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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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Date: August 25, 1994

Mr. Dave Forsythe
Atlantic Division, Naval Facilities Engineering Command
Environmental Quality Division
Code: 1822
Building N 26, Room 54
1510 Gilbert Street
Norfolk, Virginia 23511-2699

Re: Norfolk Naval Base, Virginia
Q-Area Storage Yard
Review of draft *Remedial Investigation/Feasibility Study*

Dear Mr. Forsythe:

As previously requested by Ken Walker, formerly of the Atlantic Division of the Naval Facilities Engineering Command (LANTDIV), please find ecological comments on the Navy's draft *Remedial Investigation/Feasibility Study* report for the Q-Area Storage Yard, located at the Norfolk Naval Base, Norfolk, Virginia as outlined below. The following comments are made on behalf of the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Environmental Protection Agency (EPA):

**General Comments**

1. In many areas the document raises more questions than it answers. The specific comments below will show that this is the case in several parts of the text, but in general surface water and sediment sampling is not of remedial investigation quality in terms of both numbers of samples and location.

2. Remedial alternatives are presented in a very confusing way. As it stands, we (EPA/NOAA) cannot determine which remedial alternative is the preferred nor can we ascertain which alternatives would cause the least ecological harm.

**Specific Comments.**

1. In Section 5.0 and elsewhere, we note that the investigator tied contaminant levels to the Region 3 risk-based concentration (RBC) tables for commercial industrial soils. The comparison of individual chemical concentrations to RBC values on a line by line basis is inappropriate and misleading. It is recommended that, before the baseline risk assessment process begins for the Q-Drum Area Storage Yard, the selection of chemicals of concern be accomplished. The selection of chemicals of concern for soils and groundwater should follow the procedures provided in the enclosed Region III guidance document entitled "*Selection of Contaminants of Concern by Risk-based Screening*" (SCCRBS), utilizing the associated SCCRBS tables developed by using a systemic hazard quotient of 0.1 or a lifetime cancer risk of $10^{-6}$. Updated RfDs can be obtained from newer versions of Region III's *Risk Based*

*Concentration values* and utilized in the process outlined in the SCCRBS guidance to calculate updated SCCRBS table values for selected chemicals. By utilizing the SCCRBS tables, all chemicals detected which exceed the SCCRBS table values should be retained initially as chemicals of concern and carried forward into the baseline risk assessment process. All chemical concentrations falling below the SCCRBS table values can be eliminated from further concern.

Additionally, the SCCRBS table values listed for soils are generally not protective of ecological resources and should not be used in any determinations of ecological risk, i.e. for the evaluation/screening of sediment chemical concentrations. For the evaluation/screening of sediment, please utilize NOAA *Screening Guidelines*. The table values contained in the NOAA *Screening Guidelines* can be used for the initial identification of chemicals of concern for sediment and surface water much in the same way as the above referenced EPA-Region III SCCRBS tables. For those chemicals not included on the NOAA *Screening Guidelines* tables, default values can be utilized, namely the SCCRBS table values for residential soil.

2. We note that the placement of wells appears to be logical in relation to the gradient. However, we question the wells used for reference as they may be too close to the contaminant areas to serve adequately. The preparer of the draft *Remedial Investigation/Feasibility Study* report (RI/FS) should at least explain why these wells can be regarded as adequate references. Our concern is that the low gradient may allow for upgradient contamination to interfere with the use of these wells as "background". As a result, the use of these wells as controls would be compromised.

3. We note also that the document uses surface water criteria in evaluating the severity of risk. We agree that the use of surface water criteria is acceptable when carrying out Ecological Risk Assessment, but the use here appears to be inappropriate as VA has developed ground water guidelines which are considered ARARs. These guidelines are designed to be protective of ground water resources vis-a-vis TCE and PCE as well as other VOCs and semi-VOCs. The rule of thumb is to use the more stringent numbers in most cases.

4. We note also that the base proposes to use contaminated ground water for irrigation. This contaminated water may represent a risk pathway to ecological receptors and also may contribute to surface water contamination through the pathway of runoff. In addition, if the contaminants contained in the groundwater are considered "listed" hazardous wastes, other problems maybe encountered if the base uses the groundwater for irrigation. NOAA/EPA also believe that metals are a problem with ground water, and the runoff poses a risk pathway for these contaminants as noted above.

5. As far as we can tell, only two sediment samples were analyzed and these were from the storm drainage ditches discharging into the Elizabeth River. These sediments are contaminated with Arsenic, Barium, Chromium, Magnesium, Copper, Iron, Lead and Zinc. Aside from the confusion in the text regarding why the sediments were listed as both moderately and heavily contaminated with barium, we note that the sediment samples in general show exceedances of the Long & Morgan Guidelines for several trace elements and the pesticides Chlordane and homologues of DDT. As far as we can tell only one surface water sample was analyzed during the entire RI. We believe that a real potential exists for contamination from the site to both the Elizabeth River and Willoughby Bay via both the surface water and ground water pathways. This area is located in the general southern Chesapeake Bay environment which is ecologically rich in aquatic/marine life as well as pelagic, shore, and upland birds. Because of these habitat values that are so dependent upon water quality, we do not believe that one sample at one point in time can be used to determine ecological risk. In addition, that single sample was restricted to priority pollutant metals and did not cover any other site-related contaminants. The receiving waters (Elizabeth River, Willoughby Bay and any others that were identified through reconnaissance of the area) should be sampled for TCL/TAL as well as for specific site-related contaminants. The sampling program should include the attached list of basic

water quality parameters. The document mentions such as Mason's Creek and Lafayette Pond but does not mention any other streams and ponds that may be located in the area. These should be sampled systematically along with other aquatic systems. At the same time, the investigation should include sampling of the benthic regimes at the same locations, with emphasis upon selecting depositional areas. Finally, a description of the bank and riparian areas should be included for physical and ecological values.

6. Ecological assessment has not received very broad attention and given the levels of metals, TPHs, etc., it is very possible that contamination has moved into the food chain. It is recommended that an effort be made to establish plant and animal tissue/organ levels of contaminants associated with the site. It is noted that several metals that were identified in the document have the ability to bioaccumulate, e.g., cadmium and arsenic. Sampling the ecological receptors should be carefully planned so that organisms most directly exposed to pathways from the site are considered. For example, on page 5-23 DDT homologues are noted as present in sediment samples. It is possible that either sedentary fish or fin fish with small ranges may be available as test organisms. When doing this work it is important to note that different chemical states (e.g. alternate valence states and toxicities for metals) may prevail. We believe the emphasis solely upon human receptors, exposure to the food chain ignores actual impact to ecological receptors.

7. The inadequate level of ecological characterization, media samples, and risk assessment makes it impossible to agree with the conclusion of no impact. This conclusion is based upon intuition and the speculation that impacts are 'unlikely' is not based upon any factual information. Characterization of the aquatic ecosystem would be required as an initial piece of information towards an effort to determine ecological risk potentials. The discharge of runoff to the Elizabeth River and Willoughby Bay alone is sufficient reason for gathering basic ecological information in pursuit of determining potential impacts through risk assessment. We note that the document presumes that concentrations in ground water are diluted and dispersed but, again, no factual information based on sampling and analysis is provided.

8. On page 7-11 and -12 as well as on page 8-3 the toxicity assessment concludes that "the disturbed nature of the site makes it unlikely that important terrestrial receptors currently exist". Since neither an ecological characterization nor risk assessment was done, no factual basis exists for this conclusion. In addition, no list of species is provided to determine what the term 'important' means. On page 7-10 they state that no threatened, sensitive, rare, or endangered species are <u>thought</u> to exist on the site. As stated before, the general environmental setting (i.e., lower Chesapeake Bay) argues against this. But aside from this, we could not find where the document states that appropriate state and federal authorities have been contacted regarding status species. For example, the White Marsh office of the Fish & Wildlife Service is one contact that can supply information on endangered species of the locale.

9. Cleanup criteria for TPH in soil and ground water is not addressed in the remedial plans because no human health criteria exist for this class of contaminant. TPH, on the other hand, are considered to be serious ecological contaminants and should be addressed as part of an Ecological Risk Assessment. Metals levels in sediment also exceed guidelines as do levels of DDT homologues and Chlordane, both of which are greater than NOAA ERM guidelines by several orders of magnitude. The RI failed to clearly establish a source, but implies that an upstream source exists. In light of the topography, this is questioned. Furthermore, the source is likely to be associated with the base, indicating that additional on-base remedial investigation should be carried out to pinpoint the source(s). We suggest that additional investigation should cover such pathways as the storm water system, etc., to locate the source(s).

10. We note that TCLP extraction methods were used in establishing hazardous concentrations of several contaminants. This method is not acceptable for establishing potential availability to ecological receptors.

11. In the same vein, metals, TPH, and chlorinated hydrocarbons, pesticides, and DDT homologues have been identified in the sediment, therefore, work needs to be done to complete the characterization of sediment and considered in the scope of remedial plans.

12. While we usually do not look at the quality assurance plans for RI/FS investigations conducted by the Navy, in this case it would be a good idea for us to have the opportunity to check these plans. It is our concern that the method detection levels and, in fact, the methods themselves might not have been sufficiently sensitive to meet ecological risk criteria.

13. With regard to the FS, we believe that restricting cleanup to soils and ground water is inadequate. The drainage ditch shows high levels of contamination in sediments and is likely to be of some habitat value as well as a pathway to other areas of ecological value. In addition the contamination in the sediment can act as a long term secondary source of contamination to the ultimate receiving areas, e.g., Elizabeth River.

14. We have many serious concerns with the remediation plans. The alternative ground water and soil remediation are thoroughly discussed, but we cannot see where an actual alternative was selected. One approach involves merely treating the ground water for VOC contamination that could potentially produce a discharge containing other contaminants at concentrations exceeding AWQC (chronic). This water discharged to Willoughby Bay, as in alternative 2, could allow it to both contaminate the bay and contribute to contamination of the sediment.

15. Further confusion exists in regard to Tables 11-6 and 12-1. In Table 11-6, the precipitation/flocculation alternative was eliminated from consideration but is listed in Table 12-1 as an alternative retained for the site. This is confusing to the reviewer. Alternatives 5a and 5b (in-situ thermal treatment) does not reduce metals concentrations and, in fact, appears to allow them to remain as a continuing source of ground water contamination. The capping alternative may pose a threat if for no other reason than an increase in storm pulse volume and energy of surface water drained to the Elizabeth River and Willoughby Bay.

**Recommendations:**

The following recommendations are general in nature because exhaustive details are not possible at this time due to the incomplete nature of the report. The level of effort reported by this document is really only comparable to what we see in a site investigation produced preliminary to listing.

- The Navy should have its contractor complete the characterization of the extent of contamination, including:

  a.) pinpoint sources of contamination, e.g., Chlordane, DDT homologues, etc.; characterize contamination of environmental media, e.g. surface water and sediment; identify and sample all pathways. (Additional guidance is available, if needed).

- Carry out an ecological characterization by describing the ecosystems and habitats as well as the resident flora and fauna. The sampling and analysis should be designed on a statistical basis.

- Complete an Ecological Risk Assessment using the attached Draft Interim Guidelines.

This concludes EPA's ecological review of the Navy's draft *Remedial Investigation/Feasibility Study* report for the Q-Area Storage Yard, located at the Norfolk Naval Base. If you have any questions or concerns, please feel free to call me at (215) 597-1110,

Sincerely,

Robert Thomson

Robert Thomson, PE
VA/WV Superfund Federal Facilities (3HW71)

cc: VDEQ, Federal Facilities Program
Bob Davis (USEPA, 3HW13)
Paul Leonard (USEPA, 3HW71)

Table 1. Maximum concentrations of the major contaminants in groundwater and sediments collected at the Q-Area Drum Storage Yard.

| | Groundwater | AWQC Chronic Freshwater | Marine | Sediments | ERL | ERM |
|---|---|---|---|---|---|---|
| Trace Elements | (μg/l) | | | (mg/kg) | | |
| Arsenic | 340 | 190 | 36 | 5.6 | 8.2 | 70 |
| Cadmium | 96 | 1.1 | 9.3 | 1.4 | 1.2 | 9.6 |
| Chromium[1] | 1,100 | 210/11 | NA/50 | 32 | 81 | 370 |
| Copper | 260 | 12 | 2.9* | 120 | 34 | 270 |
| Lead | 520 | 3.2 | 85 | 350 | 47 | 220 |
| Mercury | 0.38 | 0.012 | 0.025 | 0.40 | 0.15 | 0.71 |
| Nickel | 470 | 160 | 8.3 | 9.2 | 21 | 52 |
| Silver | 12 | 0.12 | 0.92 | 0.60 | 1.0 | 3.7 |
| Zinc | 1,600 | 110 | 86 | 230 | 150 | 410 |
| Pesticides (μg/kg) | | | | | | |
| Gamma-Chlordane | NA | NA | NA | 18,000 | 2** | |
| Alpha-Chlordane | NA | NA | NA | 16,000 | 2** | |
| DDD | NA | NA | NA | 650 | NA | |
| DDE | NA | NA | NA | 370 | 2.2 | 27 |
| Total DDT | NA | NA | NA | 1,000 | 1.6 | 46 |

NA: Not available or not analyzed
1: $Cr^{3+}/Cr^{6+}$
*: Acute value
**: Overall apparent effects threshold.

United States
Environmental
Protection Agency

Region III
Philadelphia, PA
19107-4431

# REGION III

# INTERIM

# ECOLOGICAL

# RISK ASSESSMENT

# GUIDELINES

JULY 27, 1994

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Technical Support Section
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## ENVIRONMENTAL RISK ASSESSMENT GUIDELINES

EPA Region III

Introduction:

Three levels of Environmental Risk Assessment (ERA) are recognized as available to the risk assessor: 1) the screening level; 2) the semi-quantitative level; and 3) the quantitative level. A logical procession from 1 through 3 is assumed and each should be carried out in such a way as to lead logically to the next, more restrictive tier.

Environmental risk assessment should play a role in the Superfund process from scoping through post-remediation. The project manager should assume that a third level risk assessment will be justified on the bases of initial sampling and analysis. He should also plan phases of the remedial investigation to satisfy the DQO needs of the most sophisticated risk assessment. The sampling plan should be designed with the worst case scenario in mind so that sufficient data is available during risk assessment to carry out that level of assessment. As the project proceeds, a determination can be made to eliminate portions of the effort and to lower the level of risk assessment needed.

The level of ecological characterization carried out at Superfund sites is designed to address the potential for risk regarding types of habitats and species mixes reported in the RI. The screening level risk assessment is not sufficiently detailed to allow the risk assessor to perform a anything more detailed than a very general risk assessment. To carry out the more detailed assessment, the assessor needs site-specific toxicological information on representative flora and fauna from all habitats. In addition, backup information such as chronic toxicity studies, tissue residue analyses, and observation of abnormality, etc. are needed.

Difficulties associated with environmental risk assessment are most clearly pointed out by acknowledging the complexities of ecosystems. It is very likely impossible to carry out a fully complete ecological risk assessment that would approach full assurance that it represents all trophic levels and all genera in a habitat. Because of this constraint, the three tiers described below range from the very conservative through the extremely complex. It is suggested that the more conservative approach be used, especially since the level and quantity of data collected in most investigations is insufficient for completion of the more sophisticated levels described.

Screening Level:

In the absence of specific studies to provide detailed information, the only approach considered to be protective of the greatest number of species is the conservative environmental effects quotient (EEQ) approach. In this approach, the most conservative criteria for a habitat that can be derived from available literature are applied to the media in that habitat. For example, in the aquatic habitat, the chronic ambient water quality criteria (AWQC) are used. (A case can be made that the AWQC are too conservative. In some cases, it may be that the NOAEL or even the LOAEL values are acceptable, but care should be exercised to err on the side of protection.) These values are then divided into the reported concentrations and where the number exceeds one, a potential for risk exists.

Note: Chronic water quality criteria are derived statistically from the literature and are often dependent upon laboratory results and, therefore, are more conceptual than real. From this view point, they are not verifiable from field studies and difficult to apply to specific receptors in the real world.

This same approach should be used in developing criteria use in calculating the EEQ for the other media of concern, but comparable criteria are not available for some media. In these cases, a literature search is used to establish a conservative basis. More specifically, the literature search is used to find information relating to organisms or populations of the habitat that have been reported as impacted by certain levels of contamination. A good example of this is the NOAA Publication, commonly referred to as 'Long & Morgan'[1] and the more recent Long & MacDonald[2]. These are then used to establish ecotoxicological values reflecting those above natural or background conditions as the denominator for calculating the EEQ. The background numbers appearing in other sources (e.g., Shacklette and Boerngen) are used only as guidance for determining reasonable background values, but should not be used in calculating the EEQ.

In some rare cases basic ecotoxicological values are less than the background values (e.g., aluminum, iron, and magnesium, due to the prevalence in soil). In these cases, the judgement can be made to drop them from consideration unless the site-related contaminant(s) is of such a nature that normal environmental concentrations are rendered toxic by chemical reaction with the released material. An example of this is the transformation of aluminum resulting from an acid spill.

The EEQ is derived from dividing the criterion value for a particular medium or habitat into the 95% UCL value(s) of the arithmetic mean of a matrix of maximum reported concentrations reported for the medium from the RI investigative reports. For

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1 Long, E.R. & L.G. Morgan (1990). *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*. NOAA Technical Memorandum NOS OMA 52.

2 Long, E.R. et al. (1993). *Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments.*

example, in aquatic assessments, the denominator is the chronic ambient water quality criterion. In cases where no criteria exist, a conservative number may be derived from literature available on the class of chemical of which that contaminant is a member. To calculate the 95% UCL, see attachment A, Data Presentation.

Those EEQ calculations that show a result higher than one (1), are considered to demonstrate a potential risk. Values higher than ten (10) are considered to be of moderately high potential risk and above 100, extreme risk. Risk to a population is complicated by a number of factors that are not included in the screening level approach. For example, immediate vs long-term impacts are not readily apparent from the screening level approach. On the other hand, uncertainty is minimized in this approach due to its inherent nature, i.e., it is assumed that the criterion value is based upon the most sensitive receptor (or set of receptors) identified in the literature and that it is found in this habitat and at this site. Probability, as well as temporal, and spatial effects are not emphasized in this approach, also due to the lack of appropriate data.

In cases where several contaminants are identified, the EEQs for each medium can be totaled and where the result is higher than 1, further interpretation to determine the potential for risk is indicated.

The uncertainty of the screening level risk assessment is minimized by using the conservative approach joined with the use of the 95% UCL of the reported data. Conversely, the risk to off-site receptors within the boundaries as described by the extent of contamination may not be fully represented. Decisions on the part of the risk assessor can eliminate this drawback through such mechanisms as conservative use of food chain models, etc. but modelling should be minimized in the screening level approach, as assumptions are incompatible with the conservative approach.

Uncertainty is further reduced through the requirement that if any calculated 95% UCL is less than 80% of any maximum reported value, the maximum value will be used. Further, in cases where the reported values are reflective of detection limits that are above the criteria, the risk assessor should use 1/2 the sample quantitation limit in calculating the 95% UCL. When that calculation results in levels lower than the criteria, the criteria value should be used with the acknowledgement that the reported level may be indicative of a 'hot-spot'.

This approach tends to eliminate extremes and outliers. While we are not concerned about low outliers, high outliers raise concern. These are commonly known as 'hot spots'. It is possible that 'hot spots' of contamination may disappear as a result of calculating the 95% UCL. This is more likely to happen if the risk assessor calculates the 95% UCL from a geometric mean rather than the arithmetic. The risk assessor is cautioned to recognize maximums and outliers, include them in calculating the 95% UCL and to reserve them for special consideration in the assessment. This operation will aid the risk manager to render more effective decisions on remediation alternatives than would not otherwise be possible. By discarding the 95% UCL where maximums are used, or where detection limits are high, these 'hot spots' will not be lost in the assessment.

An additional refinement involves the variation of the mean. The risk assessor should calculate the standard error of the mean and where it exceeds 20% of the mean, then variability is too great and the maximum reported values are to be used. This will serve as a second check for both the site variability as well as an avenue to determine 'hot spots'. In these cases, each sample location will tend to become the focus of individual attention in the risk assessment process. This is recognized as a time-consuming outcome of the screening process, but is also an objective of the approach.

In sum, the screening level risk assessment concentrates on contaminant concentrations in media within habitats. Select species and surrogates are specifically excluded because of data limitations from both the RI and the literature. For example, in the benthic environment, trophic levels are not described as such in the normal characterization effort. Therefore, assumptions regarding exposure may be based upon benthic macroinvertebrates, leaving lower trophic levels altogether out of the risk assessment picture. Assumptions may be inadequate, but the combination of the calculated 95% UCL and the conservative criterion is designed to eliminate this.

A further weakness in this approach is that it fails to consider multiple routes of exposure, but that, too, may be avoided by use of the 95% UCL and use of conservatively derived criteria.

Semi-quantitative:

In this level of risk assessment, ecological receptors are selected that are representative of the habitats and media on and around the site. They are selected from among the populations likely to be exposed in the habitats and media as well as from the pathways of contaminant transport. The indicator species selected are always more than one and from different classes of organisms and from indigenous flora and fauna. Selected species should also come from all contaminated media and pathways insofar as possible and be representative of receptors that should be found in such areas under ideal conditions. Other considerations that should be factored into selection of receptors are ranges, various life stages, foraging routines, breeding habits, and opportunistic behaviors ( e.g., resting/feeding of migratory birds). Of course, known sensitivity to specific contaminants should be heavily considered in selection of the receptor species. Exposure in some pathways, e.g. groundwater isolated from all ecological receptors, would be exempted, but information on potential attenuation and dilution should be considered.

Measures such as diversity, abundance, and density as well as inter-species relationships (e.g., predator/prey relationships) are important in this level of risk assessment. Comparison to control or background levels are used in conjunction with this information to determine relative risk. Data in this regard should be normalized internally as well as against the control or reference station(s).

Exposure routes are selected, based upon both the species selected and the type(s) of contamination as well as the fate and transport picture. Exposure routes include ingestion, respiration, incidental exposure (e.g., physical contact), exposure duration etc. Use of a foodweb model may be used, but not to the exclusion of the EEQ described in the above discussion of tier one.

Exposure point concentrations and dosage estimates are calculated, assuming 100% exposure to the contamination identified in the medium where the exposure occurs, and 100% residence factors. These two constraints should be considered when selecting the receptor species. These factors, along with other constraints, should be calculated as the daily dosage, but with the caveat that most if not all contaminants have chronic or long-term implications. The calculations should also use bioconcentration factor, chemical/biochemical mobility, and comparative toxicity of the of the contaminant(s).

The exposure point concentration is then divided by the criterion value, e.g., the AWQC-chronic value for aquatic assessments. The calculated results are evaluated just as they are in the screening level approach. The organisms studied are surrogates for each medium and habitat and extrapolation is considered possible to other members of the same ecosystem. The safety factor between species of the same class is 10 and between species of different classes is 100. That is, when extrapolating from organisms within the same class, multiply the calculated results by 10; for organisms from different classes, multiply by 100.

Uncertainty in this level of risk assessment becomes more important because of the theoretical or hypothetical use of actual, on-site, technical information. While the risk assessor can use actual information and justify means, the 95% UCL is still used. The basic criteria may be different as background/control data rather than the conservative criteria may be brought into use as the denominator for the risk calculations. However, if it is determined that these values are excessively above the literature/criteria values used in the screening level risk assessment, then the lower values should be used. In any case, uncertainty becomes more of a mathematical concern than is the case in the screening level risk assessment.

Quantitative Risk Assessment:

Insofar as it is possible to carry out complete risk assessments, this is the most detailed risk assessment. The above methods are formulated to lead to this and all calculations are aimed at meeting the objectives of this level of assessment whether it is completed to this level or not. This level is merely the analyses of information gathered for levels 2 and 3 and supplemented by studies specifically for level 3. Such studies as chronic bioassays (two organisms per medium for each habitat), tissue residues (tissue selected according to the kinds of contaminants identified), and other studies as needed (e.g., ecological succession, fledgling success, etc.).

This level of assessment requires the kinds of studies that constitute the most complete weight of evidence that can be carried out. But it must be clear that a complete quantitative risk assessment is beyond the current state of the science.

The exposure analyses and profiles are the most involved spatial and temporal analyses on each ecological component practicable.

The calculations are based upon as many factors as possible and that can be gathered through acceptable scientific practice.

In sum, this is the most scientifically rigorous assessment of the three. Extrapolation is usually not necessary at this level, but if done it is carried out using the same approach as that used in the semi-quantitative level.

Uncertainty is a large issue in this level of risk assessment. It involves both qualitative and quantitative analyses of uncertainty and should be as thorough as possible. At this level of risk assessment, uncertainty probably cannot be completed without peer review. In tier 3, uncertainty is a mathematical exercise and should be evaluated in the same light.

Conclusion:

The screening level risk assessment is based upon a minimum of information and is based upon conservative criteria. It is the art of assessing risk using weight of evidence as available and professional judgement that the level of protection offered is for 95% of the species found on the site and within the greatest extent of contamination possible. This has precedent in setting water quality criteria.

The semi-quantitative risk assessment narrows the window to specific organisms considered to be representative of the habitats, media, and pathways. It calculates the potential for risk and uses safety factors to extrapolate to associated species in each habitat and medium.

The third tier risk assessment involves rigorous scientific disciplines such as toxicological and bioassay studies. The species studied in the toxicological, bioassay work, etc. are specific to the habitats and media that are reported in the contamination descriptions. All studies are aimed at developing a weight of evidence approach by medium and habitat to determine the level of potential risk.

This level of risk assessment forms the closest link between the estimate of risk potential and the actual risk that can be expected. The other two steps leading to this level (the screening and the semi-quantitative levels) are more artful and therefore are based upon conservative criteria.

The focus of risk assessment is the potential for risk. Risk need not be proven, but potential for risk is the critical point that risk managers deal with in making decisions.

Suggested Table of Contents For Environmental Risk Assessment:

1) Problem Definition

2) Source Characterization and Exposure Pathways

3) Ecological Receptor Characterization

4) Exposure Assessment

5) Ecological Effects Characterization

6) Risk Characterization

7) Risk Assessment (Conclusions)

8) Limitations (Uncertainty)

9) Interpretation

10) Recommendations

# Attachment A: Data Presentation

It has been proven to be beneficial to represent sampling data in a tabular format based on several organizational and statistical parameters. See Figure A-1 for an example format (note that the chemicals of concern are arrayed in an alphabetical arrangement for organic and inorganic compounds).

<u>Statistical Calculations</u>

The approach for calculating upper 95% confidence levels (UCL) of the mean for the potential contaminants of concern (COC) has three major components:

- Data reduction to obtain a matrix of maximum contaminant concentrations;

- Performing statistical calculations on the contaminant data set in raw and log transformed states, assuming the data, if graphed-frequency of occurrence over value, would be characterized as either a Gaussian or skewed (lognormal) distribution; and

- Determining which UCL value (Gaussian or lognormal-based) to accept by comparing the UCL values to their respective data sets and verifying that the UCL does not exceed the maximum value in its associated data set. If the maximum value is exceeded by the UCL in both cases, then the maximum value of the raw data is substituted for the calculated UCLs. The 95% UCL is also not to be used in cases where it is less than 80% of the arithmetic mean of the matrix maximum.

The elements of data evaluation tasks which are integral to the generation of a maximum contaminant concentration matrix are presented below. It should be noted that various approaches have been taken for some of the elements itemized below. The approaches discussed represent those that have been utilized by Region III and are felt to be the most applicable to ecological risk assessments.

- <u>Duplicate Sample Results</u> - Samples collected as duplicates will be consolidated into a single result, using the higher of the two detected values for each parameter.

- <u>Split Sample Results</u> - When available, analytical results of samples collected as splits by the oversight contractor will be compared to the results obtained by the PRP's contractor. Where the value is higher in the oversight contractor's results, it will be used in place of the PRP's data (i.e., will be considered as a duplicate sample).

- <u>Non-detects</u> - Either one-half the sample quantitation limit (SQL) or the criterion (whichever is higher) will be used as a proxy concentration for parameters positively identified, but below SQLs, within a particular medium. For example, if vinyl chloride is positively identified in groundwater in at least one location but is not detected in soil, one-half of the SQL will be used to calculate the UCL concentration for groundwater; non-detects in soil will be treated as a concentration of zero.

- Blank-Affected Results - If contaminants are detected in blank samples, these values must be compared to corresponding environmental sample results (i.e., environmental media samples associated and shipped with blank samples). If the corresponding environmental sample result is less than five times the blank results (ten times for common laboratory contaminants such as acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters), then one-half the SQL is substituted. If greater, the environmental result stands as reported. If the result has been "B" qualified at the laboratory or data validation level, then either one-half of the SQL is inserted or the criterion value is used, whichever is higher.

- Qualified Results - All results associated with qualifiers which imply that a concentration, whether true or estimated, has been detected, are valid for inclusion in the UCL calculation. Exceptions to this are the aforementioned blank-qualified data and rejected data (typically qualified with an "R"). For rejected data, no one-half SQL substitution takes place - the rejected data values are eliminated and the data set population is reduced accordingly.

Upon isolating the maximum values for each potential COC at every location, UCL calculation can be carried out. For every potential COC data set, both UCL formulae are always utilized. The following details the statistical process:

UCL Method # 1: Assumes Gaussian Distribution

If a potential COC data set assumes a Gaussian (normal) distribution, then the following formula is used to calculate the UCL:

$$UCL = x_a + t\left(\frac{s_a}{\sqrt{n}}\right)$$

Where:

$x_a$ is the arithmetic mean of the raw data

$s_a$ is the arithmetic standard deviation of the raw data

t is the one-tailed t statistic value assuming n-1 degrees of freedom (df) and a selected level of significance (95%; $P<0.05$)

n is the population of the data set

UCL Method # 2: Assumes Skewed (Lognormal) Distribution

If a data set is assumed to be skewed (unbalanced), then the raw data results must be transformed into logarithmic equivalents. This is accomplished by taking the natural log of each result in the data set and calculating the UCL using the transformed data. The following formula is used to calculate the UCL for a lognormal data set:

$$UCL = e^{\frac{(x_{ln}+V/2)+(s_{ln}\times H)}{\sqrt{n-1}}}$$

Where:

$x_{ln}$ is the arithmetic mean of the log transformed data

V is the variance of the log transformed data (variance = the square of the standard deviation of the transformed data)

$s_{ln}$ is the standard deviation of the log transformed data

H is the H statistic, dependent on $s_{ln}$, the sample population n, and a selected level of significance (95%)

n is the population of the data set

When the two UCL's have been calculated, a determination is made as to which one best represents the potential COC data set. This is achieved based on the following criteria:

- If one of the two calculated UCLs exceeds the maximum concentration in the potential COC data set, then the other UCL should be used, unless it is less than 80% of the maximum concentration, in which case the maximum is used.

- If both UCL's are below the maximum concentration in the potential COC data set, then the greater UCL is used, but again it cannot be less than 80% of the maximum concentration.

- If both UCL's exceed the maximum concentration in the potential COC data set (frequently occurs when the data set is four or less), then both UCLs are eliminated and the maximum concentration is substituted.

Utilization of the approach discussed herein will produce several beneficial effects. First, PRP analytical data will be evaluated and presented in a consistent manner in the Remedial Investigation Reports. Second, subsequent data evaluation for the same site and/or comparisons among sites can be approached in a uniform manner. Third, utilization of this approach by the PRPs will eliminate the need, and subsequent cost, of re-evaluation and manipulation of the data set by EPA or its contractors. This may also make additional resources available for other ecological risk assessment tasks.

# Figure A-1 FORMAT FOR DISPLAYING ECOLOGICAL RISK ASSESSMENT DATA

| CHEMICALS OF CONCERN | BACKGROUND CONCENTRATION[1] | CONCENTRATION RANGE | | NUMBER OF DETECTS[3] | NUMBER OF SAMPLES[4] | MEAN | 95% UCL |
|---|---|---|---|---|---|---|---|
| | | MINIMUM[2] | MAXIMUM[2] | | | | |
| (Alphabetical order by parameter category) | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Units are...
Minimum/maximum detected concentration above the sample quantitation limit (SQL). Units are...
Number of times constituent was detected above the SQL. Sample results from duplicate and splits were consolidated into a single sample result using the higher detected concentration for each constituent. Number of samples taken and analyzed for the constituent. Sample number varies based on number of usable results.

# Attachment B: Basic Surface Water and Sediment Parameters

These chemical and physical parameters are considered to be the minimum required to characterize the aquatic system. In some cases, others may be required where endangerment is suspected and additional information may shed light on the situation.

Surface Water:

Field Parameters --

Temperature
Dissolved Oxygen
pH
Conductivity
Salinity (for marine and estuarine systems only)
Flow (width & depth)

Laboratory Parameters --

Total Suspended Solids
Alkalinity
Hardness
BOD, COD TDS, & Non-settleable solids (optional)

Sediment:

Field Parameters --

Temperature
Eh (use EPA method 9045)
pH
Conductivity
Color (Munsell)

Laboratory parameters --

TOC (use EPA method 415.13 combustion methodology: report as % Organic matter)
Grain size (either ASTM hydrometer or emery tube)
Moisture (report as %) (Routine Analytical Services: RAS)
Solids (report as %) (RAS)