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NAS CECIL FIELD, FL
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MEMORANDUM REGARDING CLEANUP STRATEGY FOR OPERABLE UNIT 5 (OU 5) SITE 15 SKEET RANGE NAS CECIL FIELD FL
8/16/1999
U S EPA REGION IV

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

61 Forsyth Street
Atlanta, Georgia 30303-3104

August 16, 1999

4WD-OTS

MEMORANDUM

SUBJECT: Cleanup Strategy for Site 15 Skeet Range
NAS Cecil Field, Jacksonville, FL

FROM: Ted W. Simon, PhD, DABT
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Office of Technical Services

TO: Debbie Vaughn-Wright
RPM, FFB

CC: Elmer W. Akin,
Chief, OTS

The purpose of this memorandum is provide you a cleanup strategy for the Site 15. This is a large area, approximately 90 acres, that was previously used as a skeet range. Based on conversations with you the future land use is green space/recreational. Techniques of both risk assessment and geostatistics were used to develop this strategy.

This memo will present details of the risk assessment methodology used, geostatistical methods and a delineation of the specific zones at Site 15 to be remediated.

Spatial Distribution of Lead at Site 15

There are two main areas at which high concentrations of lead in soil can be found at Site 15. These are shown graphically in figure 1. Remediation zones will be chosen for Site 15 based on the distribution of lead in

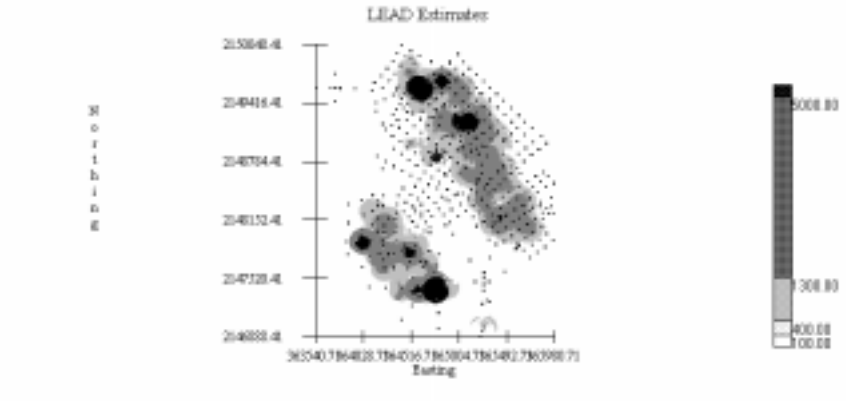

Figure 1. Spatial distribution of lead at Site 15. The darker areas represent concentrations above 5000 mg/kg. White areas are below 400 mg/kg.

soil shown in figure 1 and results of the risk assessment.

Methodology used in the Cleanup Strategy

The methodology presented here was carried through for a proposed cleanup level of 1300 mg/kg. Given the non-residential land use of the site and the expected future ecological conditions at the site, 1300 mg/kg is expected to be protective. The same methodology can be used to develop a cleanup strategy for Site 15 based on other cleanup levels. The choice of cleanup levels is the purview of the risk managers (e.g. State, Federal and DOD RPMs). Early in this memo, strategies for implementing cleanup levels of 1300 mg/kg and 400 mg/kg are presented. Details of the derivation of the cleanup strategy are presented for 1300 mg/kg only.

The Recreational Exposure Unit and Risk Assessment for Site 15

An exposure unit in a Superfund risk assessment is the geographical area about which a receptor moves and contacts a contaminated medium at random during the period of the exposure duration. Hence, the exposure point concentration (EPC) represents the long term average to which a receptor is exposed within the appropriate exposure unit. There is both a spatial and a behavioral component to the EPC, and the true but unknown average concentration is desired as the EPC because of the assumption of random contact.

The EPC is usually calculated as the 95% UCL which is the best estimate of the true arithmetic average concentration within an exposure unit that gives the benefit of the uncertainty to those potentially exposed.

For the proposed recreational land use, the size of the exposure unit is assumed to be 5 acres. 5 acres is approximately a square of about 350 yards on a side. It seems unlikely that a recreational receptor would roam over an area greater than 5 acres. A half-mile walking/jogging path will fit within 5 acres.

The methodology from the TRW was used to assess the exposure to lead by a pregnant female.[1] An acceptable average concentration for soil within an exposure unit is 1300 mg/kg. The equation and values used to derive this value are given below

$$RBRG = Pb_{Soil} = \frac{\left(PbB_{adult,central,goal} - PbB_{adult,0}\right) \cdot AT}{BKSF \cdot IR_{Soil} \cdot AF_{Soil} \cdot EF_{Soil}}$$

$$PbB_{adult,central,goal} = \frac{PbB_{fetal,0.95,goal}}{GSD_{i,adult}^{1.645} \cdot R_{fetal/maternal}}$$

where	RBRG	Risk-based remedial goal
	$PbB_{adult,\ central,\ goal}$	goal for the central estimate of blood lead concentration in adults

[1] *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*, EPA, December, 1996

$PbB_{fetal,\ 0.95,\ goal}$	goal for the 95th percentile blood lead concentration in the fetus
GSD_i	estimated value of the geometric standard deviation
$R_{fetal/maternal}$	proportionality constant between fetal and maternal blood lead concentrations
BKSF	biokinetic slope factor
IR_{Soil}	soil ingestion rate for adults
AF_{Soil}	absorption fraction for soil
EF_{Soil}	exposure frequency to contaminated soil

The table below gives the values used to calculate the RBRG.

Parameter	Value	Rationale
$PbB_{fetal,\ 0.95,\ goal}$	10 µg/dL	Considered to be a minimal effect level by the CDC
$GSD_{i,\ adult}$	2.1	Value recommended for an ethnically diverse population
$R_{fetal/maternal}$	0.9	Based on Graziano et al. (1990)
BKSF	0.4 µg/dL per µg/day	Based on Pocock et al. (1983) and Sherlock et al. (1984)
IR_{Soil}	0.05 g/day	Default value for adult non-residential exposure
EF_{Soil}	150 days/yr	Based on 3 trips/week to the recreational area
AF_{Soil}	0.12	Based on an absorption factor for soluble lead of 0.2 and a relative bioavailability of 0.6
AT	365 days	Based on a single year exposure
$PbB_{adult,\ 0}$	2.0 µg/dL	Central point of the plausible range

Consideration of Acute Risks to Children

Because the average concentration in each exposure unit needs to be less than 1300 mg/kg, some post-remedial concentrations in an exposure unit will be greater than 1300 mg/kg. It is conceivable that a pregnant woman may frequent the recreational area with a child. The child would not of course be highly exposed because the time spent would be short. Therefore, a child playing near his/her mother could possibly ingest up to 10 grams of soil. The highest levels remaining on site should not pose an acute risk to a child with a one-time high-level pica type of soil ingestion. For a cleanup level of 1300 mg/kg, the highest level left on site will be approximately 5000 mg/kg.

An alternative cleanup level would be 400 mg/kg. 400 mg/kg is a level widely accepted as protective of children.[2] For a cleanup level of 400 mg/kg, the highest level left on site will be approximately 1500 mg/kg.

One factor suggesting that relatively high levels of lead might remain on site is that lead taken as a bolus is much more poorly absorbed than lead ingested over a longer period of time. EPA is presently working with Drs. Stephen Roberts and Chris Saranko of the Center for Human and Environmental Toxicology of the University of Florida to develop lead concentrations in soil protective of acute exposure. This level will ensure that the not-to-exceed level at the site will be protective for those acutely exposed.

Ecological Risk Assessment

TTNUS, the Navy's contractor, developed remediation goals based on ecological receptors at Site 15.[3] The remediation goals range from 40 to 700 mg/kg. Risk management decisions based on ecological considerations explicitly consider tradeoffs to choose a cleanup level from within this range. Once a cleanup level has been chosen and if the remediation will be based on ecological concerns, a similar geostatistical analysis to the one presented below can be performed.

Geostatistical Analysis

Semivariograms were used to determine the spatial autocorrelation between samples. Briefly, to create a semivariogram, the variance in the concentration between pairs of samples is plotted as a function of the distance between them. The minimum distance between two samples is known as the lag. A tolerance can be assigned to a lag. For example, a lag might be 5 ± 2 meters. Colocated samples will have the same concentration and hence no variance.

A common theoretical model for the semivariogram is known as the spherical model.

$$\begin{aligned} \gamma(h) &= C\left(1.5\frac{h}{a} - 0.5\left(\frac{h}{a}\right)^3\right) && when\ h \le a \\ &= C && when\ h > a \end{aligned} \qquad (1)$$

Where $\gamma(h)$ = variance as a function of distance
h = distance
a = distance to achieve sill value
C = sill value

[2]USEPA, *Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead Contaminated Soil.* July 14, 1994.

[3]TTNUS, Ecological Remediation Goals for Soil at Site 15, September, 1998

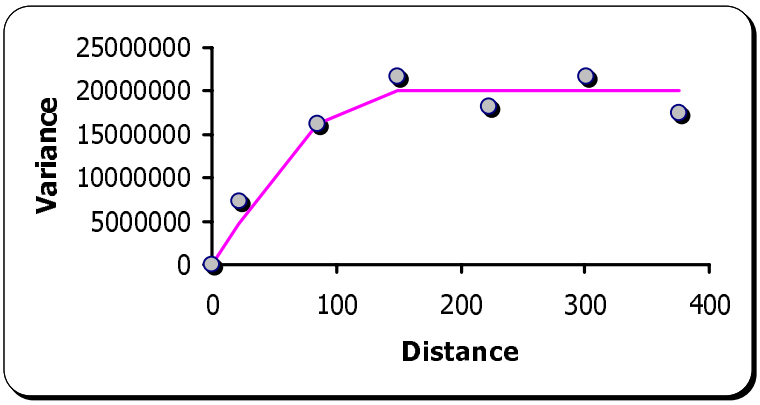

Figure 2. Experimental and theoretical semivariograms fit to the Site 15 data. A spherical model was used for the theoretical semivariogram.

To develop a semivariogram, an assessor must choose the number of lags or distance increments, the lag distance and the tolerance about the lag distances. A number of computer programs exist to calculate semivariograms. SADA (Robert Stewart, ORNL) was used for this analysis. The spherical model is then fit to the experimental semivariogram. In figure 2, the sill value was just less than 20,000,000 and the distance at the sill value was 140 meters.

Considering the range of influence for each sample to be 140 meters, each exposure unit defined as a five acre square area (320m x 320m) would encompass the range of influence of most samples within the exposure unit. Hence, Site 15 was divided into 99 five acre blocks each 320m x 320m. Each of these would represent an exposure unit. If the range of influence of a sample is greater than the size of an exposure unit, then areas greater than a single exposure unit will need to be remediated.

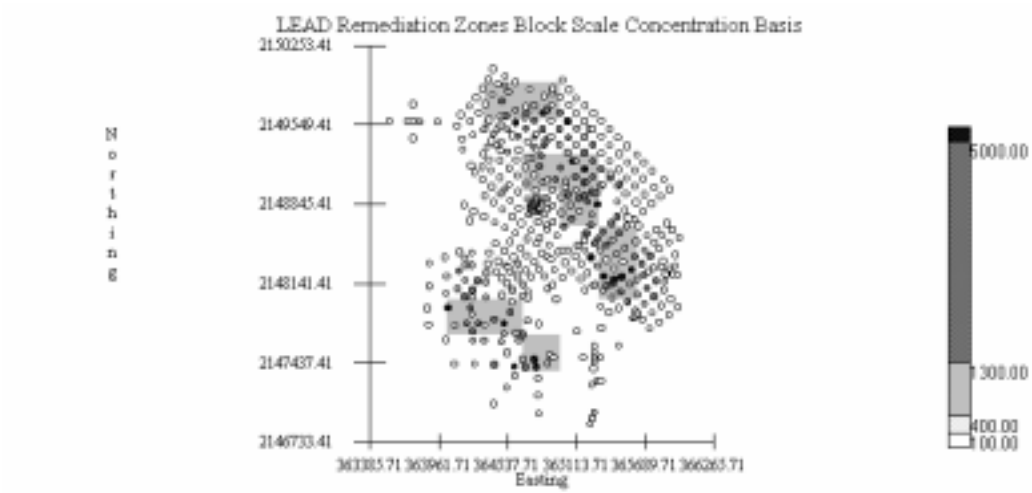

Figure 3. Map of exposure units and lead samples at Site 15. The legend at the right shows the shading representing different lead levels in surface soil. Shaded exposure units are the ones needing remediation based on a cleanup level of 1300 mg/kg.

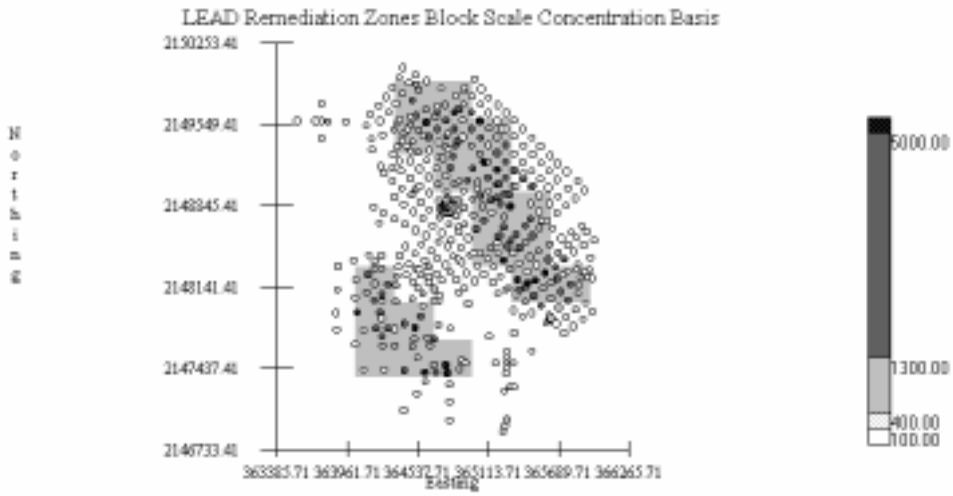

Figure 4. Map of exposure units and lead samples at Site 15. The legend at the right shows the shading representing different lead levels in surface soil. Shaded exposure units are the ones needing remediation based on a cleanup level of 400 mg/kg.

Figure 3 shows the exposure units that require remediation, that is, the average lead concentration of which is greater than 1300 mg/kg. As can be seen by comparing figures 3 and 4, almost twice as large an area would need to be remediated based on a cleanup level of 400 mg/kg in lieu of 1300 mg/kg.

General Strategy for Remediation

The following remediation strategy was developed for the four areas shown in figure 3. Starting clockwise from the upper left, these areas are called Area 1, Area 2, Area 3 and Area 4 respectively. Semivariograms were developed for each of these four areas and the distance to the sill in each case was approximately 140 m, the same as the entire area of Site 15. This finding is consistent with a homogenously deposited contaminant and characteristic of a skeet range. This remediation strategy is based on a cleanup level of 1300 mg/kg.

A remediation unit (RU) is defined as the area in which a remediatl action will affect the exposure pont concentration within an exposure unit. Generally, the distance to the sill value of the semivariogram determines the size of a remediation unit. Technological considerations would also determine the size. For example, an RU could hardly be smaller than a backhoe bucket if excavation comprised the remedial technology.

Here the remediation unit considered is a square area 140 m on a side. Removing soil from this area will ensure that all the soil with high lead concentrations will be removed. Although the remediation strategy here is presented for the four multi-exposure unit areas (fig. 3) at Site 85, such strategy could also be pursued for single exposure unit. It is appropriate to consider contiguous multi exposure unit areas for clean up here because of the relative homogeneity of the site.

Remediation Strategy for Area 1 based on a 1300 mg/kg Cleanup Level

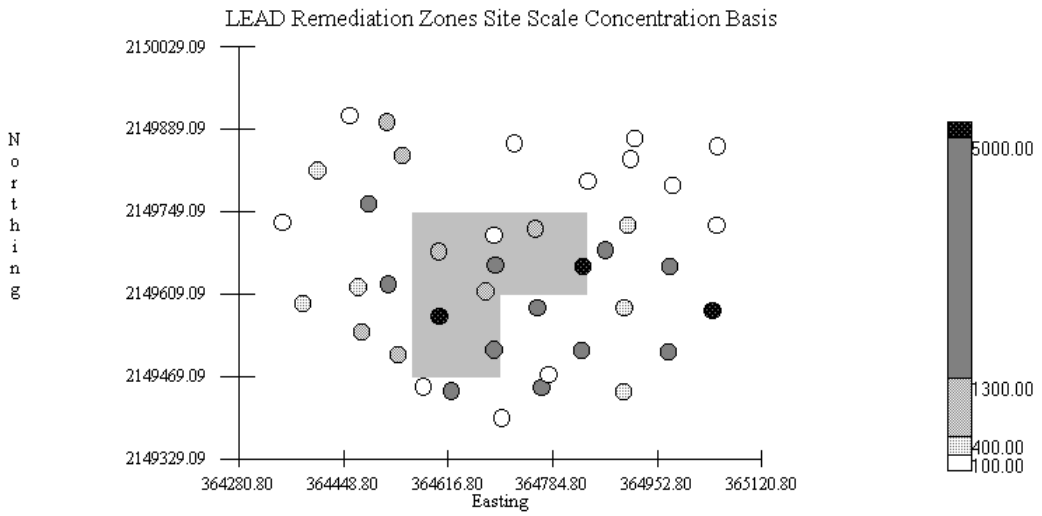

Figure 5. Regions of Area 1 needing remediation. The shaded areas encompass the remedial area. Clockwise from the upper left, the coordinates of the corners of the area are (364555.8, 2149746.5), (364843.6, 2149746.5), (364843.6, 2149606.5), (364706.4, 2149606.5), (364706.4, 2149466.25), 364555.8, 2149466.25).

65500	1900	488	43.8
25000	1900	325	42.4
5250	1830	254	40
3490	1390	229	23.9
3470	1260	186	9.2
2990	1190	117	6.9
2850	909	115	6.1
2500	828	82.3	3.4
2370	742	78	2.3
2260	658	57	2.2

A 140m x 140m grid was set up for Area 1 and grid areas needed to shift the average concentration in Area 1 to below 1300 mg/kg are shown in figure 5. The table above shows the sampling values for lead from Area 1. Conceptually, the remediation can be thought of as removing the two highest values from this sample and replacing them with surrogate values of

Remediation Strategy for Area 2 based on a cleanup level of 1300 mg/kg

Figure 7 shows the remediation zones for Area 3. The geostatistical estimation procedures identified the remediation unit at the upper left. Because no samples occur within this RU, it should be checked to determine if remediation is really needed.

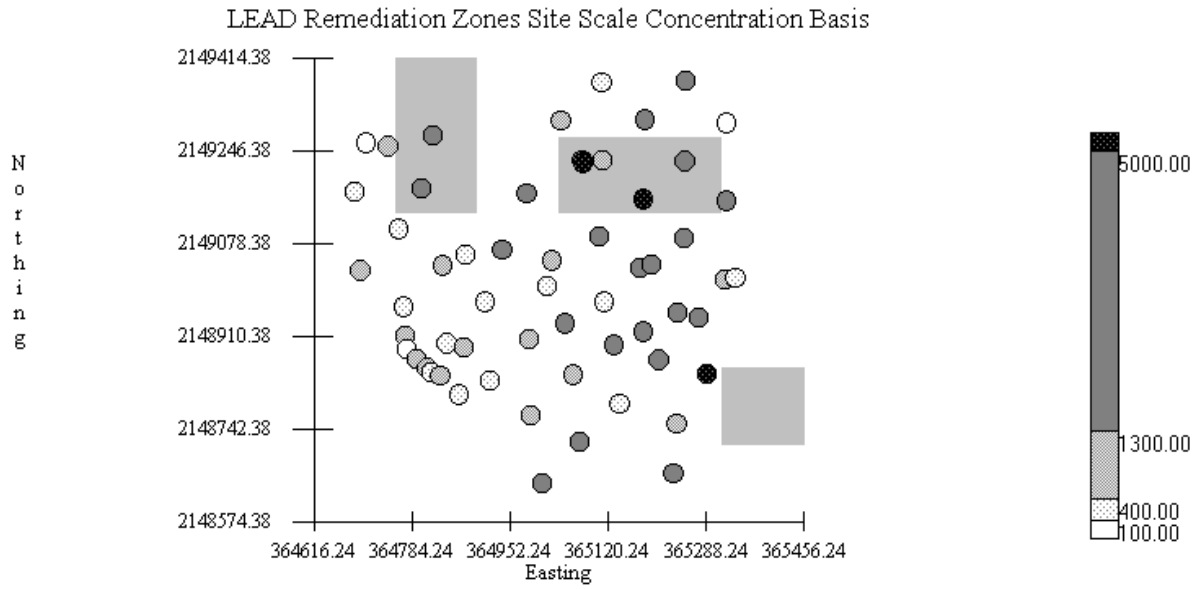

Figure 6. Regions of Area 2 needing remediation. The shaded areas encompass the remedial zones. The northwest and southeast corners of the upper left zone are (364757.0, 2149414.25) and (364896.8, 2149132.0) respectively. The northwest and southeast corners of the upper right zone are (365039.44, 2149267.0) and (365310.7, 2149132.0) respectively. The northwest and southeast corners of the lower right zone are ((365296.4, 2148867.5) and(365456.2, 2148714.5) respectively.

30115	3410	1710	773	407	205
5470	3380	1630	739	388	191
5320	3180	1510	614	388	155
4240	3150	1400	607	387	145
4070	2880	1340	561	383	126
3630	2860	1240	550	348	77.3
3620	2680	1240	539	324	21.5
3600	2630	1030	502	297	20
3580	2530	1010	434	295	
3410	2450	823	419	223	

The table above shows the sampling results for Area 2. One can think of the remediation as replacing the five highest values with the surrogate value of 400 mg/kg. This would reduce the average concentration within Area 2 from 2056 mg/kg to 1242 mg/kg.

Remediation Strategy for Area 3 based on a cleanup level of 1300 mg/kg

Figure 7 shows the remediation zones for Area 3. The geostatistical estimation procedure indentified the remediation unit at the upper left. Because no samples occur within this RU, it should be checked to determine if remediation is really needed.

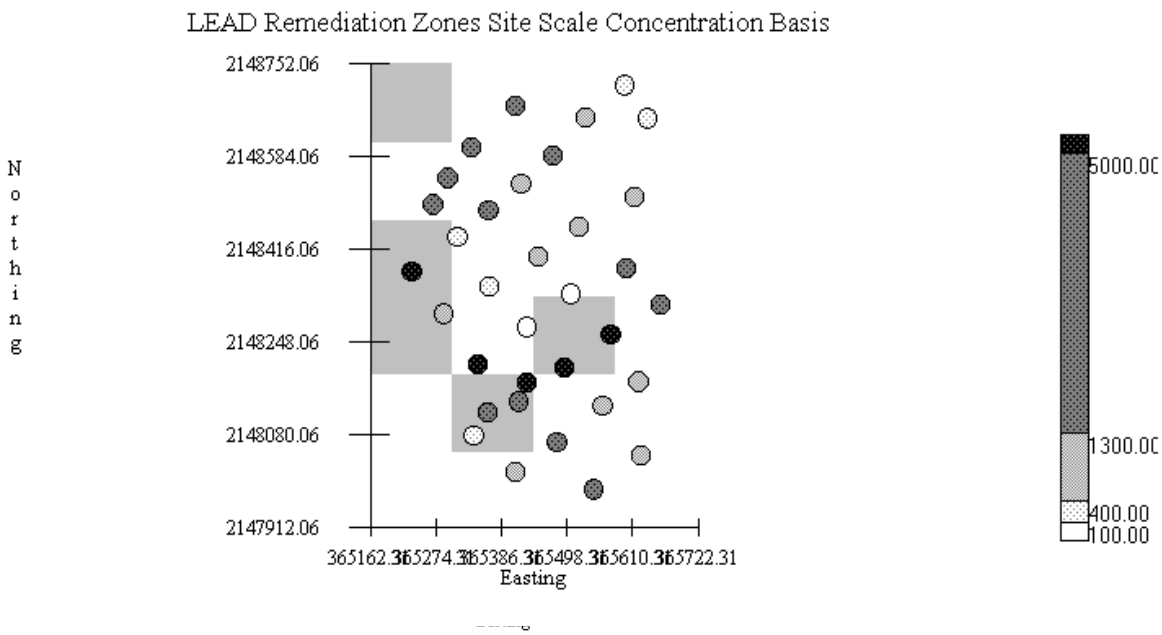

Figure 7. Regions of Area 3 needing remediation. The shaded areas encompass the remedial zones. The northwest and southeast corners of the upper left zone are (365157.5, 2148752.25) and (365229.75, 2148605.5) respectively. The northwest and southeast corners of the lower left zone are (365157.5, 2148470.5) and (365299.75, 2148186.0) respectively. The northwest and southeast corners of the central zone zone are (365299.75, 2148186.0) and (365442.0, 2148048.25) respectively. The northwest and southeast corners of the right hand zone are (365442.0, 2148329.75) and 365584.0, 2148186.0) respectively.

7510	3720	1780	927	221
6810	3260	1610	866	200
6630	3240	1440	843	178
5320	2820	1190	830	129
5170	2570	1140	554	49
4430	2450	1140	529	36
3820	1790	1030	297	

The table above shows the sampling results for Area 2. One can think of remediation as replacing the six highest concentrations with the surrogate value of 400 mg/kg. This would reduce the average from 2162 mg/kg to 1207 mg/kg.

Remediation Strategy for Area 4 based on a cleanup level of 1300 mg/kg

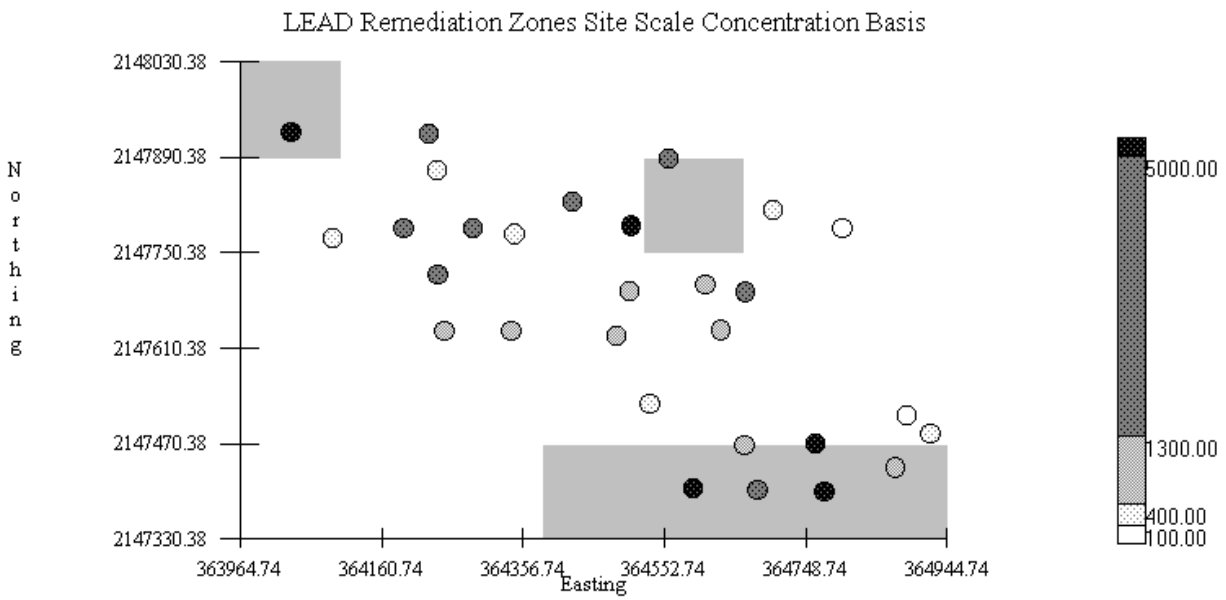

Figure 8. Regions of Area 4 needing remediation. The shaded areas encompass the remedial zones. The northwest and southeast corners of the upper left zone are (363946.7, 2148030.4) and (364194.0, 2147890.0) respectively. The northwest and southeast corners of the upper central zone are (364525.0, 2147890.0) and (364665.5, 2147750.5) respectively. The northwest and southeast corners of the lower zone are (364385.8, 2147470.0) and (364944.7, 2147330.4) respectively.

41400	2290	439
13000	2290	285
11800	1990	285
9710	1280	274
5660	1230	148
4600	982	144
4520	970	115
2980	814	80.8
2490	746	16
2420	746	

Figure 8 shows the remediation zones for Area 4. Because of the geostatistical estimation procedures, the small central remediation zone should be extended to the west to include the high sample point adjacent to it. This sample point has a concentration of 13000 mg/kg. The table above shows the sampling results for Area 4. Remediation here can be thought of as replacement of the highest five values with the surrogate value of 400 mg/kg. The average level in Area 4 would be reduced from 3920 mg/kg to 1177 mg/kg.

Summary

The same techniques of analysis can be applied to Site 15 (or to any site) no matter what the cleanup level. In the past, cleanup levels have been applied as “not-to-exceed” levels. In fact, they represent site averages or measure of the site average such as the 95% UCL. The same type of geostatistical analysis can be used basing cleanup on the 95% UCL within an exposure unit. I do not expect the analysis here will be the last word for cleanup at Site 15. Rather, it serves as a model to guide thinking.

Please let me know if you need further help.

T.W. Simon/tws:4WD-OTS:28642/08/16/99/A:\DISK6\AUG99\SITE15.WPD