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Base Closure Division
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This document sets out the background, risk-based, and ecological screening processes to determine if specific surplus operable unit study areas can be recommended for No Further Action. Study areas passing these screening processes will go on to the Technical Memorandum for evaluation of No Further Action. Study areas failing these screening processes will be carried through to the Remedial Investigation/Baseline Risk Assessment (RI/BRA) for further evaluation.

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1.0 Introduction

To reduce the number of study areas to be evaluated in the Remedial Investigation/Feasibility Study (RI/FS), and to facilitate the transfer of property where no removal or remedial action is required, the Base Realignment and Closure (BRAC) Cleanup Team (BCT) agreed to develop a risk-based screening process. The risk-based screening process uses conservative values that represent levels of constituents below which there is no concern under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In order to facilitate this screening process, it is necessary to develop a statistical procedure for the determination of background concentrations for the Ft. Sheridan Surplus Operable Unit (OU) as well as develop a procedure for using this background data as an evaluation baseline in two situations. The first situation is in deciding which study areas are to proceed on to the risk-based screening process and which study areas require no further response under CERCLA. The second situation occurs in the Remedial Investigation/Baseline Risk Assessment (RI/BRA) Report in determining if the concentrations detected in the study areas are statistically significantly above background and in identifying constituents of potential concern (COPCs).

The purpose of this document is to specify how background sampling and analysis data will be used in the study area screening and RI/BRA data evaluation processes for Fort Sheridan and to outline how the risk-based screening process will be performed. These issues were discussed generally in Section 6.0 (Data Evaluation and Technical Memorandum) of the Final Sampling and Analysis Plan for the Surplus Operable Unit (ESE, 1995a). Background data have been collected in accordance with the Final Sampling and Analysis Plan for Background Sampling (BSAP) (ESE, 1995b). Prior BCT approval of the background comparative database will be obtained before the screening process is performed.

Only screening for protection of human health is addressed by the risk-based screening. For those study areas evaluated against the risk-based screening, a screening of potential risks to ecological receptors will be presented in the Technical Memorandum. For those study areas failing the risk-based screening and passing on to the RI, a qualitative and/or quantitative ecological risk assessment will be performed as part of the RI/BRA Report.

1.1 Objectives

The objectives of background data collection and evaluation and risk-based screening processes are:

(a) to identify study areas where mission activities have left residues of potentially hazardous constituents (COPCs);

(b) to eliminate from further investigation, study areas where no COPCs are significantly elevated above site-specific background levels or risk-based screening levels;
(c) to determine if study area constituent concentrations are statistically greater than background concentrations as part of the RI; and
(d) to identify study area specific COPCs to be addressed by the BRA.

Evaluation of data and comparison of study area data to background data will proceed in a phased approach to achieve efficient use of resources. Simple screening methods will be used to identify study areas where no COPCs are significantly elevated, followed by more rigorous statistical methods to identify study area constituent exceedances of background in the RI and specific COPCs for the BRA at study areas that fail the initial screening methods.

These procedures are intended to be in conformance with Chapter 5: Data Evaluation of the Risk Assessment Guidance for Superfund (RAGS) Human Health Evaluation Manual (Part A) (EPA, 1989a).

1.2 Initial Data Evaluation

In accordance with Chapter 5 of RAGS, Phase I and Phase II RI data, validated in accordance with the Overall Quality Assurance Project Plan (OQAPP) (ESE, 1995a), will be gathered and sorted by medium. As discussed in the BSAP (1995b), samples were collected previously in Phase I to represent background conditions at the installation. However, due to the sample locations, these Phase I data are not suitable for use in an installation-wide background database. Therefore, only Phase II data will make up the background data set. The Phase II background data collection effort was intended to be sufficient for determination of background without use of the Phase I data.

Because the data collected in Phase II were collected in accordance with the approved sampling and analysis plans (ESE, 1995b; ESE, 1995c), it is assumed that these data are useable, and that the most significant data evaluation step would be to evaluate the data with respect to field/equipment blanks, trip blanks, and internal laboratory quality control samples. For instance, if a constituent is detected in blank samples associated with a specific set of field data, it will be assumed that the detection limit is five times the level observed in the blank (ten times if the COPC is a common laboratory contaminant) (EPA, 1989b).

In addition, it is possible that samples collected as potential background samples will be excluded from the background data set prior to comparison with study area data sets. The background data

will be reviewed before seeking concurrence from reviewing agencies that the data are representative of environmental media unaffected by mission activities.

1.3 Expected Characteristics of the Data Sets

Sample Size: The Phase II background data set will consist of 5 to 28 samples, depending on the environmental medium. Groundwater, surface water, and sediment media will have 8, 5, and 5 background samples, respectively. Twenty-eight Phase II background soil samples were collected and analyzed in accordance with the BSAP. It may be appropriate to separate these samples into several subsets according to soil type and/or sample depth. Consequently, each subset is likely to have 5 to 10 samples. Each background data set (e.g., surface water) is assumed to represent background conditions for that medium at each study area.

The size of individual study area data sets will vary substantially. A few study areas will have a larger number of samples than their comparison background data set. For example, Landfill 2 will have 25 soil samples and 16 groundwater samples; Landfills 3 & 4 will have 34 soil samples; CSA 1, 18 soil samples; CSA 3, 21 soil samples; VES Area 1, 20 soil samples, Building 43, 21 soil samples. These study area soil data sets may also be separated into subsets according to the same factors (soil type and sample depth) to be considered in evaluating the background data sets.

On the other hand, a number of study areas will have fewer samples, by medium, than the comparison background data sets. A few study area data sets will have only one sample per medium, (e.g., Building 43 sediments, Building 173 surface soils, McArthur Loop Drain surface waters, Building 126 groundwaters, etc.).

Frequency of Detection: Some analytes, such as metals, are likely to be detected in virtually every sample, while other chemicals may be detected infrequently (e.g., $<<$ 50 percent hits).

Distribution: Many environmental data sets have been shown to be lognormally distributed. Some data sets may appear to be drawn from a normal population. The small sample size of most of the data sets will preclude significant inferences regarding goodness of fit to any parametric distribution.

1.4 Chemical Class

Metals are naturally occurring, and many metals are detectable in soils and waters unaffected by anthropogenic sources. Pesticides are anthropogenic, but some pesticides are so widespread and persistent that they can be detected at locations far from their point of use or disposal.

Polynuclear aromatic hydrocarbons occur naturally as the result of combustion (e.g., forest fires), or may be deposited from airborne emissions unrelated to activities at Fort Sheridan (e.g., from vehicles or power plants). At this time, however, a presumption will be made that organic chemicals detected in study area samples are elevated above background. The procedures described in this document for direct comparison to background data will be applied only to inorganics. However, potential risks (if any) at the background locations due to anthropogenic sources will be addressed in the screening process and discussed in the RI/BRA Report and Feasibility Study, as necessary.

2.0 Study Area Screening

The objectives of the study area screening process are to identify those study areas that must be addressed in the RI, and, conversely, which study areas may be identified for No Further Action and dropped from further investigation. This evaluation can be characterized as a screening level analysis, with more rigorous evaluation planned as part of the RI for those study areas and COPCs that are carried forward. Considering these objectives, the screening procedure should avoid false negative errors (i.e., concluding that a study area is not adversely affected when, in fact, it is). False positive errors (i.e., carrying a study area forward when it is, in fact, not adversely affected) on the other hand, are less of a problem because they can be corrected in the RI/BRA.

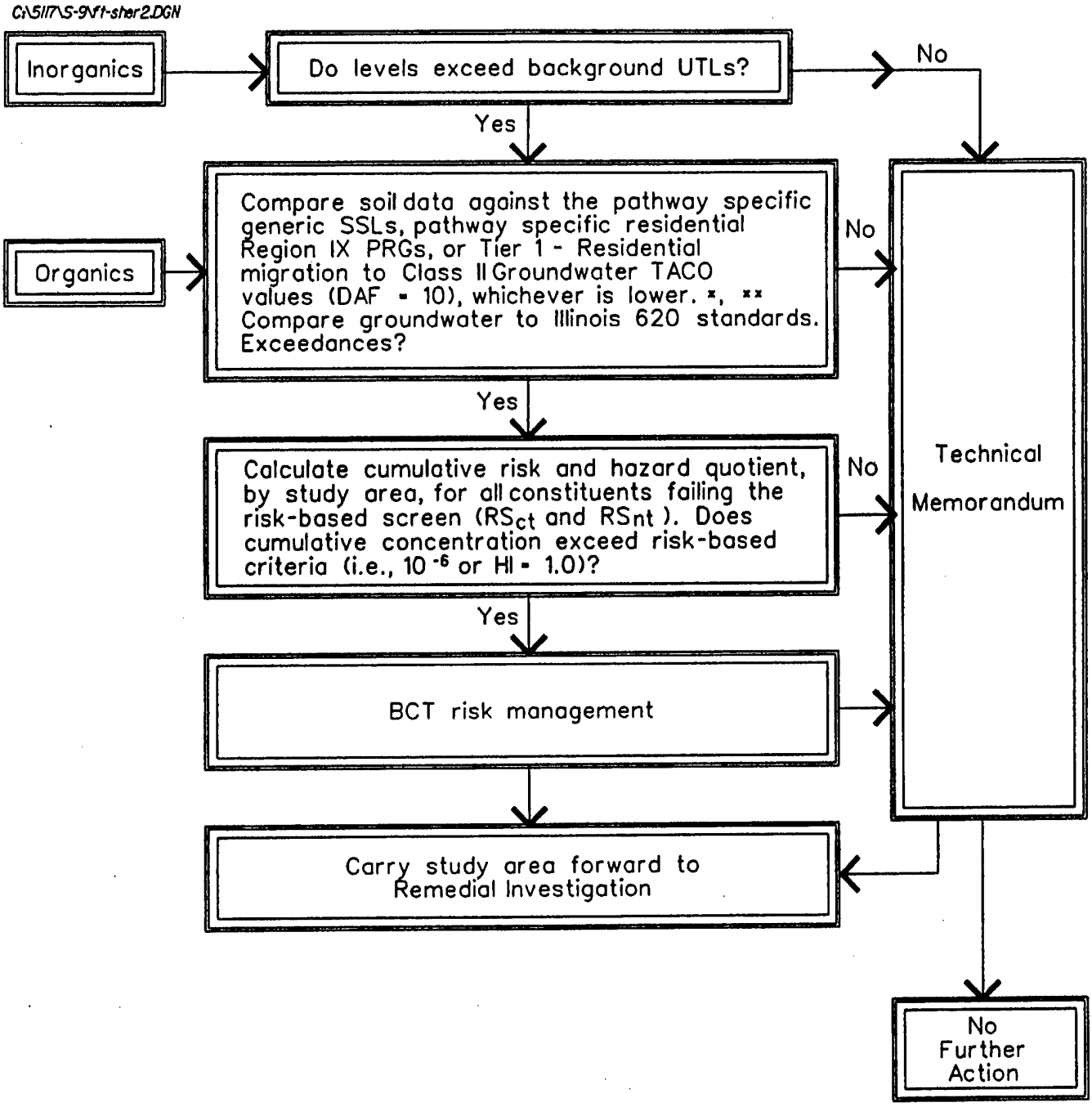
The study area screening process to be used involves multiple steps. This screening process is depicted in Figure 2-1. The process utilizes a comparison to background values and a comparison to risk-based levels. The specifics of the screening process are presented below.

2.1 Screening Against Background

A simple and widely accepted method for identifying sampling locations that may exceed background is the upper tolerance limit (UTL) method (USEPA, 1989b, 1992). This method determines whether a sample exceeds the 95th percentile of the background distribution, with 95 percent confidence. Although useful in identifying unusually high concentrations at sampling locations that may indicate mission-related contamination, this method may result in a high percentage of false positives if study area data sets have a large number of samples. Even an unaffected study area will likely have some relatively high concentration locations due to natural variation. As the number of samples collected at a study area increases, it becomes more and more likely that one sample will exceed the UTL. If even one sample from a study area exceeds the UTL, the study area will be carried forward to the risk-based screening. Failure of the UTL test is not conclusive that the study area has elevated constituent concentrations, although the method is useful in identifying hot spots. As agreed by the BCT, UTLs will not be calculated for surface water or sediment data.

2.1.1 Outlier Testing

Before calculating the UTLs, the outlier test recommended by USEPA (1992) will be performed for those analytes with at least two detected concentrations. Analytes reported below the detection limit will be halved and duplicates will be averaged. Although the USEPA guidance (USEPA, 1992) recommends that formal testing for outliers be done only if an observation seems



* In cases where no risk-based level has been published for a constituent, but sufficient toxicological data are available, a screening level may be estimated.

** In cases where the analytical detection limit is higher than the risk-based level, the constituent concentration will equal the detection limit.

RS_{ct} = study area cumulative potential carcinogenic risk
RS_{nt} = study area cumulative potential non-carcinogenic risk

Figure 2-1
RISK-BASED STUDY AREA
SCREENING PROCESS

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particularly high (by orders of magnitude) compared to the rest of the data set, all data will be tested to identify any suspect observations. If potential outliers are identified and if there are known reasons for the elevated concentrations (e.g., chemistry laboratory error), then the outliers will be discarded. Otherwise, the elevated concentrations will be retained in the data sets. The outlier test methodology presented in the USEPA guidance (USEPA, 1992) assumes that the data, except for the suspect observation, are normally or lognormally distributed. Since a nonparametric alternative is not provided in the guidance, if the Shapiro-Wilk test indicates that the data are not normally or lognormally distributed, a lognormal distribution will be assumed. The reason for this default assumption is that lognormal data typically have one or more elevated concentrations. By assuming lognormality, classifying a high lognormal measurement as an outlier just because the test assumptions were violated can be avoided (USEPA, 1992). Example calculations and tables of outlier test results will be presented in an appendix of the *Background Sampling and Data Evaluation Report*.

2.1.2 Calculating UTLs

The process that will be followed for calculating one-sided upper 95 percent UTLs is outlined in Figure 2-2. If an inorganic has no detected concentrations or an organic has one detected concentration, the detection limit will become the UTL. If there are one or more detected concentrations for inorganics or two or more detected concentrations for organics, the proportion of nondetects (P_{ND}) will be calculated.

Based on the value of P_{ND}, several outcomes are possible. If the P_{ND} is high (greater than or equal to 0.90), then a Poisson tolerance limit will be calculated (USEPA, 1992, Section 2.2.5). If the P_{ND} is between 0.50 and 0.90, then a nonparametric tolerance limit will be calculated (USEPA, 1992, Section 4.1.1).

If the P_{ND} is less than 0.50, then the data will be tested for lognormality using the Shapiro-Wilk test (USEPA, 1992, Section 1.1.4) on the natural logarithm transformed data. The Shapiro-Wilk test is considered one of the very best tests of normality available (USEPA, 1992, Section 1.1.4). If the test on the natural logarithm transformed data is significant ($PROB < W < 0.05$; SAS, 1990, Chapter 42), then the data are not lognormally distributed and the Shapiro-Wilk test will be performed on the non-transformed data. If the test on the natural logarithm transformed data is not significant ($PROB < W \geq 0.05$), then the UTL will be calculated using the natural logarithm transformed data. If the test on the non-transformed data is significant, then the data are not normally distributed and a nonparametric tolerance limit will be calculated. If the test on the non-transformed data is not significant, then the data are normally distributed and the UTL will be calculated using the non-transformed data. Note that if the P_{ND} is between 0.15 and 0.50, either

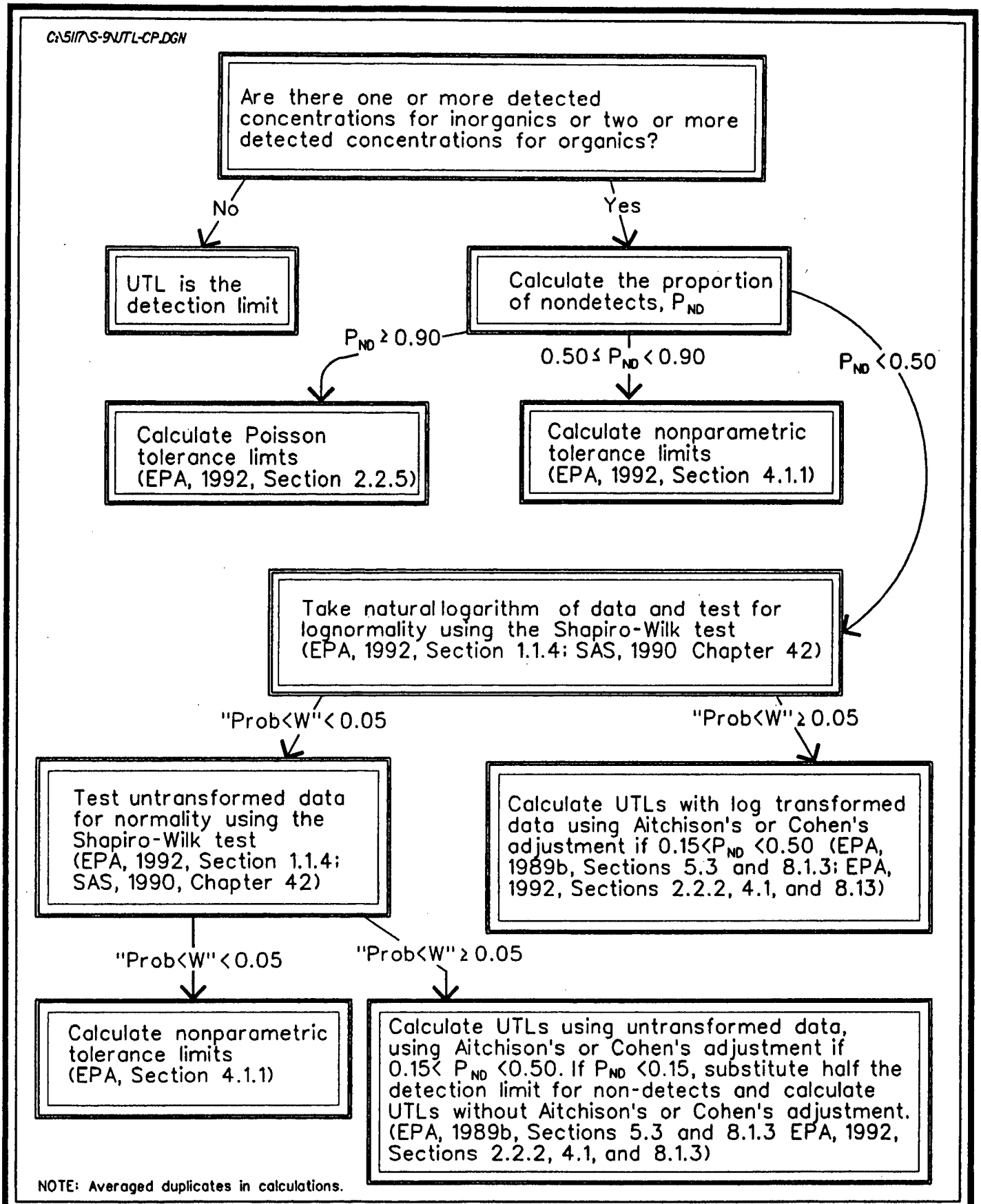

Figure 2-2
UTL CALCULATION PROCESS
TECHNICAL EVALUATION PLAN

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Cohen's or Aitchison's adjustment must be used, depending on the correlations from the censored and detects-only probability plots (USEPA, 1989, Section 8.1.3; USEPA, 1992, Section 2.2.2).

2.1.3 Procedure for Handling Nondetects and Duplicates

As recommended by USEPA (1992; Section 2.0), if 15 percent or fewer of all samples are less than the analytical detection limit, they will be replaced with half the detection limit. Additionally, duplicate samples will be averaged. These practices will be applied to the outlier test and the UTL calculations.

2.1.4 Use of UTLs in Screening

Each inorganic data point from each study area will be compared with its corresponding UTL. Study area values exceeding the UTL will be highlighted as potentially affected by mission activities. If any study area samples exceed the UTL for any inorganic constituent, the study area will be carried forward to the risk-based screening (see Section 2.2).

The study area will be eliminated from further investigation if (1) no organic constituents were detected and (2) no inorganic constituents exceed the background UTL screen as defined above. From Section 1.4, detection of organic constituents is presumed to indicate that the constituent is elevated above background. If either (1) or (2) are not true (i.e., at least one chemical exceeds background), the concentrations of exceeding constituents will be compared to risk-based screening concentrations.

2.2 Risk-Based Screening

Risk-based screening will be performed for each inorganic constituent that fails the background screening comparison as defined in Section 2.1 and each organic constituent. Concentrations will be compared with the following risk-based screening levels:

- Soil
  The most conservative of the pathway-specific (inhalation, ingestion) USEPA Soil Screening Levels (SSLs),
  USEPA Region IX Preliminary Remediation Goals (PRGs), and the IEPA Tiered Approach to Cleanup Objectives (TACO) Tier 1-Residential Migration to Class II Groundwater Values
- Groundwater
  Illinois Administrative Code (IAC) Part 620 Groundwater Standards

The SSLs were developed by USEPA as a screening tool to facilitate the RI process. Generally, if constituent concentrations fall below these generic levels, then no further study or action is warranted for residential use of that area. The PRGs were developed by USEPA Region IX using current USEPA toxicological data with reasonable maximum exposure factors to estimate concentrations that are generally agreed to be "safe" for humans. The TACO values were developed by IEPA to provide a risk-based tiered approach for protection of human health and the environment under programs administered by IEPA. If risk-based screening levels have not been published in any of the above-referenced sources, but sufficient toxicological data are available to calculate either a SSL, PRG, or TACO in accordance with methods published by USEPA and IEPA, a screening level may be estimated in accordance with those methods.

The risk-based screening process was presented previously in Figure 2-1. If a study area passes the comparison to inorganic background test or has one or more constituents that fail the comparison to inorganic background test of Section 2.1 but inorganic and organic constituents pass the relevant risk-based screening level, then the study area will be considered for No Further Action. If a study area has one or more inorganic constituents that fail the comparison to background test of Section 2.1 and/or one or more inorganic or organic constituents that fail the relevant risk-based screening levels, then the study area will be carried forward to the next step in the screening process.

In the next step of the screening process, the potential risk per constituent is calculated for those inorganic and organic constituents exceeding the risk-based screen. For potentially carcinogenic constituents, the following formula will be used:

$$RS_c = 10^{-6} \times \frac{constituent\ concentration}{risk\text{-}based\ screening\ level}$$

where, RS_c = constituent potential carcinogenic risk value.

For non-carcinogenic constituents, the following formula will be used:

$$RS_n = \frac{constituent\ concentration}{risk\text{-}based\ screening\ level}$$

where, RS_n = constituent potential non-carcinogenic hazard quotient.

Cumulative potential carcinogenic risk values and hazard quotients will be calculated, by study area, for all analytes failing the risk-based screen using the following formulas:

$$RS_{ca} = RS_{c1} + RS_{c2} + RS_{c3} + RS_{c4} + \ldots\ldots$$

where, RS_{ca} = study area cumulative potential carcinogenic risk; and

$$RS_{nt} = RS_{n1} + RS_{n2} + RS_{n3} + RS_{n4} + ...$$

where, RS_{nt} = study area cumulative potential non-carcinogenic hazard index.

If the study area cumulative calculations do not exceed risk-based criteria (i.e., 10^{-6} or HI = 1.0), the study area will be considered for No Further Action in the Technical Memorandum. If the study area cumulative calculations exceed the risk-based criteria, the study area will be further evaluated in the Technical Memorandum.

The results of the risk-based screening process will be evaluated for each study area. Depending on the number, type, and concentration of the study area constituents that fail the risk-based screening process, study areas may be recommended for No Further Action even if a few constituents fail the process. Such a recommendation is subject to BCT review and will be fully documented in the Technical Memorandum. Such a recommendation will also depend on the total number of samples collected at the study area as well as the concentrations of the "failing" constituents in the remaining samples.

2.3 Ecological Screening

Those study areas carried forward to the Technical Memorandum will undergo a qualitative ecological screening in the Technical Memorandum. In this screening, the study areas will be evaluated for significant or sensitive biological receptors, or pathways to significant or sensitive biological receptors. Study areas adjacent to or with pathways to ravines, bluffs, shoreline, and Lake Michigan are anticipated to be the more likely candidates for such receptors or pathways. Study areas that do not have significant or sensitive receptors or pathways to such receptors will be identified for No Further Action.

Data will be reviewed for those study areas identified above as having significant or sensitive biological receptors, or pathways to significant or sensitive biological receptors. COPCs for ecological receptors will be tentatively identified based upon persistence and tendency to bioaccumulate, media and extent of contamination, potential pathways of exposure, ecotoxicity for endpoints relevant to populations, and other factors. Environmental data for surface water and sediments will be compared to relevant ecotox screening values available from USEPA. In accordance with USEPA Region V Biological Technical Assistance Group guidance, total metal concentrations will be used in the screening procedure (USEPA, 1996). Where screening values are not available from USEPA, values from other sources will be used (e.g., Ontario Ministry of the Environment and Energy). In the absence of readily available benchmarks for screening, professional judgement will be exercised.

The evaluation will be based upon generally qualitative or screening level evaluations, but will be conservative. Study areas that have a significant potential for adverse effects to ecological receptors based upon this assessment will be referred to the RI/BRA for quantitative evaluation. Study areas determined not to have a significant potential for adverse effects will be identified for No Further Action.

3.0 Identification of COPCs for the BRA

Study areas that fail the screening tests of Section 2 will be carried forward to the RI/BRA. Available data relevant to each study area will be evaluated. Using relevant data, constituent concentrations above background and COPCs will be identified for the study areas using more rigorous statistical procedures to determine if the constituents are significantly elevated above site-specific background.

Recommended methods are based on "Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities" (USEPA, 1989b), as recommended by RAGS (USEPA, 1989a) in addition to the subsequent "Addendum to Interim Final Guidance" (USEPA, 1992). These methods were recommended for RCRA compliance monitoring to determine if downgradient wells at a RCRA facility were significantly elevated above background (upgradient) wells. The methods are, however, equally valid for hypothesis testing with soils, sediment, or surface water data. The methods were selected considering small sample size, low frequency of detection (<50 percent), and uncertainty regarding the underlying distribution of the data (e.g., normality). The method is as follows:

1. Edit data sets with unusually high detection limits:
   (a) Replace values listed as less than the detection limit with one-half the detection limit (EPA, 1989a).
   (b) Determine goodness of fit to normal and lognormal distributions, using the Shapiro-Wilk test (Gilbert, 1987; USEPA, 1992). The Shapiro-Wilk test can be used to test lognormality by taking the natural logarithms of the data, and then testing for normality.
   (c) If the coefficient of variation (standard deviation divided by the mean) is less than 1.2, use normal procedures (e.g., equation 11.6 of Gilbert, 1987; see also Gilbert, p. 164, for the coefficient of variation criterion).
   (d) If the coefficient of variation exceeds 1.2, select the distribution type (normal or lognormal) that best fits the data according to the Shapiro-Wilk test. Then use Gilbert equation 11.6 for normal, or Gilbert equation 13.13 for lognormal, to calculate the upper 95 percent confidence limit of the mean, UCL_{95}.
   (e) If the UCL_{95} exceeds the maximum detected concentration, delete nondetects where the detection limit is greater than the maximum detected value.
2. Determine the percentage of nondetects for each analyte at each study area, %nd.
3. If %nd < 15, the residuals are found to be normally or lognormally distributed by the Shapiro-Wilk test, and the variances are homogeneous, apply parametric one way analysis of variance (ANOVA) using normal or log transformed data (USEPA, 1992). If the data do not meet the assumptions of normality or lognormality and

homogeneity of variances, apply nonparametric ANOVA (see step 4 below). If the results of the parametric ANOVA are that a particular constituent for a study area(s) is significantly elevated above the background data, then a multiple comparison procedure will be used to determine which study area(s) are elevated.

4. If %nd > 15 or if %nd < 15 and the assumptions for parametric ANOVA are not met (see step 3 above), apply nonparametric Wilcoxon rank sum test (also referred to as the Mann-Whitney U test) if the comparison involves two groups or the Kruskal-Wallis test if the comparison involves three or more groups. . If the Kruskal-Wallis test is applied and determines a significant difference among groups, the critical difference for comparisons will be calculated (USEPA, 1989b, Section 5.2.2; 1992, Section 3.1) to determine which specific groups are different.

In each of the tests described in steps 3 and 4, a significance level, p, of 0.1 will be used.

This procedure, although somewhat complicated, has several advantages over alternative, but somewhat simpler, methods that may also be appropriate to the data. The advantages of this method are:

- It is completely consistent with USEPA guidance (USEPA, 1989a; 1989b; 1992);
- It is robust, (i.e., it is valid for most plausible data sets).

These methods are designed to determine if the mean of the study area data set is significantly greater than the mean of the background data set. If so, the constituent would be a COPC for that study area and included in the quantitative BRA.

The hypothesis tested by these methods is directly relevant to exposure assessment, which is based on a conservative estimate (UCL_{95}) of the mean exposure concentration. These methods are less relevant for the identification of small hot spots of contamination that may only affect one or a few samples. To redress the potential concern that hot spots of contamination may be overlooked by application of these statistical procedures, these results will be reviewed in the context of the UTL test results conducted during the screening level analysis. Specifically, if a constituent exceeded the UTL, but its mean was not significantly elevated above background, data for this constituent will be reviewed to determine if the exceedance was the result of hot spot contamination. If so, the constituent would be retained as a COPC.

The UTL method is more sensitive to hot spots, although it can be subject to false positives if the study area data set has a large number of samples. Only one or a few samples may exceed the UTL as a result of the natural variability in background concentrations even though the study area

may be unaffected by mission activities. Factors to be considered in evaluation of the presence of hot spots, and inclusion as a COPC for that reason, will include:

- spatial correlation of elevated samples;
- relative magnitude of exceedance of the UTL (i.e., 10 percent higher or 100 times higher);
- other evidence of mission activity at the elevated sampling locations; and
- whether the constituent is known to be associated with mission activities conducted at the study area.

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