



**New Jersey Department of Environmental Protection  
Site Remediation Program**

**Health Based and Ecological Screening Criteria for Petroleum Hydrocarbons  
Frequently Asked Questions**

**(Version 4.0, August 9, 2010)**

**DERIVATION OF REMEDIATION CRITERIA/SCREENING LEVELS**

- 1. Question: How were the extractable petroleum hydrocarbon (EPH) criteria of 5,100 mg EPH/kg for the residential exposure scenario and the 54,000 mg EPH/kg for the non-residential exposure scenario derived for number 2 (No. 2) fuel oil and diesel fuel oil?**

Answer: The 5,100 mg EPH/kg residential exposure scenario and 54,000 mg EPH/kg non-residential exposure scenario criteria are based on protection from noncarcinogenic health effects at a hazard index of 1 and only apply to discharges of No. 2 fuel oil and diesel fuel oil. These values are based solely on effects via the ingestion-dermal exposure pathway. Potential inhalation exposure pathway concerns are addressed by evaluating naphthalene, and potential impact to ground water exposure pathway concerns are addressed by evaluating 2-methylnaphthalene.

A field study (EPH-TPH Field Study) was conducted between July and August 2007 at various sites located throughout New Jersey (described in response to Question #2 below). The purpose of the field study was to determine a typical chemical composition of No. 2 fuel oil. Based on this average composition, the health-based criteria were developed.

The Site Remediation Program (SRP) decided to take the conceptual approach of Massachusetts and the Total Petroleum Hydrocarbon Working Group which evaluated No. 2 fuel oil and/or diesel fuel oil as a mixture of individual components, each with an assigned toxicity factor. The method used for the field study analyzed the samples as aliphatic and aromatic fractions, each with five equivalent carbon ranges. Representative toxicity factors were assigned to each of these analytical fractions. An average health-based criterion was then derived using standard USEPA residential and non-residential exposure scenarios and factors, by calculating a weighted average based on the composition and the assigned toxicity values, such that the hazard index does not exceed one (1). The originally calculated residential value was 4,800 mg/kg. This value has been further assessed based on new and additional information, and has been modified to the current value of 5,100 mg/kg.

- 2. Question: What are the specifics of the field study performed by the Department?**

Answer: The EPH-TPH Field Study was conducted between July and August 2007. Soil samples were collected from 14 different residential sites undergoing underground storage tank (UST) removal. The sites were located throughout New Jersey to ensure geographic and geologic variability. At each site one sample was collected near the underground storage tank in an area with free or residual product and one sample from the perimeter of the excavation. The perimeter sample was generally collected some distance away from the UST at a location with indications of contamination (odors and sheen) but no free product. All samples were analyzed using both USEPA Method 418.1 (TPH data) and the "Analysis of Extractable Petroleum Hydrocarbon Compounds (EPH) in Aqueous and Soil/Sediment/Sludge Matrices" ("NJDEP EPH Method"; EPH data).

Objectives of the EPH-TPH Field Study included empirically generating No. 2 fuel oil composition information; determining the ability of the NJDEP EPH Method to analyze actual soil samples contaminated with No. 2 fuel oil; determining whether the two methods (EPH and 418.1) yielded

comparable results; and determining whether there is a compositional difference between samples collected close to the point of discharge and those collected farther from the point of discharge.

To determine the comparability of Method 418.1 and NJDEP EPH Method, the SRP statistically evaluated the data pairs for all of the soil samples using linear regression. Based on this analysis, the SRP has concluded that the EPH and TPH data are comparable at a ratio of roughly 1:1 (regression coefficient ( $R^2$ ) of 0.8473). Therefore, Method 418.1 results can be directly applied to the findings that were derived using EPH data. Alternatively, findings based on Method 418.1 results can be extended to situations where EPH analyses are employed.

**3. Question: How was the 1,700 mg TPH/kg ecological screening level derived?**

Answer: The 1,700 mg TPH/kg ecological screening level was established following a literature search and a review of the pertinent documents. There are clear adverse effects on soil organisms above this TPH concentration. Below 1,700 mg/kg TPH, adverse effects to ecological receptors are possible but not likely and further ecological evaluation in most cases is not warranted. If data from contaminated site soil are above 1,700 mg/kg and a sensitive ecological receptor is potentially impacted, the soils shall be either remediated to 1,700 mg/kg or a site-specific risk-based ecological remediation goal shall be determined from more rigorous biological testing.

Note, the Department is referring to TPH because the documents reviewed which formed the basis of this screening criterion employed total petroleum hydrocarbon analytical methods. Based on the field study results comparing TPH and EPH, the Department is concluding that these methods produce equivalent results. As a result, the EPH values obtained using the new method will be considered to be the same as the TPH values in the historical literature.

**4. Question: For No. 2 fuel oil and diesel fuel oil soil contamination, why did the Department switch to limited base neutral (BN) compound testing from volatile organic (VO) compound testing when EPH contamination exceeds 1,000 mg/kg?**

Answer: The basis for this change is two-fold.

First, soil testing at homeowner No. 2 fuel oil cases has not detected VO compound concentrations above regulatory concern but has indicated that BN compound concentrations of regulatory concern might be present. The absence of VO compounds in No. 2 fuel oil is not entirely unexpected as they are present at relatively low levels in the pure product which has a relatively high boiling point range of 200 to 350 degrees Centigrade (note that gasoline has a boiling point range of 40 to 200 degrees Centigrade). The Total Petroleum Hydrocarbon Criteria Working Group (Volume 2, Composition of Petroleum Mixtures by T. Potter and K. Simmons, 1998) reports the following average levels of VO compounds for No. 2 fuel oil: Benzene (0.03%); Toluene (0.2%); Ethylbenzene (0.07%); Total Xylenes (0.5%), and 1,3,5-Trimethylbenzene (0.2%). Also, these low level VO compounds contaminants are subject to degradation once the discharge has occurred, potentially further reducing their presence.

Second, the BN compound analysis is needed to monitor on a contaminant-specific basis two known components of No. 2 fuel oil/diesel fuel oil: naphthalene and 2-methylnaphthalene. The reasons why the New Jersey Department of Environmental Protection (Department) is interested in these specific compounds are explained further under Questions and Responses #5 and #9. Therefore, the Department has limited the analysis of BN compounds to naphthalene and 2-methylnaphthalene for all No. 2 fuel oil/diesel fuel oil investigations. Additionally, this change has been promulgated in the Technical Requirements for Site Remediation (N.J.A.C. 7:26E) Table 2-1.

**5. Question: How is naphthalene, which has a low soil remediation standard, being addressed?**

Answer: The results of the EPH-TPH Field Study involving 14 residential No. 2 fuel oil discharges (described in response to Question #2 above) indicate that levels of regulatory concern for naphthalene (6 mg/kg for a residential exposure scenario) only were observed where the 5,100 mg/kg EPH criterion was exceeded, and therefore, where remediation would already be required. Consequently, a scan for naphthalene at 1,000 mg EPH/kg allows this contaminant to be evaluated on a compound-specific basis well before the EPH concentration at which the Department believes it becomes a real concern.

**6. Question: How will naphthalene be regulated? A recommendation was made that if naphthalene contamination above levels of regulatory concern (6 mg/kg for a residential exposure scenario) is present at 5 feet or more below grade and there is no adverse impact to ground water, an institutional control should not be required.**

Answer: The Department is required to evaluate whether changes in future use of the site or area of concern will lead to adverse risks to human health and the environment. While the contamination currently may not be a concern (because of its depth), that is true only if the status quo is maintained. If brought to the surface, the contamination would represent an adverse impact to human health and the environment. Consequently, an institutional control (i.e., deed notice) is needed to inform the public of the presence of the contamination as well as to assure that the contamination remains under its current circumstances and continues to not pose a hazard. Irrespectively, the Department does not at this time expect naphthalene to be a significant issue with regards to No. 2 fuel oil or diesel fuel oil remediations. The reader is referred to Question and Response #5.

**7. Question: How were the residual product/free product values for petroleum hydrocarbon mixtures derived?**

Answer: The Department reviewed available literature to define at what concentration(s) residual product/free product occur in soil. The results of this effort are found in Appendix 2 of the "Protocol for addressing extractable petroleum hydrocarbons" (Protocol) ([http://www.nj.gov/dep/srp/guidance/srra/eph\\_protocol.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_protocol.pdf)).

**APPLICATION OF REMEDIATION CRITERIA/SCREENING LEVELS**

**8. Question: Does the 5,100 mg EPH/kg soil remediation criterion for No. 2 fuel oil/diesel fuel oil apply below the ground water table?**

Answer: Yes. The 5,100 mg EPH/kg soil remediation criteria for No. 2 fuel oil/diesel fuel oil is a "direct contact soil remediation standard." Therefore, this criterion applies both above and below the ground water table. Pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-4.1(b)3ii, delineation below the ground water table is required for direct contact standards. The primary reasons for this delineation are to properly determine vertical limits of contamination for the purposes of the institutional control (i.e., Deed Notice), as well as to address concerns regarding future use of the site or area of concern.

**9. Question: How will potential impacts to ground water by No. 2 fuel oil or diesel fuel oil be addressed?**

Answer: The Department has concluded that residual No. 2 fuel oil (and therefore diesel fuel oil as well) does not appear to be a threat via the impact to ground water exposure pathway except for 2-methylnaphthalene. This position is in large part based on the mobility and toxicity of 2-methylnaphthalene. Using the soil-water partition equation, the impact to ground water guidance

criterion for this compound is 5 mg/kg. The results of the EPH-TPH Field Study involving 14 residential No. 2 fuel oil discharges (described in response to Question #2) suggest that levels of regulatory concern for 2-methylnaphthalene as relates to the impact to ground water exposure pathway may be exceeded when the EPH concentration exceeds 1,200 to 1,600 mg/kg. This is below the remedial goal for EPH and is why contaminant specific monitoring for 2-methylnaphthalene is required at 1,000 mg EPH/kg or greater. In this way the compound-specific risk may be assessed directly.

Analysis for 2-methylnaphthalene is required on the highest 25 percent of all samples with EPH concentrations above 1,000 mg/kg. If the 5 mg/kg standard for 2-methylnaphthalene is exceeded by any of these results, the options are to:

1. Remove/treat additional materials to eliminate all 2-methylnaphthalene exceedances as verified by post-excavation/treatment sampling and testing, or
2. Determine compliance for 2-methylnaphthalene using the SPLP protocol ([http://www.nj.gov/dep/srp/guidance/rs/splp\\_guidance.pdf](http://www.nj.gov/dep/srp/guidance/rs/splp_guidance.pdf)).

If the second option is employed, the SPLP evaluation will be performed on the contingency sample(s) with the highest 2-methylnaphthalene concentration. Note that the Department has determined that only samples in excess of 1,000 mg EPH/kg may be subjected to SPLP analysis. If the 2-methylnaphthalene leachate concentration from the SPLP analysis is equal to or less than the 2-methylnaphthalene leachate criterion (the ground water quality standard [30 ug/L] adjusted for the dilution attenuation factor [13], equals 390 ug/L for Class II ground water), the remediation is considered acceptable. If the 2-methylnaphthalene leachate concentration from the SPLP exceeds the 390 ug/L leachate criterion, removal/treatment of contaminated material will be required and the options to verify compliance using 2-methylnaphthalene analysis or the SPLP protocol are again permitted to be employed. Recognize that this is a departure from the SPLP protocol noted in bullet number 2 above and is unique to the conditions defined here.

**10. Question: Will the 5,100 mg EPH/kg No. 2 fuel oil /diesel fuel oil residential exposure scenario criterion be applied to other petroleum hydrocarbon compound mixtures?**

Answer: No. The Department has established a certified laboratory analytical method that will allow for the development of sample-specific remediation standards for the different types of petroleum hydrocarbon compound mixtures to determine if additional remediation (delineation, remedial action, etc.) is required. The NJDEP EPH Method can be found at [http://www.nj.gov/dep/srp/guidance/srra/eph\\_method.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_method.pdf). The Department has implemented a six month phase-in period prior to mandating that the NJDEP EPH Method be used to analyze all soil samples from discharges of all petroleum hydrocarbon mixtures ([http://www.nj.gov/dep/srp/guidance/srra/eph\\_phasein.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_phasein.pdf)). During this phase-in period, the existing 10,000 mg/kg criterion will be the applicable remediation goal for all petroleum hydrocarbon compound mixtures (other than No. 2 fuel oil or diesel fuel oil) that are subject to total petroleum hydrocarbon soil testing as per Table 2-1 of the Technical Requirements for Site Remediation (N.J.A.C. 7:26E). Alternatively, if the person responsible for conducting the remediation chooses, the new NJDEP EPH Method can be used immediately, provided that a New Jersey certified laboratory performs the analyses. The sample-specific remediation standard shall then be determined using the EPH Calculator provided by the Department (<http://www.nj.gov/dep/srp/guidance/srra/EPHCalculator.xls>).

In addition, changes to all of the guidance documents pertaining to EPH will be announced by email to the Department staff and posted on the Department's website to inform the regulated community.

**11. Question: How will the Department phase-in the new health based and ecological screening criteria for petroleum hydrocarbons?**

Answer: The Department has implemented a phase-in period of six months for the use of this guidance which is similar in approach the phase-in periods used in the past by the SRP. For additional information regarding the phase-in, refer to the document "Phase-in for the implementation of the 'Protocol for Addressing Extractable Petroleum Hydrocarbons' and the associated analytical method 'Analysis of Extractable Petroleum Hydrocarbon Compounds (EPH) in Aqueous and Soil/Sediment/Sludge Matrices'" ([http://www.nj.gov/dep/srp/guidance/srra/eph\\_phasein.pdf](http://www.nj.gov/dep/srp/guidance/srra/eph_phasein.pdf)).

**12. Question: Will an institutional control (i.e., deed notice) be required if there are exceedances of the residential EPH criteria?**

Answer: Yes. The residential EPH criteria for all petroleum hydrocarbon mixtures are based on human health. Pursuant to the Brownfield Act, N.J.S.A. 58:10B-12, if there are exceedances of any residential health-based standard, an institutional control is required. This applies to exceedances of any residential EPH criterion at both residential and non-residential sites. If the 5,100 mg EPH/kg residential criterion is exceeded at a residential site, an engineering control will also be required.

**13. Question: For No. 2 fuel oil/diesel fuel oil, is there an EPH concentration below which a responsible party will be ensured that institutional and/or engineering controls will not be required at a site or area of concern?**

Answer: For No. 2 fuel oil/diesel fuel oil, if contamination is remediated to below 1,000 mg EPH/kg, the Department will not require either an institutional control or an engineering control for a site or area of concern. This concentration is below the 5,100 mg/kg residential exposure scenario health based EPH remediation criterion, as well as the 1,700 mg/kg ecological screening level. Contingency analyses also are not required below this concentration. Therefore, an institutional control will not be required.

**14. Question: Will the changing of the requirement to test for BN compounds rather than VO compounds for No. 2 fuel oil/diesel fuel oil soil contamination result in the need to issue deed notices for polyaromatic hydrocarbon (PAH) compounds such as benzo(a)pyrene at residential sites?**

Answer: No. Investigation by the Department indicates that PAHs are not expected to be found in No. 2 fuel oil (and similarly diesel fuel oil) except at trace levels. Also, because No. 2 fuel oil and diesel fuel oil are distillate products, the Department does not anticipate that PAH compounds like benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene would be major components of these mixtures. The results obtained from the EPH-TPH Field Study at 14 New Jersey residential sites contaminated by No. 2 fuel oil (described in response to Question #2) indicate that PAHs were typically below detection limits and if observed, not above levels of regulatory concern.

Therefore, the Department has determined, based on the weight of the available information, that at all sites the BN compound analysis and any subsequent remedial actions will be restricted to only those compounds of interest associated with No. 2 fuel oil (and similarly for diesel fuel oil). Specifically, this means the required limited BN compound analysis triggered at 1,000 mg EPH/kg need only consist of 2-methylnaphthalene and naphthalene.

- 15. Question: Will Unregulated Heating Oil Tank Program (UHOT) participants be allowed to generate an alternative remediation standard (ARS)? It is recognized that on the Department web page entitled “Information for Environmental Professionals about the Unregulated Heating Oil Tank Program (UHOT)” (<http://www.nj.gov/dep/srp/unregulatedtanks/professionals.htm>), Item 7 states, “Cases that will be remediated to an Alternative Remediation Standard” are excluded from the UHOT program.**

Answer: Specific to naphthalene, the residential scenario direct contact soil remediation standard is determined by the inhalation exposure pathway. The Department has made available an electronic spreadsheet calculator which automates the ARS generation for this exposure pathway. Pursuant to the Remediation Standards, N.J.A.C. 7:26D, only four variables can be changed to calculate this ARS. Because the generation of the ARS will be virtually automatic, the Department prohibition for UHOT participants to generate these ARS values will be waived for naphthalene for homeowner No. 2 fuel oil cases (and similarly diesel fuel oil).

Likewise, the generation by UHOT participants of a site-specific impact to ground water criterion for 2-methylnaphthalene and naphthalene with a Department provided spreadsheet is permissible, and the Department prohibition for UHOT participants to generate these ARS values will be waived for homeowner No. 2 fuel oil cases (and similarly diesel fuel oil).

However, the use of models, such as SESOIL, AT123D, or the 4 Phase Model, to generate an ARS will prohibit participation in the UHOT program.

Note that the Department web page entitled “Information for Environmental Professionals about the Unregulated Heating Oil Tank Program (UHOT)” (<http://www.nj.gov/dep/srp/unregulatedtanks/professionals.htm>) is currently being revised to reflect the changes to the Site Remediation Program based on the Site Remediation Reform Act.

- 16. Question: For non-No. 2 fuel oil/diesel fuel oil discharges, how will results for samples collected and analyzed before September 1, 2010 be used if the case does not have an approvable remedial action workplan (RAWP) or remedial action report (RAR) and petroleum hydrocarbons were detected below 10,000 mg/kg?**

Answer: The person responsible for conducting the remediation will be required to reanalyze the 25 percent of the samples with the worst-case samples in which petroleum hydrocarbons were detected between 1,700 mg/kg and 10,000 mg/kg. The Department does not intend to make the person responsible for conducting the remediation resample all locations. However, because the new EPH health-based criterion is sample (i.e., composition) specific, it is necessary to determine whether any of the areas where petroleum hydrocarbons were historically detected exceed the sample-specific health-based criterion. The lower bound of 1,700 mg/kg is based on this concentration being the calculated remedial goal when the worst-case toxicity factor is applied to the entire mass of contamination. Mathematically, this identifies the lowest possible calculated health-based value. It is not possible to have a health-based concentration lower than 1,700 mg/kg. Therefore, based on the results of the EPH-TPH Field Study (see Question #2), which indicated that Method 418.1 results can be extended to situations where EPH analyses are employed, any historical TPH concentration below 1,700 mg/kg should also be below the sample-specific health-based criterion.

If the resampling of the worst-case historical results does not indicate contamination in exceedance of health-based criteria, no additional resampling of historical areas will be required. The Department will determine on a case-by-case basis what additional sampling is required if the resampling of the worst-case historical results indicates contamination in exceedance of health-based criteria.

## 17. At what point during the investigation is it necessary to complete the contingency analyses?

Answer: It is necessary to complete the contingency analyses as follows:

- a. As part of any initial reporting event. For instance, if the site or area of concern is being remediated using a phased approach, and a site investigation report is being produced, it will be necessary to complete any required contingency analyses as part of the site investigation. However, if the site or area of concern is being remediated all at once (i.e., the remedial action is completed as part of the initial phase of remediation), any required contingency analyses can be completed as part of the post-remedial action sampling.

Except as noted in (b) below, if the results of all of the contingency samples are below their contaminant-specific soil remediation standards, no additional contingency sampling will be required during subsequent rounds of soil sampling.

If the results of the contingency samples detect any contaminant above its contaminant-specific soil remediation standard, delineation of that contaminant of concern is required, irrespective of any future sampling conducted for EPH analysis.

- b. If subsequent sampling for EPH indicates EPH contamination at concentrations greater than the concentrations of the samples initially used for the contingency samples. For instance, for a No. 2 fuel oil discharge, the EPH results for the initial soil samples on which contingency analyses are performed are 6,000 mg EPH/kg and 7,000 mg EPH/kg. The contingency analyses on these two samples indicate all contaminants are below regulatory concern. However, subsequent sampling performed to delineate the EPH contamination yields EPH concentrations greater than 7,000 mg/kg. Contingency analyses would be required on those samples greater than 7,000 mg EPH/kg.

## **ANALYTICAL METHODS**

### **18. Question: Are there circumstances under which it is not necessary to fractionate soil samples when using the NJDEP EPH Method (“Analysis of Extractable Petroleum Hydrocarbon Compounds (EPH) in Aqueous and Soil/Sediment/Sludge Matrices”)?**

Answer: Yes. Revision 3 of the NJDEP EPH Method has been updated to acknowledge two circumstances under which it is not necessary to fractionate soil samples:

- a. All No. 2 fuel oil/diesel fuel oil discharges (“Category 1” in the Protocol).

The rationale is that SRP has set the remediation criterion for these types of discharges at 5,100 mg/kg, regardless of sample composition.

- b. Non-No. 2 fuel oil/diesel fuel oil discharges (“Category 2” in the Protocol), when the total EPH concentration is at or below 1,700 mg/kg.

The rationale is that 1,700 mg/kg is the calculated remedial goal when the worst-case toxicity factor is applied to the entire mass of contamination. Mathematically, this identifies the lowest possible calculated health-based value. It is not possible to have a health-based concentration lower than 1,700 mg/kg. Therefore, compositional information (obtained through the fractionation option of the method) is not required to make the determination that there is no regulatory concern.

Not fractionating the samples will significantly reduce the analytical costs to the person responsible for conducting the remediation, making the cost of the NJDEP EPH Method comparable to current analytical costs for the Diesel Range Organics (DRO) and OQA-QAM-025 analytical methods.

**19. QUESTION: What are the holding times for the new NJDEP EPH Method?**

Answer: For all matrices, samples must be chilled at  $4 \pm 2$  degrees Celsius at the time of collection and stored at  $4 \pm 2$  degrees Celsius until analyzed. Samples must be extracted within 14 days from the time of collection. Extracts must be analyzed within 40 days of extraction.

**MISCELLANEOUS**

**20. Question: Does the Department have any recommendations for implementing the Protocol?**

Answer: Yes. The users of the Protocol may wish to consider the following:

2. It is suggested that the Protocol user read the entire Protocol prior to initiating remediation, in order to determine the most efficient remediation strategy.
3. When formulating the remediation strategy, it is important to determine at the start whether institutional controls and/or engineering controls are options for the given site or area of concern, as well as which exposure scenario (residential, non-residential) is applicable.
4. Because of analytical holding time restrictions, it is critical to take into account laboratory analysis turnaround time. The person responsible for conducting the remediation may want to consider expediting the analyses. Although more costly, doing so may be more cost-effective than having to remobilize to collect additional samples.
5. It is suggested that sufficient soil volume be collected during each sampling event to address all potential contingency analyses. In addition to the EPH analysis, it may be necessary to perform, in a short time frame, additional testing to complete the remediation and thereby avoid remobilization and increased costs.