BrightFields, Inc.
Environmental Services

July 10, 2007

Tim Ratsep
Delaware Department of Natural Resources and Environmental Control
Site Investigation and Restoration Branch
391 Lukens Rive
New Castle, DE 19720-2774

**RE:** Final Remedial Action Plan
Former Hercules Road Parcel/Delaware National Country Club Golf Course
Wilmington, Delaware

Dear Mr. Ratsep:

BrightFields, on behalf of our client Toll Brothers, Inc., is providing the attached Final Remedial Action Plan (FRAP) for the subject property.

If you have any questions, please contact me at 302-656-9600.

Sincerely,
**BrightFields, Inc.**

J. Curtis Hatfield, P.E.
Program Manger

Attachments – Final Remedial Action Plan

*801 Industrial Street, Suite 1 ♦ Wilmington, DE 19801 ♦ (302) 656-9600 ♦ Fax (302) 656-9700*

# FINAL REMEDIAL ACTION PLAN
# HERCULES ROAD PARCEL/FORMER DELAWARE NATIONAL COUNTRY CLUB GOLF COURSE
# WILMINGTON, DELAWARE
**July 9, 2007**

On behalf of our client, Toll Brothers, Inc., BrightFields, Inc. has prepared this summary of the remedial action (RA) to present the approach for remediation at the Former Delaware National/ Hercules Country Club Golf Course site in Wilmington, Delaware.

## INTRODUCTION

The majority of the proposed cleanup site was previously used as a nine-hole golf course on Hercules Road, separate from the active section of the 18-hole Delaware National Country Club golf course along Lancaster Pike at the intersection with Hercules Road. The former golf course has subsequently grown over and appears as an open field. The remaining portion of the lot is an unoccupied wooded area. Toll Brothers, Inc. plans to construct approximately 160 single family residential units with accompanying common areas on the property.

## SITE DESCRIPTION AND HISTORY

The subject property is located on Hercules Road, approximately 2,000 feet west of the Newport Gap Pike (State Route 41) and south of Lancaster Pike (State Route 48) in Wilmington, Delaware (Figure 1). The site is composed of two tax parcels. The northern parcel was formerly used as a nine-hole golf course and covers an area of approximately 101 acres (tax parcel ID# 08-026.00-052 [Lot 5]). The parcel has been maintained as a golf course since 1947. The southern parcel is unoccupied and wooded and is approximately 61 acres (tax parcel ID# 08-033.00-001 [Lot 10]). The surrounding land is generally residential. The Hercules Research Center is adjacent to the site, occupying approximately 45 acres, the majority of which is used for development and research chemistry studies for Hercules. The Research Center, which consists primarily of research and product development laboratories, has been the subject of a separate RCRA Corrective Action Cleanup regulated by DNREC's Solid and Hazardous Waste Management Branch.

The site generally slopes toward the south. Surface water drainage discharges into Hyde Run and its tributaries on the western side of the property and into an unnamed tributary of Red Clay Creek on the eastern side.

The nearest designated New Castle County Water Resource Protection Area (WRPA), including wellheads or groundwater protection areas, is approximately 750 feet from the site (non-transient, non-community wells). The nearest surface water supply intake is greater than two miles from the site. Based on DNREC's December 1999 HSCA *Remediation Standards Guidance*, the site is not within a Critical Water Resource Area.

## ENVIRONMENTAL INVESTIGATION

In October 2004, BrightFields, Inc. (BrightFields) reported on a Remedial Investigation (RI) and Feasibility Study of the site. DNREC staff provided comments on the draft RI including requests for additional sampling and analysis which was subsequently performed by BrightFields. The RI process has involved multiple investigations for more data. In correspondence dated February 20, 2007 DNREC stated that the RI "meets the substantive requirements for a Remedial Investigation under the provisions under the Delaware Hazardous Substance Cleanup Act (HSCA) and Regulations pursuant thereto." The study incorporated the findings of a sampling event performed by TriState Environmental Management Services, Inc. (TriState) in 2003. It also included results of sampling events carried out by BrightFields in late 2003.

The environmental investigation included extensive soil samples, shallow groundwater samples, sediment samples, and ground water samples. The investigation methods and results are discussed below.

### Soil

TriState drilled approximately 79 borings throughout the property and collected 143 soil samples. Samples contained elevated concentrations of arsenic, lead, chlordane, 4-4' DDE, heptachlor epoxide and dieldrin. Samples collected from golf course greens were significantly higher in concentration than those collected from fairways.

On October 17, 2003, BrightFields personnel collected a total of four soil samples from two greens. Technical chlordane (and two of its components alpha and gamma chlordane), dieldrin, heptachlor epoxide, aldrin, arsenic, cadmium, lead and mercury were detected in several of the soil samples collected from both greens.

In November of 2003, BrightFields conducted a more extensive investigation on the property which included the collection of soil, groundwater, sediment and surface water data on the property. Twenty soil samples (10 surface and 10 subsurface) were collected from 10 locations not associated with greens, tees or fairways and were analyzed at Lancaster Laboratories for a wide range of contaminants (TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals and cyanide). The soil samples were collected from depths ranging from 0 to 12 feet below ground surface (bgs) across the golf course property. The sampling locations were selected from non-golf course areas to evaluate whether there may be a source of contaminants unrelated to the golf course operations. The data was used to supplement existing data previously collected by Tri-State and BrightFields sampling of representative greens. Collectively the data was used to prepare a Remedial Investigation Scope of Work that met the requirements of HSCA. Elevated arsenic was not detected above the Delaware default background standard of 11 mg/kg (DNREC 2004) in these samples. Cyanide, SVOCs, VOCs, pesticides, and PCBs were either not detected or were detected below screening criteria.

During the RI Investigation, BrightFields also collected 102 soil samples from the two greens that had elevated concentrations of arsenic. Based on the results of the BrightFields Greens Characterization, arsenic, mercury, cadmium, and lead were detected at elevated concentrations in soil samples from the green, fringe, and rough areas of greens 2 and 4 from the surface to a maximum depth of 3.5 feet bgs.

To date more than 350 soil samples have been collected and analyzed from 179 locations across the site (samples were taken at various depths in some locations). Additional soil samples will be collected and analyzed throughout the proposed remedial action in conjunction with the collection of real time field screening data (i.e., XRF soil analysis).

**Groundwater**

BrightFields used a direct-push device to place ten shallow wells. Eight ground water samples were collected and analyzed. Iron, manganese and chloroform were present in several samples.

**Surface Water and Sediment**

Nine surface water and 9 sediment samples were collected from locations shown on Figure 2. Metals and pesticide-related compounds were detected in several samples.

**Supplemental Investigations**

On January 27, 2005, BrightFields worked with Eastern States Engineering (ESE) as they excavated five test pits in the golf course using a backhoe. The test pits were excavated in one-foot intervals down to ESE's desired test depth. At every one foot interval, BrightFields collected a sample from the side wall of the excavation. A composite sample was obtained at every six-inch interval, down to four feet below ground surface. A total of five test pit locations, each having eight samples obtained at six-inch depth intervals below ground surface (bgs) (0-0.5 ft, 0.5-1 ft, 1-1.5 ft, 1.5-2 ft, 2-2.5 ft, 2.5-3 ft, 3-3.5 ft, and 3.4-4 ft bgs), were advanced on the property.

The laboratory results for the test pit samples indicated that organochlorine pesticides and RCRA metals were not detected above the Delaware URS for unrestricted use in soil at depths below 0.5 ft bgs in any of the test pit locations. This data confirmed vertical distribution trends found in previous samples reported in BrightFields' Remedial Investigation/Feasibility Study, October 2004.

In February 2006, per DNREC direction, BrightFields conducted additional soil investigations on the southern wooded lot (#10) to assess whether golf course operations on the adjacent lot have impacted this area where future residential lots are planned. Twenty-one hand auger locations, each having samples obtained at three depth intervals below ground surface (0-0.5 ft, 0.5-1 ft, and 1-1.5 ft), were advanced on the wooded lot.

Additional soil investigations on the golf course were also performed to confirm that additional pesticide/herbicide compounds (2,4-D, Glyphosate, Oxadiazon, and Chlorpyrifos), not analyzed previously, have the same vertical distribution with arsenic as the currently known pesticides documented in BrightFields' Remedial Investigation/Feasibility Study, October 2004. Six hand auger locations, with samples obtained at three different depth intervals below ground surface (0-0.5 ft, 0.5-1 ft, and 1-1.5 ft), were advanced on the golf course.

A composite sample was also collected from the golf course to be analyzed for waste characterization parameters. The waste characterization analysis performs a set of tests that classifies the soil as either non-hazardous or hazardous, and determines whether a disposal facility will accept the material for off-site disposal.

According to the laboratory analytical data from the soil samples collected in the wooded lot, none of the compounds analyzed were detected at levels above the State's Uniform Risk Based Standard (URS) for unrestricted (residential) use. The soil that was tested does not appear to be impacted by the application of pesticides and herbicides on the adjacent golf course and therefore the area of concern will not need to expand.

The lab results for the golf course samples establish that the additional pesticides/ herbicide compounds analyzed (2,4-D, Glyphosate, Oxadiazon, and Chlorpyrifos) were not at levels above the URS for residential use. This confirms that no modifications need to be made to the conclusions or remedial action objectives of the BrightFields' Remedial Investigation/Feasibility Study.

Based on the results of this soil Waste Characterization analysis, the material expected to be removed off-site for remediation purposes should be classified as non-hazardous.

## CONCLUSIONS

The conclusion of the remedial investigation is that compounds of concern on the site are mainly associated with soil on the greens, tees, and fairways, with concentration on greens and tees substantially higher than fairways, thus indicating the source of impact is from historical golf course maintenance activities. Due to the reconfiguration of two golf course holes during the 1980's there is an area of the property that demonstrates impact although it is not currently used as a green, tee, or fairway. Impacted areas will be subject to remediation regardless of their current use.

**Soil--**These compounds include pesticides (including: chlordane, 4-4' DDE, heptachlor epoxide and dieldrin) and metals (including: arsenic, lead, cadmium and mercury). Specifically arsenic appears to be present to depths of 3.5 feet bgs in some greens and tees, to depths of 1.5 feet bgs in the fringe and rough areas of the greens and to 6 inches bgs in the fairways. Based on the results of the TriState and BrightFields investigations, arsenic had a high degree of correlation to elevated levels of pesticides associated with golf course greens and tees.

Four of 9 tees, 5 of 8 fairways and two additional areas have arsenic concentrations between 11 and 37 mg/kg. Seven of 9 greens, 2 practice greens, 2 of 9 tees and one fairway have arsenic concentrations exceeding 37 mg/kg. The areas of contamination are shown on Figure 2.

**Sediment**--An area of sediment in a small stream tributary to Red Clay Creek (shown on Figure 2) has pesticide contamination.

**Surface water**--Surface water samples taken at locations SW01, SW04, SW05 and SW07 have alpha and gamma chlordane consistent with concentrations found at the background location (SW03). Higher concentrations of alpha chlordane are present in samples from SW08 and SW09. These elevated concentrations are likely due to historical runoff from identified impacted areas of this site.

**Ground water**--Iron and manganese are naturally occurring substances in ground water. They affect the taste and odor of drinking water but are not toxic at the concentrations present. Chloroform detected in two shallow wells (MW04 and MW03) may be related to the application of agricultural chemicals, however it is a common laboratory contaminate and may not represent true field conditions.

Additional sampling, during and after the remedial action, will be conducted, similar to a standard HSCA cleanup site.

## HUMAN HEALTH RISKS

The cumulative risk calculations indicate that exposure to site soil that is not associated with greens, tees or fairways does not pose an unacceptable carcinogenic or non-carcinogenic risk under the unrestricted (residential) use scenario.

Elevated arsenic concentrations on some of the greens and tees would result in unacceptable risks in a residential land use scenario if remediation were not performed.

Traces of inorganic substances and pesticides in shallow ground water and surface water do not contribute significantly to human health risks. Shallow groundwater at the site will not be used for drinking water supply and is not considered a risk for vapor intrusion into structures on the site.

Pesticide related compounds in sediment represent potential human health risks and current environmental risks.

## REMEDIAL ACTION OBJECTIVES

Qualitative objectives describe, in general terms, what the ultimate result of the cleanup action, if necessary, should be. The following qualitative objectives have been determined to be appropriate for the Delaware National site:

- Control potential human contact (dermal and ingestion) with, and ecological impact to contaminated sediment (on-site stream).
- Minimize migration of contaminated soil to the surface water (on-site drainage swale/stream).
- Reduce migration of pesticide-related compounds from soil to ground water.
- Control potential human contact (dermal, inhalation and ingestion) with contaminated soil.

These objectives are consistent with the planned development of the site for residential use, New Castle County zoning policies, state regulations governing water supply, State HSCA regulations and remediation standards guidance, and worker health and safety.

Quantitative objectives define specific levels of remedial action to achieve protection of human health and the environment. Based on the qualitative objectives, the quantitative objectives will be used so that future site users such as visitors and workers do not come in contact with soils that contain elevated levels of pesticides (including: chlordane, aldrin, heptachlor epoxide and dieldrin) and metals (including: arsenic, lead, cadmium and mercury).

Confirmatory sampling (to be performed by a laboratory) is a planned component of the remedial action, for both soil excavation and soil blending activities. Note that field sampling data collected with XRF technology is intended to guide field operations, but will not be used as final confirmation of achieving the remedial action objectives. Post-remedial confirmatory sampling will include laboratory analysis for arsenic, cadmium, lead, mercury, chlordane, heptachlor epoxide, aldrin, and dieldrin.

Documentation of achievement of target cleanup levels (i.e., Unrestricted Use) will follow established HSCA protocols for demonstration of attainment requirements published in the December 1999 DNREC Remediation Standards Guidance Document.

## REMEDIAL ACTION TASKS

The following remedial action tasks are presented in the sequence in which they will be performed. An Erosion and Sediment Control Plan has been submitted to New Castle County that provides the relevant details for the associated sediment and erosion controls. In addition to the work scope outlined herein, the remedial work will be performed in accordance with a Health and Safety Plan, and contractors will be provided with appropriate specifications and training covering the environmental nature and contingencies associated with the project. BrightFields personnel will be onsite during intrusive subsurface and soil handling activities during the remediation to provide environmental health and safety oversight and guidance for onsite workers and monitor for conditions that could affect the surrounding environment (e.g., nuisance dust monitoring). BrightFields will provide Toll Brothers with documentation on sampling data, off-site soil removal, and post-remedial soil conditions.

Based on an evaluation of the site information, which includes current and past environmental investigations, historical information, the above remedial action objectives, and the remedial alternatives evaluated in the remedial alternatives evaluation study the following remedial actions will be implemented:

### TASK 1 – Install Construction Entrance and Vehicle Washing Station

A construction entrance and separate truck washing area will be installed on site by the contractor as part of the required site stabilization depicted on the E&S Plan. The entrance will be created using stone as a ground cover which all construction vehicles will be required to use for access to the property. Soil on vehicle tires will be washed off before leaving the property to prevent material from being tracked off-site.

### TASK 2 – Remove and Dispose of ACM Irrigation Pipe

Irrigation piping known to contain asbestos containing materials (ACM) will be removed from the subsurface. The location and depth of the underground piping is mostly unknown, therefore the removal will begin at the known locations and the removal process will follow the pipe as it is encountered. The process will involve trenching with a backhoe to locate and remove the pipes.

Due to the asbestos content identified in the pipe material, the removal will be performed by a licensed asbestos abatement contractor. BrightFields personnel licensed by the State of Delaware to perform Project Monitoring services will oversee the contractor during the removal to document compliance with applicable regulations and to monitor ambient conditions. The removed pipe will be wrapped and transported offsite for proper disposal. After the pipes are removed and trenches backfilled, the disturbed soil will be stabilized in accordance with Delaware Sediment and Stormwater Regulations.

**TASK 3 – Remediate Impacted Soil**

Following removal of the irrigation piping the soil remediation tasks will begin. We anticipate starting with excavation of the areas identified in Section 3.1 (mostly former greens and tees), then conducting soil blending as discussed in Section 3.2. Following the soil blending the site work required for construction will take place and when the individual building lots are staked out and graded the testing outlined in Section 5 will be performed.

BrightFields has developed soil remediation guidelines based upon the stated Remedial Action Objectives:

**3.1 Offsite disposal of soil areas containing arsenic concentrations above 37 mg/kg**

Soil identified during the Remedial Investigation containing arsenic concentrations greater than 37 mg/kg has been identified in the following locations, (see Figure 2):

- Green 1
- Green 2
- Green 3
- Green 4
- Green 5
- Green 8
- Green 9
- Practice Green 3
- Men's Tee, Hole 1
- Tee, Hole 2
- End, Fairway 8

The impacted soil in these locations will be excavated and loaded directly into trucks for offsite disposal. Based on the sampling data reported in the RI/FS, the estimated depth of excavation in these areas is 1.5 feet below ground surface (bgs) to remove soil containing an arsenic concentration above 37 mg/kg. BrightFields will perform post excavation confirmatory sampling using x-ray fluorescence spectroscopy (XRF) technology to verify that remaining soils have arsenic concentrations below 37 mg/kg. The XRF technology provides real time data in the field so that further excavation can be done if necessary to achieve the target cleanup objectives. Additional confirmatory samples will be collected for laboratory analysis of RCRA metals and target pesticides and herbicides (See Appendix A).

Material removed from the site for disposal will go to a licensed facility, or location pre-approved by DNREC if applicable, with documentation on final quantities provided to Toll Brothers. BrightFields estimates that approximately 5,000 cubic yards of material will be generated from the areas listed above.

### 3.2 Blending of soil with arsenic concentrations between 11 mg/kg and 37 mg/kg

The next step in the remediation sequence will be to address soil identified in the RI/FS with arsenic concentrations between 11 mg/kg and 37 mg/kg that has been identified in the following locations, (see Figure 2):

- Practice Green 1
- Fairway 1
- Fairway 3
- Fairways 4 (2 locations)
- Fairway 5
- Fairway 8
- Fairway 9
- Women's Tee, Hole 1
- Tee, Hole 3
- Tee, Hole 4 (2 locations)
- Tees, Hole 8 (2 locations)
- Tees, Hole 9 (3 locations)
- Area A (large section between fairway 3 and practice green 3)

The remedy selected for this soil calls for mechanically blending the soil resulting in lower overall concentrations of residual contaminants. The premise of this remedy is based on the RI/FS data that indicates that soil with arsenic concentrations above 11mg/kg is present in the interval of 0 to 1 foot below the surface. Blending includes soil with elevated arsenic concentrations and soil without the elevated concentrations to achieve the stated Remedial Action Objectives.

The soil blending process will result in soil suitable for construction without environmental restrictions because the resulting concentrations will be less than the Remedial Action Objectives. This will be verified by BrightFields through confirmatory sampling and XRF technology. BrightFields will also be onsite during the blending operation to provide environmental health and safety monitoring and guidance on remedy implementation.

For the post-blending surface to be structurally suitable for construction purposes the contractor will remove the upper layer of organic material. Since this will occur after the blending operation and associated confirmatory testing this material will be suitable for reuse in an onsite borrow exchange.

**TASK 4 – Remediate Impacted Sediment**

The Remedial Investigation Report indicates that there are approximately 120 cubic yards of sediment materials with elevated pesticide concentrations in an existing drainage depression. The sediment will be transported offsite for disposal as non-hazardous material as defined by RCRA. This work will be scheduled in conjunction with the proposed stream stabilization work during the final stages of the project under the jurisdiction and permit from DNREC Sediment and Stormwater Branch.

Sediment material with high moisture content may be mixed onsite with an inert drying agent (i.e. kiln dust) as necessary to lower the moisture content to a level acceptable at the disposal facility.

**TASK 5 – Conduct Post-Remediation Sampling**

As discussed above, BrightFields will collect real time post-remedial confirmatory samples utilizing XRF technology to document that the remedial action objectives have been achieved by excavation and soil blending operations. In addition, BrightFields will collect additional confirmatory samples that will be submitted to a laboratory for analysis of post-remedial site conditions.

BrightFields will collect samples for laboratory analysis of the surface soils in areas that soil has been excavated or blended to document that these soils achieve the remedial action objectives and meet the DNREC-SIRB Unrestricted Use (residential) cleanup criteria. Fifty-nine soil samples will be obtained from the excavated areas. A minimum of 5 samples will be obtained from each individual excavation area. Four samples will be removed from the sidewalls of the excavations, one each from the north, east, south, and west directions; and one sample will be obtained from the base of the excavation. Two additional sidewall samples will be collected from the excavations at Green 8 and Practice Green 3 due to their larger area.

Eighty soil samples will be obtained from the blended areas. The number of samples was determined using the Singer and Wickman algorithm formula which indicated that at least sixty-four sample points are necessary. BrightFields increased the number of sampling locations to eighty to accommodate several sample grid layouts and increase coverage in individual hot spot areas. Appendix A contains documentation of the sampling design for the blended areas.

The confirmatory samples will be submitted for laboratory analysis of the contaminants of concern identified in the RI/FS; which are arsenic, cadmium, lead, mercury, chlordane, heptachlor epoxide, aldrin, and dieldrin. Soil data from the remediation areas were used to determine the contaminants of concern at the site. All the soil data from the areas that are scheduled to be remediated that had been analyzed by an outside laboratory was examined to determine which analytes were present above the unrestricted use URS.

In addition, the 95% UCLs from this data set were entered into the DNREC Site-Specific Standard Calculator for multiple analytes. Those analytes that were found, based on this risk assessment, to exceed either a carcinogenic risk $10^{-6}$ or a Hazard Index of 0.1 were retained. This distinction is based on criteria presented in the EPA guidance (USEPA, 2000) where contaminants of concern (COCs) can be eliminated based on a lack of risk. Contaminants that exceeded their specific URS but did not exceed the above listed risk factors were removed as potential COCs. The results showed that all the analytes that exceeded the unrestricted URS, except DDE, also were found to present a significant risk.

The next phase of site development will be grading and earthwork leading to construction of the planned residential development. Once building lots have been surveyed and staked, and excavation work completed (i.e., for basements), BrightFields will collect samples of the surface soils for laboratory analysis to document that these soils achieve the remedial action objectives and meet the DNREC-SIRB Unrestricted Use (residential) cleanup criteria. This sample will be collected as a five-point composite across each individual building lot. Samples will be analyzed for the same compounds listed above. Additional removal and/or blending of contaminated soils will be performed as needed if analysis indicates concentrations exceeding the remedial action objectives. Following receipt of the analysis documenting that remedial action objectives are achieved, construction may proceed and the surface of the site can be finished off by the placement of topsoil.

### TASK 6 – Prepare Final Remedial Summary Report

Upon completion of the remediation project BrightFields will prepare a final remedial summary report that documents the completed actions. The summary report will provide tabulations of offsite disposal activities with appropriate documentation, and a compilation of confirmatory sampling data from all post remedial sampling. This will be in addition to the monitoring reports compiled daily during the remediation. BrightFields will provide the monitoring reports to DNREC and DNREC has indicated that they will make the summary reports available to the public.

## DUST MONITORING DURING REMEDIAL ACTION TASKS

During excavation/blending activities the dust concentrations in the air at the actual excavation/blending operation will be monitored for dust particulates using a Personal Data-logging Real-time Aerosol Monitor (DataRAM), which is a hand held dust meter. Protection of excavation workers will be performed by monitoring dust particulates at the location of the excavating/blending activities and taking actions as needed consistent with Section 3 of the Health and Safety Plan (HASP) for Construction Activities Associated with Hercules Road Property, April 2007. The worker health and safety program is detailed in that HASP.

In addition, during excavation/blending activities, the dust concentrations in the air around the perimeter of the property will also be monitored using dust meters. This perimeter monitoring will be undertaken using Environmental Particulate Air Monitors (EPAM-5000), or equivalent, to evaluate if dust is extending beyond the point of excavation. Dust reducing procedures are an integral part of the remediation scope of work and actions to be taken in the event that dust levels rise are also spelled out in the scope of work.

See Appendix B for the complete Perimeter Air Monitoring Plan.

**Potential of Arsenic Inhalation**

BrightFields has assessed that under the current circumstances at the Hercules Road Property site, the inorganic arsenic located in the soil remediation areas is not an inhalation threat to workers or the public as a result of volitization.

Research has shown that arsenic compounds are not expected to volatilize from moist soil surfaces;[1] however, arsenic compounds in soil may be methylated by microorganisms and subsequently lost by volatilization. Biotransformation of arsenic can produce highly volatile compounds such as arsine (AsH3), dimethylarsine (HAs(CH3)2) and trimethylarsine (As(CH3)3), although it would take extremely anoxic environments for production to take place.[1,2] BrightFields does not expect extremely anoxic environments within the work area of the property.

To prevent worker and public inhalation of possible arsenic contaminated airborne dust, a dust suppression program will be implemented for all site activities that create sustained airborne dust concentration in the breathing zone that exceed the action levels outlined in the Health and Safety Plan (HASP).

A miniram device will be used by the onsite Safety Officer to measure the levels of air borne dust particles. If airborne dust exceeds the action level, water controls will be used to wet the problem areas and reduce the airborne dust to safe levels.

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1 "Arsenic Compounds" Hazardous Substances Data Bank. Last reviewed: 9/15/2001, U.S. National Library of Medicine, National Institutes of Health, Department of Health & Human Services, <http://www.toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~nenK18:2>

2 Bodek, Ph.d., Itamar, Warren J. Lyman, Ph.D., William F. Reehl, and David H. Rosenblatt, Environmental Inorganic Chemistry, New York: Pergamon Press, 1988. chapters 7.25-7.26

## SITE HEALTH AND SAFETY OVERSIGHT

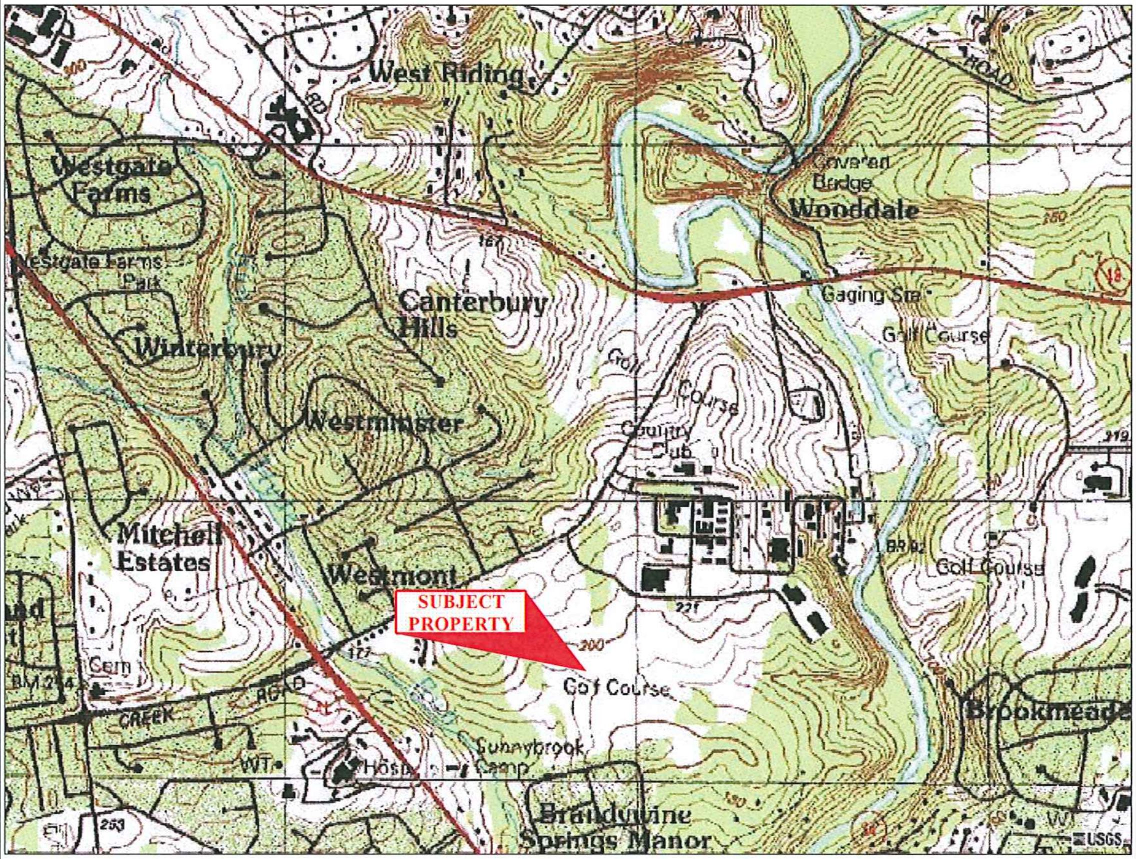
BrightFields will conduct environmental health and safety oversight during implementation of the remediation. This will include field monitoring and sample collection to confirm that the Remedial Action Objectives are achieved, that materials are handled and disposed in accordance with applicable regulations, and monitoring of site conditions (i.e., dust) for compliance with applicable health and safety regulations. Contingency plans will also be prepared which address procedures in the event unforeseen environmental conditions are encountered during implementation of the remedy. BrightFields will coordinate oversight and monitoring activities with DNREC and will document activities throughout remedy implementation.

# REFERENCES

1. BrightFields Remedial Investigation/Feasibility Study, October 2004
2. BrightFields Supplemental Soil Sampling Report, April 2006
3. BrightFields Summary of Test Pit Investigation at the Hercules Road Property, March 2007
4. Delaware Regulations Governing Hazardous Substance Cleanup
5. Remediation Standards Guidance
6. Standard Operating Procedures for Chemical Analytical Programs under HSCA.
   Operation and Maintenance Guidance Document for HSCA and VCP Sites.

# FIGURE 1

BrightFields, Inc.




## FIGURE 1 - Topographic Map

*USGS Topo Map 1 Jul 1998 ( downloaded from TerraServer 9/26/03*

Hercules Road Property

Wilmington, Delaware

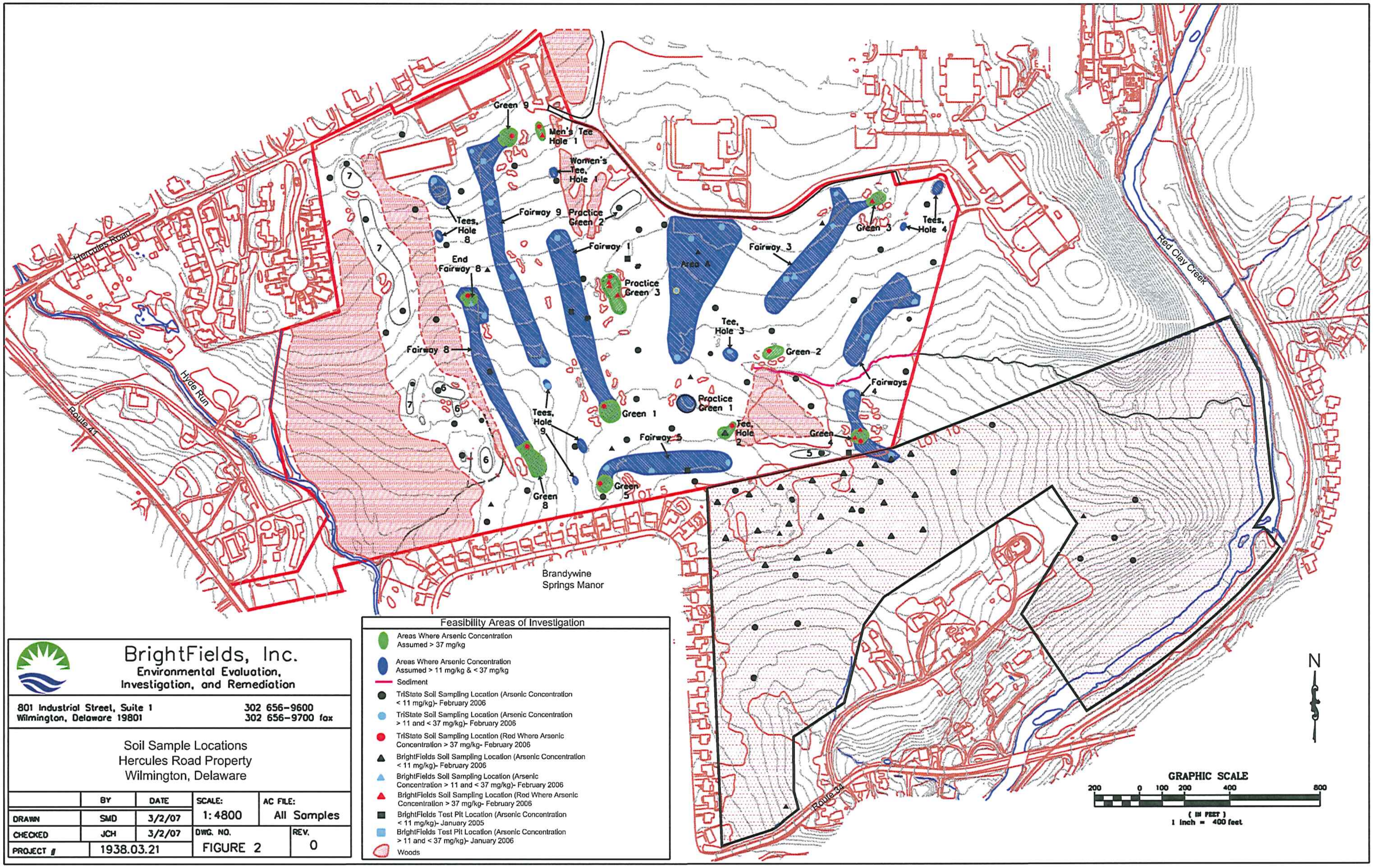
File # 1938.01.21

0 2,000

SCALE (feet)

N

# FIGURE 2




**BrightFields, Inc.**
Environmental Evaluation, Investigation, and Remediation

801 Industrial Street, Suite 1
Wilmington, Delaware 19801

302 656-9600
302 656-9700 fax

Soil Sample Locations
Hercules Road Property
Wilmington, Delaware

| | BY | DATE | SCALE: | AC FILE: |
|---|---|---|---|---|
| DRAWN | SMD | 3/2/07 | 1:4800 | All Samples |
| CHECKED | JCH | 3/2/07 | DWG. NO. | REV. |
| PROJECT # | 1938.03.21 | | FIGURE 2 | 0 |

**Feasibility Areas of Investigation**

- Areas Where Arsenic Concentration Assumed > 37 mg/kg
- Areas Where Arsenic Concentration Assumed > 11 mg/kg & < 37 mg/kg
- Sediment
- TriState Soil Sampling Location (Arsenic Concentration < 11 mg/kg)- February 2006
- TriState Soil Sampling Location (Arsenic Concentration > 11 and < 37 mg/kg)- February 2006
- TriState Soil Sampling Location (Red Where Arsenic Concentration > 37 mg/kg- February 2006
- BrightFields Soil Sampling Location (Arsenic Concentration < 11 mg/kg)- February 2006
- BrightFields Soil Sampling Location (Arsenic Concentration > 11 and < 37 mg/kg)- February 2006
- BrightFields Soil Sampling Location (Red Where Arsenic Concentration > 37 mg/kg- February 2006
- BrightFields Test Pit Location (Arsenic Concentration < 11 mg/kg)- January 2005
- BrightFields Test Pit Location (Arsenic Concentration > 11 and < 37 mg/kg)- January 2006
- Woods

# APPENDIX A

## Summary of the Sampling Design for Blended Areas

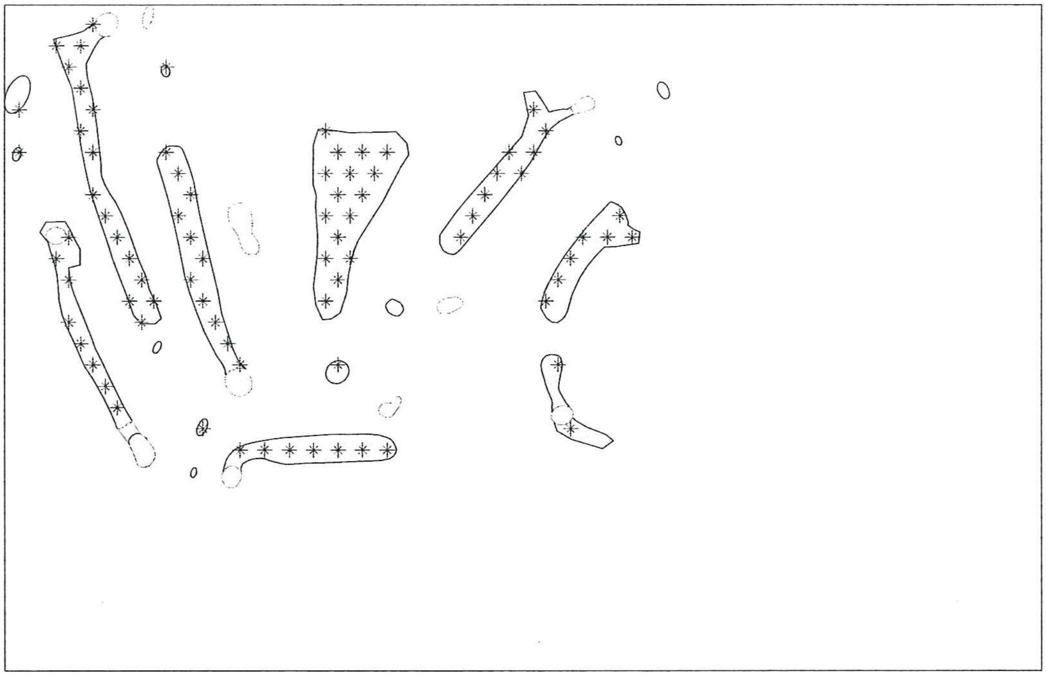
**Systematic sampling locations for detecting an area of elevated values (hot spot)**

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

| SUMMARY OF SAMPLING DESIGN | |
|---|---|
| Primary Objective of Design | Detect the presence of a hot spot that has a specified size and shape |
| Type of Sampling Design | Hot spot |
| Sample Placement (Location) in the Field | Systematic (Hot Spot) with a random start location |
| Formula for calculating number of sampling locations | Singer and Wickman algorithm |
| Calculated total number of samples | 84 |
| Type of samples | Point Samples |
| Number of samples on map [a] | 81 |
| Number of selected sample areas [b] | 1 |
| Specified sampling area [c] | 507397.15 $ft^2$ |
| Grid pattern | Triangular |
| Size of grid / Area of grid [d] | 83.9205 feet / 6099.11 $ft^2$ |
| Total cost of sampling [e] | $43000.00 |

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Size of grid / Area of grid gives the linear and square dimensions of the grid spacing used to systematically place samples.
[e] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



| Area: Area 1 | | | | | |
|---|---|---|---|---|---|
| X Coord | Y Coord | Label | Value | Type | Historical |
| 592583.8054 | 637911.7647 | | | Hotspot | |
| 592667.7258 | 637911.7647 | | | Hotspot | |
| 592751.6463 | 637911.7647 | | | Hotspot | |
| 592835.5668 | 637911.7647 | | | Hotspot | |
| 592919.4873 | 637911.7647 | | | Hotspot | |
| 593003.4077 | 637911.7647 | | | Hotspot | |
| 593087.3282 | 637911.7647 | | | Hotspot | |
| 592457.9246 | 637984.4420 | | | Hotspot | |
| 593716.7318 | 637984.4420 | | | Hotspot | |
| 592164.2030 | 638057.1192 | | | Hotspot | |
| 592122.2427 | 638129.7965 | | | Hotspot | |
| 592080.2825 | 638202.4738 | | | Hotspot | |
| 592583.8054 | 638202.4738 | | | Hotspot | |
| 592919.4873 | 638202.4738 | | | Hotspot | |
| 593674.7716 | 638202.4738 | | | Hotspot | |
| 592038.3223 | 638275.1510 | | | Hotspot | |
| 592541.8451 | 638275.1510 | | | Hotspot | |
| 591996.3620 | 638347.8283 | | | Hotspot | |
| 592248.1234 | 638347.8283 | | | Hotspot | |
| 592499.8849 | 638347.8283 | | | Hotspot | |
| 592206.1632 | 638420.5055 | | | Hotspot | |
| 592290.0837 | 638420.5055 | | | Hotspot | |

| | | | | | |
|---|---|---|---|---|---|
| 592457.9246 | 638420.5055 | | | Hotspot | |
| 592877.5270 | 638420.5055 | | | Hotspot | |
| 593632.8113 | 638420.5055 | | | Hotspot | |
| 591996.3620 | 638493.1828 | | | Hotspot | |
| 592248.1234 | 638493.1828 | | | Hotspot | |
| 592415.9644 | 638493.1828 | | | Hotspot | |
| 592919.4873 | 638493.1828 | | | Hotspot | |
| 593674.7716 | 638493.1828 | | | Hotspot | |
| 591954.4018 | 638565.8601 | | | Hotspot | |
| 592206.1632 | 638565.8601 | | | Hotspot | |
| 592457.9246 | 638565.8601 | | | Hotspot | |
| 592877.5270 | 638565.8601 | | | Hotspot | |
| 592961.4475 | 638565.8601 | | | Hotspot | |
| 593716.7318 | 638565.8601 | | | Hotspot | |
| 591996.3620 | 638638.5373 | | | Hotspot | |
| 592164.2030 | 638638.5373 | | | Hotspot | |
| 592415.9644 | 638638.5373 | | | Hotspot | |
| 592919.4873 | 638638.5373 | | | Hotspot | |
| 593339.0896 | 638638.5373 | | | Hotspot | |
| 593758.6920 | 638638.5373 | | | Hotspot | |
| 593842.6125 | 638638.5373 | | | Hotspot | |
| 593926.5330 | 638638.5373 | | | Hotspot | |
| 592122.2427 | 638711.2146 | | | Hotspot | |
| 592374.0042 | 638711.2146 | | | Hotspot | |
| 592877.5270 | 638711.2146 | | | Hotspot | |
| 592961.4475 | 638711.2146 | | | Hotspot | |
| 593381.0499 | 638711.2146 | | | Hotspot | |
| 593884.5727 | 638711.2146 | | | Hotspot | |
| 592080.2825 | 638783.8919 | | | Hotspot | |
| 592415.9644 | 638783.8919 | | | Hotspot | |
| 592919.4873 | 638783.8919 | | | Hotspot | |
| 593003.4077 | 638783.8919 | | | Hotspot | |
| 593423.0101 | 638783.8919 | | | Hotspot | |
| 592374.0042 | 638856.5691 | | | Hotspot | |
| 592877.5270 | 638856.5691 | | | Hotspot | |
| 592961.4475 | 638856.5691 | | | Hotspot | |
| 593045.3680 | 638856.5691 | | | Hotspot | |
| 593464.9704 | 638856.5691 | | | Hotspot | |
| 593548.8908 | 638856.5691 | | | Hotspot | |
| 591828.5211 | 638929.2464 | | | Hotspot | |

| | | | | | |
|---|---|---|---|---|---|
| 592080.2825 | 638929.2464 | | | Hotspot | |
| 592332.0439 | 638929.2464 | | | Hotspot | |
| 592919.4873 | 638929.2464 | | | Hotspot | |
| 593003.4077 | 638929.2464 | | | Hotspot | |
| 593087.3282 | 638929.2464 | | | Hotspot | |
| 593506.9306 | 638929.2464 | | | Hotspot | |
| 593590.8511 | 638929.2464 | | | Hotspot | |
| 592038.3223 | 639001.9237 | | | Hotspot | |
| 592877.5270 | 639001.9237 | | | Hotspot | |
| 593632.8113 | 639001.9237 | | | Hotspot | |
| 591828.5211 | 639074.6009 | | | Hotspot | |
| 592080.2825 | 639074.6009 | | | Hotspot | |
| 593590.8511 | 639074.6009 | | | Hotspot | |
| 592038.3223 | 639147.2782 | | | Hotspot | |
| 591996.3620 | 639219.9555 | | | Hotspot | |
| 592332.0439 | 639219.9555 | | | Hotspot | |
| 591954.4018 | 639292.6327 | | | Hotspot | |
| 592038.3223 | 639292.6327 | | | Hotspot | |
| 592080.2825 | 639365.3100 | | | Hotspot | |

**Primary Sampling Objective**
The primary purpose of sampling at this site is to detect "hot spots" (local areas of elevated concentration) of a given size and shape with a specified probability, 1-$\beta$.

**Selected Sampling Approach**
This sampling approach requires systematic grid sampling with a random start. If a systematic grid is not used, the probability of detecting a hot spot of a given size and shape will be different than desired or calculated.

**Number of Total Samples: Calculation Equation and Inputs**
The algorithm used to calculate the grid size (and hence, the number of samples) is based on work by Singer for locating geologic deposits [see Singer (1972, 1975) and PNNL-13450 for details]. Inputs to the algorithm include the size, shape, and orientation of a hot spot of interest, an acceptable probability of not finding a hot spot, the desired type of sampling grid, and the sampling budget. For this design, the grid size was calculated based on a given hot spot size and other parameters.

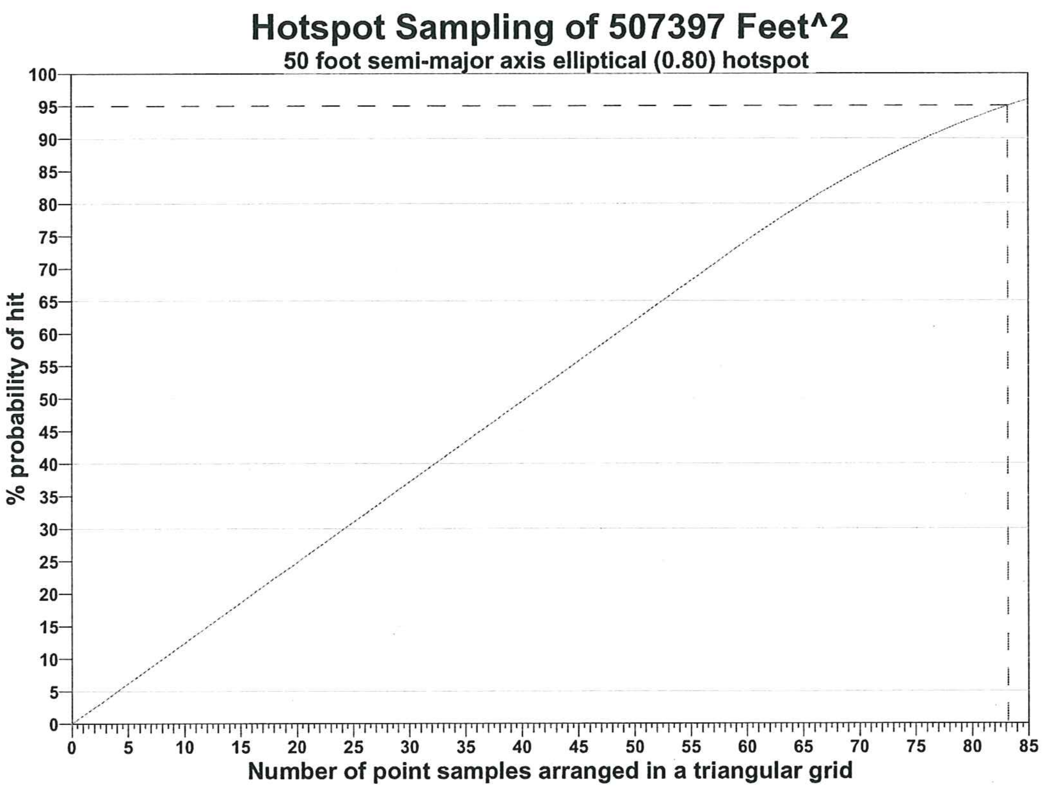
The inputs to the algorithm that result in the grid size are:

| **Parameter** | **Description** | **Value** |
|---|---|---|
| **Inputs** | | |
| 1-$\beta$ | Probability of detection | 95% |
| Grid Type | Grid pattern (Square, Triangular or Rectangular) | Triangular |
| Sample Type | Point samples or square cells | Points |
| Hot Spot Shape | Hot spot height to width ratio | 0.8 |
| Hot Spot Size | Length of hot spot semi-major axis | 50 feet |
| Hot Spot Area [a] | Area of hot spot (Length$^2$ * Shape * $\pi$) | 6283.19 ft$^2$ |
| Angle | Angle of orientation between hot spot and grid | Random |

| | | |
|---|---|---|
| Sampling Area | Total area to sample | 507397.15 $ft^2$ |
| **Outputs** | | |
| Grid Size | Spacing between samples | 83.9205 feet |
| Grid Area | Area represented by one grid | 6099.11 $ft^2$ |
| Samples [b] | Optimum number of samples | 83.192 |
| Cost | Total cost of sampling | $43000.00 |

[a] Length of semi-major axis is used by algorithm. Hot spot area is provided for informational purposes.
[b] The optimum number of samples is calculated by dividing the sampling area by the grid area.

The following graph shows the relationship between number of samples and the probability of finding the hot spot. The dashed blue line shows the actual number of samples for this design (which may differ from the optimum number of samples because of edge effects).




**Statistical Assumptions**

The assumptions associated with the sample spacing algorithm are that:

1. the target hot spot (its projection onto the coordinate plane) is circular or elliptical,
2. samples are taken on a square, rectangular, or triangular grid,
3. a very small proportion of the area being studied will be sampled (the sample is much smaller than the hot spot of interest),
4. the level of contamination that classifies a hot spot is well defined, and
5. there are no misclassification errors (a hot spot is not mistakenly overlooked or an area is not mistakenly identified as a hot spot).

These assumptions cannot be validated through data collection. The size and shape of a hot spot of interest are well defined prior to determining the number of samples and the measured value that defines a hot spot is well above the detection limit for the analytical methods that will be used. Grid sampling will be carried out to the level achievable; topographic, vegetative, and other features that prevent sampling at the specified coordinates will be noted and their influence recognized.

**Sensitivity Analysis**
The sensitivity of the calculation of number of samples was explored by varying 1-β, Shp and Size and examining the resulting changes in the number of samples. The following table shows the results of this analysis.

| Number of Samples | | | | |
|---|---|---|---|---|
| | | Size=25 | Size=50 | Size=75 |
| 1-β=90 | Shp=0.7 | 364 | 91 | 41 |
| | Shp=0.8 | 304 | 76 | 34 |
| | Shp=0.9 | 263 | 66 | 30 |
| 1-β=95 | Shp=0.7 | 404 | 101 | 45 |
| | Shp=0.8 | 333 | 84 | 37 |
| | Shp=0.9 | 286 | 72 | 32 |
| 1-β=100 | Shp=0.7 | 495 | 124 | 55 |
| | Shp=0.8 | 405 | 102 | 45 |
| | Shp=0.9 | 350 | 88 | 39 |

1-β = Probability of Hit (%)
Shp = Hot Spot Shape (Height to Width Ratio)
Size = Hot Spot Size (Length of Semi-major Axis)

**Cost of Sampling**
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $43000.00, which averages out to a per sample cost of $511.90. The following table summarizes the inputs and resulting cost estimates.

| COST INFORMATION | | | |
|---|---|---|---|
| **Cost Details** | **Per Analysis** | **Per Sample** | **84 Samples** |
| Field collection costs | | $100.00 | $8400.00 |
| Analytical costs | $400.00 | $400.00 | $33600.00 |
| **Sum of Field & Analytical costs** | | **$500.00** | **$42000.00** |
| Fixed planning and validation costs | | | $1000.00 |
| **Total cost** | | | **$43000.00** |

**Recommended Data Analysis Activities**
Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2000). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

A map of the actual sample locations will be generated so that the sampling plan and the field implementation may be compared. Deviations from planned sample locations due to topographic, vegetative, or other features will be noted. Their impacts will be qualitatively assessed. If a hot spot is discovered, additional sampling may be performed to determine its size and shape, in which case, the initial assumptions of the sampling design may then be assessed and/or reconsidered.

* - The report contents may have been modified or reformatted by end-user of software.

# APPENDIX B

## Perimeter Air Monitoring Plan

# PERIMETER AIR MONITORING PLAN

## For Remediation Activities at the Hercules Road Property

## Wilmington, Delaware

**Prepared For:**

Toll Brothers, Inc.
2747 Philmont Avenue
Huntingdon Valley, Pennsylvania

April 18, 2007

**Prepared By:**


BrightFields, Inc.
Environmental Services

801 Industrial Street, Suite 1
Wilmington, Delaware
302-656-9600


BrightFields File: 1938.03.21

# TABLE OF CONTENTS



## FIGURES



## ATTACHMENTS

## 1.0 INTRODUCTION

The Hercules Road Property (Property) is located on Hercules Road, approximately 2,000 feet west of the Newport Gap Pike (State Route 41) and south of Lancaster Pike (State Route 48) in Wilmington, Delaware (Figure 1).

The Property is composed of two tax parcels. The northern parcel is currently used as a nine-hole golf course and covers an area of approximately 101 acres (tax parcel ID# 08-026.00-052 [Lot 5]). The parcel has been maintained as a golf course since 1947. The southern parcel is unoccupied and wooded and is approximately 61 acres (tax parcel ID# 08-033.00-001 [Lot 10]). The surrounding land is generally residential. Toll Brothers is currently in negotiations with the current owner, Chaps 901, LLC, to purchase the Property for residential development.

Over the years pesticides have been used at the Hercules Road property. Arsenic compounds were one of the ingredients in some pesticides used before the EPA banned most inorganic arsenic pesticides in 1986. Elevated arsenic areas have been found in various areas on the Property. Portions of the Property are planned to be excavated to remove the elevated levels of arsenic. In addition, soil containing lower concentrations of arsenic will be blended with unimpacted soil to lower arsenic concentrations to within background levels.

During excavation/blending activities the dust concentrations in the air at the actual excavation/blending operation will be monitored for dust particulates using a Personal Data-logging Real-time Aerosol Monitor (DataRAM), which is a hand held dust meter. Protection of excavation workers will be performed by monitoring dust particulates at the location of the excavating/blending activities and taking actions as needed consistent with Section 3 of the Health and Safety Plan (HASP) for Construction Activities Associated with Hercules Road Property, March 2007. The worker health and safety program is detailed in that HASP.

In addition, during excavation/blending activities, the dust concentrations in the air around the perimeter of the property will also be monitored using dust meters. This perimeter monitoring will be undertaken using Environmental Particulate Air Monitors (EPAM-5000), or equivalent, to evaluate if dust is extending beyond the point of excavation. Dust reducing procedures are an integral part of the remediation scope of work and actions to be taken in the event that dust levels rise are also spelled out in the scope of work.

This document presents the perimeter air monitoring program. The objectives of the perimeter air monitoring program are to:

- Monitor and document perimeter ambient air concentrations of dust while intrusive remediation activities are occurring at Hercules Road Property;
- Provide a guide to evaluate the need for more rigorous dust control measures for reducing airborne concentrations of dust; and
- Protect the health and safety of residents and passersby by keeping dust concentrations below an action level determined to be protective of residents, as detailed below.

## 2.0 AIR ACTION LEVEL

This plan is intended to prevent respirable particulate matter from affecting residents and passersby. Respirable particles are small enough to be inhaled (respired) into the lungs and include particulates 10 microns or less in diameter. This size airborne Particulate Matter (PM) is known as PM10.

Risk Based Action Level. Avatar Environmental, LLC was tasked by BrightFields to develop contaminant-specific risk-based $PM_{10}$ (i.e., particles less than 10 microns) Action Levels based on contaminant levels in the soil at the Hercules Road Property. The objective of this analysis was to estimate health protective $PM_{10}$ levels that will ensure that nearby residents will not be exposed to unacceptable concentrations of site-related contaminants resulting from inhaling dust generated during remediation activities.

Site-specific air Risk Based Concentrations (RBCs) were calculated following the methodology recommended by EPA Region 3. A target cancer risk (TR) of 1E-06 (also termed one in a million) was used for contaminants known or suspected to be carcinogens. A target hazard quotient (THQ) of 1 was used for noncancer effects. RBCs were estimated for both a child and adult resident using standard EPA default values for body weight, inhalation rate, lifetime, etc. All detected contaminants in site soils were included in the analysis using the 95% upper-confidence limit of detected concentrations in soil, which is standard EPA practice . The inhalation cancer slope factors and reference doses were obtained from EPA's Integrated Risk Information System (IRIS). A conservative project duration of three months was assumed for the exposure duration.

Using this risk based approach, arsenic resulted in the most stringent $PM_{10}$ Action Level (0.870 $mg/m^3$). If the $PM_{10}$ concentrations are less than the arsenic Action Level, they would also be less than the Action Levels for all other known soil contaminants. The full report from Avatar Environmental is provided in Attachment A.

National Ambient Air Quality Standard. In addition to the risk based approach, BrightFields also researched other air quality standards that may apply to the remediation at the Hercules Road

Property. The Clean Air Act required EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. Primary standards were set to protect public health, including the health of sensitive populations such as asthmatics, children and the elderly. The primary standard for particulate matter ($PM_{10}$) is 0.150 mg/m$^3$. The primary standard is based on a 24-hour average concentration.

Selected Action Level. The more protective of the risk based action level and the NAAQS is selected as the perimeter air monitoring action level. For the EPAM-5000 (perimeter air monitoring) dust meter, the PM 10 particulate matter action level is set at 0.150 mg/m$^3$ in the breathing zone. Because excavation activities primarily occur only during daylight hours, using an action level that is based on 24-hour average exposure is a conservative approach to avoid exceeding the NAAQS.

## 3.0 AIR MONITORING PROCEDURES, RESPONSES, AND QUALITY CONTROL

EPAM-5000 perimeter air readings will be obtained using real time monitoring equipment at least every 2 hours at pre-selected locations along the perimeter of the Property. Time averaged PM10 readings will be obtained at each monitored location. Proposed monitoring locations relative to the redevelopment area are shown on Figure 1. The monitoring locations are intended to be stationary and have been spatially located primarily near the residential area boundaries.

A portable weather station will be set up on site. The weather station will record at a minimum: temperature, humidity, wind direction, and wind speed and these parameters will be downloaded. Wind direction for the day will be filed with the air monitoring log to provide a historical record of wind direction and air monitoring results.

### 3.1 Air Monitoring Procedures

Air monitoring will be performed by the individual performing environmental health and safety oversight for excavation activities on the redevelopment area. The following perimeter air monitoring equipment will be used to perform the air monitoring:

- A EPAM-5000, or equivalent, that is capable of measuring PM10 will be used to monitor airborne dust around the perimeter of the Property. Dust meters will be stationary at the selected locations and measure dust concentrations continuously (readings obtained every 60 seconds) during work hours . Time averaged dust readings will be read and logged every two hours. If the two hour average exceeds the action level, dust control measures will be implemented.

All air monitoring equipment will be calibrated according to the manufacturer's specifications prior to use each day. The time of calibration, calibration technique, and name of the person performing the calibration will be recorded in the log book.

Readings will be taken at breathing zone height (approximately 5 feet above ground surface). If readings are above the specified action levels, appropriate safety measures will be taken as described below. The monitoring time and air monitoring equipment readings will be recorded on the Perimeter Air Monitoring Log (Attachment B).

### 3.2 Air Monitoring Response

If monitoring of air indicates that action levels are exceeded, excavation activities will stop and engineering controls will be applied until all air monitoring measurements return to an acceptable level. Action levels for the perimeter dust meters are considered to be exceeded if the two hour average dust concentration exceeds 0.150 $mg/m^{3.}$ If the action level is exceeded, the Delaware Department of Natural Resources and Environmental Control will be notified with details regarding the action level exceeded and actions taken.

For dust suppression, the following actions will be taken:

- Sufficient amounts of water will be available at the site.
- Work crews will maintain equipment to disperse water.
- The excavation and surrounding areas will be sprayed with water. A sufficient amount of water will be used to cover the area, but not so much that mud is created.

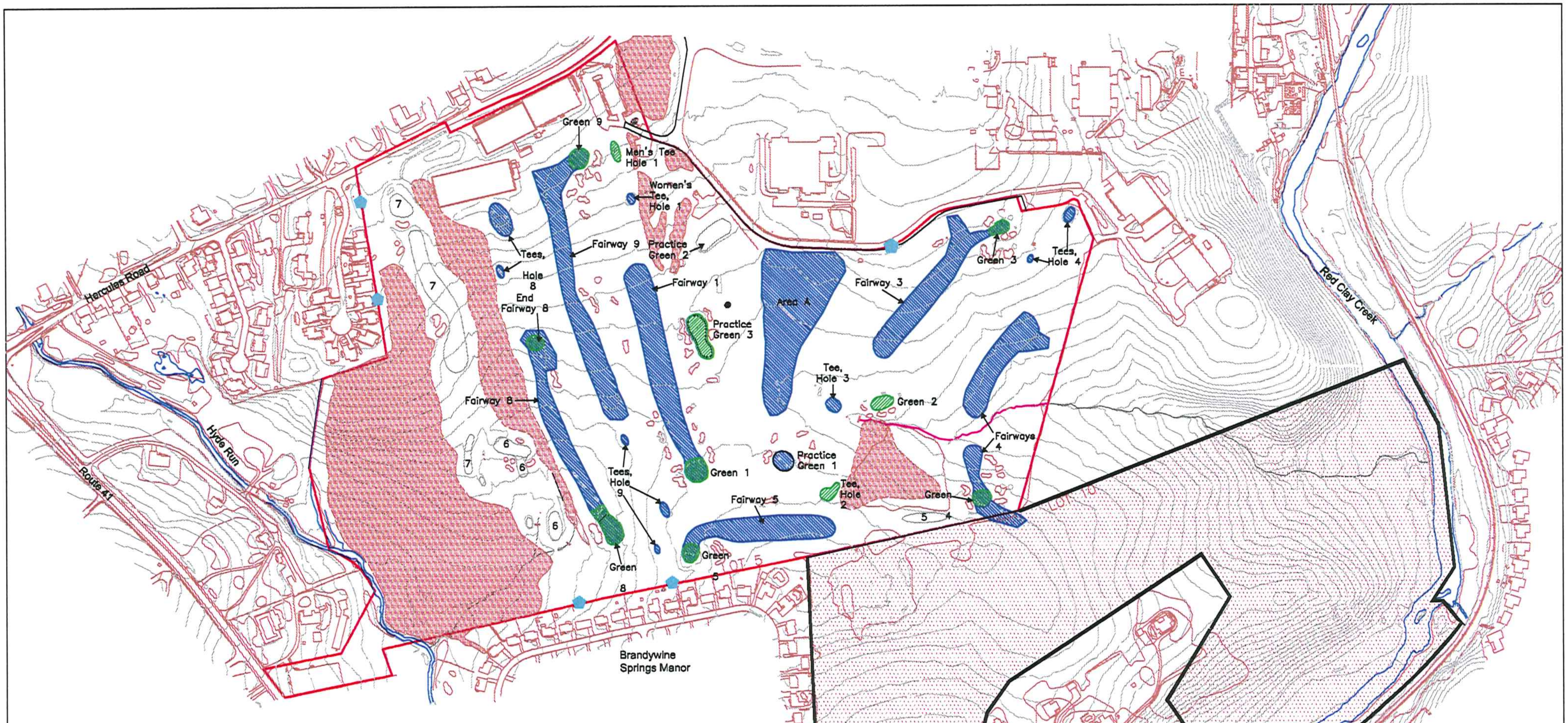
Dust suppression will be achieved during non-working times by stabilizing open excavations and areas disturbed during remediation. Seed and straw will be placed over disturbed soil in accordance with the Soil and Erosion Control Plan (Reviewed by DNREC Soil and Erosion Control Branch) to prevent dust generation. In addition, the remediation contractor will have staff available to water the site over weekends as necessary to control dust.

### 3.3 Quality Control

Quality control of measurements will be performed by adhering to the daily equipment calibration and calibration record keeping. The dust meters will be zeroed daily before the start of field measurements using a dust filter. Calibration data will be entered into the field team member's log book and recorded on the Perimeter Air Monitoring log. Re-calibration and zeroing will be performed any time the field team suspects a change in meter operation. Dust data will be downloaded at the end of the day and a permanent record of the daily data filed in the project file. Maintenance of meters will be performed according to manufacturer's recommendations and documented in meter specific maintenance logs.

# FIGURE 1

# Perimeter Air Monitoring Locations




BrightFields, Inc.
Environmental Evaluation, Investigation, and Remediation

801 Industrial Street, Suite 1
Wilmington, Delaware 19801
302 656-9600
302 656-9700 fax

DRAFT
Approximate Proposed Perimeter Dust Meter Locations
Hercules Road Property
Wilmington, Delaware

| | BY | DATE | SCALE: | AC FILE: |
|---|---|---|---|---|
| DRAWN | ALH | 3/19/07 | 1:4800 | METERLOC |
| CHECKED | JCH | 3/20/07 | DWG. NO. | REV. |
| PROJECT # | 1938.03.21 | | FIGURE 1 | 0 |

Legend

- Areas Where Arsenic Concentration Assumed > 37 mg/kg
- Areas Where Arsenic Concentration Assumed > 11 mg/kg & < 37 mg/kg
- Sediment
- Proposed Perimeter Dust Meter Locations
- Woods

# ATTACHMENT A

# Risk Based Air Action Level

# RISK-BASED $PM_{10}$ ACTION LEVEL DEVELOPMENT

## Prepared for

## BrightFields, Inc,

**Submitted by**
**Avatar Environmental, LLC**
**107 S. Church St.**
**West Chester, PA 19382**

**April 18, 2007**

AVATAR ENVIRONMENTAL

*A Service-Disabled Veteran Owned Small Business*

# RISK-BASED $PM_{10}$ ACTION LEVEL DEVELOPMENT

## 1. INTRODUCTION AND OBJECTIVES

Avatar Environmental has been tasked by BrightFields to develop contaminant-specific risk-based $PM_{10}$ (i.e., particles less than 10 microns) Action Levels based on contaminant levels in the soil at the Hercules Road Property. The objective of this analysis is to estimate health protective $PM_{10}$ levels that will ensure that nearby residents will not be exposed to unacceptable concentrations of site-related contaminants resulting from inhaling dust generated during remediation activities.

Certain areas of the Golf Course on the Hercules Road Property (mainly the greens and tee boxes) have elevated levels of pesticides, herbicides, and metals in the soil as a result of past applications. Table 1-1 presents a summary of the contaminants that are present along with descriptive statistics. For areas that are targeted for remediation, BrightFields is planning on excavating the contaminated soil and replacing with clean fill, or mixing the soil with non-contaminated soil, depending on concentration levels. It is possible that during the planned excavation activities dust will be generated and potentially transported to the residential areas that border the Golf Course.

To monitor the $PM_{10}$ concentrations, BrightFields is planning on implementing a network of sampling stations at the fence line where the residential homes are located. Data will be collected from these sampling stations during excavation activities and will be compared to a $PM_{10}$ Action Level. The information will be used to alert the remediation team when exposures to $PM_{10}$, and ultimately to contaminants assumed to be associated with the $PM_{10}$, reach a level that required some type of action to reduce exposure (i.e., Action Level).

The first step in this process is to estimate health-protective risk-based air concentrations (RBCs) for each of the contaminants presented on Table 1-1. The approach followed to calculate the RBCs is presented in Section 2 and is consistent with EPA Region 3 (EPA, 2006). Next, the contaminant-specific $PM_{10}$ levels were calculated by relating the RBCs to the 95% upper-confidence limit (UCL) in soil for each contaminant. This approach is described in Section 3.

**Table 1-1**
**Data Summary**

| Contaminant | Number of Observations | Minimum Detect (mg/kg) | Maximum Detect (mg/kg) | Arithmetic Mean (mg/kg) | 95 % Upper-Confidence Limit (mg/kg) |
|---|---|---|---|---|---|
| 4,4' -DDD | 50 | 3.50E-03 | 3.80E-01 | 4.92E-02 | 6.95E-02 |
| 4,4' -DDE | 54 | 1.70E-03 | 2.50E+00 | 3.64E-01 | 4.85E-01 |
| 4,4' -DDT | 54 | 4.00E-03 | 1.20E+00 | 1.95E-01 | 2.60E-01 |
| Aldrin | 10 | 1.00E-03 | 6.10E-02 | 2.65E-02 | 4.00E-02 |
| alpha-BHC | 10 | 1.00E-03 | 3.80E-02 | 1.53E-02 | 3.66E-02 |
| apha-Chlordane | 10 | 1.90E-02 | 9.40E+00 | 4.20E+00 | 1.18E+01 |
| Chlordane (tech) | 54 | 1.30E-02 | 2.30E+02 | 1.94E+01 | 2.90E+01 |
| delta-BHC | 6 | 1.00E-03 | 3.70E-02 | 1.47E-02 | 2.64E-02 |
| Dieldrin | 54 | 1.00E-03 | 3.80E+00 | 8.55E-02 | 2.15E-01 |
| Endosulfan I | 50 | 1.00E-03 | 4.50E-01 | 3.86E-02 | 6.62E-02 |
| Endrin | 50 | 1.00E-03 | 8.40E-02 | 5.22E-03 | 9.44E-03 |
| gamma-Chlordane | 10 | 4.00E-03 | 8.20E+00 | 3.62E+00 | 5.74E+00 |
| Heptachlor epoxide | 54 | 1.00E-03 | 1.20E+00 | 1.41E-01 | 2.17E-01 |
| Chlorpyrifos | 6 | 1.50E-04 | 5.40E-02 | 1.68E-02 | 7.85E-02 |
| Glyphosate | 6 | 7.00E-03 | 7.00E-03 | 7.00E-03 | 7.00E-03* |
| Oxadiazon | 6 | 1.50E-03 | 1.50E-03 | 1.50E-03 | 1.50E-03* |
| Arsenic | 119 | 2.03E+00 | 1.10E+03 | 6.55E+01 | 8.68E+01 |
| Barium | 13 | 3.50E+01 | 1.53E+02 | 8.32E+01 | 1.02E+02 |
| Cadmium | 13 | 1.69E-01 | 1.30E+01 | 5.44E+00 | 8.19E+00 |
| Chromium | 13 | 2.97E+01 | 2.44E+02 | 1.22E+02 | 1.57E+02 |
| Lead | 59 | 1.12E+01 | 3.40E+03 | 3.62E+02 | 5.08E+02 |
| Mercury | 13 | 5.94E-01 | 4.00E+01 | 1.71E+01 | 3.41E+01 |
| Selenium | 13 | 6.57E-01 | 6.00E+00 | 2.43E+00 | 3.69E+00 |
| Silver | 13 | 2.22E-01 | 1.28E+00 | 7.24E-01 | 9.72E-01 |

* Maximum detected value.

# 2. RISK-BASED CONCENTRATION CALCULATION METHODLOGY

The site-specific air RBCs were calculated following the methodology recommended by EPA Region 3 in their RBC table (EPA, 2006). A target cancer risk (TR) of 1E-06 (also termed one in a million) was used for contaminants known or suspected to be carcinogens. A target hazard quotient (THQ) of 1 was used for noncancer effects. Table 2-1 shows the algorithm used for calculating the RBCs for the residents. RBCs were estimated for both a child and adult resident.

**Table 2-1**
**Risk-Based Calculation Methodology**

Cancer-Based RBC

$$RBC\ (\mu g/m^3) = \frac{TR \times BW \times AT}{IRA \times EF \times ED \times CSF \times CF}$$

Noncancer-Based RBC

$$RBC\ (\mu g/m^3) = \frac{THQ \times BW \times AT}{IRA \times EF \times ED \times 1/RfD \times CF}$$

| | | |
|---|---|---|
| Where: | | |
| TR | = | Target cancer risk level (1E-06). |
| THQ | = | Target hazard quotient (1.0). |
| BW | = | Body weight:<br>Child – 15 kg (EPA, 1991)<br>Adult – 70 kg (EPA, 1991) |
| AT | = | Averaging time:<br>Cancer-based – 25,550 days (based on 70 year lifetime) (EPA, 1989)<br>Noncancer-based – 90 days (based on 3 month duration of exposure) (EPA, 1989) |
| IRA | = | Inhalation rate:<br>Child – 12 $m^3$/day (EPA, 2006)<br>Adult – 20 $m^3$/day (EPA, 2006) |
| EF | = | Exposure frequency: 90 days/year, duration of excavation activities is assumed to be 3 months. |
| ED | = | Exposure duration: 0.25 year, duration of excavation activities is assumed to be 3 months. |
| $CSF_i$ | = | Inhalation cancer slope factor $(mg/kg\text{-}day)^{-1}$: see Table 2-2. |
| $RfD_i$ | = | Inhalation reference dose (mg/kg-day): see Table 2-2. |
| CF | = | Units conversion factor: 0.001 mg/µg. |

The child and adult body weights are 15 kg and 70 kg, respectively. These are default values recommended by EPA (EPA, 1991). It is conservatively assumed that the duration of the excavation activities and thereby the duration of potential inhalation exposure is 3 months (90 days per year). The total potential duration of the inhalation exposure is 0.25 years (3 months divided by 12 months). The averaging time for cancer effects is based on a 70-year lifetime and equates to 25,550 days (70 years X 365 days/year) (EPA, 1989). The noncancer averaging time is equal to the exposure duration multiplied by 365 days/year. The child and adult are assumed to inhale 12 $m^3$ and 20 $m^3$ of air on a daily basis (EPA, 2006). The inhalation cancer slope factors (CSFs), which are used to estimate the cancer-based RBCs, and the inhalation reference doses (RfDs), which are used to estimate the noncancer-based RBCs, are presented on Table 2-2.

**Table 2-2**
**Toxicity Criteria**

| Contaminant | Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ | Inhalation Reference Dose (mg/kg-day) |
|---|---|---|
| 4,4' -DDD | 2.40E-01 [a] | NA |
| 4,4' -DDE | 3.40E-01 [a] | NA |
| 4,4' -DDT | 3.40E-01 | 5.00E-04 [a] |
| Aldrin | 1.72E+01 | 3.00E-05 [a] |
| alpha-BHC | 6.30E+00 | NA |
| apha-Chlordane | 3.50E-01 | 2.00E-04 |
| Chlordane (tech) | 3.50E-01 | 2.00E-04 |
| delta-BHC | 6.30E+00 [b] | NA |
| Dieldrin | 1.61E+01 | 5.00E-05 [a] |
| Endosulfan I | NA | 6.00E-03 [a,c] |
| Endrin | NA | 3.00E-04 [a] |
| gamma-Chlordane | 3.50E-01 | 2.00E-04 |
| Heptachlor epoxide | 9.10E+00 | 1.30E-05 [a] |
| Chlorpyrifos | NA | 3.00E-03 [a] |
| Glyphosate | NA | 1.00E-01 [a] |
| Oxadiazon | NA | 5.00E-03 [a] |
| Arsenic | 1.51E+01 | 3.00E-04 [a] |

**Table 2-2 (continued)**
**Toxicity Criteria**

| Contaminant | Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$ | Inhalation Reference Dose (mg/kg-day) |
|---|---|---|
| Barium | NA | 1.40E-04 [d] |
| Cadmium | 6.30E+00 | 5.70E-05 [e] |
| Chromium | NA | 1.50E+00 [a,f] |
| Lead | NA | NA |
| Mercury | NA | 8.57E-05 |
| Selenium | NA | 5.00E-03 [a] |
| Silver | NA | 5.00E-03 [a] |

Notes:
NA = Not available.
[a] Oral values was extrapolated to the inhalation route.
[b] delta-BHC value used as a surrogate.
[c] Endosulfan value used as a surrogate.
[d] Value taken from the Health Effects Assessment Summary Table.
[e] Value taken from the National Center for Environmental Assessment as presented on the EPA Region 3 RBC Table (EPA, 2006).
[f] Chromium III value assumed for all chromium in soil. Hexavalent chromium considered unlikely contributor (ATSDR, 2000).

The cancer potency of a contaminant is directly proportional to the CSF value; the higher the CSF, the more potent the contaminant as a carcinogen. Noncarcinogens refer to contaminants that cause toxic effects other than cancer. Noncancer effects can include, for example, central nervous system damage, reproductive effects, and other systemic effects. The premise of a reference dose is that there is an exposure level below which deleterious noncancer effects are not expected to occur. Reference doses are inversely proportional to the toxic potency of a contaminant, in other words, the lower the RfD, the more potent the contaminant. Unless noted otherwise, the inhalation cancer slope factors and reference doses were obtained from EPA's Integrated Risk Information System (IRIS) (EPA, 2007). In cases where a contaminant does not have an inhalation CSF or RfD but does have an oral CSF or RfD, the available oral value was used as a provisional value to estimate the inhalation exposure route. The use of the toxicity value developed for one exposure route to evaluate the toxicity from another is known as route-to-route extrapolation. No adjustments were made to the toxicity values when using route-to-route extrapolation (i.e., the same value was used for both routes). This adds uncertainty to the derived provisional values by not accounting for route-specific differences in contaminant absorption, metabolism, and potential target tissues.

Table 2-3 summarizes the calculated RBCs. As presented on the table, cancer- and noncancer-based RBCs were calculated for the child and adult.

**Table 2-3**
**Calculated RBCs (μg/m$^3$)**

| Contaminant | Child | | Adult | | Lowest RBC |
|---|---|---|---|---|---|
| | Cancer-Based | Noncancer-Based | Cancer-Based | Noncancer-Based | |
| 4,4' -DDD | 4.73E+00 | NA | 1.66E+01 | NA | 4.73E+00 |
| 4,4' -DDE | 3.34E+00 | NA | 1.17E+01 | NA | 3.34E+00 |
| 4,4' -DDT | 3.34E+00 | 2.02E+00 | 1.17E+01 | 7.08E+00 | 2.02E+00 |
| Aldrin | 6.62E-02 | 1.21E-01 | 2.32E-01 | 4.25E-01 | 6.62E-02 |
| alpha-BHC | 1.80E-01 | NA | 6.31E-01 | NA | 1.80E-01 |
| apha-Chlordane | 3.24E+00 | 8.09E-01 | 1.14E+01 | 2.83E+00 | 8.09E-01 |
| Chlordane (tech) | 3.24E+00 | 8.09E-01 | 1.14E+01 | 2.83E+00 | 8.09E-01 |
| delta-BHC | 1.80E-01 | NA | 6.31E-01 | NA | 1.80E-01 |
| Dieldrin | 7.05E-02 | 2.02E-01 | 2.47E-01 | 7.08E-01 | 7.05E-02 |
| Endosulfan I | NA | 2.43E+01 | NA | 8.49E+01 | 2.43E+01 |
| Endrin | NA | 1.21E+00 | NA | 4.25E+00 | 1.21E+00 |
| gamma- Chlordane | 3.24E+00 | 8.09E-01 | 1.14E+01 | 2.83E+00 | 8.09E-01 |
| Heptachlor epoxide | 1.25E-01 | 5.26E-02 | 4.37E-01 | 1.84E-01 | 5.26E-02 |
| Chlorpyrifos | NA | 1.21E+01 | NA | 4.25E+01 | 1.21E+01 |
| Glyphosate | NA | 4.04E+02 | NA | 1.42E+03 | 4.04E+02 |
| Oxadiazon | NA | 2.02E+01 | NA | 7.08E+01 | 2.02E+01 |
| Arsenic | 7.55E-02 | 1.21E+00 | 2.64E-01 | 4.25E+00 | 7.55E-02 |
| Barium | NA | 5.66E-01 | NA | 1.98E+00 | 5.66E-01 |
| Cadmium | 1.80E-01 | 2.31E-01 | 6.31E-01 | 8.07E-01 | 1.80E-01 |
| Chromium | NA | 6.07E+03 | NA | 2.12E+04 | 6.07E+03 |
| Lead | NA | NA | NA | NA | 1.50E+00* |

**Table 2-3, continued**
**Calculated RBCs (µg/m$^3$)**

| Contaminant | Child | | Adult | | Lowest RBC |
|---|---|---|---|---|---|
| | Cancer-Based | Noncancer-Based | Cancer-Based | Noncancer-Based | |
| Mercury | NA | 3.47E-01 | NA | 1.21E+00 | 3.47E-01 |
| Selenium | NA | 2.02E+01 | NA | 7.08E+01 | 2.02E+01 |
| Silver | NA | 2.02E+01 | NA | 7.08E+01 | 2.02E+01 |

NA = Not available.
* National Ambient Air Quality Standard.

# 3. $PM_{10}$ ACTION LEVEL CALCULATION METHODOLOGY

The risk-based $PM_{10}$ Action Levels were calculated based on the site-specific RBCs presented on Table 2-3 and the 95% UCLs in soil presented on Table 1-1. It was assumed that the levels measured in the soil were the same as the levels to be measured by the $PM_{10}$ samplers and therefore available for inhalation by the residents. Table 3-1 presents the procedure followed to relate the conservatively calculated air RBC and the 95% UCL to a target risk-based $PM_{10}$ Action Level concentration.

**Table 3-1**
**Target $PM_{10}$ Calculation Methodology**

$$\text{Target PM}_{10}\text{ Concentration }(\mu g/m^3) = \frac{RBC}{CS \times CF}$$

| | | |
|---|---|---|
| Where: | | |
| RBC | = | Most stringent risk-based concentration (µg/m$^3$): see Table 2-3. |
| CS | = | Concentration of the contaminant in soil represented by the 95% upper-confidence limit of the mean (mg/kg): see Table 1-1. |
| CF | = | Units conversion factor: 0.000001 kg/mg. |

Table 3-2 presents the calculated contaminant-specific target $PM_{10}$ concentrations.

**Table 3-2**
**Target $PM_{10}$ Concentrations (µg/m³)**

| Analyte | RBC (µg/m³) | CS (mg/kg) | Target $PM_{10}$ Concentration (µg/m³) |
|---|---|---|---|
| 4,4' -DDD | 4.73E+00 | 6.95E-02 | 6.81E+07 |
| 4,4' -DDE | 3.34E+00 | 4.85E-01 | 6.89E+06 |
| 4,4' -DDT | 2.02E+00 | 2.60E-01 | 7.78E+06 |
| Aldrin | 6.62E-02 | 4.00E-02 | 1.66E+06 |
| alpha-BHC | 1.80E-01 | 3.66E-02 | 4.92E+06 |
| apha-Chlordane | 8.09E-01 | 1.18E+01 | 6.88E+04 |
| Chlordane (tech) | 8.09E-01 | 2.90E+01 | 2.79E+04 |
| delta-BHC | 1.80E-01 | 2.64E-02 | 6.82E+06 |
| Dieldrin | 7.05E-02 | 2.15E-01 | 3.28E+05 |
| Endosulfan I | 2.43E+01 | 6.62E-02 | 3.67E+08 |
| Endrin | 1.21E+00 | 9.44E-03 | 1.29E+08 |
| gamma- Chlordane | 8.09E-01 | 5.74E+00 | 1.41E+05 |
| Heptachlor epoxide | 5.26E-02 | 2.17E-01 | 2.42E+05 |
| Chlorpyrifos | 1.21E+01 | 7.85E-02 | 1.55E+08 |
| Glyphosate | 4.04E+02 | 7.00E-03* | 5.78E+10 |
| Oxadiazon | 2.02E+01 | 1.50E-03* | 1.35E+10 |
| Arsenic | 7.55E-02 | 8.68E+01 | 8.70E+02 |
| Barium | 5.66E-01 | 1.02E+02 | 5.56E+03 |
| Cadmium | 1.80E-01 | 8.19E+00 | 2.20E+04 |
| Chromium | 6.07E+03 | 1.57E+02 | 3.87E+07 |
| Lead | 1.50E+00** | 5.08E+02 | 2.96E+03 |
| Mercury | 3.47E-01 | 3.41E+01 | 1.02E+04 |
| Selenium | 2.02E+01 | 3.69E+00 | 5.48E+06 |
| Silver | 2.02E+01 | 9.72E-01 | 2.08E+07 |

Notes:
* Based on maximum detected concentration.
** RBC for lead is equal to the National Ambient Air Quality Standard.

As presented on Table 3-2, arsenic resulted in the most stringent $PM_{10}$ Action Level. Therefore, the measured $PM_{10}$ concentrations can be compared to the arsenic Action

Level. If the $PM_{10}$ concentrations are less than the arsenic Action Level, they would also be less than the Action Levels for the other contaminants.

## 4. REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profile for Chromium. U.S. Department of Health and Human Services.

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U.S. Environmental Protection Agency (EPA). 2005. *Guidelines for Carcinogen Risk Assessment.* Risk Assessment Forum, Washington, DC. EPA/630/P-03/001B.

U.S. Environmental Protection Agency (EPA). 2006. *Region 3 Risk-Based Concentration (RBC) Table 2006 Update.* Revised October, 2006.

U.S. Environmental Protection Agency (EPA). 2007. *Integrated Risk Information System (IRIS).* On-Line Database [www.epa.gov/iris]. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. Accessed March 2007.

# ATTACHMENT B

# Perimeter Air Monitoring Log

# Perimeter Air Monitoring for the Month of:_______________

BrightFields, Inc.
Environmental Services

| Date | Time | Meter Location | Weather | Dust Meter Readings (mg/m$^3$) | | | Instantaneous PID Reading (ppm) | Notes (potential source of dust, wind direction, observations, etc.) | Actions Taken | Initals |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Instantaneous | Average | Maximum | | | | |
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| Perimeter Monitoring Action Levels: | NR: No readings collected | Actions: |
|---|---|---|
| VOCs = 5 ppm | NA: Not applicable due to weather | Suspend excavation activities until concentrations drop below action levels |
| PM10 = 0.150 mg/m3 | | Perform dust supression per the HASP. |
| Field Action Level = 0.050 mg/m3 | | |