Health Consultation

WRIGLEY CHARCOAL SITE FOLLOW-UP
ATHLETIC FIELD (a/k/a Old Ball Field)

WRIGLEY, HICKMAN COUNTY, TENNESSEE

EPA ID: TND980844781

Prepared by:

The Tennessee Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry
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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Background and Statement of Issues

During a public open house on February 12, 2004, a citizen asked Environmental Epidemiology (EEP) to review the environmental sampling data for the Old Ball Field and share the results with them. They were concerned that children still played at the Old Ball Field and could be exposed to chemicals from the Wrigley Charcoal Superfund Site.

This public open house discussed the *Health Consultation: Wrigley Charcoal, Wrigley, Hickman County, Tennessee*, dated December 22, 2003. This health document was produced because of concerns expressed by a property owner whose land is adjacent to the Wrigley Charcoal Site. Although no health hazards were discovered during that investigation, the request to be thoughtful of children was appropriate. As special considerations are often necessary to protect children from exposure to hazardous waste sites, EEP is following-up our initial Wrigley Charcoal Site document with this environmental public health investigation focused on the Old Ball Field.

The Old Ball Field is named the Athletic Field in U.S. Environmental Protection Agency (EPA) documents. From this point forward, the Old Ball Field, located at the corner of Ball Park Road and Maple Street, will be called the Athletic Field (Figure 1).

The Athletic Field was formerly a small valley. According to local residents, this valley was filled with slag and/or waste tar from Wrigley Charcoal operations. The field was used by local residents for ball games and community social functions. A new ball field, Buford McCord Sports Park (Figure 2), was later built in a different area near the intersection of Oak Hill Road and Old Mill Creek Road. This new ball field has become the primary place for recreation. However, the Athletic Field is still available for recreation. In fact, residents reported that children continue to play on the older Athletic Field.

The Wrigley Charcoal Superfund Site is located in Wrigley, Hickman County, Tennessee 37098, approximately 45 miles southwest of Nashville. The Wrigley Charcoal Site has a long history of different industrial processes and comprises four physically distinct areas where industrial operations occurred: the Primary Site, the Storage Basin, the Irrigation Field, and the Athletic Field. The manufacturing of charcoal was the main process. In 1988, the EPA declared the site to be an imminent and substantial danger and conducted a response action. In 1989, EPA listed Wrigley Charcoal on the National Priorities List of Superfund sites.

Surface and subsurface soil at the Athletic Field was sampled in August 1989 (EBASCO 1990), December 1990 (EPA 1991), and June–July 2001 (Black and Veatch 2003a). These soil data sets will be the basis for this investigation.

Discussion

Soil Sampling

In August 1989, the U.S. EPA sampled soil at the Athletic Field. Soil from three locations at two depths was sampled. Surface soil was collected at a depth of 0 to 6 inches, while subsurface soil was sampled at a depth of 30 to 36 inches. The samples were collected outside of the Athletic Field from beyond centerfield to the right field fence. No samples were collected from the playing field. The samples did not contain plant-related wastes. Analytical results are listed in Appendix A, Table 1. All sample locations are shown on Figure 3.

During December 10–12, 1990, the U.S. EPA collected soil samples at the Athletic Field. Fourteen soil samples were collected from three areas in neighborhoods adjacent to the Athletic Field and from the Athletic Field itself. Four of these soil samples were collected within the Athletic Field. Appendix A, Table 2 lists the analytical results for the Athletic Field (EPA 1991).

In June–July 2001, the U.S. EPA collected more surface soil and shallow subsurface soil samples to verify and supplement the previous data. Six surface and subsurface samples were collected. Samples were mixed together to form three composite samples, and then the mixture was analyzed. The analytical results of these three composite samples were reported. One duplicate sample was collected and analyzed. Appendix A, Tables 3 and 4 detail the 2001 soil testing.

Reading the Tables of Results

Appendix A, Tables 1 – 4 represent the chemicals, sample numbers, and units of measurement in the same way that the U.S. EPA reported them in the original documents.

The term, “Metals,” is the same as the term, “Inorganics.” Some soil samples begin with two letters designating the area of sampling, followed by two letters designating the type of sample, followed by the sample number. For instance, AF-SS-01 designates a sample taken at the Athletic Field (AF), from surface soil (SS), and this is sample number one (01). SB in other samples stands for subsurface.

The concentration of metals is expressed as milligrams of the metal per kilogram of soil; it is abbreviated as mg/kg. These units of mg/kg are the same as parts per million (ppm); 1 ppm means there is one part of the metal to 1,000,000 (one million) parts of soil.

The concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds, pesticides, and polychlorinated biphenyls (PCBs) are expressed as micrograms of the chemical per kilogram of soil, abbreviated as µg/kg. The units of µg/kg are the same as parts per billion (ppb); 1 ppb means there is one part of the chemical to 1,000,000,000 (one billion) parts of soil.

The concentration of dioxins and furans are expressed as nanograms of the dioxin or furan per kilogram of soil, abbreviated as ng/kg. The units of ng/kg are same as parts per trillion (ppt); 1 ppt means there is one part of the dioxin or furan to 1,000,000,000,000 (one trillion) parts of soil. The risk-adjusted concentration of dioxins and furans is determined by multiplying each

concentration by a weighting factor that adjusts the concentration and toxicity to that of the most toxic dioxin/furan – 2,3,7,8-tetrachlorodibenzodioxin (TCDD). The adjusted values are then added together; the result is called a Toxicity Equivalent (TEQ).

Chemicals in soil samples are quantified with laboratory equipment that prints out a graph with peaks representing each chemical. The heights and widths of these peaks are compared with the peaks for a known amount of the chemical. How little of a chemical the laboratory can detect depends on the specific chemical, how many other chemicals are in the sample, and how many other soil components are present in the sample. If the analytical graph shows a tiny peak that is too small or irregular to compare with the known peak, a "J" is written by the concentration. This means the concentration has been estimated. If the laboratory looked for a chemical but did not find a peak for it on the graph, then the detection limit is written in the concentration column with a "U" or an "ND" beside it. If "N" is beside a concentration, this indicates that laboratory personnel believe the chemical was present in the sample, but they could not quantify the amount.

Exposure Assessment

People have to physically contact contaminated soils and be exposed to harmful chemicals for adverse health effects to occur. In order for people to come into contact with contamination in the environment, there must be a *completed exposure pathway*. A completed exposure pathway consists of five main parts, including:

1. a source of contaminant in the environment (the primary site at Wrigley Charcoal),
2. a means for the contaminant to migrate from its source to the soil (possible burying of slag, tar, or waste from the Wrigley Charcoal site),
3. a place where people come in to contact with the contaminant (the Athletic Field),
4. a pathway (route) by which people come into contact with the contaminant, (incidental ingestion of soil and/or dermal contact with soil while playing),
5. people who could potentially be exposed (people playing on the Athletic Field).

Exposure pathways can be further explained as to when exposure occurs - in the past, in the present, or in the future.

Physical contact with the contaminant in the environment by itself does not necessarily mean that a person would develop adverse health effects. The contaminant's ability to affect a person's health is also controlled by a number of other factors, including:

- how much a person is exposed to (dose),
- how long a person is exposed (duration),
- how often a person is exposed (frequency),
- the person's age
- the person's diet and nutritional habits.

EEP assumed that people would be exposed by getting some of the dirt on their hands and then getting the dirt from their hands into their mouths by eating or other means. We also assumed

that people would get the dirt on their bodies while playing. The most sensitive people and the people with the greatest potential for exposure are children playing on the Athletic Field. Surface soil at the Athletic Field is the soil that someone playing would likely come into contact with. Subsurface soil is not available to contact when playing. Therefore, a completed exposure pathway exists at the Athletic Field for the ingestion of and/or dermal contact with surface soil.

Soil Environmental Media Evaluation Guides

Scientists today cannot precisely determine at what environmental level a particular chemical presents a clear and predictable risk to human health. Sometimes scientists in various government and private agencies disagree on the amount of a chemical necessary to harm a person. No one is wrong in these disagreements. At this time, predicting risk from exposure to chemicals in the environment is based on the professional judgments of scientists skilled in toxicology, pharmacology, biochemistry, and other similar disciplines.

The Agency for Toxic Substances and Disease Registry (ATSDR), part of the Centers for Disease Control and Prevention (CDC), is charged by Congress with providing support in the assessment of any health risk posed by Superfund or other hazardous waste sites. For non-carcinogenic effects of toxic chemicals, ATSDR derives a minimal risk level (MRL) for each chemical. From these MRLs, ATSDR has derived health guidance values, often called EMEGs (environmental media evaluation guides) for soil, air, and water. In this health consultation, Environmental Epidemiology used ATSDR's EMEGs for soil as a starting place in determining any health hazard at the Athletic Field, Wrigley, Hickman County, Tennessee.

EMEGs serve as screening levels to help scientists look more closely at the people who might be exposed. To use these screening levels we must know how much of a chemical someone is exposed to, for how long that exposure has been or will be occurring, how frequent the exposure is or will be, and age of the exposed person. If soil concentrations are below the EMEG for a particular chemical, scientists can be reasonably certain that no adverse health effects will occur in people who accidentally ingest some of the soil.

EPA is mandated to publish toxicity information that is very similar to ATSDR's MRLs and EMEGs. EPA's reference dose (RfD) is analogous to ATSDR's MRL. One difference in the numbers is that ATSDR must use information that has been published, while EPA may use results of studies that are not published. There are other policy decisions that may result in ATSDR and EPA deriving different MRLs and RfDs for the same chemical. In addition, ATSDR derives EMEGs for varying chronic, intermediate, and acute exposure frequencies. If ATSDR does not have a published EMEG for a particular chemical, EEP used EPA's health guidance values. The health comparison values of chemicals measured at the Athletic Field are detailed in Appendix A, Table 5.

Chronic exposure is defined as one year or more. Intermediate exposure is defined as 15 – 364 days. Acute exposure is defined as fourteen days or less.

MRLs will change periodically as scientists discover more about how a particular chemical does or does not cause harm to people. The MRLs can get higher or lower. Risk assessments are

based on the best information available at the time of the assessment. Some of these screening values may have changed from 1989 to 2004.

A summary of the "do's and don'ts" of using health guidance values (DeRosa 2002) follows:

Health guidance values may be properly used as:

1. Screening values to identify substances/chemicals of concern at hazardous waste sites
2. Substance-specific trigger levels to identify possible need for further investigation of potential exposure scenarios
3. To identify populations at potential risk
4. For use in computing other health guidance values (for example, use of oral MRLs for soil ingestion screening levels)

Health guidance values should not be used as:

1. Threshold levels for a toxic effect
2. Predictors of toxicity at any given level above the health guidance value
3. Absolute values (since there is an inherent area of uncertainty surrounding them)
4. Screening values for all effects and populations (without first evaluating the relevance of the critical effect upon which the health guidance value)

Results of Soil Sampling

The 1989 soil sampling and analysis data indicate that lead is somewhat above health guidance values for residential exposures. These samples were taken from outside the playing area of the Athletic Field. However, sampling and analysis in 1990 and 2001 show that lead in surface soil is very low. Lead is a naturally occurring bluish-gray metal found in small amounts in the Earth's crust. Exposure to lead may occur in several ways: (1) by eating foods or drinking water that contain lead, (2) by spending time in areas where lead-based paints have been used and are deteriorating, (3) by working in jobs where lead is used, (4) by using health-care products or folk remedies that contain lead, and (5) by having hobbies in which lead may be used. Exposure to lead at the Athletic Field would be from swallowing or breathing dust that contains lead. In this case, only a small portion of the lead would enter the blood stream. Dermal (skin) contact with lead would also result in only a small portion of the metal passing through the skin and entering the blood stream.

Young children and children in the womb are very sensitive to lead. Exposure in the womb, in infancy, and in early childhood (before the age of seven) may slow mental development and lower intelligence later in childhood. Health workers can find out whether a child may have been exposed to harmful levels of lead by taking a blood sample (ATSDR 1999a). Even though EEP could not find two data points for the 1990 sampling events, the average concentration of lead on the Athletic Field is likely to be below the 400 mg/kg that is generally considered safe for soil at a residence where daily exposure would occur. Considering all samples as an average is appropriate because it is highly unlikely that anyone would stay in one small area of the Athletic Field to play at one time or over the course of a childhood.

During the 1989 sampling event, copper was above health guidance values, although subsequent sampling and analysis found very low levels of copper. Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and, at low levels, air. It is an essential element at low levels for all known living organisms including human and other animals. Copper is usually tightly bound to soil particles.

Ingestion of water containing large amounts of copper caused symptoms of nausea, vomiting, and abdominal pain shortly after ingestion and were not persistent. Diarrhea occurred later (ATSDR 2002). Because subsequent sampling and analysis found very low levels of copper at the Athletic Field, the average concentration of copper is likely to be well below any levels of concern.

Aluminum was found in the 1990 sampling at levels near and above ATSDR's health comparison value for children, but was not found at these levels in 1989 or 2001. Aluminum is the third most abundant element in the Earth's crust, making up approximately 8% of the Earth's surface layer. The background concentration of aluminum in soils varies widely, ranging from about 700 ppm to 100,000 ppm. The typical concentration is about 71,000 ppm. The level of aluminum measured in Wrigley soil ranged from 6,500 ppm to 14,000, lower than typical levels. Aluminum is used in many products, including antacids, astringents, buffered aspirin, food additives, and antiperspirants.

Human studies indicate that very little of aluminum in the diet and drinking water is absorbed and that aluminum is not usually harmful. In addition, most of the concentrations of aluminum found at the Athletic Field were below the health comparison value for children's ingestion of aluminum from soil. The average concentration of aluminum in surface soil is certain to be below the 10,000 ppm health guidance value when all samples are considered. Considering all samples as an average is appropriate because it is highly unlikely that anyone would stay in one small area of the Athletic Field to play at one time or over the course of a childhood (ATSDR 1999b).

EPA Region 9 has developed screening values for chemicals in soil called preliminary remediation goals (PRG). The PRG for aluminum in soil to protect residents, including children, is 76,000 mg/kg. EPA Region 9's and ATSDR's comparison values are very different, with EPA's comparison number close to the level that is typically found in soil.

Given all the considerations discussed above, aluminum in the surface soil at the Athletic Field does not pose a health hazard to children playing on the field.

Antimony is a silvery white metal of medium hardness that breaks easily. Small amounts are found in the earth's crust (ATSDR 1992). Antimony was found in the 1989 sampling outside the fenced area of the Athletic Field at measurable concentrations; concentrations found in 2001 were very low, only measurable with estimated concentrations. The concentrations of antimony measured ranged from 7.5 to 35 mg/kg (ppm) in the surface soil. Background levels of antimony in soil ranges from non-detected to about 9 mg/kg. The concentrations of antimony typically found at industrial sites ranges from 109 ppm to 2,550 ppm. ATSDR's comparison value is 20 ppm, while EPA Region 9's comparison value is 31 ppm. The average concentration of

antimony at the Athletic Field in 1989, 21 ppm, is at ATSDR's health comparison value and below EPA's health comparison value.

Calcium and magnesium were found at concentrations greater than background values at all sampling events. Iron was found at concentrations greater than background in some samples, but not in all samples. Potassium was found in concentrations greater than background in a couple of samples. The source of these chemicals is unknown. These metals are not generally considered toxic and thus are not a health concern.

Toluene was found at the Athletic Field in 1989, but was not found subsequently. Because toluene is not related to primary Wrigley site, the origin of the toluene is unknown. Toluene evaporates quickly and was not detected in 1990 or in 2001 sampling events.

In 1989 and 2001, analysis was done for semi-volatile organic compounds (polyaromatic hydrocarbons or PAHs). Levels were consistently low and below any levels of concern. In 2001, EPA analyzed soil at the Athletic Field for pesticides. Only two pesticides were detected, endrin ketone and gamma chlordane, at very low concentrations. The concentrations of these pesticides do not present a risk to people.

Children's Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

Exposure of children living in the community near the Wrigley Charcoal Site was carefully considered in the preparation of this document. Parents living near the Wrigley Charcoal Site have clearly expressed their concerns and have requested more information about the remediation processes at the site and possible hazards to their families' health. This investigation of the Athletic Field sampling and analysis did not discover chemical hazards.

Conclusions

No apparent health hazard exists for children or adults playing on the Athletic Field.

Recommendations

None at this time.

Public Health Action Plan

TDH EEP is available to review additional data and conduct site visits, as needed.

TDH EEP will provide copies of the health consultation to the environmental regulatory agencies and concerned local residents. TDH will also provide information to the community about EPA's actions to cleanup the site and to protect their health.

TDH EEP will maintain dialogue with TDEC, EPA, and ATSDR until remediation of the Wrigley Charcoal Site, Wrigley, Hickman County, is complete.

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References

[ATSDR] Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Healthy children—toxic environments. Report of the Child Health Workgroup presented to the ATSDR Board of Scientific Counselors. Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry (ATSDR). 1998. Promoting children's health—progress report of the Child Health Workgroup, ATSDR Board of Scientific Counselors. Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substance and Disease Registry (ATSDR). 1999a. Toxicological profile for Lead (Update). Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substance and Disease Registry (ATSDR). 2002. Toxicological profile for Copper (Update). Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substance and Disease Registry (ATSDR). 1999b. Toxicological profile for Aluminum (Update). Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substance and Disease Registry (ATSDR). 1992. Toxicological profile for Antimony. Atlanta: US Department of Health and Human Services.

Black and Veatch. 2003a. Final supplemental remedial investigation report, Wrigley Charcoal Site, Hickman County, Tennessee. Atlanta: U.S. Environmental Protection Agency, Region IV, Contract No. 68-W-99-043.

Black and Veatch. 2003b. Final Focused Feasibility Study Report, Wrigley Charcoal Site, Wrigley, Hickman County, Tennessee. Atlanta: U.S. Environmental Protection Agency, Region IV, Contract No. 68-W-99-043.

De Rosa CT, Holler JS, Mehlman MA. 2002. Advances in modern environmental toxicology, Volume XXVI: Impact of hazardous chemicals on public health, policy, and service. International Toxicology Books, Inc. Princeton, New Jersey.

[EBASCO] EBASCO Services Incorporated. September 1990. Final remedial investigation report, Wrigley Charcoal Site, Hickman County, Tennessee. Volume VII. Atlanta: US Environmental Protection Agency, Region IV, Contract No. 68-01-7250.

[EPA] U.S. Environmental Protection Agency. March 8, 1991. Field Investigation Report, Wrigley Charcoal Site, Wrigley, Hickman County, Tennessee. ESD Project No. 91-181.

Certification

This Health Consultation: Wrigley Charcoal Site Follow-up, Athletic Field (a/k/a Old Ball Field), Wrigley, Hickman County, Tennessee, was prepared by the Tennessee Department of Health, Environmental Epidemiology under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun.

Technical Project Officer, SPS, SSAB, DHAC, ATSDR

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

Chief, State Program Section, SSAB, DHAC, ATSDR

Appendix A

Figure 1. Athletic Field (a/k/a Old Ball Field).

Figure 2. Buford McCord Sports Park.

FIGURE 3: Soil sampling locations, 1989, 1990, 2001, Athletic Field, Wrigley Charcoal Site, Wrigley, Hickman County, Tennessee.

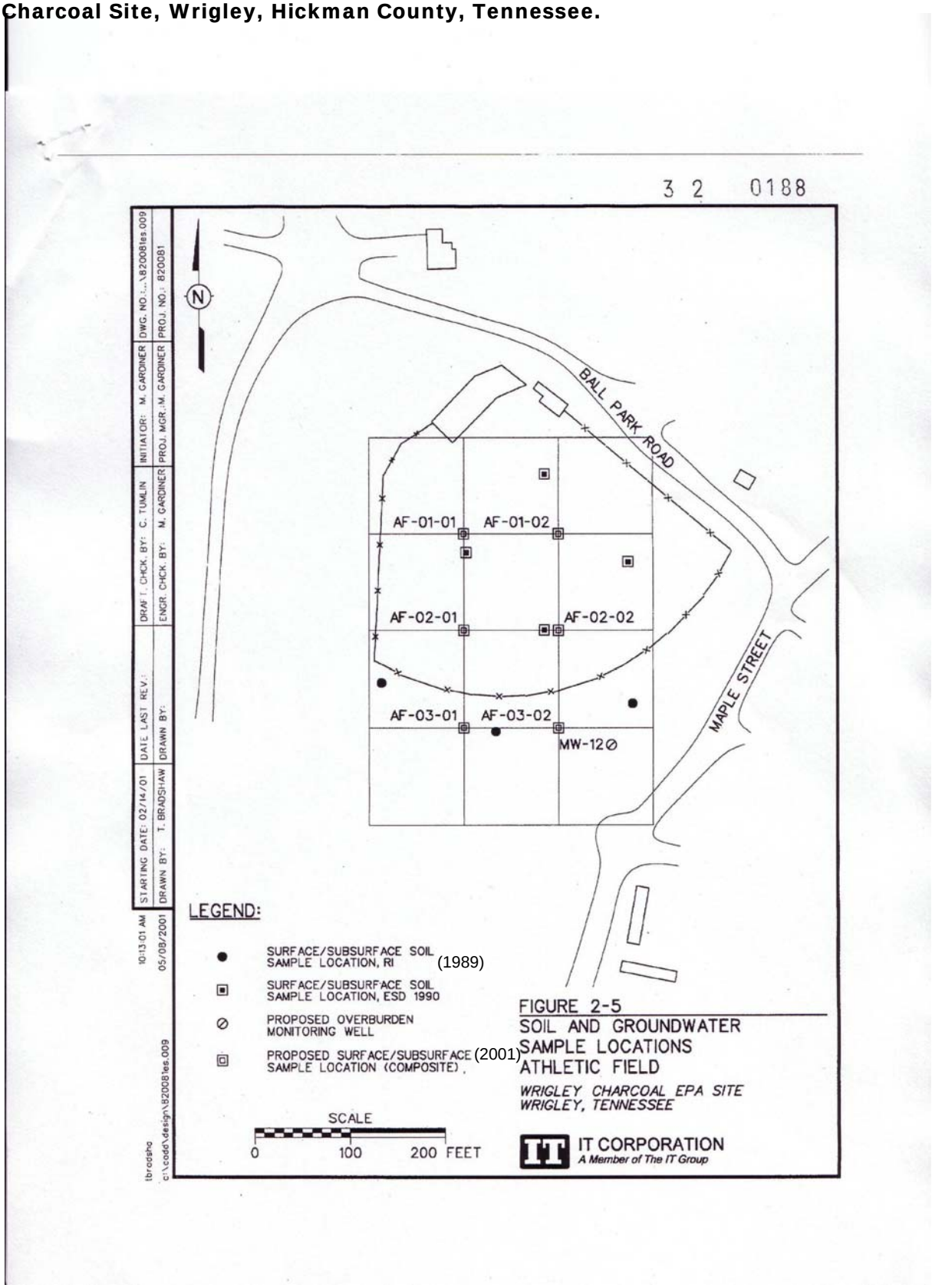

TABLE 1. Summary of US EPA August 1989 soil sampling at the Athletic Field, Wrigley Charcoal Site, Wrigley, Hickman County, TN.

Parameter	Range of Concentrations of Detected Analytes			
	Surface Soil	Surface Soil Average	Subsurface Soil	Subsurface Soil Average
Metals (mg/kg)				
Aluminum	6,100 – 9,400	7550	2,600 – 5,400	3,575
Antimony	7.5J[1]N[2] – 35JN	17.3	16 – 27	21
Arsenic	8.5J – 17J	13.6	7.2 – 8.4	7.5
Barium	570J – 640J	610	220 – 370	288
Beryllium	ND [3]	1	0.7 - 2.1	1.7
Cadmium	ND	ND	ND	ND
Calcium	6,300J – 20,000J	12,625	43,000 – 47,000	44,500
Chromium	8.6 – 56	27.7	2 – 22	14
Cobalt	8.9 – 81	41.5	5.5 – 120	61.6
Copper	840J – 69,000J	31,755	700 – 11,000	6,976
Iron	52,000 – 190,000	113,750	160,000 – 240,000	190,000
Lead	460 – 1,000	780	40 – 240	183
Magnesium	920 – 3,500	2065	720 – 5,000	2,255
Manganese	750J – 3,100J		1,900 – 2,900	2,300
Mercury	ND	ND	ND	ND
Nickel	19 – 23	21	11 – 13	12
Potassium	990 – 1,600	1,323	700 – 2,800	1,255
Selenium	1.2J – 8.3J	4.3	2.2 – 5.1	3.6
Silver	5.4J – 34J	19.2	2.5 – 31	10.5
Sodium	100 - 450	278	ND	ND
Thallium	ND	ND	ND	ND
Vanadium	21 – 39	28	21 – 37	29
Zinc	1,200 – 42,000	15,400	1,400 – 9,900	4,650
Volatile Organic Compounds (µg/kg)				
Toluene	8,100 – 41,000	22,525	8,900 – 11,000	9950
Xylenes, total	ND	ND	160J	--
Semi-Volatile Organic Compounds (µg/kg)				
Naphthalene	ND	ND	710J – 2,600J	--
Fluorene	ND	ND	420J – 620J	--
Pyrene	85J – 88J	--	460J	--
2-Methylnaphthalene	ND	ND	2,800J – 4,800J	--
Dibenzofuran	ND	ND	340J	--
Fluoranthene	21J – 74J	--	ND	ND
Benzyl butylphthlate	NND - 3,300	1098	ND	ND
Chrysene	36J – 52J	--	ND	ND

[1] J = estimated value
[2] N = presumptive evidence of presence of material
[3] ND = Not Detected

TABLE 2. Summary of US EPA December 1990 soil sampling at the Athletic Field, Wrigley Charcoal Site, Wrigley, Hickman County, TN.

Parameter	Range of Concentrations of Detected Analytes			
	Surface Soil	Surface Soil Average	Subsurface Soil	Subsurface Soil Average
Inorganics (mg/kg)				
Aluminum	9,800J [1] – 18,000J	13,000	4,500J – 14,000J	8,200
Arsenic	ND – 10J	4.9	5.8J – 31J	15
Barium	100 – 170	155	74 – 740	300
Cadmium	ND – 4.1	1.9	ND – 11	4
Calcium	4,900J – 29,000J	13,800	9,000J – 59,000J	20,000
Chromium	22 – 33	26	12 – 27	18
Cobalt	7.9 – 44	21	6.5 – 33	27
Copper	18J – 560J	254	20J – 25,000J	5,000
Iron	18,000 – 86,000	64,000	23,000 – 140,000	82,000
Lead	23 – 84	59	18 – 450	180
Magnesium	670 – 1,200	975	610 – 1,600J	1,000
Manganese	340J – 850J	690	220J – 1,600J	1,200
Mercury	ND [2]	ND	ND – 0.22	0.04
Nickel	8.4 – 12	9.4	8.4 – 16	11
Potassium	ND	ND	ND – 1,400	280
Selenium	ND – 3.2J	1.1	ND – 4.1J	1.5
Silver	ND – 5.8	2.3	ND – 10	3.4
Vanadium	28 – 36	32	8.6 – 43	18
Zinc	99 – 4,400	1800	93 – 6,400	2,800
Volatile Organic Compounds (µgkg)				
Ethyl benzene	ND	ND	ND – 2J	<2
Toluene	ND – 1J	<1	ND – 2J	<2
Dioxins/Furans (ng/kg)				
		Surface Soil	**Subsurface Soil**	
1,2,3,4,7,8-Hexachlorodibenzodioxin		ND	NS [3]	
1,2,3,6,7,8-Hexachlorodibenzodioxin		ND	NS	
1,2,3,7,8,9-Hexachlorodibenzodioxin		ND	NS	
1,2,3,4,6,7,8-Heptachlorodibenzodioxin		75 – 130	NS	
Heptachlorodibenzodioxin (total)		240J – 310J	NS	
Pentachlorodibenzodioxin (total)		ND	NS	
Hexachlorodibenzodioxin (total)		ND	NS	
Octachlorodibenzodioxin (total)		1,400 – 1,800	NS	
Hexachlorodibenzofuran (total)		ND	NS	
1,2,3,4,6,7,8-Hexachlorodibenzofuran		ND – 25	NS	
Heptachlorodibenzofuran (total)		ND – 53J	NS	
Octochlorodibenzofuran (total)		ND – 38J	NS	
Pentachlorodibenzofuran (total)		ND	NS	
TEQ (Toxic Equivalent values)		2.6 – 3.0	NS	

[1] J = Estimated Value [2] ND = Material analyzed for but not detected [3] NS = Not Sampled

TABLE 3. Results of US EPA June 2001 surface soil sampling (0 – 0.5 feet) at the Athletic Field, Wrigley Charcoal Site, Wrigley, Hickman County, TN.

Parameter	AFSS23	AFSS24	AFSS25	AFSS26 (Dup25)
Semi-Volatile Organic Compounds (µg/kg)				
2,4-Dimethylphenol	390U [1]	1,200	170J [2]	450U
2-Methylphenol	390U	1,300	64J	450U
3- and 4- Methylphenol	390U	2,500	120J	450U
Acetophenone	390U	60J	500U	450U
Benzo(a)pyrene	390UJ	450UJ	500UJ	45J
Benzo(b)fluoranthene	59J	450U	62J	62J
Benzo(k)fluoranthene	41J	450U	500U	53J
Chrysene	50J	450U	500U	54J
Fluoranthene	82J	450U	54J	75J
Indeno(1,2,3-cd)pyrene	40J	450U	500U	450U
Phenanthrene	390U	50J	500U	450U
Phenol	390U	1,400	53J	450U
Pyrene	61J	58J	57J	66J
Pesticides (µg/kg)				
Endrin Ketone	3.9U	6.6N [3]	5.2U	4.4U
Gamma-Chlordane	2U	2.3U	2.6U	0.55JN
Metals (mg/kg)				
Aluminum	8,000	10,000	5,500	6,300
Arsenic	5.9	9.8	7.3	9.9
Antimony	0.68UJ	1.1J	1.1J	1.2J
Barium	68	240	160	140
Beryllium	0.38	0.89	0.66	0.54
Cadmium	0.07U	0.62	0.09U	0.24
Calcium	3,900J	13,000J	110,000J	97,000J
Chromium	18	20	14	15
Cobalt	4.2	16	20	10
Copper	19J	650J	500J	540J
Iron	20,000	58,000	64,000	40,000
Lead	30	95	85	77
Magnesium	500	860	2,200	1,600
Manganese	380J	980J	1,000J	840J
Nickel	7.4	12	8.9	9.5
Potassium	520J	1,200J	680J	790J
Selenium	0.77UJ	2.6J	3.3J	2.1J
Silver	0.85	5.3	4	2.8
Vanadium	21	30	19	16
Zinc	210	2,700	1,700	1,600

[1] U = Material was analyzed for but not detected. The number to the left of U represents the detection limit.
[2] J = Estimated value
[3] N = Tentatively identified compound

TABLE 4. Results of US EPA June 2001 subsurface soil sampling (*&* – *&* feet) at the Athletic Field, Wrigley Charcoal Site, Wrigley, Hickman County, TN.

Parameter	AFSB23	AFSB24	AFSB25	AFSB26 (Dup25)
Volatile Organic Compounds (µg/kg)				
2-Hexanone	4.8U[1] J[2]	4.6UJ	1.8	4.6UJ
Benzene	1.9UJ	1.8UJ	0.94J	1.8UJ
Semi-Volatile Organic Compounds (µg/kg)				
3- and 4- Methylphenol	380U	54J	620U	630U
Benzo(a)anthracene	41J	470U	620U	630U
Benzo((b)fluoranthene	58J	470U	620U	630U
Chrysene	67J	470U	620U	630U
Fluoranthene	79J	470U	620U	630U
Phenanthrene	51J	49J	620U	630U
Pyrene	70J	470U	620U	630U
Pesticide/PCB (µg/kg)				
Endrin Ketone	3.8U	4.8	8.2U	6.3U
Metals (mg/kg)				
Aluminum	5,400	5,500	3,400	3,200
Arsenic	18	13	9.7	8.1
Antimony	1.1UJ	0.98UJ	1.3J	1.1UJ
Barium	370	820	380	330
Beryllium	0.93	0.76	1.3	1.2
Cadmium	0.11U	2.5	0.12U	0.11U
Calcium	31,000J	23,000J	73,000j	58,000J
Chromium	10	7.4	14	15
Cobalt	48	44	46	50
Copper	500J	500J	550J	600J
Iron	14,000	120,000	160,000	170,000
Lead	220	250	280	44
Magnesium	1,900	2,000	1,900	1,700
Manganese	1,800J	2,600J	1,900J	2,000J
Nickel	17	11	12	11
Potassium	2,600J	1,100J	840J	870J
Selenium	8.1U	7.6J	8.2J	7.2J
Silver	12	23	8.5	9.2
Sodium	330	329	171U	130U
Vanadium	12	9	16	19
Zinc	4,800	12,000	3,900	3,900

[1] U = Material was analyzed for but not detected. The number to the left of U represents the detection limit.
[2] J = Estimated value

TABLE 5. ATSDR soil comparison values and background concentrations of metals, Athletic Field, Wrigley Charcoal Site, Wrigley, Hickman County, Tennessee.

Parameter	ATSDR Comparison Values			Background
	Pica Child	Child	Adult	
Metals (ppm) (mg/kg)				
Aluminum	4,000 I [1]	10,000 I	1,000,000 I	6,500-14,000
Antimony	NA [2]	20 I	300 I	NA
Arsenic	NA	20 C [3]	200 C	3.1-14
Barium	NA	4,000	50,000	15-72
Beryllium	NA	100 C	1,000 C	ND-2.6
Cadmium	NA	10 C	100 C	ND-2.3
Calcium	NA	NA	NA	43-800
Chromium	NA	200 – 80,000[4]	2,000 – 1,000,000	13-66
Cobalt	20 I	500 I	7,000 I	5.5-120
Copper	60 I	2,000 I	20,000I	ND-38
Iron				11,000-47,000
Lead	Based on statistical modeling to maintain blood lead level less than 10 µg/dL			
Magnesium				230-410
Manganese	NA	3,000 E	40,000 E	210-740
Mercury	4 I [5]	100 I	1,000 I	ND
Nickel	NA	1,000 E	10,000 E	ND-47
Potassium				ND-990
Selenium	NA	300 C	4,000 C	ND
Silver	NA	300 E	4,000 E	ND
Sodium				ND
Thallium	NA	4 E [6]	60 E	ND
Vanadium	6 I	200 I	2,000 I	18-54
Zinc	600 I	20,000 C	200,000 C	34-340

[1] I = intermediate exposure (15 days to 364 days)

[2] NA = not available

[3] C = chronic exposure (1 year or more)

[4] EPA comparison values. The lower number is for trivalent chromium; the higher number is for hexavalent chromium. Most chromium in soil is in the trivalent state.

[5] Comparison value for mercuric chloride which may be more soluble from ingestion than the form of mercury in the soil.

[6] Comparison value for thallium acetate which may not be the form of the thallium in soil.