



Characterization and Reuse of Petroleum Hydrocarbon Impacted Soil

INTRODUCTION

This guidance relates to the on-site reuse of non-hazardous petroleum hydrocarbon impacted soil on the same contiguous property (assessor's parcel) where it was generated. This guidance does not apply to hazardous waste, nor does it apply to the off-site reuse or disposal of soil, or the import of soil for construction or other uses. Soil proposed for reuse must be approved by San Mateo County Environmental Health Services staff prior to placement.

The standards applied in this guidance are designed to meet risk-based screening levels for residential (or potential future residential) land use, as presented in the San Francisco Bay Regional Water Quality Control Board (RWQCB) *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, February 2005*. The standards are also intended to demonstrate that the soil is inert, as defined in Title 27, Section 20230 of the California Code of Regulations with respect to the water quality objectives set forth in the RWQCB Water Quality Control Plan. It is also designed to be consistent with the RWQCB Draft – December 2005 *Characterization and Reuse of Petroleum Hydrocarbon Impacted Soil as Inert Waste*.

For the purposes of this guidance, petroleum hydrocarbon impacted soil is defined as soil impacted with gasolines and middle distillates, including diesel, kerosene, and jet fuel, collectively referred to as "diesel". Inert waste is defined as "a subset of solid waste that does not contain hazardous waste or soluble pollutants at concentrations in excess of applicable water quality objectives and does not contain significant quantities of decomposable waste". This guidance does not apply to hazardous waste, nor does it apply to the off-site reuse or disposal of soil, or the import of soil for construction or other uses. This guidance is also not intended to address reuse of soils impacted with heavier petroleum products (e.g., fuel oil Nos. 4, 5, and 6, lubricating oils, motor oil, etc.) or any other contaminant. Used motor oil, hydraulic fluids and other common types of heavy petroleum products/wastes may contain significant amounts of polynuclear aromatic hydrocarbons (PAHs), heavy metals, polychlorinated biphenyls (PCBs), chlorinated solvents, pesticides, volatile organic compounds (VOCs) and other potentially harmful chemicals. Evaluation of soil impacted with heavy petroleum hydrocarbons and other contaminants (especially those that may be construed as



RCRA Listed Wastes) for reuse should be based on a more complete assessment of potential constituents and exposure concerns.

This guidance is not intended to supersede any site-specific decisions regarding cleanup, cleanup standards, or reuse of excavated soil in areas undergoing cleanup pursuant to an approved remedial action plan.

SITE CONDITIONS

The proposed reuse location must meet the following conditions to the extent practicable. In all cases, the discharger must demonstrate that the reuse location (both laterally and vertically) is protective of beneficial uses of waters of the State in a manner consistent with Title 27.

1. **Separation from Groundwater:** The petroleum hydrocarbon impacted soil must be placed at least 5 feet above the highest anticipated elevation of groundwater.
2. **Separation from Surface Water:** The petroleum hydrocarbon impacted soil must be placed at least 100 feet from the nearest surface water body.
3. **Flood Plain Protection:** The petroleum hydrocarbon impacted soil must be protected against 100-year peak stream flows as defined by the County flood control agency.
4. **Cover and Erosion Protection:** The petroleum hydrocarbon impacted soil must be buried at least three feet beneath the surface grade. It shall also be capped with erosion-resistant materials such as compacted soil, rock, asphalt, concrete, etc. The petroleum hydrocarbon impacted soil must be protected from erosion and exposure at the ground surface for as long as it remains in place and has detectable concentrations of petroleum hydrocarbons.
5. **Property Owner Acknowledgement:** By written correspondence to County Environmental Health Services staff, the owner of the property where the petroleum hydrocarbon impacted soil is proposed for reuse must acknowledge their acceptance of the placement of the petroleum hydrocarbon impacted soil and any maintenance required to comply with the above conditions. The property owner must also acknowledge that potential buyers of the property will be notified, and that County Environmental Health Services will also be notified prior to any change in ownership of the property.

SAMPLING AND CHARACTERIZATION

All stockpiled soil to be reused must be characterized in accordance with the methodology set forth in the most recently promulgated edition of "Test Methods for



SAN MATEO COUNTY HEALTH
**ENVIRONMENTAL
HEALTH SERVICES**

**Environmental Health Services
Groundwater Protection Program**

2000 Alameda de las Pulgas, Suite #100
San Mateo, CA 94403
Phone: (650) 372-6200 | Fax: (650) 627-8244
smchealth.org/gpp

Evaluation Solid Waste, Physical/Chemical Methods,
SW-846", U.S. Environmental Protection Agency (EPA SW-846).

Sampling Frequency

Procedures in EPA SW-846 provide a method for determining the mean concentration of a given constituent within a soil mass and the appropriate number of samples necessary to calculate this mean to within a specified confidence level. Initial sampling should generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels specified in EPA SW-846, therefore, archiving of samples may be appropriate. Archived samples must be appropriately preserved and analyzed within maximum holding times.

The minimum number of discrete (not composited) samples necessary to adequately characterize the petroleum hydrocarbon impacted soil should be determined in accordance with the statistical procedure in EPA SW-846. The following schedule can be used to estimate the minimum number of samples necessary to meet the statistical requirements in EPA SW-846, in most cases. If the number of samples analyzed is fewer than indicated in the following schedule, then the statistical basis for the deviation must be appropriately justified for review by Environmental Health Services staff.

- Stockpiles less than 500 cubic yards (cy): One sample every 25 cy (e.g., 20 samples for a 500 cy stockpile).
- Stockpiles from 500 to 1,000 cy: Twenty (20) samples plus one sample for every 100 cy in excess of the initial 500 cy (e.g., 25 samples for a 1,000 cy stockpile).



- Stockpiles from 1,000 to 10,000 cy: Twenty-five (25) samples plus one sample for every 500 cy in excess of the initial 1,000 cy (e.g., 43 samples for a 10,000 cy stockpile).
- Stockpiles greater than 10,000 cy: Forty-three (43) samples plus one sample for every 5,000 cy in excess of the initial 10,000 cy (e.g., 61 samples for a 100,000 cy stockpile).

Discrete vs. Composite Sampling

The statistical method in EPA SW-846 assumes that contaminants are heterogeneously distributed within the soil mass and that hotspots exist and are of concern. Composite sampling is not well suited for identifying hotspots because of the “dilution” or “averaging” effect of mixing samples to create a single composite. Furthermore, composite sampling is not appropriate when sampling for volatile organic compounds, due to the losses inherent in the composite mixing process. In addition, the statistical method in EPA SW-846 requires a reasonably accurate measure of sample variability in order to estimate a reasonably accurate confidence interval about the mean for each constituent in the soil mass. Variability between composite sample results tends to be muted due to the averaging effect of the mixing process, which generally leads to a falsely narrow confidence interval about the mean. It is the upper limit of the confidence interval that is compared to the regulatory limit to determine if a sufficient number of samples have been analyzed to identify hotspots and capture the true range of constituent concentrations. Therefore, composite sampling is not appropriate and discrete sampling is required.

Sample Location/Distribution

Sample locations/distribution within the soil mass should be random, uniform, or biased toward hotspot areas, based on professional judgment and field screening indications. The methods for determining sample locations (e.g., random x,y,z coordinates), with appropriate justification of method selection, must be submitted to County Environmental Health Services for approval prior to the sampling. Simply sampling soil approximately 6 inches beneath the surface of the stockpile **is not** appropriate.

Analyses

A two-tiered evaluation may be required to determine if soil is suitable for reuse under this guidance. Therefore, two types of analyses may be required. The Tier 1 analyses consist of determining the total concentrations of contaminants in the soil. The Tier 2 analyses consist of determining the leachable concentrations of contaminants from the soil.



Tier 1 Analyses:

Gasoline (C6 – C12)

Soils impacted with gasoline should be analyzed for total petroleum hydrocarbons (TPH) as gasoline through the carbon range C6 through C12, as well as benzene, toluene, ethylbenzene, total xylenes (BTEX), methyl-tertiary butyl ether (MtBE) (and other fuel oxygenates as required on a case-by-case basis). TPH soil sample results from the Tier 1 analyses should be ranked from highest concentration to lowest concentration for comparison to regulatory criteria. Minimum laboratory reporting limit should be conducive to the use of the data.

Middle Distillates (C9 – C25)

Soils impacted with middle distillate petroleum fuels should be analyzed for TPH through the carbon range C9 through C25, as well as BTEX and naphthalene. Analyses for MtBE and other fuel oxygenates may be required on a case-by-case basis. TPH soil sample results from the Tier 1 analyses should be ranked from highest concentration to lowest concentration for comparison to regulatory criteria. Minimum laboratory reporting limit should be conducive to the use of the data.

Tier 2 Analyses:

Gasoline (C6 – C12)

TPH soil sample results from the Tier 1 analyses should be ranked from highest concentration to lowest concentration. The highest 25% of samples for TPH (minimum of four samples) should be extracted using the Synthetic Precipitation Leaching Procedure (SPLP). Procedures for the SPLP are described in EPA SW-846 (EPA Method 1312). The SPLP extract should be analyzed for TPH as gasoline through the carbon range C6 through C12, as well as BTEX, MtBE (and other fuel oxygenates as required on a case-by-case basis). Minimum laboratory reporting limit should be conducive to the use of the data.

Middle Distillates (C9 – C25)

TPH soil sample results from the Tier 1 analyses should be ranked from highest concentration to lowest concentration. The highest 25% of samples for TPH (minimum of four samples) should be extracted using the SPLP. The SPLP extract should be analyzed for TPH through the carbon range C9 through C25, as well as BTEX and naphthalene. Analyses for MtBE and other fuel oxygenates may be required on a case-by-case basis. Minimum laboratory reporting limit should be conducive to the use of the data.



EVALUATION CRITERIA AND REGULATORY LIMITS

There are three types of regulatory limits applicable to the reuse of petroleum hydrocarbon impacted soil. These include 1) the Not-to-Exceed soil concentration limits, 2) the Tier 1 soil concentration limits, and 3) the Tier 2 leachate concentration limits. The Not-to-Exceed and Tier 1 soil limits are listed in Table 1 and the Tier 2 leachate limits are listed in Table 2.

Tier 1 not-to-exceed limits must be compared to individual stockpile sample results for each constituent. Not-to-exceed limits are based the lowest screening level protective of direct exposure (the lower of either carcinogenic at 1×10^{-6} excess risk or hazard index of 0.2 [0.5 for TPH]) or vapor intrusion concerns for residential land use as presented in Table A-1 of the RWQCB, *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, February 2005*. Tier 1 soil concentration limits may be compared to the 95% upper confidence limit (UCL) of the mean calculated from the stockpile sample data for each constituent. Soil concentration limits are based on soil leaching screening levels for a drinking water resource, as presented in Table G of the RWQCB February 2005 screening levels document. Tier 2 leachate concentration limits are based on the lowest water quality objective that is protective of nuisance odors, human health, or aquatic life, as presented in the RWQCB February 2005 screening levels document.

Computing the 95% UCL of the Mean

After an appropriate number of samples have been collected from the stockpiled soil, the 95% UCL of the mean can be determined for each constituent of concern. If a data set is not normally distributed, it must be appropriately transformed. Guidance on determining the 95% UCL of the mean can be found in EPA SW-846 and in the EPA publication *Supplemental Guidance to RAGS: Calculating the Concentration Term*, as presented in [Risk Assessment Guidance for Superfund \(RAGS\) Volume 1, Human Health Evaluation Manual](#), publication 9285.7, May 1992.

Evaluation Process

The evaluation process is graphically represented in figure 1 below.



After ranking the soil analytical concentration results from highest to lowest, if the highest concentration for each constituent does not exceed the Tier 1 soil concentration limits, as presented in Table 1 below, then no further evaluation is necessary, and the soil is suitable for reuse in accordance with this guidance. If any constituent concentration exceeds the Tier 1 not-to-exceed limits, as presented in Table 1 below, then the soil is **not** suitable for reuse without further remedial action. Further remedial action may entail actions such as further segregation of soil or soil treatment (to be followed by further confirmation sampling and data evaluation).

If based on the above evaluation, no constituent concentration exceeds the not-to-exceed limits, but at least one constituent concentration does exceed the Tier 1 soil concentration limits, then the 95% upper confidence limit (UCL) of the mean, as computed from the soil characterization data for each constituent, can be used for comparison to the Tier 1 soil concentration limit for each constituent. If the 95% UCL of the mean of the soil data does not exceed the Tier 1 soil concentration limits for any constituents, then the soil is suitable for reuse in accordance with this guidance.

If the 95% UCL of the mean of the soil data does exceed the Tier 1 soil concentration limits for any constituents (but is less than the not-to-exceed limits), then the Tier 2 leachability analyses must be performed. If the 95% UCL of the mean of the leachate concentrations for any constituent exceeds the Tier 2 leachate limits listed in Table 2 below, then the soil is **not** suitable for reuse without further remedial action and re-evaluation.

Figure 1: Evaluation Process for Reuse of Non-Hazardous, Petroleum Hydrocarbon Impacted Soil

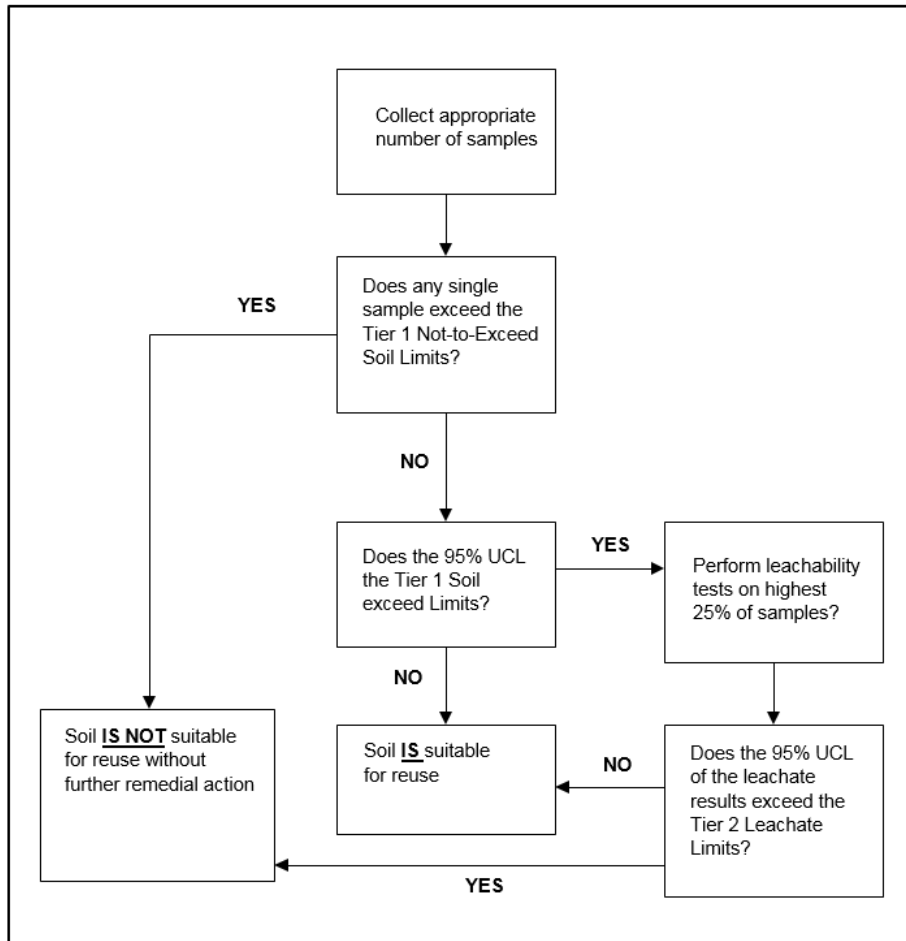


Table 1: Tier 1 Concentration Limits for Gasoline and Diesel¹ in Soil

Contaminant	Constituent of Concern	Soil Concentration Limits (mg/kg)	Not-to-Exceed Limits (mg/kg)
Gasoline	TPH-Gasoline	100	400
Diesel	TPH-Diesel	100	400
Gasoline/Diesel	Benzene	0.044	0.18
Gasoline/Diesel	Toluene	2.9	100
Gasoline/Diesel	Ethylbenzene	3.3	390
Gasoline/Diesel	Xylenes	2.3	310
Gasoline	MtBE ²	0.023	2
Gasoline	TBA	0.073	57
Diesel	Naphthalene	0.46	1.5

Table 2: Tier 2 Leachate (SPLP) Concentration Limits for Gasoline and Diesel¹ in Soil



Contaminant	Constituent of Concern	Leachate Concentration Limits (µg/l)
Gasoline	TPH-Gasoline	100
Diesel	TPH-Diesel	100
Gasoline/Diesel	Benzene	1.0
Gasoline/Diesel	Toluene	40
Gasoline/Diesel	Ethylbenzene	30
Gasoline/Diesel	Xylenes	20
Gasoline	MtBE ²	5
Gasoline	TBA	12
Diesel	Naphthalene	17

WORK PLAN AND REPORTING REQUIREMENTS

For all sites in San Mateo County where soil reuse is proposed, a technical work plan containing the compliance information summarized below must be submitted to County Environmental Health Services staff for review and approval before any soil is reused. If the site is a corrective action case under County GPP oversight, the work plan must be uploaded to Geotracker, along with any other relevant electronic data reports (analytical data, survey data, geomap files, etc.), in compliance with SWRCB (Geotracker) requirements.

¹ Includes comparable middle distillates (C9 – C25) including diesel, kerosene, jet fuel, etc.

² Testing for other fuel oxygenates may be required on a case-by-case basis.

The work plan must include the following.

- Source of the petroleum hydrocarbon impacted soil (e.g., gas station, farm tank, etc.).
- An estimate of the volume of impacted soil (including measurements and calculations)
- A description of the contaminant(s).
- A description of the proposed sampling methodology, proposed sample locations and proposed sample selection process.
- A scaled map detailing the stockpile and proposed sample locations.



Once the work plan has been approved and the sampling has been conducted, the following information must be submitted for approval before any soil is reused.

- Any changes to the approved scope of work or sample locations with appropriate explanation/justification.
- All sample laboratory analytical results, chain-of-custody documents, and QA/QC supporting data.
- A summary table of the laboratory results for the stockpile sampling.
- All statistical calculations.
- A tabular comparison of the statistical results for each constituent for each stockpile to the Table 1 and Table 2 regulatory limits.
- Description and map of the site and proposed soil reuse location(s) (proposed area and depth of placement).
- A statement, signed by the discharger/responsible party and a registered professional³, certifying compliance with the restrictions, site conditions, sampling and analysis, and evaluation criteria described in this guidance.
- A statement signed by the property owner acknowledging the reuse of the impacted soil on the property and responsibility for maintaining compliance with the conditions of this guidance.

If, based on the information submitted, the reuse is approved by Environmental Health Services, County staff will issue a letter approving implementation of the soil reuse. After implementation of the approved reuse, a letter must be submitted to Environmental Health Services by the registered professional in charge of the work certifying that the soil was reused in accordance with the approved scope of work.

³ California Professional Geologist or Civil Engineer.