Advanced Design Application & Data Analysis for Field-Portable XRF

A Series of Web-based Seminars Sponsored by Superfund's Technology & Field Services Division

Session 8 – Final Session

Q&A for Session 7

Q&A Review

Resources

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How To . . .

- Ask questions
  - » "?" button on CLU-IN page
- Control slides as presentation proceeds
  - » manually advance slides
- Review archived sessions
  - » http://www.clu-in.org/live/archive.cfm
- Contact instructors

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Notes

- When you registered, you were directed to this seminar's specific URL, which is the front page of today's seminar. The Front Page of the web cast contains a short abstract of today's session. We have also included pictures and short biosketches of the presenters. Please note the presenters' email addresses are hotlinked on that page in case you have any questions for one of them after today's presentation.

- For those of you joining us via the phone lines, we request that you put your phone on mute for the seminar. We will have Q&A sessions at which point you are welcome to take your phone off mute and ask the question. If you do not have a mute button on your phone, we ask that you take a moment RIGHT NOW to hit *6 to place your phone on MUTE. When we get to the question and answer periods you can hit #6 to unmute the phone. This will greatly reduce the background noises that can disrupt the quality of the audio transmission.

- Also, please do not put us on HOLD. Many organizations have hold music or advertisements that can be very disruptive to the call. Again, keep us on MUTE. DO NOT put us on HOLD.

- Also, if you experience technical difficulties with the audio stream, you may use the ? icon to alert us to the technical difficulties you are encountering. Please include a telephone number where you can be reached and we will try to help you troubleshoot your problem.

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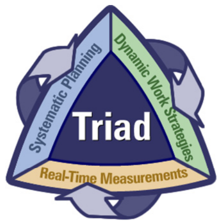
Q&A For Session 7 – Dynamic Work Strategies Part 2

7-3

Example of an XRF MIS Strategy



Deana Crumbling, EPA/OSRTI/TIFSD
crumbling.deana@epa.gov 703-603-0643
NEMC Conference Aug 12, 2008

7-4

Review the Factors that Complicate Data Quality for Soils
(and need to be controlled)

7-5

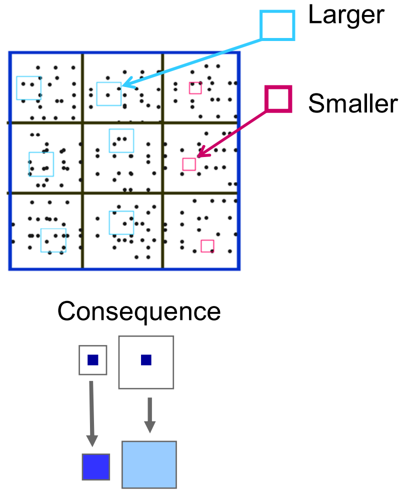
Contaminants Bind Best to Smaller Soil Particles: Causes a "Nugget Effect"

Soil Grain Size Fractions (from largest to smallest)	Pb Concentration in Fraction (ppm)
Greater than 3/8"	**10**
Between 3/8" & 4-mesh	**50**
Between 4- & 10-mesh	**108**
Between 10- & 50-mesh	**165**
Between 50- & 200-mesh	**836**
Less than 200-mesh	**1,970**
Bulk Average Concentration	**927**

Firing range data, adapted from ITRC (2003)

7-6

Interaction Between Sample Support and Concentration



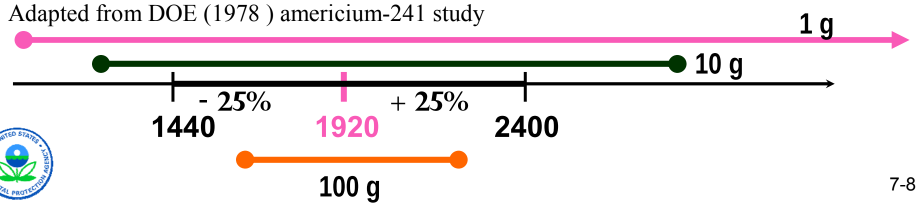
7-7

Relationship of Analysis Mass to Data Uncertainty

True sample mean known to be 1920 ppb

Subsample mass taken from a large partially homogenized soil sample	Range of results for 20 replicate subsamples (ppb)	How many subsamples to average to get a result w/in 25% of true sample mean? [1440 - 2400 ppb]
1 g	1010 – 8000	39
10 g	1360 – 3430	5
100 g	1700 - 2300	1

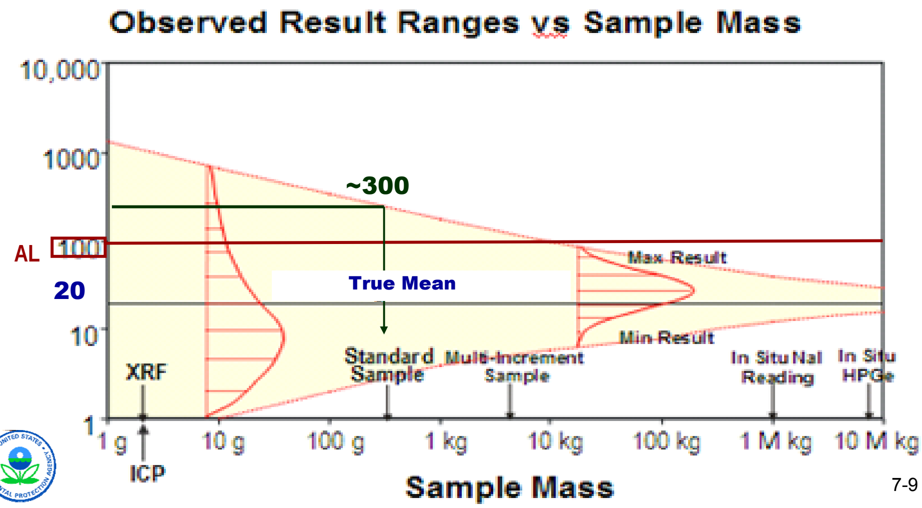
Adapted from DOE (1978) americium-241 study



7-8

How High Does a Result Need to Be To Know an Action Level Exceedance is Real?

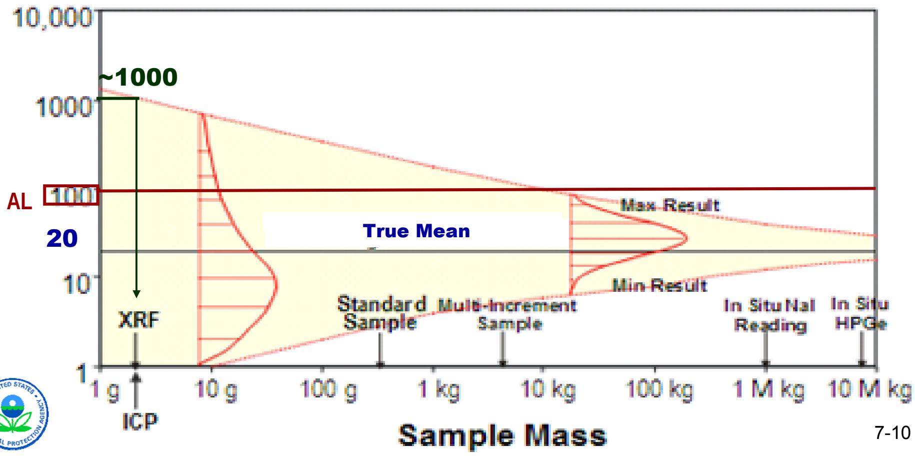
Graph assumes <u>entire</u> sample mass analyzed to generate result



7-9

Data Variability Complicates Decision-Making

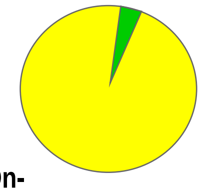
Graph assumes entire sample mass is analyzed to generate the result



7-10

Short-scale Heterogeneity Effects Usually Much Larger than Analytical Method Differences

> 95% of variability due to sample location



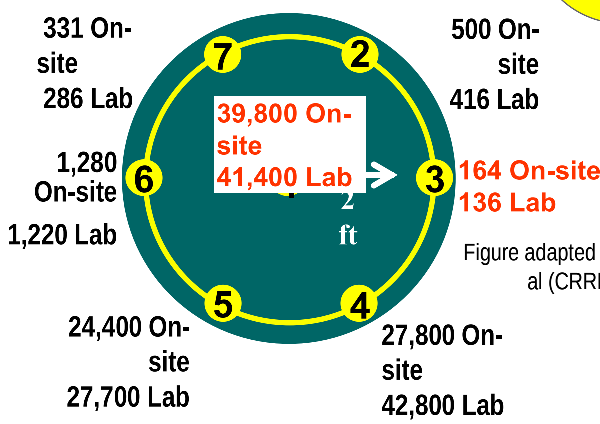


Figure adapted from Jenkins et al (CRREL), 1996

Managing Data Uncertainty Critical for Confident Decisions

This is why the definition of "definitive data" in the "DQOs for Superfund" 1993 guidance (p. 43) includes:

"For the data to be definitive, either analytical or total measurement error [variability] must be determined."

7-12

Using XRF to Generate Definitive Data: Making Exceedance Decisions using MIS

(This material is drawn from 2 actual XRF projects, but also contains some embellishment to make it a more complete example)

Sampling Goal: Determine whether DU average exceeds Action Level

Action Level = 500 ppm Pb

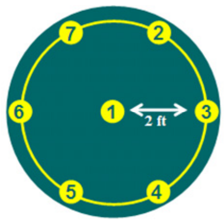
Decision Unit (DU = Exp U): ½-acre

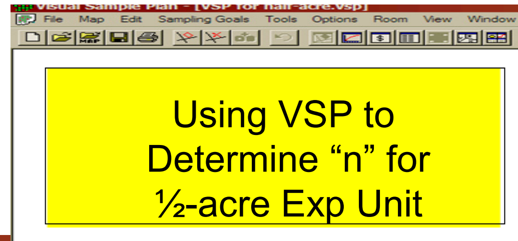
MIS Strategy: 20 increments per DU into single plastic bag (How? -- Pilot)

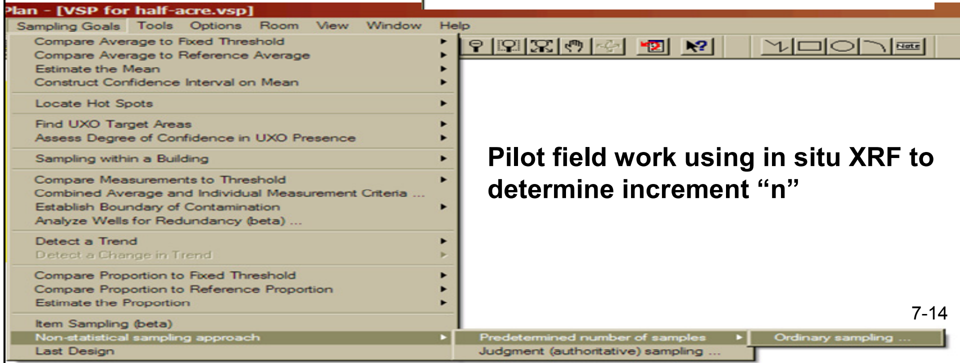
Examination of pilot data allowed selection of LIL and UIL (How?)

7-13

1st: Control for Short-Scale Heterogeneity

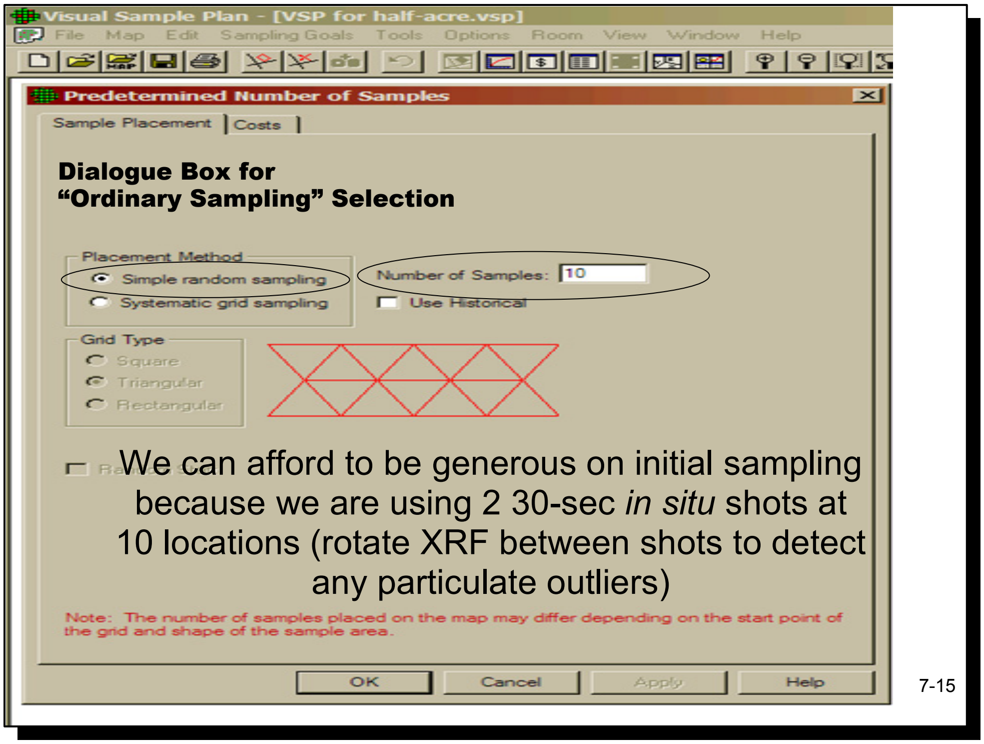




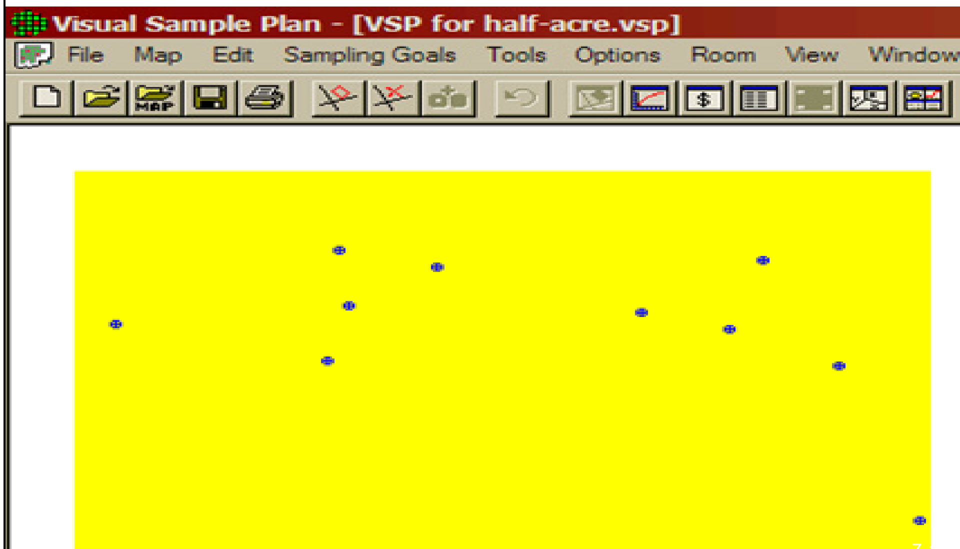


Pilot field work using in situ XRF to determine increment “n”

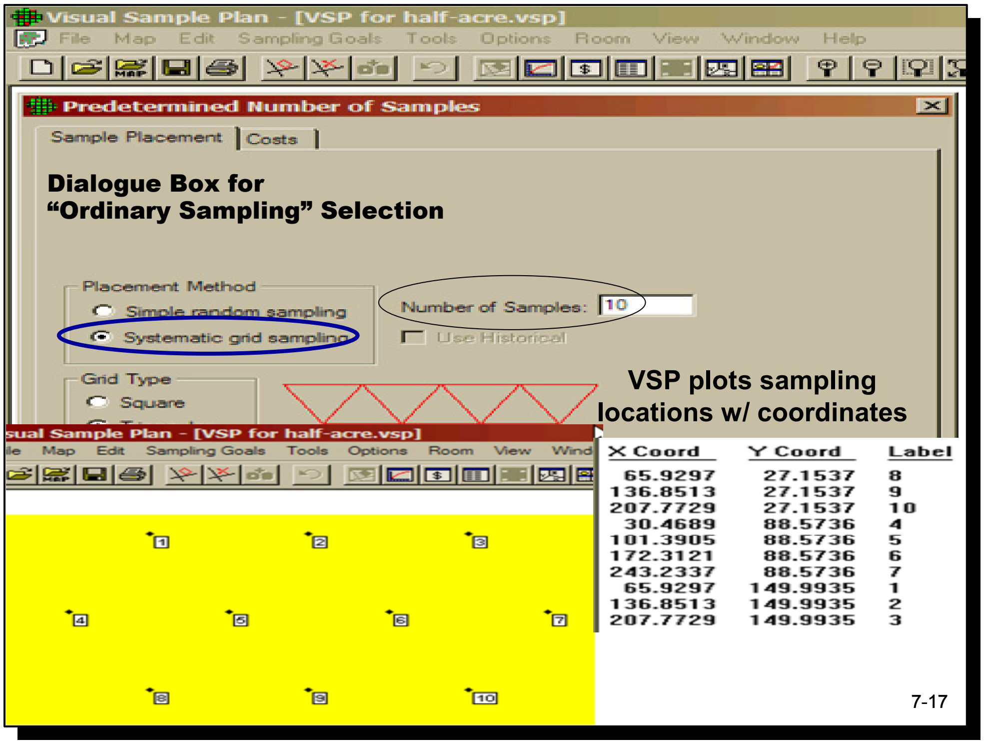
7-14


Visual Sample Plan - [VSP for half-acre.vsp]
File Map Edit Sampling Goals Tools Options Room View Window Help
Predetermined Number of Samples
Sample Placement
Costs
Dialogue Box for
"Ordinary Sampling" Selection
Placement Method
Simple random sampling
Systematic grid sampling
Number of Samples: 10
Use Historical
Grid Type
Square
Triangular
Rectangular
We can afford to be generous on initial sampling because we are using 2 30-sec *in situ* shots at 10 locations (rotate XRF between shots to detect any particulate outliers)
Note: The number of samples placed on the map may differ depending on the start point of the grid and shape of the sample area.
OK
Cancel
Apply
Help
7-15

Might Get Poor Placement with Random Sampling



7-16


Visual Sample Plan - [VSP for half-acre.vsp]
File Map Edit Sampling Goals Tools Options Room View Window Help
Predetermined Number of Samples
Sample Placement Costs
Dialogue Box for
"Ordinary Sampling" Selection
Placement Method
Simple random sampling
Systematic grid sampling
Number of Samples: 10
Use Historical
Grid Type
Square
VSP plots sampling
locations w/ coordinates
X Coord Y Coord Label
65.9297 27.1537 8
136.8513 27.1537 9
207.7729 27.1537 10
30.4689 88.5736 4
101.3905 88.5736 5
172.3121 88.5736 6
243.2337 88.5736 7
65.9297 149.9935 1
136.8513 149.9935 2
207.7729 149.9935 3
7-17

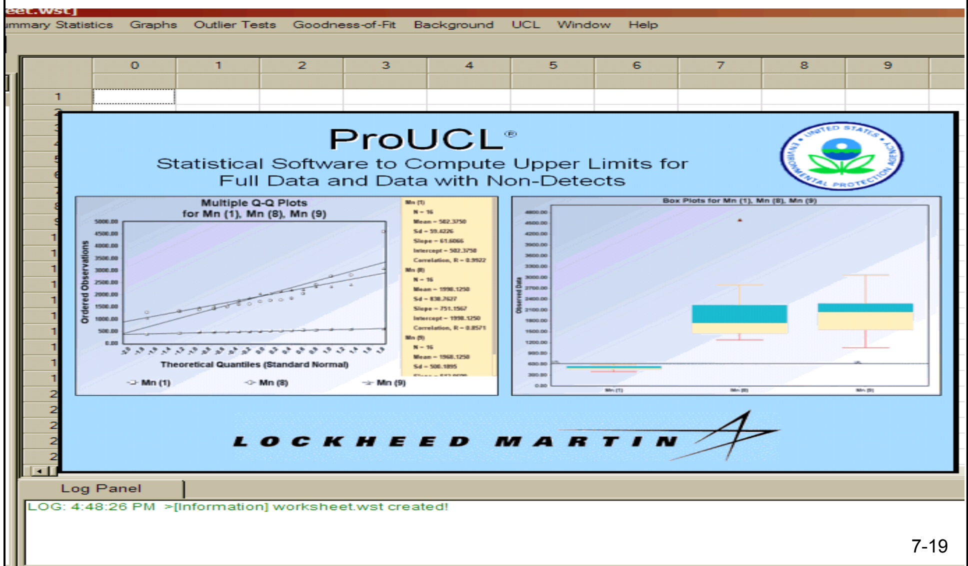
Pilot Study Spreadsheet Calculations on 10 In Situ Shots

Rotated duplicate shots (in same location) that are different by >50 are repeated, closest 2 of 3 used

	A	B	C	D	E	F
1	**Pilot Study Results XRF Pb Results**					
2	Sample ID	1st shot	2nd (rotated)	3rd (recheck)		
3	Pilot Location 1	418	450			
4	2	401	437			
5	3	572	749	681	(use 681 instead of 749)	
6	4	543	498			
7	5	356	342			
8	6	589	542			
9	7	210	472	462	(use 462 instead of 201)	
10	8	398	413			
11	9	564	587			
12	10	608	541			
13						
14	Pilot Study Mean =	491	495			
15	Std Dev =	93.7	96.6			
16	n	10	10			
17	95%UCL	545	551			
18	1-sided interval	54.3	56.0			
19			rotated duplicate check ok			

7-18

ProUCL Used to Evaluate Pilot Data Set



7-19

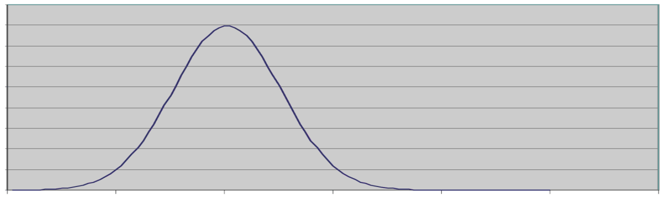
Summary of ProUCL's Assessment of *in situ* Pilot Data

22				
23		**Summary of ProUCL Output**		
24				
25	Statistical Confidence		95%	
26	Number of Bootstrap Operations		2000	
27	**General Statistics**			
28	Number of Samples	10		
29	Minimum		356	
30	Maximum		608	
31	Mean		491.1	
32	Median		517.5	
33	SD		93.71	
34	Coefficient of Variation		0.191	
35	Skewness		-0.14	
36	**Distribution Tests**			
37	Data appear Normal at 5% Significance Level			
38	Data appear Lognormal at 5% Significance Level			
39	Data appear Gamma Distributed at 5% Significance Level			
40	**95% UCLs depend on assumptions**			
41	Assuming normal dist, 95UCLs range from			538 to 545
42	Assuming lognorm dist, UCLs range from			556 to 624
43	Assuming gamma dist, UCLs range from			553 to 564
44	Assume non-parametric, UCLs range from			540 to 620

7-20

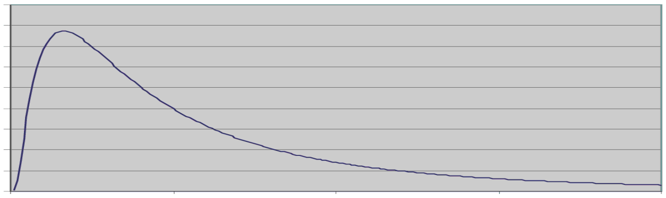
Statistical Frequency Distribution Shapes

Normal Distribution Shape



Lognormal Distribution Shape

(Gamma Distribution Similar)



There are too few samples and too much variability to be sure what the underlying distribution is (normal, lognormal, gamma, or none of those) from which the data were drawn. If you don't know the distribution, you shouldn't use its equations to predict the UCL

7-21

Summary of ProUCL's Assessment of *in situ* Pilot Data

22		
23	**Summary of ProUCL Output**	
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31	Mean	491.1
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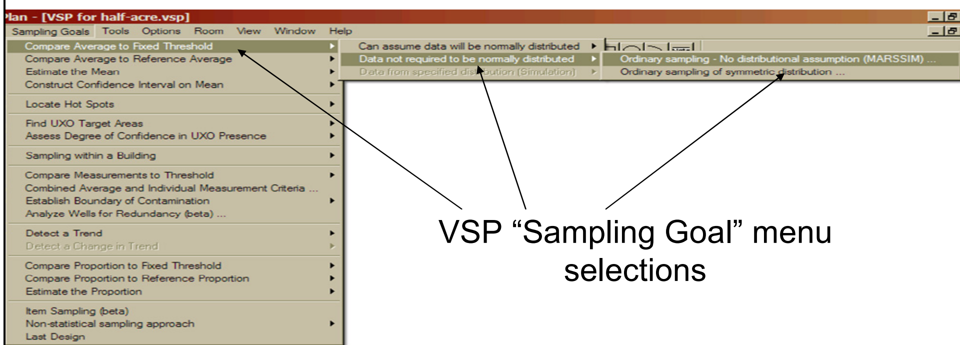
41	Assuming normal dist, 95UCLs range from	538 to 545
42	Assuming lognorm dist, UCLs range from	556 to 624
43	Assuming gamma dist, UCLs range from	553 to 564
44	Assume non-parametric, UCLs range from	540 to 620

The distribution assumption and choice of technique can cause 95% UCL to range from 538 to 624

7-22

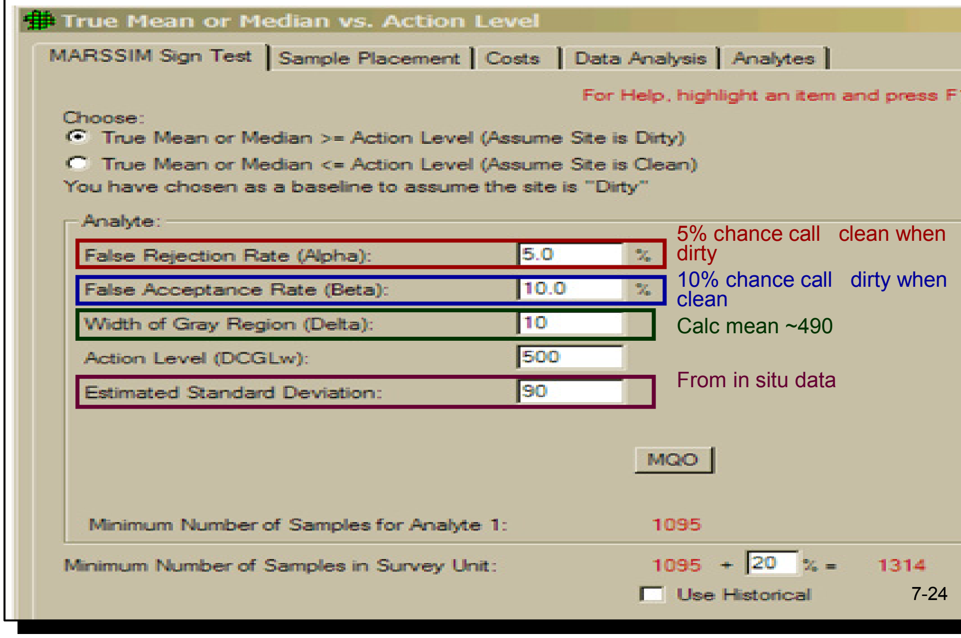
How Many Increment to Pool into the MIS?

Use pilot study data in Visual Sample Plan (VSP)



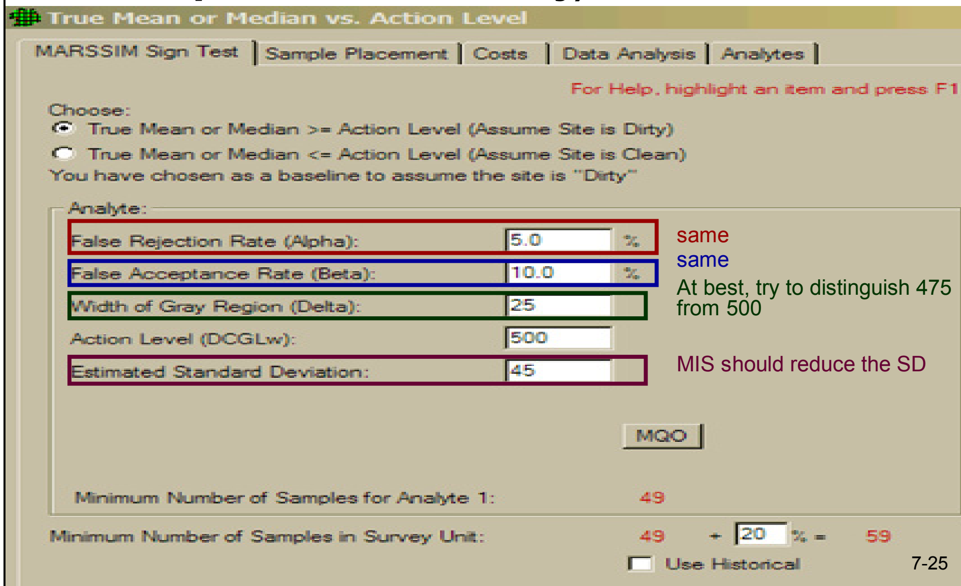
7-23

Using conservative VSP inputs predicts too many samples, even for MIS

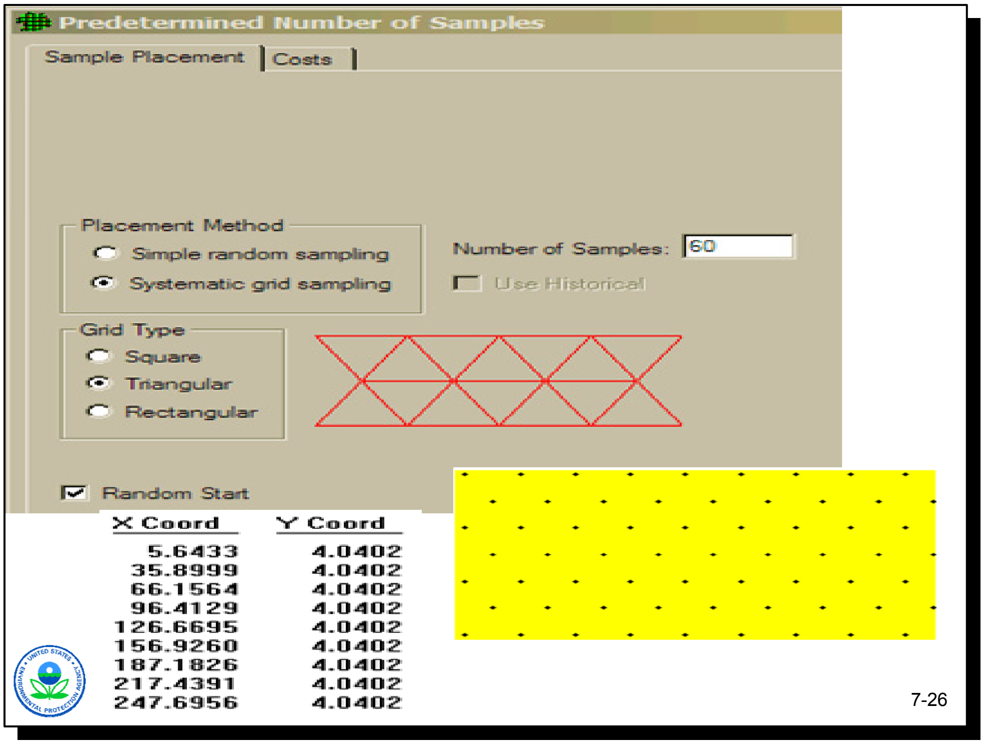


7-24

Provide rationale for adjustments to VSP inputs (Remember, VSP is just a prediction, your actual data set performance will vary)



7-25



X Coord	Y Coord
5.6433	4.0402
35.8999	4.0402
66.1564	4.0402
96.4129	4.0402
126.6695	4.0402
156.9260	4.0402
187.1826	4.0402
217.4391	4.0402
247.6956	4.0402

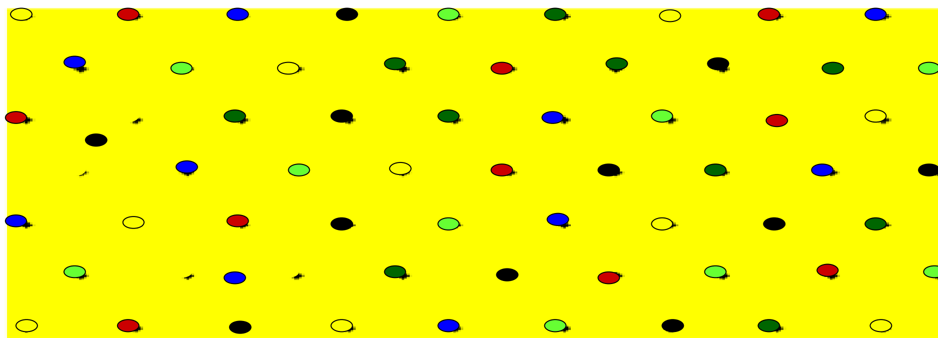
Want to estimate variability when using MIS, may be able to reduce increment n

Group increments and test statistics

Increment n = 60; divide into 6 groups of 10

Grp 1 = lt blue; Grp 2 = red; Grp 3 = dk blue; Grp 4 = black; Grp 4 = lt grn; Grp 6 = dk grn

All 10 of same color get pooled into 1 soil bag



7-27

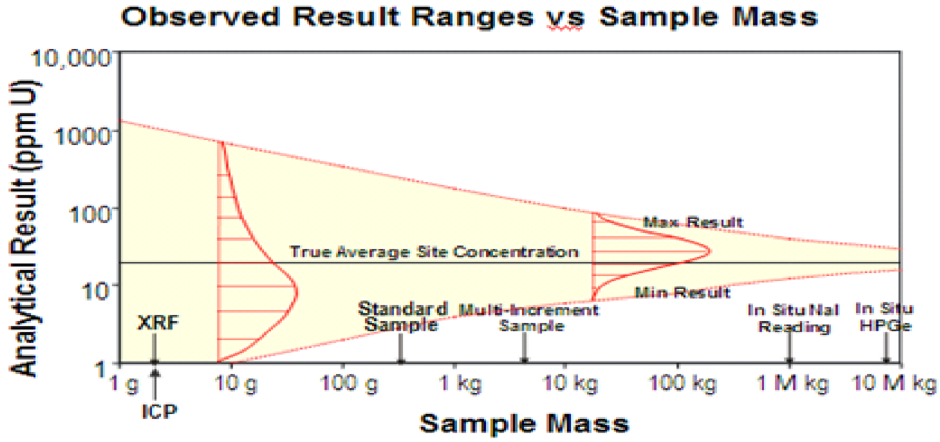
6 Multi-Increment Sample (MIS) bags of 10 increments each

Each bag mixed WELL by kneading!
Now need to measure the bags by shooting with the XRF

Now need to control for within-bag (“micro-scale) variability

7-28

When analyzing the bag, need to control for XRF's susceptibility to particle effects and small sample supports



7-29

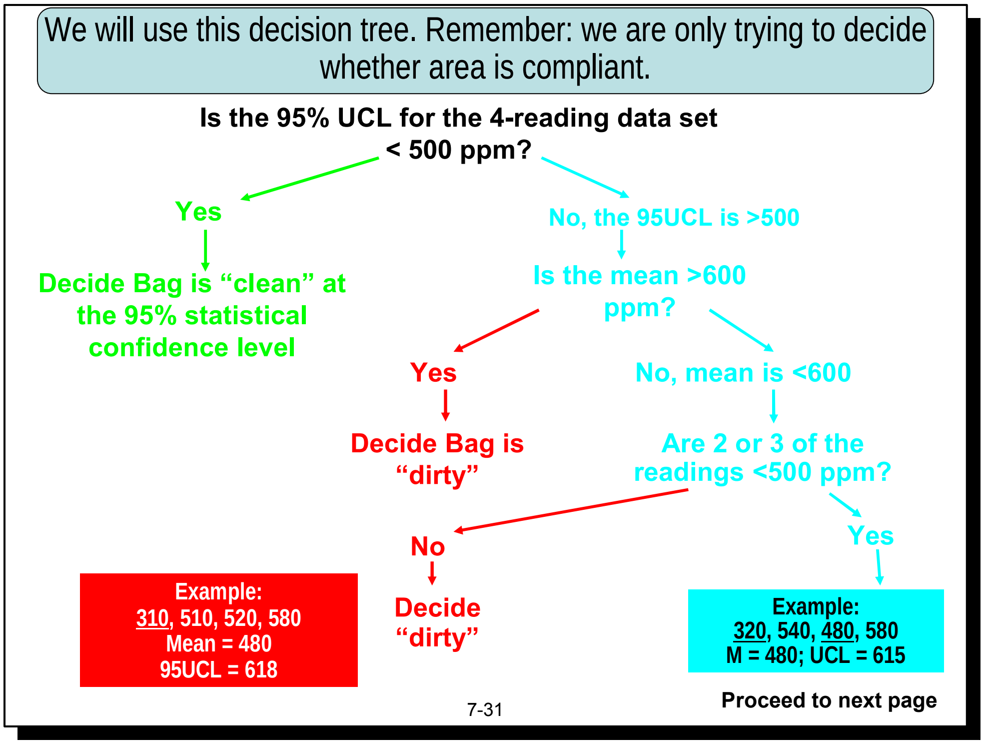
Do not shake bag! Confirm bag contents look homogeneous, flat and smooth. Take 2 shots over the top side of the bag, 1 from 1 half and the other from the other half…then gently turn bag over and take 2 similar readings on the other side, for a total of
4 readings (2 from each side of the bag)

Once sample is WELL-MIXED in bag, justified to assume a normal distribution

↓

Transfer data from instrument (electronically or by hand) into a programmed spreadsheet to **calculate mean**, standard deviation (SD) and 95% upper confidence interval (**95UCL**) on the bag's 4-point data set

7-30


We will use this decision tree. Remember: we are only trying to decide whether area is compliant.
Is the 95% UCL for the 4-reading data set < 500 ppm?
Yes
Decide Bag is "clean" at the 95% statistical confidence level
No, the 95UCL is >500
Is the mean >600 ppm?
Yes
Decide Bag is "dirty"
No, mean is <600
Are 2 or 3 of the readings <500 ppm?
No
Decide "dirty"
Yes
Example:
310, 510, 520, 580
Mean = 480
95UCL = 618
Example:
320, 540, 480, 580
M = 480; UCL = 615
Proceed to next page
7-31

Examine the mean, SD and 95% UCL calculated on the 4 XRF readings from a bag.

Is the 95% UCL for the 4-reading data set < 500 ppm?

Yes

Decide Bag is "clean" at the 95% statistical confidence level

No, the 95UCL is >500

Remember, we are trying to control for data uncertainty when deciding if the MIS bag represents an area that is <500 or >500

7-32

XRF Pilot Study Red MIS Bag Data Spreadsheet

H	I	J	K	L	M	N
	Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
	Red MIS Bag					
	Bag reading 1	1512	47	30	301	47
	2	1515	48	30	479	49
	3	1516	49	30	340	49
	4	1517	50	30	279	50
				Mean	349.8	
				SD	89.8	
				95% UCL	455	
	5					
	6					
	7					
	8					
	9					
	10					
				Mean	N/A	
				SD	N/A	
				95% UCL	N/A	

Conclusion: area from which the MIS bag came is <500 at the 95% statistical confidence level.

7-33

XRF Pilot Study Dk Blue MIS Bag Data Spreadsheet

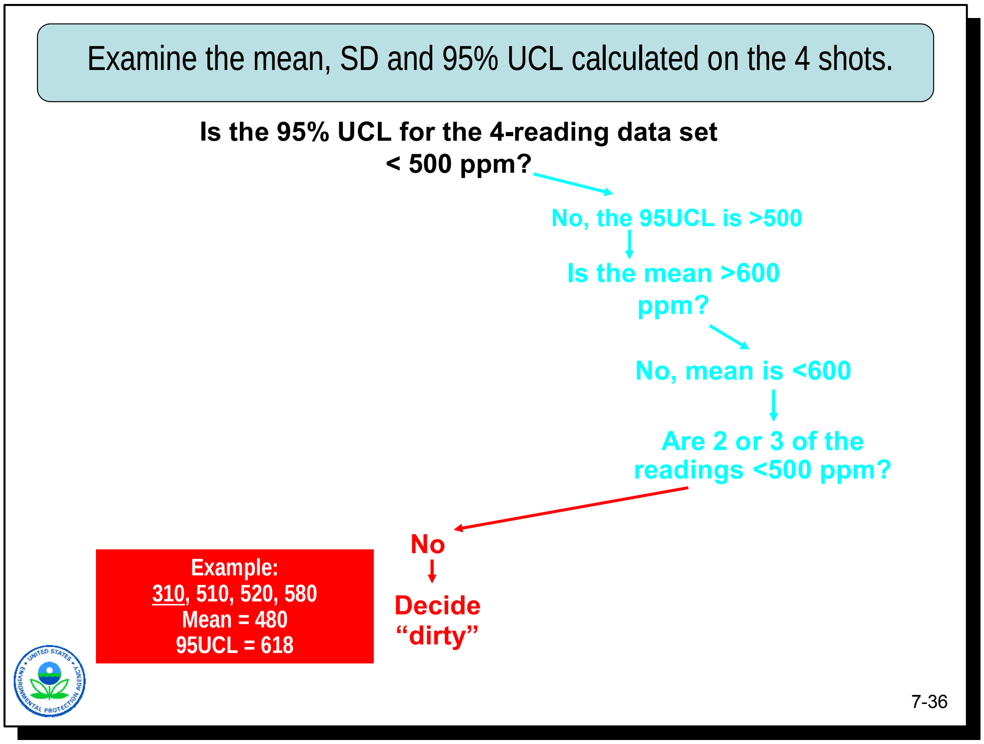
P	Q	R	S	T	U
Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
Dk Blue MIS Bag					
Bag reading 1	1522	51	30	365	43
2	1523	52	30	379	42
3	1525	53	30	338	44
4	1526	54	30	346	46
			Mean	357.0	
			SD	18.5	
			95% UCL	379	
5					
6					
7					
8					
9					
10					
			Mean	N/A	
			SD	N/A	
			95% UCL	N/A	

7-34

XRF Pilot Study Lt Grn MIS Bag Data Spreadsheet

AC	AD	AE	AF	AG	AH	AI
	Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
	Lt Grn MIS Bag					
	Bag reading 1	1534	59	30	184	34
	2	1536	60	30	137	30
	3	1537	61	30	179	34
	4	1538	62	30	173	32
				Mean	168.3	
				SD	21.3	
				95% UCL	193	
	5					
	6					
	7					
	8					
	9					
	10					
				Mean	N/A	
				SD	N/A	
				95% UCL	N/A	

7-35


Examine the mean, SD and 95% UCL calculated on the 4 shots.
Is the 95% UCL for the 4-reading data set < 500 ppm?
No, the 95UCL is >500
Is the mean >600 ppm?
No, mean is <600
Are 2 or 3 of the readings <500 ppm?
No
Decide "dirty"
Example:
310, 510, 520, 580
Mean = 480
95UCL = 618
7-36

XRF Pilot Study Lt Blue MIS Bag Data Spreadsheet

	A	B	C	D	E	F	G
2							
3		Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
4		**Lt Blue MIS Bag**					
5	Bag reading 1		1505	43	30	552	54
6		2	1506	44	30	542	54
7		3	1509	45	30	491	52
8		4	1510	46	30	501	52
9					**Mean**	521.5	
10					**SD**	30.0	
11					**95% UCL**	557	
12		5					
13		6					
14		7					
15		8					
16		9					
17		10					
18					**Mean**	N/A	
19					**SD**	N/A	
20					**95% UCL**	N/A	

7-37

Examine the mean, SD and 95% UCL calculated on the 4 shots.

Is the 95% UCL for the 4-reading data set < 500 ppm?

No, the 95UCL is >500

Is the mean >600 ppm?

No, mean is <600

Are 2 or 3 of the readings <500 ppm?

Yes

Proceed to next page

7-38

XRF Pilot Study Black MIS Bag Data Spreadsheet

W	X	Y	Z	AA	AB
Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
Black MIS Bag					
Bag reading	1528	55	30	512	48
2	1529	56	30	409	50
3	1530	57	30	528	48
4	1532	58	30	304	48
			Mean	**438.3**	
			SD	**103.9**	
			95% UCL	**560**	
5					
6					
7					
8					
9					
10					
			Mean	**N/A**	
			SD	**N/A**	
			95% UCL	**N/A**	

7-39

XRF Pilot Study Dk Grn MIS Bag Data Spreadsheet

AK	AL	AM	AN	AO	AP
Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
Dk Grn MIS Bag					
Bag reading 1	1534	59	30	491	34
2	1536	60	30	542	30
3	1537	61	30	438	34
4	1538	62	30	389	32
			Mean	465.0	
			SD	66.1	
			95% UCL	543	
5					
6					
7					
8					
9					
10					
			Mean	N/A	
			SD	N/A	
			95% UCL	N/A	

7-40

Remix/knead sample bag and flatten. Take 3 readings on 1 side (top, middle and bottom), then similar 3 on the other side for an additional 6 readings. Add to previous 4 for total data set of 10 readings in spreadsheet.

Calculate mean and 95% UCL on the set of 10 readings.

Is the 95% UCL <500 ppm?

Yes

Decide "clean" at the 95% statistical confidence level

7-41

XRF Pilot Study MIS Bag Data Spreadsheet

W	X	Y	Z	AA	AB
Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
Black MIS Bag					
Bag reading	1528	55	30	512	48
2	1529	56	30	409	50
3	1530	57	30	528	48
4	1532	58	30	304	48
			Mean	438.3	
			SD	103.9	
			95% UCL	560	
5				483	
6				411	
7				373	
8				333	
9				294	
10				251	
			Mean	389.8	
			SD	95.9	
			95% UCL	445	

7-42

XRF Pilot Study Dk Grn MIS Bag Data Spreadsheet

AJ	AK	AL	AM	AN	AO	AP
	Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
	Dk Grn MIS Bag					
Bag reading	1	1534	59	30	491	34
	2	1536	60	30	542	30
	3	1537	61	30	438	34
	4	1538	62	30	389	32
				Mean	465.0	
				SD	66.1	
				95% UCL	543	
	5				558	
	6				467	
	7				438	
	8				476	
	9				425	
	10				443	
				Mean	466.7	
				SD	52.4	
				95% UCL	497	

7-43

Selecting a Low End Bag-Decision Rule and a High End Bag-Decision Rule

(Recall Module 6.1, slide 31)

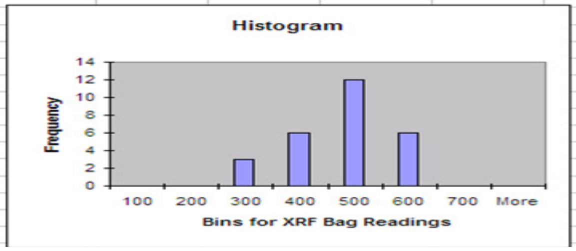
- Below low end bag-decision value, only 1 shot per bag is needed to decide "clean" because data shows that below this value, 95% UCL for bag always < 500 action level.
- Above high end bag-decision value, only 1 shot per bag is needed to decide "dirty" because data shows that above this value, 95% UCL for bag always > 500 action level.

7-44

Low End: Select XRF readings from bags that have UCLs > 450. Plot in a histogram. (Excel Data Analysis pkg)

Reading		Bins
552		1
542		100
491		200
501		300
301		400
479		500
340		600
279		700
512		
409	*1*	*Frequency*
528	100	0
304	200	0
483	300	3
411	400	6
373	500	12
333	600	6
294	700	0
251	More	0
491		
542		
438		
389		
558		
467		
438		
476		
425		
443		

No readings < 300 when 95% UCL for soil bag is near and above the 500 action level. So set 300 as the LIL.



This means that if the 1st bag reading is <300, can call "clean" without more shots. If want to be more conservative at the start of main field work, can make it lower (e.g., <200) until have more data to revisit.

7-45

Selecting High End-Decision Value

- Examine bag data
- Notice that no data points are above 600 (Because our pilot study area is largely below the action level.)
- Likely that a UIL of 600 is too conservative: because of particle effect, might call bags “dirty” when possibly not (false dirty decision error).
- A high UIL (like 1000) means that more “dirty” MIS bags get 4 shots, when don’t need to.
- Seek balance
  - » Want to find value that when present in data set, bag almost always “dirty”

7-46

Since No Data Sets Fit this Description, Have to "Experiment" with Spreadsheet

- Examine bag data where mean on the 4 readings was close enough to 500 so that 95% UCL was >500 until the 6 additional readings were added to data set. Ex: Black MIS bag.

W	X	Y	Z	AA	AB
Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
Black MIS Bag					
Bag reading	1528	55	30	512	48
2	1529	56	30	409	50
3	1530	57	30	528	48
4	1532	58	30	304	48
			Mean	438.3	
			SD	103.9	
			95% UCL	560	
5				483	
6				411	
7				373	
8				333	
9				294	
10				251	
			Mean	389.8	
			SD	95.9	
			95% UCL	445	

7-47

Test Different High Values in Spreadsheet

- ◆ What is the highest single value whose substitution kicks the final 95UCL over 500 (when shouldn't)?
- ◆ Substitute "test values" for highest actual

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 2SD)
Black MIS Bag					
Bag reading	1528	55	30	512	48
2	1529	56	30	409	50
3	1530	57	30	800	48
4	1532	58	30	304	48
			Mean	506.3	
			SD	213.5	
			95% UCL	757	
5				483	
6				294	
7				251	
8				333	
9				411	
10				373	
			Mean	417.0	
			SD	158.0	
			95% UCL	509	

7-48

Selecting 800 as Upper End Decision-Value

- Setting 700 or 800 or 1000 doesn't risk a false clean decision error, only affects amount of work on each bag vs greater cleanup cost
- Means that if 1st reading is 800, stop work on bag and call it "dirty"
- Revisit the upper end value to see if can be lowered (saves bag shots) it as more data comes in from "dirty" ½-acre units.

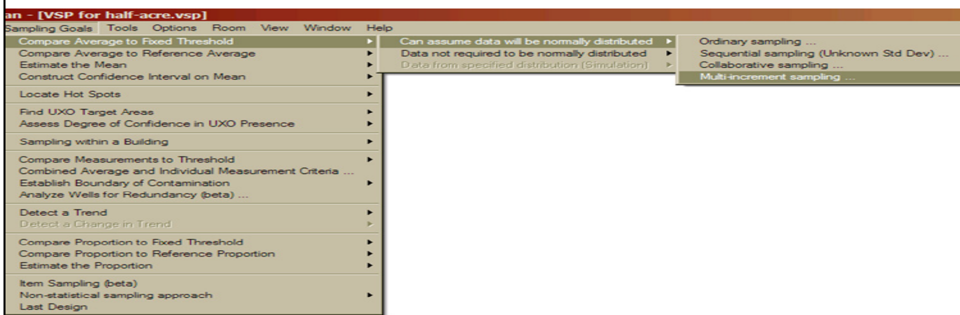
7-49

Constructing the MIS Decision Tree

- Need to know
  - » How many increments per MIS bag
  - » How many MIS bags to take
  - » What steps to take to control for decision error when likely present
  - » When decision error doesn't exist…avoid taking unnecessary steps to control for a decision error that doesn't exist

7-50

VSP has a MIS Module



Can use information gathered from pilot study as inputs to VSP

7-51

Analyte:

False Rejection Rate (Alpha):	5.0 %	same
False Acceptance Rate (Beta):	10.0 %	same
Width of Gray Region (Delta):	25	At best, try to distinguish 475 from 500
Action Level (DCGLw):	500	
Estimated Standard Deviation:	45	MIS should reduce the SD

Prior VSP inputs for *in situ* XRF study

	A	B	C	D	E	F
1	Pilot Study Results XRF Pb Results					
2	Sample ID	1st shot	2nd (rotated)	3rd (recheck)		
3	Pilot Location 1	418	450			
4	2	401	437			
5	3	572	749	681	(use 681 instead of 749)	
6	4	543	498			
7	5	356	342			
8	6	589	542			
9	7	210	472	462	(use 462 instead of 201)	
10	8	398	413			
11	9	564	587			
12	10	608	541			
13						
14	Pilot Study Mean =	491	495			
15	Std Dev =	93.7	96.6			
16	n	10	10			
17	95%UCL	545	551			
18	1-sided interval	54.3	56.0			
19			rotated duplicate check ok			

Between location variability ("increment SD")

7-52

Inputs to VSP from MIS Pilot Study

Grand Mean, SD & 95% UCL for entire area (6 MI samples of 10 increments each)	
1/2-acre Mean =	376
1/2-acre (10 bags) SD =	121
Section 95%UCL (1-sided) =	475
Average within-bag SD =	51
Between-bag (10 MIS bags) SD =	121

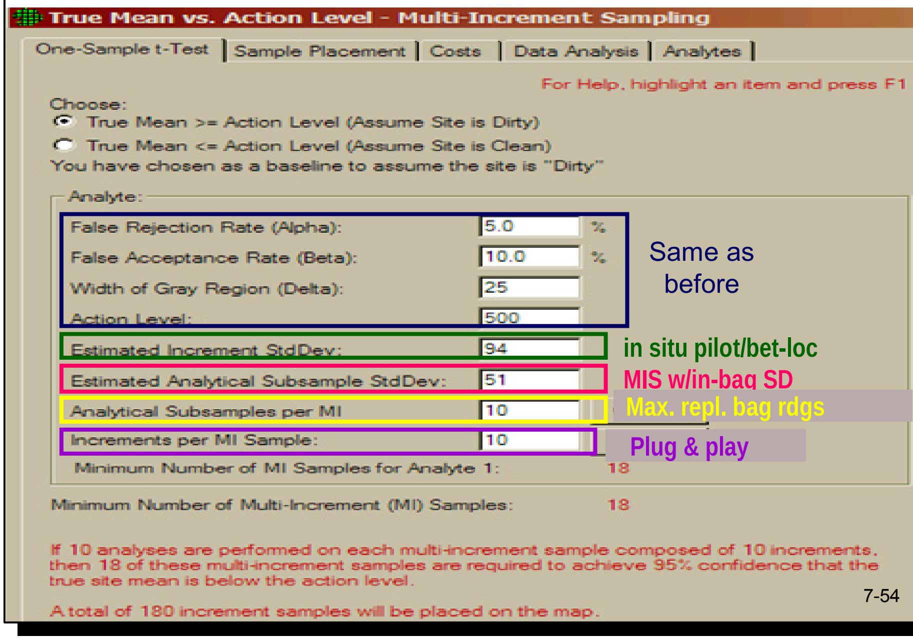
Input to VSP "width of gray region": the mean for this ½-acre unit = 376. If rest of units have similar means, UCL can be ~100 ppm higher than mean before kick over 500.

Gray region = AL – presumed mean = 500 - ~400

Input to VSP as "Analytical Subsample SD" (replicate XRF readings on single MIS bag)

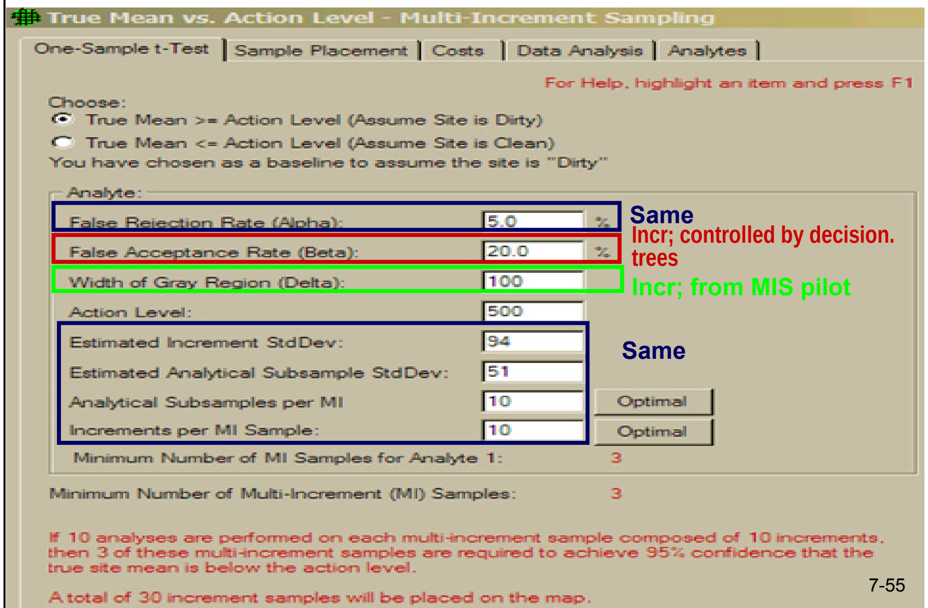
7-53

Based on previous inputs and new data from *in situ* and MIS pilot studies



7-54

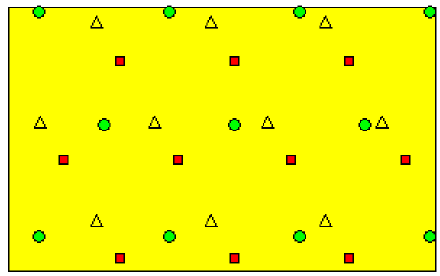
Too Many for ½-acre Area!
Refine…remember the dynamic nature of the analysis allows increasing sampling effort when needed



7-55

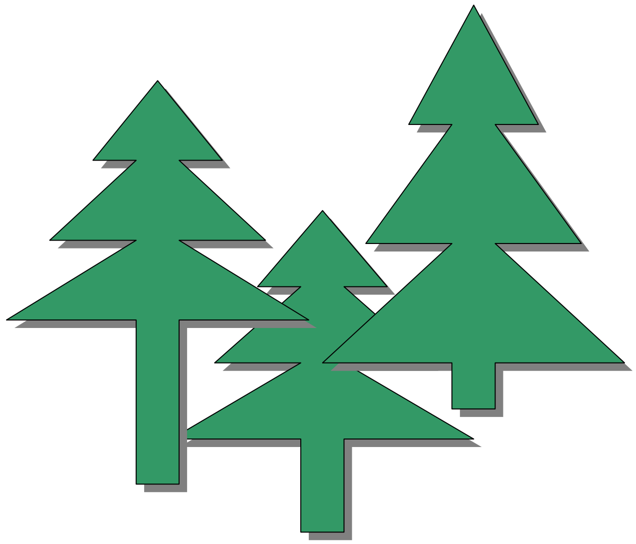
3 MIS of 10 Increments Each is Reasonable

- Take 3 MI samples of 10 increments
  - » Not addressed increment support!
  - » Match decision support
  - » Increase increment mass if bet-bag SD too high; but not too much for bag
- VSP will plot them and give you coordinates
  - » MIS 1 = red square locations
  - » MIS 2 – green circle locations
  - » MIS 3 = yellow triangle locations

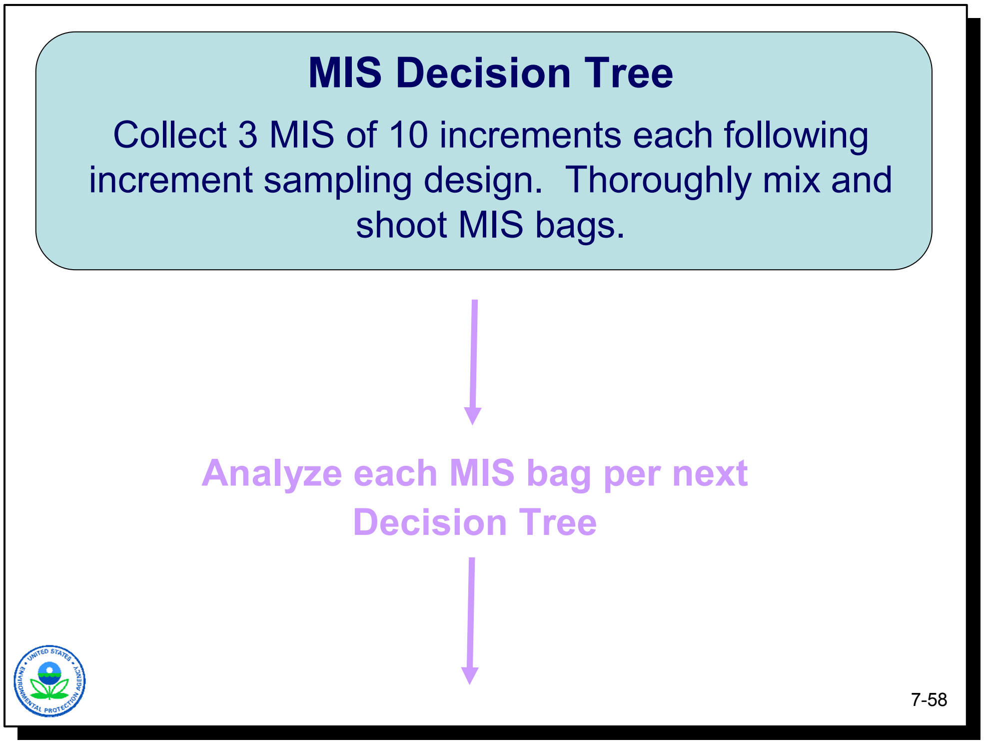


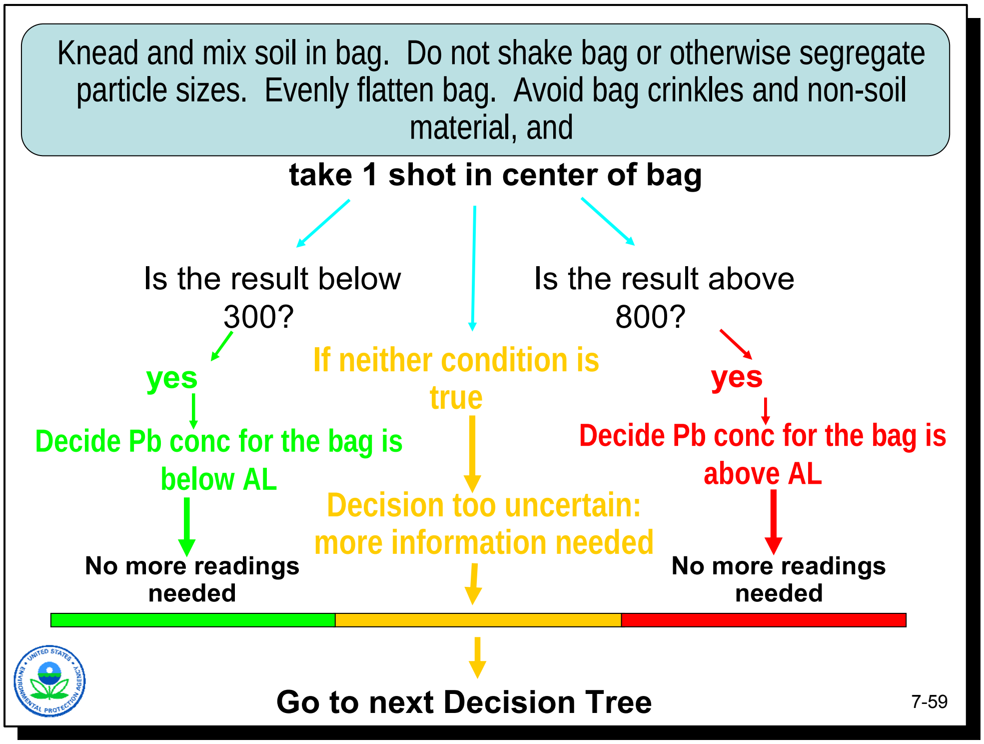
7-56

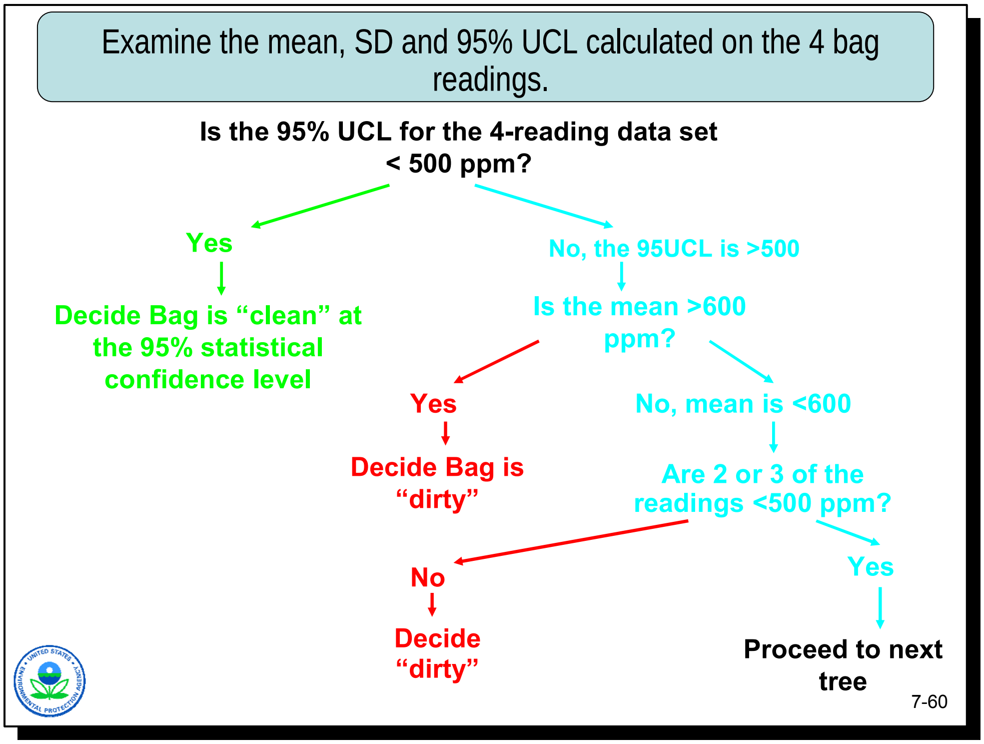
What Do the Final Decision Trees Look Like?

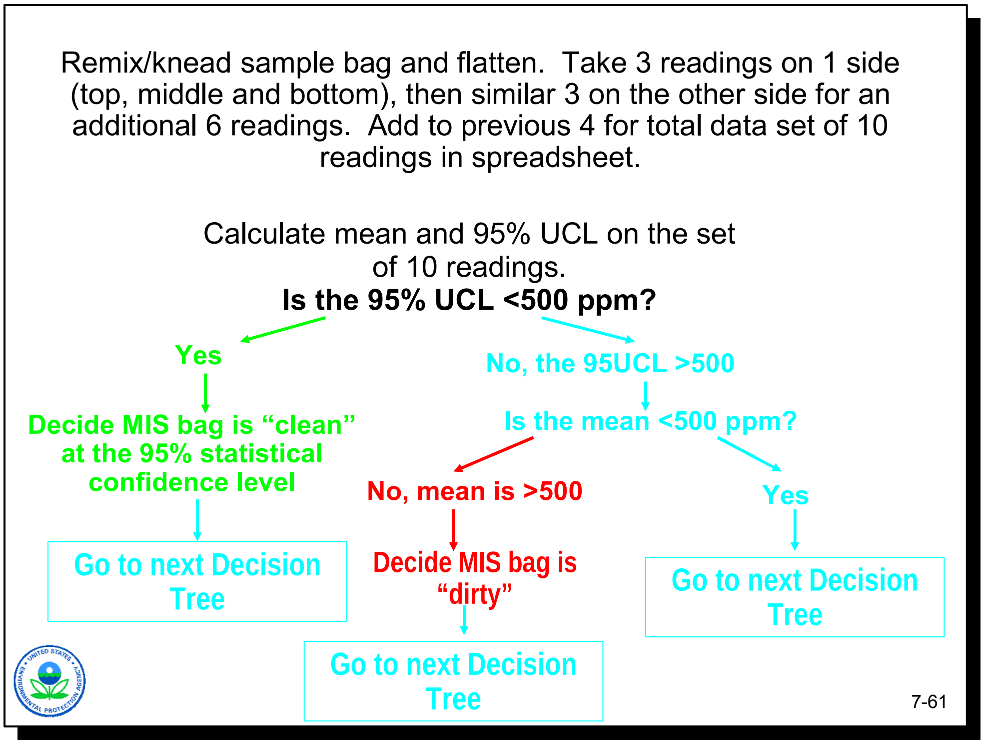


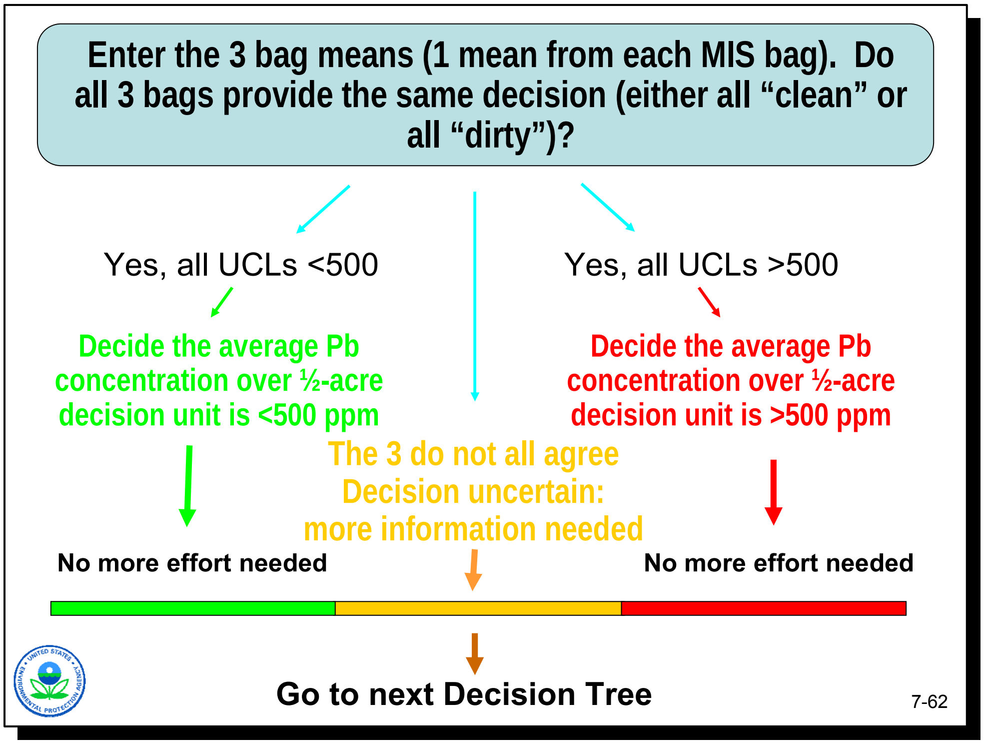
7-57


MIS Decision Tree
Collect 3 MIS of 10 increments each following increment sampling design. Thoroughly mix and shoot MIS bags.
Analyze each MIS bag per next Decision Tree
7-58


Knead and mix soil in bag. Do not shake bag or otherwise segregate particle sizes. Evenly flatten bag. Avoid bag crinkles and non-soil material, and
take 1 shot in center of bag
Is the result below 300?
Is the result above 800?
yes
If neither condition is true
yes
Decide Pb conc for the bag is below AL
Decide Pb conc for the bag is above AL
Decision too uncertain: more information needed
No more readings needed
No more readings needed
Go to next Decision Tree
7-59


Examine the mean, SD and 95% UCL calculated on the 4 bag readings.
Is the 95% UCL for the 4-reading data set < 500 ppm?
Yes
Decide Bag is “clean” at the 95% statistical confidence level
No, the 95UCL is >500
Is the mean >600 ppm?
Yes
Decide Bag is “dirty”
No, mean is <600
Are 2 or 3 of the readings <500 ppm?
No
Decide “dirty”
Yes
Proceed to next tree
7-60


Remix/knead sample bag and flatten. Take 3 readings on 1 side (top, middle and bottom), then similar 3 on the other side for an additional 6 readings. Add to previous 4 for total data set of 10 readings in spreadsheet.
Calculate mean and 95% UCL on the set of 10 readings.
Is the 95% UCL <500 ppm?
Yes
Decide MIS bag is "clean" at the 95% statistical confidence level
Go to next Decision Tree
No, the 95UCL >500
Is the mean <500 ppm?
No, mean is >500
Decide MIS bag is "dirty"
Go to next Decision Tree
Yes
Go to next Decision Tree
7-61


Enter the 3 bag means (1 mean from each MIS bag). Do all 3 bags provide the same decision (either all "clean" or all "dirty")?
Yes, all UCLs <500
Decide the average Pb concentration over ½-acre decision unit is <500 ppm
No more effort needed
The 3 do not all agree
Decision uncertain:
more information needed
Yes, all UCLs >500
Decide the average Pb concentration over ½-acre decision unit is >500 ppm
No more effort needed
Go to next Decision Tree
7-62

Are 2 out of the 3 “dirty”?

Use professional judgment, is the degree of “dirty” large enough to make it probable that another MIS of 10 samples will make 3 out of 4 “dirty”?

No

Decision uncertain: more information needed

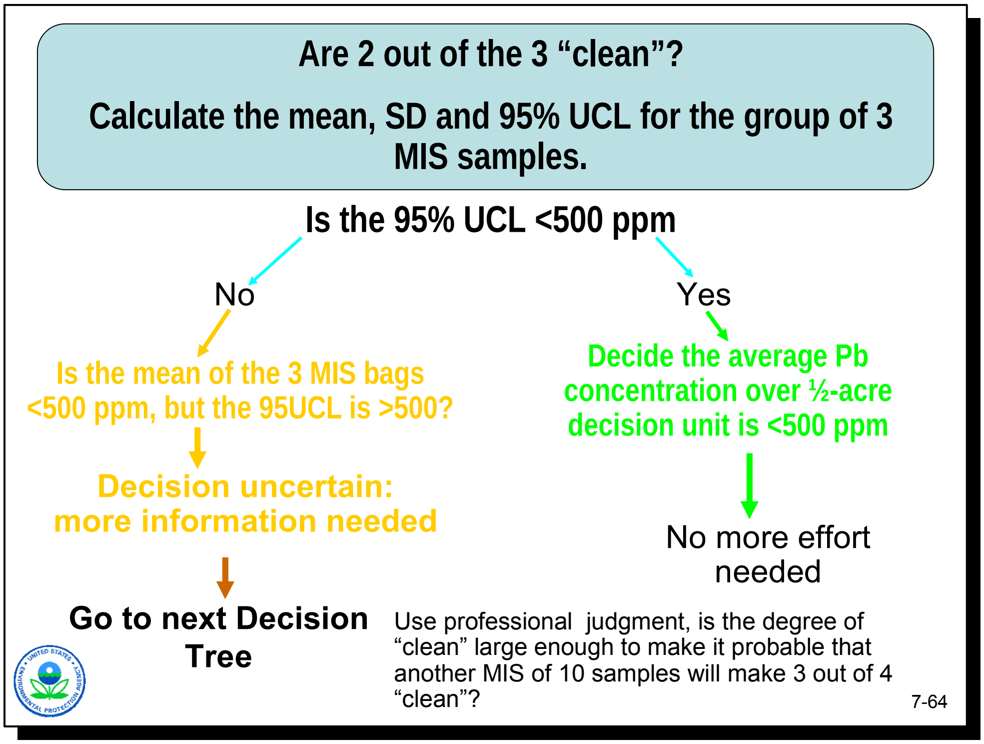
Go to next Decision Tree

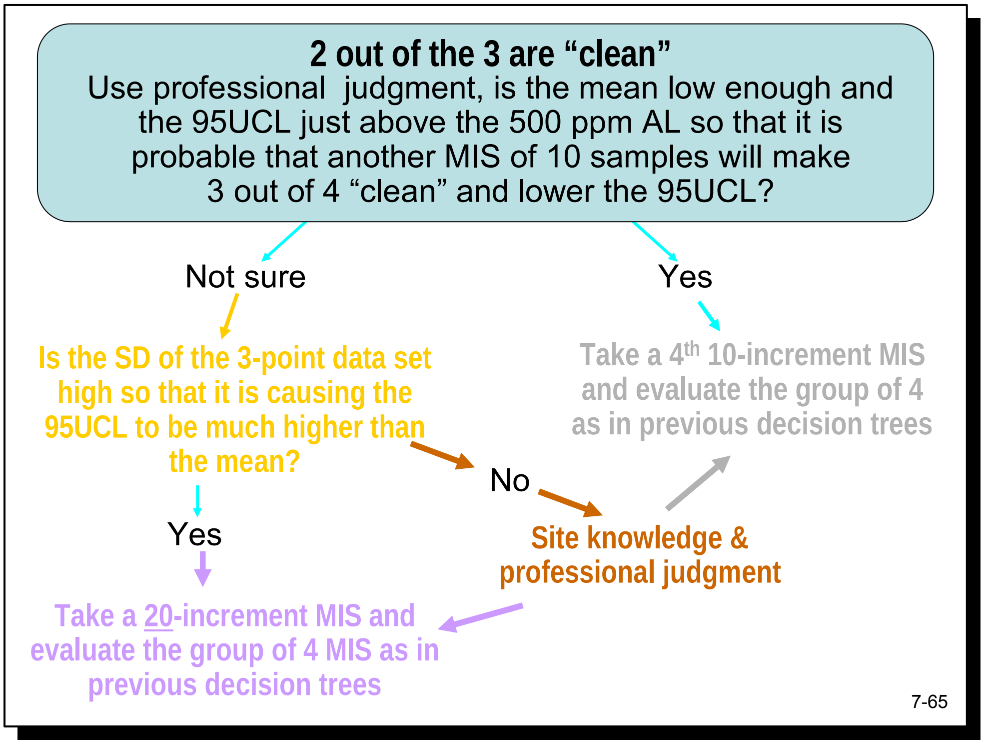
Yes

Decide the average Pb concentration over ½-acre decision unit is >500 ppm

No more effort needed

7-63


Are 2 out of the 3 "clean"?
Calculate the mean, SD and 95% UCL for the group of 3 MIS samples.
Is the 95% UCL <500 ppm
No
Yes
Is the mean of the 3 MIS bags <500 ppm, but the 95UCL is >500?
Decision uncertain: more information needed
Go to next Decision Tree
Decide the average Pb concentration over ½-acre decision unit is <500 ppm
No more effort needed
Use professional judgment, is the degree of "clean" large enough to make it probable that another MIS of 10 samples will make 3 out of 4 "clean"?
7-64


2 out of the 3 are "clean"
Use professional judgment, is the mean low enough and the 95UCL just above the 500 ppm AL so that it is probable that another MIS of 10 samples will make 3 out of 4 "clean" and lower the 95UCL?
Not sure
Yes
Is the SD of the 3-point data set high so that it is causing the 95UCL to be much higher than the mean?
Take a 4th 10-increment MIS and evaluate the group of 4 as in previous decision trees
No
Yes
Site knowledge & professional judgment
Take a 20-increment MIS and evaluate the group of 4 MIS as in previous decision trees
7-65

Q&A Review for XRF Internet Seminar

7-66

General and Specific Technical Resources

RESOURCES

7-67

General On-Line Resources

- Clu-In Web site
  http://www.cluin.org
- Brownfields Technology Support Center
  http://www.btsc.org
- Field Analytics Encyclopedia Web site
  http://clu-in.org/char/technologies
- Archived Internet seminars
  http://cluin.org/studio/seminar.cfm
- ITRC Web site
  http://www.itrcweb.org
- Argonne National Laboratory ASAP Web site
  http://www.ead.anl.gov/project/dsp_topicdetail.cfm?topicid=23

7-68

More General On-Line Resources

- Free geostatistical-based decision assistance software (SADA)
  http://www.tiem.utk.edu/~sada/
- DOE DQO/statistics training materials Web site & VSP links
  http://www.hanford.gov/dqo/training/contents1.html
- USACE Engineering Manuals (EMs) [Especially see manuals for CSM (EM 1110-1-1200) & systematic planning (TPP) (EM 200-1-2)]
  http://www.usace.army.mil/inet/usace-docs/eng-manuals/em.htm

7-69

Sampling Design Assistance

- Collected items on the Clu-In Web site (www.cluin.org)
  - » Sample Collection and Handling http://cluin.org/char1_edu.cfm#samp_coll
  - » Statistics/Sampling Design http://cluin.org/char1_edu.cfm#stat_samp
- RCRA Waste Sampling Draft Technical Guidance http://www.epa.gov/epaoswer/hazwaste/test/samp_guid.htm
- EPA statistical sampling guidance (USEPA QA/G-5S) http://www.epa.gov/quality/qs-docs/g5s-final.pdf
- FRTR long-term monitoring optimization http://www.frtr.gov/optimization/index.htm

7-70

Sample Collection Assistance

- Sampling procedures (USEPA Region 4) http://www.epa.gov/Region4/sesd/eisopqam/eisopqam.html and http://www.epa.gov/athens/learn2model/part-one/field/index.html
- USEPA ERT Web page http://www.ert.org/mainContent.asp?section=Products&subsection=List
- EPA ORD Soil Sampling Quality Assurance User's Guide http://www.triadcentral.org/ref/ref/documents/soilsamp.pdf
- EPA ORD Subsampling Guidance http://www.cluin.org/download/char/epa_subsampling_guidance.pdf

(continued)

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Sample Collection Assistance

- ASTM D6232: Selecting Sampling Equipment
- USACE CRREL Reports
  http://www.crrel.usace.army.mil/products/products.html
- USACE Waterways Experimental Station reports
  http://itl.erdc.usace.army.mil/library/
- VOCs in solid samples
  - EPA OSW developing sampling guidance; USACE also has guide available - see:
    http://cluin.org/char1_edu.cfm
- Explosive residues in soil sampling design & handling guidance in SW-846 Method 8330 (see App. A)
  http://www.epa.gov/epaoswer/hazwaste/test/pdfs/8330b.pdf

7-72

Innovative Sampling Technologies
Direct Push

- In situ measurement of subsurface properties (stratigraphic logging) with CPT
  - » DOE Innovative Technology report on CPT http://web.em.doe.gov/plumesfa/intech/conepen/index.html
  - » EPA information: Direct Push technologies
    - – http://www.epa.gov/athens/learn2model/part-one/field/b-probing_field.htm
    - – http://www.epa.gov/swerust1/pubs/esa-ch5.pdf
    - – http://clu-in.org/char/technologies/

7-73


Triad Resource Center. Triad: A smarter solution to site cleanup. - Netscape
Glossary
Search Site
Triad Overview
Triad Management
Regulatory Information
Technical Components
User Experiences
Reference/Resources
Privacy/Security
Triad Resource Center
TRIAD: A SMARTER SOLUTION TO SITE CLEANUP
The Triad is an innovative approach to decision-making for hazardous waste site characterization and remediation. The Triad approach proactively exploits new characterization and treatment tools, using work strategies developed by innovative and successful site professionals. The Triad Resource Center provides the information hazardous waste site managers and cleanup practitioners need to implement the Triad effectively.
Triad Overview
Introduction to Triad key concepts, guiding principles, and benefits
Triad Management
Triad vs. traditional, cost estimation, procurement, QA/QC, logistics and implementation, and other management concerns
Regulatory Information
Legal defensibility, relationship to DQO process, QA/QC, and other regulatory issues
Technical Components
Triad and cleanup programs, systematic planning, dynamic work plans, real-time measurements, and other technical information
User Experiences
Triad projects map, case studies, and lessons learned
References/Resources
Triad documents, web links, training classes, and resource providers
"The NJDEP supports and encourages the use of the Triad for sites undergoing investigation and remediation within the Site Remediation and Waste Management Program where feasible."
Evan Van Hook
New Jersey Department of Environmental Protection
Assistant Commissioner for Site Remediation and Waste Management
Multiagency support for Triad
News
ITRC Releases Triad Guidance Document for State Environmental Protection Agencies
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more info >
Glossary Search and browse definitions
Acronyms Search and browse acronyms
Frequently Asked Questions
E-mail this page
Printable version
Home | Overview | Triad Management | Regulatory Info | Technical Components | User Experiences | Reference/Resources
Privacy/Security | Site Map | Contact Us | E-Mail Announcements
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Selected Articles Describing the Triad Approach

See the Technical Components & References sections in the Triad Resource Center:

http://www.triadcentral.org/ref/index.cfm

- Interstate Technology & Regulatory Council TechReg Guideline for Triad: http://www.triadcentral.org/ref/ref/documents/SCM-1.pdf
- 2001 ES&T "Managing Uncertainty in Environmental Decisions" article: http://www.triadcentral.org/tech/documents/oct01est.pdf
- 2001 Quality Assurance journal "Representativeness" article: http://www.triadcentral.org/tech/documents/dcrumbling.pdf

(continued) 7-75

Selected Articles Describing the Triad Approach

- 2003 Remediation journal "Next Generation Practices" article: http://www.triadcentral.org/tech/documents/spring2003v13n2p91.pdf
- 2003 Remediation journal "Insurance" article: http://www.triadcentral.org/ref/doc/Remediation_preprint_Triad-Insurance.pdf
- Fall 2004 Remediation journal "Triad Myths" article: http://www.triadcentral.org/ref/doc/Fall04RemediationArticlePostprint.pdf

(continued)

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Selected Articles Describing the Triad Approach

- Winter 2004 Remediation journal articles:
  - » "Triad as Catalyst" article: http://www.triadcentral.org/ref/doc/RemediationCatalystPostprint.pdf
  - » Triad Case Study: Rattlesnake Creek: http://www.triadcentral.org/ref/doc/TriadCaseStudy_RattlesnakeCreek.pdf
  - » Triad Case Study: Marine Corps Base Camp Pendleton http://www.triadcentral.org/ref/doc/Winter_04_Remediation_Preprint_Navy_Case_Study.pdf
  - » Triad Case Study: Former Small Arms Training Range http://www.triadcentral.org/ref/doc/ShawTriadCaseStudypreprint.pdf

7-77

Final Instructions

- You can download the archived sessions of this 8-session XRF series and other technical presentations at: http://www.clu-in.org/live/archive.cfm

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