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LEVINE•FRICKE
ENGINEERS, HYDROGEOLOGISTS & APPLIED SCIENTISTS

September 14, 1994 LF 1649.36

Ms. Susan Hugo
Alameda County Health Care Agency
1131 Harbor Bay Parkway, Second Floor
Alameda, California 94502

Subject: Transmittal of the Evaluation of the Potential Toxicity of Residual TPH Concentrations in Soil at Area C of the Yerba Buena/East Baybridge Project Site

Dear Susan:

On behalf of Catellus Development, Levine•Fricke is submitting the evaluation of the potential toxicity of residual total petroleum hydrocarbons concentrations in soil at Area C of the Yerba Buena/East Baybridge Project Site. This evaluation was performed by SOMA Environmental Engineering, Inc. at the request of the Alameda County Health Care Agency.

If you have any questions or comments regarding this letter or the attached letter, please call me or Ms. Kimberly Brandt at Catellus Development (415) 974-4500.

Sincerely,

Ron Goloubow
Senior Project Geologist

enclosure

cc: Mr. Sumadhu Arigala - Regional Water Quality Control Board
Ms. Kimberly Brandt - Catellus Development
Mr. Ravi Arulanantham PhD. CHMM - Regional Water Quality Control Board
Mr. John Faustini - SOMA Environmental Engineering, Inc.

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94-2050

August 30, 1994

Mr. Ron Goloubow
Levine•Fricke, Inc.
1900 Powell Street, 12th Floor
Emeryville, California 94608

Subject: Evaluation of the Potential Toxicity of Residual TPH Concentrations in Soil, Yerba Buena Project Site, Area C, Emeryville and Oakland, California

Dear Ron:

SOMA Environmental Engineering, Inc. is pleased to submit our report titled "Evaluation of the Potential Toxicity of Residual TPH Concentrations in Soil, Yerba Buena Project Site, Area C, Emeryville and Oakland, California." The report presents the results of our evaluation of potential health risks associated with residual TPH contamination in soil in Area C of the Yerba Buena Project Site in Emeryville and Oakland, California. This work was performed at your request in accordance with our proposal dated July 13, 1994.

After reviewing the site data and literature on TPH toxicity studies, we decided a quantitative evaluation of risks due to heavy fraction TPH would be the most appropriate response to the concerns expressed by Susan Hugo at ACDEH with respect to residual TPH contamination in soil. Our evaluation considered the potential health effects resulting from TPH exposure for on-site construction workers, the only population for which a significant exposure pathway exists. The evaluation concluded that residual TPH concentrations reported in Area C soils would not be expected to produce adverse health effects in on-site construction workers.

If you have any questions or comments regarding this report or our evaluation, please call me or Dr. Mansour Sepehr at (510) 832-7662.

Sincerely,

John M. Faustini

John M. Faustini, R.G.
Senior Associate Hydrogeologist

enclosure

cc: Kim Brandt, Catellus Development Corp.

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EVALUATION OF THE POTENTIAL TOXICITY OF RESIDUAL TPH CONCENTRATIONS IN SOIL

YERBA BUENA PROJECT SITE, AREA C
EMERYVILLE AND OAKLAND, CALIFORNIA

Previous investigation results for Area C of the Yerba Buena site indicated that localized areas of soil were affected by total petroleum hydrocarbons (TPH), primarily oil and grease (Levine-Fricke, 1994). In addition, some TPH as diesel (TPHd) and TPH as gasoline (TPHg) were also detected with low to non-detected levels of VOCs (benzene, toluene, ethylbenzene, and xylene (BTEX)). Large areas of affected soil were excavated and removed from the site. TPH cleanup goals established for the Yerba Buena site were as follows:

- Less than 100 ppm TPHd
- Less than 1000 ppm TPH as oil and grease
- Less than 10 ppm TPHg

Very localized areas of TPH-affected soil were left in place (i.e., in the vicinity of Phase I sampling location C-19) and will be managed by containment beneath a low permeability cap to reduce surface water infiltration.

Once the residual TPH is covered by asphalt or concrete, there is no potential for exposure, and consequently, no potential for adverse health impacts. However, during the development of the property and subsequent construction activities, on-site construction workers could be exposed to TPH in soil. The following section presents a risk evaluation for construction workers assumed to be exposed to TPH in soil.

Previously, in the risk assessment for Area C (SOMA Environmental Engineering, Inc., 1994), the most toxic constituents of TPHd and TPHg were evaluated. Specifically, exposure to benzene, toluene, ethylbenzene, and xylene was evaluated. Benzene is a known human carcinogen, and such it has a published cancer slope factor. Toluene, ethylbenzene, and xylene each have published chronic reference doses (RfDs). Excluding these VOC components, TPH has no published health criteria (i.e., cancer slope factors or reference doses). Typically, TPH in soil is only addressed qualitatively as there are no health based criteria for comparison.

Since the majority of TPH left in place is oil/grease, and since the VOC components of TPHd and TPHg have previously been evaluated, this assessment will focus on potential exposures to the "heavy fraction" of TPH in soil. Exposures will be evaluated for incidental ingestion of soil and dermal contact with soil. Although inhalation of particulates containing TPH is possible,

this route of exposure would be insignificant compared to ingestion and dermal contact. Further, there is no evidence to suggest that oil/grease would be toxic via inhalation and extrapolation of the oral or dermal RfD to this route would involve far too much uncertainty.

In order to develop provisional reference doses for oil/grease, animal studies involving dosing with crude oil were conservatively used. It should be noted that oil and grease as found in soil at Yerba Buena is a refined petroleum product, and as such would be even less toxic than the crude oil source used to develop the health criteria used in this evaluation. In order to develop a dermal reference dose, the dermal application study entitled "28-Day Subchronic Dermal Toxicity Study in Rats", conducted for the American Petroleum Institute, was used (API, 1985). In this study, experimental animals were exposed to crude oil 5 days/week for 28 days. The animals were exposed to 0.25 g/kg or 2.5 g/kg of crude oil. A control group was also included. Clinical chemistry determinations were performed during the course of the experiment, and major organ tissues were analyzed for gross and microscopic pathology.

Since the highest dose administered in this study, 2.5 g/kg, did not produce toxicity, this dose level was used a no observed adverse effect level (NOAEL). To account for the uncertainty in extrapolating from this subchronic study to a chronic study, an uncertainty factor of 10 was applied. Another 100-fold uncertainty factor was applied to account for the uncertainties in extrapolating from animal data to human effects and differences in sensitivity in the human population. Dividing the NOAEL by a total uncertainty factor of 1000 results in an acceptable daily intake (ADI) or reference dose for the dermal route of exposure equal to 2.5 mg/kg/day.

In order to develop an oral ADI, the systemic toxicity study of Prudhoe Bay Crude Oil (PBCO) on mice was used (Leighton 1990). This was a subacute study in which doses of crude oil ranging from 0 ml/kg to 16 ml/kg were administered to mice by gavage on a daily basis for a period of five days. Following necropsy, the liver, spleen and thymus organs were removed and weighed. Also, tissue ultrastructure was observed.

The lowest dose of PBCO administered was 2 ml/kg/day. This group exhibited a decreased thymus weight/body weight as compared to the control mice. The study found a strong dose-response relationship with the dose of PBCO administered. Ultrastructurally, thymus glands from mice in the 10 ml/kg/day groups had very thin cortices and reduced densities of lymphocytes in the remaining cortex compared to controls. The histological morphology of thymus glands from mice that received 5 ml/kg/day was intermediate between that of the 10 ml/kg/day group and that of the control group.

The minor toxic effect at the 2 ml/kg/day dosage suggests that this is an appropriate level for a lowest observed adverse effect level. Again, uncertainty factors are used for the extrapolation to an acceptable daily intake level. Specifically, safety factors of 10 are used to account for the uncertainty in extrapolating from a subacute study to a subchronic study, from a subchronic study to a chronic study, from an animal species to humans, and from a LOAEL to a NOAEL.

An additional factor of 10 is applied to account for the variability in human sensitivity. The cumulative uncertainty factor is thus 100,000. Dividing the 2 ml/kg/day LOAEL level by the uncertainty factor of 100,000 results in an ADI level of 2.0×10^{-2} μl/kg/day. To obtain an ADI in mg/kg/day it is necessary to multiply the volume by the specific gravity of crude oil (0.83 gm/ml). This produces an ADI of 1.66×10^{-2} mg/kg/day.

Hypothetical Worker Scenario

This scenario assumes that a construction worker is exposed to TPH-contaminated soil through incidental ingestion and dermal contact with soil. The exposure scenario will use standard default exposure parameters for a typical industrial/commercial receptor, as found in the USEPA Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors", OSWER Directive 9285.6-03, 25 March 1991.

Chemical uptakes were defined as follows:

$$Uptake_{oral} = \frac{[SOIL] \times IR \times CF \times BF \times EF \times ED}{BW \times AT}$$

Where

[SOIL] = Concentration of TPH, mg/kg

IR = Soil ingestion rate, 50 mg/day

CF = Conversion factor, 1×10^{-6} kg_{soil}/mg_{soil}

BF = Bioavailability factor, assumed to be 100%

EF = Exposure frequency, 250 days/year

ED = Exposure duration, 25 years

BW = Body Weight, 70 kg

AT = Averaging time, ED x 365 days/year

$$Uptake_{dermal} = \frac{[SOIL] \times SL \times SA \times BF \times EF \times ED}{BW \times AT}$$

Where

[SOIL] = Concentration of TPH in soil, mg/kg

SL = Skin loading rate of soil, 1 x 10^{-6} kg/cm^2-day

SA = Exposed skin surface are, 5800 cm^2

BF = Bioavailability factor, assumed to be 100%

EF = Exposure frequency, 250 days/year

ED = Exposure duration, 25 years

BW = Body weight, 70 kg

AT = Averaging time, ED x 265 days/year

Then

$Uptake_{oral}$ = 4.89 x 10^{-7} [SOIL], and

$Uptake_{dermal}$ = 5.68 x 10^{-5} [SOIL]

In order to estimate the potential noncarcinogenic health effects associated with exposure to TPH in soil, the Hazard Index (HI) approach was used, where:

$$HI = \frac{Uptake\ TPH_{oral}}{ADI_{oral}} + \frac{Uptake\ TPH_{dermal}}{ADI_{dermal}}$$

An HI less than or equal to 1 indicates that no adverse health affects would be expected from the combined lifetime dermal and oral exposure to crude oil. By setting the HI equal to 1 and solving for [SOIL], the maximum TPH concentration in soil that conservatively would not be expected to result in adverse health effects can be calculated:

$$HI = 1.0 = \frac{4.89 \times 10^{-7}[SOIL]}{1.66 \times 10^{-2} mg/kg/day} + \frac{5.68 \times 10^{-5}[SOIL]}{2.5 mg/kg/day}$$

[SOIL] = 19,165 mg/kg

= 19,165 ppm

Based on a typical outdoor worker scenario, the maximum concentration of TPH in soil that would not be expected to result in adverse health effects would be 19,165 ppm, indicating that oil/grease or the "heavy fraction" of TPHd is of a low order of toxicity. This threshold concentration is higher than any of the residual TPH concentrations in soil which have been reported in Area C. Therefore, any localized areas of TPH in soil exceeding the cleanup levels would not be expected to produce adverse health effects in outdoor workers during construction activities.

REFERENCES

American Petroleum Institute (API), 1985. 28-Day Subchronic Dermal Toxicity Study in Rats. API Med. Res. Publ.:32-32652, August 1985.

Leighton, F.A., 1990. The systemic toxicity of Prudhoe Bay Crude and other petroleum oils to CD-1 mice. Arch. Environ. Contam. Toxicol., 19(2):257-62.

Levine-Fricke, 1994. Summary of Environmental Investigation Results for Area C of the Yerba Buena Project Site, Emeryville and Oakland, California, March 9, 1994.