

Health Consultation

UNIVERSITY OF MINNESOTA STADIUM
THERMAL TREATMENT OF CREOSOTE-CONTAINING SOILS
MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

JUNE 13, 2007

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

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HEALTH CONSULTATION

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THERMAL TREATMENT OF CREOSOTE-CONTAINING SOILS
MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

Prepared By:

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

FOREWORD

This document summarizes public health concerns related to thermal treatment of contaminated soils at 2 proposed sites in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). For a formal site evaluation, a number of steps are necessary:

- *Evaluating exposure:* MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect environmental sampling data. Rather, MDH relies on information provided by the Minnesota Pollution Control Agency (MPCA), the US Environmental Protection Agency (EPA), and other government agencies, private businesses, and the general public.
- *Evaluating health effects:* If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. MDH's report focuses on public health—that is, the health impact on the community as a whole. The report is based on existing scientific information.
- *Developing recommendations:* In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site and offers recommendations for reducing or eliminating human exposure to pollutants. The role of MDH is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. If, however, an immediate health threat exists, MDH will issue a public health advisory to warn people of the danger and will work to resolve the problem.
- *Soliciting community input:* The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the individuals or organizations responsible for the site, and community members living near the site. Any conclusions about the site are shared with the individuals, groups, and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us.*

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Introduction

Creosote-containing soils near 6th St SE and 23rd Ave SE, Minneapolis, Hennepin County Minnesota will be excavated within a few months in preparation for construction of the new University of Minnesota Football Stadium. The source of contamination at this site is waste from a former wood treating facility. Two contractors, AB Environmental, Inc. (AB) and DCI Environmental, Inc. (DCI), have submitted proposals to the University of Minnesota (University) for thermal treatment of the soils prior to landfilling. Both proposals include estimated airborne emissions from thermal treatment equipment. These estimated emissions can be used to evaluate exposures for treatment either onsite or offsite. Onsite treatment for both contractors would take place near the southwest corner of 6th St SE and 23rd Ave SE, Minneapolis. As an offsite alternative, AB has proposed to treat soils on property they own near Henderson, Sibley County, Minnesota. A second contractor, DCI, had also provided data to the MPCA as part of their proposal to the University for performing the remediation. Since these submittals and subsequent review, the University has awarded the contract to AB Environmental, however, analyses from both contractors will be discussed in this document as both were reviewed by the MPCA and MDH. The choice of location for treatment, which will be made by the University, is complicated because each site requires different permits or approvals and there is a tight schedule for beginning stadium construction.

The Minnesota Pollution Control Agency (MPCA) requested the Minnesota Department of Health (MDH) evaluate the potential for emissions from thermal treatment to impact public health. This is a technical health consultation without discussion of exposed populations. This Health Consultation is confined to discussing issues directly related to the thermal treatment of creosote-contaminated soils and does not address the overall Stadium site cleanup. MDH has relied on MPCA to evaluate whether data submitted by the contractors reflects potential emissions that could occur during thermal treatment. In addition, MDH has relied on the MPCA's review and acceptance of dispersion modeling of these emissions, and resulting calculations of the potential public exposures to emissions. MDH understands that the data submitted by DCI were from treatment of creosote-containing soils from this site; in 1995, that were more highly contaminated than the soils proposed to be treated at this time. AB emissions data are from treatment of petroleum-contaminated soils in 1997.

MDH has reviewed the chemical outputs from the dispersion model, the resulting potential health hazards, and the modeled fractions of the National Ambient Air Quality Standards (NAAQS) as calculated by the MPCA's Risk Assessment Spreadsheet (RASS). RASSes, submitted by the contractors, contain conservative calculations of risks that may be associated with exposure at or beyond the property fenceline. However, because there are not data available to describe current ambient air concentrations for chemicals at the treatment sites, total or cumulative exposures are not calculated or reviewed. As a result, exposures reviewed are in addition to normal, ambient exposures at the sites.

Thermal treatment of soils from this site is expected to take less than 3 months of continuous operation. Therefore, acute and subchronic toxicity endpoints are of most concern. Onsite treatment would take place in an urban area. The proposed onsite treatment area is in a parking lot that is adjacent to the University Bus, Bicycle and Pedestrian Transitway. The Fay Thompson Environmental Management Center is directly across 23rd Ave. SE from the proposed onsite treatment area. The University Center for Public Health Education and Outreach, a motel, a residential hotel (students residence), a children's health clinic, and a number of restaurants are within 500 meters of treatment area (see Figure 1).

This Health Consultation does not address any of the permitting issues that may impact the choice of a thermal treatment site.

Site Background and History

This site, owned by the University of Minnesota, was previously called the Chicago-Northwestern Railroad Site. Republic Creosoting treated railroad ties at this site from 1903 – 1916 (Dahl & Associates 1990). The site was remediated in the 1990s and creosote contaminated soils were thermally treated by Dustcoating, Inc., now called DCI. Most of the more highly contaminated soils were cleaned up in 1994-1995. DCI used a natural-gas fired Gencor Model 90 Rotary Drum Dryer to treat the soils at an average rate of 24 tons per hour. Pre- and post-treatment soil and air quality testing results for this cleanup were reported in a Dustcoating, Inc report (1995). Some contaminated soils were left on site following the 1990's cleanup. The approximate location of these contaminated soils are shown in Figure 1.

Thermal Treatment Equipment

Generally, equipment used to thermally treat soils is multi-stage, with a desorber, particulate emission controls and a thermal oxidizer (TO). The desorber removes organic contaminants from the soil by evaporating them at high temperatures. Cleaned soils are piled outside of the thermal treatment equipment and, typically, away from emission controls as they cool. Vapors desorbed inside the desorber are passed through a cyclone and a baghouse to remove particulates. Vapors are then passed through a TO, where they are burned. The TO emits hot, treated gases directly up a stack into the air.

To minimize exposures it is important that the desorber remove almost all of the contamination from the soil. The cyclone and baghouse remove particulates from the desorbed vapors; and the thermal oxidizer destroys the organic compounds that were desorbed. If significant amounts of contaminants remain in the treated soil, they can offgas directly into the ambient air as the soil cools, and the soil may remain too contaminated to use or to dispose in a landfill. If particulate controls (cyclone and baghouse) are not functioning properly, particulate emissions to ambient air can increase to levels that may impact health. If the temperature in the TO is not maintained above a pre-determined temperature or the gas residence time in the TO is not sufficient, the destruction efficiency of the TO will decrease and emissions may include significant amounts of untreated contaminants. In addition, small amounts of dibenzo-p-dioxins and dibenzofurans can be formed in TOs by *de novo* synthesis (EPA 2003). This can be

minimized by maintaining high thermal oxidizer temperatures with appropriate residence times and by limiting the time that it takes gas temperatures to fall back to ambient temperatures outside of the exhaust stack.

Chemicals of Interest

Creosote and Polycyclic Aromatic Hydrocarbons

Creosote and polycyclic aromatic hydrocarbons (PAHs) that make up creosote are the soil contaminants at this site. Creosote is the name used to describe a variety of tar-like products that are used as wood preservatives. Typically, creosote used to treat railroad ties is coal tar pitch. During the thermal treatment of creosote-contaminated soils, volatile chemicals released are likely to be PAHs, volatile organic compounds (VOCs), phenols, and heterocyclic or alkylated PAHs. Lighter PAHs (containing 2-4 benzene rings) that are released will remain in the gaseous form some distance from the point of emission, whereas heavier PAHs (4-6 rings) may condense on small airborne particulates close to the point of emission. Characterizing the emissions and potential health impacts from complex PAH mixtures is difficult. Some uncertainties occur in modeling the movement of the contaminants from their source, but considerable uncertainties are also encountered when evaluating the human exposure/uptake kinetics and toxic effects of complex mixtures of gases and particulate-bound pollutants.

Desorption efficiency of thermal treatment is equal to one minus the ratio of the mass of creosote in treated soil to the mass of creosote in untreated contaminated soil. In practice PAHs are used as a surrogate measure for creosote. High desorption efficiency for creosote during thermal treatment will lead to less emission from hot, processed soil on site. Emissions from the hot, treated soil are not easily quantifiable. But it is expected that the rate of emissions from the soil piles will always be less than the rate of desorption inside the desorber, and will rapidly decrease as the soil cools. High desorption efficiency will also lead to less potential exposure when the soils are transported and disposed. Exposures to volatiles from hot treated soils or from contaminated soils that are to be treated are not evaluated in this document.

Destruction efficiency is equal to one minus the ratio of the mass of volatile creosote emitted from the thermal oxidizer to the creosote exiting the thermal desorber or entering the thermal oxidizer. Efficient destruction of volatilized creosote in the thermal oxidizer will lead to fewer emissions from the thermal treatment stack, less consequent *de novo* formation of other organic chemical species (see below), and less potential exposure.

Desorption and destruction efficiencies calculated from field test data are likely to be closely related to the concentration of contaminant in feed soil. While testing methods may be standard, there is no standard contaminated soil to test. Therefore, efficiency limits at sites are often not specified and limits are placed on the maximum contaminant concentration of treated soils. Future use of the treated soils is typically considered when these limits are set. MDH supports the use of MPCA Risk-based Guidance for the Soil - Human Health Pathway (MPCA 1999) for determining appropriate use-related soil

contamination limits. For example, this guidance sets a limit of 2 parts per million (ppm) benzo[a]pyrene toxic equivalents (B[a]P TEQs) for carcinogenic PAHs (cPAHs) in residential soil.

Combustion Products / Products of De Novo Synthesis

When creosote is burned in the thermal oxidizer, the goal is to minimize emissions of hydrocarbons. Not only are emitted hydrocarbons pollutants that can impact health at sufficient concentrations, but they are also the building blocks for the formation of dioxin-like compounds in cooling exhaust (called *de novo* synthesis of dioxin). Cooling emissions quickly, so that there is not enough time for dioxins to form, can minimize the production of dioxins.

Available Data

AB and DCI have submitted a number of reports and spreadsheets on their thermal treatment equipment, including these documents reviewed by MDH: AB Environmental 2007; DCI Environmental Inc. 2007; Geomatrix 2007; Wenck Associates Inc. 2006; 2007.

AB's thermal treatment emission data were acquired in 1997 during treatment of petroleum and PAH-contaminated soils, whereas, DCI's data were acquired in 1995, during treatment of creosote from the Chicago-Northwest Railway site. The TO emissions data were entered into the MPCA Risk Assessment Screening Spreadsheet (RASS). The RASS models dispersion, using emission rate, stack height, stack gas temperature, exit velocity, and building downwash, to calculate potential non-cancer hazard quotients and hazard indices, cancer risks, and it approximates fractions of the National Ambient Air Quality Standard (NAAQS) concentrations attributable to facility criteria pollutants emissions at the fence line. Information from the RASSes submitted by AB (AB Environmental 2007a; Wenck Associates Inc. 2006) and DCI (DCI Environmental Inc. 2007) are shown in Tables 1-7. Tables 1-3 refer to onsite treatment and show calculated emissions entered into the RASS (Table 1), chemical emissions as fractions of the NAAQS (Table 2), hazard quotients, hazard indices, and cancer risks from emitted chemicals (Table 3). Tables 4-7 refer to off-site treatment, and show calculated emissions entered into the RASS (Table 4), fractions of the NAAQS (Table 5), hazard quotients, hazard indices, cancer risks for emitted chemicals (Table 6), as well as multi-media hazards and cancer risks to nearby residents and farmers (Table 7).

As shown in tables 1 and 4, the testing conducted by both DCI and AB included analysis of BTEX (benzene, toluene, ethylbenzene, xylene), lead, and PAHs, but did not include an analysis of VOCs, such as formaldehyde, acrolein and other irritating compounds, or metals other than lead. The NO_x, propylene, formaldehyde, acetaldehyde, acrolein and 1,3-butadiene data in the AB offsite submission (Table 4) is calculated from emission factors for a generator that will be used for powering some of the equipment, and not emissions from the treatment equipment or soils (Wenck Associates Inc. 2006). In addition, the DCI submission did not contain information on SO₂ emissions.

There were also discrepancies between the lead NAAQS entries into the RASS and the lead “Air Toxics” entries from both companies (see Tables 1 and 4) that should be reviewed and corrected, though they are not likely to impact health risks.

Emissions from incinerators contain hundreds of different polycyclic organic compounds. Unsubstituted heterocyclic compounds are generally called polycyclic aromatic hydrocarbons (PAHs). Typically analyses of PAHs are limited to a number of common and/or toxic compounds that are grouped into 2 categories: carcinogenic PAHs (cPAHs) and non-carcinogenic PAHs (nPAHs). MDH has recommended analyzing a list of 25 cPAHs and that cancer risk for screening purposes be determined using a potency equivalence approach (<http://www.health.state.mn.us/divs/eh/risk/guidance/pahmemo.html>). The recommendation is that benzo[a]pyrene be used as the index carcinogen for 21 cPAHs, and the calculated cancer risks for the remaining 4 cPAHs be determined directly from their existing individual cancer slopes. In addition, MPCA has used 5% of the unit risk of B[a]P (risk per concentration) applied to the total particulate organic matter (POM) to evaluate POM (MPCA RASS). Quantification of the health hazard from inhalation exposure to nPAHs is more uncertain because of the lack of toxicity reference values for inhalation of nPAHs, other than naphthalene.

DCI reported emissions of 7 PAHs from testing performed in January 1995. Naphthalene was the only detected PAH that was entered separately into the RASS for evaluation (Tables 1, 4). The remaining 6 PAHs found in emissions were not entered into the RASS, and are not included in the tables, because there are no toxicity criteria for non-carcinogenic PAHs (nPAHs), other than naphthalene. AB submitted a report on 3 test burns in September 1997. A total of eleven PAHs were detected during the runs. However, as was the case with DCI, the AB submission does not calculate a noncancer hazard for any PAH other than naphthalene. This is a general shortcoming in the analysis of PAH health effects that is not restricted to this project or site.

Analyses of cPAH samples taken during the DCI January 1995 test burns was limited to 7 of the 25 compounds currently recommended by MDH. These 7 cPAHs are presumed to be among the most common cPAHs, yet none were found at or above their detection limits. DCI entered conservative emission rates into the RASS, calculated from the detection limits for 7 cPAHs, as proxies for their actual emissions (Tables 1, 4). However, when individual cPAHs are entered into the RASS, the RASS adjusts the potency for each entry. The cancer risks were calculated in the RASS from potency equivalents for these individual cPAHs, based on their detection limits, but 18 other cPAHs, including some of the more potent cPAHs, were not considered. This is not a conservative method when only a limited number of cPAHs have been analyzed. It is not clear whether the total cancer risk is underestimated or overestimated in the DCI RASS submission because the emission rates entered into the RASS are restricted by analytical detection limits (conservative) but there are no data for 18 additional cPAHs (not conservative). It is possible that the additional risks from unanalyzed PAHs may balance out the exaggerated risks from chemicals that are presumed to be emitted at a rate calculated from their detection limits.

AB also only analyzed 7 cPAHs, but they found 3 in their September 1997 test burns. AB entered the sum of the mean concentrations or detection limits of all 20 PAHs (7 cPAHs and 13 nPAHs) analyzed, excluding naphthalene, into the RASS as the total PAH emissions (Tables 1,4). The RASS evaluated the total PAH emissions as benzo[a]pyrene (a cPAH). This evaluation considers non-carcinogenic PAHs (nPAHs) as cPAHs, and it uses the cancer potency of benzo[a]pyrene to evaluate all PAHs. Even though the cancer risk from 18 cPAHs was not calculated, this is likely a conservative method for calculating cancer risk from PAH emissions.

DCI and AB data from test burns in 1995 and 1997 did not include chlorinated dibenzo-p-dioxin (PCDD) or chlorinated dibenzofuran (PCDF) emissions. These compounds are often emitted by thermal incinerators/desorbers (ATSDR 2002). At the urban site exposures to PCDDs/PCDFs, as well as other chemicals, are expected to be shortterm. Deposition of PCDDs/PCDFs on agricultural land could result in these persistent bioaccumulative toxins (PBTs) entering the human food supply. However, the total emissions and deposition from a relatively short burn that is monitored to minimize hydrocarbon releases, is expected to be limited.

Particulate matter measured in both the DCI and the AB burns (Tables 1,4) were measured in stack tests and did not include particulates that are formed from condensation of semi-volatile emissions down stream of the stack. Particulates formed by condensation are likely to be small (2.5 micrometer or less) and their composition may contribute to respiratory irritation. Therefore, omission of these particles from modeling may lead to an underestimation of particulate concentrations in air. This issue is not limited to this project, as the AERA process in general does not routinely evaluate health effects from secondary PM_{2.5}. In addition it is likely that a large portion of the semi-volatile PAH exposures (PAHs with more than 3-4 rings) is to PAHs in particulates, or PAHs in POM.

Discussion

RASS Results

Tables 2, 3, 5, 6, and 7 show the results of the RASS. The largest potential impacts from the data entered into the RASS were nitrogen oxide (NO₂) with an acute hazard index of about 0.3 (Tables 3, 6). The highest chronic hazard quotient for all locations and either contractor is less about 0.0001, and highest calculated cancer risk from available data is about 7.5×10^{-8} . These hazards and risks are generally not of concern to MDH. In addition, the shortterm contribution to the SO₂ NAAQS from AB was approximately 50% of the standard. However, note that the preceding and following sections discuss numerous problems with the available data and analyses, and underscore the broad uncertainties of conducting a health assessment for this site.

Using the RASS to Evaluate Chronic and Cancer Effects From Shortterm Exposures

It is generally inappropriate to use shortterm exposure data to estimate longterm risk. Furthermore, the RASS is designed to assume that the annual exposure is a recurring exposure over a chronic duration or lifetime (in cancer evaluations). Therefore

application of the results of the chronic and carcinogenic RASS calculations, in an instance where the exposures are for less than a year, is not appropriate. However:

- the chronic/cancer RASS may be used to (qualitatively) identify the chemicals of most concern. For this site, with the limited available data, it is not clear that the chemicals of most concern have been identified.
- if the potential exposure is severe, the chronic/cancer RASS may identify a particularly hazardous potential exposure. None was identified, as the results from the RASS (Tables 2, 3, 5, 6, and 7) do not show any hazards and risks at levels of concern even with modeling over an extended exposure period.
- the chronic/cancer RASS may be used to evaluate quantitative risks if additional thermal treatment may occur at the proposed site (Tables 2, 3, 5, 6, and 7). It is MDH's understanding that thermal treatment of other contaminated soils could occur at the proposed rural sites.

It is appropriate to use the RASS to evaluate shortterm risks (acute and subchronic) from the shortterm data. Results suggest that shortterm exposures to the chemicals evaluated in the RASS are not likely to result in adverse health effects (Tables 2, 3, 5, and 6). However, note that this conclusion is subject to additional caveats raised in this document.

Use of Old Data

Test burn data submitted is 10 and 12 years old. Numerous chemicals were not analyzed during test burns.

*DCI Test-Burn Data From University Site**

The test-burn data submitted by DCI is from the 1994-5 remediation of this same Republic Creosote site (Dustcoating Inc 1995). The creosote concentrations in the soil that was remediated in 1994-5 was said to be many times more contaminated with the remaining contaminated soils that are to be remediated this year. While this would generally lead one to assume that emissions should be less than those seen in the 1994-5 treatment, it is not clear that this can be assumed. The amount of fuel in the soil, soil moisture, soil type and operating parameters can have a large effect on the efficiency of a thermal treatment system.

Variability In Emissions Data and Data Entered Into the RASS

Emissions from a thermal treatment facility can change with treatment of heterogeneous materials containing different concentrations of contaminant, soil moisture, soil types, as well as changing parameters that are within the operator's control, such as feed rate and temperature within the desorption and combustion chambers.

In January 1995 DCI collected emissions data from 3 runs (Dustcoating Inc 1995). These data showed highly variable individual PAH emissions (up to a 66-fold range) across the 3 runs (fluorene, 200 to < 2.9 g/μsec). While it is assumed that operating conditions

* Since initial preparation of this document, the University has chosen not to award the contract for remediation to DCI.

during these test burns were “worst-case”, these data suggest that emissions may vary over a wide range during operation, and also that it is likely that worst-case emissions were not measured during these 3 runs.

In addition, data from AB (AB Environmental 2007b) suggests that the chemical profiles of thermal treatment emissions may shift from one run to the next. From Run 1 to Run 3 naphthalene concentrations decreased about 4 times; acenaphthene decreased greater than 19-fold; fluorene decreased greater than 32-fold. Whereas, also from Run 1 to Run 3, for example, benzo[a]pyrene, benzo[b]fluoranthene and fluoranthene increased greater than 5-fold, 38-fold and 44-fold, respectively. These data suggest that there were differences in operating parameters or feed stock contamination between the runs, but it is not obvious what these differences were.

There are also differences between submissions from AB and DCI. For instance, the DCI lead emissions are about 7 times less than the AB lead emissions (Tables 1, 4). It is not clear whether these differences are due to differences in material treated, soil type, moisture, or the treatment equipment.

Lack Of Emissions Data On Chemicals

When creosote and other organic wastes are thermally treated, VOCs, metals and polycyclic aromatic hydrocarbons are primary chemicals of interest for direct exposure. As noted above, there are no emissions data for metals, other than lead, or for VOCs, other than BTEX. There are screening concentrations for many of these pollutants that could have been compared with modeled concentrations if those data were available.

Lack Of Toxicity Information On Chemicals Emitted

While there are limited emissions data for PAHs, it is difficult to quantify their toxicity. The cancer risk from cPAHs can be evaluated, but there are no health-based exposure values with which to evaluate the potential non-cancer hazards to the public from chronic and shortterm exposures to PAHs. Shortterm, exposure to PAHs is of concern at the urban site because of the potential for respiratory, dermal and eye irritation. This irritation can be potentiated by sunlight, resulting in photo-enhanced PAH toxicity (Johnson and Ferguson 1990). In addition, exposure to the combination of PAHs and particulate matter, or PAH-containing particulate matter can result in respiratory irritation. Furthermore, exposures to PAHs (and VOCs) in air are often associated with odors that could result in shortterm discomfort. The urban, onsite treatment has been proposed in an area with a high amount of pedestrian and bicycle traffic, close to some residences, including hotels that house student residents during the school year. Therefore, it is reasonable to assume that shortterm exposures at modeled concentrations are likely to occur during urban treatment.

Summary and Conclusions

It is not clear that there is a reliable way to determine whether a public health hazard is occurring during treatment, except by gross, subjective measures such as community complaints.

Total emissions from treatment of creosote contamination at this site

There is a limited volume of contaminated soils at this site. Therefore, the total amount of emissions from thermal treatment of the contaminants at this site will be limited. The calculation of chronic hazards and cancer risks in the RASS is not appropriate because the RASS assumes multi-year exposure to the annual emissions. Calculating a site-specific, cancer risk (or chronic hazard index) requires information about longterm effects caused by shorter exposures. Such information is generally not available. Because of the expected short duration of thermal treatment of wastes from this site, shortterm health impacts are of greater concern.

Likelihood of exposures at rural and urban treatment sites

If offsite concentrations of thermal treatment emissions are irritating, odorous, or have other shortterm impacts, it is likely that they could affect individuals if remediation is performed at the urban site. If emissions contain significant amounts of PCDDs/PCDFs then they could result in increased cancer risk to a farmer who lives adjacent to the burner at a rural site and ingests contaminated food. However, uncertainties of exposures and effects at both locations are very large. These uncertainties could be reduced by additional testing or investigation, or they can be made less important by requiring restrictive operating procedures and real-time monitoring of emissions.

Additional Testing / Investigation

The reports on test burns by AB and DCI do a poor job of describing relationships between operating conditions and emissions. Without data or information describing conditions under which emissions are predictable it will not be possible to characterize potential exposures. Further, for many chemicals, especially nPAHs, toxicity data are limited. However, there is considerable experience with thermal treatment and it is likely that there are some emission or exposure benchmarks from other sites that can be matched with health and odor complaints. Investigation of other thermal treatment experiences could provide important information.

Emissions data from the thermal treatment equipment proposed for this project are 10 to 12 years old, or the data are calculated from sector emissions factors. In addition, emissions data are limited to BTEX and a handful of other chemicals.

Remodeling Dispersion And Quantitative Risk Evaluation

MDH did not review information in the RASS that is related to dispersion and receptor modeling. It is assumed that applied parameters were reasonable and were reviewed by the MPCA. However, some data were missing (e.g. the DCI RASS did not include evaluation of SO₂).

Both AB and DCI used the mean of their 3 test run emission results to determine both the 1 hour and annual emissions. This is not appropriate for assessing potential health impacts. For shortterm dispersion modeling it is appropriate to model the maximum emissions during a single run. For longterm modeling it is appropriate to enter the 90-

95% upper confidence limit of the mean into the dispersion model. This change in both RASSes could result in significant increases in the estimated pollutant concentrations at the fence line.

Restrictive Operating Procedures / Real-Time Monitoring

If thermal treatment is conducted in an urban area, exposure concerns are likely the greatest for chemicals or particulates that may cause short-term irritation. Completed exposure pathways to the public can be limited or broken by: limiting emissions, or limiting exposures by operating the thermal treatment facility in an area where there are few people. On the other hand, in a rural area short-term health impacts may be of less concern than indirect exposure to persistent bioaccumulative compounds (PBTs) that are deposited on pasture, consumed by cattle who are, in turn, consumed by a farmer. This food consumption exposure pathway can be significant, but the exposure pathway can be broken at many points: decreasing PBT emissions, conducting thermal treatment away from pasture and other agricultural fields, or by taking action to limit the exposure to specific high-risk individuals (e.g. a resident farmer).

Recommendations

MDH has three categories of recommendations for this site that are listed in the following paragraphs. MDH recognizes this project will be a short-term project and, likely, the investigation will be limited. MDH believes that the first set of recommendations (A) should be a priority for this site. If additional investigation is possible, MDH has additional recommendations (B) that could impact site decisions. Furthermore, this project provides an opportunity to collect important emission information (C) that could be used at future thermal treatment sites.

A) MDH recommends:

- Community organizations, businesses and healthcare providers in the area should be notified prior to operation of thermal treatment equipment onsite.
- A process for mitigating community complaints should be clearly described.
- In an urban area, operating procedures that can minimize irritating emissions such as PAHs, particulates and odors should be employed.
- In rural areas the production of PCDDs and PCDFs should be minimized.
- Realtime emissions monitoring should be used to help minimize hydrocarbon emissions during treatment.
- Soil piles, piles of treated soil, and truck beds with treated or untreated soils should be covered on site and during transit.
- Operating parameters should be limited to conditions that assure minimal particulate and PAH emissions in an urban area, and limited PBT emissions in a rural area.
- Operating parameters should be recorded during operation.
- Realtime emissions monitoring (e.g. stack monitoring for chemicals and particulates) should be conducted to confirm anticipated emissions and to record variances.

B) Additional information may be useful to help understand the potential exposures.

- A review of other urban thermal treatment experiences could provide the best information about limiting public exposures and complaints.

- Acquisition of additional and current VOC, PAH, PCDD/F and metals emission data should be considered.
- Corrections should be made to the RASS submissions, including: use of maximum test burn emissions for hourly emissions, and use of 90-95% CL of the mean for determining longterm emissions.
- Risks and fractional contributions to the NAAQS Standards should be reviewed following emissions updates.

C) MDH also recommends that MPCA and the thermal treatment contractor consider taking samples during operation to provide equipment-specific data on NAAQS emissions. It would also be desirable to obtain information on PAH emissions for the complete MDH list of cPAHs, PCDD/PCDF emissions, VOC emissions, and metals emissions. These data may help contractor, MPCA and MDH to evaluate potential risks for subsequent projects.

Public Health Action Plan

MDH will work with the MPCA, the University of Minnesota and the southeast Minneapolis community to help address concerns that arise during remediation of this site.

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CERTIFICATION

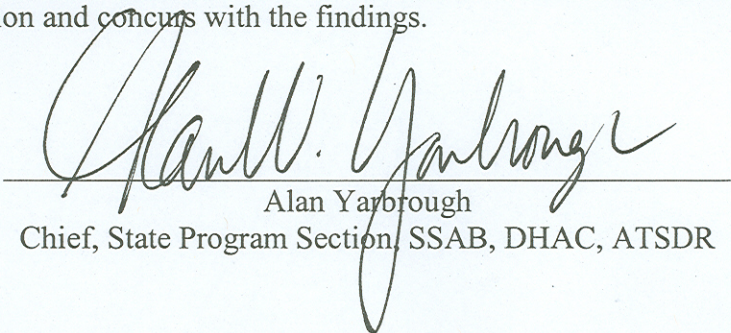
This University of Minnesota Stadium, Thermal Treatment Of Creosote-Containing Soils Health Consultation was prepared by the Minnesota Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.



Alan Parham

Technical Project Officer, SPS, SSAB, DHAC, ATSDR

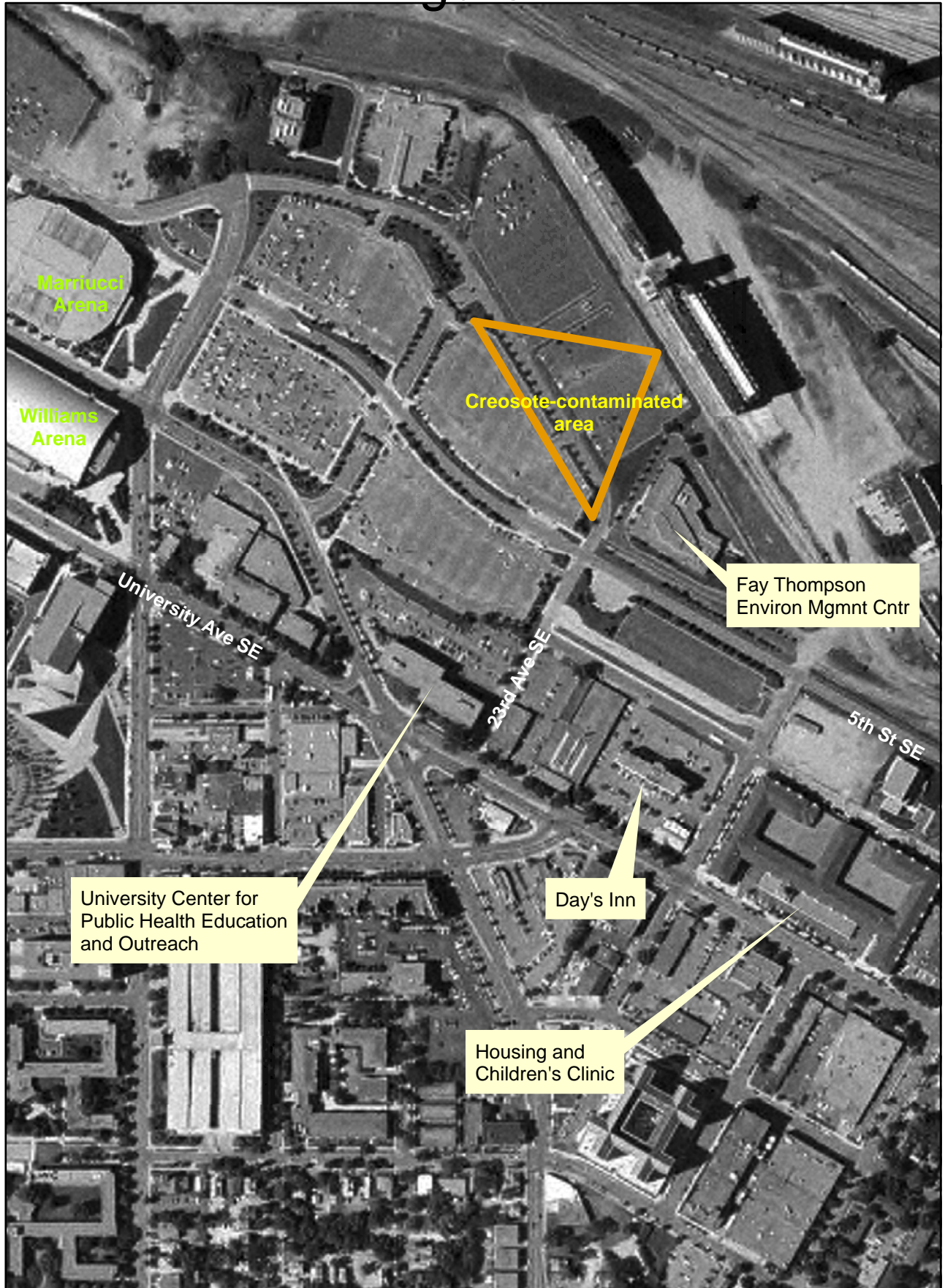
The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.



Alan Yarbrough

Chief, State Program Section, SSAB, DHAC, ATSDR

Figure 1



0 50 100 200 300 400 Meters

**Table 1: On-Site Treatment -
Desorption Unit Emissions (from submitted RASSes)**

Chemical Name	AB Environmental, Inc.			DCI Environmental, Inc.		
	Hourly Emissions (lb/hr)	Annual Emissions (tpy)	Hours of Operation (at hourly emissions rate)	Hourly Emissions (lb/hr)	Annual (1200 hr) Emissions (tpy)	Hours of Operation (at hourly emissions rate)
SO ₂ ¶	43.1	32.3	1500			
PM ₁₀ ¶	2.37	1.19	1000	4.13	2.48	1200
PM _{2.5} ¶	2.37	1.19	1000	4.13	2.48	1200
NO _x ¶	12.1	6.05	1000	12.6	7.56	1200
Carbon Monoxide	0.72	0.36	1000	0.29	0.174	1200
Lead	2.60E-03	1.30E-03	1000	3.10E-04	1.86E-04	1200
VOCs ¶	0.24	0.12	1000	3.00E-02	1.80E-02	1200
Total HAPs ¶	0.155	7.76E-02	1000			
Nitrogen oxide (NO ₂) ¶	12.1	6.05	1000	12.6	7.56	1200
Benzene **	3.88E-02	1.94E-02	1000	2.00E-03	1.20E-03	1200
Ethyl benzene **	3.88E-02	1.94E-02	1000			
Toluene **	3.88E-02	1.94E-02	1000	2.00E-03	1.20E-03	1200
Xylenes **	3.88E-02	1.94E-02	1000	2.00E-03	1.20E-03	1200
Polycyclic Aromatic Hydrocarbons (PAH)	1.12E-04 §	5.61E-05 §	1000	(2.47E-04)†	(1.49E-04)†	
Naphthalene	7.00E-05	3.50E-05	1000	2.20E-03	1.32E-03	1200
Lead				2.54E-04	1.52E-04	1200
Chrysene **				6.43E-05	3.86E-05	1200
Benz[a]anthracene **				4.23E-05	2.54E-05	1200
Benzo(k)fluoranthene **				3.99E-05	2.40E-05	1200
Indeno(1,2,3-cd)pyrene **				2.83E-05	1.70E-05	1200
Benzo[a]pyrene *				2.79E-05	1.68E-05	1200
Benzo[b]fluoranthene *				2.32E-05	1.39E-05	1200
Dibenz[a,h]anthracene **				2.14E-05	1.29E-05	1200

¶ Calculated, not directly measured

* Detection Limit (analyte undetected) - DCI Environmental - January, 1995

** Detection Limit (analyte undetected) - AB Environmental - September, 1997 & DCI Environmental - January, 1995

§ Sum of 20 PAHs (10 at detection limits and 10 detected) - AB Environmental - September, 1997

† Sum of detection limits for 7 carcinogenic PAHs - DCI Environmental - January, 1995

**Table 2: On-Site Treatment - Criteria Pollutant Screening -
Fraction of NAAQS (from submitted RASSes)**

Chemical	AB Environmental, Inc.					DCI Environmental, Inc.				
	Fraction of 1-hr std	Fraction of 3-hr std	Fraction of 24-hr std	Fraction of qtrly std	Fraction of annual std	Fraction of 1-hr std	Fraction of 3-hr std	Fraction of 24-hr std	Fraction of qtrly std	Fraction of annual std
SO ₂	0.432	0.505	0.545		0.023					
PM ₁₀			0.073		0.001			0.123		0.002
PM _{2.5}			0.168		0.003			0.285		0.007
NO _x					0.003					0.003
CO	0.000					0.000				
Pb				0.000					0.000	

Table 3: On-Site Treatment - Inhalation Screening - Hazard Quotients and Cancer Risks for Individual Substances (from submitted RASSes)								
Chemical Name	AB Environmental, Inc.				DCI Environmental, Inc.			
	Acute Hazard Quotient	Subchronic Noncancer Hazard Quotient	Chronic Noncancer Hazard Quotient	Cancer Risk	Acute Hazard Quotient	Subchronic Noncancer Hazard Quotient	Chronic Noncancer Hazard Quotient	Cancer Risk
Totals	0.336		0.000039	9.2E-09	0.31		0.0000080	3.9E-09
Nitrogen oxide (NO ₂)	0.335				0.31			
Benzene	5.0E-04		2.8E-05	6.5E-09	2.3E-05		1.6E-06	3.7E-10
Ethyl benzene	5.0E-05		8.3E-07					
Toluene	1.4E-05		2.1E-06		6.2E-07		1.2E-07	
Xylenes	1.2E-05		8.3E-06		5.3E-07		4.8E-07	
Naphthalene	4.6E-06		1.7E-07	5.1E-11	1.3E-04		5.8E-06	1.8E-09
Polycyclic Aromatic Hydrocarbons (PAH)				2.6E-09				(1.71E-9)†
Benzo[a]pyrene								7.3E-10
Dibenz[a,h]anthracene								6.1E-10
Benz[a]anthracene								1.1E-10
Benzo(k)fluoranthene								1.0E-10
Indeno(1,2,3-cd)pyrene								7.4E-11
Lead								7.3E-11
Benzo[b]fluoranthene								6.1E-11
Chrysene								1.7E-11

† Sum of cancer risk from 7 carcinogenic PAHs in DCI submission

**Table 4: Off-Site Treatment -
Desorption and Generator Unit Emissions (from submitted RASSes)**

Chemical Name	AB Environmental, Inc.			DCI Environmental, Inc.		
	Hourly Emissions (lb/hr)	Annual Emissions (tpy)	Hours of Operation (at hourly emissions rate)	Hourly Emissions (lb/hr)	Annual Emissions (tpy)	Hours of Operation (at hourly emissions rate)
SO ₂ ¶	43.5	33.5	1540			
PM ₁₀ ¶	2.8	2.49	1770	4.13	2.48	1200
PM _{2.5} ¶	2.8	2.49	1770	4.13	2.48	1200
NO _x ¶	18.3	24.6	2690	12.6	7.56	1200
Carbon Monoxide	2.05	4.35	4240	0.29	0.174	1200
Lead	2.60E-03	1.30E-03	1000	3.10E-04	1.86E-04	1200
VOCs ¶	0.744	1.63	4390	0.03	0.018	1200
Total HAPs ¶	0.161	9.39E-02	1170			
Nitrogen oxide (NO ₂) ¶	18.3	24.6	2690	12.6	7.56	1200
Benzene **	4.01E-02	2.33E-02	1160	2.00E-03	1.20E-03	1200
Ethyl benzene **	3.88E-02	1.94E-02	1000			
Toluene **	3.93E-02	2.11E-02	1070	2.00E-03	1.20E-03	1200
Xylenes **	3.92E-02	2.06E-02	1050	2.00E-03	1.20E-03	1200
Polycyclic Aromatic Hydrocarbons (PAH)	2.29E-04	4.06E-04	3550	(2.47E-4)†	(1.49E-4)†	
Naphthalene	1.89E-04	3.91E-04	4150	2.20E-03	1.32E-03	1200
Lead				2.54E-04	1.52E-04	1200
Chrysene **				6.43E-05	3.86E-05	1200
Benz[a]anthracene **				4.23E-05	2.54E-05	1200
Benzo(k)fluoranthene **				3.99E-05	2.40E-05	1200
Indeno(1,2,3-cd)pyrene **				2.83E-05	1.70E-05	1200
Benzo[a]pyrene *				2.79E-05	1.68E-05	1200
Benzo[b]fluoranthene *				2.32E-05	1.39E-05	1200
Dibenz[a,h]anthracene **				2.14E-05	1.29E-05	1200
Propylene ¶	3.61E-03	1.08E-02	6000			
Formaldehyde ¶	1.65E-03	4.96E-03	6000			
Acetaldehyde ¶	1.07E-03	3.22E-03	6000			
Acrolein ¶	1.30E-04	3.89E-04	6000			
Butadiene, 1,3- ¶	5.47E-05	1.64E-04	6000			

¶ Calculated, not directly measured

* Detection Limit (analyte undetected) - DCI Environmental - January, 1995

** Detection Limit (analyte undetected) - AB Environmental - September, 1997 & DCI Environmental - January, 1995

§ Sum of 20 PAHs (10 at detection limits and 10 detected) - AB Environmental - September, 1997

† Sum of detection limits for 7 carcinogenic PAHs - DCI Environmental - January, 1995

**Table 5: Off-Site Treatment - Criteria Pollutant Screening -
Fraction of NAAQS (from submitted RASSes)**

Chemical	AB Environmental, Inc.					DCI Environmental, Inc.				
	Fraction of 1-hr std	Fraction of 3-hr std	Fraction of 24-hr std	Fraction of qtrly std	Fraction of annual std	Fraction of 1-hr std	Fraction of 3-hr std	Fraction of 24-hr std	Fraction of qtrly std	Fraction of annual std
SO2	0.436	0.509	0.550		0.093					
PM10			0.086		0.007			0.031		0.000
PM2.5			0.199		0.024			0.072		0.001
NOx					0.023					0.001
CO	0.001					0.000				
Pb				0.000					0.000	

Table 6: Off-Site Treatment - Inhalation Screening - Hazard Quotients and Cancer Risks for Individual Substances (from submitted RASSes)								
Chemical Name	AB Environmental, Inc.				DCI Environmental, Inc.			
	Acute Hazard Quotient	Subchronic Noncancer Hazard Quotient	Chronic Noncancer Hazard Quotient	Cancer Risk	Acute Hazard Quotient	Subchronic Noncancer Hazard Quotient	Chronic Noncancer Hazard Quotient	Cancer Risk
Totals	0.51	0.000179	0.001165	7.5E-08	0.16		0.0000013	6.6E-10
Nitrogen oxide (NO ₂)	0.51				1.6E-01			
Benzene	5.2E-04		1.7E-04	4.0E-08	1.2E-05		2.6E-07	6.2E-11
Ethyl benzene	5.0E-05		5.0E-06					
Toluene	1.4E-05		1.3E-05		3.2E-07		2.0E-08	
Xylenes	1.2E-05		5.0E-05		2.7E-07		7.9E-08	
Naphthalene	1.2E-05		2.7E-06	8.2E-10	6.5E-05		9.7E-07	3.0E-10
Polycyclic Aromatic Hydrocarbons (PAH)				3.2E-08				(2.9E-10)†
Benzo[a]pyrene								1.2E-10
Dibenz[a,h]anthracene								1.0E-10
Benz[a]anthracene								1.8E-11
Benzo(k)fluoranthene								1.7E-11
Indeno(1,2,3-cd)pyrene								1.2E-11
Lead								1.2E-11
Benzo[b]fluoranthene								1.0E-11
Chrysene								2.8E-12
Formaldehyde	2.3E-04		7.1E-05	1.1E-09				
Acrolein	8.4E-04	1.8E-04	8.3E-04					
Acetaldehyde			1.5E-05	3.0E-10				
Butadiene, 1,3-			3.5E-06	2.3E-10				
Propylene			1.5E-07					

† Sum of cancer risk from 7 carcinogenic PAHs in DCI submission

Table 7: Off-Site Treatment - Multi-exposure Route Screening - Hazard Quotients and Cancer Risks for Individual Substances (from submitted RASSes)

Chemical Name	AB Environmental, Inc.				DCI Environmental, Inc.			
	Farmer Noncancer Hazard Quotient	Farmer Cancer Risk	Resident Noncancer Hazard Quotient	Resident Cancer Risk	Farmer Noncancer Hazard Quotient	Farmer Cancer Risk	Resident Noncancer Hazard Quotient	Resident Cancer Risk
Totals	0.0012	9.8E-06	0.0012	7.5E-08	0.0000013	1.2E-06	0.0000013	1.0E-09
Nitrogen oxide (NO ₂)								
Benzene	1.7E-04	4.0E-08	1.7E-04	4.0E-08	2.6E-07	6.2E-11	2.6E-07	6.2E-11
Ethyl benzene	5.0E-06		5.0E-06					
Toluene	1.3E-05		1.3E-05		2.0E-08		2.0E-08	
Xylenes	5.0E-05		5.0E-05		7.9E-08		7.9E-08	
Naphthalene	2.7E-06	8.2E-10	2.7E-06	8.2E-10	9.7E-07	3.0E-10	9.7E-07	3.0E-10
Polycyclic Aromatic Hydrocarbons (PAH)		9.7E-06		3.2E-08		(1.2E-06)†		(6.5E-10)†
Benzo[a]pyrene						4.9E-08		2.4E-10
Dibenz[a,h]anthracene						4.1E-07		2.0E-10
Benz[a]anthracene						1.9E-09		7.4E-11
Benzo(k)fluoranthene						1.0E-08		3.5E-11
Indeno(1,2,3-cd)pyrene						7.4E-07		6.2E-11
Lead						3.6E-11		1.2E-11
Benzo[b]fluoranthene						3.1E-09		2.0E-11
Chrysene						5.6E-10		1.1E-11
Formaldehyde	7.1E-05	1.1E-09	7.1E-05	1.1E-09				
Acrolein	8.3E-04		8.3E-04					
Acetaldehyde	1.5E-05	3.0E-10	1.5E-05	3.0E-10				
Butadiene, 1,3-	3.5E-06	2.3E-10	3.5E-06	2.3E-10				
Propylene	1.5E-07		1.5E-07					

† Sum of cancer risk from 7 carcinogenic PAHs in DCI submission