DRAFT

May 14, 2009

Project 13310.000

Ms. Deborah Castles
McGrath Properties, Inc.
130 Webster Street
Oakland, California 94607

Subject: **Addendum to Screening-Level Risk Evaluation**
1001 42nd Street, Oakland, California

Dear Ms. Castles:

Per your request, AMEC Geomatrix, Inc. (AMEC), has prepared this addendum to the *Screening-Level Risk Evaluation*[1] for the property located at 1001 42nd Street, Oakland, California (the site). In this addendum, the potential migration of total petroleum hydrocarbons quantified as mineral spirits (TPHms) and other volatile organic compounds (VOCs) detected in the subsurface through the soil column and into indoor air of enclosed buildings is evaluated for students, teachers, and administrative staff who may use the site as a charter school. This migration pathway is typically referred to as the vapor intrusion pathway. Vapor intrusion is the process where volatile constituents migrate from soil or groundwater into soil vapor, migrate in vapor phase through soil pores to an area near a building foundation, and then are drawn into a building through cracks or other penetrations in the floor.[2] For this evaluation, risk-based screening levels (RBSLs) for indoor air and soil gas were calculated using exposure information that is appropriate for school populations.[3] Based on the data collected to date and the results of this evaluation, there is no apparent unacceptable health risk posed by the vapor intrusion pathway at the site, and further characterization of the vapor intrusion pathway is not recommended at this time.

BACKGROUND

TPHms is a heterogeneous mixture of aliphatic and aromatic carbon chains. It is comprised of numerous compounds with variable physicochemical properties and toxicities. Methods presented by the Total Petroleum Hydrocarbon (TPH) Criteria Working Group[4] and the Department of Toxic Substances Control were used to identify the chemical-specific properties and toxicity criteria that best represent the entire mixture. The physicochemical and toxicity

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1 Geomatrix Consultants, Inc., 2007, Screening-Level Risk Evaluation, 1001 42nd Street, Oakland, CA., June 5
2 Department of Toxic Substances Control (DTSC), California Environmental Protection Agency, 2005, Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, Interim Final, February.
3 Office of Environmental Health Hazard Assessment (OEHHA), California Environmental Protection Agency, 2005, *Guidance for Assessment of Exposures and Health Risks at Existing and Proposed School Sites*. February.
4 Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG), 1997, Selection of Representative TPH Fractions Based on Fate and Transport Considerations, Volume 3, July.

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criteria for TPHms used in this evaluation are based on the values presented in the *Screening-Level Risk Evaluation*; a detailed presentation of these methodologies is not included in this addendum. For VOCs, Cal-EPA and U.S. EPA are the primary sources of published toxicity estimates.

The following sections summarize the selection of exposure parameters for students, teachers, and administrative staff, the calculation of RBSLs, and the results of the screening-level risk evaluation.

EXPOSURE ASSESSMENT

The possible receptors for the exposure scenarios evaluated in this screening-level risk assessment are students and staff (i.e., teachers and administrative staff). The exposure assessment is based on a reasonable maximum exposure (RME) scenario, which is defined by the U.S. EPA as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site[5]. RME factors for hypothetical students and staff were based on guidelines presented in the California Environmental Protection Agency (Cal-EPA), Office of Environmental Health Hazard Assessment (OEHHA), *Guidance for Assessment of Exposures and Health Risks at Existing and Proposed School Sites* (Guidance) and the *School Risk Screening Model* (SCHOOLSCREEN Version 1.01). Exposure factors for students are unique in that factors such as body weight are adjusted by a student's age while in school. As a conservative measure, students were assumed to attend the charter school at the site from grades kindergarten through 6th or between the ages of 5 and 11 years. Exposure factors for students and staff are summarized in Table A-1.

RISK-BASED SCREENING LEVEL CALCULATIONS

The methodologies used to calculate RBSLs in indoor air and soil gas are presented below.

<u>Indoor Air</u>

U.S. EPA and Cal-EPA have defined an "acceptable" cancer risk range to be from 1 in 1,000,000 ($1{\times}10^{-6}$) to 1 in 1,000 ($1{\times}10^{-4}$). The Clean Air Act mandates that the incremental excess lifetime cancer risk associated with exposure to constituents in ambient air be limited to a range of $1{\times}10^{-6}$ to $1{\times}10^{-4}$. A theoretical excess lifetime cancer risk less than $1{\times}10^{-6}$ is deemed *de minimus* or the *point of departure* and warrants no further action. The risk is an *excess* risk on top of an individual's risk from other sources such as genetic predisposition or life style. The equivalent *point of departure* based on noncarcinogenic effects is a target hazard quotient (HQ) of 1.0. In general, RBSLs based on carcinogenic risks are typically lower (more protective) than those based on noncarcinogenic effects. In this evaluation, every VOC classified by U.S. EPA

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5 U.S. EPA, 1989, Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final, Office of Emergency and Remedial Response, Washington,

or Cal-EPA as carcinogens was evaluated based on both carcinogenic and noncarcinogenic end points and the lower value was used for the target indoor air RBC. Because TPHms is not classified by U.S. EPA and Cal EPA as a carcinogen, the acceptable target concentrations in indoor air were calculated using the recommended inhalation reference dose[6] and a target hazard quotient of 1.0.

AMEC calculated target indoor air RBSLs based on a carcinogenic risk endpoint using the recommended inhalation cancer slope factors and a target risk level of 1×10^{-6} and the following equation:

$$C_{ia} = \frac{TR_c \times \mathrm{BW} \times AT_c}{INH \times \mathrm{ET} \times EF \times ED \times CSF \times \mathrm{CF}}$$

Where:

Cia = target concentration in indoor air (µg/m^3)
TR_c = acceptable target risk level ($1\text{x}10^{-6}$)
BW = body weight (kilograms)
AT_c = averaging time for carcinogens (70 years x 365 days/year) = 25,550 days
INH = inhalation rate indoors (m^3/hour)
ET = Exposure Time indoors (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CSF = Cancer slope factor based on inhalation (mg/kg-day)$^{-1}$
CF = conversion factor from mg to µg

AMEC also calculated target indoor air RBSLs based on noncarcinogenic hazards using the inhalation reference dose and a target hazard quotient level of 1.0 based on the following equation:

$$C_{ia} = \frac{TR_{nc} \times \mathrm{BW} \times AT_{nc}}{INH \times \mathrm{ET} \times EF \times ED \times (1/RfDi) \times CF}$$

6 Target concentrations in indoor air were previously calculated by using a Reference Concentration (RfC) for TPHms. In this addendum, the inhalation reference dose (RfDi) was used to allow for inhalation rates and exposure times that are appropriate for students and staff.

Where:

> Cia = target concentration in indoor air (µg/m^3)
> TR_{nc} = acceptable target level (1.0)
> BW = body weight (kilograms)
> AT_c = averaging time for carcinogens (ED x 365 days/year)
> INH = inhalation rate indoors (m^3/hour)
> ET = Exposure Time indoors (hours/day)
> EF = Exposure frequency (days/year)
> ED = Exposure duration (years)
> RfDi = Noncancer Reference Dose based on inhalation (mg/kg-day)
> CF = conversion factor from mg to µg

Summaries of the indoor air RBSLs for a student and staff are presented in Tables A-2.

<u>Soil Gas</u>

Soil gas RBSLs were calculated for each VOC based on the target indoor air concentrations and an attenuation factor. Vapors in the subsurface are confined to the dry void space between soil particles. When vapors migrate from this confined space to the relatively open and ventilated indoor environment, the vapor is significantly diluted. This dilution process is described by an attenuation factor, which represents the ratio of concentrations between indoor air and crawl space or soil vapor as follows:

$$\alpha = {C_{ia}} / {C_{sv}}$$

Where:

> α = attenuation factor from crawl space or soil vapor to indoor air (unitless)
> Cia = constituent concentration in indoor air (µg/m^3)
> Csv = constituent concentration in soil vapor at sampling point (µg/m^3)

Rearranging the equation, a target concentration in crawl space or soil vapor can be calculated based on the estimated attenuation factor and acceptable target concentrations in indoor air.

$$C_{sv} = {C_{ia}} / {\alpha}$$

The attenuation factor depends on site-specific parameters such as soil properties, building foundation type, pressure differential inside the building and the subsurface, indoor air exchange rates, and constituent specific properties. Attenuation factors are predicted using the Johnson & Ettinger (J&E) vapor intrusion model[7]. The model accounts for the diffusion of constituents through the subsurface, the advection of constituents through soil and concrete slabs due to pressure differentials between the soil and buildings, and the mixing in indoor air caused by heating and ventilation systems.

Building structural properties were consistent with the current commercial/industrial building (without engineered fill) scenario[8]. The estimated attenuation factor is based in part upon an air exchange rate of 1.0 exchanges per hour, which is significantly lower than the default air exchange rate of 4.7 exchanges per hour that OEHHA has recommended for buildings at school sites.

<u>Mineral Spirits Risk-Based Screening Levels</u>

The RBSLs for TPHms were determined for staff and student exposure to indoor air and vapor intrusion from soil gas. The RBSLs for students are 571 μg/m^3 and 488,000 μg/m^3 for indoor air and soil gas, respectively. The RBSLs for staff are 522 μg/m^3 and 446,000 μg/m^3 for indoor air and soil gas, respectively.

TPHms was not detected in indoor air or soil gas at the site. It should be noted that although the laboratory reporting limit of 3,000 μg/m^3 is higher than the indoor air RBSLs of 522 μg/m^3 and 571 μg/m^3, there is no direct evidence that TPHms is a potential concern in indoor air because TPHms was not detected in soil gas at reporting limits (2,600 μg/m^3) well below the RBSLs (446,000 μg/m^3 and 488,000 μg/m^3).

UNCERTAINTIES

A variety of factors contribute uncertainty to the calculation of the RBSLs. Some of these uncertainties are described in this section; as explained below, whenever there is uncertainty, the highest possible exposure frequency or duration is assumed. As a result, uncertainty leads to more conservative (lower) RBSLs than may be necessary or appropriate.

The J&E Model used to estimate the RBSLs in soil vapor are based on an assumed infinite source directly beneath the building foundation. The calculation does not take into account the actual mass of the constituent that is present in the vadose zone. The concentrations and mass in soil vapor are expected to decrease over time. This would lead to a decreasing potential for

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7 U.S. EPA, 2004b, *User's Guide for the Johnson and Ettinger* (1991) *Model for Subsurface Vapor Intrusion Into Buildings* (Revised), Office of Emergency and Remedial Response, December.

8 Office of Environmental Health Hazard Assessment (OEHHA), 2005a, Guidance for Assess of Exposures and Health Risks at Existing and Proposed School Site, February 15.

impacts to indoor air. The amount of vapors remaining in the soil vadose zone will likely run out well before the exposure duration being considered is reached (i.e., 40 years).

For a more comprehensive and realistic evaluation of average, long-term impacts to indoor air, it would be appropriate to consider the total mass of volatile constituents present and calculate a "mass-balanced" long-term vapor emission rate from the subsurface. The proposed soil vapor RBSLs are therefore conservative estimates for the evaluation of potential long-term impacts to indoor air.

In addition, the RBSLs are based on highly conservative exposure assumptions; assumptions where students or staff are present in a building for the entire exposure frequency and duration of 7.5 hours per day for 233 days per school year. In reality, the buildings at the site are likely used by students and staff for a few hours on a rotating basis. Site-specific information regarding detailed activity patterns for the buildings may be used to refine the RBSLs.

CONCLUSIONS

In summary, there is no apparent unacceptable risk posed by vapor intrusion given concentrations of TPHms and other VOCs reported in soil gas. In addition, based on a possible use of the site as a charter school, the concentrations of chemicals in soil gas are below their respective school-specific RBSLs indicating that the chemicals do not pose human health concerns under the conditions evaluated.

If you have any questions or require additional information, please do not hesitate to call.

Sincerely yours,
AMEC Geomatrix, Inc.

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Attachments: Table A-1 – Analytical Results for Soil Gas Samples
Table A-2 – Soil Characteristics Properties