Health Consultation

REVIEW OF GROUNDWATER DATA
(2005 EPA DELINEATION INVESTIGATION)

SIGMON'S SEPTIC TANK SERVICE SITE

STATESVILLE, IREDELL COUNTY, NORTH CAROLINA

REGION IV

EPA FACILITY ID: NCD062555792

OCTOBER 12, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation 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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Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
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Background and Statement of Issues

On June 23, 2005, the Agency for Toxic Substances and Disease Registry (ATSDR) received additional sampling and analysis data of the groundwater medium at the Sigmon Septic Tank Service Site, a hazardous waste site under investigation by the U. S. Environmental Protection Agency (EPA), Region IV Office, Atlanta, Georgia (John A. Blanchard, Black & Veatch Special Projects Corporation, EPA Contractor, e-mail of June 2005 copied David S. Sutton, Division of Health Assessment and Consultation, ATSDR.). The additional data were collected as part of a delineation investigation conducted at the site during the week of April 18, 2005. The investigation was a follow-up action by EPA to its initial delineation investigation (October 2002–April 2004) of the site to reassess lead and nitrate levels in nearby private wells. None of the wells showed lead concentrations at levels of health concern during the 2005 investigation. Moreover, EPA has placed the Sigmon Septic Tank Site on its National's Priority List (NPL), thus the need for cleaning up the site is a priority (70 FR 21644; April 27, 2005). Hazardous waste sites placed on the NPL must follow the procedural guidelines for cleanup as described and documented under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Superfund Amendments and Reauthorization Act of 1986 (SARA).

ATSDR reviewed the additional data and assessed whether exposures to substances detected in the groundwater pose any potential impacts to the health of nearby private well users. The review served as a follow-up to an earlier request from ATSDR's Division of Regional Operations (DRO), Region IV Office, Atlanta, Georgia. DRO requested ATSDR to determine the potential public health impacts that the Sigmon Septic Tank Service Site—a former septic tank service and waste removal business—would have on nearby private well users. (Benjamin Moore, Division of Regional Operations, ATSDR, Region 4, e-mail of October 2004 to Susan Moore, Division of Health Assessment and Consultation, ATSDR.). The request actually originated from the United States Environmental Protection Agency (EPA), Region IV Office, Atlanta, Georgia. EPA initially sent analytical results of groundwater samples to ATSDR's DRO Region IV Office for public health review and evaluation (Warren Dixon, EPA, Region 4, e-mail of October 2004 to Benjamin Moore, ATSDR, Division of Regional Operations). These earlier groundwater samples were also collected from the site as a part of the delineation investigations conducted in October 2002 and April 2004. ATSDR completed its assessment for the earlier request and released its findings in a public health consultation (PHC) (ATSDR 2006).

Sigmon Septic Tank Service Site (CERCLIS No. NCD062555792) is located at 1268 Eufola Road, approximately 5 miles southwest of Statesville, Iredell County, North Carolina (NCDENR 1998, 2000; Black & Veatch 2004). This site has been listed under several names, including Sigmon's Septic Tank Service, AAA Enterprises, and Sigmon Environmental Services. Services provided by the business have included the pumping and removal of septic tank wastes and heavy sludges for residential, commercial, and industrial customers, installation and repair of septic tanks, and other waste removal services to various industries.

Both federal and state environmental regulatory agencies have for several years investigated the groundwater pathway at the site (NCDENR 1998, 2000; Black & Veatch 2004). The earliest that the site groundwater was sampled began in 1987, at which time water samples were collected from on-site monitoring wells. Starting in 1991, water samples were collected from nearby private wells.

ATSDR released a PHC for the site on March 29, 2002, assessing the site's groundwater pathway. ATSDR determined that the groundwater pathway appeared to be of concern because two private wells showed nitrate levels greater than 10,000 parts per billion (ppb) (ATSDR 2002a). Infants (0–6 months) who consume formula prepared with water containing nitrate levels greater than 10,000 ppb have an increased risk of higher methemoglobin levels (EPA 1990; Bosch et al. 1950; Walton 1951). Similarly, fetuses might be exposed to potential health risks if pregnant females drink water with comparable nitrate levels (Muhrer et al. 1959; MMWR 1996). ATSDR released another PHC on April 3, 2006 that assessed the site's groundwater pathway based on EPA's initial delineation investigation of the site (October 2002–April 2004). ATSDR determined that the groundwater pathway again appeared to be of concern because two private wells showed maximum lead levels of 50 and 140 ppb. Although no notable cause surfaced as to why the groundwater samples contained these high lead levels, some notable causes can be attributed to either lead plumbing or improper sampling protocol. Whatever the real cause, the maximum detected levels in the private wells presented the potential of adversely affecting public health. The table below summarizes ATSDR's assessment of the site's groundwater pathway thus far:

Groundwater Sampling Data	**Public Health Consultation Release Date**
1991 – 1999	March 29, 2002
October 2002 – April 2004	April 3, 2006
April 2005	this report

Figure 1 shows the Sigmon Septic Tank Service Site and nearby residences. Former waste areas still remain at the site. These were used for waste handling and disposal during past operations at the septic tank service facility. These areas include the Lagoon Area, Waste Pile, and Open Pits (Figure 1). These former waste areas are believed to be the chief source of groundwater problems within the area. In its previous PHC, ATSDR recommended that environmental regulatory agencies consider removing these areas from the Sigmon Septic Tank Service Site (ATSDR 2002a). EPA is presently considering this recommendation while its site investigations continue. ATSDR believes that removing the remaining waste areas at the site could reduce or even eliminate potential releases of hazardous substances to the surrounding soil, groundwater, or surface water, thereby reducing or eliminating any potential impacts on public health.

Discussion

Environmental Sampling and Chemical Analyses

ATSDR reviewed groundwater samples collected in April 2005 from 11 private wells. The water samples were collected as a follow-up response to determine whether the private wells contained any significant levels of lead and nitrates. The private well owners use the groundwater for drinking and other domestic purposes (e.g., washing, bathing, irrigation).

Rationale for the Selective Screening of Substances in Groundwater

The first step in any public health evaluation or assessment process is the application of conservative screening values to the available sampling data. This phase of the process helps to rule out any site-specific substances that would not pose a public health hazard under virtually any plausible exposure scenario. The substances remaining after the preliminary screen would then require further analysis to evaluate their potential for causing adverse health effects under site-specific exposure conditions (ATSDR 2005). It is during this second phase of the process that potential public health hazards are identified. The preliminary screening phase does not identify toxic exposures; it merely eliminates obviously nontoxic exposures so that the evaluation of public health implications can focus on a reduced list of substances.

A substance is initially selected for further public health evaluation if its maximum detected level in groundwater exceeds its most relevant water comparison value (CV). A substance is also initially selected for further evaluation if it is detected in groundwater and no water CV exists for the substance. Following this initial screening, the detected concentration(s) of the selected substance(s) are compared to concentration ranges considered to pose no apparent public health hazards in the two previous PHCs released for the site (ATSDR 2002a, 2006), see Tables 1 and 2. To avoid repeating work already done, if the detected concentrations fell within the concentration ranges previously considered to pose a no apparent public health hazard, the substances were not reevaluated.

2005 Delineation Investigation

EPA contracted Black and Veatch Special Projects Corporation (Black & Veatch) to conduct follow-up sampling activities at the Sigmon Septic Tank Service Site in accordance with its Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EPA 1997). In April 2005, samples were taken from the groundwater.

Twelve groundwater samples were collected from 11 private wells (Figures 2 and 3) and were subsequently analyzed for metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and nitrates. Tables 3 through 14 (Appendix B) list the results of these analyses. The results were compared to water comparison values (CVs) together with the selection screening criteria to determine whether further analysis was indicated for any of these substances. The following is a summary of ATSDR's initial public health screen for each private well.

- *Private well PW-01***.** Of the 10 substances detected in the well, none exceeded any available water CV; nevertheless, 3 substances were found for which CVs were not available. The concentrations of these 3 substances were within ranges of levels previously considered to pose no apparent public health hazard at this site (ATSDR 2002a, 2006). Accordingly, none of the substances in PW-01 were selected for further public health evaluation (Table 3).

- *Private well PW-03.* Of the 26 substances detected in the well, 4 showed maximum levels that exceeded available water CVs; however, 2 of these substances did not require further public health evaluation because their maximum measured concentrations were within ranges considered to pose a no apparent public health hazard. Three other substances were also detected in the well that had no available water CVs; however, all 3 were within ranges considered to pose a no apparent public health hazard. Thus, two of the substances detected in PW-03 were selected for further public health evaluation (Table 4). One was nitrates, a previous concern in ATSDR's March 2002 assessment of the site's groundwater pathway (ATSDR 2002a), and the other was vinyl chloride.
- *Private well PW-04.* Of the 14 substances detected in this well, none exceeded any available water CV. That said, 3 of these substances had no available water CV and all 3 were within ranges considered a no apparent public health hazard. Therefore, none of the substances detected in PW-04 were selected for further evaluation (Table 5).
- *Private well PW-05.* Only one of the 13 substances detected in this well showed levels that exceeded available water CVs. This one substance did not require further public health evaluation because its measured concentration was within a range considered to pose a no apparent public health hazard. Three other substances in the well had no available water CVs; however, all three had concentrations within ranges previously considered to pose a no apparent public health hazard. Therefore, none of the substances detected in PW-05 were selected for further evaluation (Table 6).
- *Private well PW-06.* Two (duplicate) water samples were collected from well PW-06. In the first of the two samples, none of the 12 substances detected in the sample exceeded any available water CVs. Three of these substances had no available water CVs, but all 3 showed measured concentrations within ranges considered not to pose a public health hazard (Table 7). The second duplicate sample also showed that none of its 12 detected substances exceeded any available water CVs. Again, three of these substances had no available water CVs and all 3 showed measured concentrations within ranges considered not to pose a public health hazard (Table 8). Therefore, none of the substances detected in PW-06 were selected for further evaluation.
- *Private well PW-07.* None of the 10 substances detected in this well exceeded the available water CVs; however, no water CVs were available for 3 of these substances. The concentrations of all 3 were within ranges considered to pose a no apparent public health hazard. Therefore, none of the substances detected in this well were selected for further evaluation (Table 9).
- *Private well PW-08.* Only one of the 12 substances detected in this well exceeded the available water CVs; however, no water CVs were available for 3 of the substances. The concentrations of the 3 were within ranges considered to pose a no apparent public health hazard. Therefore, only the one substance, bis(2-ethyhexyl)phthalate, detected in well PW-08 was selected for further evaluation (Table 10).

- *Private well PW-09.* None of the 12 substances detected in this well exceeded the available water CVs; however, for 3 of these substances no water CVs were available. The concentrations of all 3 were within ranges considered to pose a no apparent public health hazard. Therefore, none of the substances detected in this well were selected for further evaluation (Table 11).
- *Private well PW-10.* Only one of the 14 substances detected in this well showed levels that exceeded available water CVs. The one substance did not require further public health evaluation because its measured concentration was within the range considered to pose a no apparent public health hazard. Three of the substances in the well had no available water CVs; still, all three had concentrations within ranges considered to pose a no apparent public health hazard. Therefore, none of the substances detected in PW-10 were selected for further evaluation (Table 12).
- *Private well PW-11.* Only one of the 16 substances detected in this well showed levels that exceeded available water CVs. This one substance did not require further public health evaluation because its measured concentration was within the range considered to pose a no apparent public health hazard. Three of the substances in the well had no available water CVs; however, all three had concentrations within ranges considered to pose a no apparent public health hazard. Therefore, none of the substances detected in PW-11 were selected for further evaluation (Table 13).
- *Private well PW-12.* None of the 13 substances detected in this well exceeded the available water CVs; however, no water CVs were available for 3 of these substances. The concentrations of all 3 were within ranges considered to pose a no apparent public health hazard. Therefore, none of the substances detected in this well were selected for further evaluation (Table 14).

Chemicals Selected for Further Public Health Analysis

ATSDR's review of the groundwater analyses of the private wells is summarized in Table 15. Using Table 15, our environmental health scientists selected certain substances detected in the private wells for further public health analysis. These substances were categorized as exceeding available CVs or for which no CVs were available. The following substances were selected for in-depth public health analysis:

<u>Substances Exceeding Drinking Water CVs</u>

1) Nitrates, 2) Vinyl Chloride, 3) Bis(2-ethyhexyl)phthalate

<u>Substances without Drinking Water CVs</u>

None

Exposure Pathways

Being that the residential community is comprised of long term residents and short term renters, ATSDR determined that the exposures to the chemicals detected in the water samples were *intermediate* and *chronic* (i.e., moderate and long-term exposures, respectively) that can occur via ingestion, inhalation (VOCs), and dermal contact when groundwater is used for drinking, showering, and bathing, or for other household purposes (NCDENR 1998, 2000). Several studies have indicated that exposures to VOCs can occur during showering and bathing, as chemicals volatilize and enter the body through inhalation, absorption, or both. Such exposures to VOCs may equal or exceed those from ingestion, but usually by no more than a factor of 2 (Jo et al. 1990; Kerger et al. 2000; Kezic et al. 1997; Mattie et al. 1994; EPA 1999). Because of the low frequency of VOC detection (8%) and the fact that only one (vinyl chloride) of the nine detected VOCs had a level that exceeded any available drinking water comparison values, ATSDR considered VOC exposure through inhalation and skin absorption to be minimal or nonexistent. Thus, ingestion was the primary route of human exposure considered in this PHC. Ingestion is also the route of exposure for other, nonvolatile substances that were detected at a higher frequency (e.g., nitrates and metals).

Other Public Health Concerns

The former site operators disposed of septic waste in the former lagoon area. It remains there to this day, raising concerns about the former lagoon area becoming an anaerobic (oxygen-depleted) environment for the formation of hydrogen sulfide. As part of the federally mandated cleanup, that material from the former lagoons will be removed and transported to an appropriate hazardous waste, treatment, and disposal facility. When removing the material from the former lagoons, however, it is possible that hydrogen sulfide may be released into the atmosphere, which may place workers and those residents living next to the site at risk. As a precaution during remediation and cleanup at the site, necessary steps should be taken to prevent any possible exposures to hydrogen sulfide.

Environmental health scientists from ATSDR visited the site in December 2005 and observed that private well PW-02 was inoperable and not in use. Even though the well is not currently in use, this does not restrict it from future use. Because the well is inoperable and not in use, ATSDR recommends that the well be properly capped and restricted from any future use; past pre-2000 sampling has shown that the well contained nitrate levels as high as 23,350 ppb. If future use is planned for the well, ATSDR recommends removal of all potential source areas at the site and to make necessary improvements in bringing well PW-02 water quality within safe drinking water standards.

Past sampling data have shown that groundwater is probably flowing in a southerly to southwesterly direction (see Figure 4). Most recently—in March 2006—groundwater samples were collected from private wells in areas north, east, and west of the site; however, no samples were collected in the areas south to southwest of the site. Past sampling data identified two problem wells in those areas, PW-02 and PW-03. Both wells contained elevated levels of nitrates. These nitrates pose a potential health risk to infants 6 months or younger and for the fetuses of pregnant women. Therefore, it may be wise to delineate further the groundwater underlying those areas south to southwest of the site.

Public Health Implications

After application of the selective screening criteria for this PHC, three substances were selected for in-depth analysis. That analysis is an integrated approach that studies site-specific exposures in conjunction with substance-specific toxicological, medical, and epidemiologic data (ATSDR 2005). The three substances were selected because their detected levels in well PW-03 and well

PW-08 exceeded available water CVs. (See Appendix A for a description of comparison values and their proper interpretation.)

Substances detected in the groundwater through the sampling of the private potable wells were screened with health-based comparison values (Tables 3-15). Health-based CVs represent those levels expected to be safe even for sensitive populations, excluding hypersensitive (allergic) individuals. Exceeding a CV does not indicate that adverse health effects are expected, but it does reveal substances that may require additional evaluation of factors that influence the toxicity and likelihood of health effects. Those substances exceeding CVs or for which comparison values do not exist were further evaluated for potential adverse health effects.

That further evaluation, as described below, identified nitrates as the only substance for which intervention is recommended. A nitrate level of 13,000 μg/L (ppb) was detected in one specific well. This level exceeded EPA's maximum contaminant level (MCL) of 10,000 μg/L. This level may be a cause of concern for infants 6 months or younger and for the fetuses of pregnant women.

Nitrates

The toxicity of nitrates is due to their conversion (reduction) to nitrites by bacteria in the gastrointestinal tract (i.e., intestines). These nitrites then combine with hemoglobin in the blood. Once combined, the nitrites convert the hemoglobin to methemoglobin, a form of hemoglobin that cannot carry oxygen. When enough hemoglobin is converted into methemoglobin, the blood's ability to transport oxygen from the lungs to the tissues is impaired. Infants are susceptible to methemoglobinemia because the higher pH (nonacidity) of their gastric juice is more compatible with the growth of nitrate-reducing bacteria in the gut. Older children, with their more acidic gastric juices, are much less susceptible (Craun et al. 1981). Probably the most important factor that makes infants more susceptible to methemoglobinemia is their inability to convert methemoglobin back to hemoglobin; they lack the necessary levels of methemoglobin reductase, a red-blood cell (RBC) enzyme, which makes this metabolic transition possible. Again, adults and older children do tend to have the necessary levels of this RBC enzyme, making them less susceptible. The characteristic blueness (cyanosis) of lips and mucous membranes can be produced by methemoglobin levels between 20% and 45% (Clinical Toxicology 2001). Methemoglobin levels under 30% produce minimal symptoms (fatigue, lightheadedness, headache) in healthy children and adults, while levels between 30% and 50% cause moderate depression of the cardiovascular and central nervous systems (e.g., weakness, headache, rapid breathing and heartbeat, mild shortness of breath). Levels between 50% and 70% cause severe symptoms (e.g., stupor, slow and abnormal heartbeat, respiratory depression, convulsions), and levels above 70% are usually fatal (Ellenhorn and Barceloux 1988). Any levels of methemoglobin that might be associated with the maximum detected nitrate levels in water from private wells at this site are likely to be less than 2%. (See discussion below.)

EPA has developed a chronic oral reference dose for the ingestion of nitrates based on the early clinical signs of methemoglobinemia (cyanosis) in infants ingesting water containing varying concentrations of nitrate-nitrogen. That RfD is equivalent to the observed NOAEL (i.e., No Observed Adverse Effect Level) of 1,600 μg nitrate-nitrogen/kg/day, which is the dose that would be received by a 0–3 month old infant weighing approximately 8.8 pounds (4 kg) and drinking 0.64 liters/day of water (as formula) containing 10,000 µg/L nitrate-nitrogen.

A primary source of organic nitrates is human sewage, the processing of which formerly occurred at the site (i.e., removal and handling of septic wastes). Due to high solubility and weak retention in soil, nitrates and nitrites are very soil-mobile and have a high potential to migrate to groundwater. Most nitrogenous materials in natural waters tend to be converted to nitrate, so all sources of combined nitrogen, particularly organic nitrogen and ammonia, should be considered as potential nitrate sources. Because it does not volatilize, nitrate/nitrite is likely to remain in water until consumed by plants or other organisms. Ammonium nitrate will be taken up by bacteria. Nitrate is more persistent in water than is the ammonium ion. Nitrate degradation is fastest in anaerobic conditions (i.e., little to no oxygen present).

Nitrate was detected at a level above drinking water CVs in one private well, PW-03, approximately 450 feet southwest of the site. The estimated daily dose of nitrate from water containing 13,000 ppb (maximum nitrate detection in Private Well PW3) would be 371 µg/kg/day for a 70-kg (i.e., 150 pounds) adult ingesting 2 liters of water per day; 1,300 µg/kg/day for a 10-kg (i.e., 20 pound) child ingesting 1 liter of water per day; and 2,080 µg/kg/day for a 4-kg (i.e., 8 pound) infant ingesting 0.64 liters of water (as formula) per day. Although the estimated daily dose for a child is slightly higher than the RfD, at these dose levels noncancerous health effects are not expected in adults or children older than 6 months. Although chronic exposure to levels of nitrates that exceed EPA's RfD (in this case, by a factor of 2.3) is not recommended for infants 1–3 months of age, adverse effects would not be likely to occur in those infants, either. In one study, oral doses of nitrate ranging from 100 µg/kg/day to 15,500 µg/kg/day in 111 infants less than 6 months old was associated with methemoglobin levels as high as 5.3% (mean 1.6%), but none of the children had the typical symptoms of methemoglobinemia (Winton et al. 1971). In another study, mean methemoglobin levels were only 1.3% in infants aged 1–3 months who received water containing 11,000–23,000 µg nitrate-nitrogen/L (Simon et al. 1964). Also, no clinical signs of methemoglobinemia were detected in any of these infants. Low levels of methemoglobin (0.5 to 2.0%) occur normally and, due to the large excess capacity of blood to carry oxygen, levels of methemoglobin up to 10% are seldom associated with any clinically significant signs such as cyanosis (EPA-IRIS 2006). Most cases of infant methemoglobinemia are associated with exposure to nitrate in drinking water used to prepare infants' formula at levels >20,000 ppb of nitrate-nitrogen. Cases have been reported, however, at levels of 11,000–20,000 ppb nitrate-nitrogen, especially when associated with concomitant exposure to bacteriologically contaminated water or excess intake of nitrate from other sources. Therefore, if other sources of drinking water are available, well water from private well PW-03 should not be used for making infant formula.

The findings from studies investigating the influence of nitrate on the reproductive outcomes in laboratory animals and livestock have not been consistent; some studies do, however, suggest a possible connection between nitrate consumption and spontaneous abortions or miscarriages (Sund et al. 1957; Sleight and Atallah 1968; FDA 1972). One epidemiologic study of humans has suggested a possible relation between ingestion of drinking water containing elevated nitrate levels and an increased risk for neural tube defects (Dorsch et al. 1984). Yet another study indicated a possible relation between methemoglobin levels in women during early pregnancy and subsequent spontaneous abortions (Schmitz 1961).

Public health scientists investigated this possible link between spontaneous abortions and the ingestion of nitrate-contaminated well water (MMWR 1996). During March 1993, the LaGrange County (Indiana) Health Department (LCHD) identified three women who reported a total of six spontaneous abortions during 1991–1993 and who resided in close proximity to each other. Each of the three women had obtained drinking water from nitrate-contaminated private wells in LaGrange County. Nitrate was the only well contaminant present at elevated levels. In the wells from which the three women drank, nitrate levels were 19,000 µg/L; 26,000 µg/L; and 19,200 µg/L. In comparison, for five households in which women reported giving birth to full-term, live-born infants, drinking water nitrate levels ranged from 1,600 µg/L to 8,400 µg/L (mean: 3.1 µg/L). An investigation of potential sources of nitrate contamination indicated that the probable source of groundwater contamination was animal waste from a hog-confinement facility. The facility was approximately ½ to 1 mile from the residences of the women who experienced spontaneous abortions; the facility was, however, approximately 2 miles from the residences of the women reporting full-term births.

Subsequently, LCHD was notified about a fourth case in which a woman from another part of LaGrange County had two spontaneous abortions after she had moved into a new home with a nitrate-contaminated private well. The woman, age 35, lived approximately 10 miles from the other three women. During 1984–1992 she gave birth to five live infants. But the woman's doctor also reported to LCHD that the woman had two spontaneous abortions during April and August 1994, both at 8 weeks' gestation: the first occurred 24 months after the birth of her fifth child and 44 months after beginning use of a new well. A mean nitrate-Nitrogen level of 28,700 µg/L was detected in water samples collected during August 1994 from the household's well, which had been used since 1990. A nitrate-Nitrogen level of 1,200 µg/L was detected in a second well on the property, approximately 100 feet from the first well; during her first four pregnancies, this well had supplied the woman's drinking water. The only nitrate source identified near the contaminated well was the family's septic system, which was installed in sandy soil approximately 70 feet upgradient from the contaminated well. Although the well probably became contaminated by effluent from the septic tank, when that contamination occurred is unknown.

Following the investigations, all four women changed to nitrate-free sources of drinking water (i.e., bottled or reverse-osmosis treated). Subsequently, each delivered one or more full-term, live infants.

Vinyl Chloride

Vinyl chloride was only detected in one private well, PW-03, with an estimated value of 0.21 µg/L. This concentration is one order of magnitude (or 10 times) lower than the MCL of 2.0 µg/L, which is set at a conservatively low level to protect the health of sensitive individuals, such as children and the elderly. The detected level of vinyl chloride exceeded only one water CV, ATSDR's cancer risk evaluation guide (CREG). The CREG and other similar CVs are the most conservative of long-term health benchmarks, given that they are based on estimates of theoretical cancer risk. The level of vinyl chloride detected in well PW-03 would correspond to a dose of 0.021 micrograms per kilogram per day (µg/kg/day) for a 10-kilogram (kg) child drinking 1 liter of water per day (L/day) and 0.006 µg/kg/day for a 70-kg adult drinking 2 L/day. Both values are well below EPA's reference dose of 3 µg/kg/day. (A reference dose is an estimate of daily exposure to a contaminant unlikely to cause noncancer adverse health effects.) No drinking water studies of vinyl chloride exposure have been conducted in either humans or animals; given the high volatility and low water solubility of vinyl chloride, ingestion of drinking water is not a toxicologically effective route of exposure for this compound. To deliver toxic oral doses to laboratory animals, investigators must administer vinyl chloride in oil by gavage or in a diet containing PVC powder. It is from such animal studies that EPA derived its chronic oral reference dose (RfD) of 3 µg/kg/day.

Taking into consideration supporting evidence for carcinogenesis, cancer-based CVs for ingesting vinyl chloride or any carcinogen are derived using the methodology of quantitative risk assessments. The methodology of quantitative risk assessments usually employs EPA's cancer slope factors (CSFs) and inhalation unit risks (IURs). CSFs and IURs are computed on the basis of two limiting assumptions: 1) zero-threshold for carcinogens, and 2) low-dose linearity. Zero-threshold incorporates the assumption that the process of chemical carcinogenesis can cause cancer and can have an associated cancer risk at any exposure no matter how small or low the dose—even doses approaching zero (Bogdanffy et al. 2001). Moreover, low-dose linearity incorporates the assumption that in the low-dose region of a dose-response curve (i.e., the graphical display of cancer incidence observed over a range of chemical doses in animal or occupational studies), the rate of change between the carcinogenic response and chemical dose approaches a constant and behaves linearly, even down to zero dose. Using statistical models, a mathematical equation of a straight line can be developed to approximate the linear relationship of the low-dose region of the dose-response curve. The slope of the resulting straight line is called a CSF (for dose data) or IUR (for air concentration data). And the straight line can be extrapolated to any dose or water concentration—no matter how small—to give a corresponding estimate of cancer risk. Because no actual data points exist in the region of extrapolation (i.e., estimated risks of 10^{-4} and less), these estimates of cancer risk are theoretical and may not reflect the true or actual risk, which is in fact unknown and may be as low as zero (EPA 1986, 2003).

Vinyl chloride is a known human carcinogen only under certain circumstances. Vinyl chloride has been consistently associated with elevated incidences of rare angiosarcomas of the liver in humans, but only by inhalation and only at the extremely high worker exposures that were once associated with certain job categories that no longer exist (Zocchetti 2001). This same form of liver cancer has also been produced experimentally in rats treated with chronic oral doses of 300 µg/kg/day. In humans, this dose would be numerically (if not biologically) equivalent to 10,500 µg/L in drinking water for an adult drinking for several decades 2 L/day, or 3,000 µg/L for a child drinking 1 L/day over a similar time period. These toxic levels are 14,300 to 50,000 times higher than the detected level of vinyl chloride in private well PW-03 (i.e., greater than four orders of magnitude).

Because the level of vinyl chloride did not exceed any CVs for noncancer effects and was not detected in the other private wells, ATSDR concludes that the vinyl chloride detected in private well PW-03 does not pose a public health hazard to anyone drinking water from it.

Bis(2-ethyhexyl)phthalate (DEHP)

DEHP was detected in only one private well (PW-08), and at a concentration (6.2 µg/L)—practically indistinguishable from the MCL of 6 µg/L. ATSDR's chronic Minimum Risk Level (MRL) for DEHP is 60 µg/kg/day. ATSDR's chronic MRLs are derived human no-effect levels (expressed as doses) that are designed to be conservatively protective against noncancer health effects for exposure durations of more than 1 year, up to an entire lifetime. Assuming a 70-kg adult drinks 2 liters of water a day, and a 10-kg child drinks 1 liter of water a day, the 60 µg/kg/day MRL for DEHP converts to ATSDR's adult and child chronic drinking water EMEGs of 2000 ug/L and 600 µg/L, respectively. Therefore, ATSDR's chronic drinking water EMEGS for DEHP exceed by two or more orders of magnitude the only level of DEHP detected in private wells water surrounding the site. This indicates that DEHP poses no noncancer hazard.

Under default conditions of exposure over a lifetime, a CREG coincides with a theoretical 1-in-a-million risk of cancer in humans. ATSDR's CREG of 3 ppb was the only one of ATSDR's CVs in which the single detect of 6.2 ppb did, in fact, exceed. Nevertheless, neither this nor any other plausible concentration of DEHP in drinking water is likely to yield a carcinogenic dose in humans. Most supporting evidence (i.e., animal studies) does not show a causal relationship between DEHP exposure and cancer in humans. First, the spontaneous incidence of liver tumors in rodents can be as much as 1–2 orders of magnitude higher than it is in humans (Compare: Derelanko & Hollinger 1995 and SEER Cancer Statistics Review 1975–2003), which means that high doses of a nongenotoxic promoting agent like DEHP will, generally speaking, promote many more spontaneously initiated cells in rodents than the same concentrations ever could in humans. Second, statistically significant increases in the lifetime incidence of liver tumors can be produced in rodents only by high, environmentally irrelevant doses of DEHP (i.e., hundreds or thousands of mg/kg/day for life) which are 3–4 orders of magnitude higher than human exposures in the general population (ATSDR 2002b). Even the highest, short-term human exposures, (i.e., up to an estimated 2–3 mg/kg/day in hemodialysis patients) are 2–3 orders of magnitude higher than the lifelong daily doses required to produce liver cancer in rodents (ATSDR 2002b). Finally, DEHP evidently produces excess rodent liver tumors via a nongenotoxic, species-specific mechanism (i.e., induction of peroxisome proliferation by the monoester metabolite MEHP), which is irrelevant to human beings—"humans are non-responsive to peroxisome proliferation" (ATSDR 2002b). Thus even if humans had the same spontaneous incidence of liver tumors as do rodents, and chronic human doses of hundreds or even thousands of mg/kg/day were possible, DEHP would still not cause cancer in humans, at least not by the same mechanism that pertains in animals.

Therefore, ATSDR concludes that the single detect of 6.2 µg/L in a private well PW-08 does not pose a public health hazard.

Child Health Considerations

ATSDR considers children in the evaluation for all environmental exposures and uses health guidelines that are protective for children. When evaluating any potential health effects via ingestion, children are considered a special or sensitive population. Because of their lower body weight, the same exposure will result in a higher dose as compared to adults. ATSDR's child

EMEGs take into account average body weight differences as well as average differences in child-specific intake rates for various environmental media.

The April 2005 delineation investigation showed an elevated level of nitrates in one private well located approximately 450 feet southwest of on-site source areas. The level was high enough to pose an increased risk of elevated methemoglobin levels in very young infants (less than 6 months of age) who drank formula prepared with this water. Another group at similar risk is pregnant females, drinking the tainted water could adversely affect their fetuses. ATSDR has evaluated this site in the past and has written several PHCs. ATSDR again recommends that with regard to those households whose wells have been affected by nitrates or by other substances that perhaps migrated from the site, such households should be supplied with an alternative water source (bottled water or municipal water) or have installed a water filtration/purification system that yield safe drinking water.

Conclusions

1. During the April 2005 delineation investigation at the Sigmon Septic Tank Service Site, private well PW-03 showed nitrate levels of 13,000 ppb. This detected level posed an increased risk of higher methemoglobin levels in very young infants (0–6 months) drinking formula prepared with water from this well. The sensitive population also included pregnant females who drank water from this well, which could adversely affect their fetuses.
2. The vinyl chloride concentration detected in private well PW-03 pose no apparent public health hazard to residents; however, drinking water from private well PW-03 did pose a potential health concern to two sensitive subgroups, very young infants (0–6 months) and pregnant females, if they used the water from the well (i.e., not because of the detected vinyl chloride level but because of the detected level of nitrates, refer to conclusion #1). Moreover, the detected level of. bis(2-ethyhexyl)phthalate in private well PW-08 pose no apparent public health hazard to residents using water from the well.

Recommendations

1. Supply an alternative water source (bottled water) or implement another remedy (e.g., installation of a water filtration/purification system) that yields potable water within safe drinking water standards to households whose private wells are impacted by nitrates or other substances that could have migrated from the site. Continue this responsive action until the appropriate investigations are completed, strategies formulated, remedial actions implemented, and local water supplies are brought within safe drinking standards.
2. Consider removing the source areas from the Sigmon Septic Tank Service facility to reduce, prevent or both any potential migration of hazardous substances into nearby private wells.
3. Consider properly capping private well PW-02 if no future use is intended for the well.

4. Implement within health safety plan appropriate actions of preventing any possible exposures to hydrogen sulfide during remediation and cleanup at the site.
5. Continue routinely to collect and analyze groundwater samples, particularly for nitrates and lead, from both the monitoring wells and from nearby private wells (notably in the area of private wells PW-02 and PW-03) until the appropriate investigations are completed, strategies formulated, remedial actions implemented, and local water supplies are brought within safe drinking standards.

Public Health Action Plan

1. Follow up with EPA in educating and informing concerned residents about the public health importance of using an alternative water source (bottled water) or implementing another remedy (installation of a water filtration/purification system) that yields safe drinking water until further notified that their own water is within safe drinking water standards.

Authors

David S. Sutton, PhD, PE
Environmental Health Scientist
Site Assessment Team
Exposure Investigations and Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Frank C. Schnell, PhD, DABT
Senior Toxicologist
Exposure Investigations Team
Exposure Investigations and Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Reviewers

Susan Moore
Branch Chief
Exposure Investigations and Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Peter Kowalski, MPH, CIH
Lead, Environmental Health Specialist
Site Assessment Team
Exposure Investigations and Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Kenneth Orloff, PhD, DABT
Assistant Director of Science
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Annmarie K. DePasquale, MPH
Environmental Health Scientist
Site Assessment Team C
Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Januett P. Smith-George, MSW
Senior Program Management Officer
Team A
Health Promotion and Community Involvement Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Benjamin Moore, MS
Regional Representative
Region IV
Division of Regional Operations
Agency for Toxic Substances and Disease Registry

Wallace K. Sagendorph, JD
Writer Editor
Office of Communication
National Center for Environmental Health
and Agency for Toxic Substances and Disease Registry

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Appendix A. Comparison Values

ATSDR comparison values (CVs) are media-specific concentrations that are considered to be safe under default conditions of exposure. They are used as screening values in selecting site-specific chemicals for further evaluation of their public health implications. Generally, a chemical is selected for further public health evaluation because its maximum concentration in air, water, or soil at the site exceeds at least one of ATSDR's CVs. Supplementing this conservative approach is ATSDR's guidance that requires environmental health scientists to exercise professional judgment when selecting chemicals for further public health evaluation, evaluating exposure pathways, and determining the public health implications of site-specific exposures (ATSDR 1992). ATSDR may also select detected chemical substances for further public health evaluation and discussion because ATSDR has no CVs for certain specified chemicals or because the community has expressed special concern about the substance, whether it exceeds CVs or not.

It must be emphasized that CVs are *not* thresholds of toxicity. While concentrations at or below the relevant CV are generally considered to be safe, it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. In fact, the whole purpose behind highly conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health problems before they become actual health hazards. For that reason, ATSDR's CVs are typically 1 to 3 orders of magnitude (10–1,000 times) lower than the corresponding no-effect levels or lowest-effect levels on which they are based. The probability that adverse health outcomes will actually occur depends not on environmental concentrations alone, but on several additional factors, including site-specific conditions of exposure, individual lifestyle, and genetic factors affecting the route, magnitude, and duration of actual exposures, and individual physiological responses to those exposures.

Listed below are the abbreviations for selected CVs and units of measure used within this document. Following this list of abbreviations are more complete descriptions of the various comparison values used within this document, as well as a brief discussion on one of ATSDR's most conservative CVs.

CREG = cancer risk evaluation guide

EMEG = environmental media evaluation guide

LTHA = drinking water lifetime health advisory

MCL = maximum contaminant level

MCLA = maximum contaminant level action

MRL = minimal risk level

RBC = risk-based concentration

RfD = reference dose

RMEG = reference dose media evaluation guide

Units of measure

ppm	=	parts per million, e.g., mg/L (water), mg/kg (soil)
ppb	=	parts per billion, e.g., μg/L (water), μg/kg (soil)
ppt	=	parts per trillion, e.g., ng/L (water)
kg	=	kilogram (1,000 grams)
mg	=	milligram (0.001 gram)
μg	=	microgram (0.000001 gram)
ng	=	nanogram (0.000000001 gram)
L	=	liter (1,000 milliliters or 1.057 quarts of liquid, or 0.001 m^3 of air)
m^3	=	cubic meter (a volume of air equal to 1,000 liters)

Cancer risk evaluation guides (CREGs) are derived by ATSDR. They are estimated chemical concentrations theoretically expected to cause no more than one excess case of cancer per million people exposed over a lifetime. CREGs are derived from EPA's cancer slope factors and therefore reflect estimates of risk based on the assumption of zero threshold and lifetime exposure. Such estimates are necessarily hypothetical. As stated in EPA's 1986 Guidelines for Carcinogenic Risk Assessment (EPA 1986), "the true value of the risk is unknown and may be as low as zero."

Drinking water equivalent levels (DWELs) are lifetime exposure levels specific for drinking water (assuming that all exposure is from that medium) at which adverse, noncarcinogenic health effects would not be expected to occur. They are derived from EPA reference doses (RfDs) by factoring in default ingestion rates and body weights to convert the RfD to an equivalent concentration in drinking water.

Minimal risk levels (MRLs) are ATSDR estimates of daily human exposures to a chemical that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated with data from human and animal studies and are reported for acute (≤14 days), intermediate (15–364 days), and chronic (≥365 days) exposures. MRLs for oral exposure ingestion) are doses typically expressed in mg/kg/day. Inhalation MRLs are concentrations typically expressed in either parts per billion (ppb) or $\mu g/m^3$ (ppt, or parts per trillion). The latter are identical to ATSDR's EMEGs for airborne contaminants. ATSDR's MRLs are published in ATSDR toxicological profiles for specific chemicals.

Environmental media evaluation guides (EMEGs) are media-specific concentrations that are calculated from ATSDR's Minimal Risk Levels by factoring in default body weights and ingestion rates. Different EMEGs are calculated for adults and children, as well as for acute (≤14 days), intermediate (15–364 days), and chronic (≥365 days) exposures.

EPA reference dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause any noncarcinogenic adverse health effects over a lifetime of chronic exposure. Like the ATSDR MRL, the EPA RfD is a dose and is typically expressed in mg/kg/day.

Reference dose media evaluation guide (RMEG) is the concentration of a contaminant in air, water, or soil that ATSDR derives from EPA's RfD for that contaminant by factoring in default values for body weight and the media-specific intake rate. Like ATSDR EMEGs, RMEGs are calculated for both adults and children.

Risk-based concentrations (RBCs) are media-specific values derived by the Region III Office of the U.S. Environmental Protection Agency from EPA RfDs, RfCs, or cancer slope factors, by factoring in default values for body weight, exposure duration, and ingestion/inhalation rates. These values represent levels of chemicals in air, water, soil, and fish that are considered safe over a lifetime of exposure. RBCs for noncarcinogens and carcinogens are analogous to ATSDR EMEGs and CREGs, respectively.

Lifetime health advisories (LTHAs) are calculated from the drinking water equivalent level (DWEL) and represent the concentration of a substance in drinking water estimated to have negligible deleterious effects in humans over a lifetime of 70 years, assuming 2 liter per day water consumption for a 70-kilogram adult. In the absence of chemical-specific data, LTHAs are 20% and 10% of the corresponding DWELs for noncarcinogenic organic and inorganic compounds, respectively. LTHAs are not derived for compounds that are potentially carcinogenic for humans.

Maximum contaminant levels (MCLs) are drinking water standards established by the EPA. They represent levels of substances in drinking water that EPA deems protective of public health over a lifetime (70 years) at an adult exposure rate of 2 liters of water per day. They differ from other protective comparison values in that they (1) reflect consideration of both carcinogenic and noncarcinogenic effects, (2) take into account the availability and economics of water treatment technology, and (3) are legally enforceable.

Maximum contaminant level action (MCLA) are action levels for drinking water set by EPA under Superfund. When the relevant action level is exceeded, a regulatory response is triggered.

When screening individual chemical substances, ATSDR staff compares the highest single concentration of a chemical detected at the site with the appropriate CV available for the most sensitive of the potentially exposed individuals (usually children). Typically, the cancer risk evaluation guide (CREG) or chronic environmental media evaluation guide (cEMEG) is used. This worst-case approach introduces a high degree of conservatism into the analysis and often results in the selection of many chemical substances for further public health evaluation that upon closer scrutiny will not be judged to pose any hazard to human health. In the interest of public health, it is, however, more prudent to use an environmental screen that identifies many chemicals for further evaluation that may later be determined to be harmless, as opposed to one that may overlook even a single potential hazard to public health. The reader should keep in mind the conservativeness of this approach when interpreting ATSDR's analysis of the potential health implications of site-specific exposures.

Appendix B. Tables

TABLE 1: Chemical Levels Considered a No Apparent Health Hazard

ATSDR's 2002 Public Health Response for Sigmon's Septic Tank Service Facility

(Summary of Detected Chemical Concentrations found in all Private Wells between 1991 -- 1999)

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)			ATSDR PUBLIC HEALTH CONCLUSION AS CITED IN March 2002 HEALTH CONSULTATION
	Detected Concentrations			
	Range	Mean	Median	
INORGANIC MOITIES				
Nitrates	100 -- 23,350	8,164	8,600	Potential Public Health Concern
Sulfates	6,000	6,000	6,000	No Apparent Public Health Hazard
METALS				
Aluminum	200 -- 1,700	950	950	No Apparent Public Health Hazard
Barium	16 -- 400	164	90	No Apparent Public Health Hazard
Calcium	21,000 -- 95,000	58,000	58,000	No Apparent Public Health Hazard
Cobalt	1.2 -- 2.6	2.1	2.4	No Apparent Public Health Hazard
Copper	14 -- 60	37.6	38	No Apparent Public Health Hazard
Iron	14 -- 5,500	1,736	195	No Apparent Public Health Hazard
Lead	2 -- 28	8.9	4.5	No Apparent Public Health Hazard
Magnesium	1,600 -- 12,000	6,983	7,250	No Apparent Public Health Hazard
Manganese	4.2 -- 830	153.1	78	No Apparent Public Health Hazard
Mercury	1 -- 7	2.8	1.6	No Apparent Public Health Hazard
Nickel	2.3 -- 4.2	3.25	3.25	No Apparent Public Health Hazard
Potassium	1,300 -- 7,000	2,990	2,150	No Apparent Public Health Hazard
Sodium	5,300 -- 15,000	10,150	10,150	No Apparent Public Health Hazard
Zinc	28 -- 2,500	541	155	No Apparent Public Health Hazard
ORGANIC COMPOUNDS				
Acetone	5 -- 233	71.9	47.5	No Apparent Public Health Hazard
Benzene	0.4	0.4	0.4	No Apparent Public Health Hazard
Bromodichloromethane	3	3	3	No Apparent Public Health Hazard
Chlorobenzene	0.4	0.4	0.4	No Apparent Public Health Hazard
Chloroform	0.6 -- 39	13.46	0.78	No Apparent Public Health Hazard
Dibromochloromethane	1	1	1	No Apparent Public Health Hazard
1,2-Dichlorobenzene	0.3 -- 48	24	24	No Apparent Public Health Hazard
1,4-Dichlorobenzene	0.27 -- 44	3.91	0.77	No Apparent Public Health Hazard
1,1-Dichloroethane	0.4 -- 1.5	0.7	0.6	No Apparent Public Health Hazard
1,2-Dichloroethane	0.53	0.53	0.53	No Apparent Public Health Hazard
cis-1,2-Dichloroethene	0.43 -- 3.5	1.3	0.8	No Apparent Public Health Hazard
Methylene Chloride	2	2	2	No Apparent Public Health Hazard

TABLE 1: Chemical Levels Considered a No Apparent Health Hazard

ATSDR's 2002 Public Health Response for Sigmon's Septic Tank Service Facility

(Summary of Detected Chemical Concentrations found in all Private Wells between 1991 -- 1999)

CHEMICAL SUBSTANCE	**CHEMICAL CONCENTRATIONS (ppb)**			**ATSDR PUBLIC HEALTH CONCLUSION AS CITED IN March 2002 HEALTH CONSULTATION**
	Detected Concentrations			
	Range	Mean	Median	
Tetrachloroethene (PCE)	0.29 -- 0.53	0.41	0.41	No Apparent Public Health Hazard
Trichloroethene (TCE)	0.27 -- 0.89	0.5	0.35	No Apparent Public Health Hazard
Xylenes	0.5 -- 5.1	2.2	1.6	No Apparent Public Health Hazard
Reference:	*Agency for Toxic Substances and Disease Registry. March 29, 2002. Health Consultation: Sigmon's Septic Tank Service Facility (Review of Groundwater Data). US DHHS, Public Health Service; Atlanta, GA.*			

TABLE 2: Chemical Levels Considered a No Apparent Health Hazard

ATSDR's 2006 Public Health Response for Sigmon's Septic Tank Service Site

(Summary of Detected Chemical Concentrations found in all Private Wells between October 2002 -- May 2004)

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb) Detected Concentrations			ATSDR PUBLIC HEALTH CONCLUSION AS CITED IN September 2005 HEALTH CONSULTATION
	Range	Mean	Median	
METALS				
Aluminum	56 -- 200	107.2	110	No Apparent Public Health Hazard
Arsenic	1.2 -- 1.2	1.2	1.2	No Apparent Public Health Hazard
Barium	12 -- 130	34	31	No Apparent Public Health Hazard
Beryllium	0.14 -- 0.14	0.14	0.14	No Apparent Public Health Hazard
Calcium[5]	1,700 -- 39,000	7,989.4	5,900	No Apparent Public Health Hazard
Cobalt	0.08 -- 3.6	0.27	0.27	No Apparent Public Health Hazard
Copper[2]	2.8 -- 270	45.21	45	No Apparent Public Health Hazard
Iron[1]	37 -- 250	83.78	79	No Apparent Public Health Hazard
Lead[2]	1.3 -- 140	6.04	5	Potential Public Health Concern
Magnesium[5]	390 -- 6,900	1,217.31	1,350	No Apparent Public Health Hazard
Manganese[1, 5]	3.6 -- 270	11.87	8.2	No Apparent Public Health Hazard
Mercury[5]	0.98 -- 2.1	1.43	1.54	No Apparent Public Health Hazard
Nickel	1.3 -- 3.2	2.19	2.4	No Apparent Public Health Hazard
Potassium[5]	840 -- 3,100	1,447.75	1,300	No Apparent Public Health Hazard
Selenium	0.43 -- 0.43	0.43	0.43	No Apparent Public Health Hazard
Silver	0.07 -- 0.07	0.07	0.07	No Apparent Public Health Hazard
Sodium[3]	910 -- 9,400	3,958.84	4,100	No Apparent Public Health Hazard
Strontium	12 -- 180	26.12	25.5	No Apparent Public Health Hazard
Vanadium	0.45 -- 1.8	0.9	1.13	No Apparent Public Health Hazard
Yttrium	2.1 -- 2.1	2.1	2.1	No Apparent Public Health Hazard
Zinc[1]	4.9 -- 3,400	54.82	42	No Apparent Public Health Hazard
VOLATILE ORGANIC COMPOUNDS				
Benzene	0.26 -- 0.26	0.26	0.26	No Apparent Public Health Hazard
Bromoform[4]	1.6 -- 1.6	1.6	1.6	No Apparent Public Health Hazard
Carbon Disulfide	1.6 -- 1.6	1.6	1.6	No Apparent Public Health Hazard
Chlorobenzene	0.54 -- 0.54	0.54	0.54	No Apparent Public Health Hazard
Chloroform[4]	0.32 -- 0.32	0.32	0.32	No Apparent Public Health Hazard
1,2-Dichlorobenzene	0.17 -- 0.46	0.28	0.32	No Apparent Public Health Hazard

TABLE 2: Chemical Levels Considered a No Apparent Health Hazard

ATSDR's 2006 Public Health Response for Sigmon's Septic Tank Service Site

(Summary of Detected Chemical Concentrations found in all Private Wells between October 2002 -- May 2004)

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)			ATSDR PUBLIC HEALTH CONCLUSION AS CITED IN September 2005 HEALTH CONSULTATION
	Detected Concentrations			
	Range	Mean	Median	
1,4-Dichlorobenzene	1 -- 2.2	1.48	1.6	No Apparent Public Health Hazard
1,1-Dichloroethane	0.2 -- 0.69	0.37	0.45	No Apparent Public Health Hazard
cis-1,2-Dichloroethene	0.52 -- 0.52	0.52	0.52	No Apparent Public Health Hazard
1,2-Dichloropropane	0.67 -- 0.67	0.67	0.67	No Apparent Public Health Hazard
2-Hexanone	0.52 -- 0.52	0.52	0.52	No Apparent Public Health Hazard
Methyl Acetate	0.91 -- 0.91	0.91	0.91	No Apparent Public Health Hazard
Methylcyclohexane	0.12 -- 0.12	0.12	0.12	No Apparent Public Health Hazard
Methyl-T-Butyl Ether (MTBE)	0.26 -- 0.39	0.32	0.33	No Apparent Public Health Hazard
Tetrachloroethene (PCE)	0.1 -- 0.21	0.14	0.12	No Apparent Public Health Hazard
PESTICIDES				
alpha-BHC *(Hexachlorocyclohexane-Alpha)*	0.027 -- 0.027	0.027	0.027	No Apparent Public Health Hazard
Endosulfan II	0.011 -- 0.011	0.011	0.011	No Apparent Public Health Hazard
Endrin Aldehyde	0.017 -- 0.017	0.017	0.017	No Apparent Public Health Hazard
Endrin Ketone	0.01 -- 0.01	0.01	0.01	No Apparent Public Health Hazard
Gamma-Chlordane	0.011 -- 0.67	0.086	0.341	No Apparent Public Health Hazard
Heptachlor Epoxide	0.01 -- 0.032	0.02	0.02	No Apparent Public Health Hazard
Reference:	*Agency for Toxic Substances and Disease Registry. February 2006. Health Consultation: Sigmon's Septic Tank Service Site (Review of Groundwater Data - EPA Delineation Investigations of 2002, 2003, and 2004). US DHHS, Public Health Service; Atlanta, GA.*			

TABLE NOTES

Footnotes for Tables 3 through 11

Notes:

A substance is selected for further public health evaluation if its maximum detected level in groundwater exceeds its respective water comparison value (see blue highlighting). This screening criteria is neglected if the No. 5 disclaimer is specified (see lavender highlighting). Moreover, a substance may also be selected for further public health evaluation if detected and no available water comparison value exists for the substance (see yellow highlighting); however, this screening criteria is also neglected if the No. 5 disclaimer is specified (see green highlighting). Therefore, a response of "Yes" under the column labeled "Further Public Health Evaluation Required" indicated that the substance was further evaluated by ATSDR health scientists.

CREG: *Cancer Risk Evaluation Guide*

EMEG: *Environmental Media Evaluation Guide (prefixes: a = acute, c = chronic, and i = intermediate)*

LTHA: *Drinking Water Lifetime Health Advisory*

MCL: *Maximum Contaminant Level*

RBC: *Risk Based Concentration (Note, RBC values derived from equations documented in following reference: EPA Region III Risk-Based Concentration Table. United States Environmental Protection Agency, Region III, 841 Chestnut Street, Philadelphia, PA, 19107. Available on EPA Region III's Internet website, http://www.epa.gov/reg3hwmd/risk/riskmenu.htm, Background Information - [PDF].)*

RMEG: *Reference Dose Media Evaluation Guide*

ppb: *parts per billion*

[1] *Listed value in "EPA MCL" column is a Secondary Drinking Water Regulation (SDWR) as set by EPA. SDWRs are unenforceable federal guidelines regarding taste, odor, color, and other non-aesthetic effects of drinking water. EPA recommends them to States as reasonable goals, but federal law does not require water supply systems to comply with them. States may, however, adopt their own enforceable regulations governing these concerns. To be safe, check your State's drinking water regulations.*

[2] *Listed value in "EPA MCL" column is a Maximum Contaminant Level Action (MCLA) for drinking water as set by EPA under Superfund. If the relevant action level is exceeded, a regulatory response is triggered.*

[3] *Listed value in "EPA MCL" column is a health-based Drinking Water Advisory as set by EPA. The Drinking Water Advisory is based on the assumption that an individual is placed on a sodium restricted diet of 500 mg/day.*

[4] *Listed value in "EPA MCL" column is a proposed MCL under the 1994 proposed rule for disinfection by products rule; the current MCL for most trihalomethanes is 100 ppb under the 1996 Drinking Water Advisory Report.*

[5] *Detected concentration(s)are within a range of concentration levels designated for the specific chemical and considered a no apparent public health hazard as cited in a previous public health consultation released for the Sigmon Septic Tank Service site (ATSDR, 2002).*

TABLE 3

Detected Substances found in Private Well PW-01

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	34	700 child RMEG	2,000	No
Calcium[5]	2,700 J			No
Cobalt	0.11 J	100 child iEMEG		No
Copper[2]	28 J	200 child iEMEG	1,300	No
Lead[2]	3.7 J		15	No
Magnesium[5]	500 J			No
Manganese[1]	8.2	300 LTHA	50	No
Potassium[5]	1,600 J			No
Zinc[1]	35 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	1,200	20,000 child RMEG	10,000	No

TABLE 4

Detected Substances found in Private Well PW-03

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Arsenic	0.41 J	0.02 CREG	10	No
Barium	72	700 child RMEG	2,000	No
Calcium[5]	48,000			No
Cobalt	0.79 J	100 child iEMEG		No
Copper[2]	1.4 J	200 child iEMEG	1,300	No
Iron[1]	63 J	11,000 RBC	300	No
Magnesium[5]	4,300 J			No
Manganese[1,5]	71	300 LTHA	50	No
Mercury[5]	0.2	2 LTHA	2	No
Nickel	1.5	100 LTHA		No
Potassium[5]	3,600 J			No
Silver	0.03 J	50 child RMEG		No
Sodium[3]	6,600		20,000	No
Thallium	0.07 J	0.5 LTHA	2	No
Vanadium	1.9	30 child iEMEG		No
Zinc[1]	2.8 J	3,000 child iEMEG	5,000 (SDWR)	No
VOLATILE ORGANIC COMPOUNDS				
Benzene	0.54	0.6 CREG	5	No
Chlorobenzene	2.2	100 LTHA	100	No
1,2-Dichlorobenzene	1.4	600 LTHA	600	No
1,4-Dichlorobenzene	2.5	75 LTHA	75	No
1,1-Dichloroethane	0.84	800 RBC		No
cis-1,2-Dichloroethene	0.83	70 LTHA	70	No
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	0.55	300,000 child RMEG		No
Vinyl Chloride	0.21 J	0.03 CREG	2	Yes
Total Xylenes	0.39 J	2,000 child iEMEG	10,000	No

TABLE 4

Detected Substances found in Private Well PW-03

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
CLASSICAL / NUTRIENTS				
Nitrates	13,000	20,000 child RMEG	10,000	Yes

TABLE 5

Detected Substances found in Private Well PW-04

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	100	700 child RMEG	2,000	No
Beryllium	0.12 J	20 child cEMEG	4	No
Calcium[5]	6,100			No
Cobalt	0.41 J	100 child iEMEG		No
Copper[2]	23 J	200 child iEMEG	1,300	No
Lead[2]	1.6 J		15	No
Magnesium[5]	2,400 J			No
Manganese[1]	19	300 LTHA	50	No
Nickel	1.8	100 LTHA		No
Potassium[5]	3,200 J			No
Sodium[3]	4,300 J		20,000	No
Thallium	0.09 J	0.5 LTHA	2	No
Zinc[1]	130 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	6,300	20,000 child RMEG	10,000	No

TABLE 6

Detected Substances found in Private Well PW-05

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	50	700 child RMEG	2,000	No
Calcium[5]	5,200			No
Cobalt	0.35 J	100 child iEMEG		No
Copper[2]	33 J	200 child iEMEG	1,300	No
Lead[2]	1.1 J		15	No
Magnesium[5]	1,100 J			No
Manganese[1]	4.9	300 LTHA	50	No
Nickel	2.3	100 LTHA		No
Potassium[5]	2,000 J			No
Thallium	0.06 J	0.5 LTHA	2	No
Zinc[1]	18 J	3,000 child iEMEG	5,000 (SDWR)	No
PESTICIDES				
Heptachlor Epoxide	0.0095 J	0.004 CREG	0.2	No
CLASSICAL / NUTRIENTS				
Nitrates	1,300	20,000 child RMEG	10,000	No

TABLE 7

Detected Substances found in Private Well PW-06

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	30	700 child RMEG	2,000	No
Calcium[5]	3,200 J			No
Cobalt	0.27 J	100 child iEMEG		No
Copper[2]	16 J	200 child iEMEG	1,300	No
Lead[2]	1.1 J		15	No
Magnesium[5]	710 J			No
Manganese[1]	14	300 LTHA	50	No
Nickel	1.9	100 LTHA		No
Potassium[5]	1,400 J			No
Thallium	0.07 J	0.5 LTHA	2	No
Zinc[1]	17 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	150	20,000 child RMEG	10,000	No

TABLE 8

Detected Substances found in Private Well PW-06 (Duplicate Sample)

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	30	700 child RMEG	2,000	No
Calcium[5]	3,200 J			No
Cobalt	0.28 J	100 child iEMEG		No
Copper[2]	20 J	200 child iEMEG	1,300	No
Lead[2]	1.3 J		15	No
Magnesium[5]	710 J			No
Manganese[1]	13	300 LTHA	50	No
Nickel	2	100 LTHA		No
Potassium[5]	1,400 J			No
Thallium	0.07 J	0.5 LTHA	2	No
Zinc[1]	20 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	160	20,000 child RMEG	10,000	No

TABLE 9

Detected Substances found in Private Well PW-07

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	17	700 child RMEG	2,000	No
Calcium[5]	2,300 J			No
Copper[2]	9.8 J	200 child iEMEG	1,300	No
Magnesium[5]	590 J			No
Nickel	0.19 J	100 LTHA		No
Potassium[5]	1,500 J			No
Sodium[3]	5,100		20,000	No
Vanadium	1.2	30 child iEMEG		No
Zinc[1]	19 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	640	20,000 child RMEG	10,000	No

TABLE 10

Detected Substances found in Private Well PW-08

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	13	700 child RMEG	2,000	No
Calcium[5]	8,200			No
Copper[2]	4.5 J	200 child iEMEG	1,300	No
Magnesium[5]	1,700 J			No
Manganese[1]	1.3	300 LTHA	50	No
Nickel	0.35 J	100 LTHA		No
Potassium[5]	2,100 J			No
Sodium[3]	5,600		20,000	No
Vanadium	2.1	30 child iEMEG		No
Zinc[1]	69 J	3,000 child iEMEG	5,000 (SDWR)	No
SEMI-VOLATILE ORGANIC COMPOUNDS				
Bis(2-ethyhexyl)phthalate	6.2	3 CREG	6	Yes
CLASSICAL / NUTRIENTS				
Nitrates	2,000	20,000 child RMEG	10,000	No

TABLE 11

Detected Substances found in Private Well PW-09

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb) Detected Concentrations April 18, 2005	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
METALS				
Barium	16	700 child RMEG	2,000	No
Beryllium	0.08 J	20 child cEMEG	4	No
Calcium[5]	9,600			No
Cobalt	0.04 J	100 child iEMEG		No
Copper[2]	17 J	200 child iEMEG	1,300	No
Lead[2]	4.3 J		15	No
Magnesium[5]	1,200 J			No
Manganese[1]	2.7	300 LTHA	50	No
Nickel	0.35 J	100 LTHA		No
Potassium[5]	1,400 J			No
Zinc[1]	22 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	680	20,000 child RMEG	10,000	No

TABLE 12

Detected Substances found in Private Well PW-10

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb) Detected Concentrations April 18, 2005	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
METALS				
Barium	11	700 child RMEG	2,000	No
Calcium[5]	4,600 J			No
Cobalt	0.19 J	100 child iEMEG		No
Copper[2]	3.2 J	200 child iEMEG	1,300	No
Iron[1]	490	11,000 RBC	300	No
Lead[2]	11 J		15	No
Magnesium[5]	1,100 J			No
Manganese[1]	18	300 LTHA	50	No
Nickel	0.35 J	100 LTHA		No
Potassium[5]	1,700 J			No
Sodium[3]	11,000		20,000	No
Vanadium	1.3	30 child iEMEG		No
Zinc[1]	2,600 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	1,300	20,000 child RMEG	10,000	No

TABLE 13

Detected Substances found in Private Well PW-11

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb) Detected Concentrations April 18, 2005	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
METALS				
Arsenic	0.29 J	0.02 CREG	10	No
Barium	4.5 J	700 child RMEG	2,000	No
Calcium[5]	10,000			No
Copper[2]	20 J	200 child iEMEG	1,300	No
Lead[2]	2.7 J		15	No
Magnesium[5]	1,500 J			No
Manganese[1]	3.6	300 LTHA	50	No
Nickel	0.34 J	100 LTHA		No
Potassium[5]	2,000 J			No
Sodium[3]	8,400		20,000	No
Vanadium	3.2	30 child iEMEG		No
Zinc[1]	1,500 J	3,000 child iEMEG	5,000 (SDWR)	No
PESTICIDES				
alpha-BHC *(Hexachlorocyclohexane-Alpha)*	0.0042 J	0.006 CREG		No
beta-BHC *(Hexachlorocyclohexane-Beta)*	0.004 J	0.02 CREG		No
Gamma-BHC *(Hexachlorocyclohexane-Gamma orLindane)*	0.0027 J	0.1 child iEMEG	0.2	No
CLASSICAL / NUTRIENTS				
Nitrates	1,500	20,000 child RMEG	10,000	No

TABLE 14

Detected Substances found in Private Well PW-12

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb)	WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Detected Concentrations April 18, 2005			
METALS				
Barium	29	700 child RMEG	2,000	No
Calcium[5]	3,100 J			No
Cobalt	0.16 J	100 child iEMEG		No
Copper[2]	37 J	200 child iEMEG	1,300	No
Iron[1]	66 J	11,000 RBC	300	No
Lead[2]	2.4 J		15	No
Magnesium[5]	590 J			No
Manganese[1]	25	300 LTHA	50	No
Nickel	0.56 J	100 LTHA		No
Potassium[5]	1,600 J			No
Thallium	0.05 J	0.5 LTHA	2	No
Zinc[1]	8.9 J	3,000 child iEMEG	5,000 (SDWR)	No
CLASSICAL / NUTRIENTS				
Nitrates	390	20,000 child RMEG	10,000	No

TABLE 15

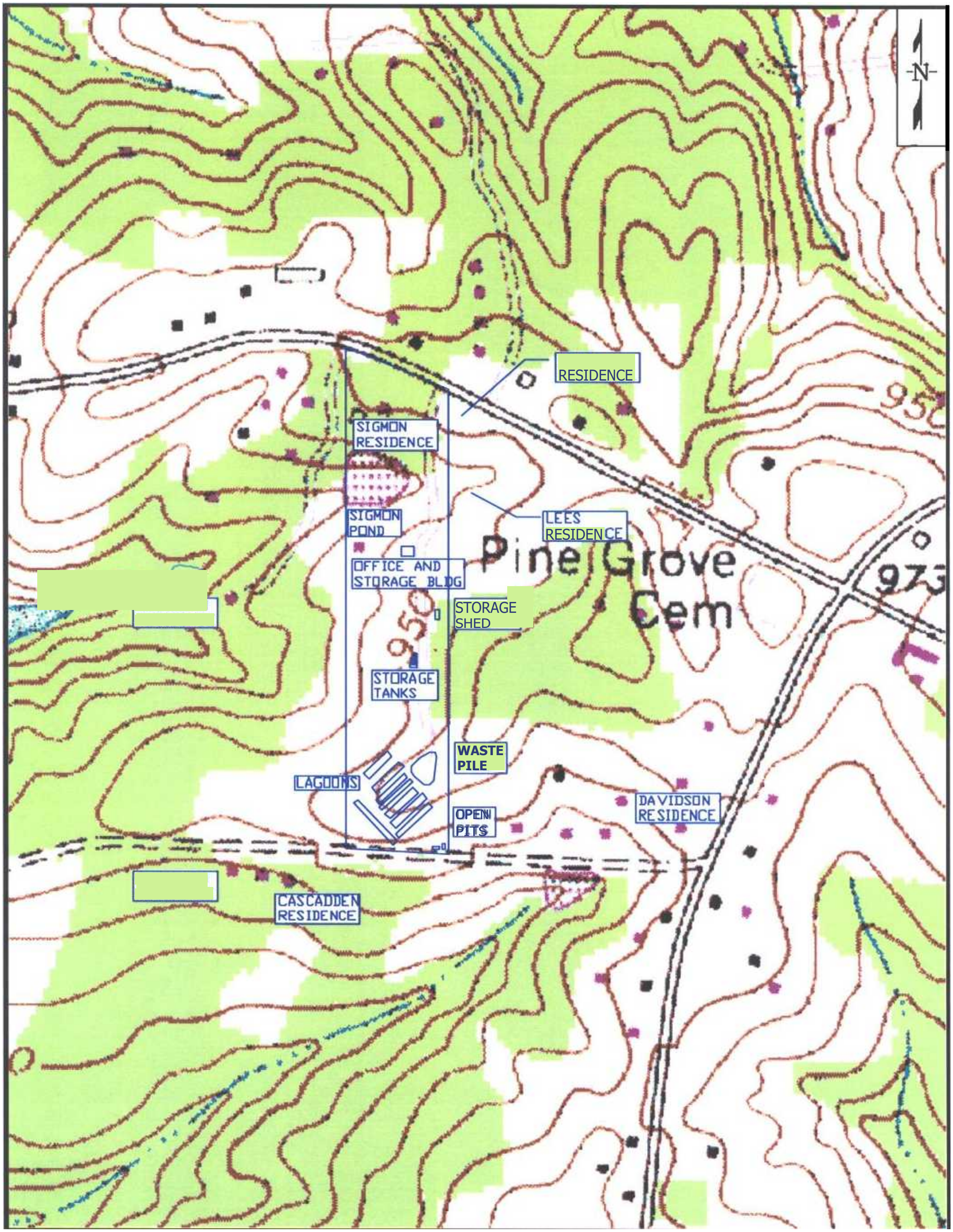
Detected Substances found in Private Wells near the Sigmon Facility

(Summary of Detected Chemical Concentrations found in all Private Wells on April 2005)

CHEMICAL SUBSTANCE	CHEMICAL CONCENTRATIONS (ppb) Detected Concentrations				WATER COMPARISON VALUES (ppb)	EPA MCL (ppb)	FURTHER PUBLIC HEALTH EVALUATION REQUIRED
	Range	Mean	Median	Detection Rate			
METALS							
Arsenic	0.29 -- 0.41	0.34	0.35	2/12	0.02 CREG	10	No
Barium	4.5 -- 100	24.87	29.50	12/12	700 child RMEG	2,000	No
Beryllium	0.08 -- 0.12	0.10	0.10	2/12	20 child cEMEG	4	No
Calcium[5]	2,300 -- 48,000	8,850.00	5,662.58	12/12			No
Cobalt	0.04 -- 0.79	0.22	0.27	9/12	100 child iEMEG		No
Copper[2]	1.4 -- 37	12.66	18.50	12/12	200 child iEMEG	1,300	No
Iron[1]	63 -- 490	126.77	66.00	3/12	11,000 RBC	300	No
Lead[2]	1.1 -- 11	2.42	2.40	9/12		15	No
Magnesium[5]	500 -- 4,300	1,106.07	1,100.00	12/12			No
Manganese[1, 5]	1.3 -- 71	9.49	13.00	11/12	300 LTHA	50	No
Mercury[5]	0.2 -- 0.2	0.20	0.20	1/12	2 LTHA	2	No
Nickel	0.19 -- 2.3	0.74	0.56	11/12	100 LTHA		No
Potassium[5]	1,400 -- 3,600	1,861.69	1,650.00	12/12			No
Silver	0.03 -- 0.03	0.03	0.03	1/12	50 child RMEG		No
Sodium[3]	4,300 -- 11,000	6,492.43	6,100.00	6/12		20,000	No
Thallium	0.05 -- 0.09	0.07	0.07	6/12	0.5 LTHA	2	No
Vanadium	1.2 -- 3.2	1.82	1.90	5/12	30 child iEMEG		No
Zinc[1]	2.8 -- 2,600	45.47	21.00	12/12	3,000 child iEMEG	5,000 (SDWR)	No
VOLATILE ORGANIC COMPOUNDS							
Benzene	0.54 -- 0.54	0.54	0.54	1/12	0.6 CREG	5	No
Chlorobenzene	2.2 -- 2.2	2.20	2.20	1/12	100 LTHA	100	No
1,2-Dichlorobenzene	1.4 -- 1.4	1.40	1.40	1/12	600 LTHA	600	No
1,4-Dichlorobenzene	2.5 -- 2.5	2.50	2.50	1/12	75 LTHA	75	No
1,1-Dichloroethane	0.84 -- 0.84	0.84	0.84	1/12	800 RBC		No
cis-1,2-Dichloroethene	0.83 -- 0.83	0.83	0.83	1/12	70 LTHA	70	No
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	0.55 -- 0.55	0.55	0.55	1/12	300,000 child RMEG		No
Vinyl Chloride	0.21 -- 0.21	0.21	0.21	1/12	0.03 CREG	2	Yes
Total Xylenes	0.39 -- 0.39	0.39	0.39	1/12	2,000 child iEMEG	10,000	No
SEMI-VOLATILE ORGANIC COMPOUNDS							
Bis(2-ethyhexyl)phthalate	6.2 -- 6.2	6.2	6.2	1/12	3 CREG	6	Yes
PESTICIDES							
alpha-BHC (Hexachlorocyclohexane-Alpha)	0.0042 -- 0.0042	0.0042	0.0042	1/12	0.006 CREG		No
beta-BHC (Hexachlorocyclohexane-Beta)	0.004 -- 0.004	0.004	0.004	1/12	0.02 CREG		No
gamma-BHC (Hexachlorocyclohexane-Gamma orLindane)	0.0027 -- 0.0027	0.0027	0.0027	1/12	0.1 child iEMEG	0.2	No
Heptachlor Epoxide	0.0095 -- 0.0095	0.0095	0.0095	1/12	0.004 CREG	0.2	No
CLASSICAL / NUTRIENTS							
Nitrates	150 -- 13,000	1,060.77	1,250.00	12/12	20,000 child RMEG	10,000	Yes

Appendix C. Figures

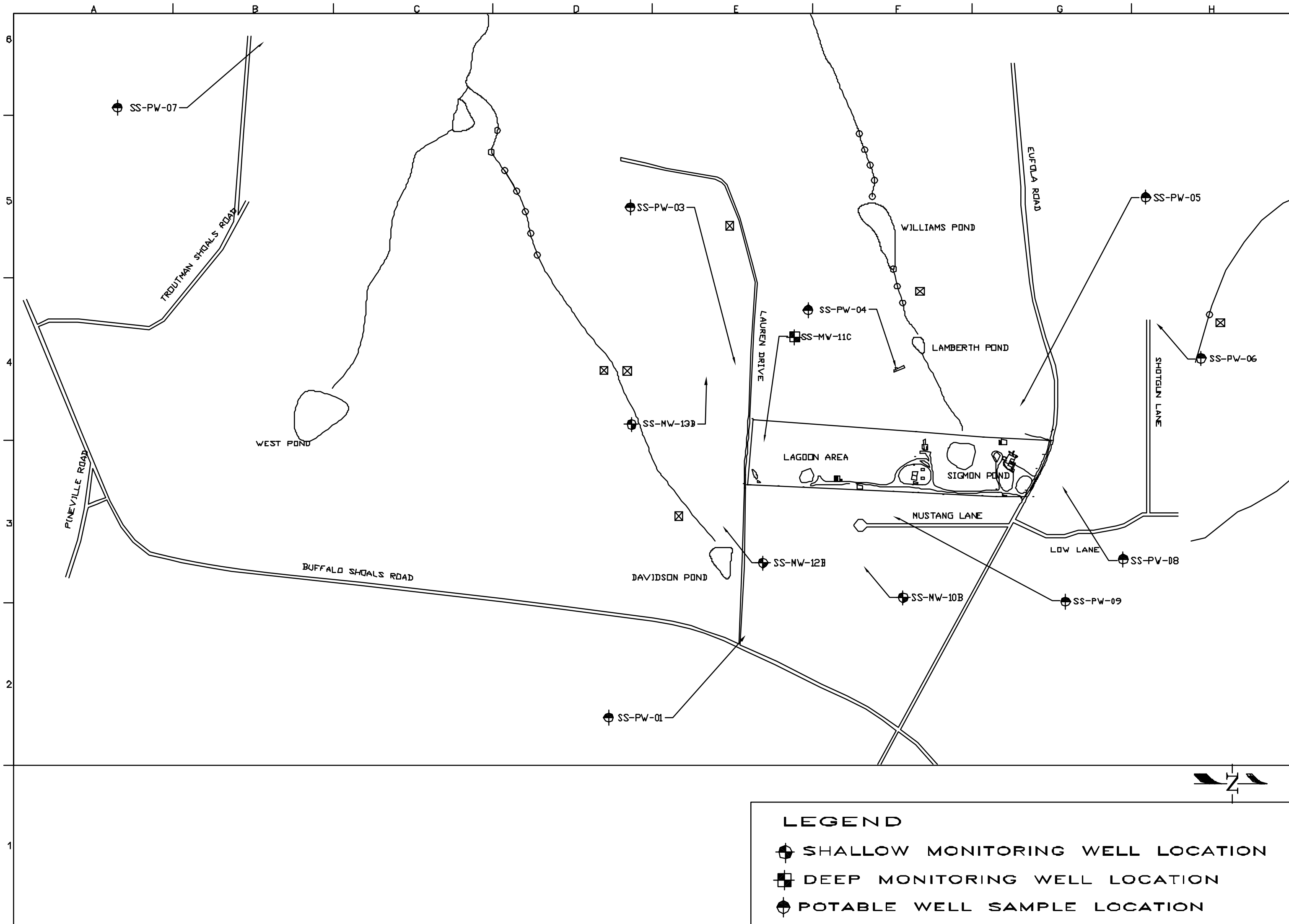
FIGURES



REP. - USGS 7.5 MINUTE SERIES TOPOGRAPHIC **MAP;** TROUTMAN, NC 1993. 1" **= 600'**

SITE LAYOUT **MAP**
SIGMON'S SEPTIC TANK **SITE**
STATESVILLE, IREDELL COUNTY, NORTH CAROLINA

FIGURE 1



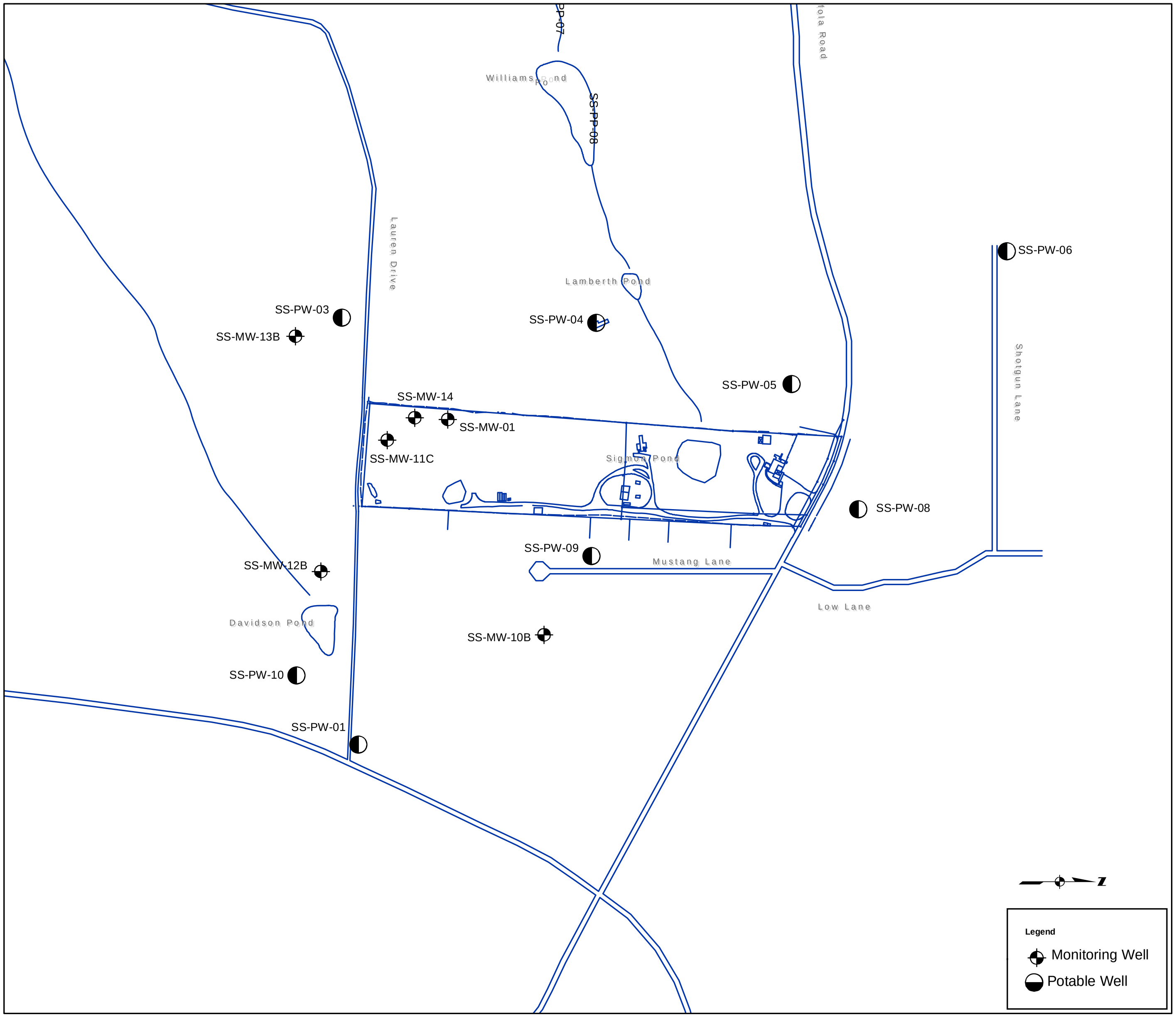
MONITORING WELL AND POTABLE WELL LOCATION MAP

SIGMON'S SEPTIC TANK SITE
STATESVILLE, IREDELL COUNTY, NORTH CAROLINA

BLACK & VEATCH Special Projects Corp.

SCALE
1" = 300'

Figure 2



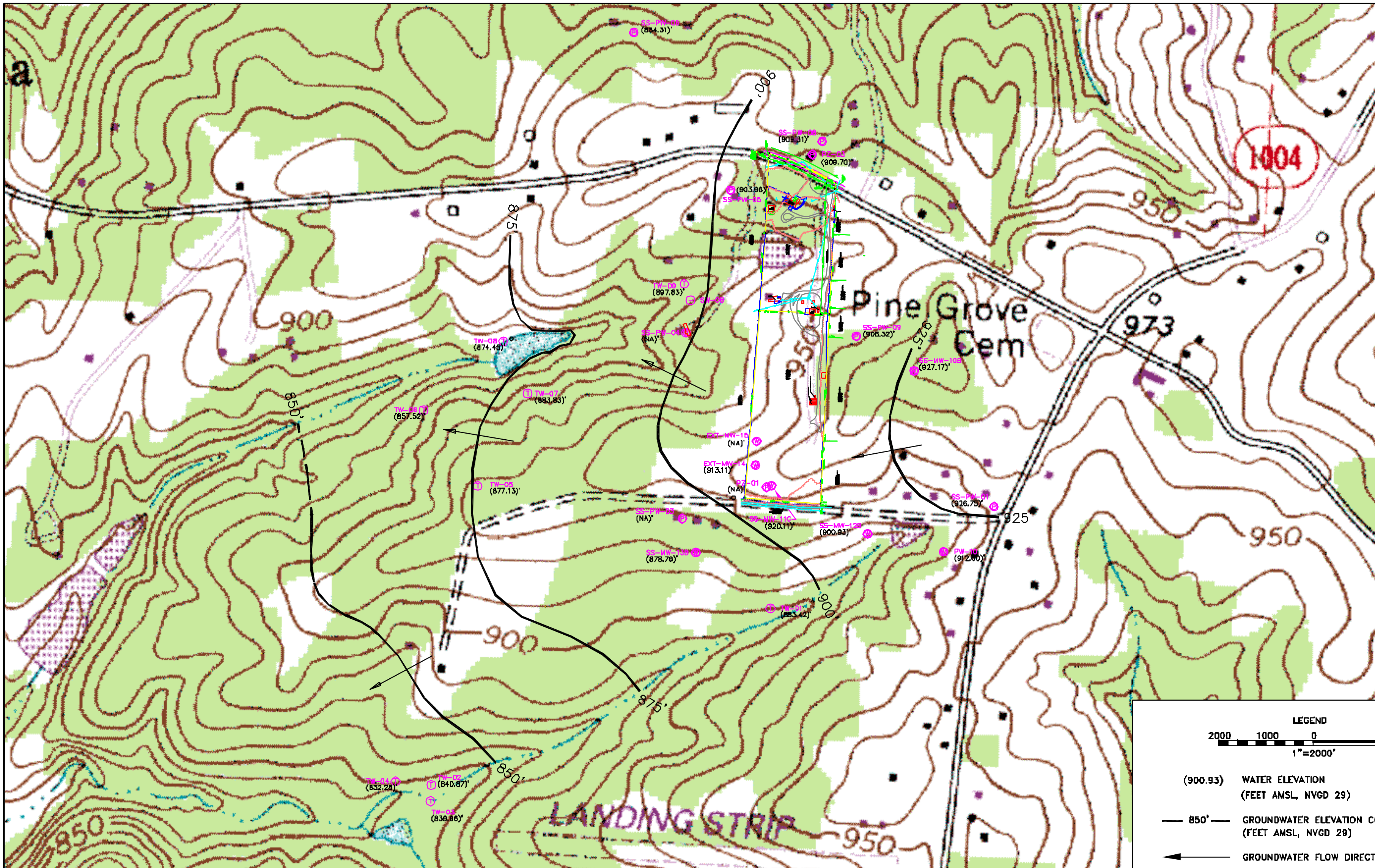
2004 ACTUAL RI GROUNDWATER, PUSHPOINT, & POTABLE WATER
LOCATION MAP

SIGMON'S SEPTIC TANK SITE
STATESVILLE, IREDELL COUNTY, NORTH CAROLINA

SCALE
1 in. equals 400 ft.

Figure
3

CAD DWG NO: 25PHASE1-GW ORIGINAL DWG SIZE 11 x 17
DATE: 02-03-00 NDG
PLOT SCALE: 1"=200' FILE: R:\MACDILL\SWMU25\ACAD\



LEGEND

2000 1000 0 2000
1"=2000'

(900.93) WATER ELEVATION (FEET AMSL, NVGD 29)

850' GROUNDWATER ELEVATION CONTOURS (FEET AMSL, NVGD 29)

GROUNDWATER FLOW DIRECTION

SIGMONS SEPTIC TANK SITE
STATESVILLE NORTH CAROLINA

GROUNDWATER POTENTIOMETRIC SURFACE MAP
AS MEASURED ON 05-21-2004

FIGURE 4