ENTRIX

FINAL
INTERIM REMEDIAL ACTION PLAN
WORK AREA 3
UNDER AGREED WORK ORDER NO. 1315
BRIGGS NURSERY, INC.
OLYMPIA, WASHINGTON

Prepared for Submittal to:

WASHINGTON STATE DEPARTMENT OF ECOLOGY
Southwest Region Toxics Cleanup Program

Prepared by:

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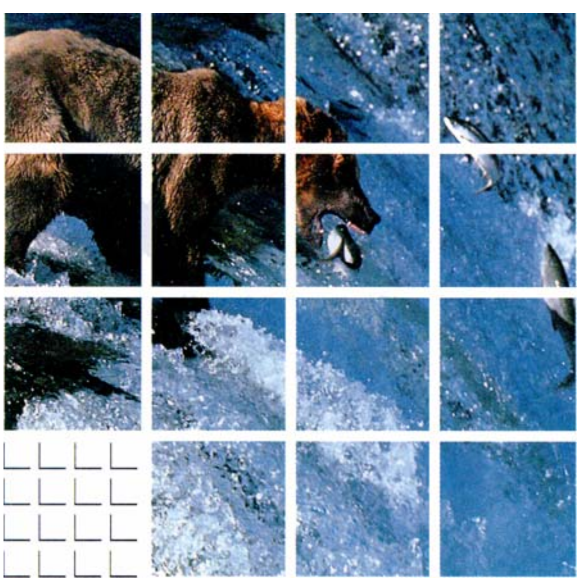

On behalf of:

Briggs Nursery, Inc.
4407 Henderson Blvd.
Olympia, WA 98501

Project No. 3105102

August 9, 2007

ENTRIX

ENVIRONMENTAL CONSULTANTS

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FINAL INTERIM REMEDIAL ACTION WORK PLAN BRIGGS NURSERY, INC. OLYMPIA, WASHINGTON

1.0 INTRODUCTION

This Interim Remedial Action Plan (IRAP) details remedial actions that will be conducted to address human health risks relating to Work Area 3 uplands surficial soils and for the Northeast and Southeast Kettles.

1.1 WORK AREA 3 UPLAND SOILS

Based on the results of systematic grid sampling across the upland portions of Work Area 3 at the Briggs Nursery site (Site), as defined in Remedial Investigation Feasibility Study Work Plan: Work Area 3 (ENTRIX, 2007) and associated with Agreed Order No. 1315 between Briggs Nursery and the Washington State Department of Ecology (Ecology), an Interim Remedial Action is proposed to address localized areas of low-level dieldrin and PCB contamination. This Interim Remedial Action Plan (IRAP), developed in consultation with Ecology, provides the work plan to accomplish the excavation and disposal of contaminated soils consistent with the Model Toxics Control Act (MTCA) and other relevant state and federal regulations.

1.2 NORTHEAST AND SOUTHEAST KETTLES

A baseline human health risk assessment (HHRA) was conducted for the Northeast and Southeast kettle bottoms located either wholly or partially in Work Area 3. These HHRAs addressed the potential risks associated with polychlorinated dibenzo-dioxins and -furans (PCDD/Fs), which are found in the waters and sediments in the kettle bottoms. For the risk calculations, the HHRAs assumed that the bottoms of the kettles in Work Area 3 will remain in their current state and that a residential exposure scenario is appropriate.

The human health risks associated with Site chemicals in the upland areas of Work Area 3 will be addressed by the soil removals conducted as part of the IRA (Section 3.0 and 4.0). The remaining human health risks in the Site Kettles in Work Areas 3 are assessed in Section 5.0 and the IRA is presented in Section 6.0 and 7.0.

2.0 DELINEATION OF CONTAMINATED UPLAND SOIL

2.1 INITIAL SOIL SAMPLING ANALYTICAL RESULTS

Surficial soil samples were initially collected on a 100-foot grid within Work Area 3 in November 2006, April and June 2007. All soil samples were analyzed for pesticides using EPA Method 8081A. Select soil samples were also analyzed for PCBs using EPA Method 8082 wherever PCB interferences were detected by the analytical laboratory during analysis for pesticides. This rationale is described in detail in Section 2.5.2 of the RI/FS Report for Work Areas 1 and 2 (ENTRIX, 2006).

Results of the grid sample analyses indicate that soil collected from four grid nodes in Work Area 3 have concentrations of dieldrin and/or PCBs that exceed the MTCA cleanup standard for unrestricted land use. Two of these four grid nodes (A2 and A3) contain soil that exceeds the MTCA standard for dieldrin only, one of these four grid nodes (C5) contains soil that exceeds the MTCA standard for PCBs only, and one of these four grid nodes (E6) contains soil that exceeds the MTCA standards for both dieldrin and PCBs. These four grid nodes define four proposed excavation areas as shown on Figure 1 (attached). Concentrations of pesticides other than dieldrin either were below the MTCA cleanup levels or were not detected in the remaining soil samples. Comprehensive soil analytical data for samples collected in Work Area 3 is provided in Appendix A.

It should be noted that the reporting limits for dieldrin in samples 110206-D6 and 110206-C5 contained elevated detection limits above the MTCA cleanup standard for dieldrin due to the presence of PCBs. These detection limits were 0.066 mg/Kg for D6 and 0.22 mg/Kg for C5.

An evaluation of the raw data for these samples was conducted by ENTRIX (Appendix B). It was concluded that dieldrin is present in the D6 sample at an estimated concentration of 0.031 mg/Kg (below the MTCA cleanup standard for dieldrin).

An estimated concentration for dieldrin was not able to quantified in the C5 sample, however it was concluded that a detection limit of 0.137 mg/Kg is likely appropriate. This detection limit, however, is still above the MTCA cleanup standard for dieldrin. Soil from this location will be excavated and removed due to the presence of PCBs, as mentioned above. Confirmation samples will be analyzed for PCBs and dieldrin at this location to ensure that all soil above the MTCA cleanup standards are removed. Confirmation sampling activites are described in Section 4.0.

2.2 FURTHER DELINEATION METHODS

A detailed description of the original grid set-up and initial sampling approach are provided in the RI/FS Workplan: Work Area 3 (ENTRIX 2006). To further delineate the extent of dieldrin and PCB contamination, additional soil samples were collected in the vicinity of the four grid node samples where concentrations exceeded the MTCA cleanup standard for either dieldrin and/or PCBs.

2.2.1 Horizontal Delineation

To the extent feasible, additional soil samples were collected at 25 feet, 50 feet, and 75 feet, in the four cardinal directions (based on grid north) from the grid nodes where soil exceeded MTCA standards for dieldrin and/or PCBs. Soil samples were also collected at approximately 72 feet and 106 feet in the appropriate diagonal directions (NE, SE, SW, and NW) from the grid nodes in exceedance of the MTCA standards. On the diagonals between two nodes on the 100-foot grid, 72 feet and 106 feet from a given node equal ½ and ¾ of the distance to the next grid node, respectively.

Sampling was conducted according to the protocols described in Sections 3.1, 3.4, 3.5, 3.6, and 3.7 of the RI/FS Work Plan: Work Area 3 (ENTRIX 2006).

2.2.2 Vertical Delineation

Vertical delineation was conducted prior to soil excavation during previous RI activities described in Section 8.1.2 of the RI/FS Report for Work Areas 1 and 2 (ENTRIX, 2006). These results concluded that dieldrin concentrations in exceedance of MTCA Method B unrestricted land use standards are restricted to the upper 12 inches of the soil column. This finding is consistent with known fate and transport properties of dieldrin as described in Section 8.1.2 of the RI/FS Report for Work Areas 1 and 2 (ENTRIX, 2006).

Additionally, confirmation sampling conducted for Work Areas 1 and 2, confirmed that dieldrin and PCBs in exceedance of MTCA Method B unrestricted land use standards are, in general, restricted to the upper 12 inches of the soil column.

Vertical delineation will be completed in conjunction with confirmation sampling activities, described in Section 4.0. Excavation floor samples collected in each of the excavated areas will provide vertically distributed data for dieldrin and/or PCBs.

2.3 SAMPLING RESULTS

2.3.1 Horizontal Grid Soil Samples

Soil samples collected 25 feet from the grid node were analyzed first. Where a 25-foot sample exceeded MTCA cleanup standards for dieldrin and/or PCBs, the sample collected 50 feet from the grid node along the same transect was analyzed. If the 50-foot sample exceeded MTCA cleanup standards, the 75-foot sample along the same transect was analyzed.

Similarly, the 72-foot diagonal samples were analyzed wherever 50-foot samples exceeded the MTCA cleanup standards. Where a 72-foot sample exceeded MTCA cleanup standards, the 106-foot sample along the same diagonal transect (NE, SE, SW, or NW) was analyzed. Samples not immediately queued for analysis were stored in frozen archive at a temperature of -20 degrees C.

The grid sample and subsequent delineation sample results that exceed MTCA cleanup standards are provided in Table 1, below. The sample points are provided in Figure 1 with categories designating the levels of dieldrin and/or PCB exceedance.

Table 1. Exceedances of MTCA Unrestricted Use Cleanup Standard for Dieldrin and PCBs in Surficial Soil Samples.

Grid Location	Sample ID	Sample Date	Dieldrin Conc. (mg/kg)	Dieldrin MDL/RL (mg/kg)	Total PCBs Conc. (mg/kg)	PCBs MDL/RL (mg/kg)
A2 Area						
A2	110206-A2	11/02/06	**0.1095**		NA	NA
A2+25 S	041107-A2+25S	4/11/07	**0.074 P**	0.0063/0.016	NA	NA
A2+25 E	041107-A2+25E	4/11/07	**0.14 P**	0.00634/0.016	NA	NA
A2+25 Ea (dup)	041107-A2+25Ea	4/11/07	**0.084 P**	0.00626/0.016	NA	NA
A3 Area						
A3	110206-A3	11/02/06	**0.17**	0.00456/0.012	NA	NA
A3+25 N	041107-A3+25N	4/11/07	**0.13 P**	0.00625/0.016	NA	NA
A3+25 E	041107-A3+25E	4/11/07	**0.12 P**	0.00626/0.016	NA	NA
A3+25 S	041107-A3+25S	4/11/07	**0.16 P**	0.00618/0.016	NA	NA
C5 Area						
C5	110206-C5	11/02/06	<0.22 Y	0.0183/0.22	**3.22**	0.48
E6 Area						
E6	110206-E6	11/02/06	**0.094**	0.00455/0.012	**1.10**	0.12
E6+25 E	041207-E6+25E	4/12/07	**0.10 P**	0.00624/0.016	0.45	0.06
E6+25 S	041207-E6+25S	4/12/07	**0.11 P**	0.00639/0.017	0.13	0.06

NOTES:
Results exceeding MTCA Cleanup Criteria are presented in **bold**
P = Greater than 40% difference between the two columns
Y = Sample result contains matrix interference
NA: Not Analyzed
MDL: Method Detection Limit
RL: Reporting Limit (PQL)

3.0 EXCAVATION AND DISPOSAL OF CONTAMINATED SOIL

3.1 SOIL EXCAVATION

Areas identified for excavation were determined based on analytical results from the initial sampling activities described in Section 2.1 and from the subsequent sampling activities described in Section 2.2. The methods for excavation and removal of the contaminated soils are presented in this section.

3.1.1 Determination of Excavated Area

The proposed excavation areas are based on the delineation of dieldrin and PCB contamination as described previously in Section 2.0 (Figure 1). The excavation boundaries were determined by selecting a point half the distance from the sample location with the exceedance to the nearest non-exceedance sample location outside the excavation area. The excavation boundary is determined by connecting these halfway points using best professional judgement.

On the site, halfway points will be measured from the surveyed sample points and marked with survey stakes or distinctive spray paint markings. From these halfway points, the boundary of the excavation will be marked on the ground with spray paint.

All excavation areas identified on Figure 1 for both dieldrin and PCB impacted soils will be excavated to approximately 12 inches in depth in accordance with the findings described in Section 2.2.2.

3.1.2 Excavation Procedure

An excavator will be used to remove the top 12 inches from the designated areas. Care will be taken to minimize the equipment traffic through the excavation area. Truck traffic will be limited to rock roads adjacent to excavation areas and truck loading will occur at the edge of excavation or stockpiling areas, in order to prevent the movement of excavation soils onto clean areas of the Site or public roads. The excavated soil will then be transported off-site to an appropriate disposal facility as described in Section 3.2. The trucks will be tarped prior to leaving the Site to prevent wind dispersion.

During excavation, standard practices to prevent dispersion of excavated soil will be employed. These will include the following:

- Trucks will access the excavation using a Site construction entrance/exit constructed as per BMP C105;
- A water truck will be on-Site to control excavation and loading dust;
- Truckloads will be tarped;
- Truck tires will be swept prior to leaving the Site;
- Excavated soil will be placed directly into trucks whenever possible, otherwise excavated soils will be stockpiled on plastic sheeting and covered, and
- Erosion control measures will be employed where surface water runoff can erode excavations.

3.2 Disposal Of Excavated Soil

This section discusses the applicable regulatory requirements for determining the disposal location of the excavated soils.

3.2.1 Washington Dangerous Waste Regulations

The State of Washington Dangerous Waste Regulations do not identify a criterion specific to dieldrin under WAC 173-303-090. However, dieldrin is a halogenated organic compound (HOC) that must meet the "Dangerous Waste Criteria Level" under WAC 173-303-100. This criterion requires that the sum of all HOC concentrations is less than 1% (or 10,000 mg/kg). With dieldrin being the only HOC of concern at the site, the sum is substantially below 1% and therefore below the Dangerous Waste standards.

In addition, WAC 173-303-100 also provides a formula to ensure that the Equivalent Concentration does not exceed the "Toxic Dangerous Waste". The sum of the pesticide concentrations (on a percentage basis) is divided by 10. That value is then summed with other chemical classes to see if the total is less than 0.001% (or 10 mg/kg). Again, dieldrin concentrations are well below this criterion. The soil is therefore below the standards for Toxic Dangerous Waste. The dieldrin-contaminated soils are designated as non-hazardous waste under the Washington Dangerous Waste regulations.

The soils associated with the PCB-contaminated areas also do not meet the requirements to be listed as a dangerous waste under Chapter 173-303 WAC. These soils are not associated with any of the waste types covered under the listing for W001 (including, *e.g.*, transformers, capacitors, bushings, and associated wastes).

3.2.2 MTCA

Unrestricted land use criteria under MTCA have driven the need to remove soils from the Briggs Nursery site. The most stringent unrestricted land use cleanup standard for dieldrin is 0.0625 mg/kg and 1.0 mg/kg for PCBs based on dermal contact and inhalation exposure pathway. The highest level of contamination in site soils that will be excavated under this IRAP based on the recent sampling and analysis program is 0.17 mg/kg for dieldrin and 3.22 mg/kg for PCBs.

3.3 Disposal of Excavated Soil

The excavated soil, whether it is contaminated with dieldrin or PCBs will be transported to a landfill that meets the requirements of WAC 173-351 or a Subtitle D landfill. The soil will be transported to the Centralia Intermodal transfer facility where it will be railed to Regional Disposal Landfill in Roosevelt, WA.

The excavation is expected to take three working days once the process has begun. An estimated 350 cubic yards of material will be removed. The trucks will be securely covered with tarps during transportation to prevent potential wind dispersion.

4.0 CONFIRMATIONAL SAMPLING

At the conclusion of soil excavation, samples will be collected for analysis within the excavated area to confirm that soil with dieldrin and PCBs at concentrations above MTCA cleanup standards has been removed. The procedures are described below.

4.1 Sample Collection, Handling, and Analysis

The sample locations will be selected in consultation with Ecology. Ecology staff will be provided splits of confirmation samples upon request, or they may collect separate samples; the choice is at their discretion. These independent confirmation samples will be analyzed at Ecology's Manchester laboratory.

Soil samples will be collected and handled and sampling equipment will be decontaminated according to the protocols described in Sections 3.1, 3.4, 3.5, 3.6, and 3.7 of the RI/FS Work Plan. Each confirmation sample will be labeled with a unique sample identification number that facilitates tracking and cross-referencing of sample information. Proposed confirmation sampling locations are shown in Figure 1, along with the choice of analyte – dieldrin or PCBs – for each sample.

Every hundred feet or less, discrete soil samples will be collected from 0-6 inch depth in the floor of the excavation and at the midpoint of the excavation depth for sidewall samples. Excavation floor samples will also provide vertical delineation data for each of the four excavation areas. All sample locations will be approved by the Ecology Site Manager prior to sample collection.

4.2 Criteria for Confirmation Sampling Analysis

Dieldrin concentrations in confirmation samples will be compared to the MTCA criterion of 0.0625 mg/kg and PCB concentrations will be compared to the MTCA criterion of 1.0 mg/kg.

Each excavation area will be tested separately for compliance, and therefore the number of samples in each area will be substantially less than 20. With small sample size, statistical estimates of confidence about distributional parameters or quantiles become unreliably high. For this reason, each individual sample concentration in a given excavation area will be compared to the cleanup standard. If no sample exceeds the criterion of 0.0625 mg/kg dieldrin and/or 1.0 mg/kg for PCBs, that excavation area will be considered clean.

It should be noted, however, that Ecology guidance provides a procedure for comparison of a confirmation sample group to a cleanup standard. Wherever possible (i.e., where sample sizes for a given excavation area are greater than 10 in quantity), these evaluations were applied.

The procedure compares the cleanup standard to two statistical estimates, such that:

- The upper confidence limit of the mean cannot exceed the cleanup standard; and

- The upper tolerance limit on the 90^{th} percentile;

And two additional criteria:

- No sample value may exceed two times the cleanup standard; and
- No more than 10% of the sample values may exceed the cleanup standard.

In the second step of the statistical methodology, the guidance allows for the occasional, relatively small exceedance of the cleanup standard (i.e., no more than 10% in exceedance, none greater than two times the standard).

4.2.1 Course of Action If Analytical Results Indicate Soil Exceeds MTCA Standards

If soil contaminated above appropriate MTCA levels is encountered, the affected soil will be removed and transported off-site, consistent with the disposal procedures outlined in Section 3.2. An additional round of confirmation samples will be collected and submitted to the laboratory for analysis. The excavated areas will remain open until samples have been analyzed and it is determined that the soil contaminant levels do not exceed applicable MTCA cleanup standards.

4.2.2 Course of Action When Analytical Results Indicate Soil Does Not Exceed MTCA Standards

When analytical results indicate contaminant concentrations are below appropriate MTCA levels the excavated areas will be closed in place or be graded until acceptable slopes are met, if necessary. Hydroseeding will be conducted in these areas to achieve final soil stabilization.

5.0 HUMAN HEALTH RISK ASSESSMENT OF NORTHEAST AND SOUTHEAST KETTLES

5.1 INTRODUCTION

There are two bowl-shaped depressions or kettles that are either wholly or partially situated on the Site in Work Area 3. These kettles are remnant geologic features from the region's last glacial episode[1]. They are important drainage features on the Site. Over many years, stormwater and irrigation runoff from the Site, adjoining roads, and residential properties have been diverted into some of the kettles. The kettles have been the focus of some of the Site investigations.

In previous reports, the kettles have been named based on their location on the Site and this nomenclature is retained here. The Northeast and Southeast Kettles lie east of Henderson Boulevard within Work Area 3.

5.2 BASELINE HUMAN HEALTH RISK ASSESSMENTS OF SITE KETTLES

A baseline HHRA was conducted for the Northeast and Southeast Kettles in Work Area 3. They address the potential risks associated with PCDD/Fs, which were identified by Ecology as the COCs therein. These risk assessments assume that these Site Kettles remain in their current state and that a residential exposure scenario is appropriate. The assessments are provided as Appendix B to this IRAP, and conclude that:

- The sediments and waters of the Northeast and Southeast Kettles pose an unacceptable risk to human health.

The risk assessments assumed that both the Northeast and Southeast Kettles contained water since the Kettles contained water during sampling activities conducted in 2000, 2003, and 2004. While the Northeast Kettle typically does contain water, the Southeast Kettle contains water only sporadically during periods of increased precipitation. Previous hydrogeological studies have concluded that the water table is present at approximately 35 feet below the bottom of the Southeast Kettle. Therefore, the probability of the groundwater table intersecting the Southeast Kettle is highly unlikely to occur. Additionally, stormwater and irrigation runoff is no longer diverted to the Southeast Kettle. To be conservative, however, the risk assessment was completed assuming that the Southeast Kettle contained water.

An IRA is planned to reduce human health risk to acceptable levels in the Northeast and Southeast Kettles. The details of this IRA are presented in Section 6.0.

1 The kettles were created when stranded blocks of glacial ice gradually melted during the last glacial recession of the Puget Sound lobe over 12,000 years ago.

6.0 INTERIM REMEDIAL ACTION FOR NORTHEAST AND SOUTHEAST KETTLES

The baseline HHRAs of the Northeast and Southeast Kettles determined that sediments and water of the Northeast and Southeast Kettles may pose an unacceptable risk to human health due to the presence of PCDD/Fs. To mitigate the risk to human health, an IRA is planned. The components of the IRA are described below. Construction details are described in Section 7.0.

The IRA consists of the following items:

- A restrictive covenant,
- warning signs, and
- fencing.

A suite of institutional controls will be used to limit human access to the Kettle bottoms. A restrictive covenant will be filed with the appropriate language according to the Uniform Environmental Covenant Act as part of IRA activities. Under this restrictive covenant, the following conditions would be applied to the Kettles:

- The Kettle bottoms will be deeded to a foundation that will maintain them as ecological reserves and natural features.
- The Kettle bottoms will be accessed in the course of maintenance, but no soil or sediment may be removed from the Kettle bottoms, without the prior consent of Ecology.
- Public access to the Kettle bottoms will be expressly prohibited.
- Unauthorized access will be considered criminal trespass, and the violators will be subject to prosecution; this prohibition will extend to homeowners, family members, clients, and guests.
- No-trespassing signs will be posted around the perimeters of the Kettle bottoms at intervals of approximately 100 feet. The signs will be permanently maintained.

In addition, physical control – in the form of fencing – will be installed around the Kettle bottoms. The fence will be six feet in height, constructed of chain-link mesh, with a knuckled upper selvage (finished edge) without barbed wire. The fencing will be installed at an elevation about 3 feet above the estimated mean high water lines for the Northeast Kettle. Fencing for the Southeast Kettle will also be installed at an elevation about 3 feet above the estimated mean high water line, however the fence may be installed along the property line located to the North and Northeast of the Southeast Kettle, if the estimated mean high water mark falls on private property in this area. This positioning will serve to prevent human access to water and sediment, as well as to facilitate the fence installation.

The use of this type of fence to restrict human access to certain hazardous areas is consistent with guidance and regulations from Washington State and its municipalities, counties, and industries. These areas include:

- Swimming pools,
- Solid waste, hazardous waste, and composting facilities,
- Electrical substations, and
- Nuclear waste facilities.

Appendix D of this IRAP includes an evaluation of the requirements for fences in these circumstances. In summary, that evaluation determined that a chain-link fence six feet in height is consistent with the level of risks – both physical and chemical – that the Kettle bottoms present to humans.

7.0 CONSTRUCTION

7.1 CONSTRUCTION OF FENCING

A permanent fence will be installed around the Northeast and Southeast Kettles. Permanent fencing is defined here as chain-link mesh fencing that is built of durable materials and designed to last 25 to 30 years or more. The chain-link mesh fabric, fence posts, framework, fittings, tension wires, and gates of the fences will be consistent with general specifications for commercial and industrial applications[2]. The following general specifications are required for the fences:

- A minimum of six feet in finished height
- Galvanized 1-3/4” to 2-3/8” diamond size chain-link mesh
- A knuckled upper selvage (finished edge) on the chain-link mesh
- Both top and bottom tension wires
- No barbed wire
- Two eight-foot lockable swing gates in each kettle’s fence, in locations that provide access by vehicles and workers to various portions of each kettle

The fences will be installed on the side slopes of the Kettles at an elevation at least three feet above the estimated mean high water line except where private property prohibits this installation (Northeastern side of Southeast Kettle). These elevations are based on review of the available information about the kettles, in collaboration with the Ecology Site Manager. The planned locations of the fences will be verified and located in collaboration with the Ecology Site Manager, and the fences will be surveyed after their installation.

Other factors for construction of the fencing will include topography and soil type. The contractor is required to install the fence at an elevation *at least as high as* specified in this work plan for a given kettle, but is *not* required to follow the exact elevation contour for a given kettle. The lay of the land may be taken into account wherever possible for efficient fence construction.

The slope, soil composition, and soil stability will determine post placement and installation method(s). Where possible, braces will be located in firm soil. The contractor will need to account for possible soil erosion on steeper slopes and its effects on the fence.

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[2] For example, ASTM Standard F1553-01 “Standard Guide for Specifying Industrial and Commercial Chain Link Fence” may be used as guidance to provide design specifications.

Signs (as described in detail in Exhibit B of the Restrictive Covenant) will be placed at intervals no greater than 50 feet around the perimeter of the fence, and be displayed at a height of four (4) feet above ground surface. The signs will be permanently attached to the outside of the fence fabric.

The swing gates installed in each kettle are to allow for future vehicular and pedestrian access for the maintenance of the kettles and their fences.

7.2 HEALTH AND SAFETY

The construction contractor will provide a health and safety plan (HASP) in accordance with applicable OSHA guidelines for all work activities on the Site. Work activities will be conducted on the side slopes of the Kettles; therefore, construction workers will not be directly exposed to the PCDD/Fs in sediment or water of the kettle bottoms. The risks associated with accidental exposures by workers to the water and sediment are not significant[3]. Standard industrial hygiene will be practiced while working in the kettles. This includes wearing long-sleeved shirts, long pants, and boots. If any accidental contact is made with sediments or water, workers will leave the kettle and wash the skin area with clean water and soap prior to returning. A suggested approach is that work parties have small pump sprayers containing soapy and clear tap water for this purpose.

At least one person who is current in 40-hour general site worker and 8-hr supervisor HAZWOPER training will be present during construction to ensure that all work activities are completed properly and safely. Work activities will be documented in a written log (including photographs) to demonstrate that construction was conducted in accordance with the Site-specific HASP.

[3] Assuming that a worker installing fencing accidentally gets water and mud on the skin and waits an hour before washing it off, the incremental risk lifetime cancer risk associated with one such incident, based on the sediment and water concentrations used in the HHRA for the Briggs Nursery Site (Intertox 2006), is estimated to be less than 1 in 10,000,000 ($1x10^{-7}$). The applicable MTCA standard is $1x10^{-6}$, or more than one-tenth the conservative risk estimate.

8.0 REFERENCES

CFR 40. Code of Federal Regulations; Title 40 Protection of Environment Section 268 Land Disposal Restrictions. http://www.ecfr.gpoaccess.gov/cgi/text/. Viewed on October 20, 2004. Data current as of October 18, 2004.

Ecology, 1991. Guidance for Site Checks and Site Assessments for Underground Storage Tanks. Washington Department of Ecology Publication # 90-52. February 1991, revised April 2003.

Ecology, 1997. Discussion Paper – Polychlorinated Biphenyl (PCB) Dangerous Waste W001. Ecology Publication # 97-415. Revised May 1997.

ENTRIX, Inc., 2005. Revised Draft Remedial Investigation Feasibility Study Work Plan Briggs Nursery, July 29, 2004 revised March 15, 2005.

ENTRIX, Inc., 2006. Final Remedial Investigation/Feasibility Study Report for Work Areas 1 and 2, Briggs Nursery, February 15, 2006.

ENTRIX, Inc., 2007. Final Remedial Investigation/Feasibility Study Work Plan: Work Area 3, Briggs Nursery, May 29, 2007.

EPA, 1992. Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies. July 1992 EPA/600/R-92/128.

EPA, 1997. Best Management Practices (BMPs) for Soils Treatment Technologies – Suggested Operational Guidelines to Prevent Cross-Media Transfer of Contaminants During Cleanup Activities. Environmental Protection Agency Publication No. EPA530-R-97-007, May 1997.

EPA , 1998. Management of Remediation Waste Under RCRA. EPA Publication EPA530-F-98-026. October, 1998.

EPA, 2002. Final Guidance on Demonstrating Compliance with the Land Disposal Restrictions (LDR) Alternative Soil Treatment Standards. EPA Publication EPA530-R-02-003, July, 2002.

Farallon, 2000. Letter Report: Environmental Media Management Plan (Revised Final) for Able Pest Control Site. Farallon Consulting LLC. April 6, 2000.

Farallon, 2004. Draft Amended Cleanup Action Plan Able Pest Control Site. Farallon Consulting LLC. March 23, 2004.

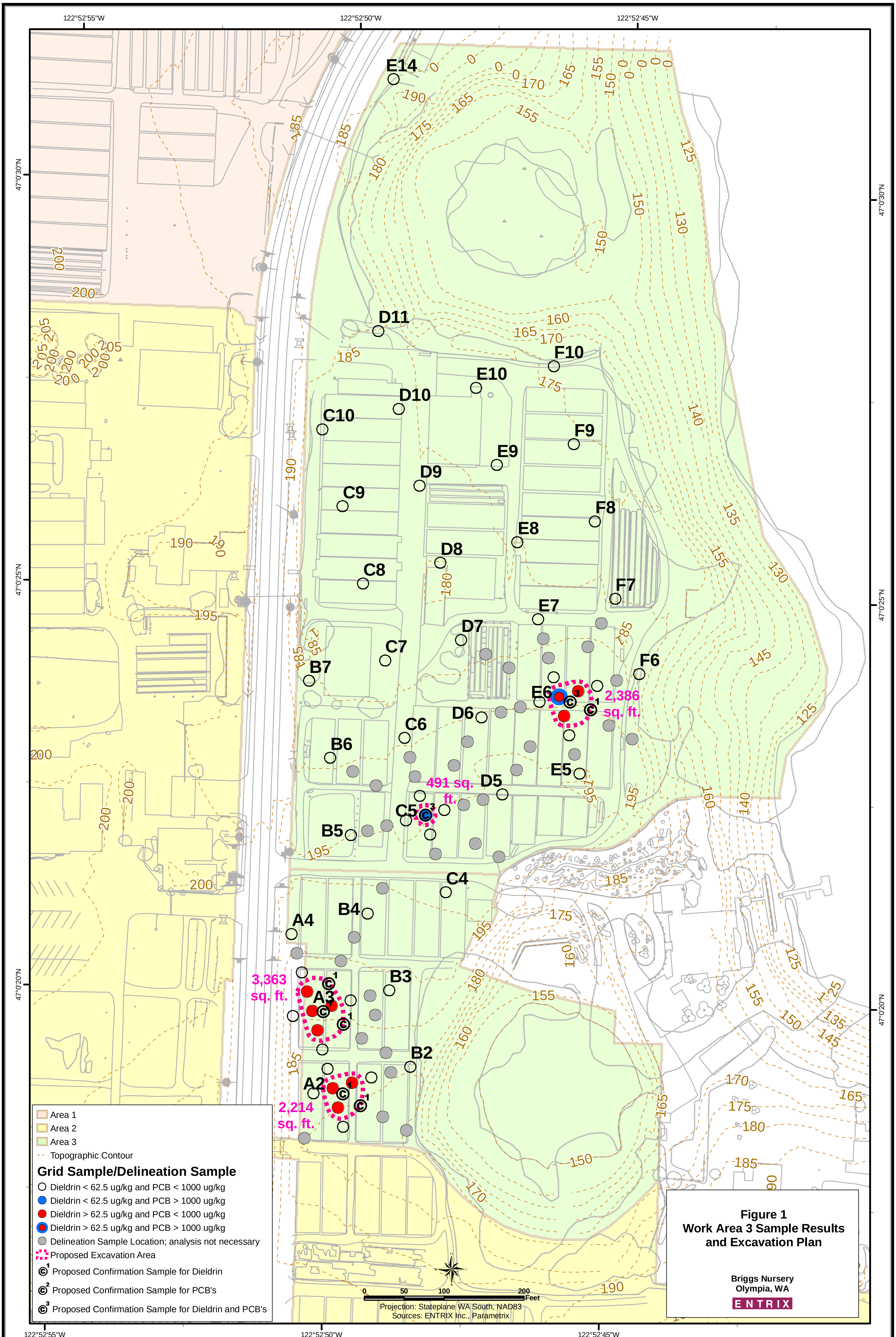
IPCS 2004. International Programme on Chemical Safety 2004. Website: http://www.inchem.org/documents/ehc/ehc/ehc91.htm#SectionNumber:2.2 Viewed on October 25, 2004.

Phillips Services Corporation, 1998. Limited Phase I Site Assessments, Briggs Nursery Olympia Facility, Briggs Nursery, Porter Facility.

Toxicological Profile for Aldrin/Dieldrin. 2002. U.S. Department of Health and Human Services. Public Health Services. Agency for Toxic Substances and Disease Registry. Website: http://www.atsdr.cdc.gov/toxprofiles/tp1.pdf Viewed on January 4, 2005.

WAC Chapter 173-303, Dangerous Waste Regulations. Revised April 2003.

WAC Chapter 173-340, Model Toxics Control Act. Revised February 2001.



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APPENDIX A

WORK AREA 3 SURFICIAL SOIL ANALYTICAL DATA

Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	110206-A2			110206-A2a			110206-A3			110206-A4			110206-B2			110206-B3			110206-B4			110206-B5		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			-			-			-			-			-			-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			-			-			-			-			-			-			-		
Herbicide	2,4-D	na	-			-			-			-			-			-			-			-		
Herbicide	2,4-DB	640000	-			-			-			-			-			-			-			-		
Herbicide	Dalapon	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dicamba	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dichloroprop	na	-			-			-			-			-			-			-			-		
Herbicide	Dinoseb	80000	-			-			-			-			-			-			-			-		
Herbicide	MCPA	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1016	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1221	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1232	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1242	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1248	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1254	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1260	na	-			-			-			-			-			-			-			-		
PCB	Total PCB	1000																									
Pesticide	4,4'-DDD	4170	39	3.81	12	40	3.79	12	35	3.88	12	<3.2 U	1.06	3.2	6.2	1.07	3.3	<3.2 U	1.06	3.2	<3.3 U	1.08	3.3	<3.2 U	1.06	3.2
Pesticide	4,4'-DDE	2940	21	4.57	12	23	4.55	12	24	4.65	12	3.9 J	1.27	3.2	8.2	1.29	3.3	<3.2 U	1.27	3.2	<3.3 U	1.30	3.3	5.6 P	1.27	3.2
Pesticide	4,4'-DDT	2940	99	4.79	12	110	4.77	12	140	4.87	12	11	1.33	3.2	39	1.35	3.3	5.4	1.33	3.2	24	1.36	3.3	28	1.33	3.2
Pesticide	Aldrin	58.8	<5.8 U	4.02	5.8	<5.8 U	4.00	5.8	7.8	4.09	5.9	<1.6 U	1.12	1.6	<1.6 U	1.13	1.6	<1.6 U	1.12	1.6	<1.7 U	1.14	1.7	<1.6 U	1.12	1.6
Pesticide	alpha Chlordane	2860	<39 Y	2.26	39	<42 Y	2.25	42	<38 Y	2.30	38	<4.3 Y	0.629	4.3	<4.6 Y	0.637	4.6	<1.6 U	0.630	1.6	<7.6 Y	0.643	7.6	<1.6 U	0.628	1.6
Pesticide	alpha-BHC	na	<5.8 U	3.31	5.8	<5.8 U	3.30	5.8	<5.9 U	3.37	5.9	<1.6 U	0.921	1.6	<1.6 U	0.932	1.6	<1.6 U	0.922	1.6	<1.7 U	0.941	1.7	<1.6 U	0.920	1.6
Pesticide	beta-BHC	na	<5.8 U	5.12	5.8	<5.8 U	5.09	5.8	<5.9 U	5.20	5.9	<1.6 U	1.42	1.6	<1.6 U	1.44	1.6	<1.6 U	1.43	1.6	<1.7 U	1.45	1.7	<1.6 U	1.42	1.6
Pesticide	delta-BHC	na	<5.8 U	2.68	5.8	<5.8 U	2.67	5.8	<5.9 U	2.73	5.9	<1.6 U	0.746	1.6	<1.6 U	0.755	1.6	<1.6 U	0.747	1.6	<1.7 U	0.762	1.7	<1.6 U	0.745	1.6
Pesticide	Dieldrin	62.5	**99**	4.49	12	**120**	4.47	12	**170**	4.56	12	14	1.25	3.2	<17 Y	1.26	17	<3.2 U	1.25	3.2	<3.3 U	1.28	3.3	<7.3 Y	1.25	7.3
Pesticide	Endosulfan I	480000	<5.8 U	2.50	5.8	<5.8 U	2.48	5.8	<5.9 U	2.54	5.9	<1.6 U	0.694	1.6	<1.6 U	0.702	1.6	<1.6 U	0.695	1.6	<1.7 U	0.709	1.7	<1.6 U	0.693	1.6
Pesticide	Endosulfan II	480000	<12 U	5.50	12	<12 U	5.48	12	<12 U	5.60	12	<3.2 U	1.53	3.2	<3.3 U	1.55	3.3	<3.2 U	1.53	3.2	<3.3 U	1.56	3.3	<3.2 U	1.53	3.2
Pesticide	Endosulfan Sulfate	na	<12 U	5.96	12	<12 U	5.93	12	<12 U	6.06	12	<3.2 U	1.66	3.2	<3.3 U	1.68	3.3	<3.2 U	1.66	3.2	<3.3 U	1.69	3.3	<3.2 U	1.65	3.2
Pesticide	Endrin	24000	<12 U	3.32	12	<12 U	3.31	12	<12 U	3.38	12	<3.2 U	0.925	3.2	<3.3 U	0.936	3.3	<3.2 U	0.925	3.2	<3.3 U	0.944	3.3	<3.2 U	0.923	3.2
Pesticide	Endrin Aldehyde	na	<12 U	4.24	12	<12 U	4.22	12	<12 U	4.32	12	<3.2 U	1.18	3.2	<3.3 U	1.19	3.3	<3.2 U	1.18	3.2	<3.3 U	1.21	3.3	<3.2 U	1.18	3.2
Pesticide	Endrin Ketone	na	<12 U	5.84	12	<12 U	5.81	12	<12 U	5.94	12	<3.2 U	1.63	3.2	<3.3 U	1.64	3.3	<3.2 U	1.63	3.2	<3.3 U	1.66	3.3	<3.2 U	1.62	3.2
Pesticide	gamma Chlordane	2860	42	2.23	5.8	46	2.22	5.8	36	2.26	5.9	3.1	0.620	1.6	3.4	0.627	1.6	<1.6 U	0.620	1.6	4.1	0.633	1.7	<1.6 U	0.618	1.6
Pesticide	gamma-BHC (Lindane)	769	<5.8 U	2.67	5.8	<5.8 U	2.66	5.8	<5.9 U	2.71	5.9	<1.6 U	0.743	1.6	<1.6 U	0.752	1.6	<1.6 U	0.744	1.6	<1.7 U	0.759	1.7	<1.6 U	0.741	1.6
Pesticide	Heptachlor	222	<5.8 U	2.81	5.8	<5.8 U	2.80	5.8	<5.9 U	2.86	5.9	<1.6 U	0.782	1.6	<1.6 U	0.791	1.6	<1.6 U	0.783	1.6	<1.7 U	0.798	1.7	<1.6 U	0.780	1.6
Pesticide	Heptachlor Epoxide	110	34	3.71	5.8	37	3.69	5.8	20	3.77	5.9	<1.6 U	1.03	1.6	<1.6 U	1.04	1.6	<1.6 U	1.03	1.6	<1.7 U	1.05	1.7	<1.6 U	1.03	1.6
Pesticide	Methoxychlor	400000	<58 U	26.5	58	<58 U	26.3	58	<59 U	26.9	59	<16 U	7.36	16	<16 U	7.45	16	<16 U	7.37	16	<17 U	7.52	17	<16 U	7.35	16
Pesticide	Toxaphene	na	<580 U	583	580	<580 U	580	580	<590 U	593	590	<160 U	162	160	<160 U	164	160	<160 U	162	160	<170 U	166	170	<160 U	162	160

RL : Reporting Limit
MDL: Method Detection Limit
-: Not analyzed
na: Cleanup level not available
U: Analyte note detected below the indicated RL (PQL)
P: Greater than 40% difference between the two columns
Y: Sample result contains matrix interference
E: Estimated concentration calculated for analyte response above the valid instrument calibration range

Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	110206-B6			110206-C4			110206-C5			110206-C7			110206-D5			110206-D6			110206-D7			110206-E14		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			<1.8 U	1.8	1.8	-			-			-			-			-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			<1.8 U	1.8	1.8	-			-			-			-			-			-		
Herbicide	2,4-D	na	-			<7.3 U	7.3	7.3	-			-			-			-			-			-		
Herbicide	2,4-DB	640000	-			<36 U	36	36	-			-			-			-			-			-		
Herbicide	Dalapon	2400000	-			<7.3 U	7.3	7.3	-			-			-			-			-			-		
Herbicide	Dicamba	2400000	-			<3.6 U	3.6	3.6	-			-			-			-			-			-		
Herbicide	Dichloroprop	na	-			<7.3 U	7.3	7.3	-			-			-			-			-			-		
Herbicide	Dinoseb	80000	-			<1.8 U	1.8	1.8	-			-			-			-			-			-		
Herbicide	MCPA	na	-			<1800 U	1800	1800	-			-			-			-			-			-		
PCB	Aroclor 1016	na	-			-			<480 U	58	480	-			<62 U	7.6	62	<82 U	10	82	-			-		
PCB	Aroclor 1221	na	-			-			<480 U	58	480	-			<62 U	7.6	62	<82 U	10	82	-			-		
PCB	Aroclor 1232	na	-			-			<480 U	58	480	-			<62 U	7.6	62	<82 U	10	82	-			-		
PCB	Aroclor 1242	na	-			-			<480 U	58	480	-			<62 U	7.6	62	<82 U	10	82	-			-		
PCB	Aroclor 1248	na	-			-			<480 U	58	480	-			<62 U	7.6	62	<82 U	10	82	-			-		
PCB	Aroclor 1254	na	-			-			2400	58	480	-			260	7.6	62	320	10	82	-			-		
PCB	Aroclor 1260	na	-			-			820	58	480	-			130	7.6	62	110	10	82	-			-		
PCB	Total PCB	1000							**3220**						390			430								
Pesticide	4,4'-DDD	4170	<3.2 U	1.05	3.2	<3.3 U	1.07	3.3	<48 U	15.6	48	60	2.07	6.3	<6.2 U	2.03	6.2	<8.2 U	2.67	8.2	12	1.01	3.1	<3.2 U	1.04	3.2
Pesticide	4,4'-DDE	2940	33	6.32	16	4.2	1.28	3.3	<48 U	18.7	48	16	2.48	6.3	<17 Y	2.44	17	<8.2 U	3.21	8.2	7.2 P	1.21	3.1	13	1.25	3.2
Pesticide	4,4'-DDT	2940	110	6.62	16	35	1.34	3.3	<48 U	19.6	48	26	2.60	6.3	<6.2 U	2.56	6.2	<8.2 U	3.36	8.2	14	1.27	3.1	28	1.31	3.2
Pesticide	Aldrin	58.8	<1.6 U	1.11	1.6	<1.6 U	1.12	1.6	<24 U	16.4	24	<3.2 U	2.18	3.2	<3.1 U	2.15	3.1	<4.1 U	2.82	4.1	<1.5 U	1.06	1.5	<1.6 U	1.10	1.6
Pesticide	alpha Chlordane	2860	<22 U	3.13	22	<3.2 Y	0.632	3.2	<24 U	9.25	24	<9.4 Y	1.23	9.4	<3.1 U	1.21	3.1	<4.1 U	1.59	4.1	<4.6 Y	0.599	4.6	<1.6 U	0.618	1.6
Pesticide	alpha-BHC	na	<1.6 U	0.915	1.6	<1.6 U	0.926	1.6	<24 U	13.5	24	<3.2 U	1.79	3.2	<3.1 U	1.77	3.1	<4.1 U	2.32	4.1	<1.5 U	0.877	1.5	<1.6 U	0.904	1.6
Pesticide	beta-BHC	na	<1.6 U	1.42	1.6	<1.6 U	1.43	1.6	<24 U	20.9	24	<3.2 U	2.77	3.2	<3.1 U	2.73	3.1	<4.1 U	3.59	4.1	<1.5 U	1.35	1.5	<1.6 U	1.40	1.6
Pesticide	delta-BHC	na	<1.6 U	0.741	1.6	<1.6 U	0.750	1.6	<24 U	11.0	24	<3.2 U	1.45	3.2	<3.1 U	1.43	3.1	<4.1 U	1.88	4.1	<1.5 U	0.710	1.5	<1.6 U	0.732	1.6
Pesticide	Dieldrin	62.5	<16 U	6.20	16	<55 Y	1.25	55	<220 Y	18.3	220	36	2.43	6.3	<25 Y	2.39	25	<66 Y	3.15	66	11	1.19	3.1	<3.2 U	1.23	3.2
Pesticide	Endosulfan I	480000	<8.1 U	3.45	8.1	<1.6 U	0.698	1.6	<24 U	10.2	24	<3.2 U	1.35	3.2	<3.1 U	1.33	3.1	<4.1 U	1.75	4.1	<1.5 U	0.660	1.5	<1.6 U	0.681	1.6
Pesticide	Endosulfan II	480000	6.6 P	1.52	3.2	<3.3 U	1.54	3.3	<48 U	22.5	48	<6.3 U	2.98	6.3	<26 Y	2.94	26	<34 Y	3.86	34	<3.1 U	1.46	3.1	<3.2 U	1.50	3.2
Pesticide	Endosulfan Sulfate	na	<16 U	8.24	16	<3.3 U	1.67	3.3	<48 U	24.4	48	<6.3 U	3.23	6.3	<6.2 U	3.18	6.2	<8.2 U	4.18	8.2	<3.1 U	1.58	3.1	<3.2 U	1.63	3.2
Pesticide	Endrin	24000	<3.2 U	0.919	3.2	<3.3 U	0.929	3.3	<48 U	13.6	48	<6.3 U	1.80	6.3	<6.2 U	1.77	6.2	<8.2 U	2.33	8.2	<3.1 U	0.880	3.1	<3.2 U	0.908	3.2
Pesticide	Endrin Aldehyde	na	<16 U	5.87	16	<3.3 U	1.19	3.3	<48 U	17.3	48	<6.3 U	2.30	6.3	<6.2 U	2.26	6.2	<8.2 U	2.98	8.2	<3.1 U	1.12	3.1	<3.2 U	1.16	3.2
Pesticide	Endrin Ketone	na	<16 U	8.07	16	<3.3 U	1.63	3.3	<48 U	23.9	48	<6.3 U	3.16	6.3	<6.2 U	3.12	6.2	<8.2 U	4.10	8.2	<3.1 U	1.55	3.1	<3.2 U	1.60	3.2
Pesticide	gamma Chlordane	2860	13	3.08	8.1	2.0	0.623	1.6	<140 Y	9.10	140	7.6	1.21	3.2	<3.1 U	1.19	3.1	<20 Y	1.56	20	<4.3 Y	0.590	4.3	<1.6 U	0.608	1.6
Pesticide	gamma-BHC (Lindane)	769	<8.1 U	3.69	8.1	<1.6 U	0.746	1.6	<24 U	10.9	24	<3.2 U	1.45	3.2	<3.1 U	1.42	3.1	<4.1 U	1.87	4.1	<1.5 U	0.707	1.5	<1.6 U	0.729	1.6
Pesticide	Heptachlor	222	<1.6 U	0.777	1.6	<1.6 U	0.786	1.6	<24 U	11.5	24	<3.2 U	1.52	3.2	<3.1 U	1.50	3.1	<4.1 U	1.97	4.1	<1.5 U	0.744	1.5	<1.6 U	0.767	1.6
Pesticide	Heptachlor Epoxide	110	2.1	1.03	1.6	<1.6 U	1.04	1.6	<120 Y	15.2	120	<3.3 Y	2.01	3.3	<3.1 U	1.98	3.1	<4.1 U	2.60	4.1	<1.5 U	0.981	1.5	<1.6 U	1.01	1.6
Pesticide	Methoxychlor	400000	<81 U	36.6	81	<16 U	7.40	16	<240 U	108	240	<32 U	14.3	32	<31 U	14.1	31	<41 U	18.6	41	<15 U	7.01	15	<16 U	7.23	16
Pesticide	Toxaphene	na	<810 U	806	810	<160 U	163	160	<2400 U	2380	2400	<320 U	316	320	<310 U	311	310	<410 U	409	410	<150 U	154	150	<160 U	159	160

RL : Reporting Limit
MDL: Method Detection Limit
-: Not analyzed
na: Cleanup level not available
U: Analyte note detected below the indicated RL (PQL)
P: Greater than 40% difference between the two columns
Y: Sample result contains matrix interference
E: Estimated concentration calculated for analyte response abc

Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	110206-E14a			110206-E5			110206-E6			110206-E7			110206-E9			110206-F10			110206-F6			110206-F7		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			-			-			-			-			-			-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			-			-			-			-			-			-			-		
Herbicide	2,4-D	na	-			-			-			-			-			-			-			-		
Herbicide	2,4-DB	640000	-			-			-			-			-			-			-			-		
Herbicide	Dalapon	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dicamba	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dichloroprop	na	-			-			-			-			-			-			-			-		
Herbicide	Dinoseb	80000	-			-			-			-			-			-			-			-		
Herbicide	MCPA	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1016	na	-			-			<120 U	14	120	-			-			-			-			-		
PCB	Aroclor 1221	na	-			-			<120 U	14	120	-			-			-			-			-		
PCB	Aroclor 1232	na	-			-			<120 U	14	120	-			-			-			-			-		
PCB	Aroclor 1242	na	-			-			<120 U	14	120	-			-			-			-			-		
PCB	Aroclor 1248	na	-			-			<120 U	14	120	-			-			-			-			-		
PCB	Aroclor 1254	na	-			-			790	14	120	-			-			-			-			-		
PCB	Aroclor 1260	na	-			-			310	14	120	-			-			-			-			-		
PCB	Total PCB	1000							**1100**																	
Pesticide	4,4'-DDD	4170	<3.1 U	1.02	3.1	<3.3 U	1.07	3.3	<12 U	3.86	12	<3.2 U	1.06	3.2	<3.0 U	0.985	3.0	<3.2 U	1.06	3.2	<16 U	5.23	16	<3.2 U	1.06	3.2
Pesticide	4,4'-DDE	2940	9.9	1.23	3.1	<3.3 U	1.29	3.3	<70 Y	4.63	70	5.1	1.27	3.2	3.7 J	1.18	3.0	<3.2 U	1.27	3.2	31	1.25	3.2	<16 U	6.33	16
Pesticide	4,4'-DDT	2940	22	1.29	3.1	<3.3 U	1.35	3.3	<210 Y	4.86	210	36	1.33	3.2	11	1.24	3.0	12	1.33	3.2	57 E	1.32	3.2	84 E	1.33	3.2
Pesticide	Aldrin	58.8	<1.6 U	1.08	1.6	<1.6 U	1.13	1.6	<5.9 U	4.08	5.9	<1.6 U	1.11	1.6	<1.5 U	1.04	1.5	<1.6 U	1.12	1.6	<8.0 U	5.52	8.0	<8.1 U	5.58	8.1
Pesticide	alpha Chlordane	2860	<1.6 U	0.608	1.6	<1.6 U	0.638	1.6	<29 Y	2.29	29	<1.6 U	0.627	1.6	<1.5 U	0.584	1.5	<1.6 U	0.630	1.6	<8.0 U	3.11	8.0	<1.6 U	0.627	1.6
Pesticide	alpha-BHC	na	<1.6 U	0.890	1.6	<1.6 U	0.934	1.6	<5.9 U	3.35	5.9	<1.6 U	0.917	1.6	<1.5 U	0.856	1.5	<1.6 U	0.922	1.6	<8.0 U	4.55	8.0	<1.6 U	0.918	1.6
Pesticide	beta-BHC	na	<1.6 U	1.38	1.6	<1.6 U	1.44	1.6	<5.9 U	5.19	5.9	<1.6 U	1.42	1.6	<1.5 U	1.32	1.5	<1.6 U	1.42	1.6	<1.6 U	1.41	1.6	<1.6 U	1.42	1.6
Pesticide	delta-BHC	na	<1.6 U	0.721	1.6	<1.6 U	0.756	1.6	<5.9 U	2.72	5.9	<1.6 U	0.743	1.6	<1.5 U	0.693	1.5	<1.6 U	0.747	1.6	<1.6 U	0.736	1.6	<1.6 U	0.743	1.6
Pesticide	Dieldrin	62.5	<3.1 U	1.21	3.1	<22 Y	1.27	22	**94**	4.55	12	6.0	1.24	3.2	<3.0 U	1.16	3.0	<3.2 U	1.25	3.2	38	1.23	3.2	<38 Y	1.24	38
Pesticide	Endosulfan I	480000	<1.6 U	0.670	1.6	<1.6 U	0.703	1.6	<5.9 U	2.53	5.9	<1.6 U	0.691	1.6	<1.5 U	0.645	1.5	<1.6 U	0.695	1.6	<1.6 U	0.685	1.6	<1.6 U	0.692	1.6
Pesticide	Endosulfan II	480000	<3.1 U	1.48	3.1	<3.3 U	1.55	3.3	<64 Y	5.58	64	<3.2 U	1.52	3.2	<3.0 U	1.42	3.0	<3.2 U	1.53	3.2	<16 U	7.55	16	<16 U	7.63	16
Pesticide	Endosulfan Sulfate	na	<3.1 U	1.60	3.1	<3.3 U	1.68	3.3	<12 U	6.04	12	<3.2 U	1.65	3.2	<3.0 U	1.54	3.0	<3.2 U	1.66	3.2	<16 U	8.18	16	<3.2 U	1.65	3.2
Pesticide	Endrin	24000	<3.1 U	0.893	3.1	<3.3 U	0.937	3.3	<12 U	3.37	12	<3.2 U	0.920	3.2	<3.0 U	0.859	3.0	<3.2 U	0.925	3.2	<16 U	4.56	16	<3.2 U	0.921	3.2
Pesticide	Endrin Aldehyde	na	<3.1 U	1.14	3.1	<3.3 U	1.20	3.3	<12 U	4.30	12	<3.2 U	1.18	3.2	<3.0 U	1.10	3.0	<3.2 U	1.18	3.2	<3.2 U	1.17	3.2	<16 U	5.88	16
Pesticide	Endrin Ketone	na	<3.1 U	1.57	3.1	<3.3 U	1.65	3.3	<12 U	5.92	12	<3.2 U	1.62	3.2	<3.0 U	1.51	3.0	<3.2 U	1.63	3.2	<16 U	8.02	16	<3.2 U	1.62	3.2
Pesticide	gamma Chlordane	2860	<1.6 U	0.598	1.6	<1.6 U	0.628	1.6	<49 Y	2.26	49	<1.6 U	0.617	1.6	<1.5 U	0.575	1.5	<1.6 U	0.620	1.6	<8.0 U	3.06	8.0	<1.6 U	0.617	1.6
Pesticide	gamma-BHC (Lindane)	769	<1.6 U	0.717	1.6	<1.6 U	0.753	1.6	<5.9 U	2.71	5.9	<1.6 U	0.740	1.6	<1.5 U	0.690	1.5	<1.6 U	0.743	1.6	<1.6 U	0.733	1.6	<1.6 U	0.740	1.6
Pesticide	Heptachlor	222	<1.6 U	0.755	1.6	<1.6 U	0.792	1.6	<5.9 U	2.85	5.9	<1.6 U	0.778	1.6	<1.5 U	0.726	1.5	<1.6 U	0.782	1.6	<8.0 U	3.86	8.0	<1.6 U	0.779	1.6
Pesticide	Heptachlor Epoxide	110	<1.6 U	0.996	1.6	<1.6 U	1.05	1.6	<38 Y	3.76	38	<1.6 U	1.03	1.6	<1.5 U	0.958	1.5	<1.6 U	1.03	1.6	<8.0 U	5.09	8.0	<1.6 U	1.03	1.6
Pesticide	Methoxychlor	400000	<16 U	7.11	16	<16 U	7.46	16	<59 U	26.8	59	<16 U	7.33	16	<15 U	6.84	15	<16 U	7.37	16	<80 U	36.3	80	<16 U	7.34	16
Pesticide	Toxaphene	na	<160 U	157	160	<160 U	164	160	<590 U	591	590	<160 U	161	160	<150 U	151	150	<160 U	162	160	<800 U	800	800	<810 U	808	810

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Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	041007-C5+25E			041007-C5+25Ea			041007-C5+25N			041007-C5+25S			041007-C5+25W			041107-A2+25E			041107-A2+25Ea			041107-A2+25N		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			-			-			-			-			-			-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			-			-			-			-			-			-			-		
Herbicide	2,4-D	na	-			-			-			-			-			-			-			-		
Herbicide	2,4-DB	640000	-			-			-			-			-			-			-			-		
Herbicide	Dalapon	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dicamba	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dichloroprop	na	-			-			-			-			-			-			-			-		
Herbicide	Dinoseb	80000	-			-			-			-			-			-			-			-		
Herbicide	MCPA	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1016	na	<59 U	20	59	<60 U	20	60	<65 U	22	65	<61 U	20	61	<190 U	63	190	-			-			-		
PCB	Aroclor 1221	na	<59 U	20	59	<60 U	20	60	<65 U	22	65	<61 U	20	61	<190 U	63	190	-			-			-		
PCB	Aroclor 1232	na	<59 U	20	59	<60 U	20	60	<65 U	22	65	<61 U	20	61	<190 U	63	190	-			-			-		
PCB	Aroclor 1242	na	<59 U	20	59	<60 U	20	60	<65 U	22	65	<61 U	20	61	<190 U	63	190	-			-			-		
PCB	Aroclor 1248	na	<59 U	20	59	<60 U	20	60	<65 U	22	65	<61 U	20	61	<190 U	63	190	-			-			-		
PCB	Aroclor 1254	na	240	20	59	190	20	60	90	22	65	400	20	61	410	63	190	-			-			-		
PCB	Aroclor 1260	na	77	20	59	61	20	60	<65 U	22	65	130	20	61	<190 U	63	190	-			-			-		
PCB	Total PCB	1000	317			251			90			530			410											
Pesticide	4,4'-DDD	4170	-			-			-			-			-			-			-			-		
Pesticide	4,4'-DDE	2940	-			-			-			-			-			-			-			-		
Pesticide	4,4'-DDT	2940	-			-			-			-			-			-			-			-		
Pesticide	Aldrin	58.8	-			-			-			-			-			-			-			-		
Pesticide	alpha Chlordane	2860	-			-			-			-			-			-			-			-		
Pesticide	alpha-BHC	na	-			-			-			-			-			-			-			-		
Pesticide	beta-BHC	na	-			-			-			-			-			-			-			-		
Pesticide	delta-BHC	na	-			-			-			-			-			-			-			-		
Pesticide	Dieldrin	62.5	-			-			-			-			-			**140 P**	6.34	16	**84 P**	6.26	16	40 P	1.24	3.2
Pesticide	Endosulfan I	480000	-			-			-			-			-			-			-			-		
Pesticide	Endosulfan II	480000	-			-			-			-			-			-			-			-		
Pesticide	Endosulfan Sulfate	na	-			-			-			-			-			-			-			-		
Pesticide	Endrin	24000	-			-			-			-			-			-			-			-		
Pesticide	Endrin Aldehyde	na	-			-			-			-			-			-			-			-		
Pesticide	Endrin Ketone	na	-			-			-			-			-			-			-			-		
Pesticide	gamma Chlordane	2860	-			-			-			-			-			-			-			-		
Pesticide	gamma-BHC (Lindane)	769	-			-			-			-			-			-			-			-		
Pesticide	Heptachlor	222	-			-			-			-			-			-			-			-		
Pesticide	Heptachlor Epoxide	110	-			-			-			-			-			-			-			-		
Pesticide	Methoxychlor	400000	-			-			-			-			-			-			-			-		
Pesticide	Toxaphene	na	-			-			-			-			-			-			-			-		

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U: Analyte note detected below the indicated RL (PQL)
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Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	041107-A2+25S			041107-A2+25W			041107-A2+50E			041107-A2+50N			041107-A2+50S			041107-A3+106NE			041107-A3+25E			041107-A3+25N		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			-			-			-			-			<2 U	2	2	-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			-			-			-			-			<2 U	2	2	-			-		
Herbicide	2,4-D	na	-			-			-			-			-			<8 U	8	8	-			-		
Herbicide	2,4-DB	640000	-			-			-			-			-			<40 U	40	40	-			-		
Herbicide	Dalapon	2400000	-			-			-			-			-			<8 U	8	8	-			-		
Herbicide	Dicamba	2400000	-			-			-			-			-			<4 U	4	4	-			-		
Herbicide	Dichloroprop	na	-			-			-			-			-			<8 U	8	8	-			-		
Herbicide	Dinoseb	80000	-			-			-			-			-			<2 U	2	2	-			-		
Herbicide	MCPA	na	-			-			-			-			-			<2000 U	2000	2000	-			-		
PCB	Aroclor 1016	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1221	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1232	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1242	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1248	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1254	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1260	na	-			-			-			-			-			-			-			-		
PCB	Total PCB	1000																								
Pesticide	4,4'-DDD	4170	-			-			-			-			-			-			-			-		
Pesticide	4,4'-DDE	2940	-			-			-			-			-			-			-			-		
Pesticide	4,4'-DDT	2940	-			-			-			-			-			-			-			-		
Pesticide	Aldrin	58.8	-			-			-			-			-			-			-			-		
Pesticide	alpha Chlordane	2860	-			-			-			-			-			-			-			-		
Pesticide	alpha-BHC	na	-			-			-			-			-			-			-			-		
Pesticide	beta-BHC	na	-			-			-			-			-			-			-			-		
Pesticide	delta-BHC	na	-			-			-			-			-			-			-			-		
Pesticide	Dieldrin	62.5	**74 P**	6.3	16	28 P	1.27	3.3	26 P	1.27	3.3	25 P	2.52	6.5	<3.2 U	1.24	3.2	-			**120 P**	6.26	16	**130 P**	6.25	16
Pesticide	Endosulfan I	480000	-			-			-			-			-			-			-			-		
Pesticide	Endosulfan II	480000	-			-			-			-			-			-			-			-		
Pesticide	Endosulfan Sulfate	na	-			-			-			-			-			-			-			-		
Pesticide	Endrin	24000	-			-			-			-			-			-			-			-		
Pesticide	Endrin Aldehyde	na	-			-			-			-			-			-			-			-		
Pesticide	Endrin Ketone	na	-			-			-			-			-			-			-			-		
Pesticide	gamma Chlordane	2860	-			-			-			-			-			-			-			-		
Pesticide	gamma-BHC (Lindane)	769	-			-			-			-			-			-			-			-		
Pesticide	Heptachlor	222	-			-			-			-			-			-			-			-		
Pesticide	Heptachlor Epoxide	110	-			-			-			-			-			-			-			-		
Pesticide	Methoxychlor	400000	-			-			-			-			-			-			-			-		
Pesticide	Toxaphene	na	-			-			-			-			-			-			-			-		

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Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	041107-A3+25S			041107-A3+25Sa			041107-A3+25W			041107-A3+50E			041107-A3+50N			041107-D11			041207-E6+25E			041207-E6+25N		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			-			-			-			-			-			-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			-			-			-			-			-			-			-		
Herbicide	2,4-D	na	-			-			-			-			-			-			-			-		
Herbicide	2,4-DB	640000	-			-			-			-			-			-			-			-		
Herbicide	Dalapon	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dicamba	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dichloroprop	na	-			-			-			-			-			-			-			-		
Herbicide	Dinoseb	80000	-			-			-			-			-			-			-			-		
Herbicide	MCPA	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1016	na	-			-			-			-			-			-			<60 U	20	60	<57 U	19	57
PCB	Aroclor 1221	na	-			-			-			-			-			-			<60 U	20	60	<57 U	19	57
PCB	Aroclor 1232	na	-			-			-			-			-			-			<60 U	20	60	<57 U	19	57
PCB	Aroclor 1242	na	-			-			-			-			-			-			<60 U	20	60	<57 U	19	57
PCB	Aroclor 1248	na	-			-			-			-			-			-			<60 U	20	60	<57 U	19	57
PCB	Aroclor 1254	na	-			-			-			-			-			-			320	20	60	120	19	57
PCB	Aroclor 1260	na	-			-			-			-			-			-			130	20	60	<57 U	19	57
PCB	Total PCB	1000																			450			120		
Pesticide	4,4'-DDD	4170	-			-			-			-			-			<3.3 U	1.08	3.3	-			-		
Pesticide	4,4'-DDE	2940	-			-			-			-			-			<3.3 U	1.3	3.3	-			-		
Pesticide	4,4'-DDT	2940	-			-			-			-			-			5.8	1.36	3.3	-			-		
Pesticide	Aldrin	58.8	-			-			-			-			-			<1.6 U	1.14	1.6	-			-		
Pesticide	alpha Chlordane	2860	-			-			-			-			-			<1.6 U	0.642	1.6	-			-		
Pesticide	alpha-BHC	na	-			-			-			-			-			<1.6 U	0.94	1.6	-			-		
Pesticide	beta-BHC	na	-			-			-			-			-			<1.6 U	1.45	1.6	-			-		
Pesticide	delta-BHC	na	-			-			-			-			-			<1.6 U	0.761	1.6	-			-		
Pesticide	Dieldrin	62.5	**160 P**	6.18	16	56 P	6.34	16	12 P	1.26	3.3	12 P	1.25	3.3	5.6 P	1.28	3.3	<3.3 U	1.27	3.3	**100 P**	6.24	16	61	6.3	16
Pesticide	Endosulfan I	480000	-			-			-			-			-			<1.6 U	0.708	1.6	-			-		
Pesticide	Endosulfan II	480000	-			-			-			-			-			<3.3 U	1.56	3.3	-			-		
Pesticide	Endosulfan Sulfate	na	-			-			-			-			-			<3.3 U	1.69	3.3	-			-		
Pesticide	Endrin	24000	-			-			-			-			-			<3.3 U	0.943	3.3	-			-		
Pesticide	Endrin Aldehyde	na	-			-			-			-			-			<3.3 U	1.2	3.3	-			-		
Pesticide	Endrin Ketone	na	-			-			-			-			-			<3.3 U	1.66	3.3	-			-		
Pesticide	gamma Chlordane	2860	-			-			-			-			-			<1.6 U	0.632	1.6	-			-		
Pesticide	gamma-BHC (Lindane)	769	-			-			-			-			-			<1.6 U	0.758	1.6	-			-		
Pesticide	Heptachlor	222	-			-			-			-			-			<1.6 U	0.798	1.6	-			-		
Pesticide	Heptachlor Epoxide	110	-			-			-			-			-			<1.6 U	1.05	1.6	-			-		
Pesticide	Methoxychlor	400000	-			-			-			-			-			<16 U	7.51	16	-			-		
Pesticide	Toxaphene	na	-			-			-			-			-			<160 U	165	160	-			-		

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Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	041207-E6+25S			041207-E6+25W			041207-E6+50E			041207-E6+50S			061207-B7			061207-C10			061207-C6			061207-C8		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			-			-			-			-			-			-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			-			-			-			-			-			-			-		
Herbicide	2,4-D	na	-			-			-			-			-			-			-			-		
Herbicide	2,4-DB	640000	-			-			-			-			-			-			-			-		
Herbicide	Dalapon	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dicamba	2400000	-			-			-			-			-			-			-			-		
Herbicide	Dichloroprop	na	-			-			-			-			-			-			-			-		
Herbicide	Dinoseb	80000	-			-			-			-			-			-			-			-		
Herbicide	MCPA	na	-			-			-			-			-			-			-			-		
PCB	Aroclor 1016	na	<60 U	20	60	<59 U	20	59	-			-			-			-			-			-		
PCB	Aroclor 1221	na	<60 U	20	60	<59 U	20	59	-			-			-			-			-			-		
PCB	Aroclor 1232	na	<60 U	20	60	<59 U	20	59	-			-			-			-			-			-		
PCB	Aroclor 1242	na	<60 U	20	60	<59 U	20	59	-			-			-			-			-			-		
PCB	Aroclor 1248	na	<60 U	20	60	<59 U	20	59	-			-			-			-			-			-		
PCB	Aroclor 1254	na	130	20	60	290	20	59	-			-			-			-			-			-		
PCB	Aroclor 1260	na	<60 U	20	60	120	20	59	-			-			-			-			-			-		
PCB	Total PCB	1000	130			410																				
Pesticide	4,4'-DDD	4170	-			-			-			-			<3.3 U	1.08	3.3	<3.5 U	1.13	3.5	<3.2 U	1.05	3.2	<16 U	5.34	16
Pesticide	4,4'-DDE	2940	-			-			-			-			<3.3 U	1.3	3.3	<3.5 U	1.36	3.5	<3.2 U	1.26	3.2	26	6.4	16
Pesticide	4,4'-DDT	2940	-			-			-			-			6.3	1.36	3.3	17 P	1.42	3.5	<15 Y	1.32	15	100 E	1.34	3.3
Pesticide	Aldrin	58.8	-			-			-			-			<1.7 U	1.14	1.7	<1.7 U	1.19	1.7	<1.6 U	1.11	1.6	<8.2 U	5.63	8.2
Pesticide	alpha Chlordane	2860	-			-			-			-			<1.7 U	0.643	1.7	<1.7 U	0.671	1.7	<1.6 U	0.624	1.6	15 P	0.633	1.6
Pesticide	alpha-BHC	na	-			-			-			-			<1.7 U	0.941	1.7	<1.7 U	0.982	1.7	<1.6 U	0.914	1.6	<1.6 U	0.927	1.6
Pesticide	beta-BHC	na	-			-			-			-			<1.7 U	1.45	1.7	<1.7 U	1.52	1.7	<1.6 U	1.41	1.6	<8.2 U	7.16	8.2
Pesticide	delta-BHC	na	-			-			-			-			<1.7 U	0.762	1.7	<1.7 U	0.795	1.7	<1.6 U	0.74	1.6	<1.6 U	0.751	1.6
Pesticide	Dieldrin	62.5	**110 P**	6.39	17	43	1.25	3.2	19 P	1.26	3.3	8.8 P	1.24	3.2	<3.3 U	1.28	3.3	8.2 P	1.33	3.5	5.5	1.24	3.2	32 P	6.28	16
Pesticide	Endosulfan I	480000	-			-			-			-			<1.7 U	0.709	1.7	<1.7 U	0.74	1.7	<1.6 U	0.689	1.6	<8.2 U	3.49	8.2
Pesticide	Endosulfan II	480000	-			-			-			-			<3.3 U	1.56	3.3	<3.5 U	1.63	3.5	<3.2 U	1.52	3.2	<16 U	7.7	16
Pesticide	Endosulfan Sulfate	na	-			-			-			-			<3.3 U	1.69	3.3	<3.5 U	1.77	3.5	<3.2 U	1.64	3.2	<3.3 U	1.67	3.3
Pesticide	Endrin	24000	-			-			-			-			<3.3 U	0.944	3.3	<3.5 U	0.985	3.5	<3.2 U	0.917	3.2	<3.3 U	0.93	3.3
Pesticide	Endrin Aldehyde	na	-			-			-			-			<3.3 U	1.21	3.3	<3.5 U	1.26	3.5	<3.2 U	1.17	3.2	<16 U	5.94	16
Pesticide	Endrin Ketone	na	-			-			-			-			<3.3 U	1.66	3.3	<3.5 U	1.73	3.5	<3.2 U	1.61	3.2	<16 U	8.17	16
Pesticide	gamma Chlordane	2860	-			-			-			-			<1.7 U	0.633	1.7	<1.7 U	0.66	1.7	2.8	0.615	1.6	11	3.12	8.2
Pesticide	gamma-BHC (Lindane)	769	-			-			-			-			<1.7 U	0.758	1.7	<1.7 U	0.792	1.7	<1.6 U	0.737	1.6	<8.2 U	3.74	8.2
Pesticide	Heptachlor	222	-			-			-			-			<1.7 U	0.798	1.7	<1.7 U	0.833	1.7	<1.6 U	0.775	1.6	<8.2 U	3.93	8.2
Pesticide	Heptachlor Epoxide	110	-			-			-			-			<1.7 U	1.05	1.7	<1.7 U	1.1	1.7	<1.6 U	1.02	1.6	<1.6 U	1.04	1.6
Pesticide	Methoxychlor	400000	-			-			-			-			<17 U	7.52	17	<17 U	7.85	17	<16 U	7.3	16	<82 U	37	82
Pesticide	Toxaphene	na	-			-			-			-			<170 U	166	170	<170 U	173	170	<160 U	161	160	<820 U	816	820

RL : Reporting Limit
MDL: Method Detection Limit
-: Not analyzed
na: Cleanup level not available
U: Analyte note detected below the indicated RL (PQL)
P: Greater than 40% difference between the two columns
Y: Sample result contains matrix interference
E: Estimated concentration calculated for analyte response abc

Appendix B
Work Area 3 Surficial Soil Samples
November 2006 - June 2007

Group	Chemical	MTCA Method B Cleanup Level	061207-C9			061207-D10			061207-D8			061207-D9			061207-E10			061207-E8			061207-F8			061207-F8a			061207-F9		
			Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL	Result	MDL	RL
Herbicide	2,4,5T	na	-			-			-			-			-			-			-			-			-		
Herbicide	2,4,5-TP (Silvex)	640000	-			-			-			-			-			-			-			-			-		
Herbicide	2,4-D	na	-			-			-			-			-			-			-			-			-		
Herbicide	2,4-DB	640000	-			-			-			-			-			-			-			-			-		
Herbicide	Dalapon	2400000	-			-			-			-			-			-			-			-			-		
Herbicide	Dicamba	2400000	-			-			-			-			-			-			-			-			-		
Herbicide	Dichloroprop	na	-			-			-			-			-			-			-			-			-		
Herbicide	Dinoseb	80000	-			-			-			-			-			-			-			-			-		
Herbicide	MCPA	na	-			-			-			-			-			-			-			-			-		
PCB	Aroclor 1016	na	-			-			-			-			-			-			-			-			-		
PCB	Aroclor 1221	na	-			-			-			-			-			-			-			-			-		
PCB	Aroclor 1232	na	-			-			-			-			-			-			-			-			-		
PCB	Aroclor 1242	na	-			-			-			-			-			-			-			-			-		
PCB	Aroclor 1248	na	-			-			-			-			-			-			-			-			-		
PCB	Aroclor 1254	na	-			-			-			-			-			-			-			-			-		
PCB	Aroclor 1260	na	-			-			-			-			-			-			-			-			-		
PCB	Total PCB	1000																											
Pesticide	4,4'-DDD	4170	<6.6 U	2.16	6.6	<3.2 U	1.05	3.2	13 P	1.07	3.3	7.5	1.08	3.3	29	1.07	3.3	<3.2 U	1.06	3.2	<3.3 U	1.08	3.3	<3.2 U	1.06	3.2	<3.3 U	1.09	3.3
Pesticide	4,4'-DDE	2940	15	2.59	6.6	<3.2 U	1.26	3.2	8.3 P	1.28	3.3	4.1	1.3	3.3	<10 Y	1.28	10	6.1	1.27	3.2	<3.3 U	1.3	3.3	<3.2 U	1.27	3.2	<3.3 U	1.3	3.3
Pesticide	4,4'-DDT	2940	59 E	1.36	3.3	<3.2 U	1.32	3.2	29	1.35	3.3	5	1.36	3.3	25	1.35	3.3	44	1.33	3.2	<3.3 U	1.36	3.3	3.6	1.33	3.2	<3.3 U	1.37	3.3
Pesticide	Aldrin	58.8	<1.6 U	1.14	1.6	<1.6 U	1.11	1.6	<1.6 U	1.13	1.6	<1.7 U	1.14	1.7	<1.6 U	1.13	1.6	<1.6 U	1.11	1.6	<1.7 U	1.14	1.7	<1.6 U	1.11	1.6	<1.7 U	1.15	1.7
Pesticide	alpha Chlordane	2860	2.4	0.64	1.6	<1.6 U	0.624	1.6	<1.6 U	0.636	1.6	<1.7 U	0.643	1.7	20 P	0.635	1.6	<1.6 U	0.627	1.6	<1.7 U	0.642	1.7	<1.6 U	0.626	1.6	<1.7 U	0.645	1.7
Pesticide	alpha-BHC	na	<1.6 U	0.936	1.6	<1.6 U	0.913	1.6	<1.6 U	0.931	1.6	<1.7 U	0.942	1.7	<1.6 U	0.93	1.6	<1.6 U	0.917	1.6	<1.7 U	0.94	1.7	<1.6 U	0.917	1.6	<1.7 U	0.944	1.7
Pesticide	beta-BHC	na	<3.3 U	2.9	3.3	<1.6 U	1.41	1.6	<1.6 U	1.44	1.6	<1.7 U	1.46	1.7	<1.6 U	1.44	1.6	<1.6 U	1.42	1.6	<1.7 U	1.45	1.7	<1.6 U	1.42	1.6	<1.7 U	1.46	1.7
Pesticide	delta-BHC	na	<3.3 U	1.52	3.3	<1.6 U	0.739	1.6	<1.6 U	0.754	1.6	<1.7 U	0.763	1.7	<1.6 U	0.753	1.6	<1.6 U	0.743	1.6	<1.7 U	0.761	1.7	<1.6 U	0.743	1.6	<1.7 U	0.764	1.7
Pesticide	Dieldrin	62.5	12	2.54	6.6	<3.2 U	1.24	3.2	11 P	1.26	3.3	<3.3 U	1.28	3.3	27 P	1.26	3.3	11	1.24	3.2	<3.3 U	1.27	3.3	<3.2 U	1.24	3.2	<3.3 U	1.28	3.3
Pesticide	Endosulfan I	480000	<3.3 U	1.41	3.3	<1.6 U	0.688	1.6	<1.6 U	0.701	1.6	<1.7 U	0.71	1.7	<1.6 U	0.701	1.6	<1.6 U	0.691	1.6	<1.7 U	0.708	1.7	<1.6 U	0.691	1.6	<1.7 U	0.711	1.7
Pesticide	Endosulfan II	480000	<3.3 U	1.56	3.3	<3.2 U	1.52	3.2	<3.3 U	1.55	3.3	<3.3 U	1.56	3.3	<3.3 U	1.55	3.3	<3.2 U	1.52	3.2	<3.3 U	1.56	3.3	<3.2 U	1.52	3.2	<3.3 U	1.57	3.3
Pesticide	Endosulfan Sulfate	na	<3.3 U	1.68	3.3	<3.2 U	1.64	3.2	<3.3 U	1.67	3.3	<3.3 U	1.69	3.3	<3.3 U	1.67	3.3	<3.2 U	1.65	3.2	<3.3 U	1.69	3.3	<3.2 U	1.65	3.2	<3.3 U	1.7	3.3
Pesticide	Endrin	24000	<3.3 U	0.94	3.3	<3.2 U	0.916	3.2	<3.3 U	0.934	3.3	<3.3 U	0.945	3.3	<3.3 U	0.933	3.3	<3.2 U	0.921	3.2	<3.3 U	0.944	3.3	<3.2 U	0.92	3.2	<3.3 U	0.947	3.3
Pesticide	Endrin Aldehyde	na	<3.3 U	1.2	3.3	<3.2 U	1.17	3.2	<3.3 U	1.19	3.3	<3.3 U	1.21	3.3	<3.3 U	1.19	3.3	<3.2 U	1.18	3.2	<3.3 U	1.21	3.3	<3.2 U	1.18	3.2	<3.3 U	1.21	3.3
Pesticide	Endrin Ketone	na	<3.3 U	1.65	3.3	<3.2 U	1.61	3.2	<3.3 U	1.64	3.3	<3.3 U	1.66	3.3	<3.3 U	1.64	3.3	<3.2 U	1.62	3.2	<3.3 U	1.66	3.3	<3.2 U	1.62	3.2	<3.3 U	1.66	3.3
Pesticide	gamma Chlordane	2860	<3.3 U	1.26	3.3	<1.6 U	0.614	1.6	4.1	0.626	1.6	<1.7 U	0.633	1.7	10	0.625	1.6	<1.6 U	0.617	1.6	<1.7 U	0.632	1.7	<1.6 U	0.617	1.6	<1.7 U	0.635	1.7
Pesticide	gamma-BHC (Lindane)	769	<1.6 U	0.755	1.6	<1.6 U	0.736	1.6	<1.6 U	0.751	1.6	<1.7 U	0.759	1.7	<1.6 U	0.75	1.6	<1.6 U	0.74	1.6	<1.7 U	0.758	1.7	<1.6 U	0.739	1.6	<1.7 U	0.761	1.7
Pesticide	Heptachlor	222	<1.6 U	0.795	1.6	<1.6 U	0.775	1.6	<1.6 U	0.79	1.6	<1.7 U	0.799	1.7	<1.6 U	0.789	1.6	<1.6 U	0.778	1.6	<1.7 U	0.798	1.7	<1.6 U	0.778	1.6	<1.7 U	0.801	1.7
Pesticide	Heptachlor Epoxide	110	<1.6 U	1.05	1.6	<1.6 U	1.02	1.6	<1.6 U	1.04	1.6	<1.7 U	1.05	1.7	<1.6 U	1.04	1.6	<1.6 U	1.03	1.6	<1.7 U	1.05	1.7	<1.6 U	1.03	1.6	<1.7 U	1.06	1.7
Pesticide	Methoxychlor	400000	<16 U	7.49	16	<16 U	7.3	16	<16 U	7.44	16	<17 U	7.53	17	<16 U	7.43	16	<16 U	7.33	16	<17 U	7.51	17	<16 U	7.33	16	<17 U	7.54	17
Pesticide	Toxaphene	na	<160 U	165	160	<160 U	161	160	<160 U	164	160	<170 U	166	170	<160 U	164	160	<160 U	162	160	<170 U	166	170	<160 U	161	160	<170 U	166	170

RL : Reporting Limit
MDL: Method Detection Limit
-: Not analyzed
na: Cleanup level not available
U: Analyte note detected below the indicated RL (PQL)
P: Greater than 40% difference between the two columns
Y: Sample result contains matrix interference
E: Estimated concentration calculated for analyte response abc

APPENDIX B

RAW DATA EVALUATION MEMO FOR SAMPLES 110206-D6 AND 110206-C5

ENTRIX, Inc.
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Seattle, WA 98121
P 206-269-0104
FAX 206-269-0098

Date: 8/9/2007

To: Kevin Freeman

Cc: Ryan Shatt

From: Rob Barrick

Re: **Briggs Raw Data Evaluation for Samples 110206-D6 and 110206-C5**

At your request, I reviewed the raw data for the following samples and chemicals:

110206-D6 (dieldrin 66 Y ppb reporting limit)

110206-C5 (dieldrin 220 Y ppb reporting limit; and heptachlor epoxide 120 Y ppb reporting limit)

The reported values represent elevated reporting (quantification) limits where the compound may or may not be present but in any case chemical interferences prevented the reporting limit from being reliably set lower. In this case, the samples contained a mixture of Aroclor 1254 and a small amount of Aroclor 1260 (potentially a smaller proportion than reported). There are PCB congener peaks in these Aroclor mixtures that can overlap with the dieldrin peak in chromatograms, limiting both the identification and quantification of dieldrin. The same is true of heptachlor epoxide, primarily because of Aroclor 1254.

To improve reporting, pesticide and PCB analyses are run on two different chromatographic columns that have unique physical and chemical properties. These characteristics cause dissimilar chemicals to shift position in different ways, so what may interfere on one column, does not on another. Likewise, what may look like the chemical of interest on one column will prove not to be that chemical when examined on the second column. This analysis is called dual-column verification.

Sample 110206-D6

The reported 66 Y dieldrin reporting limit came from the second column that exhibited substantial interference in the dieldrin range. The PCB interference produced a higher reporting level compared with that of the first column. The higher of the two values is typically the reported result under current standard practice (that will change under pending guidelines). If quantified from the first column, the reported value would have been 31 ppb. The resolution and peak position were sufficient to have treated this result as a detection of dieldrin, had there been adequate confirmation on the second column.

Single compound peaks should be sharply resolved on chromatograms, or the instrument integration needs to accurately allocate areas for clusters of poorly resolved peaks, On examination, the peak broadening, slight shouldering, and long tail indicates that multiple compounds contributed to a single peak area that was attributed to "dieldrin" on the second column. Therefore, the 66 Y detection limit is an overestimate. Dieldrin is likely present on the second column because of the proportion of the peak relative to other peaks attributable to PCB mixtures, but its concentration is uncertain. Therefore, an appropriate reporting would be to (1) identify dieldrin as detected in this sample based on clear detection on the first column and probable presence on the second column, and (2) use the first column to quantify its concentration because there is much less interference to bias the calculation.

Based on the QA review, a conservative result for this sample is to attribute all of the peak area on the first column to the presence of dieldrin and report it as **detected at a reporting level of 31 J ppb**. A "J" qualifier has been added in the QA review to indicate that the estimated concentration is less than the laboratory's reporting limit and is made without dual-column verification of the presence of dieldrin. The reported concentration is biased high because, although dieldrin is present based on best professional judgment, there are likely overlapping PCB interferences.

Sample 10206-C5
The laboratory used the first column to report dieldrin as undetected at 220 Y and the second column to report heptachlor epoxide as undetected at 120 Y, both exceeding cleanup levels. This sample contained substantially higher PCB concentrations than Sample 110206-D6. There was little evidence of either compound based on variations in the PCB patterns. If anything, the patterns suggested no contribution. **The lower value of 137 Y for dieldrin, and 31 Y for heptachlor epoxide are likely appropriate**, but the estimated dieldrin detection limit still exceeds the cleanup level.

One factor that has a large effect on concentration calculations for this sample is the small sample size (0.84 g dry weight compared with a more typical weight of 4-6 g dry weight). Because of that and the PCB interferences, the data user should put less weight on the elevated detection limits. They may be biased high, although the magnitude is uncertain.

Robert C. Barrick
Senior Consultant
ENTRIX, Inc.
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APPENDIX C

REMEDIAL INVESTIGATION HUMAN HEALTH RISK ASSESSMENTS OF NORTHEAST AND SOUTHEAST KETTLES

BASELINE HUMAN HEALTH RISK ASSESSMENT (HHRA) FOR DIOXINS/FURANS AT THE BRIGGS NURSERY SITE (WORK AREA 3) IN OLYMPIA, WASHINGTON

FINAL

Prepared for:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

This document presents the results of a baseline risk assessment conducted to characterize the potential human health risks from current onsite exposure to dioxins and furans in sediment/soil and water at the Briggs Nursery site in Olympia, Washington. This human health risk assessment (HHRA) quantitatively estimates cancer risks from exposure to dioxins and furans associated with the Northeast and Southeast Kettle bottoms in Work Area 3, located at the Briggs Nursery site. Using Washington State Model Toxics Control Act (MTCA) default assumptions and equations where applicable, this HHRA evaluates risks to current residents within the site perimeters in the absence of any remedial action and institutional controls, such as fence installations around the kettles. Potential risks were calculated for children age 6, as this is the default population under MTCA.

The HHRA was conducted using dioxin and furan concentrations measured in sediments/soils and water collected at the two kettle bottom locations between 2000-2004 by ENTRIX and L.C. Lee and Associates. Although low levels of some congeners were found in a few samples, the majority of the dioxin and furan congeners (including 2,3,7,8-tetrachlorodibenzodioxin, or TCDD) were not detected in any samples.

The exposure pathways identified in the HHRA are for hypothetical current residents living adjacent to the kettle bottoms in Work Area 3, and include incidental ingestion of and dermal contact with sediments/soils and kettle water. Exposure factor values were based on point estimates of the Reasonable Maximum Exposure (RME), as described under MTCA.

Cancer risks to child residents were calculated. Because non-cancer reference doses for dioxins and furans are not available, non-cancer risks were not evaluated. Cancer risks were evaluated as the excess lifetime risk of developing cancer due to exposure to the chemicals being evaluated. The cancer risk is expressed as a probability and is based on the cancer potency of the chemical, known as a cancer slope factor or SF. For dioxins and furans, a SF is only presented for a single congener, 2,3,7,8-TCDD. The approved U.S. EPA SF of 1.5×10^5, based on the U.S. EPA's Health Effects Assessment Tables, (HEAST 1997), was used for this assessment. This value is also presented in the Washington State MTCA Cleanup Levels and Risk Calculations (CLARC) tables (WDOE 2001a). U.S. EPA and the World Health Organization (WHO) have identified Toxic Equivalency Factors (TEFs) for other carcinogenic dioxin/furan congeners, based on the potency of each compound relative to that of 2,3,7,8-TCDD. For this assessment, the most current TEFs from WHO (1998) were used to convert each carcinogenic congener concentration to an equivalent concentration of 2,3,7,8-TCDD.

For known or suspected carcinogens, MTCA considers upper-bound excess lifetime cancer risks to an RME individual of less than 10^{-6} (1 in 1,000,000) to be acceptable. To elaborate on the meaning of this risk designation, the average U.S. citizen has an approximately 1 in 4 chance (0.250000) of being diagnosed with cancer at some point in his or her lifetime. Thus, if the result of this cancer risk analysis estimated an excess cancer risk of 1 in 1,000,000 (0.000001, also written as 1E-06 or 10^{-6}), the total cancer risk to an exposed individual would be 0.250001. Or, conversely, if the estimated excess cancer risk is 1 in 1,000,000, then in an exposed population of 1,000,000 people, an upperbound of 1 additional cancer due to the exposure would be expected.

In this HHRA, risks associated with the scenarios for children exposed to dioxins and furans at each of the two kettle bottoms were 1.2×10^{-4} in the Northeast Kettle to 3.3×10^{-4} in the Southeast Kettle.

Acronyms

ABS	Absorption Factor
ADD	Average Daily Dose
COI	Chemical of Interest
EPC	Exposure Point Concentration
HHRA	Human Health Risk Assessment
IRIS	Integrated Risk Information System
LADD	Lifetime Average Daily Dose
MTCA	Model Toxics Control Act
RAGS	Risk Assessment Guidance for Superfund
RME	Reasonable Maximum Exposure
SF	Slope Factor
TEF	Toxicity Equivalency Factor
TEQ	Toxicity Equivalents
U.S. EPA	United States Environmental Protection Agency
UCL	Upper Confidence Limit

GLOSSARY

Absorption	The process of taking in. Chemicals can be absorbed through the skin into the bloodstream and then transported to other organs. Chemicals can also be absorbed into the bloodstream through breathing or swallowing.
Absorption Factor (ABS)	Factor used to estimate the rate at which a chemical desorbs from an environmental medium, such as soil or sediment, and absorbs through the skin upon dermal contact.
Bioavailability	The fraction of a chemical substance that is absorbed into the bloodstream and available to cause toxicity.
Carcinogen	An agent capable of inducing a cancer response.
Carcinogenesis	The origin or production of cancer, very likely a series of steps. The carcinogenic event so modifies the genome and/or other molecular control mechanisms in the target cells that these can give rise to a population of altered cells.
Chemical of Interest (COI)	Chemical carried through the risk assessment process. These chemicals are usually selected from all the chemicals potentially present at a site as those most likely to contribute significantly to the overall site risk.
Concentration	The amount of one substance dissolved or contained in a given amount of another. For example, seawater contains a higher concentration of salt than fresh water.
Dermal	Referring to the skin. For example, dermal absorption means absorption through the skin.
Dose	The amount of a substance taken in by an individual over a period of time from a variety of sources, including food, water, soil, and air, by such exposure pathways as ingestion, inhalation, or absorption through the skin. In this assessment, doses are described as daily intake rates averaged over periods of one year (for noncarcinogenic effects) or a lifetime (for cancer), and presented on a per kilogram of body weight basis.
Excess Lifetime Risk	The additional or extra risk incurred over the lifetime of an individual by exposure to a toxic substance.
Exposure	Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (*e.g.*, skin, lungs, gut) and available for absorption.
Exposure Assessment	The determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure.

Exposure Pathway The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (*e.g.,* air) or media (in cases of intermedia transfer) also is included.

Exposure Point A location of potential contact between an organism and a chemical or physical agent.

Exposure Point Concentration (EPC) The concentration term used in the dose equation to estimate exposure. The concentration term is typically regarded either as a reasonable average or an upper bound estimate of the concentration that is likely to be contacted over time.

Exposure Route The way a chemical or physical agent comes in contact with an organism (*e.g.,* by ingestion, inhalation, dermal contact).

Integrated Risk Information System (IRIS) A U.S. EPA database containing verified reference doses (RfDs) and Information System cancer slope factors (SFs) as well as up to date health risk and U.S. EPA regulatory information for numerous chemicals. IRIS is U.S. EPA's preferred source for toxicity information for Superfund.

Media Soil, water, air, plants, animals, or any other parts of the environment that can contain contaminants.

Micrograms/Kilogram (µg/kg) A measure of concentration used in the measurement of solids, such as soil, sediment, or food. A µg/kg is one one-thousandth of a mg/kg, and is equivalent to one part per billion.

Micrograms/Liter (µg/L) A measure of concentration used in the measurement of fluids. A µg/L is one one-thousandth of a mg/L, and is roughly equivalent to one part per billion.

Milligrams/Kilogram (mg/kg) A measure of concentration used in the measurement of solids, such as soil, sediment, or food. Mg/kg is the most common way to present a concentration in soil and is equivalent to parts per million.

Milligrams/Liter (mg/L) A measure of concentration used in the measurement of fluids. Mg/L is the most common way to present a concentration in water and is roughly equivalent to parts per million.

Model Toxics Control Act The Model Toxics Control Act (MTCA) is the Washington State counterpart to the federal Superfund law, also known as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Like CERCLA, MTCA sets up a process to identify, investigate, and cleanup

	contaminated properties that are, or may be, a threat to human health or the environment. Both the state and federal programs allow for the assessment of natural resource damages where the contamination injures wildlife or the environment.
Reasonable Maximum Exposure (RME)	The highest exposure that is reasonably expected to occur at a site. Per U.S. EPA risk assessment guidance, actions at Superfund sites should be based on an estimate of the RME.
Risk	The probability of injury, disease, or death under specific circumstances. In quantitative terms, risk is expressed in values ranging from zero (representing the certainty that harm will not occur) to one (representing the certainty that harm will occur). The following are examples showing the manner in which risk is expressed in U.S. EPA risk assessment: E-4 or 10-4= a risk of 1/10,000; E-5 or 10-5= a risk of 1/100,000; E-6 or 10-6= a risk of 1/1,000,000. Similarly, 1.3E-3 or 1.3 × 10-3= a risk of 1.3/1,000 = 1/770; 8E-3 or 8 × 10-3= a risk of 8/1,000 = 1/125.
Risk Assessment	A process to determine the increased risk from exposure to environmental pollutants together with an estimate of the severity of impact. Risk assessments use specific chemical information plus exposure information.
Slope Factor (SF)	An estimate of the upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen. The units of the slope factor are usually expressed as 1/(mg/kg-day).
Superfund	Federal authority, established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980, given to the U.S. EPA to respond directly to releases or threatened releases of hazardous substances that may endanger health or welfare.
Toxicity Equivalency Factor (TEF)	A generally 10-fold factor used to establish cancer slope factors for dioxins and furan congeners based on the relative potency of the compound compared to 2,3,7,8-tetrachlorodibenzodioxin.
Upper Confidence Limit (UCL)	The 95% UCL about the arithmetic mean is typically used as the concentration term for chemicals of interest in environmental media in U.S. EPA risk assessments. Because of the uncertainty associated with estimating the true average concentration at a site, the 95% UCL of the arithmetic mean is used as an estimate of the average concentration.

1.0 INTRODUCTION

This document presents the results of a baseline risk assessment conducted by Intertox, Inc. (Intertox) to characterize the potential human health risks from hypothetical current residential exposure to dioxins and furans in sediment/soil and water associated with two kettles located in Work Area 3 at the Briggs Nursery site in Olympia, Washington. These kettles are named the Northeast Kettle and Southeast Kettle. This HHRA evaluates risks to hypothetical residents who are assumed to live within the site perimeter near the kettles in the absence of any remedial action or institutional controls, such as fencing around the kettles. An exposure duration of six years is assumed. The resulting risk estimates likely overestimate risks for most scenarios due to the use of multiple conservative assumptions based on non site-specific default values.

This HHRA follows guidance from the State of Washington Model Toxics Control Act (MTCA). Default exposure factors and equations from MTCA guidance were used where applicable. If MTCA did not specify a required factor, current U.S. EPA policy guidance or site-specific data and analyses were used. This approach is consistent with MTCA guidance for evaluating potential human health risk associated with exposure to dioxins and furans in sediments and water (WAC 173-340). The principal guidance documents relied upon for this assessment included the following:

- MTCA. Washington State Code Section 173.
- U.S. EPA, 1989. Risk Assessment Guidance for Superfund (RAGS), Volume I. Human Health Evaluation Manual, Part A. Interim Final. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. Washington, D.C. EPA/540/1-89/002. December.
- U.S. EPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Parameters. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. Washington, D.C. June.
- U.S. EPA. 1999. Exposure Factors Handbook (EPA/600/C-99/001). Office of Research and Development, United States Environmental Protection Agency. Washington, D.C.

1.1 Document Overview

The subsequent sections of this document are organized as follows:

- **Data Evaluation and Hazard Characterization (Section 2.0)**. This section describes the process used to evaluate the quality of available data for conducting the HHRA, outlines the process used to select chemicals of interest (COIs), and identifies the COIs.
- **Toxicity Assessment (Section 3.0).** This section characterizes the toxicity of the COIs and identifies toxicity criteria for each chemical, for use in evaluating the significance of estimated exposures.
- **Exposure and Risk Characterization (Section 4.0).** This section identifies and characterizes the populations and pathways for which exposures will be evaluated and outlines the development of contaminant-specific estimates of intake. This section also integrates the results of the toxicity and exposure assessments to develop quantitative measures of the potential for adverse health effects.

- **Conclusions (Section 5.0).** This section summarizes the results of the risk assessment, and provides recommendations for further evaluation.
- **References (Section 6.0).** This section provides the references used to conduct this evaluation.

2.0 DATA EVALUATION AND HAZARD CHARACTERIZATION

The objective of the data evaluation and hazard characterization step is to review the quality of the available data for use in the HHRA. The HHRA focuses on dioxins and furans measured at the bottom of the Southeast and Northeast Kettles.

2.1 Media of Concern

This HHRA was conducted using both recent and historical data on concentrations of dioxins and furans in sediment or soil and water in the kettles (Table 2-1). Historical sampling data for the Southeast Kettle were collected by L.C. Lee and Associates in 2000 and ENTRIX in 2003 and 2004. Data for the Northeast Kettle were collected by ENTRIX in 2004. The Southeast Kettle has generally been dry during the recent past due to redirection of runoff from the former nursery. However, since there are water samples available for this kettle, a conservative approach that assumes the Southeast Kettle has water has been used here.

2.2 Data Evaluation

Data were reviewed for quality by ENTRIX prior to delivery to Intertox for use in the HHRA. Additional review of data sets compiled by ENTRIX against available original data was also conducted by Intertox to ensure accuracy prior to use in the risk assessment.

2.2.1 Data Sets Included in the HHRA

The following data sets were used in the HHRA:

- Samples of sediments from both kettles collected in 2004 (Entrix).
- Samples of kettle water collected from both kettles in 2004 (Entrix).
- Samples of kettle water and sediment for the Southeast Kettle collected in 2003.
- Samples of sediments and kettle water collected from the Southeast Kettle in 2000 (L.C. Lee and Associates).

A summary of the available data used in the HHRA is provided in Table 2-1, differentiated by media type.

Table 2-1. Summary of Data Types Used in the HHRA for the Briggs Nursery

Media	NE Kettle	SE Kettle
Sediment	6 samples in 2004[b]	1 sample in 2000[a] 7 samples in 2003[b] 4 samples in 2004[b]
Water	2 samples in 2004[b]	1 sample in 2000[a] 7 samples in 2003[b] 2 samples in 2004[b]
Total Number of Samples	6 sediment 2 water	12 sediment 10 water

[a] *L.C. Lee and Associates, 2000*
[b] *ENTRIX, 2003-2004*

2.2.2 Initial Data Review

All data from the above identified sampling events were evaluated for use in the HHRA. Data validation results were reviewed to identify data with "B" qualifiers (indicating the constituent was also detected in blank samples); all data with "B" qualifiers were treated as undetected if the level was within 10 times the blank result (U.S. EPA, 1989). When replicate analyses were conducted on the same sample, only one of the analyses was used in the HHRA; if the analyte was detected in one or more of these samples, the highest detected concentration was used. If the analyte was detected in neither sample, the sample with the lowest limit of detection was used.

2.3 Identification of Chemicals of Interest

The term "chemicals of interest" (COIs) is used to refer to those chemicals detected in site media that are likely to be of greatest toxicological significance and are selected for analysis in the HHRA. Due to the limited scope of this analysis (*i.e.*, Intertox was tasked with evaluating only dioxin and furan data) and the detection of some dioxin and furan congeners in water and sediment samples, all of the congeners included in the analytical suite were considered to be COIs (Table 2-2). This has the potential to overestimate risks since many of the congeners were never detected (see Appendix A).

U.S. EPA (2000) and numerous other health organizations (WHO, 1998) use a relatively unique methodology to assess the human health risks posed by exposure to dioxin and furan congeners. This methodology involves the calculation of a Toxicity Equivalent Quotient (TEQ) using individual congener concentrations multiplied by Toxicity Equivalency Factors (TEFs). A TEF (Table 2-2) is a ratio (usually a factor of 10) of a specific congener's toxicity relative to 2,3,7,8-tetrachlorodibenzodioxin (TCDD). For example, 1,2,3,7,8,9-HxCDD is considered to be one-tenth as toxic as TCDD and has a TEF of 0.1. Most dioxins toxicity data are for 2,3,7,8-TCDD, and 2,3,7,8-TCDD is the only dioxin congener with a toxicity criterion established by U.S. EPA. TEFs are considered appropriate for dioxin and furan risk assessment because the congeners are structurally and toxicologically similar, and all are thought to exert their effects through the same mode of action (WHO, 1998). This mode of action involves binding to the aryl hydrocarbon receptor, a common intracellular protein involved in gene transcription and synthesis which can result in a cascade of events including effects on metabolism, cell growth and differentiation, and disruption of signal-transduction pathways (NTP, 2002).

Table 2-2. Chemicals of Interest Evaluated in the Briggs Nursery HHRA and Their TEFs

Dioxin/Furan Congener	TEFs
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
1,2,3,4,6,7,8,9-OCDD	0.0001
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.05
2,3,4,7,8-PeCDF	0.5
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
1,2,3,4,6,7,8,9-OCDF	0.0001

Note: TEFs are from WHO, 1998

3.0 TOXICITY ASSESSMENT

The goal of the Toxicity Assessment step is to characterize the toxicity of the COIs and identify quantitative toxicity criteria for each chemical, for use in evaluating the likelihood of adverse health effects from estimated exposures.

3.1 Source of Toxicity Data

As non-cancer reference doses for dioxins and furans are not available, only cancer risks were calculated. The cancer risk is expressed as a probability and is based on the cancer potency of the chemical, known as a cancer slope factor or SF. For dioxins and furans, an SF is available for only one congener, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The most recently published U.S. EPA SF was used for this assessment. U.S. EPA develops cancer SFs based on extrapolations from estimates of the increase in cancer incidence associated with exposure to specific doses of the substance in animal or human exposure studies. A SF represents the upper bound increased cancer risk from lifetime exposure to an agent. The currently approved SF from the U.S. EPA (1997) guidelines for TCDD is 1.5×10^5 $(mg/kg\text{-}day)^{-1}$.

U.S. EPA and the World Health Organization (WHO) have identified TEFs for other carcinogenic congeners, based on the potency of each compound relative to that of 2,3,7,8-TCDD. For this assessment, the most current TEFs from WHO (1998) were used to convert each carcinogenic congener concentration to an equivalent concentration of 2,3,7,8-TCDD.

3.2 Route-to-Route Extrapolation of Slope Factors

Based on MTCA guidance (WAC 173-340-740), an adjustment factor was used to derive a dermal SF for the dermal soil contact pathway. The dermal SF for 2,3,7,8-TCDD was calculated by dividing the oral SF by an adjustment factor of 0.5 (the MTCA-recommended factor for non-volatile organic compounds) to account for differences in absorption between the two routes of exposure. No guidance is provided regarding adjustment for the surface water pathways, thus no adjustment was made to the SF for calculating risk from dermal surface water exposure.

3.3 Toxicity Assessment Uncertainties

The SF used in this HHRA has some inherent uncertainty. For example, as with many chemicals, the SF developed for 2,3,7,8-TCDD is based on a study using high doses in animals. The relevance of these data to humans exposed to much lower doses is not completely understood. However, SFs are generally calculated to estimate an upper bound (approximating a 95% upper confidence limit) cancer risk, and thus are intended to overestimate actual risks to exposed populations (U.S. EPA, 2003).

4.0 EXPOSURE AND RISK ASSESSMENT

The goals of the Exposure Assessment are to identify and characterize the populations and pathways for which exposures will be evaluated and to develop contaminant-specific estimates of lifetime average daily doses. The populations and pathways that were evaluated in the HHRA and the exposure parameters that were used are described below. Exposure parameters used in this HHRA are based primarily on MTCA default values. However, for several parameters, default values from U.S. EPA were used.

4.1 Exposure Populations and Scenarios

The HHRA focuses on a current hypothetical residential population that has the potential to be the most highly exposed to dioxins and furans at the Briggs Nursery site. As required under MTCA, the exposed population was limited to children age 6. It is assumed that this population could be exposed to COIs through direct contact with sediments/soils and surface water during such activities as digging in sand near the kettles or wading in kettles that contain water. As required under MTCA, children were assumed to be exposed every day of the year.

A Reasonable Maximum Exposure (RME) was evaluated for hypothetical child residents for each of the two kettle bottoms described above. The RME scenario is defined as the highest exposure that could reasonably be expected to occur for a given exposure pathway and kettle, and accounts for uncertainty and variability in the dioxin and furan concentrations and exposure rates by using reasonable maximum or 95th percentile estimates for these parameters.

4.2 Exposure Pathways

An exposure pathway is the course a chemical takes from its source to the exposed individual. In order for an exposure pathway to be complete, it must have four elements (U.S. EPA, 1989):

- A source and mechanism of chemical release;
- A retention or transport medium;
- A point of potential human contact with the contaminated medium; and
- An exposure route (*e.g.*, ingestion) at the contact point.

Based on these elements, the following exposure pathways were identified as potentially complete and were quantitatively evaluated in this HHRA:

- Incidental ingestion of sediment/soil while engaged in recreational activities such as digging or playing;
- Dermal contact with sediment/soil while engaged in recreational activities such as wading, digging or playing;
- Incidental ingestion of surface water while engaged in recreational activities such as wading, digging or playing; and
- Dermal contact with surface water while engaged in recreational activities such as wading, digging or playing.

Because dioxins and furans are relatively non-volatile (WHO, 1998) and entrainment of dust particles from affected sediments is not expected to be significant, inhalation of volatilized substance or wind-blown dust was not evaluated in this HHRA.

4.3 Quantification of Risk

The following sections present the equations used to calculate risk, the methods used to estimate exposure point concentrations, and the parameters used to estimate average daily doses.

4.3.1 Risk/Exposure Equations

The equations used to estimate risk for each pathway evaluated in the HHRA are provided below. The equations involving soil/sediment contact are taken from MTCA guidance (WAC 173-340-740). Because MTCA does not provide calculations for incidental surface water ingestion or dermal contact with surface water, U.S. EPA methods were used to address those exposure pathways.

Dermal Contact and Incidental Ingestion of Sediment/Soil (modified from Equation 730-5 in WAC 173-340-740)

$$RISK = C_{sed} \times EF \times ED \times \frac{\left(\frac{SIR \times AB1 \times CPFo}{CF} + \frac{SA \times AF \times ABS \times CPFd}{CF} \right)}{BW \times AT}$$

Where:

C_{sed}	=	Sediment/Soil concentration, mg/kg, site-specific
BW	=	Average body weight over the exposure duration, 16 kg
AT	=	Averaging time, 75 years
EF	=	Exposure frequency, 365 day/year
ED	=	Exposure duration, 6 years
SIR	=	Soil ingestion rate, 200 mg/day
AB1	=	Gastrointestinal absorption fraction, 0.5, unitless
CPFo	=	Oral cancer potency factor, kg-day/mg, chemical specific
CPFd	=	Dermal cancer potency factor, kg-day/mg, equal to CPFo/GI
GI	=	Gastrointestinal absorption conversion factor, 1.0, unitless
SA	=	Dermal surface area, 2,200 cm^2
AF	=	Adherence factor, 0.2 mg/cm^2
ABS	=	Dermal absorption fraction, 0.03, unitless
CF	=	Conversions factor mg/kg, 1 X 10^6

Incidental Ingestion of Surface Water

$$RISK = \frac{C_{water} \times CR \times CF \times t_{event} \times ET \times EF \times ED}{BW \times AT} \times CPFo$$

Where:

C_{water}	=	Concentration of contaminant in surface water, mg/L, site specific
CR	=	Incidental surface water ingestion rate, 50 mL/hr
CF	=	Conversion factor, 1×10^{-3} L/ml
t_{event}	=	Event duration, 24 hours/event
ET	=	Event frequency, 1 event/day
EF	=	Exposure frequency, 365 day/yr
ED	=	Exposure duration, 6 yr
BW	=	Body weight, 16 kg
AT	=	Averaging time, 27,375 days (75 years)
CPFo	=	Oral cancer potency factor, kg-day/mg, chemical specific

Dermal Contact with Surface Water

$$DAevent_{water}\ (mg/cm^2 - event) = 2FA \times Kp \times C_{water} \sqrt{((6\tau event \times tevent)/\pi))}$$

$$RISK = \frac{DAevent_{water} \times SA \times ET \times EF \times ED}{BW \times AT} \times CPFd$$

Where:

$DAevent_{water}$	=	Dermal absorption per event (mg/cm^2), site specific
FA	=	Fraction absorbed water, unitless
Kp	=	Chemical-specific dermal permeability constant, cm/hr
C_{water}	=	Concentration of contaminant in surface water, mg/L, chemical specific
τ_{event}	=	Lag time per event, 6.82 hr
t_{event}	=	Event duration, hours/event
SA	=	Skin surface area available for contact with surface water, 2200 cm^2
CF	=	Conversion factor, 0.001 L/cm^3
ET	=	Exposure time, hr/event
EF	=	Exposure frequency, event/yr
ED	=	Exposure duration, 6 yr
BW	=	Body weight, 16 kg
AT	=	Averaging time, 27,375 days (75 years)
CPFd	=	Dermal cancer potency factor, kg-day/mg, derived by CPFo/GI

4.3.2 Exposure Point Concentrations

Samples collected from each of the two kettle bottoms were used to calculate the exposure point concentrations (EPCs) used to estimate potential intake of dioxins and furans for each kettle. For non-detect values, one-half of the reported detection limit was used to calculate EPCs. However, several of the COIs were detected infrequently or not at all but had detection limits that were greater than their risk-based screening values. Use of one-half the detection limit for these compounds can result in a large fraction of estimated risks being due to non-detected values.

Per MTCA and U.S. EPA risk assessment guidance (U.S. EPA, 1989; 1992), the 95% upper confidence limit (95% UCL) of the arithmetic mean was calculated from TEQ values for each sample at each location. The 95% UCL was compared with the maximum TEQ value for each location. Although use of the 95% UCL provides reasonable confidence that the true average will not be underestimated, if the 95% UCL exceeded the maximum TEQ for any location, the maximum TEQ was used as the EPC for that location.

Prior to calculating 95% UCLs, the data were transformed using the natural logarithm function (*i.e.*, ln(x)) based on the assumption that environmental contaminant data sets are usually lognormally distributed. The 95% UCL of the arithmetic mean for a lognormally distributed data set was calculated using the following equation (U.S. EPA, 1992):

$$UCL = \exp(\bar{x} + 0.5s^2 + \frac{sH}{\sqrt{n-1}})$$

Where:

UCL	=	Upper confidence limit
$\bar{x}$	=	Mean of the transformed data
s	=	Standard deviation of the transformed data
H	=	H-statistic (from Gilbert, 1987)
n	=	Number of samples

Due to relatively small number of samples collected at each location, neither of the two kettles in Work Area 3 used the 95% UCL. For both kettles, the maximum TEQ was used for both water and sediments/soil. A table of data for each of the kettles is provided in Appendix A.

4.3.3 Exposure Parameters

As shown in the equations in Section 3.3.1, quantification of exposure requires information on the behavioral characteristics of the population of interest (*e.g.*, how frequently the population engages in an activity, how many years the population is exposed). For this baseline HHRA, MTCA default exposure parameters were used where feasible.

For children involved in activities such as digging in the sand near the water, exposure estimates for dermal contact with kettle water and soil/sediments, and incidental ingestion of water and soil/sediments were developed. For soil/sediment dermal exposure, the MTCA default for soil adherence to the surface of the skin of 0.2 mg/cm^2 was used. For dermal absorption, the MTCA recommended value absorption factor of 0.03 (based on volatile organic compounds with vapor pressure less than benzene) was used. The MTCA default for exposed surface area (2,200 cm^2) was applied for this scenario.

For children wading in the kettles, exposure estimates of dermal contact with and incidental ingestion of kettle water were developed. The RME assumption for time spent wading in the kettle water by a child was 365 days per year in accordance with MTCA defaults. Although an equation for calculating dermal exposure with surface water is not described in MTCA, the surface area applied to the dermal sediment pathway was assumed for this pathway as well.

The exposure duration was assumed to be 6 years for the child RME estimate based on MTCA guidance. Other MTCA default factors used included body weight of 16 kg and an averaging time of 27,375 days (75 years).

4.3.4 Chemical-Specific Uptake Factors

A chemical-specific uptake factor was used to estimate absorption of chemicals into tissue from water. For this HHRA, uptake factors for dioxins/furans were identified from a U.S. EPA (2001b) guidance document. Uptake factors used in the HHRA include:

- *Permeability constants (Kp)*, used to estimate the rate at which a chemical in surface water absorbs through the skin. The standard default value of 0.81 cm/hr for 2,3,7,8-TCDD was used for this HHRA.

4.4 Exposure Assessment Uncertainties

EPCs were calculated assuming that for non-detected congeners, the congener was present in the sample at one-half its detection limit. This practice is consistent with U.S. EPA guidance for screening level risk assessments (U.S. EPA, 1989). In both water and sediment, COIs that were detected in very few samples or none at all had reported detection limits that resulted in relatively high TEQs. Thus, even for samples in which nothing was detected, a significant risk could be calculated simply by assuming the congeners are present at one-half their detection limits. Use of one-half the limit of detection as the assumed concentration for non-detected congeners may significantly overestimate actual exposures and risks.

Doses estimated using the exposure parameters in this evaluation may underestimate or overestimate actual doses to individuals who are exposed to dioxins and furans in soil/sediments or water near the two kettles at the Briggs Nursery site. However, since the parameters compiled by MTCA and U.S. EPA are generally intended to represent upperbound estimates of exposures for average populations, it is likely that doses estimated in this assessment are overestimated.

This HHRA assumes that dioxins/furans in ingested soil/sediment are as bioavailable as dioxin in the toxicity study upon which the toxicity criterion is based (*i.e.*, an absorption factor of 1.0 was used). However, chemicals in soil/sediment are likely to be more tightly bound to soil or sediment particles than they are to food pellets to which they are recently added, such that a smaller fraction of the total ingested dose is absorbed into the circulation. Thus, assuming the same bioavailability likely overestimates exposures for the soil/sediment ingestion pathway.

4.5 Risk Characterization

Excess cancer risks for each pathway were summed to estimate lifetime excess cancer risks for each location. Lifetime excess cancer risk is the probability of cancer occurring as a result of the exposure at some point during an individual's lifetime (U.S. EPA, 1989).

To elaborate on the meaning of these risk designations, the average U.S. citizen has approximately a 1 in 4 chance (0.250000) of being diagnosed with cancer at some point in his or her lifetime. Thus, if the result of this cancer risk analysis estimated a 1 in 100,000 (0.00001, also written as 1E-05 or 1(10-5) excess cancer risk, the total cancer risk to an exposed individual would be 0.25001. Or, conversely, if the estimated excess cancer risk is 1 in 100,000, then in an exposed population of 100,000 people, an upperbound of 1 additional cancer due to the exposure would be expected.

Although there is no universally accepted risk standard, U.S. EPA under federal Superfund law generally considers upper-bound excess lifetime cancer risks to an RME individual of 10^{-6} to 10^{-4} (1 in 1,000,000 to 1 in 10,000) to be acceptable. Risks less than 1 in a 1,000,000 are nearly always considered acceptable, whereas risks greater than 1 in 10,000 are typically considered unacceptable. In this HHRA, a cancer risk guideline value of 1 in 1,000,000 was selected based on the guidelines in MTCA (WDOE, 2001b; 2001c).

4.6 Results

The cancer risks estimated for each pathway for the resident child exposure scenario are provided in Table 5-1.

Table 5-1. Kettle Cancer Risk Summary

Kettle Location	Sediment/Soil Dermal and Ingestion	Water Dermal	Water - Incidental Ingestion	Total Risk
Northeast	3.7E-06	1.1E-04	4.3E-06	**1.2E-04**
Southeast	2.8E-06	3.2E-04	1.2E-05	**3.3E-04**

5.0 CONCLUSIONS

The results of this baseline HHRA provide information regarding possible health hazards that could exist if people reside on the Briggs Nursery site without any remediation or institutional controls. Based on the methods and assumptions described in this report, the following observations and recommendations can be made:

- The upperbound cancer risk for the hypothetical residential child scenario for the Northeast and Southeast Kettles exceed accepted cancer risk guideline levels established by MTCA.
- The majority of the risk at each kettle where water was assumed to be present was from dermal contact with water.
- The assumptions used to calculate risks in the HHRA are intended to overestimate potential cancer risks, and provide a conservative estimate of risks for the two kettles. Factors that are likely to lead to overestimates of risk include the use of conservative exposure assumptions and use of assumed dioxin concentrations in water and sediment that are based on the maximum TEQ value for each location except the Central Kettle (where the 95% UCL was applied).
- Based on these results, the inclusion of the Northeast and Southeast Kettles in a Feasibility Study is recommended.

6.0 REFERENCES

Gilbert R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold.

NTP. 2002. Report on Carcinogens, Tenth Edition. U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, December.

U.S. EPA, 1989. Risk Assessment Guidance for Superfund (RAGS), Volume I. Human Health Evaluation Manual, Part A. Interim Final. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. Washington, D.C. EPA/540/1-89/002. December.

U.S. EPA, 1990. National Contingency Plan. United States Environmental Protection Agency. Washington, D.C.

U.S. EPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Parameters. Office of Solid Waste and Emergency Response, United States Environmental

Protection Agency. Washington, D.C. June.

U.S. EPA, 1991b. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. Washington, D.C. OSWER Directive 9355.0-30. April 22. http://www.epa.gov/oerrpage/superfund/programs/risk/baseline.pdf

U.S. EPA, 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Solid Waste and Emergency Response. Washington, D.C. May.

U.S. EPA. 1997. Health Effects Assessment Summary Tables, FY 1997 Update (EPA/540/R-97/036). Washington, D.C.: Office of Solid Waste and Emergency Response.

U.S. EPA. 1999. Exposure Factors Handbook (EPA/600/C-99/001). Washington, D.C.: Office of Research and Development.

U.S. EPA, 2000. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. Office of Emergency and Remedial Response, United States Environmental Protection Agency. Washington, D.C.

U.S. EPA, 2001a. The Integrated Risk Information System (IRIS). United States Environmental Protection Agency, Washington, D.C. Online at http:/www.epa.gov/iris/intro.htm.

U.S. EPA. 2001b. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, Interim). Review Draft--for Public Comment. Washington, D.C.: Office of Emergency and Remedial Response.

U.S. EPA. 2003. The Integrated Risk Information System (IRIS) Glossary. United States Environmental Protection Agency, Washington, D.C. Online at http://www.epa.gov/iris/gloss8.htm.

WDOE. 2001a. Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation. CLARC version 3.1. Publication No. 94-145. November

WDOE. 2001b. Developing Surface Water Cleanup Standards under the Model Toxics Control Act. Washington State Department of Ecology Focus No. 01-09-050. August.

WDOE. 2001c. Developing Soil Cleanup Standards under the Model Toxics Control Act. Washington State Department of Ecology Focus No. 01-09-071. August.

World Health Organization. 1998. Assessment of the Health Risk of Dioxins: Re-evaluation of the Tolerable Daily Intake (TDI). Geneva: WHO European Centre for Environment and Health, International Programme on Chemical Safety. Obtained online at http://www.who.int/pcs/docs/dioxin-exec-sum/exe-sum-final.html

APPENDIX A
BRIGGS NURSERY SITE DATA

SE Kettle Sediments **(pg/g)**

	2000		2003														2004							
0.5 LOD for ND	**SEK-Sed 2**		**SEK-10082003-1**		**SEK-10082003-2**		**SEK-10072003-3**		**SEK-10082003-4**		**SEK-10082003-5**		**SEK-10072003-6**		**SEK-10082003-7**		**SEK01**		**SEK02**		**SEK03**		**SEK04**	
2,3,7,8-TCDD	0.2	U	0.65	U	0.38	U	0.06	U	0.33	U	0.6	U	0.085	U	0.55	U	0.8	U	0.21	U	1		0.205	U
1,2,3,7,8-PeCDD	0.2	U	1.55	U	0.7	U	0.125	U	0.6	U	1.35	U	0.14	U	1.45	U	2.15	U	0.9	U	1.6	U	0.495	U
1,2,3,4,7,8-HxCDD	0.25	U	1	U	0.385	U	0.125	U	0.47	U	3.9	J	0.14	U	0.95	U	3.35	U	1.75	U	6.2		1.05	U
1,2,3,6,7,8-HxCDD	NR		0.95	U	1.4	U	0.435	U	3.5	J	12		0.65	U	6	J	24		11		22		8.3	
1,2,3,7,8,9-HxCDD	0.25	U	0.9	U	1.2	U	0.4	U	1.3	U	10		0.49	U	3.8	J	21		2.65	U	14		4.1	
1,2,3,4,6,7,8-HpCDD	29		14		61		20		71		440		32		250		520		230		450		170	
1,2,3,4,6,7,8,9-OCDD	283		78	B	410	B	130		570	B	2200	B	240	J	2300	B	3400		1500		2700		1100	
2,3,7,8-TCDF	0.15	U	0.7	U	0.9		0.96		0.27	U	0.65	U	0.34	U	1.4		4		1.2		3.4		1	
1,2,3,7,8-PeCDF	0.2	U	0.8	U	0.38	U	0.085	U	0.355	U	0.7	U	0.06	U	0.75	U	0.9	U	0.395	U	0.95	U	0.39	U
2,3,4,7,8-PeCDF	0.15	U	0.8	U	0.375	U	0.155	U	0.355	U	0.7	U	0.065	U	0.75	U	1.8	U	0.6	U	1.2	U	0.47	U
1,2,3,4,7,8-HxCDF	0.55	UJ*	0.65	U	1.05	U	0.325	U	0.7	U	1.45	U	0.385	U	1.25	U	3.4	U	1.85	U	4.7		3.6	
1,2,3,6,7,8-HxCDF	0.245	UJ*	0.6	U	0.65	U	0.17	U	0.365	U	1.5	U	0.21	U	0.7	U	2.65	U	1.05	U	1.65	U	0.8	U
2,3,4,6,7,8-HxCDF	0.15	U	0.6	U	0.305	U	0.11	U	0.275	U	0.9	U	0.105	U	0.55	U	2.05	U	0.85	U	1.6	U	0.6	U
1,2,3,7,8,9-HxCDF	0.15	U	0.65	U	0.3	U	0.1	U	0.29	U	0.6	U	0.085	U	0.55	U	0.5	U	0.36	U	0.39	U	0.31	U
1,2,3,4,6,7,8-HpCDF	2.5	UJ*	0.95	U	5.5	U*	1.8	U	5	U*	62	B	6.5	J	31	B	87		38		57		39	
1,2,3,4,7,8,9-HpCDF	0.25	U	0.49	U	0.385	U	0.085	U	0.315	U	1.7	U	0.19	U	0.8	U	2.75	U	1.45	U	1.8	U	1.6	U
1,2,3,4,6,7,8,9-OCDF	24.4		2.05	U	25		9.3	J	27		130		17		100		240		120		120		76	

	(pg/L)																			
SE Kettle Water	**2000**		**2003**														**2004**			
0.5 LOD for ND	**WS-4 SEK**		**SEK-10072003-1**		**SEK-10072003-2**		**SEK-10072003-3**		**SEK-10072003-4**		**SEK-10072003-5**		**SEK-10072003-6**		**SEK-10072003-7**		**SEK-01**		**SEK-02**	
2,3,7,8-TCDD	1.05	U	1.45	U	1.075	U	1.35	U	1.5	U	1.55	U	1.65	U	1.3	U	0.55	U	0.46	U
1,2,3,7,8-PeCDD	1.1	U	1.8	U	3.1	U	1.75	U	1.9	U	2.55	U	2.4	U	1.75	U	1.75	U	1.55	U
1,2,3,4,7,8-HxCDD	5.6	J	1.2	U	2.1	U	1.2	U	1.4	U	1.7	U	1.9	U	1.05	U	1.2	U	1.4	U
1,2,3,6,7,8-HxCDD	16.6	J	1.15	U	2	U	1.15	U	2.45	U	1.65	U	1.8	U	2.3	U	1.1	U	1.3	U
1,2,3,7,8,9-HxCDD	13.2	J	1.1	U	1.95	U	1.1	U	1.3	U	1.6	U	1.75	U	1.5	U	1.05	U	1.25	U
1,2,3,4,6,7,8-HpCDD	385		**4.35**	U	**39**	J	27	J	**120**		**12**	U	**11**	U	**110**		2.1	U	12.5	U
1,2,3,4,6,7,8,9-OCDD	2410		**57**	J	**250**		190		**840**		**200**		**160**	J	**770**		14.5	U	180	
2,3,7,8-TCDF	6.3	J	0.85	U	**1.25**	U	0.85	U	1.05	U	0.95	U	1	U	0.9	U	0.5	U	0.435	U
1,2,3,7,8-PeCDF	0.85	U	1.15	U	2.1	U	1.25	U	1.7	U	1.7	U	1.9	U	1.25	U	0.85	U	0.85	U
2,3,4,7,8-PeCDF	0.85	U	1.15	U	2.1	U	1.25	U	1.7	U	1.7	U	1.9	U	1.25	U	0.85	U	0.85	U
1,2,3,4,7,8-HxCDF	7.6	J	0.95	U	1.95	U	0.95	U	1.45	U	1.45	U	1.55	U	1	U	0.8	U	0.65	U
1,2,3,6,7,8-HxCDF	4.1		0.9	U	1.85	U	0.9	U	1.35	U	1.4	U	1.5	U	0.95	U	0.8	U	0.65	U
2,3,4,6,7,8-HxCDF	5.9	J	1	U	2.05	U	1	U	1.5	U	1.5	U	1.65	U	1.05	U	0.9	U	0.7	U
1,2,3,7,8,9-HxCDF	1.1	U	1.1	U	2.2	U	1.1	U	1.65	U	1.65	U	1.8	U	1.15	U	0.95	U	0.75	U
1,2,3,4,6,7,8-HpCDF	62.3		1.8	U	**4.4**	U	2.8	U	**10.5**	U	**3.1**	U	**2.65**	U	11	U	0.8	U	2.1	U
1,2,3,4,7,8,9-HpCDF	6.7	J	2.1	U	1.3	U	1	U	1.35	U	1.25	U	0.9	U	1.1	U	0.95	U	0.8	U
1,2,3,4,6,7,8,9-OCDF	199		2.4	U	**12**	U	6.5	U	**68**	J	**7.5**	U	**8.5**	U	67	J	1.8	U	9	U

Northeast Kettle Sediment (pg/g)

	2004												
0.5 LOD for ND	**NEK01**		**NEK03**		**NEK05**		**NEK07**		**NEK09**		**NEK11**		
2,3,7,8-TCDD	0.415	U	0.6	U	1.7		1.2		0.195	U	1.4		
1,2,3,7,8-PeCDD	2.95	U	1.95	U	2.1	U	1.75	U	0.55	U	2.1	U	
1,2,3,4,7,8-HxCDD	10		8.8		7.8		8.8		0.95	U	8		
1,2,3,6,7,8-HxCDD	34		35		33		31		7.9		33		
1,2,3,7,8,9-HxCDD	23		21		18		18		4.8		20		
1,2,3,4,6,7,8-HpCDD	680		720		590		610		140		680		
1,2,3,4,6,7,8,9-OCDD	5100		4600		3500		3700		930		4100		
2,3,7,8-TCDF	2.9		7.2		5.4		4.8		1.3		5.2		
1,2,3,7,8-PeCDF	1.05	U	1.35	U	1.6	U	1.25	U	0.335	U	1.55	U	
2,3,4,7,8-PeCDF	1.35	U	1.95	U	2.05	U	1.7	U	0.48	U	1.9	U	
1,2,3,4,7,8-HxCDF	9.7		14		12		12		1.35	U	12		
1,2,3,6,7,8-HxCDF	2.9	U	7		6		6.3		0.65	U	6.5		
2,3,4,6,7,8-HxCDF	2.4	U	2.1	U	2	U	1.85	U	0.44	U	2.1	U	
1,2,3,7,8,9-HxCDF	0.305	U	0.4	U	0.335	U	0.27	U	0.22	U	0.405	U	
1,2,3,4,6,7,8-HpCDF	110		110		86		99		20		100		
1,2,3,4,7,8,9-HpCDF	9.1		7.7		6.8		7.2		0.9	U	7.2		
1,2,3,4,6,7,8,9-OCDF	360		220		180		240		57		240		

Northeast Kettle Water (pg/L)

0.5 LOD for ND	2004			
	NEK01		NEK02	
2,3,7,8-TCDD	0.65	U	0.7	U
1,2,3,7,8-PeCDD	1.6	U	1.95	U
1,2,3,4,7,8-HxCDD	1.1	U	1.4	U
1,2,3,6,7,8-HxCDD	1.8	U	1.3	U
1,2,3,7,8,9-HxCDD	1	U	1.25	U
1,2,3,4,6,7,8-HpCDD	59		54	
1,2,3,4,6,7,8,9-OCDD	410		380	
2,3,7,8-TCDF	0.5	U	0.6	U
1,2,3,7,8-PeCDF	0.9	U	1.05	U
2,3,4,7,8-PeCDF	0.9	U	1.05	U
1,2,3,4,7,8-HxCDF	0.85	U	1	U
1,2,3,6,7,8-HxCDF	0.8	U	1	U
2,3,4,6,7,8-HxCDF	0.9	U	1.1	U
1,2,3,7,8,9-HxCDF	1	U	1.15	U
1,2,3,4,6,7,8-HpCDF	5.5	U	4.8	U
1,2,3,4,7,8,9-HpCDF	0.9	U	0.95	U
1,2,3,4,6,7,8,9-OCDF	13.5	U	14.5	U

APPENDIX B – EXPOSURE FACTORS

Exposure Factor	Units	Digging in the sand near the water		Wading	
		Value	Source	Value	Source
Chemical Concentration in Water (Cw)	mg/L	NA	NA	SS	NA
Contact Rate (CR)	ml/hr	NA	NA	50	BPJ
Conversion Factor, water (CFw)	L/ml	NA	NA	1.00E-03	Default
Chemical Concentration in Sed/Soil (Cs)	mg/kg	SS	NA	NA	NA
Ingestion Rate, sediment (IRs)	mg/d	200	MTCA	NA	NA
Conversion Factor, sediment (CFs)	kg/mg	1.00E-06	NA	NA	NA
Fraction Ingested from Effluent-Containing Sediments (FIs)	-	1.0	MTCA	NA	NA
Adherence Factor	mg/cm^2-day	0.2	MTCA	NA	NA
Dermal Absorption Factor	-	0.03	U.S. EPA, 1997	NA	NA
Exposure Frequency (EF)	days/yr	365	MTCA	365	MTCA
Exposure Duration (ED)	yrs	6	MTCA	6	MTCA
GI Absorption Factor	-	1	U.S. EPA, 1997	1	U.S. EPA, 1997
Averaging Time Carcinogen (ATc)	days	27,375	MTCA	27,375	MTCA
Body Weight (BW)	kg	16	MTCA	16	MTCA
Skin Surface Area Available for Contact (SA)	cm2	2,200	MTCA	2,200	MTCA

SS – Site Specific
NA – Not applicable

BPJ – Best Professional Judgement
EFH – Exposure Factors Handbook

Notes:

Contact Rate (water ingestion):

The children's contact rate is based on the adult exposure factor from U.S. EPA (1989), Exhibit 6-12. The was based on best professional judgement; although intake rates are usually lower for children, it was assumed in this case that they may have a greater propensity to ingest water than adults. Hence, the same value was chosen for children.

APPENDIX D

EVALUATION OF POTENTIAL HUMAN HEALTH RISK REDUCTIONS ASSOCIATED WITH ACCESS CONTOL ALTERNATIVES

THE BRIGGS NURSERY SITE (WORK AREA 3) IN OLYMPIA, WASHINGTON: EVALUATION OF POTENTIAL HUMAN HEALTH RISK REDUCTIONS ASSOCIATED WITH ACCESS CONTROL ALTERNATIVES

FINAL

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TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

This evaluation prepared by Intertox Inc. (Intertox) is a human health risk assessment that evaluates the risks associated with various risk management strategies that might be employed in Work Area 3 of the Briggs Nursery site in Olympia, Washington. This evaluation describes proposed access control measures for reducing potential exposure to polychlorinated dibenzo-dioxins and polychlorinated dibenzo-furans (PCDD/PCDF) in sediment/soil and water associated with the Northeast and Southeast Kettles at the Briggs Nursery. The evaluation presented here assesses the possible effect of the access control measures on reducing potential human health risks.

This document follows an earlier baseline Human Health Risk Assessment (HHRA) conducted for hypothetical residents assumed to live within the site perimeter near the Southeast and Northeast Kettles in the absence of any remedial action, institutional controls, or engineering controls, such as fencing around the kettles.

The purpose of this evaluation is to provide information that allows risk managers to select the most appropriate access control measures. This evaluation qualitatively and quantitatively evaluates potential exposure and health risks assuming that access control measures presented were in place. Two access control measure options are assessed, hereafter referred to as Alternatives A and B. Alterative A involves using access controls (*i.e.*, deed restrictions, signage, protective covenants) without physical controls to restrict kettle access, while Alternative B involves using institutional and physical controls (*i.e.*, fencing).

As part of the qualitative assessment, a comparison is presented of regulatory requirements and recommendations for access control measures at sites having various degrees of hazard. This comparison establishes that fences are routinely used to control access to various locations that require access restriction comparable to the Briggs Nursery site.

The quantitative assessment indicates that each exposure event, defined as an hour divided equally between swimming in a kettle and playing along the kettle shore, would result in an estimated excess risk of between 2.5×10^{-06} to 3.7×10^{-06}. Under Alternative A, the assumed excess lifetime cancer risks were as follows: Southeast Kettle – 3.7×10^{-05}, Northeast Kettle – 2.5×10^{-06}. Under Alternative B, it is assumed that fencing effectively restricts any access to the kettles, and thus risks are negligible.

The results of our evaluation lead us to recommend Alternative B. While Alternative A could be effective, exposure is not completely restricted and there is significant uncertainty about how much exposure will actually occur. Alternative B protects residential populations from exposures to PCDD/PCDF at the site, as well as from accidental drowning in the kettles.

The concentrations of PCDD/PCDF at the site are essentially the same as many urban Washington areas, and are most likely the result of street runoff as described within this evaluation. Alternative B is thus likely protecting children from exposure to PCDD/PCDF concentrations that are similar to those they could be exposed to in any urban neighborhood. In addition, although it was assumed that the Southeast Kettle had water in it for the purposes of this analysis, redirection of water runoff may lead to this kettle becoming dry in the future, which would substantially reduce risk (and bring its risk values below the 1.0×10^{-06} threshold). Regardless, this alternative provides the most appropriate and acceptable remedy to the potential exposure to PCDD/PCDF in the kettles at the Briggs Nursery site.

1.0 INTRODUCTION AND PURPOSE

This risk evaluation, prepared by Intertox Inc. (Intertox), supplements the baseline risk assessment prepared by Intertox for Work Area 3 at the Briggs Nursery site in Olympia, Washington. This baseline assessment examined hypothetical residents assumed to live near the kettles within the site perimeter in the absence of any remedial action, institutional controls or engineering controls, such as fencing around the kettles. Estimated risks to child residents at the two kettles (Northeast and Southeast) were determined to be above the Washington Department of Ecology (Ecology) lifetime excess cancer risk threshold of $1x10^{-6}$, and thus remedial actions are required.

This evaluation proposed access control alternatives for reducing health risks to the hypothetical residents. The evaluation characterizes the human health risk reductions associated with each access control alternative. This information will allow risk managers to select the most appropriate access control options for the two kettles. A comparison of regulatory requirements for control measures at hazardous sites is presented. Data on potential sources of polychlorinated dibenzo-dioxins and polychlorinated dibenzo-furans (PCDD/PCDF) are also described.

1.1 Document Overview

The subsequent sections of this document are organized as follows:

- **Site History and Background (Section 2.0)**. This section provides a brief description and history of the site, and discusses likely sources of the PCDD/PCDF in the kettles based on sample results taken from off-site.
- **Remedial Goals and Alternatives (Section 3.0)**. This section provides a summary of the proposed control measures that are intended to limit access to the site.
- **Evaluation Methodology (Section 4.0).** This section describes access control measures proposed for the site under two different Alternatives (A and B).
- **Assessment of Human Health Risk Reductions Associated with Access Control Alternatives (Section 5.0).** This section qualitatively and quantitatively evaluates the potential health risk reductions associated with Alternatives A and B. In addition to quantitative risk calculations, a qualitative assessment compares regulatory requirements for access control for various types of hazards including swimming pools, landfills and hazardous waste sites.
- **Uncertainties (Section 6.0**). This section qualitatively describes major sources of uncertainty in the analysis of the two Alternatives.
- **Conclusions and Recommendations (Section 7.0).** This section summarizes the results of the evaluation and provides recommendations for further evaluation.
- **References (Section 8.0).** This section provides the references used to conduct this evaluation.

2.0 SITE HISTORY AND BACKGROUND

Briggs Nursery is located in the City of Olympia in Thurston County, Washington near the intersection of Yelm Highway and Henderson Boulevard SE. Briggs has operated at this location as a fruit and vegetable farm and ornamental nursery since 1912. The Site is bounded to the north and west by several single-family residences, to the south by the YMCA and Yelm Highway, and to the east by Ward Lake and several single-family residences. Henderson Boulevard cuts through the property, running north-south (Entrix 2006).

The Briggs Nursery Site is situated on a relatively flat to gently sloping upland terrace. No major or minor streams cut through or are adjacent to the property, but there are six bowl-shaped depressions or "kettles" that are either wholly or partially situated on the Site. These kettles are important drainage features on the Site and have been the focus of some previous investigations. These kettles are remnant geologic features from the region's last glacial episode[1] (Entrix 2006).

2.1 Human Health Risk Assessment (HHRA)

A baseline Human Health Risk Assessment (HHRA) was conducted to support the Remedial Investigation at the Briggs Nursery site. This HHRA evaluated risks to hypothetical residents assumed to live on the Briggs Nursery site near the kettles in the absence of any remedial action or institutional controls, such as fencing around the kettles. As part of the HHRA, Chemicals of Interest (COIs) were identified following a data evaluation and hazard characterization step. The HHRA focused on PCDD/PCDF measured at the bottom of the Southeast and Northeast Kettles, since no other COIs were identified above Ecology's risk screening level (City of Olympia 2003). The HHRA relied on multiple conservative assumptions based on non-site specific default values; thus the resulting risk estimates likely overestimate risks for most scenarios.

Results from the HHRA indicate that acceptable cancer risk levels (1.0×10^{-6} lifetime excess cancer risk) would be exceeded at both kettles (Northeast and Southeast) if the conservative exposure assumptions are applied. Cancer risk is generally considered to be the most sensitive toxicological endpoint for PCDD/PCDF, thus noncancer hazard was not considered in this analysis.

2.2 Source Attribution Investigation

Due to their creation during the burning of organic matter (*e.g.*, forest fires, fossil fuel consumption), PCDD/PCDF are widespread in the environment at very low levels. In a Summary Letter submitted to Ecology, Entrix presented findings from an evaluation of potential sources for the PCDD/PCDF levels reported at the Brigg's Nursery site (Entrix 2005b). As part of this evaluation, Entrix collected samples from a location offsite of Briggs Nursery adjacent but upgradient from the Nursery (on or near Henderson Boulevard). This location was not expected to have any contaminants from the nursery due to its upgradiant location and lack of historical use by the Nursery. Henderson Boulevard is a medium-sized thoroughfare in a primarily residential neighborhood. No nearby industrial sources have been identified.

Entrix evaluated PCDD/PCDF levels on an organic carbon (OC)-normalized basis, consistent with an

[1] These kettles were created when stranded blocks of glacial ice gradually melted during the last glacial recession of the Puget Sound lobe over 12,000 years ago

Ecology Technical Memorandum (Michelson 1992). PCDD/PCDF concentrations from the Henderson Boulevard samples were found to be comparable to levels measured in soil/sediment in the Southeast and Northeast Kettles. The Summary Letter states that:

> *"…the predominant source of dioxin/furan contamination in the kettles is from urban street runoff…no upland sources of dioxin/furan contamination exist at this Site."*

The Department of Ecology indicated agreement with this interpretation. A letter from Lisa Pearson of Ecology (March 11, 2005) states that:

> *"Ecology is satisfied that the PCDD/PCDF concentrations found in site kettles are a result of street runoff, as Briggs contends, and our research demonstrates."*

Ecology provides additional data on PCDD/PCDF levels in Washington State (Washington State Department of Ecology 1999). The authors of this report [Rogowski *et. al*] collected samples throughout the state from urban, open land, agricultural and forest areas. In urban soil samples (n=14), the mean PCDD/PCDF concentration was 5.7 parts per trillion (pptr) Toxicity Equivalent Quotient (TEQ) with a range of 0.64 to 22 ppt [for a more in-depth explanation of the use of TEQ, see Intertox 2006]. The mean TEQ values reported in the Northeast and Southeast Kettles were comparable to these reference values (Table 1).

Table 1. Mean TEQ levels measured within the Briggs Nursery kettles.

Location	Mean TEQ concentration (pptr)	TEQ Concentration Range (pptr)
Northeast Kettle	18.2	4.47 – 22
Southeast Kettle	3.63	0.91 – 14.01
Reference values**	5.7	0.64 – 22

** (Washington State Department of Ecology 1999)

3.0 REMEDIAL GOALS AND ALTERNATIVES

The goal of this evaluation is to evaluate remedial alternatives for the Briggs Nursery site. The identified remedial alternatives are:

- Alternative A: Use site access controls such as deed restrictions and signage to reduce exposure and health risk (*i.e.,* institutional controls only)

- Alternative B: Use Alternative A with the addition of physical access controls (*i.e.*, a fence around the kettle bottoms).

The goal of both alternatives is to discourage or restrict physical access to the three kettles determined in the HHRA to have potential risks above 1.0×10^{-6}. Soil/sediment removal was evaluated in the initial stages of the Entrix's evaluation of the site but was determined not feasible due to damage and potential destruction to the ecologically sensitive wetlands. Access control strategies were considered to be the most appropriate measures for the site.

Ecology and the U.S. EPA differ slightly in their definition of institutional controls. Ecology (Washington State Department of Ecology 2001) defines institutional controls as follows (WAC 173-340-350):

> *Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the integrity of an interim action or cleanup action or that may result in exposure to hazardous substances at a site. Institutional controls may include:*
>
> *(a) Physical measures such as fences;*
>
> *(b) Use restrictions such as limitations on the use of property or resources; or requirements that cleanup action occur if existing structures or pavement are disturbed or removed;*
>
> *(c) Maintenance requirements for engineered controls such as the inspection and repair of monitoring wells, treatment systems, caps or ground water barrier systems;*
>
> *(d) Educational programs such as signs, postings, public notices, health advisories, mailings, and similar measures that educate the public and/or employees about site contamination and ways to limit exposure; and*
>
> *(e) Financial assurances (see subsection (11) of this section).*
>
> *(2) Relationship to engineered controls. The term institutional controls refers to nonengineered measures while the term engineered controls means containment and/or treatment systems that are designed and constructed to prevent or limit the movement of, or the exposure to, hazardous substances. See the definition of engineered controls in WAC 173-340-200 for examples of engineered controls….*
>
> *Institutional controls should demonstrably reduce risks to ensure a protective remedy. This demonstration should be based on a quantitative, scientific analysis where appropriate.*

The U.S. EPA definition is similar, but does not consider physical measures such as fences to be institutional controls. In this document, an access control is considered to be any measure that is intended to limit access to a site, whereas the term "institutional control" is assumed to exclude physical controls (*e.g.*, fences). Support for the use of access controls as a means for controlling entry access onto a number of types of sites is provided in numerous resources (ASTM 2000; ASTSWMO 1997; Oregon Department of Environmental Quality 1998; Florida Department of Environmental Protection 2004; US EPA 2000).

3.1 Alternative A: Access Controls without Fence

Alternative A involves using multiple non-physical access controls such as deed restrictions, protective covenants, and signage to reduce exposure to PCDD/PCDF in the kettle bottoms, as described in the Feasibility Study for Work Area 1 of the site, Section 10.4.2, "Alternative A" (Entrix 2006). Access control measures pertinent to Alternative A include the sections listed below.

- *No soil is to be removed from the Kettle Bottoms unless approved by Ecology.*

- *Public access to the Kettle Bottoms is expressly prohibited.*

- *No trespassing signs will be posted around the perimeter of the Kettle Bottoms at 100-foot intervals, and maintained appropriately. .*

These measures should significantly discourage individuals from visiting the kettle areas, thereby limiting exposure to the kettle bottoms, which in turn will reduce exposure to PCDD/PCDF present, as well as potential accidental hazards such as drowning.

3.2 Alternative B: Access Controls with Fences

Alternative B uses the same suite of access controls as described above for Alternative A, but also includes the installation of a six foot chain link fence along the border of the kettle bottoms. Details regarding specifications of the fence are provided in the Feasibility Study for Work Area 1 at the site, Section 10.4.2, under "Alterantive B" (Entrix 2006). The addition of fences is considered a significant deterrent to trespassing at the site, and would essentially eliminate exposure to the hazards associated with the kettles (chemical and physical). This is represented in the quantitative risk evaluation as an exposure frequency of 0 days/year.

4.0 QUANTITATIVE EVALUATION METHODS

In order to assess potential exposure and risks to hypothetical residents living at the Briggs Nursery site, both qualitative and quantitative evaluations were conducted. Results of the qualitative and quantitative evaluation are presented in Section 5.0

The Quantitative Assessment of risk was conducted using the standard U.S. EPA baseline risk assessment approach (US EPA 1989). The stepwise process for conducting risk assessment is described in detail in the HHRA. The inherent uncertainties described previously in the HHRA (Intertox 2007) would also apply to this assessment. Exposure parameters are listed below in Table 2 including those that differed from the HHRA. Equations used to calculate risk are also provided below. As in the HHRA, PCDD/PCDFs were the only COIs evaluated, and only cancer risks were considered for this evaluation. Exposure point concentrations were the same as presented in the HHRA (Intertox 2007).

4.1 Exposure Populations and Scenarios

Specific guidance on the adjustment of risk assessment exposure factors to apply to sites where access controls are in place is limited; therefore, best professional judgment was used for some of the exposure assumptions.

It was assumed that the population most likely to use the site in spite of access controls would be adolescent children, due to parental restriction of younger children. However, for the soil and sediment exposure pathways, standard MTCA exposure factors that apply to younger children (approximately aged six) were used, as done in the HHRA. For the surface water pathways assessment (not covered under MTCA), children aged nine were selected as a conservative target population. Based on the target age of nine years old, the body weight and skin surface area estimates were adjusted to reflect this population.

For this evaluation, an event duration (T_{event}) of one hour per event was assumed, revised from the assumption of 24 hours per event (365 days/year) in the HHRA. This hour was assumed to be spent equally engaged in the activities of wading and digging (*i.e.*, one half-hour for wading, and one half-hour for digging). An hour is a reasonable assumption of the amount of time that a child might trespass in a kettle before a parent or other adult notices them and removes them from the kettle.

As in the HHRA, children were assumed to be exposed to COIs through direct contact with sediments/soils and with surface water during such activities as digging in sand near the kettles or wading in kettles that contain water. However, the implementation of institutional access controls (no fence) was assumed to result in a decrease in exposure days to 52 days per year (once per week); and the combination of institutional controls and fencing was assumed to effectively eliminate exposure (0 days per year). The uncertainty in these estimates is discussed further in Section 6.0. A comparison of the exposure assumptions for Alternative A and Alternative B is presented below in Table 2.

Table 2. Summary of Exposure Factors

	Alternative A		**Alternative B**		
Exposure Factor	**Soil**	**Water**	**Soil**	**Water**	**Source**
Incidental ingestion of water (ml/hr)	NA	50	NA	50	US EPA, Superfund Exposure Assessment Manual (US EPA 1988)
Ingestion rate for sediment and soil (mg/d)	200	NA	200	NA	MTCA recommended value
Event Frequency (events/d)	1	1	1	1	Professional Judgment
Tevent (hrs/event)	0.5	0.5	0.5	0.5	Professional Judgment
Exposure Frequency (days/yr)	52	52	0	0	Professional Judgment
Exposure Duration (yrs)	6	6	6	6	MTCA default value
Averaging Time (yrs)	75	70	75	70	75 years is MTCA default value; 70 years is US EPA default value
Body Weight (kg)	16	31.5	16	31.5	16 kg from MTCA; 31.5 kg based on BW of 9 yr old (US EPA 2002)
Skin Surface (cm2)	2,200	6,048	2,200	6,048	2,200 is MTCA default value; 6,048 is estimate for hands, feet, arms + legs of 7-8 yr old (US EPA 2002)
Adherence Factor (mg/cm^2)	0.2	NA	0.2	NA	0.2 is MTCA default value

4.2 Risk/Exposure Equations

The equations used to estimate risk for each pathway are provided below. The soil/sediment contact equations are derived from MTCA guidance (Washington State Department of Ecology 2005). MTCA does not provide guidance for calculating exposure from incidental surface water ingestion or dermal contact with surface water; therefore, U.S. EPA methods were used to address these exposure pathways (US EPA 1992).

Dermal Contact and Incidental Ingestion of Sediment/Soil (modified from Equation 730-5 in WAC 173-340-740)

$$RISK = C_{sed} \times EF \times ED \times \frac{\left(\frac{SIR \times AB1 \times CPFo}{CF} + \frac{SA \times AF \times ABS \times CPFd}{CF}\right)}{BW \times AT}$$

Where:

C_{sed}	=	Sediment/Soil concentration, mg/kg, site-specific
BW	=	Average body weight over the exposure duration, 16 kg
AT	=	Averaging time, 75 years (27,375 days)
EF	=	Exposure frequency, 52 days/yr for Alternative A, 0 days/yr for Alternative B
ED	=	Exposure duration, 6 years
SIR	=	Soil ingestion rate, 200 mg/day
AB1	=	Gastrointestinal absorption fraction, 0.5, unitless
CPFo	=	Oral cancer potency factor, kg-day/mg, chemical specific
CPFd	=	Dermal cancer potency factor, kg-day/mg, equal to CPFo/GI
GI	=	Gastrointestinal absorption conversion factor, 1.0, unitless
SA	=	Dermal surface area, 2,200 cm^2
AF	=	Adherence factor, 0.2 mg/cm^2
ABS	=	Dermal absorption fraction, 0.03, unitless
CF	=	Conversions factor mg/kg, 1 x 10^6

Incidental Ingestion of Surface Water

$$RISK = \frac{C_{water} \times CR \times CF \times t_{event} \times ET \times EF \times ED}{BW \times AT} \times CPFo$$

Where:

C_{water}	=	Concentration of contaminant in surface water, mg/L, site specific
CR	=	Incidental surface water ingestion rate, 50 mL/hr
CF	=	Conversion factor, 1×10^{-3} L/ml
t_{event}	=	Event duration, 0.5 hours/event
ET	=	Event frequency, 1 event/day
EF	=	Exposure frequency, 52 days/yr for Alternative A, 0 days/yr for Alternative B
ED	=	Exposure duration, 6 yr
BW	=	Body weight, 31.8 kg
AT	=	Averaging time, 25,550 days (70 years)
CPFo	=	Oral cancer potency factor, kg-day/mg, chemical specific

Dermal Contact with Surface Water

$$DAevent_{water}\ (mg/cm^2 - event) = 2FA \times Kp \times C_{water} \sqrt{((6\tau event \times tevent)/\pi))}$$

$$RISK = \frac{DAevent_{water} \times SA \times ET \times EF \times ED}{BW \times AT} \times CPFd$$

Where:

$DAevent_{water}$	=	Dermal absorption per event (mg/cm^2), site specific
FA	=	Fraction absorbed water, unitless
Kp	=	Chemical-specific dermal permeability constant, cm/hr
C_{water}	=	Concentration of contaminant in surface water, mg/L, chemical specific
τ_{event}	=	Lag time per event, 6.82 hr
t_{event}	=	Event duration, 0.5 hours/event
SA	=	Skin surface area available for contact with surface water, 6,048 cm^2
CF	=	Conversion factor, 0.001 L/cm^3
ET	=	Exposure time, hr/event
EF	=	Exposure frequency, event/yr
ED	=	Exposure duration, 6 yr
BW	=	Body weight, 31.8 kg
AT	=	Averaging time, 25,550 days (70 years)
CPFd	=	Dermal cancer potency factor, kg-day/mg, derived by CPFo/GI

5.0 ASSESSMENT OF HUMAN HEALTH RISK REDUCTIONS ASSOCIATED WITH ACCESS CONTROL ALTERNATIVES

This section qualitatively and quantitatively evaluates the potential health risk reductions associated with Alternatives A and B. In addition to quantitative risk calculations, a qualitative assessment compares regulatory requirements for access control for various types of hazards including swimming pools, landfills and hazardous waste sites. The results of the qualitative and quantitative evaluations for each alternative are presented below.

5.1 Alternative A: Effectiveness of Access Controls without Fence

Effectively no guidance is provided by regulatory bodies on the likely reduction in exposure from the use of access controls[2]. Hence, qualitative studies and professional judgment were used to evaluate their likely effectiveness.

A survey of the effectiveness of institutional control mechanisms in Washington State performed by the Association of State and Territorial Solid Waste Management (ASTSWMO) indicates a general lack of consensus regarding the effectiveness of institutional control measures. Over half of the 61 entities surveyed indicated that they were unable to determine how effective the institutional control

[2] The term "access controls", as used in this document, refer to "institutional controls" either with or without physical barriers (*i.e.* fencing).

had been. Of the remaining responses, 22% (5 out of 23) indicated that institutional controls "have worked very well" and 17% (4 out of 23) indicated that "inappropriate use and/or exposures have occurred where Institutional Controls have been used."

Table 3 summarizes the results of the quantitative risk assessment for Alternative A, assuming exposure of a hypothetical child resident for 52 days per year.

Table 3. Lifetime Excess Cancer Risks Estimation Associated With Alternative A

Kettle Location	Soil/Sediment Ingestion & Dermal Contact	Water Dermal Contact	Water Ingestion	Total Calculated Risk	Previously Calculated (HHRA) Risk (Intertox 2007)
Northeast	5.3×10^{-07}	1.9×10^{-06}	5.7×10^{-09}	**2.5×10^{-06}**	1.2×10^{-4}
Southeast	4.0×10^{-07}	3.3×10^{-06}	1.6×10^{-08}	**3.7×10^{-06}**	3.3×10^{-4}

5.2 Alternative B: Effectiveness of Access Controls Including Fence

The physical access control proposed for the Briggs Nursery site in Alternative B is a 6 foot high fence around the bottom perimeter of the Northeast and Southeast Kettles. This additional physical control measure is expected to significantly reduce the incidence of trespassing into the kettles.

5.2.1 Qualitative Evaluation of Access Controls

Limited guidance on the relative effectiveness of different types of access controls is available for sites comparable to Briggs Nursery, thus guidance for a variety of different site types where the goal is discourage or restrict trespassing to lessen a potential hazard was evaluated.

The type of sites for which information was found included the following:

- Swimming pools
- Solid waste, hazardous waste and composting facilities
- Electrical substations
- Nuclear waste facilities

The evaluation of this information shows that the use of fences is an established method for access restriction. In some cases a minimum fence height requirement is provided while in other cases, fence height is not specified.

5.2.1.1 Swimming Pools

Hazards associated with swimming pools are well established. According to the Consumer Product Safety Commission (CPSC 2000) an average of 300 children under five years old drown in swimming pools annually. Guidelines for fence height around swimming pools have been established by the Washington State legislature, as well as municipalities, federal safety advocacy groups. Additionally, manufacturers of pool fencing products provide recommendations for appropriate fence heights. Guidelines were found to range from approximately three to six feet depending on the type of pool and the target age for children. Various examples of regulations and guidelines for these types of sites are provided below:

State of Washington (Washington State Department of Health 2005)

- For new construction and remodeling, requires:

  "Barriers at limited use pools must be at least sixty inches high."

  "Barriers at general use pools must be at least seventy-two inches high."

King County (King County Department of Development and Environmental Services 2005)

- Requires "a solid structure or a fence not less than five feet in height" that completely surrounds the pool to minimize the risk that unsupervised children will have access to the pool.

Consumer Product Safety Commission, "Safety Barrier Guidelines for Home Pools" (CPSC 2000)

- Recommends that the top of a pool barrier be at least 48 inches above grade, measured on the side of the barrier that faces away from the swimming pool.

5.2.1.2 Solid Waste, Hazardous Waste and Composting Facilities

Limited guidance pertaining to access restriction was identified in an online search for solid waste, hazardous waste and composting facilities. Tacoma-Pierce County (Pierce County Government 2005) has established access control guidelines for several types of facilities including: Solid/Hazardous Waste Handling, Treatment, and Storage Facilities**;** Waste Disposal Facilities; and Municipal Solid Waste (MSW) Composting Facilities. Common to these facilities is a provision stating that:

- "To impede entry by the public and animals, a facility composting municipal solid waste shall have perimeter fencing six feet to eight feet in height with a lockable gate."

5.2.1.3 Utilities/Electrical Substations

Electrical substations present a potentially extreme danger for trespassers. Puget Sound Energy (PSE) has the following guidelines:

Puget Sound Energy; Standards for Electrical substations (Puget Sound Energy 2001)

- Seven foot high chain link fence shall be installed on line posts, corner posts and gate posts.
- These fences include Extension Arms with barbed wire.

City of Renton, WA Regulations for Utilities (City of Renton 1998):

- "An unhoused installation of a dangerous nature, such as an electrical distribution substation, shall be enclosed with an eight foot (8ft) high open wire fence."

5.2.1.4 Nuclear Waste Facility – Hanford

The Hanford Reservation in Eastern Washington includes a sizable area with a range of potential hazards. Access restriction is variable depending on the area within the site. A 2003 site-wide assessment (US DOE 2003) of institutional controls included the following statement:

- "The objective of fencing around waste sites is to prevent unauthorized people and large animal access to hazardous or sensitive areas. Fencing also provides protective barriers to standard industrial hazards. To determine their effectiveness, fences were assessed for integrity and to verify lock and key control. Fences were found to be in good conditions, and keys to fenced areas were found to be under the control of the appropriate responsible organizations (pg 11)."

Although the fence height and other characteristics of the fences (*e.g.* chain link vs. barbed) are not specified, this evaluation establishes that fences are an integral part of the access restriction strategy applied at Hanford.

5.2.2 Quantitative Risk Assessment

The proposed implementation of fencing in the kettles at the Brigg's Nursery site is expected to effectively eliminate exposure to PCDD/PCDF at the site. Given that no regulatory guidance was found identifying appropriate exposure reduction factors for fencing, it is assumed that this implies an exposure frequency of "0" for Alternative B. This assumption also reduces the risk in any fenced kettle to "0." Further discussion of the uncertainty involved in this assumption can be found in Section 6.0.

6.0 UNCERTAINTIES

Several sources of uncertainty are inherent in the evaluation of potential risks from both Alternatives A and B. These include a lack of knowledge regarding whether kettles will have water in them in the future or not, the amount of time children might be in the kettle, and the maintenance of the fence and institutional controls in the future. In addition, almost any of the parameters in the equations used above have some degree of uncertainty. However, the primary source of uncertainty in this assessment is the exposure frequency. For Alternative A, a frequency of once per week (52 days per year) was assumed, while a frequency of "0" was assumed for Alternative B. The difference in the two Alternatives is the use of a physical access control (a fence) in Alternative B.

Regulatory guidance or literature studies that evaluate the effectiveness of access controls in reducing exposure are extremely limited, and no actual values were identified to assist with this assessment. Thus, the frequency estimate of one exposure per week in Alternative A is subjective and based entirely on expert judgment. The true value could plausibly range from once per day to once per year.

Any fence is unlikely to be completely effective at keeping trespassers out of the kettles. However, as discussed in the qualitative section above, this type of access control is widely used and appears to be the most appropriate for this type of site. In addition, small children will likely be excluded from the kettle bottoms by this control measure. It is possible that older children might occasionally scale a fence and gain access to the area; however, this would probably only happen a limited number of times during the period that they resided near Briggs Nursery. Given the results of our qualitative evaluation, we feel that assuming a value of "0" times per year the Alternative B exposure frequency is appropriate.

Regardless, the risk assessment equations described above were used to calculate the incremental risk for each trespassing incident was calculated. For each incident, a hypothetical trespasser was assumed to climb over the fence and spend one half-hour wading and one half-hour digging in the bottom of the kettle. Table 4 presents the incremental risk for this scenario for each kettle. It may be seen from these analyses that incremental risks in the event of the infrequent trespass are less than 1 x 10^{-06}.

Table 4. Incremental Risk From One Trespassing Incident in the Kettles

Kettle Location	Calculated Soil/Sed Ingestion + Dermal	Dermal Water	Ingestion water	Total Risk
Northeast	1.7 x 10^{-09}	2.2 x 10^{-08}	5.4 x 10^{-11}	2.4 x 10^{-08}
Southeast	1.3 x 10^{-19}	3.8 x 10^{-08}	1.5 x 10^{-10}	3.9 x 10^{-08}

7.0 RECOMMENDED REMEDIES AND CONCLUSIONS

The results of our evaluation lead us to recommend Alternative B as the most appropriate method to reduce exposure and risk from PCDD/PCDF concentrations in the three kettles of interest. Although it is possible that Alternative A would be effective, exposure could occur. Alternative B protects residential populations from both exposures to PCDD/PCDF at the site, as well as from potential accidents related to the water and mud in the kettles.

As discussed above, the concentrations of PCDD/PCDF at the site are essentially the same as many urban Washington areas, and are most likely the result of street runoff as described within this evaluation. Alternative B is thus likely protecting children from exposure to PCDD/PCDF concentrations that are similar to those they could be exposed to in any urban neighborhood. In addition, although it was assumed that the Southeast Kettle had water in it for the purposes of this analysis, redirection of water runoff may lead to this kettle becoming dry in the future, which would substantially reduce risk (and bring its risk values below the 1.0 x 10^{-06} threshold). Regardless, this alternative provides the most appropriate and acceptable remedy to the potential exposure to PCDD/PCDF in the kettles at the Briggs Nursery site.

8.0 REFERENCES

ASTM. 2000. *Standard Guide for Use of Activity and Use Limitations, Including Institutional and Engineering Controls: E 2091-05*: American Society for Testing and Materials.

ASTSWMO. 1997. *Survey of State Institutional Control Mechanisms*. Washington, D.C.: Association of State and Territorial Solid Waste Management Officials.

City of Olympia. 2003. Findings and Recommendation of the Hearing Examiner of the City of Olympia, August 15, 2003. Case No. 97-0187 (Recommendation on Master Plan Approval for Briggs Urban Village). Bjorgen, Thomas R., Olympia Hearing Examiner.

City of Renton. 1998. 4-3-090 Shoreline Master Program Regulations; L. Specific Use Regulations; 18. Utilities (iii): Environmental Regulations and Overlay Districts, Chapter 3; Development Regulations; Title 4; Revised And Compiled Ordinances; City of Renton, Washington. http://www.mrsc.org/mc/renton/renton04/ch03.html

CPSC. 2000. *Safety Barrier Guidelines For Home Pools [Pub. No. 362]*: United States Consumer Product Safety Commission.

Entrix. 2005a. *Revised Draft Remedial Investigation Feasibility Study Work Plan Briggs Nursery, Revised April 4, 2005*.

Entrix. 2005b. Letter to Washington State Department of Ecology submitted by Matt Butcher, February 2, 2005.

ENTRIX, Inc., 2006. Remedial Investigation/Feasibility Study Report for Work Areas 1 and 2. Briggs Nursery, February 15, 2006.

Florida Department of Environmental Protection. 2004. *Institutional Controls Procedures Guidance*: Division of Waste Management.

Intertox. 2007. Baseline Human Health Risk Assessment (HHRA) for Dioxins/Furans at the Briggs Nursery Site (Work Area 3) in Olympia, Washington.

King County Department of Development and Environmental Services. 2005. *Final Code Interpretation L05ci002 [Interpretation of King County Code Chapters 16.70 and 21A.12]*. http://www.metrokc.gov/ddes/CodeInterp/PDFs/L05CI002.pdf

Michelson T. 1992. Organic carbon normalization of sediment data (Ecology Technical Information Memorandum).

Oregon Department of Environmental Quality. 1998. *Final: Guidance for Use of Institutional Controls*. Portland, OR: Waste Management and Cleanup Division.

Pierce County Government. 2005. *Pierce County Development Regulations: Zoning, Title 18A*. http://piercecountywa.org/xml/abtus/ourorg/council/code/Title%2018a%20pcc.pdf

Puget Sound Energy. 2001. *Chain-Link Fence (with or without slats) (1025.9310)*.

US DOE. 2003. *2003 Sitewide Institutional Controls Annual Assessment Report: Hanford CERCLA Response Actions (DOE/RL-2003-37)*: United States Department of Energy.

US EPA. 1988. *Superfund Exposure Assessment Manual [OSWER Directive 9285.5-1. EPA/540/1-88/001. NTIS PB89-135859]*. Washington, DC: United States Environmental Protection Agency, Office of Emergency and Remedial Response. http://risk.lsd.ornl.gov/homepage/Exposure_Assessment_Manual_1988_EPA5401881001.pdf

US EPA. 1989. *Risk Assessment Guidance for Superfund (RAGS), Volume I. Human Health Evaluation Manual, Part A. Interim Final (EPA/540/1-89/002)*. Washington, D.C.: United States Environmental Protection Agency, Office of Solid Waste and Emergency Response.

US EPA. 1992. *Dermal Exposure Assessment: Principles and Applications (EPA/600/8-91/011B)*: United States Environmental Protection Agency, Exposure Assessment Group, Office of Health and Environmental Assessment. http://www.epa.gov/ncea/pdfs/efh/references/DEREXP.PDF

US EPA. 2000. *Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups*: Office of Solid Waste and Emergency Response.

US EPA. 2002. *Child-Specific Exposure Factors Handbook (EPA-600-P-OO-002B)*: National Center for Environmental Assessment-Washington Office, Office of Research and Development, United States Environmental Protection Agency. http://www.fda.gov/ohrms/dockets/dockets/95s0316/95s-0316-rpt0242-25-Appendix-20-vol177.pdf

Washington State Department of Ecology. 1999. *Final Report: Screening Survey for Metals and Dioxins in Fertilizer Products and Soils in Washington State, Ecology Publication No. 99-309*. http://www.p2pays.org/ref/14/13146.pdf

Washington State Department of Ecology. 2001. *Remedial investigation and feasibility study:*

Washington Administrative Code 173-340-350.
http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-350
Washington State Department of Ecology. 2005. *Unrestricted land use soil cleanup standards: Washington Administrative Code 173-340-740*.
Washington State Department of Health. 2005. *General design, construction, and equipment for all WRF pool facilities: Washington Administrative Code 246-260-031*.
http://apps.leg.wa.gov/WAC/default.aspx?cite=246-260-031