach bloating and excess amounts of gas. If a doctor rules out lactose intolerance, and stomach bloating occurs frequently, you should see a doctor (AMA 2003).

Stomach bloating has been associated with exposure to 1,1-dichloroethene. The lowest dose of 1,1-dichloroethene that caused stomach bloating in an ingestion study with rats (200 mg/kg/day) was thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.05 mg/kg/day). Therefore, the levels of 1,1-dichloroethene in Tallevast ground water are not expected to cause stomach bloating.

Stress-Related Problems/Anxiety/Worry/Mental Anguish/Depression/Nervousness:

Stress may cause both physical and mental responses. Too much stress can be highly damaging and can add to physical and mental illness. Symptoms of stress can include anxiety (uneasiness/feelings of dread); rapid heartbeat; fainting; hot flashes; intestinal distress (upset stomach or diarrhea); insomnia; poor concentration; depression and feelings of hopelessness. Physical causes of stress can include hyperthyroidism (when the body makes too much thyroid hormone), caffeine, decongestants (medicine taken to treat nasal congestion), asthma inhalers, and other drugs. Over-working, alcohol abuse, poor diet and poor sleeping patterns can cause stress-related illnesses. Stress can cause or worsen physical conditions such as asthma, migraine headaches, irritable bowel syndrome, mental illness, and menstrual problems. You should take steps to reduce stress and seek the advice of a doctor to combat stress-related problems (AMA 2003).

Almost anything upsetting can cause stress. Living near a hazardous waste site can be stressful. Feelings of fear/uncertainty, frustration, anger, and loss of control/security/safety by residents near hazardous waste sites can cause stress. To deal with stress nearby residents should learn/ get involved, take care of their health, spend time with family/friends, and focus on solutions (DOH 2000).

Reports of neurological effects from ingestion of inorganic arsenic are inconsistent. Some human studies report fatigue, headache, depression, dizziness, insomnia, nightmare, and numbness, while others reported no neurological effects. Therefore, not enough is known about the toxicity of inorganic arsenic to determine if the levels in Tallevast soil could cause these health effects (ATSDR 2005d).

Swelling of Ankles, Hands, Feet, Wrists and Fingers:

Swelling (or edema) of extremities (ankles, hands, feet, wrist and fingers) is caused when the body retains excess fluids. Normally there is a constant flow of nutrients and fluids between body tissue and capillaries. Capillaries are narrow, thin-walled blood vessels that connect small arteries with small veins to form a network throughout the body. When something disrupts this exchange, swelling can occur. Causes of swelling can be both life threatening or of no great concern. Standing or sitting for long periods can cause swelling. Kidney disease, liver problems, and congestive heart failure (when the heart cannot pump away the blood returning to it fast enough, causing too much fluid in the veins) are serious causes of swelling, especially in the legs and feet. If someone has continuous, unexplained swelling, they should see a doctor (MERCK 2003).

Available studies have not shown an association between swelling and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Thyroid Problems:

The thyroid gland secretes hormones that control the body's metabolism, use of other hormones and growth. The two most common thyroid disorders are hypothyroidism and hyperthyroidism.

Hypothyroidism (an under-active thyroid) can occur when the body does not make enough thyroid hormone. This condition slows down the body's metabolism, which results in having less energy and makes the body less likely to control body temperature. Hypothyroidism is common in older adults, although it can occur at any age. This disorder affects about 10% of older women. The symptoms of an under active thyroid can include sensitivity to cold temperatures, constipation, dry skin, chronic fatigue, poor appetite and weight gain. The common cause of hypothyroidism is Hashimoto's thyroiditis, an autoimmune reaction that runs in families.

Hyperthyroidism (an overactive thyroid) is caused by an overproduction of thyroid hormone. The symptoms of hyperthyroidism vary widely but can include increased perspiration, increased heart rate, irritability, nervousness, elevated blood pressure and unexplained weight loss. Hyperthyroidism affects about 1% of the US population. The disorder can occur at any age, but is most common in women after childbirth and during menopause. Hyperthyroidism has several causes including overactive pituitary gland, radiation exposure, inflammation from toxic substances, thyroiditis (when the thyroid gland is inflamed), and Grave's disease (autoimmune disorder) (AMA 2003, MERCK 2003).

Available studies have <u>not</u> shown an association between thyroid problems and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Toxemia (Blood Poisoning or Septicemia):

Most people know toxemia as blood poisoning or septicemia. It is a condition caused by contamination or poisoning of the bloodstream. Untreated bacterial infections can lead to toxemia. The bacteria can spread from an infection in one organ to other organs in the body, resulting in very high fevers, rapid breathing, high blood pressure and a severely ill appearance. If toxemia goes untreated, it can lead to septic shock and even death. Toxemia can occur during pregnancy (known as eclampsia); this condition is rare but very serious (AMA 2003).

Available studies have <u>not</u> shown an association between toxemia and any of the contaminants of concern identified in soil or groundwater collected in the Tallevast neighborhood.

Vision Problems (Blurry, Pain, Redness, Running & Surgery):

The most common eye ailment is redness of the conjunctiva (the white of the eye). Allergies, infections, fatigue, abrasions or corneal ulcers can cause vision problems. Allergies can also prompt itchy, watery eyes. When the redness is also painful, causes could include dry eye, ulcers or having something trapped in the eye. Pain and swelling could be the sign of a serious problem and someone with those signs should see their doctor.

Blurry vision can also be a common complaint and happens more often as people age. The cornea and the lens of the eye work together, to focus light into the retina. When the cornea and the lens no longer focus properly, the result is refractive problems (when the eye cannot properly bend light in order to focus the retina) and blurry vision. Refractive disorders include nearsightedness (myopia), farsightedness (hyperopia), and astigmatism. Nearsightedness, when the cornea (the clear convex membrane that covers the pupil and the iris of the eye) and the lens focus light in front of the retina, causes distant objects to be blurry. Farsightedness, when the cornea and the lens focus light behind the retina, causes close objects to be blurry.

Astigmatism, when the cornea is imperfectly shaped, causes all objects, regardless of distance, to be blurry. Eyeglasses, soft contact lenses and surgery can correct refractive disorders. This kind of surgery reshapes the cornea so that it can properly focus light on the retina. The three most common types of refractive surgery are LASIK (laser in situ keratomileusis), photorefractive keratectomy (PRK), and radial and astigmatic keratotomy. LASIK is the most common type of refraction surgery and doctors use it to correct all three refractive disorders. The most serious complication of any type of refractive surgery is the risk of infection (MERCK 2003).

Vision problems have been associated with exposure to trichloroethylene, tetrachloroethylene, 1,4-dioxane, inorganic arsenic and barium.

The lowest concentration of trichloroethylene that caused vision problems (itchy, watery, inflamed eyes) in a human inhalation study (200 ppm) was approximately 16 times higher than the highest estimated concentration for Tallevast residents (12 ppm). The lowest dose of trichloroethylene that caused vision problems in an ingestion study with rats (549 mg/kg/day) was thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.2 mg/kg/day) (ATSDR 1997b). Therefore, the highest trichloroethylene levels in Tallevast groundwater are not expected to cause a higher incidence of vision problems.

The lowest concentration of tetrachloroethylene that caused vision problems (loss of color vision) in a human inhalation study (7.3 ppm) was higher than the highest estimated concentration for Tallevast residents (3 ppm) (ATSDR 1997a). Therefore, the levels of tetrachloroethylene in Tallevast groundwater are not expected to cause a higher incidence of vision problems.

The lowest concentration of 1,4-dioxane that caused vision problems (eye irritation) in a human inhalation study (50 ppm) was higher than the highest concentration for Tallevast residents (4 ppm) (ATSDR 2004). Therefore, the levels in Tallevast groundwater are not expected to cause a higher incidence of vision problems.

The lowest dose of inorganic arsenic that caused vision problems (chronic conjunctivitis) in a human ingestion study (0.032 mg/kg/day) was hundreds of times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, the levels in Tallevast soil are not expected to cause a higher incidence of vision problems.

The lowest dose of barium that caused vision problems (eye discharge) in an ingestion study with rats (198 mg/kg/day) was tens of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.002 mg/kg/day) (ATSDR 1992). Therefore, levels of barium in Tallevast soil are not expected to cause a higher incidence of vision problems.

Weight Loss:

Any unexplained weight loss can be the sign of a serious medical condition and if it occurs, the person should see their doctor. Weight loss has been associated with exposure to inorganic arsenic, barium and beryllium.

The lowest concentration of inorganic arsenic that caused weight loss in an inhalation study with rats (8 mg/m^3) was millions of times higher than the highest estimated concentration for Tallevast residents (0.000001 mg/m^3). The lowest dose of inorganic arsenic that caused weight loss in a human ingestion study (0.015 mg/kg/day) was hundreds of times higher than the highest estimated average daily dose for Tallevast residents (0.00007 mg/kg/day) (ATSDR 2005d). Therefore, the levels of inorganic arsenic in Tallevast soil are not expected to cause a higher incidence of weight loss.

The lowest dose of barium that caused weight loss in an ingestion study with mice (160 mg/kg/day) was tens of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.002 mg/kg/day) (ATSDR 1992). Therefore, the levels of barium in Tallevast soil are not expected to cause a higher incidence of weight loss.

The lowest concentration of beryllium that caused weight loss in an inhalation study with rats (0.034 mg/m^3) was thousands of times higher than the highest estimated concentration for Tallevast residents (0.000004 mg/m^3). The lowest dose of beryllium that caused weight loss in an ingestion study with dogs (12 mg/kg/day) was tens of thousands of times higher than the highest estimated average daily dose for Tallevast residents (0.0002 mg/kg/day) (ATSDR 2002). Therefore, beryllium levels in Tallevast soil are not expected to cause a higher incidence of weight loss.

6.0 Conclusions

Groundwater

- We categorize past groundwater use at the former American Beryllium site as a "public health hazard." If every day for 18 years, former American Beryllium workers drank contaminated groundwater from an on-site well with the highest measured trichloroethylene concentration (13,000 ug/L), they would be at a "moderate" to "high" (60 to 1,000 in 100,000) increased theoretical risk of cancer including kidney, liver, leukemia, and lymphoma. If they drank this groundwater, the concentration likely varied over time and they may have been exposed for less than 18 years.

  We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in former workers.

  The concentrations of 1,1-dichloroethene, 1,4-dioxane, and tetrachloroethylene in on-site groundwater are not likely to cause illness. Too little is known about the toxicity of 1,1-dichloroethane and *cis*-1,2-dichloroethene to determine the public health threat. The toxicity of 1,1-dichloroethene, 1,4-dioxane, tetrachloroethylene, and trichloroethylene in a mixture may be additive. Too little is known, however, to quantify the public health risk from exposure to multiple chemicals.

- We categorize past groundwater use in the Tallevast community for drinking, showering, and other household use as a "public health hazard."

  Tallevast residents who every day for 42 years drank contaminated groundwater with the highest trichloroethylene concentration measured in a private drinking water well or off-site irrigation well are at a "low" to "high" (8 to 4,000 in 100,000) increased risk of kidney cancer, liver cancer, leukemia, and lymphoma. Tallevast residents who every day for 42 years used this same contaminated groundwater for drinking and showering are at a "moderate" to "very high" (60 to 20,000 in 100,000) theoretical increased cancer risk.

  Tallevast residents who every day for 42 years drank contaminated groundwater with the highest measured 1,4-dioxane concentration are at a "low" (20 in 100,000) increased theoretical risk of cancer. Tallevast residents who every day for 42 years used this same contaminated groundwater for drinking and showering are at a "moderate" (100 in 100,000) increased theoretical risk of cancer.

  We base these theoretical cancer risk calculations on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

  The trichloroethylene and 1,4-dioxane concentrations that Tallevast residents were actually exposed to likely varied over time and may have been lower or higher. In addition, Tallevast residents may have been exposed for less than 42 years since it is unknown when ground water contamination first moved off site.

Ingestion of the highest concentration of 1,1-dichloroethene in Tallevast groundwater or inhalation of its vapors from showering or other household uses is not likely to cause non-cancer illness. Too little is known about 1,1-dichloroethene to estimate the risk of cancer.

Ingestion of the highest concentration of tetrachloroethylene in Tallevast groundwater is not likely to cause non-cancer illness. Too little is known about tetrachloroethylene to estimate the health risk from inhalation of vapors or the risk of cancer from either ingestion or inhalation.

Too little is known about the toxicity of 1,1-dichloroethane, *cis*-1,2-dichloroethene, and *trans*-1,2-dichloroethene to determine the public health threat. The toxicity of 1,1-dichloroethene, 1,4-dioxane, tetrachloroethylene, and trichloroethylene in a mixture may be additive. Too little is known, however, to quantify the public health risk from exposure to multiple chemicals in Tallevast groundwater.

This public health assessment estimates the health risk for individuals exposed to the highest measured levels of contamination. This assessment, however, does not apply equally to all Tallevast residents. Most Tallevast residents with wells were exposed to less than the highest contaminant levels. The health risk for these individual would be less than the health risk estimated in this report. For those Tallevast residents whose wells were not contaminated, the health risk from ground water is essentially zero.

As long as Tallevast residents do not use groundwater for drinking, showering, or other household uses, there is no current or future public health hazard from groundwater. The Florida Department of Environmental Protection will, however, require ground water cleanup to restore the resource and protect the public.

Soil

- We categorize soil on the former American Beryllium site as "no apparent public health hazard." The highest levels of chemicals in the soil found on the site are not likely to cause illness in current or former workers.
- We categorize surface soil in the Tallevast community surrounding the former American Beryllium site as "no apparent public health hazard." The highest levels of chemicals found in the surface soil of the Tallevast community are not likely to cause non-cancer illness. Except for elevated lead concentrations in one yard, pica behavior (unusual eating or swallowing of large amounts of soil) by Tallevast children is not expected to cause non-cancer illness. The additional theoretical risk of skin and lung cancer from the highest level of inorganic arsenic in Tallevast soil is "no apparent" (0.3 to 6 in 100,000). The additional theoretical cancer risk from the highest levels of beryllium and polycyclic aromatic hydrocarbons (PAHs) in Tallevast soil ranges from "extremely small" (0.5 in 100,000) to "no apparent" (3 in 100,000). We base this theoretical calculation on the assumption there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk

estimate does not equal the increased number of cancer cases that will actually occur in Tallevast residents.

Surface Water

- We categorize surface water on the former American Beryllium site as "no apparent public health hazard." The highest levels of chemicals found in the on-site pond are not likely to cause illness.
- We categorize surface water in Tallevast as "no apparent public health hazard." The highest levels of chemicals found in off-site surface water are not likely to cause illness.

7.0 Recommendations

- Avoid use of contaminated Tallevast groundwater for drinking, showering, or other household uses. Restrict installation of new wells in the area of contaminated groundwater.
- Test blood lead levels for any Tallevast children who have pica behavior (unusual eating or swallowing of large amounts of soil).
- Explore possible follow-up health studies.

8.0 Public Health Action Plan

Past Activities –

- Florida DOH and DEP tested 17 Tallevast private drinking water wells.
- Florida DOH tested indoor air in four Tallevast buildings and reported the results.
- Florida DOH tested Tallevast fruits and vegetables and reported the results.
- Manatee and Sarasota CHDs tested 359 former American Beryllium workers, family members, and Tallevast residents for beryllium sensitivity. As part of this effort, Manatee CHD and Florida DOH held a public meeting to discuss the testing. Florida DOH and ATSDR analyzed the test data and reported the results.
- Between May 2004 and August 2005, Florida DOH and Manatee CHD participated in numerous meeting and conference calls with Tallevast residents and other agencies.
- In a July 2004 fact sheet, the Florida DOH informed nearby residents that except for lead in one surface soil sample, the levels of chemicals found in Tallevast surface soil samples are not likely to cause illness.
- In November 2004 and June 2005, Florida DOH mailed newsletters to Tallevast residents updating them on the status of their assessment.
- In April 2006, Florida DOH mailed a newsletter to Tallevast residents informing them of the two ATSDR beryllium sensitivity health consultation reports.
- Florida DOH epidemiologists reviewed the Florida Cancer Data System for the rates of kidney, liver, leukemia, and lymphoma cancer in the Tallevast area.
- Between February 28 and May 30, 2008, Florida DOH solicited public comments on the draft public health assessment report. Florida DOH addressed 27 different comments.

Future Activities –

- Florida DOH will inform the Tallevast community of the findings of this pubic health assessment report and post this report on-line (www.myfloridaeh.com/community/superfund/pha.html).
- Florida DOH epidemiologists will reexamine cancer data from the Florida Cancer Data System and report on their findings separately from this public health assessment report.
- Florida DOH epidemiologists will explore the possibility of a follow-up health study.
- Florida DOH will consider assessing additional environmental data as they become available.
- Manatee County will create an area where installation of private drinking water wells will be restricted once the plume of contamination is delineated.
- Florida DOH will inform local physicians about this public health assessment report and potential health effects for residents exposed to contaminated drinking water.

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Appendix A - Figures

Figure 1. Location of Tallevast in Manatee County

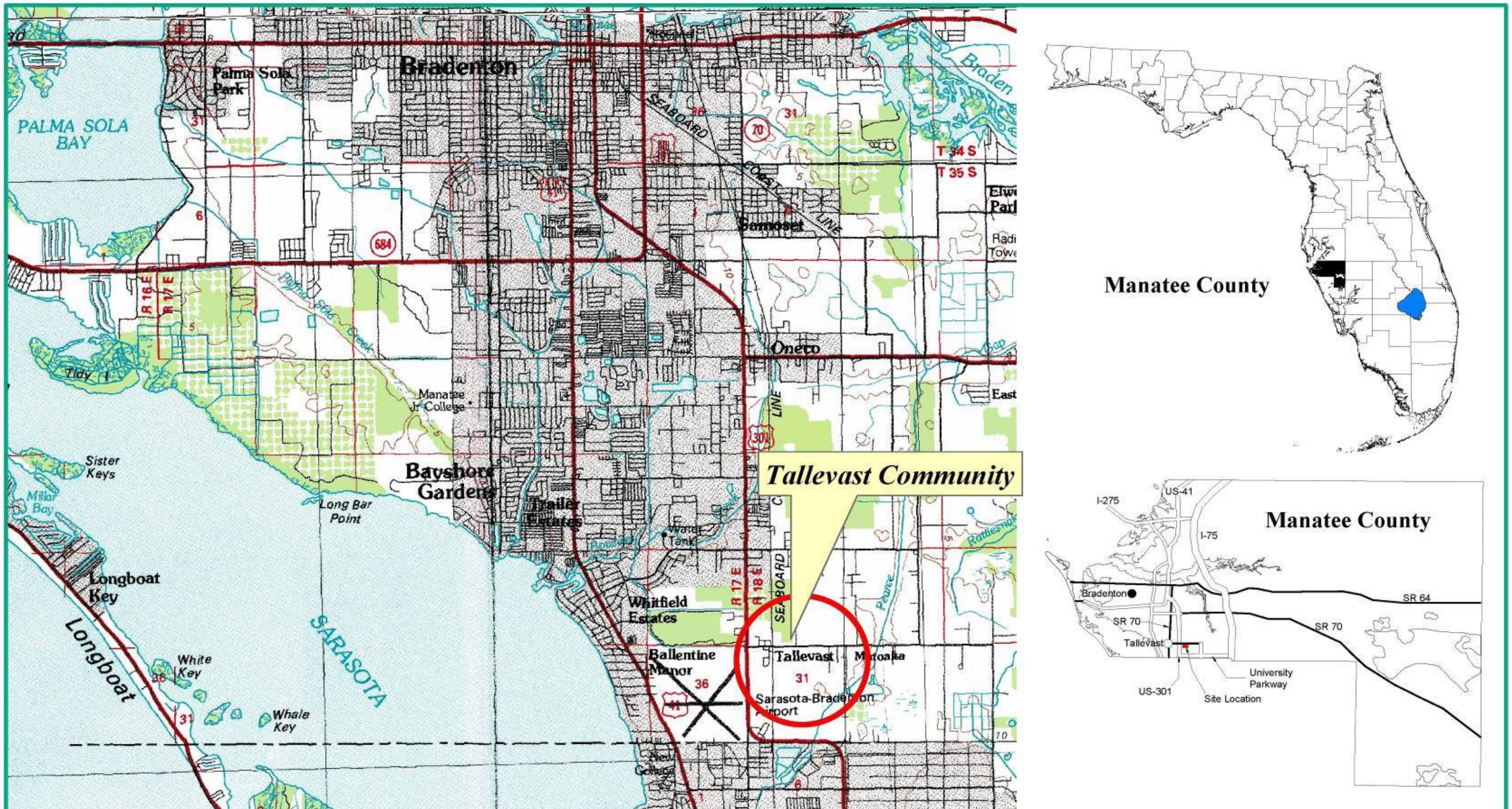


Figure 1: Site Location Map
Tallevast Community
Tallevast, Manatee County, Florida

Figure 2. Site Map

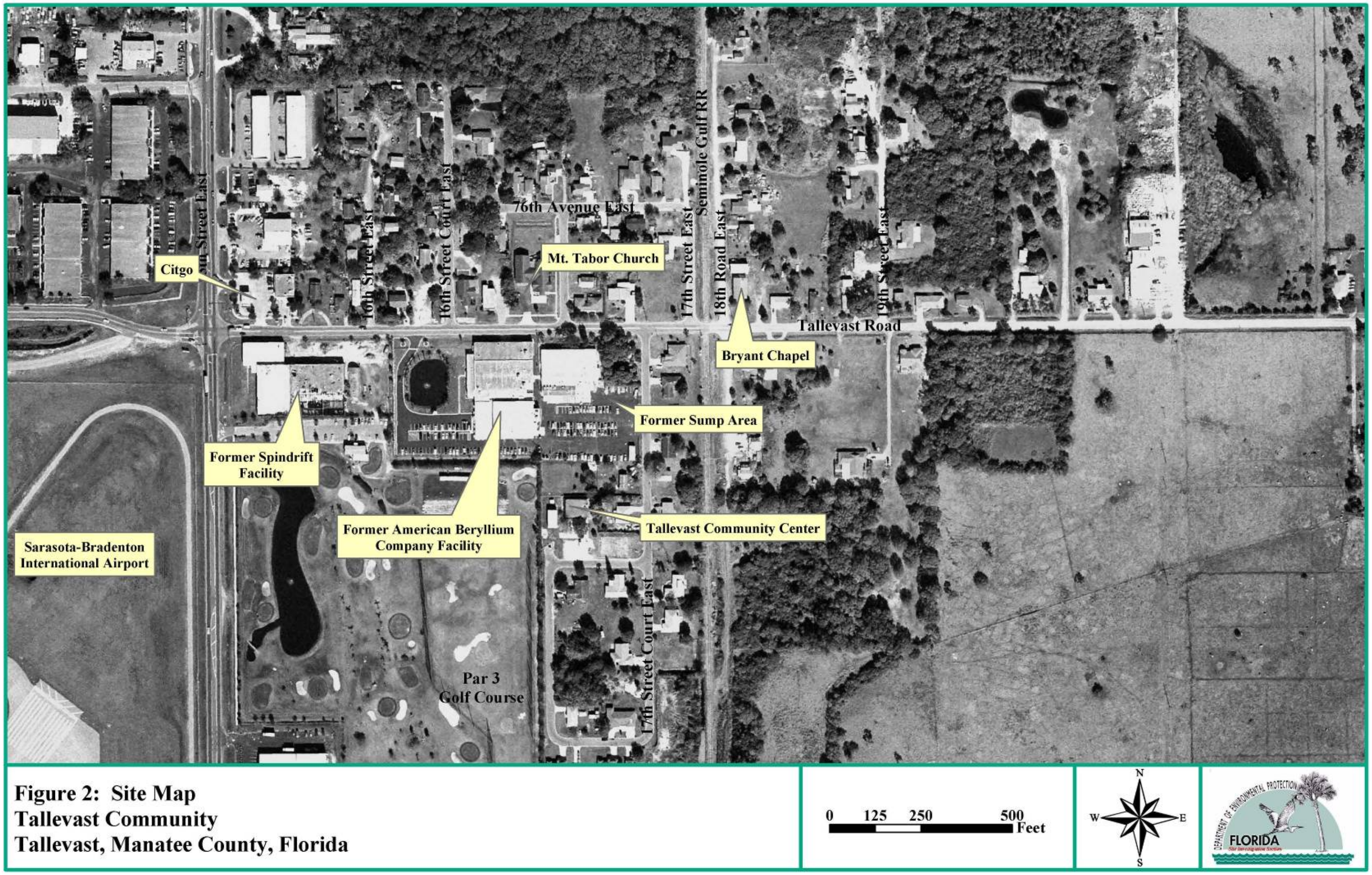


Figure 2: Site Map
Tallevast Community
Tallevast, Manatee County, Florida

Figure 3. Former Loral American Beryllium Site Boundary

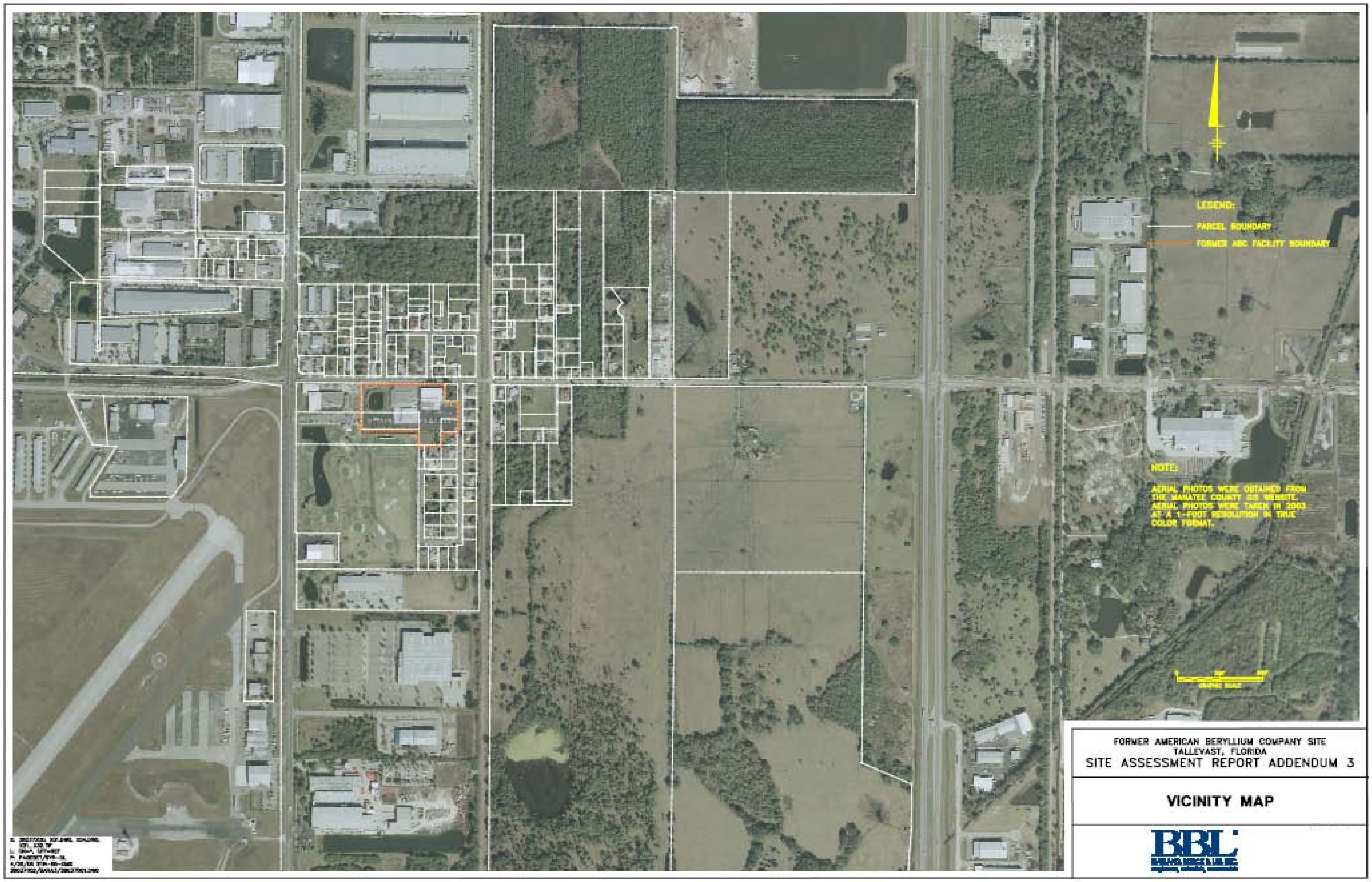


Figure 4. Florida DEP and Tetra Tech Soil Sample Locations, June 2004

Figure 5. PSI Soil Sample Locations

Figure 6. Tetra Tech Soil Sample Locations, November and December 2004

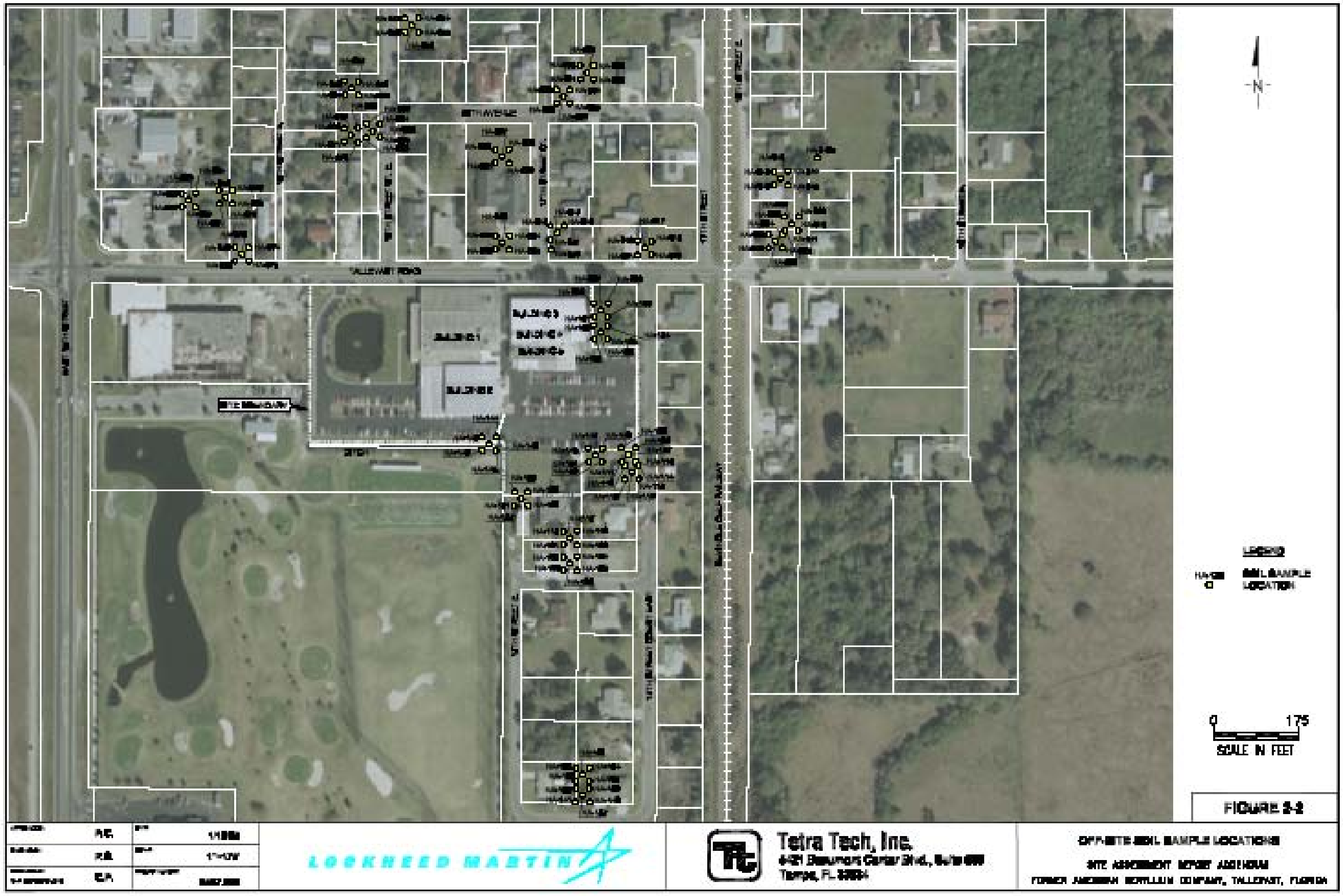


Figure 7. Florida DEP and DOH Well Sample Locations

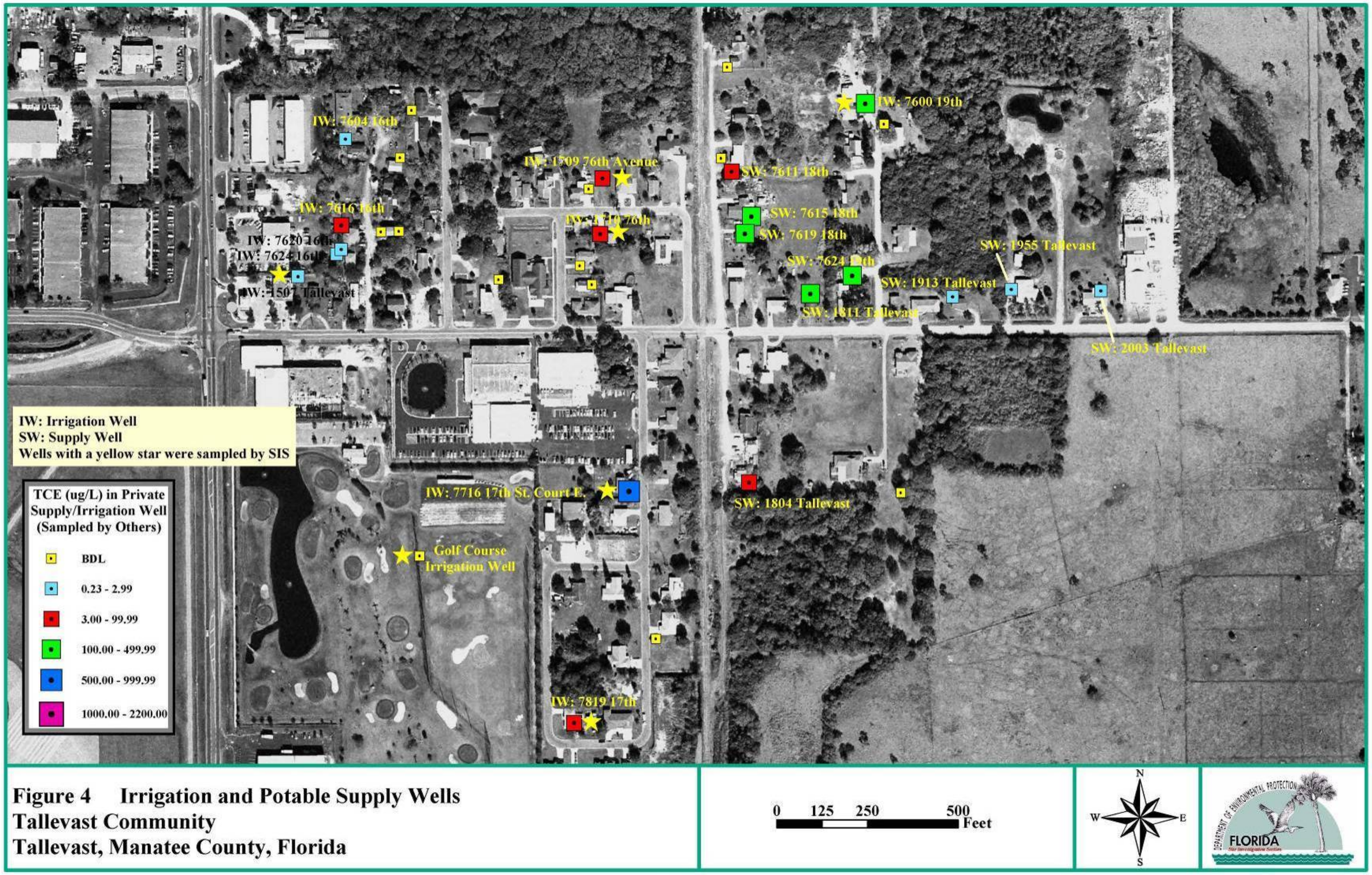


Figure 4 Irrigation and Potable Supply Wells
Tallevast Community
Tallevast, Manatee County, Florida

Figure 8. Tetra Tech 2004 Well Sample Locations

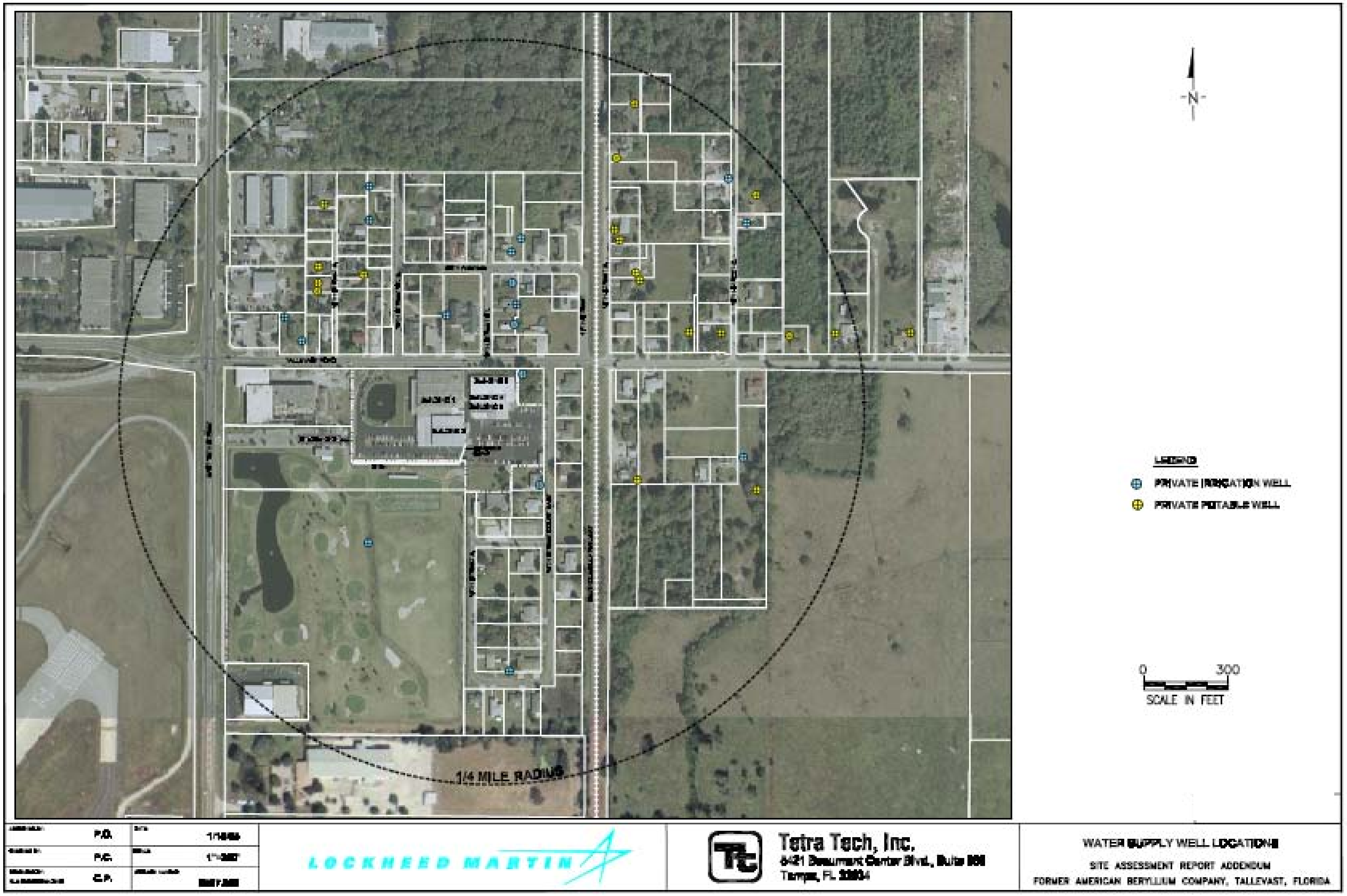
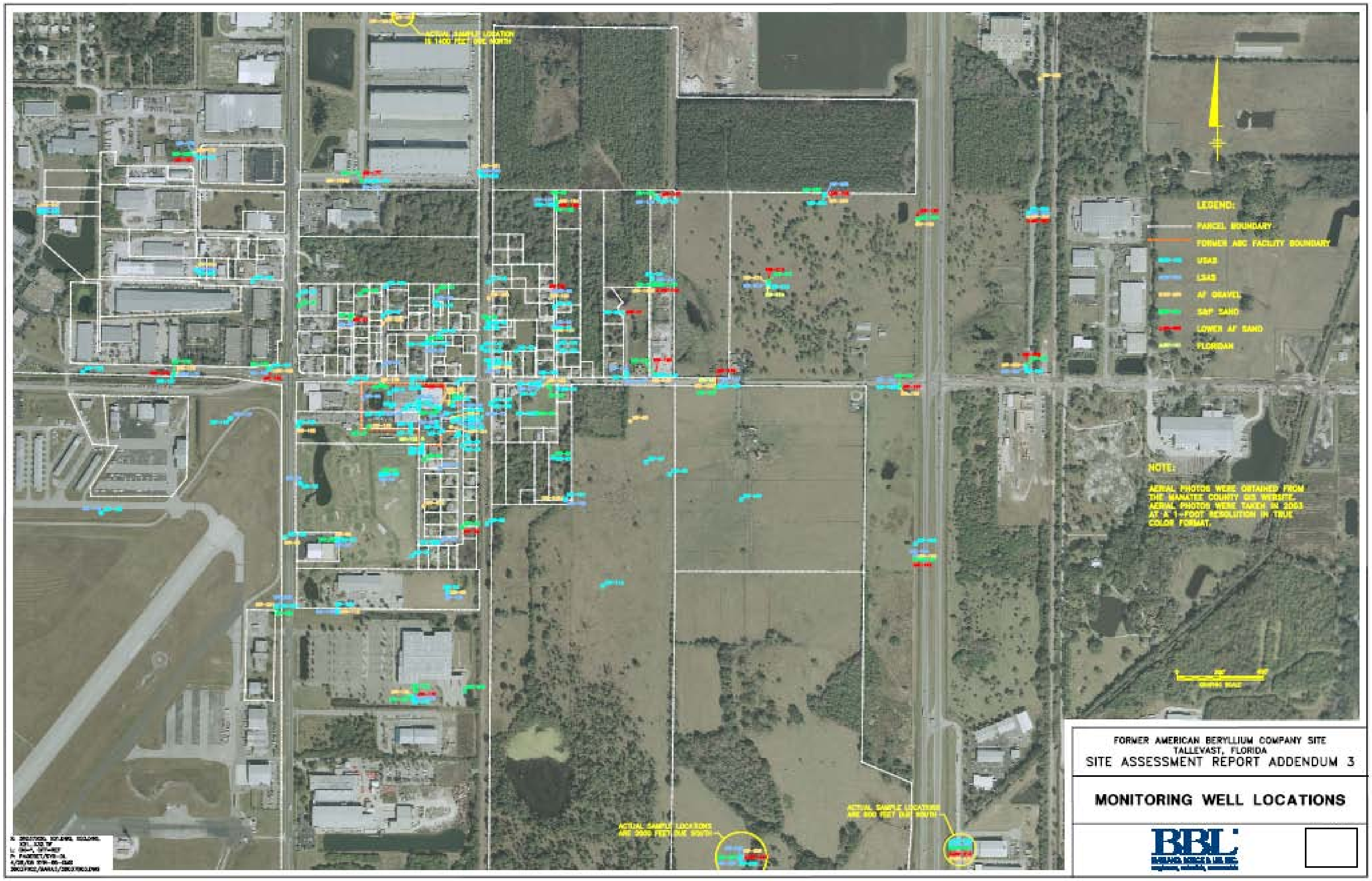


Figure 9. Monitoring Well Locations



Appendix B - Tables

Table 1. Contaminants of Concern in On-Site Groundwater

Contaminants of Concern	Highest Concentration (ug/L)	MCL/HAL (ug/L)	ATSDR Screening Value child/adult (ug/L)
1,1-Dichloroethane	360	70*	NA
1,1-Dichloroethene	940	7	90/300 (Chronic EMEG)
cis-1,2-Dichloroethene	1,300	70	3000/10000 (Intermediate EMEG)
1,4-Dioxane	930	NA	3 (CREG)
Tetrachloroethylene	510	3**	100/400 (RMEG)
Trichloroethylene	13,000	3**	2000/7000 (Acute EMEG)

mg/L = Milligrams per Liter
ug/L= Micrograms per Liter
EMEG = Environmental Media Evaluation Guide
RMEG = Reference Dose (from EPA) Media Evaluation Guide
Int = Intermediate exposure length of 15 to 364 days
NA = Not Available
* = Florida Health Advisory Level (HAL)
** = Florida Maximum Contaminant Level (MCL)
Source: [BBL 2006, DEP 2004, EST 2005, PSI 2005, Tetra Tech 2004, Tetra Tech 2005, BBL 2006, Arcadis 2007]

Table 2. Estimated Maximum Adult Worker Dose from Drinking On-Site Groundwater

Contaminants of Concern (maximum concentration) (ug/L)	Oral MRL (mg/kg/day)	Estimated Average Daily Dose (ADD) for Ingestion (mg/kg/day)	Estimated Lifetime Average Daily Dose (LADD) for Ingestion (mg/kg/day)
1,1-Dichloroethane (360)	None	0.004	0.001
1,1-Dichloroethene (940)	0.009 Chr	0.009	0.002
cis-1,2-dichloroethene (1,300)	0.3 Int; 1.0 Acu;	0.01	0.003
1,4-Dioxane (930)	0.1 Chr; 0.6 Int; 4 Acu	0.009	0.002
Tetrachloroethylene (510)	0.05 Acu	0.005	0.001
Trichloroethylene (13,000)	0.2 Acu	0.1	0.03

MRL = Minimal Risk Level. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure
Chr = Chronic exposure length of more than 365 days
Int = Intermediate exposure length of 15 to 364 days
Acu = Acute exposure length of less than 14 days
mg/kg/day = milligram chemical per kilogram body weight per day
ppm = parts per million
ug/L = micrograms per liter

Table 3. Contaminants of Concern in Off-Site Groundwater

Contaminants of Concern	Highest Concentration in Drinking Water Well (ug/L)	Highest Concentration in Monitor or Irrigation Wells (ug/L)	MCL/HAL (ug/L)	ATSDR Screening Value child/adult (ug/L)
1,1-Dichloroethane	18	1,200	70*	NA
1,1-Dichloroethene	49	1,800	7	90/300 (Chronic EMEG)
cis-1,2-Dichloroethene	50	350	70	3000/10000 (Intermediate EMEG)
trans-1,2-Dichloroethene	6	10	100	2000/7000 (Intermediate EMEG)
1,4-Dioxane	not analyzed	1,200	NA	3 (CREG)
Tetrachloroethylene	2.7	2,000	3**	100/400 (RMEG)
Trichloroethylene	240	6,000	3**	2000/7000 (Acute EMEG)

mg/L = Milligrams per Liter
ug/L= Micrograms per Liter
EMEG = Environmental Media Evaluation Guide
RMEG = Reference Dose (from EPA) Media Evaluation Guide
Int = Intermediate exposure length of 15 to 364 days
NA = Not Available
* = Florida Health Advisory Level (HAL)
** = Florida Maximum Contaminant Level (MCL)
Source: [BBL 2006, DEP 2004, EST 2005, PSI 2005, Tetra Tech 2004, Tetra Tech 2005, BBL 2006, Arcadis 2007, EST 2007]

Table 4. Estimated Indoor Air Levels, Drinking Doses, Shower (Inhalation/Skin) Doses, and Combined Drinking//Shower Doses for Maximum Contaminant Levels in Off-site Groundwater (Monitoring and Private Wells)

Contaminants of Concern (maximum concentration in ug/L)	Indoor Air Levels Estimated from Showering* (ppm)	Drinking Estimated ADD* (mg/kg/day)		Drinking Estimated LADD* (mg/kg/day)	Shower Inhalation/Skin Absorption Estimated ADD** (mg/kg/day)		Combined Drinking and Shower Inhalation /Skin Absorption Estimated ADD (mg/kg/day)		Combined Drinking and Shower Inhalation/ Skin Absorption Estimated LADD (mg/kg/day)
		Child	Adult	Adult	Child	Adult	Child	Adult	Adult
1,1-Dichloroethane (1,200)	3	0.2	0.03	0.02	0.3	0.2	0.5	0.2	0.1
1,1-Dichloroethene (1,800)	5	0.2	0.05	0.03	0.5	0.3	0.7	0.4	0.2
Cis-1,2-dichloro-ethene (350)	1	0.04	0.01	0.006	0.1	0.06	0.1	0.07	0.04
Trans-1,2-dichloro-ethene (1.5)	0.004	0.0002	0.00004	0.00003	0.02	0.001	0.02	0.001	0.0006
1,4-Dioxane (1,200)	4	0.2	0.03	0.02	0.3	0.2	0.5	0.2	0.1
Tetrachloroethylene (2,000)	3	0.3	0.05	0.03	0.5	0.3	0.8	0.4	0.2
Trichloroethylene (drinking well: 240)	0.5	0.03	0.007	0.004	0.06	0.04	0.09	0.05	0.03
Trichloroethylene (irrigate well: 6,000)	12	0.8	0.2	0.1	1	1	2	1	0.6

ADD = Average daily dose. LADD = Lifetime average daily dose = ADD x (exposure years/lifetime years) = ADD x (42 / 70).
ppm = parts per million; mg/kg/day = milligram chemical per kilogram body weight per day; ug/L – micrograms per liter
* Risk Assistant used to estimate indoor air concentration from showering, average daily dose (ADD) via drinking (ingestion), and lifetime average daily dose (LADD) via drinking (ingestion).
** ATSDR model used to estimate average daily dose (ADD) from dermal absorption during showering and inhalation during and after showering.
Concentrations and doses rounded to one significant figure.

Table 5. Contaminants of Concern in Off-Site Soils *

Contaminants of Concern	Highest Concentration (mg/kg)	Florida DEP Residential SCTL (mg/kg)	ATSDR Screening Value (mg/kg)
Inorganic arsenic	26	2.1*	0.5 CREG
Barium	671	120	4000 RMEG
Beryllium	82	120	100/1000 EMEG
Lead	1114** / 240	400	NA
PAHs	2	0.1	0.1 CREG
TRPH	449	340	NA

* Florida DEP raised the SCTL for Arsenic from 0.8 mg/kg to 2.1 mg/kg in April 2005
** Highest level of lead only occurred in one sample
mg/kg = milligrams per kilogram
SCTL = Florida DEP Soil Concentration Target Level
PAHs = Polycyclic Aromatic Hydrocarbons
TRPH = Total Recoverable Petroleum Hydrocarbons
CREG = Cancer Risk Evaluation Guide
EMEG = Environmental Media Evaluation Guide
RMEG = Reference Dose (from EPA) Media Evaluation Guide
NA = Not Available
Source: [BBL 2006, DEP 2004, EST 2005, PSI 2005, Tetra Tech 2004, Tetra Tech 2005]

Table 6. Estimated Maximum Dose from Exposure of Tallevast Residents to Off-Site Surface Soil

Contaminant of Concern (maximum concentration in mg/kg)	Oral MRL (mg/kg/day)	Estimated Maximum Soil Ingestion Dose (mg/kg/day)				Inhalation MRL (mg/m^3)	Estimated Maximum Dust Concentration (mg/m^3)
		Child	Adult ADD	Adult LADD	Pica Child		
Inorganic Arsenic (26)	0.0003 Chr	0.00006	0.00007	0.00004	0.01	None	0.0006
Barium (671)	None	0.002	0.002	0.001	0.2	None	0.00006
Beryllium (82)	0.002 Chr	0.0002	0.0002	0.0001	0.03	None	0.000007
Lead* (150 & 1,114)	None	*	*	*	**	None	*
PAHs (2)	None	0.000004	0.000006	0.000004	0.0007	None	0.0000002

MRL = Minimal Risk Level. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure
mg/kg = milligrams per kilogram
PAHs = Polycyclic Aromatic Hydrocarbons
Chr = Chronic exposure length of more than 365 days
mg/kg/day = milligram chemical per kilogram body weight per day mg/m3 = milligram of chemical per cubic meter of air
* See Table 7 for blood lead level estimates
****** Pica blood lead level calculated using Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children = 23.4/11.1 micrograms per deciliter (ug/dL)

ADD = Average Daily Dose
LADD = Lifetime Average Daily Dose

Table 7. Estimated Blood Lead Concentrations From Exposure to Off-Site Soils

Media	Conc. *		Time	Slope'		Low (ug/dL)	High (ug/dL)
	low	high		Low	high		
Air (out) *	0.1	0.2	0.33	2.46	3.04	0.08118	0.20064
Air (in) *	0.3	0.6	0.33	2.46	3.04	0.24354	0.60192
Food*	5	5	0.33	0.24	0.24	0.396	0.396
Water*	4	4	0.33	0.16	0.16	0.2112	0.2112
Soil	240	1114	0.33	0.002	0.016	0.1584	5.88192
Dust	240	1114	0.33	0.004	0.004	0.3168	1.47048
Total						1.40712	8.76216
Media	Conc. *		Time	Slope'		Low (ug/dL)	High (ug/dL)
	low	high		Low	high		
Air (out) *	0.1	0.2	0.33	1.59	3.56	0.05247	0.23496
Air (in) *	0.3	0.6	0.33	1.53	3.56	0.15147	0.70488
Food*	5	5	0.33	0.016	0.0195	0.0264	0.032175
Water*	4	4	0.33	0.03	0.06	0.0396	0.0792
Soil	240	1114	0.33	0.002	0.016	0.1584	5.88192
Dust	240	1114	0.33	0.004	0.004	0.3168	1.47048
Total						0.74514	8.403615

ug/dL = micrograms per deciliter
Table created with information from the ATSDR Draft Toxicological Profile for Lead 2005.
Source: [ATSDR 2005e]

Table 8. Contaminants of Concern in On-Site Soils

Contaminants of Concern	Highest Concentration (mg/kg)	Florida DEP Residential SCTL (mg/kg)	ATSDR Screening Value (mg/kg)
Inorganic Arsenic	11	2.1**	0.5 CREG
Barium	8	120	4000 RMEG
Beryllium	99	120	100/1000 EMEG
Lead	62	400	NA
PAHs	1.53	0.1	0.1 CREG
TRPH	130	340	NA

** Florida DEP raised the SCTL for Arsenic from 0.8 mg/kg to 2.1 mg/kg in April 2005
mg/kg = milligrams per kilogram
PAHs = Polycyclic Aromatic Hydrocarbons
TRPH = Total Recoverable Petroleum Hydrocarbons
CREG = Cancer Risk Evaluation Guide
EMEG = Environmental Media Evaluation Guide
RMEG = Reference Dose (from EPA) Media Evaluation Guide
NA = Not Available
Source: [BBL 2006, DEP 2004, EST 2005, PSI 2005, Tetra Tech 2004, Tetra Tech 2005]

Table 9. Estimated Maximum Worker Exposure to On-Site Surface Soil*

Contaminant of Concern (maximum concentration) (mg/kg)	Oral MRL (mg/kg/day)	Estimated Maximum Soil Ingestion Dose (mg/kg/day)		Inhalation MRL (mg/m^3)	Estimated Maximum Dust Concentration (mg/m^3)
		Average Daily Dose (ADD)	Lifetime Average Daily Dose (LADD)		
Inorganic Arsenic (11)	0.0003 Chr	0.000005	0.000001	None	0.000001
PAHs (1.53)	None	0.0000007	0.0000002	None	0.0000001

MRL = Minimal Risk Level. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure
mg/kg = milligrams per kilogram
PAHs = Polycyclic Aromatic Hydrocarbons
Chr = Chronic exposure length of more than 365 days
mg/kg/day = milligram chemical per kilogram body weight per day
mg/m^3 = milligram of chemical per cubic meter of air
ADD = average daily dose
LADD = lifetime average daily dose
* Calculated using Risk Assistant ™

Table 10. Model Parameters and Assumptions for Tables 1-9.

Exposure Medium:	**Groundwater**
Exposure Point:	**On-site tap water**
Scenario Time frame:	Future
Land Use Conditions:	Residential

Receptor Population: Residents

These doses were calculated using Risk Assistant software by Hampshire Research Institute, Version 2.0. The part of this software Florida DOH uses allows us to set custom exposures that we can use for every site with accepted values for groundwater consumption (EPA, 1991).

Doses were calculated using the following values:

Adult body weight-	70 kg
Child body weight-	15 kg
Adult water consumption-	2 liters/day
Child water consumption-	1 liter/day

µg/L = microgram per liter of water
mg/kg/day = milligrams per kilogram body weight per day
$mg/^{M3}$ = milligrams per cubic meter

N.D.- Not detected
N.A.- Not applicable
N.S.- Not significant

Exposure Medium: Soil	
Exposure Point:	**On-site soil and dust**
Scenario Time frame:	Future
Land Use Conditions:	Residential

Receptor Population: Residents

These doses were calculated using Risk Assistant software and accepted values for soil consumption, dust inhalation exposure and dermal exposure parameters (EPA, 1991).

The following doses were calculated using the following values:

Adult body weight-	70 kg
Child body weight-	15 kg
Adult soil consumption-	100 mg/day
Child soil consumption-	200 mg/day

mg/kg = milligram per kilogram of soil
mg/kg/day = milligrams per kilogram body weight per day

Table 11. Oral Hazard Quotient Calculations for Mixture Evaluation

General HI

Chemical	Conc. (ug/L)	Dose (mg/kg/day)	MRL/RfD (mg/kg/day)	MRL/RfD Info	LOAEL/NOAEL (mg/kg/day)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	0.08	na		382	lowest LOAEL	1000	0.382	0.20942
1,1-DCE	1800	0.12	0.009	Chronic - hepatic	9		1000		13.3333
c-1,2-DCE	220	0.01	na			no chronic data			
t-1,2-DCE	1.5	0.0001	na			no chronic data			
1,4-dioxane	470	0.03	0.1	Chronic - hepatic	81		1000	0.081	0.3
PCE	1400	0.09	0.01	Chronic RfD-hepatic	941		1000		9
TCE	6000	0.4			250	lowest LOAEL	1000	0.25	1.6
								HI oral =	24.4428

Hepatic HI

Chemical	Conc. (ug/L)	Dose (mg/kg/day)	MRL/RfD (mg/kg/day)	MRL/RfD Info	LOAEL/NOAEL (mg/kg/day)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	0.08			475	lowest NOAEL hepatic - no LOAEL available	100	4.75	0.01684
1,1-DCE	1800	0.12	0.009	Chronic - hepatic	9	lowest LOAEL hepatic	1000		13.3333
c-1,2-DCE	220	0.01	na		na	no chronic inhalation data			0

t-1,2-DCE	1.5	0.0001	na		na	no chronic inhalation data			0
1,4-dioxane	470	0.03	0.1	Chronic - hepatic	81	lowest LOAEL hepatic	1000		0.3
PCE	1400	0.09	0.01	Chronic RfD-hepatic	941	lowest NOAEL hepatic	100	9.41	9
TCE	6000	0.4			250	lowest NOAEL hepatic - no LOAEL available	100	2.5	0.16
								HI oral hepatic =	22.8102

Renal HI

Chemical	Conc. (ug/L)	Dose (mg/kg/day)	MRL/RfD (mg/kg/day)	MRL/RfD Info	LOAEL/NOAEL (mg/kg/day)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	0.08	na		475	lowest NOAEL - renal	100	4.75	0.01684
1,1-DCE	1800	0.12	na		19.3	lowest NOAEL - renal	100	0.193	0.62176
c-1,2-DCE	220	0.01	na		na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.0001	na		na	no chronic inhalation data			0
1,4-dioxane	470	0.03	1	Chronic - hepatic	94	lowest LOAEL - renal	1000	0.094	0.31915
PCE	1400	0.09	0.04	Chronic - neurological	386	lowest LOAEL - renal	1000	0.386	0.23316
TCE	6000	0.4	na		250	lowest LOAEL - renal	1000	0.25	1.6
								HI oral renal =	2.77407

Hema.

HI									
Chemical	**Conc. (ug/L)**	**Dose (mg/kg/day)**	**MRL/RfD (mg/kg/day)**	**MRL/RfD Info**	**LOAEL/NOAEL (mg/kg/day)**	**LOAEL Info**	**UF**	**TTD**	**HQ**
1,1-DCA	1200	0.08	na		764	lowest NOAEL - hemato.	100	7.64	0.01047
1,1-DCE	1800	0.12	na		19.3	lowest LOAEL - hemato.	1000	0.0193	6.21762
c-1,2-DCE	220	0.01	na		na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.0001	na		na	no chronic inhalation data			0
1,4-dioxane	470	0.03	1	Chronic - hepatic	81	lowest LOAEL - hemato.	1000	0.081	0.37037
PCE	1400	0.09	0.04	Chronic - neurological	na				
TCE	6000	0.4	na		na	na			
								HI oral hemato. =	6.58799

Resp. HI									
Chemical	**Conc. (ug/L)**	**Dose (mg/kg/day)**	**MRL/RfD (mg/kg/day)**	**MRL/RfD Info**	**LOAEL/NOAEL (mg/kg/day)**	**LOAEL Info**	**UF**	**TTD**	**HQ**
1,1-DCA	1200	0.08	na		475	lowest NOAEL - res.	100	4.75	0.01684
1,1-DCE	1800	0.12	na		na				
c-1,2-DCE	220	0.01	na		na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.0001	na		na	no chronic inhalation data			0

1,4-dioxane	470	0.03	1	Chronic - hepatic	103	lowest LOAEL - res.	1000	0.103	0.29126
PCE	1400	0.09	0.04	Chronic - neurological	941	lowest NOAEL - res.	100	9.41	0.00956
TCE	6000	0.4	na		250	lowest NOAEL - res.	100	2.5	0.16
								HI oral resp. =	0.46083

Conc. = Concentration
Dose = Estimated Dose (calculated using Risk Assistant)
MRL/RfD = Minimum Risk Level/ Reference Dose
LOAEL = Lowest Observable Adverse Effect Level
NOAEL – No Observable Adverse Effect Level
UF = Uncertainty Factor (determined by type of study and duration of stuffy)
TTD = Target organ Toxicity Dose
HQ = Hazard Quotient
mg/kg/day = milligram chemical per kilogram body weight per day
ug/L – micrograms per liter
Source: [BBL 2006, DEP 2004, EST 2005, PSI 2005, Tetra Tech 2004, Tetra Tech 2005, ATSDR 2001a]

Table 12. Inhalation Hazard Quotient Calculations for Mixtures Evaluation

General HI

Chemical	Conc. (ug/L)	Est. Conc. (ppm)	MRL/RfD (ppm)	MRL/RfD Info	LOAEL/NOAEL (ppm)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	3.26	na		Na	no chronic inhalation data			0
1,1-DCE	1800	4.98	na		25	lowest LOAEL - hepatic	1000	0.025	199.2
c-1,2-DCE	220	0.61	na		Na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.003	na		Na	no chronic inhalation data			0
1,4-dioxane	470	1.43	1	Chronic - hepatic	111	NOAEL animal	100	1.11	1.43
PCE	1400	2.27	0.04	Chronic - neurological	15	lowest LOAEL - neurological	1000	0.015	56.75
TCE	6000	12.27	na		300	lowest LOAEL - renal	1000	0.3	40.9
								HI inhal. =	298.28

Hepatic HI

Chemical	Conc. (ug/L)	Est. Conc. (ppm)	MRL/RfD (ppm)	MRL/RfD Info	LOAEL/NOAEL (ppm)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	3.26	na		Na	no chronic inhalation data			0
1,1-DCE	1800	4.98	na		25	lowest LOAEL - hepatic	1000	0.025	199.2
c-1,2-DCE	220	0.61	na		Na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.003	na		Na	no chronic inhalation data			0
1,4-	470	1.43	1	Chronic -	111	lowest NOAEL -	100	1.11	1.43

dioxane				hepatic		hepatic			
PCE	1400	2.27	0.04	Chronic - neurological	15.8	lowest LOAEL - hepatic	100	0.158	14.367
TCE	6000	12.27	na		600	lowest NOAEL - hepatic	100	6	2.045
								HI inhal. Hep. =	217.04

Renal HI

Chemical	Conc. (ug/L)	Est. Conc. (ppm)	MRL/RfD (ppm)	MRL/RfD Info	LOAEL/NOAEL (ppm)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	3.26	na		Na	no chronic inhalation data			0
1,1-DCE	1800	4.98	na		25	lowest LOAEL - renal	1000	0.025	199.2
c-1,2-DCE	220	0.61	na		Na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.003	na		Na	no chronic inhalation data			0
1,4-dioxane	470	1.43	1	Chronic - hepatic	111	lowest NOAEL - renal	100	1.11	1.2883
PCE	1400	2.27	0.04	Chronic - neurological	10	lowest LOAEL - renal	100	0.1	22.7
TCE	6000	12.27	na		300	lowest LOAEL - renal	1000	0.3	40.9
								HI inhal. renal =	264.09

Hemato. HI

Chemical	Conc. (ug/L)	Est. Conc. (ppm)	MRL/RfD (ppm)	MRL/RfD Info	LOAEL/NOAEL (ppm)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	3.26	na		Na	no chronic inhalation data			0
1,1-DCE	1800	4.98	na		55	lowest NOAEL -	100	0.55	9.0545

						hemato.			
c-1,2-DCE	220	0.61	na		Na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.003	na		Na	no chronic inhalation data			0
1,4-dioxane	470	1.43	1	Chronic - hepatic	111	lowest NOAEL - hemato.	100	1.11	1.2883
PCE	1400	2.27	0.04	Chronic - neurological	20	lowest NOAEL - hemato.	10	2	1.135
TCE	6000	12.27	na		Na	na			
								HI inhal. hemato. =	11.478

Resp. HI

Chemical	Conc. (ug/L)	Est. Conc. (ppm)	MRL/RfD (ppm)	MRL/RfD Info	LOAEL/NOAEL (ppm)	LOAEL Info	UF	TTD	HQ
1,1-DCA	1200	3.26	na		Na	no chronic inhalation data			0
1,1-DCE	1800	4.98	na		75	lowest NOAEL - res.	100	0.75	6.64
c-1,2-DCE	220	0.61	na		Na	no chronic inhalation data			0
t-1,2-DCE	1.5	0.003	na		Na	no chronic inhalation data			0
1,4-dioxane	470	1.43	1	Chronic - hepatic	111	lowest NOAEL - res.	100	1.11	1.2883
PCE	1400	2.27	0.04	Chronic - neurological	100	lowest LOAEL - res.	1000	0.1	22.7
TCE	6000	12.27	na		600	lowest NOAEL - res.	100	6	2.045
								HI inhal. resp. =	32.673

Conc. = Concentration
Dose = Estimated Dose (calculated using Risk Assistant)

MRL/RfD = Minimum Risk Level/ Reference Dose
LOAEL = Lowest Observable Adverse Effect Level
NOAEL – No Observable Adverse Effect Level
UF = Uncertainty Factor (determined by type of study and duration of stuffy)
TTD = Target organ Toxicity Dose
HQ = Hazard Quotient
ppm = parts per million
ug/L – micrograms per liter
Source: [BBL 2006, DEP 2004, EST 2005, PSI 2005, Tetra Tech 2004, Tetra Tech 2005, ATSDR 2001a]

Table 13. Summary Non-Cancer Health Risk Estimates

Soil	Former Worker (on-site)	Tallevast Resident (off-site)	Pica Child (off-site)
Inorganic arsenic	N	N	N
Barium	N	N	N
Beryllium	N	N	N
Lead	N	N	N
Polycyclic Aromatic Hydrocarbons (PAHs)	N	N	N
Total Recoverable Petroleum Hydrocarbons (TRPHs)	I	I	I
Ground Water			
1,1-Dichloroethane	I	I	I
1,1-Dichloroethene	N	N	N
Cis-1,2-Dichloroethene	I	I	I
Trans-1,2-Dichloroethene	NA	I	I
1,4-Dioxane	N	N	N
Tetrachloroethylene	N	N	N
Trichloroethylene	I	I	I

N = Not expected to cause illness

I = Insufficient: too little know about toxicity to determine risk of non-cancer illness.

NA = not analyzed

Pica: an unusual eating or swallowing of large amounts of soil by one and two-year-old children.

Table 14. Summary Theoretical Increased Cancer Risk Estimates per 100,000

Soil	**Former Worker (on-site)**	**Tallevast Resident (off-site)**	
Inorganic arsenic	0.03 - 0.2 (“extremely small”)	0.3 – 6 (“no apparent”)	
Barium	-----	-----	
Beryllium	-----	0.5 (“extremely small”)	
Lead	-----	-----	
Polycyclic Aromatic Hydrocarbons (PAHs)	0.1 (“extremely small”)	3 (“no apparent ”)	
Ground Water	**Former Worker (on-site)**	**Tallevast Resident: Drinking Water Only**	**Tallevast Resident: Drinking Water and Showering**
1,1-Dichlorethane	-----	-----	-----
1,1-Dichloroethene	-----	-----	-----
Cis-1,2-Dichloroethene	-----	-----	-----
Trans-1,2-Dichloroethene	-----	-----	-----
1,4-Dioxane	2 (“no apparent”)	20 (“low”)	100 (“moderate”)
Tetrachloroethylene	-----	-----	-----
Trichloroethylene	60 – 1,000 (“moderate” to “high”)	8 – 4,000 (“low” to “high”)	60 - 20,000 (“moderate to “very high”)

----- Contaminant does not cause cancer or there is insufficient information to estimate the risk.

Appendix C – Community Health Concerns

Tallevast Community
American Beryllium Site
Summary of Health Concerns
Reported to the Florida DOH at the June and July 200_Open House Meetings
and received via mail and phone calls
(including 36 health concerns received from the FOCUS community group)

Health Concerns:

Acid reflux
Alcoholism
Allergies (to food, etc.)
Arthritis (rheumatoid and other forms)
Asthma
Attention Deficit Disorder (ADD/ADHD)
Body pain (arms back, chest, legs and joints)
Cancer (all kinds, including breast, liver, and lung and leukemia, plus undiagnosed)
Cholesterol
Circulatory problems
Colon polyps
Dementia/Senility
Dermatomyositis or polymositis
Dental problems (such as cavities/premature tooth pulling (at age 18 mos.) also gum disease)
Diabetes & irregular glucose levels
Difficulty walking w/o walker or help
Diverticulitis
Dizziness/faintness/vertigo
Epilepsy/seizures
Fatigue & reduced energy
Gallstones
Gastritis
Hair Thinning
Headaches, including migraines
Heart conditions & disease & pains
High blood pressure
Hysterectomies (at young age)
Immune system
Infertility
Irritable Bowel Syndrome
Kidney damage or disease
Laryngitis (Chronic)
Liver disease

Low potassium blood levels
Lupus
Menstrual problems (heavy bleeding, clots, and frequent periods)
Miscarriages
Muscle cramps
Night sweats
Nosebleeds
Numbness of feet, legs, hands, fingers, shoulder, and back
Phlebitis
Poor appetite
Prostate infection
Rash
Respiratory and breathing problems (including cough, wheezing, phlegm, and shortness of breath)
Sickle Cell Anemia
Sinus infections and sinus problems
Skin darkening/lightening
Sleeplessness (insomnia), sleep apnea and sleep disorders
Sore throat
Stomach bloating
Stress-related problems/anxiety/worry/mental anguish/depression/nervousness
Swelling ankles, hands, feet, wrists, and fingers
Thyroid problems
Toxemia
Vision problems (blurry, pain, redness, running & surgery)
Weight loss

Appendix D - Evaluation of the Health Threat from Individual Chemicals and Chemical Mixtures

The Manatee CHD requested the Florida DOH to evaluate the possibility of harmful effects when people are exposed to contaminated water through private drinking water wells. This evaluation examines the possibility of health affects from chemicals both individually and as a mixture. The evaluation of individual chemicals serves as a first step for evaluating a chemical mixture. Information about individual chemicals in this report comes from ATSDR's toxicological profile, which are a series of publications by ATSDR about individual chemicals.

First, this section will explain the general principles and terms used to evaluate individual chemicals, followed by a brief description of the process ATSDR has developed for evaluating a chemical mixture.

How to Evaluate Exposure to a Single Chemical

Several risk assessment methods are available for evaluating exposure to individual chemicals in the environment. To evaluate the risk of non-cancerous effects, three major steps are required: 1) estimating a person's exposure to a chemical, which is called a dose, 2) comparing the estimated dose to a health guideline established by a health or environmental agency, and 3) if the health guideline is exceeded or if a health guideline does not exist, comparing the estimated dose to doses from human or animal studies that have or have not shown harmful effects. The goal for these steps is not only to decide if a health guideline has been exceeded, but also to decide what harmful effects might be possible.

How to Evaluate Exposure to Multiple Chemicals

Because people are often exposed to several chemicals at the same time, health scientists are often asked to evaluate exposure to a mixture of chemicals. ATSDR recently developed guidance for evaluating chemical mixtures: the "Guidance Manual for the Assessment of Joint Toxic Action of Chemical Mixtures" (ATSDR 2004). ATSDR's mixtures guidance manual describes ATSDR's method to screen chemical mixtures initially for non-cancerous and for cancerous effects.

For non-cancerous effects, the guidance manual requires the health scientist to estimate an oral or an inhalation HQ for each chemical. The oral HQ for each chemical is then used to determine the oral Hazard Index (HI) for the mixture of chemicals. In the same manner, the inhalation HQ for each chemical is used to determine the inhalation Hazard Index (HI) for the mixture of chemicals. This step is used as a screening technique to indicate whether further evaluation is needed. Additional work would be needed to understand completely the interaction of the chemicals. Like the individual HQs, the oral and inhalation HI for the mixture is a number that provides insight into potential toxicity of the mixture. Specifically, the oral HI for a mixture is the sum of the oral HQ for each chemical in the mixture. Similarly, the inhalation HI for a mixture is the sum of the inhalation HQ for each chemical in the mixture. The formula for determining the HI for a mixture containing three chemicals follows:

Oral HI $_{mixture}$ = oral HQ $_{chemical\ one}$ + oral HQ $_{chemical\ two}$ + oral HQ $_{chemical\ three,}$ or

Inhalation HI$_{mixture}$ = inhalation HQ $_{chemical\ one}$+ inhalation HQ $_{chemical\ two}$+ inhalation HQ $_{chemical\ three}$

Whenever an HI for a mixture of chemicals exceeds 1, a concern for possible harmful effects might exist. Thus, the health scientist needs to use methods beyond the initial screening method to make that decision. Because the HQs are based on different health endpoints (e.g., a kidney endpoint for chemical one, a neurological endpoint for chemical two), the health scientist can also conduct additional evaluations by looking at organ specific endpoints when the HI exceeds 1, using scientific and medical judgment to determine the potential for harmful effects.

Depending on the oral or inhalation HI for the mixture, the health scientist might also have to conduct binary weight of evidence (BINWOE) analysis. A BINWOE analysis uses three parts to determine:

- how two chemicals in a mixture might interact together by reviewing mechanistic information available for the chemicals,
- the toxicological significance of two chemicals interaction, and
- if any information is available that might be used to modify their actions.

The results of the BINWOE analysis provide qualitative information that helps the health scientist interpret the HI score more accurately.

An important part of a BINWOE analysis is to predict whether any combination of two chemicals in the mixture might act in an additive, greater than additive, or less than additive manner. For instance, if two chemicals in the mixture act in an additive manner, the health scientist would expect that the dose of each chemical has an equal weight in its ability to cause harmful effects. Mathematically, the additive nature of chemical interactions is often presented as 2 + 3 = 5. If two chemicals act in an additive manner, their individual HQs can be added when evaluating the two chemicals as a mixture.

Sometimes a mixture of chemicals might act in a greater than additive manner, which is referred to as a synergistic effect or synergism. When two chemicals are acting synergistically, one chemical is enhancing the effect of the other chemical. Mathematically, a chemical mixture with a synergistic effect is often presented as 2 + 3 = 8 (or 6 or 12, depending upon how strong the synergistic effect between the two chemicals might be.) If a mixture contains two chemicals that interact synergistically, the health scientist knows that the HI for those two chemicals is greater than simply adding the individual HQs for each chemical.

A chemical mixture that acts in a less-than-additive manner is referred to as an antagonistic effect. In this case, one of the chemicals is reducing the effect of the other chemical. Stated another way, one chemical is protecting against the effect of another chemical. An antagonistic effect might be presented mathematically as 2 + 3 = 4. If a mixture contains two chemicals that interact in an antagonistic manner, the health scientist knows that the HI for those two chemicals is less than simply adding the individual HQs for each chemical. Other types of chemical reactions in a mixture are possible, and these are described in more detail in ATSDR's guidance manual for chemical mixtures. However, the three types of reactions described here (additivity, synergism, and antagonism) are the primary types. The BINWOE analysis provides the health scientist with more information about how the chemicals in the mixture might interact. This additional insight helps the health scientist to decide if harmful effects might be possible.

Appendix E - Risk of Illness, Dose Response/Threshold and Uncertainty

RISK OF ILLNESS, DOSE RESPONSE/THRESHOLD, AND UNCERTAINTY IN PUBLIC HEALTH ASSESSMENTS

Risk of Illness

In this public health assessment, the risk of illness is the chance that exposure to a hazardous contaminant is associated with a harmful health effect or illness. The risk of illness is not a measure of cause and effect-only an in-depth health study can identify a cause and effect relationship. Instead, Florida DOH uses the risk of illness to decide if the site needs a follow-up health study and to identify possible associations.

The greater the exposure to a hazardous contaminant (dose), the greater the risk of illness. The amount of a substance required to harm a person's health (toxicity) also determines the risk of illness. Exposure to a hazardous contaminant above a minimum level increases everyone's risk of illness. Only in unusual circumstances, however, do many persons become ill.

Information from human studies provides the strongest evidence that exposure to a hazardous contaminant is related to a particular illness. Some of this evidence comes from doctors reporting an unusual incidence of a specific illness in exposed individuals. More formal studies compare illnesses in people with different levels of exposure. Nevertheless, human information is very limited for most hazardous contaminants, and scientists must frequently depend upon data from animal studies. Hazardous contaminants associated with harmful health effects in humans are often associated with harmful health effects in other animal species. There are limits, however, to relying only on animal studies. For example, scientists have found some hazardous contaminants are associated with cancer in animals, but lack evidence of a similar association in humans. In addition, humans and animals have differing abilities to protect themselves against low levels of contaminants, and most animal studies test only the possible health effects of high exposure levels. Consequently, the possible effects on humans of low-level exposure to hazardous contaminants are uncertain when information comes solely from animal experiments.

Dose Response/Thresholds

The focus of toxicological studies in humans or animals is identification of the relationship between exposure to different doses of a specific contaminant and the chance of having a health effect from each exposure level. This dose-response relationship provides a mathematical formula or graph used to estimate a person's risk of illness. The actual shape of the dose-response curve requires scientific knowledge of how a hazardous substance affects different cells in the human body. There is one important difference between the dose-response curves used to estimate the risk of non-cancer illnesses and those used to estimate the risk of cancer: the existence of a threshold dose. A threshold dose is the highest exposure dose at which there is no risk of illness. The dose-response curves for non-cancer illnesses include a threshold dose that is greater than zero. Scientists include a threshold dose in these models because the human body can adjust to varying amounts of cell damage without illness. The threshold dose differs for different contaminants and different exposure routes. It is estimated from information gathered in human and animal studies. By contrast, the dose-response curves used to estimate the risk of cancer assume no threshold dose (or, in other words, the cancer threshold dose is zero). This assumes a single contaminant molecule could be sufficient to cause a clinical case of cancer.

Such an assumption is very conservative; indeed, many scientists also believe a threshold dose greater than zero exists for the development of cancer.

Uncertainty

All risk assessments, to varying degrees, require the use of assumptions, judgments, and incomplete data. These contribute to the uncertainty of the final risk estimates. Some more important sources of uncertainty in this public health assessment include environmental sampling and analysis, exposure parameter estimates, use of modeled data, and present toxicological knowledge. These uncertainties can cause risk to be overestimated or underestimated. Because of the uncertainties described below, this public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the former American Beryllium site.

Environmental chemistry analysis errors can arise from random errors in the sampling and analytical processes, resulting in either an over- or underestimation of risk. Increasing the number of samples collected/analyzed and sampling the same locations over several different periods can control these errors to some extent. These actions tend to minimize any uncertainty caused by random sampling errors.

Two areas of uncertainty affect exposure parameter estimates. The first is the exposure-point concentration estimate. The second is the estimate of the total chemical exposures. In this assessment maximum detected concentrations were used as the exposure point concentration. Using the maximum measured value is considered appropriate because one cannot be certain of the peak contaminant concentrations, and cannot statistically predict peak values. Nevertheless, this assumption introduces uncertainty into the risk assessment that could over or underestimate the actual risk of illness. When selecting parameter values to estimate exposure dose, default assumptions and values within the ranges recommended by the ATSDR or the EPA were used. These default assumptions and values are conservative (health protective) and can contribute to the overestimation of risk of illness. Similarly, the maximum exposure period was assumed to have occurred regularly for each selected pathway. Both assumptions are likely to contribute to the overestimation of risk of illness.

There are also data gaps and uncertainties in the design, extrapolation, and interpretation of toxicological experimental studies. Data gaps contribute uncertainty because information is either not available or is addressed qualitatively. Moreover, the available information on the interaction among chemicals found at the site, when present, is qualitative; that is, a description instead of a number-a mathematical formula cannot be applied to estimate the dose. These data gaps can tend to underestimate the actual risk of illness. In addition, there are great uncertainties in extrapolating from high to low doses, and from animal to human populations. Extrapolating from animals to humans is uncertain because of the differences in the uptake, metabolism, distribution, and body organ susceptibility between different species. Human populations are also variable because of differences in genetic makeup, diet, home and occupational environment, activity patterns, and other factors. These uncertainties can result in an over or underestimation of risk of illness. Finally, there are great uncertainties in extrapolating from high doses to low doses, and controversy in interpreting these results. Because the models used to estimate dose-response relationships in experimental studies are conservative, they tend to overestimate the risk. Techniques used to derive acceptable exposure levels account for such variables by using safety factors. Currently, there is much debate in the scientific community about the extent to which the actual risks are overestimated and what the resultant risk estimates really mean.

Appendix F: Response to Community Leaders and Responsible Party Comments

In April 2007, the Florida Department of Health (DOH) solicited public comment on the draft public health assessment from Tallevast community leaders and the responsible party. At the request of Tallevast community leaders, Florida DOH limited its initial call for public comment to these two groups. In June, the responsible party and a consultant for Tallevast community leaders submitted written comments.

At the request of Tallevast community leaders, Florida DOH attended a July 10, 2007 meeting of Tallevast community leaders, their consultant, their attorneys, elected officials, other agency officials, and the media. At this meeting, the consultant for Tallevast community leaders repeated their written comments. After this meeting, Florida DOH received additional written comments from the consultant for Tallevast community leaders. In August, Florida DOH also received written comments from an independent scientist. In September, Florida DOH received one comment from a newspaper reporter. The following summarizes these 18 comments and response by Florida DOH and the Agency for Toxic Substances and Disease Registry (ATSDR). Where appropriate, the Florida DOH/ATSDR has modified this report to address these comments.

Comment #1: To insure that all Tallevast residents don't mistakenly think the worst case scenario applies to them, one commenter suggested incorporating and highlighting the following language at the beginning of the report:

> "This report assesses the public health threat from exposure to contaminated soil, ground water, and surface water on and around the former American Beryllium facility in Tallevast, Florida. Because of uncertainties, it does not represent an absolute estimate of risk. The assumptions, interpretations, and recommendations made throughout this public health assessment, however, tend to err on the side of protecting public health and may overestimate the risk."

Response: We expanded the Statement of Issues section at the beginning of the report to emphasize uncertainties inherent in public health assessments and the focus on the maximum possible health risk.

Comment #2: For each exposure scenario, one commenter suggested including the Risk Assistant dose calculation reports in an appendix.

Response: The Risk Assistant model outputs are too long to include in the report but are available upon request. Because some of the original printouts could not be located, we reran all of the Risk Assistant models. This resulted in slightly different numbers for some of the model outputs.

Comment #3: One commenter suggested collecting all of the theoretical excess cancer risks in one table and all of the non-cancer risks in another table. The commenter also suggested expressing all of the theoretical cancer risk per 100,000 population.

Response: We added Tables 13 and 14 to the report summarizing the cancer and non-cancer health risk for each of the chemicals of concern. We have modified the report to use a consistent population size (100,000) to facilitate comparison of theoretical cancer risks.

Comment #4: One commenter suggested including a quantitative estimate of the theoretical excess cancer risk with each qualitative estimate.

Response: We added a quantitative estimate along with each qualitative estimate of the theoretical cancer risk.

Comment #5: One commenter suggested including more information about the how data from the Florida Cancer Data System were utilized.

Response: We added more information in section 3.5 Health Outcome Data, regarding review of the Florida Cancer Data System.

Comment #6: One commenter suggested including the cancer slope factor (q*) used for each theoretical excess cancer risk calculation.

Response: We added cancer slope factors to the report.

Comment #7: One commenter suggested that since Tallevast residents were consuming water with concentrations of chemical above the drinking water Maximum Contaminant Level, it was a "public health hazard."

Response: Based on contaminant concentrations, contaminant toxicity, and the likely length of exposure; we changed the description of the public health hazard to more accurately describe the overall risk.

Comment #8: One commenter suggested using a descriptor other than "not insignificant" to describe very low risks.

Response: We replaced "not significant" with "extremely small" to describe increased theoretical cancer risk of one-in-a-million or less.

Comment #9: One commenter suggested the report clarify the difference between theoretical approximations of the cancer risk based on conservative assumptions and actual number of cancer cases.

Response: We clarified the distinction between theoretical cancer risk and the actual number of cancer cases.

Comment #10: One commenter estimated it would have taken at least five years for contaminated ground water to travel from the site to the nearest private drinking water well. The commenter suggested using 1967 as the beginning of the exposure period for drinking contaminated ground water.

Response: Since the length of time Tallevast residents were exposed to contaminated ground water is not precisely known, we use the longest period to avoid underestimating the risk. In the absence of modeled, site-specific ground water travel times, we continue to estimate some Tallevast residents could have been exposed between 20 and 42 years. Reducing the estimated exposure period by five years would not affect the report conclusions or recommendations.

Comment #11: One commenter suggested using probabilistic risk modeling for exposure scenarios with identified theoretical excess risk values.

Response: Florida DOH/ATSDR public health assessments typically use conservative exposure assumptions and toxicological values with incorporated uncertainty (safety) factors. This approach provides assurance these evaluations are protective of public health, including sensitive subpopulations. Although probabilistic risk assessments may give a better estimate of the uncertainty surrounding a risk, they are beyond the purview of FL DOH/ATSDR public health assessment program.

Comment #12: One commenter suggested clarifying that not all Tallevast residents were exposed to the highest contaminant levels and therefore the same level of public health threat would not have existed across the entire Tallevast community.

Response: We clarified that the estimated cancer risk applies only to the most contaminated wells and not universally across the entire community.

Comment #13: One commenter suggested estimating the risk for each chemical for all three routes of exposure combined: ingestion, inhalation, and dermal.

Response: We added an evaluation of the health risk from exposure to individual chemicals from all three routes of exposure combined (ingestion, inhalation, and dermal). For Tallevast residents, we estimated a total dose from exposure to each volatile organic chemical in private drinking water wells by combining ingestion (drinking), inhalation (breathing vapors), and dermal (skin) absorption doses (Table 4). We then compared the combined dose to doses from ingestion studies.

Comment #14: Two commenters suggested estimating the theoretical health risk from exposure to multiple chemicals.

Response: In this report, we used the most recent ATSDR guidance for evaluating possible health effects from exposure to a mixture of chemicals (www.atsdr.cdc.gov/interactionprofiles/ipga.html). Additional research to advance the toxicology of chemical mixtures is beyond the purview of the FL DOH/ATSDR public health assessment program.

Comment #15: One commenter asserted this report failed to assess exposure to

a. contaminants in the air and soil vapor exposures

b. historical exposure to beryllium ladened dust on-site

c. historical exposure to solvents in the workplace

d. historical off-site exposure to beryllium contaminated dust via air and workers' clothes

e. ongoing exposure to household and attic dust

Response:

a. We evaluated indoor air quality and soil vapor in two previous reports (ATSDR 2005a, DOH 2007).

b. Florida DOH/ATSDR tested former workers for beryllium sensitivity. Florida DOH/ATSDR detailed the results of these tests in two previous reports (ATSDR 2005b, ATSDR 2006a). Five former workers or household members were positive for beryllium sensitivity and were referred to a lung specialist.

c. This draft report did not assess historical exposures of former workers to solvents in the work place. Worker health and safety is the responsibility of the federal Occupational Safety and Health Administration (OSHA). Florida DOH/ATSDR assessments focus on health risk to nearby residents, not workers. In the case of American Beryllium, we had enough information to estimate exposures to former workers to solvents dissolved in the drinking water and the risk of illness. We didn't, however, have enough information to assess the risk to former workers from direct inhalation of vapors or from skin contact with pure solvents used in the work place.

d. Florida DOH/ATSDR tested nearby residents and household members of former workers for beryllium sensitivity. The results of these tests were detailed in two previous reports (ATSDR 2005b, ATSDR 2006a). This testing assumed nearby residents were exposed to beryllium dust in the air from American Beryllium. It also assumed that former workers carried beryllium dust home on their clothes and exposed household members. The only Tallevast residents who were positive for beryllium sensitivity were either former workers or household members of former workers.

e. Florida DOH/ATSDR tested nearby residents for beryllium sensitivity. Beryllium sensitivity testing is more accurate in assessing the risk from beryllium exposures than estimating the risk based on levels of beryllium dust. It is not possible to accurately assess health risk from dust samples. Beryllium sensitivity testing, on the other hand, identifies at-risk individuals for further testing and/or treatment.

Comment #16: Two commenters suggested considering ground water data collected since 2005.

Response: We added ground water test data from the April 2006 Site Assessment Report, Addendum 3 (BBL 2006) and the May 2007 Remedial Action Plan (Arcadis 2007).

For on-site ground water, the highest concentrations of contaminants of concern reported in these two documents were slightly higher than those reported prior to 2005. Therefore, we updated Tables 1 and 2 to reflect the highest concentrations measured in on-site ground water through early 2007.

For off-site ground water, the highest concentrations of three of seven contaminants of concern reported in these two documents (*cis*-1,2-dichloroethylene, 1,4-dioxane, and tetrachloroethylene) were slightly higher than those reported prior to 2005. Likewise, we updated Tables 3 and 4 to reflect the highest concentrations measured in off-site ground water through early 2007.

Comment #17: One commenter suggested evaluating the health risk for individuals who were both former workers and nearby residents.

Response: Florida DOH/ATSDR assessments focus on health risk to nearby residents, not workers. Worker health and safety is the responsibility of the federal Occupational Safety and Health Administration.

Comment #18: One commenter recommended additional health studies using the most recent ground water data, appropriate receptors, household/attic dust test results, and new information about the toxicity of TCE.

Response: Florida DOH/ATSDR incorporated recent ground water data into this report. Florida DOH/ATSDR has also incorporated recent information about the toxicity of TCE in this report. When Florida DOH/ATSDR explore possible follow-up health studies, they will consider other factors.

Appendix G: Response to Public Comments

Between February 28 and May 30, 2008, the Florida Department of Health (DOH) solicited public comment on its draft public health assessment report. At the request of Tallevast community leaders, Florida DOH attended a March 24, 2008 meeting of Tallevast community leaders, their consultant, elected officials, and the media. After this meeting, Florida DOH received written comments from community members, the consultant for Tallevast community leaders, a Georgia community leader, and the responsible party. The following summarizes these 27 comments and responses by Florida DOH. Where appropriate, the Florida DOH modified this report to address these comments.

Comment #1: Two commenters assert there is a high incidence of deaths, cancer, and other illnesses in the Tallevast community caused by living near the former American Beryllium site.

Response: During the public comment period, community members raised questions about the reliability of the health outcome data. In response to these concerns, Florida DOH epidemiologists will reexamine cancer data from the Florida Cancer Data System including the 34270 ZIP code. They will report on their findings separately from this public health assessment report.

In section 5.0 Community Health Concerns of this report, Florida DOH explores the association between exposure to contaminants from American Beryllium and 57 different community health concerns.

As recommended in this public health assessment report, Florida DOH epidemiologists are discussing with community leaders the possibility of additional health investigations.

Comment #2: Two commenters recommended the report define the geographical extent of the Tallevast community.

Response: Florida DOH added the following definition of the Tallevast community under Section 2.2 Site Description: 16th Street East, 16th Street Court East, 17th Street East, 17th Street Court East, 17th Court Street East, 18th Street East, 18th Street Court East, 19th Street East, 76th Avenue East, and Tallevast Road between 16th Street East and 19th Street East.

Comment #3: One commenter asserted the demographic data presented in Section 2.2.1 are incorrect.

Response: Florida DOH estimated the demographic data in Section 2.2.1 using US census data for 2000. The US census maps, however, may not have coincided exactly with the definition of the Tallevast community as defined in response to comment #2, above. Florida DOH modified the demographics section of the final report to describe more accurately the Tallevast community.

Comment #4: Two commenters asserted the ZIP code for the Tallevast Post office--34270--is not representative of the Tallevast community.

Response: Florida DOH epidemiologists review data from state disease registries such as the Florida Cancer Data System (FCDS). These registries record cases by mailing address at the time of diagnosis or death. Tallevast residents have used the 34270 ZIP code for their mailing address for many years. Florida DOH is aware that this ZIP code is for a PO Box and not a physical address. In addition, individuals living outside of the Tallevast area may have used the 34270 ZIP code. The inability to identify accurately residents' location in existing state databases limits the states' ability to count accurately the number of cancer cases or deaths that occurred among Tallevast residents. This is one factor leading the state to support an independent health study including personal interviews and the ability to link cases to a physical address. This will also help Florida DOH assess the accuracy of the FCDS data for the Tallevast community.

Comment #5: One commenter questioned whether the four non-Hispanic white male cancer cases reported in the Florida Cancer Data System for Tallevast are Tallevast residents.

Response: As discussed in response to Comment #4 above, state databases contain address provided by the respondent. In general, if PO Boxes are provided as addresses, the state cannot assign a geographic location. Previous cases among non-Hispanic whites were identified based on a ZIP code or PO ZIP code that included Tallevast residents. Individuals living outside of Tallevast may have also used this PO ZIP code.

Comment # 6: One commenter questioned the inclusion of data from Lockheed Martin, its quality, and the exclusion of data from Michael Graves.

Response: Florida DOH considers all available environmental data when assessing the public health threat at hazardous waste sites. For this public health assessment, they considered data from the Florida Department of Environmental Protection, consultants for Manatee County, consultants for Lockheed Martin, and consultants for FOCUS including the December 2005 report by Michael Graves of Environmental Sciences & Technologies. Once it became available, Florida DOH added to the final report the November 15, 2007 letter by Michael Graves of Environmental Sciences & Technologies.

As stated in Section 3.1.3 Quality Assurance and Quality Control, page 10:

> "This PHA uses existing environmental data. Florida DOH assumes these data are valid because government consultants or consultants overseen by government agencies collected and analyzed the environmental samples. Florida DOH also assumes that consultants who collected and analyzed these samples followed adequate quality assurance and quality control measures concerning chain-of-custody, laboratory procedures, and data reporting."

Comment # 7: One commenter suggested the report use the most recent risk assessment theory.

Response: Florida DOH prepared this public health assessment report using the most recent ATSDR guidelines (ATSDR 2005c). Florida DOH relied on toxicological data contained in the most recent ATSDR toxicological profiles. For trichloroethylene (TCE), Florida DOH also relied on EPA's most recent trichloroethylene health risk assessment (EPA 2001).

Comment # 8: One commenter asserted there are inaccuracies in the definition of health conditions and issues.

Response: In Section 5.0 Community Health Concerns, Florida DOH compiled background information on health conditions and issues from the 2003 Complete Medical Encyclopedia of the American Medical Association, the National Institute of Alcohol Abuse and Alcoholism, and the 2003 Merck Manual of Medical Information.

Comment # 9: One commenter suggested that any follow-up health study or epidemiology work be completed before finalizing this report.

Response: The state is in the process of evaluating available state level databases to assess cancer incidence and death in the Tallevast area. Florida DOH epidemiologists have identified a number of limitations, however. First is the difficulty in assessing in and out migration of residents. Individuals who have moved out of the Tallevast community are not captured as residents. Likewise, newly arrived individuals are counted even though they may have spent years in other communities. The only study design that is able to address in and out migration issues involves personal interviews. Second, interviews would be necessary to determine a physical address/location for the majority of Tallevast cases in state records that only list a PO Box. Third, cancer cases treated and diagnosed solely in Veteran's Administration Hospitals may not be recorded in FCDS. These cases would only be learned of through personal interview. For these and other methodological reasons, Florida DOH supports an independent health study including personal interviews of residents. This study will take a number of months to plan, gather information, interview residents, and verify/analyze the data. The state prefers not to delay this public health assessment but will make future health study reports available to the community and other stakeholders.

Comment # 10: One commenter asserted that the figures in Appendix A are unclear and lack legends.

Response: For most of the maps in Appendix A, Florida DOH photo reduced 11” X 17” originals to fit the 8.5” X 11” public health assessment report format. Some of the details on these photo-reduced maps are hard to read. Florida DOH will make available copies of the final report containing 11” X 17” maps. These maps do include the original legends.

Comment # 11: One commenter suggested adding chloroethane and carbon disulfide to the list of contaminants of concern.

Response: As described in Section 3.1 Environmental Contamination, page 7, Florida DOH used screening guidelines to select contaminants of concern. The highest concentration of chloroethane found in Tallevast groundwater (6 ug/L) is less than its screening guideline (12 ug/L), is unlikely to cause illness, and thus not selected as a contaminant of concern. Likewise, the highest concentration of carbon disulfide found in Tallevast ground water (24 ug/L) is less than its screening guideline (1,000 ug/L), is unlikely to cause illness, and thus not selected as a contaminant of concern.

Comment # 12: Two commenters recommended correcting the year municipal water became available in Tallevast, clarifying the number of houses/people still using private drinking water wells in May 2004, and using all of the available ground water quality data (specifically a November 15, 2007 letter by Michael Graves).

Response: Florida DOH modified the final report to clarify when Manatee County extended municipal water lines in the Tallevast community. Florida DOH modified the final report to clarify that before 1984/1985 all Tallevast residents relied on private wells for their drinking water supply. Florida DOH modified the final report to clarify which streets the County did not extend municipal water lines to and deleted the reference to the number of people. Florida DOH modified the final report to include data from the November 15, 2007 Environmental Sciences & Technologies, Inc letter prepared by Michael Graves. Mr. Graves found only one ground water contaminant at a higher concentration than previously measured in an off-site well: *trans*-1,2-dichloroethylene @ 10 ug/L. FL DOH included these new data in Table 3.

Comment # 13: One commenter asserted the draft public health assessment report is in error in by stating the Florida aquifer "does not appear to be contaminated."

Response: Florida DOH removed this statement from the final report.

Comment # 14: One commenter reports that in the past Tallevast residents ate fish from the pond on the former American Beryllium site. The commenter also reports children swam in this pond. The commenter reports that children still play in the pond when the gate is left open.

Response: Florida DOH modified the final report to clarify that a well-maintained fence currently secures the site. Florida DOH also modified the final report to include reports by community leaders that in the past, Tallevast residents swam in, and ate fish from, the on-site pond. Florida DOH also modified the final report to include reports by community leaders that children still access the on-site pond when the gate is left open.

Comment # 15: One commenter asserted that volatile organic chemical (VOC) vapors from the contaminated ground water could be migrating through buried PVC water supply lines.

Response: While it is possible for VOCs to migrate through PVC pipes, the health threat to the municipal water supply in Tallevast is remote for three reasons. First, municipal water is under pressure that tends to push water out of any leaks and prevent migration of contaminants into the water lines. Second, if any contaminants did migrate into the water lines, they would likely be diluted to below detection limits by the relatively large volume/flow of water in the water lines. Third, water lines in Tallevast are buried a few feet down and not in the contaminated ground water. Soil gas tests have identified only very low concentrations of VOCs.

Comment # 16: One commenter suggested clarifying the degree of uncertainty in the risk estimates.

Response: Uncertainty is inherent in hazardous waste site public health assessments. When faced with uncertainties (such as exposure concentration or length of exposure), Florida DOH errs on the side of public health by choosing values that may overestimate the risk. Because of these choices, the public health assessment tends to overestimate the risk, but the magnitude is unknown.

Comment # 17: One commenter asserted that wells being used for irrigation in 2004 were once drinking water wells.

Response: Florida DOH modified the text on page 12 of the final report to clarify that the private well that had 6,000 ug/L trichloroethylene in 2004, was likely a drinking water well before 1984/1985.

Comment # 18: One commenter asserted that nearby residents could have been drinking contaminated ground water for 25 rather than 18 years.

Response: In section 3.3.1.2 On-Site Groundwater, FL DOH/ATSDR estimated that former American Beryllium workers could have been drinking contaminated ground water for 18 years. In section 3.3.1.6 Off-Site Groundwater, Florida DOH/ATSDR estimated that residents who did not get municipal water until 2004 could have been drinking contaminated for 42 years (1962-2004).

Comment # 19: One commenter suggested that the highest trichloroethylene (TCE) concentration former workers were exposed to was higher than 13,000 ug/L.

Response: 13,000 ug/L was the highest concentration of TCE measured in an on-site monitor well. Although the concentrations of TCE in on-site ground water may have been higher in the past, FL DOH used the highest measured concentration to estimate the risk for former workers. The well referred to on page 15, first paragraph under 3.3.1.2 On-Site Groundwater, is a drinking water well FL DOH assumes existed on-site before 1985. Although this well has not been located, FL DOH assumes one existed since municipal water was not available for workers before 1984/1985.

Comment # 20: One commenter asserted that in addition to a sump leak, ground water contamination could have resulted from disposal of waste solvent directly to the ground and to retention ponds and ditches.

Response: FL DOH modified the final report to clarify that the source of ground water contamination was not limited to the sump leak.

Comment # 21: One commenter asserted the Florida Cancer Data System is not an accurate list of cancer cases in Tallevast.

Response: The Florida Cancer Data System (FCDS) is a nationally recognized registry receiving accolades and accreditations for completeness and accuracy. Florida DOH uses FCDS to examine cancer trends in large populations over time. No registry is 100% complete, however. Cases prior to the registry's start in 1981, cases seen only in a Veterans Administration hospital, and cases that did not seek medical care or were never diagnosed may be missing. Because FCDS does not include residence history, former Tallevast residents who move out of the area would be missed. Because most Tallevast residents used the PO Box for their address, a search of FCDS includes other cases living outside the area who also used this PO Box. For these and other methodological reasons, Florida DOH supports an independent health study including personal interviews that would likely capture more cancer cases.

Comment # 22: One commenter asserted that although the small population may make it difficult to determine the cancer rates in Tallevast, it is possible.

Response: The small population size of Tallevast is a methodological and statistical challenge. Florida DOH will address these challenges in its evaluation of available state databases. Florida DOH supports an independent health study including personal interviews of residents to gather more complete data than available in existing registries.

Comment # 23: One commenter suggested adding a simple explanation that exposure to multiple chemicals may increase the health risk.

Response: FL DOH used the most recent ATSDR guidance for evaluating possible health effects from exposure to a mixture of chemicals (www.atsdr.cdc.gov/interactionprofiles/ipga.html). Although some of the chemicals may act in an additive effect, too little is known to quantify the public health risk.

Comment # 24: One commenter asserted that based on the Florida DOH review of the Florida Cancer Data System, the incidence rates for cancers in the Tallevast community are not known.

Response: As highlighted in the response to Comment #22 above, a review of both Florida Cancer Data System and vital statistics will provide information on cancer cases in this community but will not be the most accurate picture of cancer incidence over time. For this and other methodological reasons, Florida DOH supports an independent health study including personal interviews that would likely capture more cancer cases.

Comment # 25: One commenter requested review of recent ambient air monitoring data.

Response: Once they become available, Florida DOH/ATSDR will evaluate recent air sampling data and report their findings in a separate document.

Comment # 26: One commenter requested that the report be clear that the lack of toxicity data for a chemical not be misinterpreted as not toxic.

Response: The report identifies contaminants with insufficient information from which to estimate the health risk. The report also points out too little is known to quantify the public health risk from exposure to multiple chemicals.

Comment # 27: One commenter suggested evaluating the health risk to individuals who are both nearby residents and former workers.

Response: Florida DOH assessments focus on health risk to nearby residents, not workers. Worker health and safety is the responsibility of the federal Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health.

Appendix H

Glossary of Environmental Health Terms

Absorption: How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure: Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

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.

Biota: Used in public health, things that humans would eat B including animals, fish and plants.

Cancer: A group of diseases that 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.

CERCLA: See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

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 are 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.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): **CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

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**).

Dose: The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day”.

Dose / Response: The relationship between the amount of exposure (dose) and the change in body function or health that result.

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 chemicals 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**.

U.S. Environmental Protection Agency (EPA): The federal agency that develops and enforces environmental laws to protect the environment and the public’s health.

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:

- Source of Contamination,
- Environmental Media and Transport Mechanism,
- Point of Exposure,
- Route of Exposure, and
- 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**).

LOAEL: **L**owest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

MRL: **M**inimal **R**isk **L**evel. An estimate of daily human exposure B by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL: The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious, uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL: **N**o **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

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: **P**ublic **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 undergroundwater 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.

PRP: **P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

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.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are 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

Receptor Population: People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, lifetime exposure of human populations to a possible hazard that is <u>not</u> 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).

Safety Factor: Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is <u>not</u> likely to cause harm to people.

SARA: The **S**uperfund **A**mendments and **R**eauthorization **A**ct in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from chemical exposures at hazardous waste sites.

Sample Size: The number of people that are needed for a health study.

Sample: A small number of people chosen from a larger population (See **Population**).

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**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Superfund Site: See **NPL**.

Survey: A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.

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.

CERTIFICATION

This American Beryllium Public Health Assessment was prepared by the Florida Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health assessment was begun. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.

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