TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE

(Read instructions on reverse side prior to initiating this form)

DATE: 2/4/03

TRANSMITTAL NO: 17.21.91-02- 001

SECTION I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS (This section will be initiated by the Contractor)

TO:
U.S. Army Corps of Engineers - New Bedford Resident Office
130 Sawyer Street
New Bedford, MA 02746
Attention: Mr. Maurice Beaudoin

FROM:
Foster Wheeler Environmental Corporation
New Bedford Harbor Superfund Site Project Office
130 Sawyer Street
New Bedford, MA 02746

CONTRACT NO: DACW33-94-D-0002

CHECK ONE:
X THIS IS A NEW TRANSMITTAL
___ THIS IS A RESUBMITTAL OF TRANSMITTAL ______

SPECIFICATION SECTION NO: (Cover only one section with each transmittal) NA

PROJECT TITLE AND LOCATION: New Bedford Harbor Superfund Site OU#1 and OU#2 Remedial Design and Remedial Action

ITEM NO. a.	DESCRIPTION OF ITEM SUBMITTED (Type, size, model number, etc.) b.	MFG. OR CONTR. CAT. CURVE DRAWING OR BROCHURE NO. (See instruction No. 8) c.	NO. OF COPIES d.	CONTRACT REFERENCE DOCUMENT: SPEC. PARA. NO. e.	CONTRACT REFERENCE DOCUMENT: DRAWING SHEET NO. f.	FOR CONTRACTOR USE CODE g.	VARIATION (See instruction No. 6) h.	FOR CE USE CODE i.
1	Draft Technical Memorandum	na	2	na	na	GA	na	
	Decision Rules for Evaluating Individual Confirmatory Sampling Results to Support							
	Field Decisions for Supplemental Sediment Removal Prior to Formal Compliance							
	Demonstration Testing							
2	Meeting Minutes from 12/2/02							
	TSCA Issues & Attachment							

REMARKS

FWENC Document #:2003-017-0022

Distribution:

M. Beaudoin	J. Brown	R. Francisco
G.Morin	P. Craffey	J. Kraycik
R. Simeone	G. Willant	H. Douglas
C. Turek	J. Holwell	R. Marnicio
D. Dickerson	M. Otten	TO 17

I certify that the above submitted items have been reviewed in detail and correct and in strict conformance with the contract drawings and specifications except as otherwise stated.

Helen Douglas

NAME AND SIGNATURE OF CONTRACTOR

SECTION II - APPROVAL ACTION

ENCLOSURES RETURNED (List by Item No.)

NAME, TITLE AND SIGNATURE OF APPROVING AUTHORITY

DATE

USACE CONTRACT NO. DACW33-94-D-0002
TASK ORDER NO. 017
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

DRAFT
TECHNICAL MEMORANDUM

DECISION RULES FOR EVALUATING INDIVIDUAL CONFIRMATORY SAMPLING RESULTS TO SUPPORT FIELD DECISIONS FOR SUPPLEMENTAL SEDIMENT REMOVAL PRIOR TO FORMAL COMPLIANCE DEMONSTRATION TESTING

NEW BEDFORD HARBOR SUPERFUND SITE
New Bedford, Massachusetts
February 2003

Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

2003-017-0022
2/3/03

USACE CONTRACT NO. DACW33-94-D-0002
TASK ORDER NO. 017
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

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TECHNICAL MEMORANDUM

DECISION RULES FOR EVALUATING INDIVIDUAL CONFIRMATORY SAMPLING RESULTS TO SUPPORT FIELD DECISIONS FOR SUPPLEMENTAL SEDIMENT REMOVAL PRIOR TO FORMAL COMPLIANCE DEMONSTRATION TESTING

NEW BEDFORD HARBOR SUPERFUND SITE
New Bedford, Massachusetts

February 2003

Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

Prepared by

Foster Wheeler Environmental Corporation
133 Federal Street
Boston, Massachusetts 02110

Revision	Date	Prepared By	Approved By	Pages Affected
0	2/3/03	R. Marnicio	H. Douglas	All

2003-017-0022
2/3/03

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LIST OF ACRONYMS

CDA	Compliance Demonstration Area
DQO	Data Quality Objective
fd	Fraction of the total number the number of confirmatory samples collected from a CDA with concentrations above the applicable target PCB clean-up level for that CDA
MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
PCB	Polychlorinated Biphenyl
PTC	The characteristic sediment PCB concentration in the "clean" portion of the CDA expressed as a fraction of the applicable target PCB clean-up level for that CDA
ppm	parts per million
ROD	Record of Decision
TCUL	Target PCB Clean-Up Level
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency

1.0 PURPOSE

The purpose of this technical memorandum is to present the technical justification for guidance to support field decisions regarding supplemental sediment removal prior to conducting the formal compliance demonstration testing for that area. The memorandum provides the upfront rationale and a process to facilitate and standardize these decisions that will affect the operational sequencing and construction costs associated with the project.

Compliance demonstration testing calculations using the results of the confirmatory sampling conducted in a Compliance Demonstration Area (CDA) can only be performed formally when all the specified confirmatory samples for that CDA have been collected and analyzed. In general, analytical results for a given CDA will be received over some period of time as the dredging or excavation progresses through the CDA. It would be advantageous to track these results as they become available so that an early indication may be obtained as to whether the specified compliance metric for that CDA will ultimately comply with its corresponding target PCB clean-up level(s) (TCUL). If one or more relatively high post-removal PCB sediment concentrations are observed early in the dredging or excavation of the CDA, it becomes less likely that the CDA will ultimately comply with its target level(s) when the formal compliance testing calculations are performed. If an appropriate action level can be identified relative to an individual sample that could effectively warn of this situation, a field decision could be made to immediately remove additional sediment from that location or those locations prior to relocation of the removal equipment outside the CDA. Following this supplemental removal, the area would be re-sampled and the new sample result for that location should be lower and result in an increased probability that the CDA will achieve its target level(s).

2.0 APPROACH AND ANALYSIS

The calculated value of the compliance metric for a CDA (i.e., either an area average or a 95% upper confidence limit (UCL)) ultimately depends on the full set of confirmatory samples collected (e.g., the actual concentrations observed and their relative variability). As such, an appropriate action level for any individual sample being collected for a CDA will depend on the results that are, or *will be*, obtained for the other specified confirmatory samples collected in that CDA. The appropriate action level also will depend on the form of the compliance metric, the absolute magnitude of the TCUL, and the number of confirmatory samples being collected in that CDA. Consequently, defining an appropriate action level for this purpose prior to sampling must be based, in part, on assumptions and professional judgment. A modification or update to this memorandum may be appropriate following the results of applying these rules in the field.

Toward this end, a series of "what if?" calculations were performed to identify an individual sample sediment concentration that may be a suitable and effective action level for justifying a field decision for additional removal at a location prior to the formal compliance demonstration testing using all the specified confirmatory sample results. Hypothetical compliance calculations were performed relative to two different cases of confirmatory sampling to explore the factors affecting this concentration:

Case 1: For CDAs where the TCUL is 10 ppm or 50 ppm (i.e., the indirect human health protection target levels) and the compliance metric is an area average sediment concentration of the confirmatory samples collected and analyzed as specified in the Final Confirmatory Sampling Approach Document; and

Case 2: For CDAs where the TCUL is 1 ppm or 25 ppm (i.e., the direct contact human health protection target levels) and the compliance metric is a 95% UCL of the mean sediment concentration of the confirmatory samples collected and analyzed as specified in the Final Confirmatory Sampling Approach Document.

These "what if?" calculations and a detailed discussion of the results and their implications are presented in Attachment A. The average sediment concentration (under Case 1) was calculated for two distinct conditions, reflecting different characteristic patterns of the confirmatory sampling results that would be available at that point in the field work. These patterns correspond to data distributions being compiled that indicate that there:

(1) may be an isolated "hot spot" within the CDA (i.e., a single high result within a broad area of low PCB concentration) or

(2) does not appear to be a "hot spot" within the CDA (i.e., the analytical results are more uniform, varying somewhat around the TCUL for that CDA).

As discussed in Attachment A, the analysis of these two conditions suggests that one single action level would not be appropriate for all Case 1 conditions in consideration of the purpose defined in Section 1.0 of this memorandum.

Some regulatory programs for assessing compliance with an area average concentration have specified a maximum concentration of the contaminant that may be left in place in, for example, the soil or sediment regardless of the magnitude of the calculated average. This maximum concentration may be referred to as the "ceiling concentration." A ceiling concentration is established at times to further constrain the range of environmental conditions and potential exposures in the area when relatively high variability exists in the residual concentrations. The Record of Decision (ROD) did not specify a ceiling concentration for this project, nor did it indicate that a maximum concentration must or should be identified. The specification of a ceiling concentration in some similar compliance programs (including the Massachusetts Contingency Plan (MCP)) suggests that the Site Managers may choose to establish a ceiling concentration for PCBs in sediment. In that event, the specification is likely to depend on the context in which the sediment is found (e.g., in a direct contact exposure area or an indirect contact exposure area; in a heavily utilized or a seldomly used area). Few benchmarks are available for recommending what this ceiling sediment PCB concentration should be. The MADEP's Upper Concentration Limit (UCL) for PCBs in soil is 100 ppm. The UCL under the MCP plays a similar role to the ceiling concentration - representing a maximum concentration that should not be left in place from the perspective of promoting the public welfare (not necessarily to prevent or reduce impacts to people or the environment). The corresponding reportable concentrations and Method 1 standards for PCBs in soil are 2 ppm, and the 2-hour notification threshold in soil is 10 ppm. Relative to PCBs in soil, the ceiling concentration was set between 5 and 50 times higher than the corresponding risk-based standard. This would translate to a ceiling concentration between 50 and 500 ppm in a CDA with a TCUL of 10 ppm, and a ceiling concentration of between 250 and 2,500 ppm in a CDA with a TCUL of 50 ppm. As is illustrated in Attachment A, the specification of a ceiling concentration would only be of practical significance relative to Case 1 CDA (i.e., CDAs with TCULs of either 10 ppm or 50 ppm) because of the explicit restriction of higher concentrations associated with the 95% UCL compliance metric.

3.0 RESULTS AND RECOMMENDATIONS

As discussed above, the calculated value of the compliance metric for any CDA (i.e., either an area average or a 95% UCL) will ultimately depend on the full set of confirmatory sampling results reported for that area. As such, an appropriate action level for any individual sample being collected for a CDA will depend on the results that are, or *will be*, obtained for the other samples collected in that CDA. The appropriate action level also will depend on the form of the compliance metric, the absolute magnitude of the TCUL, and the number of confirmatory samples being collected in that CDA. Consequently, as was noted above, defining an appropriate action level for this purpose prior to any sampling must be based on assumptions and professional judgment. The analysis presented in Attachment A was aimed at exploring the relationship between a number of these factors and assumptions.

The action levels recommended below are supported by the information and data that is now available (i.e., before any confirmatory samples have actually been collected and analyzed) and a systematic evaluation. Unfortunately, we do not know what the distribution and nature of the "other" confirmatory sampling results will be in any particular CDA at this point in time. In addition, actual conditions to be encountered in the field are acknowledged to be more complicated than the simplified scenarios defined for this analysis. That being said, the analysis in Attachment A adds confidence that the action levels recommended are reasonable relative to supporting field decisions about supplemental removal.

Based on these analyses, the following action levels are recommended for application during sediment removal actions to aid field decision making regarding performing additional (supplemental) sampling in areas previously completed:

Case 1: CDAs where the TCUL is 10 ppm or 50 ppm and there is an Apparent Hot Spot

> Remove additional sediment at a location (within the confirmatory sampling grid square associated with the result) if the individual sample result is greater than five (5) times the TCUL for that area (i.e., >50 ppm for a CDA with a TCUL of 10 ppm and > 250 ppm for a CDA with a TCUL of 50 ppm). Use the location of the confirmatory sample as the center of the supplemental removal area, which would be the same size as one confirmatory grid in extent. The depth of the supplemental removal would be defined by the set of sample results obtained for that location.

Case 1: CDAs where the TCUL is 10 ppm or 50 ppm and there is No Apparent Hot Spot

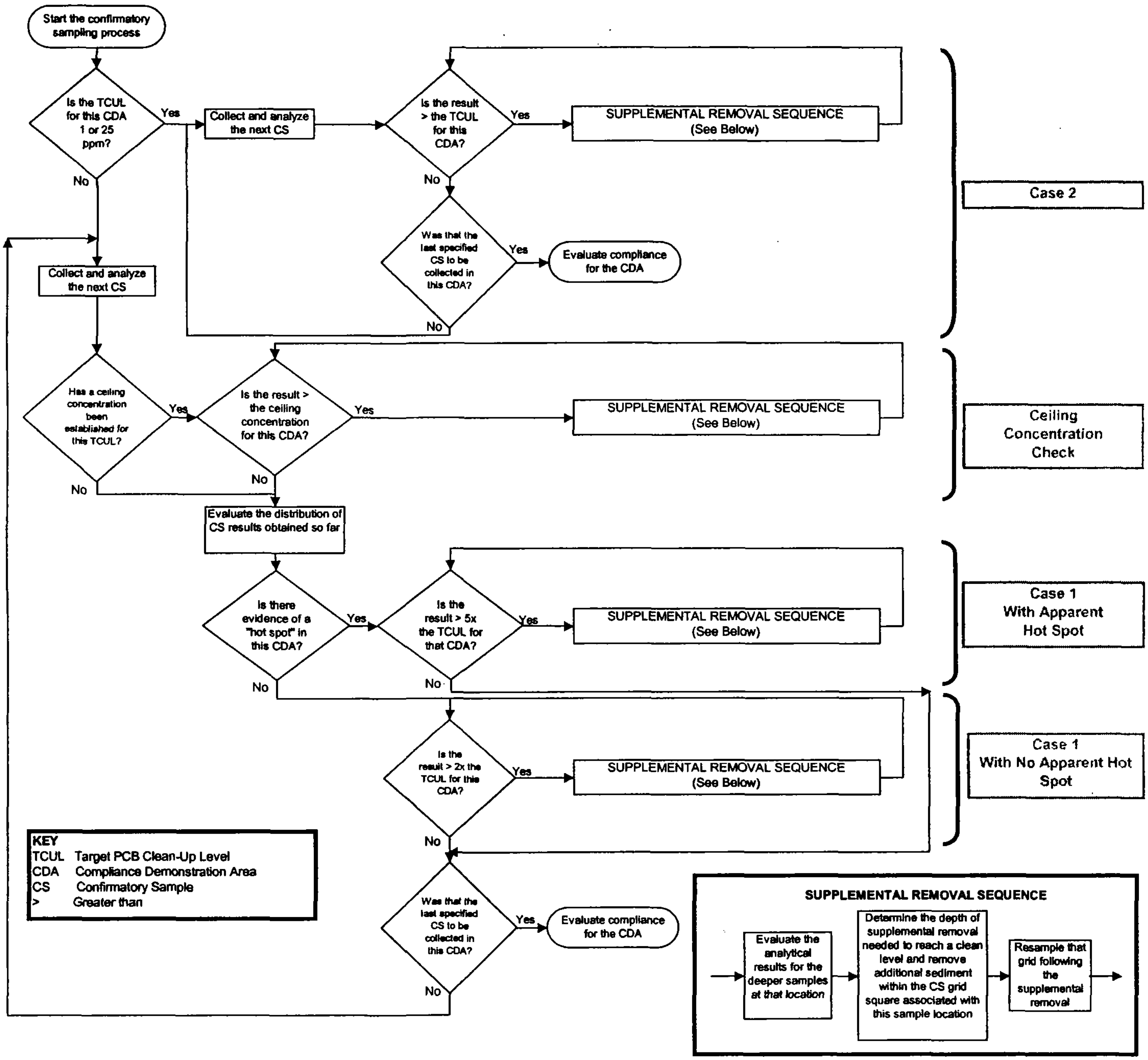
> Remove additional sediment at a location (within the confirmatory sampling grid square associated with the result) if the individual sample result is greater than two (2) times the TCUL for that area (i.e., >20 ppm for a CDA with a TCUL of 10 ppm and > 100 ppm for a CDA with a TCUL of 50 ppm). The extent and depth of the supplemental removal would be established as noted above.

Case 2: All CDAs where the TCUL is 1 ppm or 25 ppm

> Remove additional sediment at a location (within the confirmatory sampling grid square associated with the result) if the individual sample result is greater than the TCUL for that area (i.e., >1 ppm for a CDA with a TCUL of 1 ppm and > 25 ppm for a CDA with a TCUL of 25 ppm). The extent and depth of the supplemental removal would be established as noted above.

Figure 1 illustrates the process for evaluating the early confirmatory sampling results from a CDA to make decisions about supplemental sediment removal within that CDA prior to the formal compliance check for that CDA using the full set of specified confirmatory samples. While no specific ceiling concentration has or may be established, the potential role of a ceiling concentration set at a level higher than the TCULs for the Case 1 CDAs is reflected in the flowchart. A simplified version of this flowchart or an equivalent checklist is envisioned for use in the field.

Figure 1 Flowchart for Applying the Field Decision Rules Relative to Supplemental Sediment Removal Prior to Formal Compliance Demonstration Testing



DEFINITIONS: "Hot Spot" = A single high concentration measured within a broad area of low PCB concentration.
"Ceiling Concentration" = The maximum sediment PCB concentration that may be left in place in consideration of factors other than the direct or indirect exposure of people or the environment.

ATTACHMENT A

ATTACHMENT A

Case 1: A CDA with an Indirect Human Health Protection Target PCB Clean-Up Level

This case involves the calculation of an area average sediment concentration. The equation for calculating a CDA-specific average is:

$$EQN\,1 \qquad Average\,Concentration = \frac{\sum Confirmatory\,Sample\,Concentrations}{Total\,Number\,of\,Confirmatory\,Sampling\,\mathrm{Re}sults}$$

A simplified description of the conditions that would be encountered following sediment removal in a CDA under the Case 1 assumption is that there would be one or more, relatively higher concentration results together with a larger number of "clean" results (i.e., concentrations that are less than the applicable TCUL for that CDA). If some assumptions are made (see below), the relationship between the parameters of most interest to identifying an effective action level (as described in the main text) can be explored:

N	=	Number of confirmatory samples specified to be collected in the CDA (unitless)
n	=	Number of confirmatory samples that ultimately will be "dirty", or have a PCB concentration higher than the applicable target PCB clean-up level (unitless)
TCUL	=	The applicable target PCB clean-up level for that CDA (mg/kg or ppm)
PTC	=	The characteristic sediment PCB concentration in the "clean" portion of the CDA expressed as a fraction of the applicable TCUL for that CDA (unitless) (i.e., the characteristic sediment PCB concentration in the "clean" portion of the CDA is PTC x TCUL)

Using these definitions, Equation 1 can be rewritten as:

$$EQN\,2 \qquad Average\,Concentration = \frac{n * C_{Dirty} + (N - n) * C_{Clean}}{N}$$

Where:

C_{Dirty}	=	The assumed characteristic PCB concentration in the sediment samples that exceed the TCUL applicable to that CDA (mg/kg or ppm)
C_{Clean}	=	The assumed characteristic PCB concentration in the sediment samples that do not exceed the TCUL applicable to that CDA (mg/kg or ppm)

Substituting in PTC * TCUL for C_{Clean}, and equating the Average Concentration to the TCUL (as the maximum value of the compliance metric), one gets:

$$EQN\,3 \qquad TCUL = \frac{n * C_{Dirty} + [(N - n) * (PTC\,x\,TCUL)]}{N}$$

Simplifying and collecting like terms leads to:

$$EQN\,4 \qquad C_{Dirty} = TCUL * [(\left(\frac{N}{n} \right) * (1 - PTC)) + PTC]$$

This simplified representation assumes that all the confirmatory sampling results will fall into one of only two categories: "clean" results at a specified concentration below the TCUL and "dirty" results at a specified higher concentration. In that situation, C_{Dirty} (or a parameter scaled from it) represents the individual sample action level discussed above. It was also seen that the ratio of C_{Dirty} to TCUL is easily formed (NOTE: The parameter "Multiplier" was defined for possible use in specifying the action level as a multiplicative factor times the TCUL):

$$EQN\,5 \qquad Multiplier = \frac{C_{Dirty}}{TCUL} = [(\left(\frac{N}{n} \right) * (1 - PTC)) + PTC]$$

Two different situations under Case 1 are likely to be encountered. The first is an apparent localized hot spot of high PCB concentration within the CDA. This situation would ideally be represented by 1 "dirty" sample being found within an otherwise "clean" area. In this situation, n = 1 and the Multiplier of Equation 5 becomes:

$$EQN\,6 \qquad Multiplier = [(N * (1 - PTC)) + PTC]$$

This relationship for the Multiplier ratio is plotted in Figure A1 as a function of N, for three values of PTC (i.e., 0.25, 0.50 and 0.75). It should be noted that the individual sample action level would be the product of the Multiplier and the TCUL. Figure A1 illustrates that relative to the Multiplier (and hence the individual sample action level for a given TCUL), observing "cleaner" confirmatory sample results outside the apparent hot spot and taking a greater number of confirmatory samples both act to increase the individual sample action level for the situation of a CDA with an apparent hot spot.

Table A1 further illustrates the value of the Multiplier for some special combinations of N, PTC and the two indirect human health protection target PCB clean-up levels. These specific values of N are those that minimally meet the Data Quality Objectives (DQOs) established for confirmatory sampling as defined in the Final Confirmatory Sampling Approach Document. The Multiplier values shown in Table A1 are the values from Figure A1 where the vertical lines intersect the plotted curves.

Again, the calculations supporting Table A1 and Figure A1 reflect the hypothetical hot spot assumption that only 1 confirmatory sample from the CDA has a relatively high concentration and the rest are "clean" (i.e., below the applicable TCUL). The degree of "cleanness" was characterized in terms of the fraction of the TCUL (e.g., all samples from areas not in the apparent hot spot being observed to be either 25%, 50%, or 75% of that target concentration). The range of values presented in Table A1 for PTC = 75% were used to recommend a conservative action level for the Case 1 situation in which there is an apparent hot spot (see the main text). This conservative specification reflects a recognition that actual confirmatory sampling results are likely to vary from the simple model assumed for these calculations.

Table A1 Back-Calculated Individual Sample Action Levels Based on an Area Average Assuming Only One Sample Location with a Sediment Concentration Above the Action Level (Case 1 with an Apparent Hot Spot)								
	TCUL = 10 ppm				TCUL = 50 ppm			
Characteristic Concentration of the "Clean" Confirmatory Samples [PTC*TCUL]	N = 31		N = 75		N = 9		N = 20	
PTC	**Action Level (ppm)**	**Multiplier**	**Action Level (ppm)**	**Multiplier**	**Action Level (ppm)**	**Multiplier**	**Action Level (ppm)**	**Multiplier**
PTC = 25%	235	**23**	565	**56**	350	**7**	762	**15**
PTC = 50%	160	**16**	380	**38**	250	**5**	525	**10**
PTC = 75%	85	**8.5**	195	**19**	150	**3**	288	**6**

The second situation that is likely to be encountered under Case 1 is the one where there is no apparent hot spot in the CDA and all the confirmatory sampling results cluster around the applicable TCUL for that CDA with some variability. In this situation, there may be a number of observed "dirty" results somewhat above the TCUL and a comparable number of "clean" results somewhat below the TCUL. In this situation, $n > 1$ and the characteristic "clean" concentration may be relatively closer in magnitude to the TCUL than was considered for the apparent hot spot situation. This situation may be a reasonable representation of the physical conditions that may result from contaminant suspension and re-deposition following dredging. Mathematically, this would correspond to an assumption that $PTC > 0.75$ (perhaps 0.80 or higher). One could express the number of confirmatory samples with concentrations above the TCUL as a fraction of the total number collected (i.e., as fd x N). Incorporating these assumptions, Equation 5 can be rewritten as:

$$EQN\,7 \qquad Multiplier = \frac{C_{Dirty}}{TCUL} = [((\frac{N}{fd * N}) * (1 - PTC)) + PTC]$$

$$EQN\,8 \qquad Multiplier = \frac{C_{Dirty}}{TCUL} = [((\frac{1}{fd}) * (1 - PTC)) + PTC]$$

This relationship for the Multiplier ratio is plotted in Figure A2 as a function of fd for three values of PTC (i.e., 0.7, 0.8 and 0.9). Again, it should be noted that the individual sample action level would be the product of the Multiplier and the TCUL. It is seen from Figure A2 that relative to the Multiplier (and hence the individual sample action level for a given TCUL), observing "dirtier" clean confirmatory sample results (i.e., a higher characteristic PTC for the "clean" confirmatory sample results) and observing a greater number of confirmatory samples above the TCUL (i.e., a larger fd) both act to decrease the single sample action level for the situation of a CDA with confirmatory sampling results clustered around the TCUL. The rectangular box highlighted in the lower left hand corner of Figure A2 indicates that if fd is 0.20 or less (i.e., less than 1 out of 5 of the early confirmatory samples comes back above the TCUL), Multipliers in the range of 1.5 to 3 predominate, depending on the exact value of PTC. These results were used to develop a recommendation for a conservative action level for the Case 1 situation in which no hot spot is apparent (see the main text).

Case 2: A CDA with a Direct Contact Human Health Protection Target PCB Clean-Up Level

Case 2 involves the calculation of a 95% UCL of the mean sediment concentration. The equation for calculating the 95% UCL of the mean is different depending on the shape of the distribution (e.g., whether the post-removal sediment concentrations for a CDA follow a normal (i.e., bell-shaped) distribution, a lognormal distribution, or one of many "non-parametric" distributions). For a normally distributed data set, the equation for the 95% UCL of the arithmetic mean is:

$$EQN9 \qquad 95\%UCL = X + t*(s/\sqrt{n})$$

Where:

X	=	The arithmetic mean of the confirmatory samples collected in the CDA (mg/kg or ppm)
s	=	The standard deviation of the confirmatory samples collected in the CDA (mg/kg or ppm)
n	=	The number of confirmatory samples collected in the CDA (unitless)
t	=	Statistic from the Student's t Distribution (unitless) [t is selected based on the level of confidence required (i.e., 95%) and the number of samples reflected in the database (i.e., n)]

For a lognormally distributed data set, the equation for the 95% UCL of the arithmetic mean is:

$$EQN10 \qquad 95\%UCL = \exp\left(X + 0.5 * Sy\verb|^|2 + Sy*H/\sqrt{n-1}\right)$$

Where:

X	=	The arithmetic mean of the logarithmically transformed confirmatory sample results for the samples collected in the CDA (unitless)
Sy	=	The standard deviation of the logarithmically transformed confirmatory sample results for the samples collected in the CDA (unitless)
n	=	The number of confirmatory samples collected in the CDA (unitless)
H	=	The H Statistic (unitless) [H is selected based on the level of confidence required (i.e., 95%), the number of samples reflected in the database (i.e., n), and the value of Sy]

The equations for the 95% UCL for other distributions are not as easily expressed. All of these have now been incorporated into a software package developed by USEPA called "ProUCL". It is anticipated that ProUCL may be used to calculate the 95% UCL values for the formal compliance demonstration testing if the data distributions in the Case 2 CDAs are non-parametric.

In developing the approach and specifying the DQOs for confirmatory sampling in the Final Confirmatory Sampling Approach Document, estimates were made of the post-removal data distributions in areas with different TCULs. This estimate was made using the pre-removal Site Characterization sediment concentrations. The analytical results for the sediment column were examined and the samples that exceeded the TCUL were conceptually "removed" leaving an underlying hypothetical contour of sediment that met the TCUL. The shallowest compliant sample at each location was then taken as the "post-removal surface" and the data from that sample was put into a data set for analysis. This exercise was done in multiple areas having each of the TCULs. The finding was that the projected post-removal data sets were generally normally distributed. Based on that finding, the development of a single sample action level for a CDA under Case 2 continued assuming the confirmatory sampling results would be approximately normally distributed.

Given this assumption, the relationship between the 95% UCL and the arithmetic mean of the confirmatory sample data set can be uniquely identified.

$$EQN\,11 \qquad Ratio\,of\,95\%\,UCL\,to\,Mean = \frac{95\%\,UCL}{X} = 1 + \left\{ t*\left(\left[\frac{s}{X}\right] / \sqrt{n}\right)\right\}$$

Table A2 shows the values of the 95% UCLs and the ratios of the 95% UCLs to the projected mean of the post-removal distribution calculated using Equations 10 and 11. Similarly calculated values for the requirement of 99% confidence also are shown in Table A2 for comparison.

Table A2
Calculated 95% and 99% UCLs for a Normal Distribution with a Mean at the Target Clean-Up Level and the Projected Post-Removal Standard Deviation for Target Clean-Up Levels of 1 ppm and 25 ppm

	TCUL = 1 ppm		**TCUL = 25 ppm**	
	N = 31		**N = 9**	
	Concentration (mg/kg or ppm)	**Ratio of 95% UCL to Mean Concentration**	**Concentration (mg/kg or ppm)**	**Ratio of 95% UCL to Mean Concentration**
95% UCL	1.09	**1.09**	28.8	**1.15**
99% UCL	1.12	**1.12**	30.6	**1.22**

These ratios can be used to identify the mean or average of a normal distribution of confirmatory sampling results with the specified standard deviation when the 95% UCL is set equal to the TCUL. This average may be used as another possible action level for field decision making. The equation for this average is given by:

$$EQN\,12 \qquad Mean\,of\,the\,Distribution = \frac{TCUL\,\{95\%\,UCL\}}{Ratio\,of\,the\,95\%\,UCL\,to\,the\,Mean}$$

For TCULs of 1 ppm and 25 ppm, the back calculated mean concentrations would be 0.92 ppm and 21.7 ppm, respectively. From these results, it can be seen that there is not much of a quantitative difference between the mean of the confirmatory sampling data set and the 95% UCL compliance metric. Any individual sample result exceeding the TCUL is likely to lead to an exceedance of the compliance metric. This finding is reflected in the recommendation that the TCUL be used as the action level for decision making for the Case 2 CDAs (see the main text).

FIGURE A1 CASE 1: With An Apparent Hot Spot

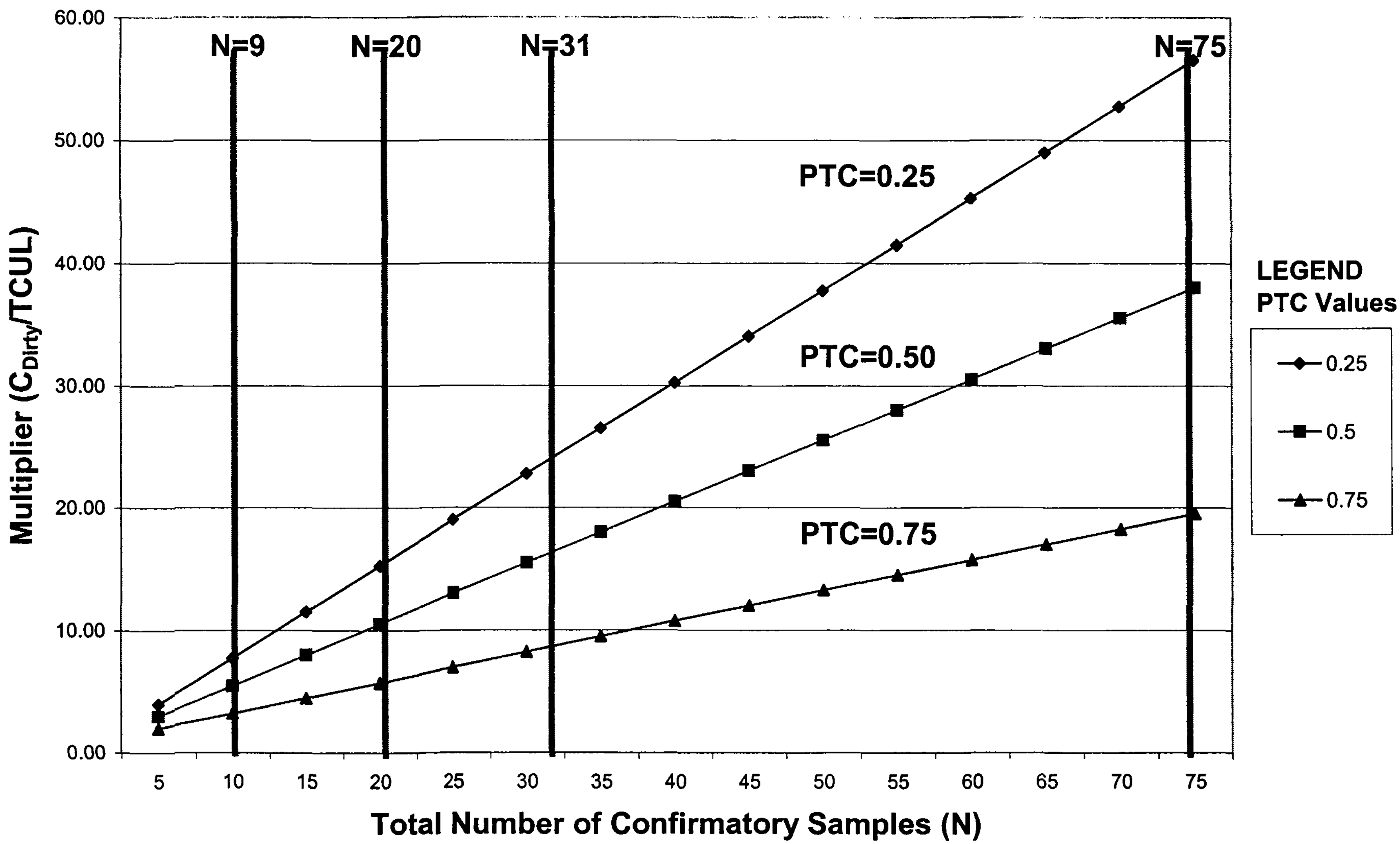
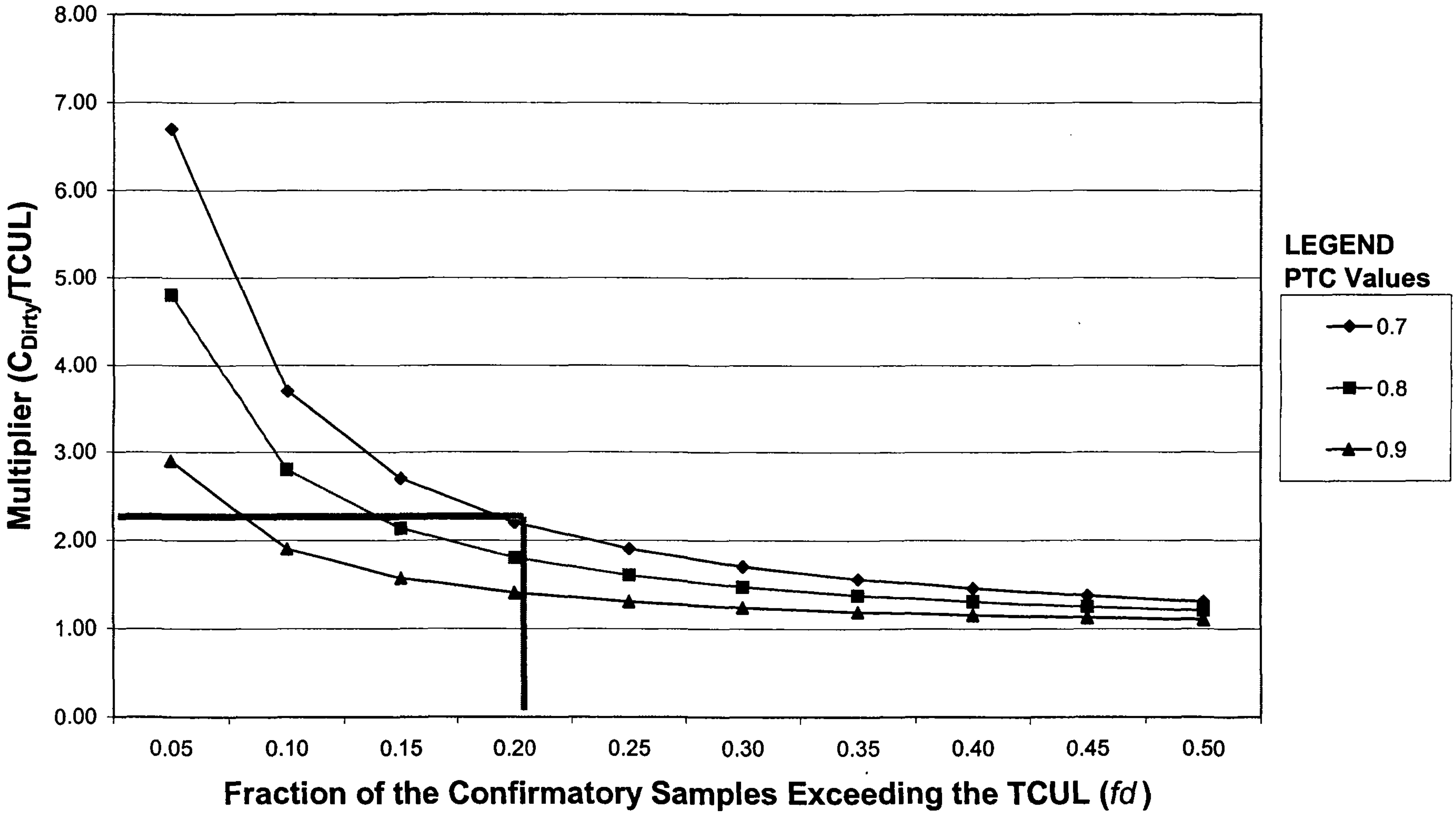


FIGURE A2 CASE 1: With No Apparent Hot Spot



Draft Tech Memo
Decision Rules For Evaluating.....

February 2003

The concept is fine, however, depending on the size of the grid established for a particular CDA (look into max grid size) additional sediment characterization samples may be needed to minimize the amount of additional dredging.

Not clear from Attachment A what the rationale was for selecting the multipliers of five and two.