Pilot Study for Contracting and Use of Advanced Classification in the Military Munitions Response Program

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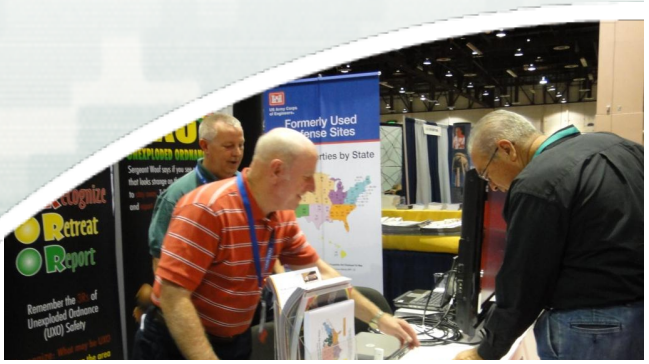

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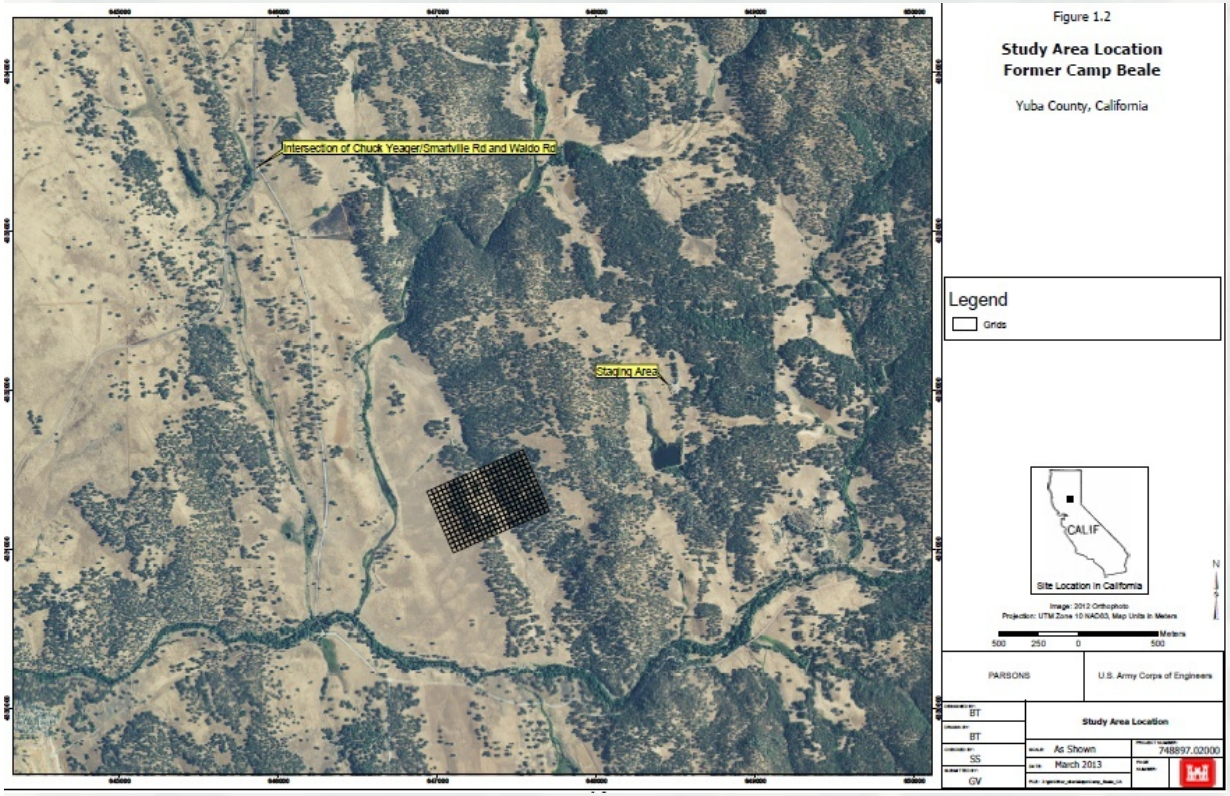
Agenda

- Background
- Purpose and Intent of Pilot Study at Camp Beale
- Initial Results
- Intrusive Investigation and Verification Process
- Rough costing estimates

Background



- ESTCP selects Former Camp Beale for FY10 Advanced Classification Demonstration (fourth in their series)
- 50 acres of EM61 data (75 cm line spacing) is collected across site of which ~10 acres is selected for the demonstration and recollected at 50 cm spacing

Background cont.

- Summer of 2010: During site walk, USACE and DTSC discuss what to do with remaining EM61 data and brainstorm Pilot Study
- Fall of 2011: Multiple Advanced Sensors and multiple processors demonstrate resounding success
- December 2011: Confirm 75cm line spacing detects TOI from Beale Demonstration
- January 2012: Scope of Work for Phase 1 agreed to by USACE and DTSC
- March 2012: Project kick-off meeting with DTSC, USACE and ESTCP
- April 2012: Blind Seeding Plan acknowledged as appropriate by USACE and DTSC and TLI is funded to perform blind seeding
- Spring 2012: Parsons funded to perform Phase 1
- December 2012: Parsons funded to perform Phase II
- Intrusive Investigation and verification planned for May 2013

Pilot Study Objective

- Objective: learn how to apply a classification process in a real-world setting and actually leave metal in the ground, where both USACE and the DTSC agree on what is left in the ground does not need to be recovered
- Two phase project:
  - Phase 1 – Classify detected anomalies as TOI or Not TOI; come to consensus on dig list and don't dig list
  - Phase 2 – Dig the dig list, verify the process, write a report

What we will get from this pilot study

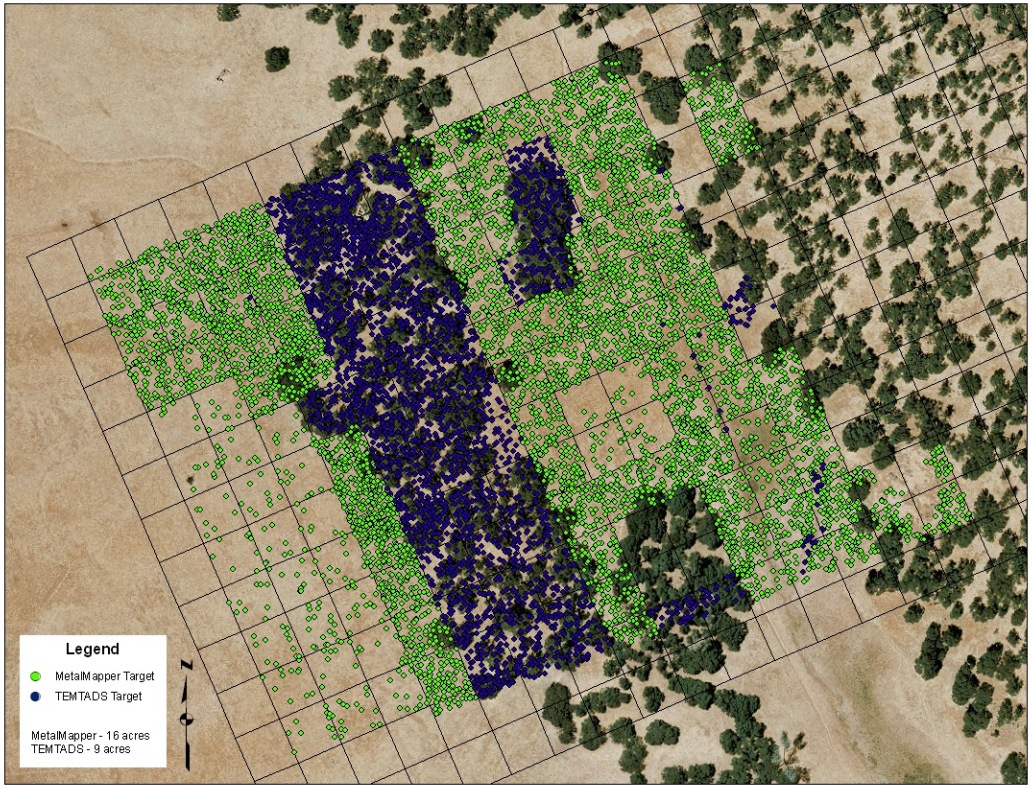
- A classification process and a verification process that are acceptable to both USACE and DTSC
- UXO recovery over 25 more acres of Former Camp Beale
- A statement from USACE and DTSC that most, and perhaps all, explosive hazards have been recovered from the pilot study area
- A model to implement advanced classification on future projects

What we will not get from this pilot study

- Response Complete for the MRS
- A proven UXO-free site

Beale II, Phase I

- MetalMapper
  - 6,363 targets (green)
- TEMTADS
  - 2,806 targets (blue)



Dig List – Phase I Dig Target Statistics

MetalMapper TOI

Total analyzed: 6,363

Total TOI: **624**

- Can't Analyze: **253**
- P1: **273**
- P2: **16**
- P3: **13**
- P4: **64**
- Training: **5**

Size Predictions

- Large: **78**
- Medium: **57**
- Small: **231**
- Can't reliably call: **258**

TEMTADS TOI

Total analyzed: 2,806

Total TOI: **415**

- Can't Analyze: **97**
- P1: **238**
- P2: **32**
- P3: **15**
- P4: **32**
- Training: **1**

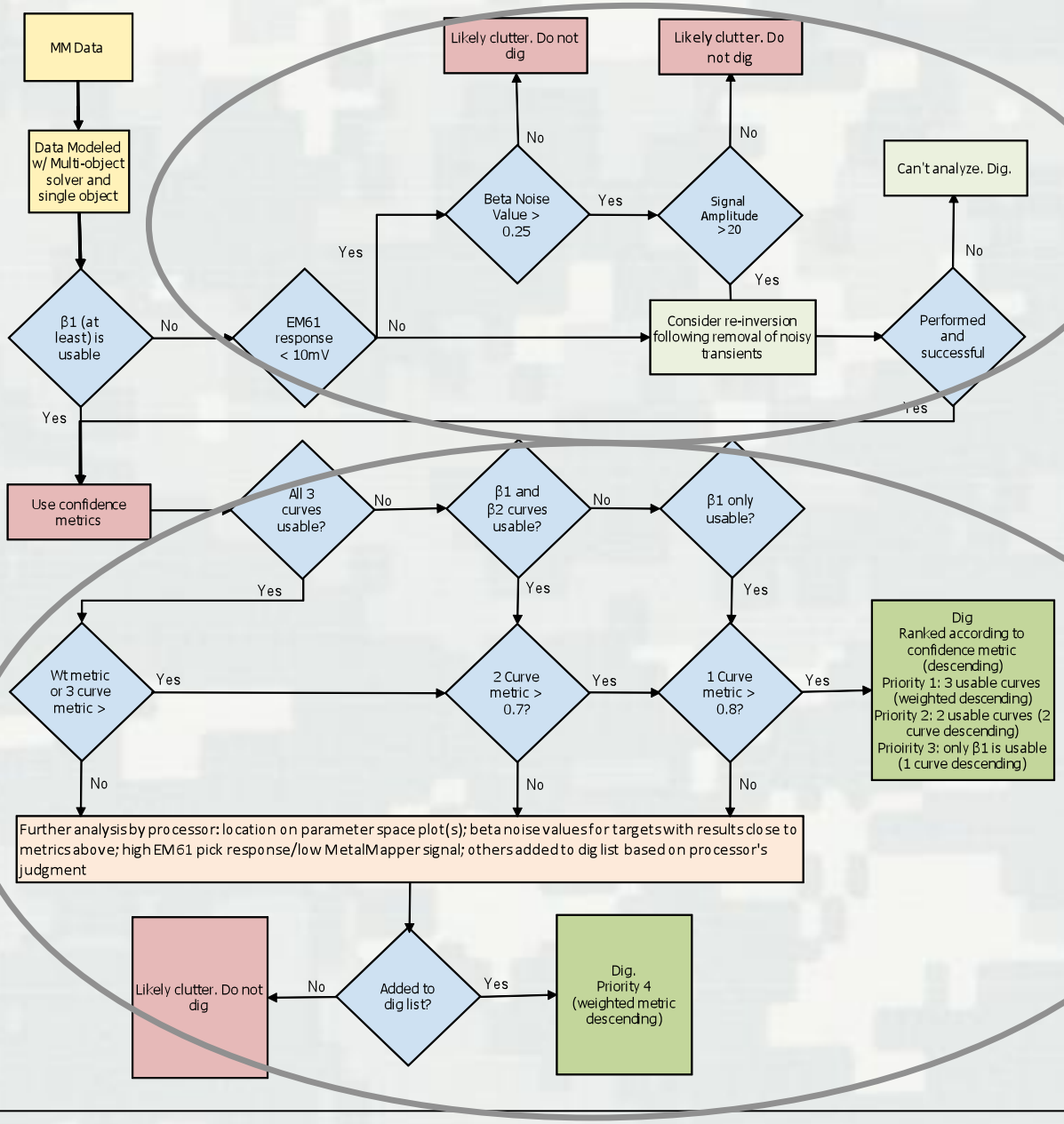
Size Predictions

- Large: **22**
- Medium: **113**
- Small: **182**
- Can't reliably call: **98**

Legend

Priority 1: 3-curve
Priority 2: 2-curve
Priority 3: 1-curve
Priority 4: feature space
Large: ~large ISO
Medium: ~medium ISO
Small: ~small ISO

Camp Beale II MM
Classification Rationale



QC & Can't-Analyze Decisions

Classification Process

Includes 4 methods of comparing inversions to library data

Process Verification Memorandum

- Process Verification involves:
  - ▶ QA of collection process ☑ Done in Phase I
  - ▶ QA of inversion process ☑ Done in Phase I
  - ▶ QA of classification process ☑ Done in Phase I
  - ▶ Verification digging

QA of collection process

Performance Objective	Success Criteria	MetalMapper	TEMTADS
	Collection Objectives		
Correctly identify seed items in IVS strip	98% of IVS items identified correctly with confidence metric of > 0.7	**Passed**	**Passed**
Correctly position MetalMapper relative to source	100% of inverted locations within 40cm of collection point unless re-shot also outside radius	**100% of inverted locations within 40cm of collection point or re-shot performed (9 reshots)**	**13 re-shots no collected due to time constraints. All will be intrusively investigated (562 reshots)**
Correctly position MetalMapper relative to EM61 target	100% of collection points within 73cm of EM61 target location	**100% of collection points within 73cm**	**Not applicable. Reacquisition performed prior to TEMTADS collection**
Collect background point every two hours	Backgrounds collected no less than every two hours	**Passed**	**Passed**

QA of inversion process

Performance Objective	Success Criteria		MetalMapper		TEMTADS	
			Processing Objectives			
Minimize number of Can't Analyze targets	Less than 15% of points indentified as Can't Analyze		**< 4% identified as Can't Analyze**		**< 4% identified as Can't Analyze**	
All collection points corrected with appropriate background	All collection points corrected with appropriate background		**100% of collection points appropriately corrected for background***		**100% of collection points appropriately corrected for background**	
Utilize UXAnalyze to perform all inversions	All data points run through multi and/or single solver		**Pass- 137 TOI added based on single solver (7 seeds)**		**Pass**	
Utilize field notes	All poor inversion results due to field conditions added to dig list		**Pass (9 QA added)**		**Pass (4 QA added)**	
Correct estimation of target location	X, Y Z	< 30 cm (1s) < 15 cm (1s)	**X, Y** **Z**	**1σ = 7.0 cm** **1σ = 13.6 cm**	**X, Y** **Z**	**1σ = 12.4 cm** **1σ= 10.0 cm**

QA of classification process

Performance Objective	Success Criteria	MetalMapper	TEMTADS
	Classification Objectives		
Develop appropriate library	Site/Instrument specific library is developed with appropriate TOI	**Pass**	**Pass**
Perform Feature Space analysis	Identify clusters or anomalies based on feature space relationships	**Pass- 33 TOI added**	**Pass- 23 TOI added**
Maximize correct classification of targets of interest	98% of TOI classified correctly	**100% of seeds classified correctly**	**100% of seeds classified correctly**
Maximize correct classification of non-TOI	60% of non-TOI left in ground	**> 92% of non-TOI left in ground (based only on seeds)**	**> 87% of non-TOI left in ground (based only on seeds)**
Correctly identify type of TOI	75% of TOI identified correctly	**93% of TOI Type identified correctly (based only on seeds)**	**95% of TOI identified correctly (based only on seeds)**
Correctly identify type of non-TOI	50% of non-TOI identified correctly	Pending dig results	Pending dig results
Correctly classify QC small ISO seeds	100% of QC seeds are classified as TOI	**100% of QC seeds on TOI list (48 seeds)**	**100% of QC seeds on TOI list (24 seeds)**

QA of classification process
A Look At The Seeds

MetalMapper

Predicted Item Group

QC Seed Group	small	medium	large
small	82	3	0
med	2*	12	3*
2.75	0	1	9
large	0	0	16

*deeper
(52,55,70,66cm)

TEMTADS

Predicted Item Group

QC Seed Group	small	medium	large
small	49	3	0
med	0	10	0
large	0	0	3

Process Verification Memorandum

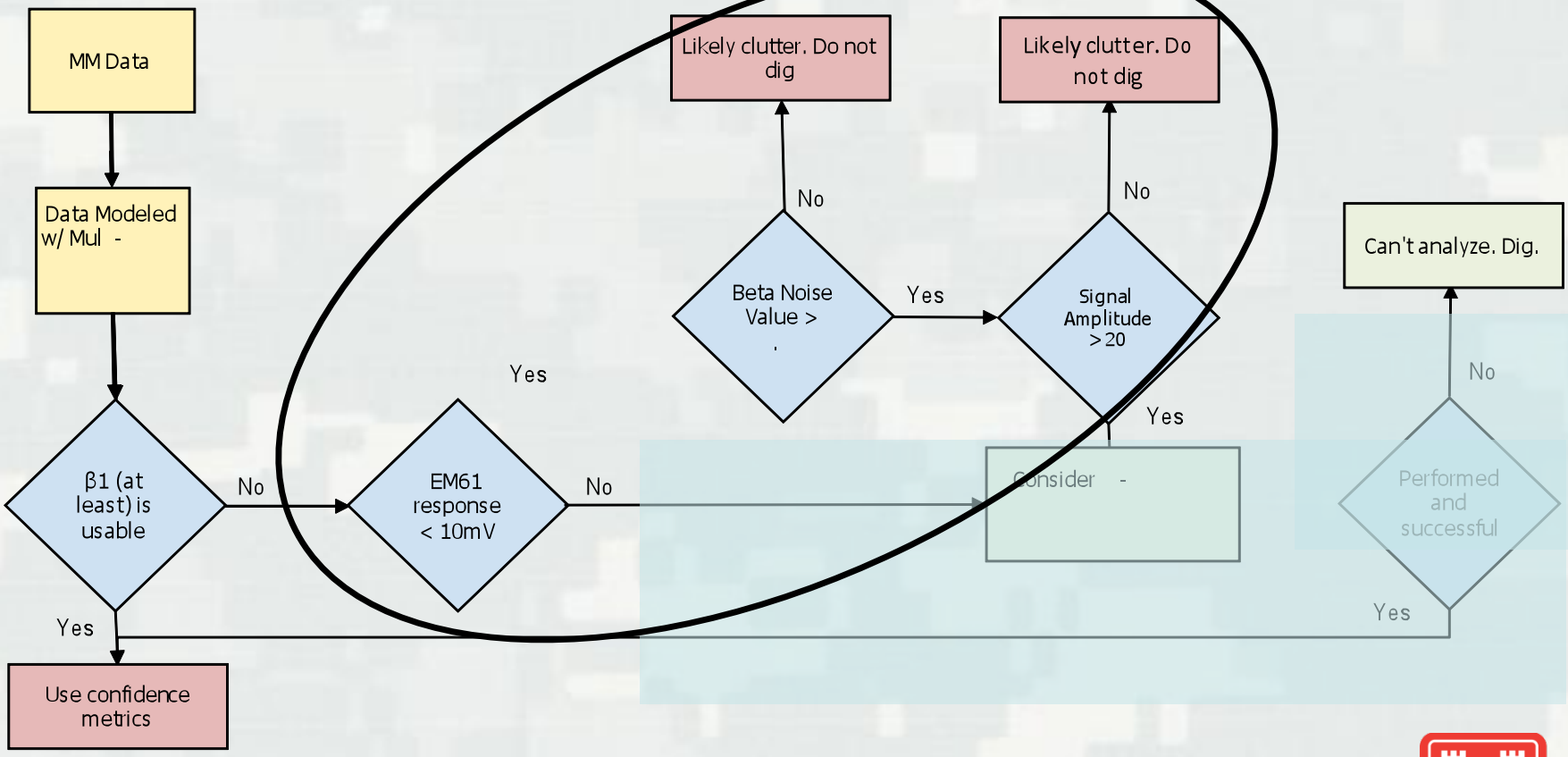
- Process Verification involves:
  - ▶ QA of collection process ☑ Done in Phase I
  - ▶ QA of inversion process ☑ Done in Phase I
  - ▶ QA of classification process ☑ Done in Phase I
  - ▶ Verification digging

Verification digging

Decision Boundary Verification

- The following components of the Non-TOI classification logic will be tested:
  - Non-TOI predicted deep from lower signal inversions→Did we maybe miss something deep?
  - Non-TOI near the can't analyze decision points→Did we miss something shallow?
  - Non-TOI near the Library Match decision boundaries→Did we miss something close to a library match?

Camp Beale II MM
Classification Rationale



Verification digging

Decision Boundary Verification

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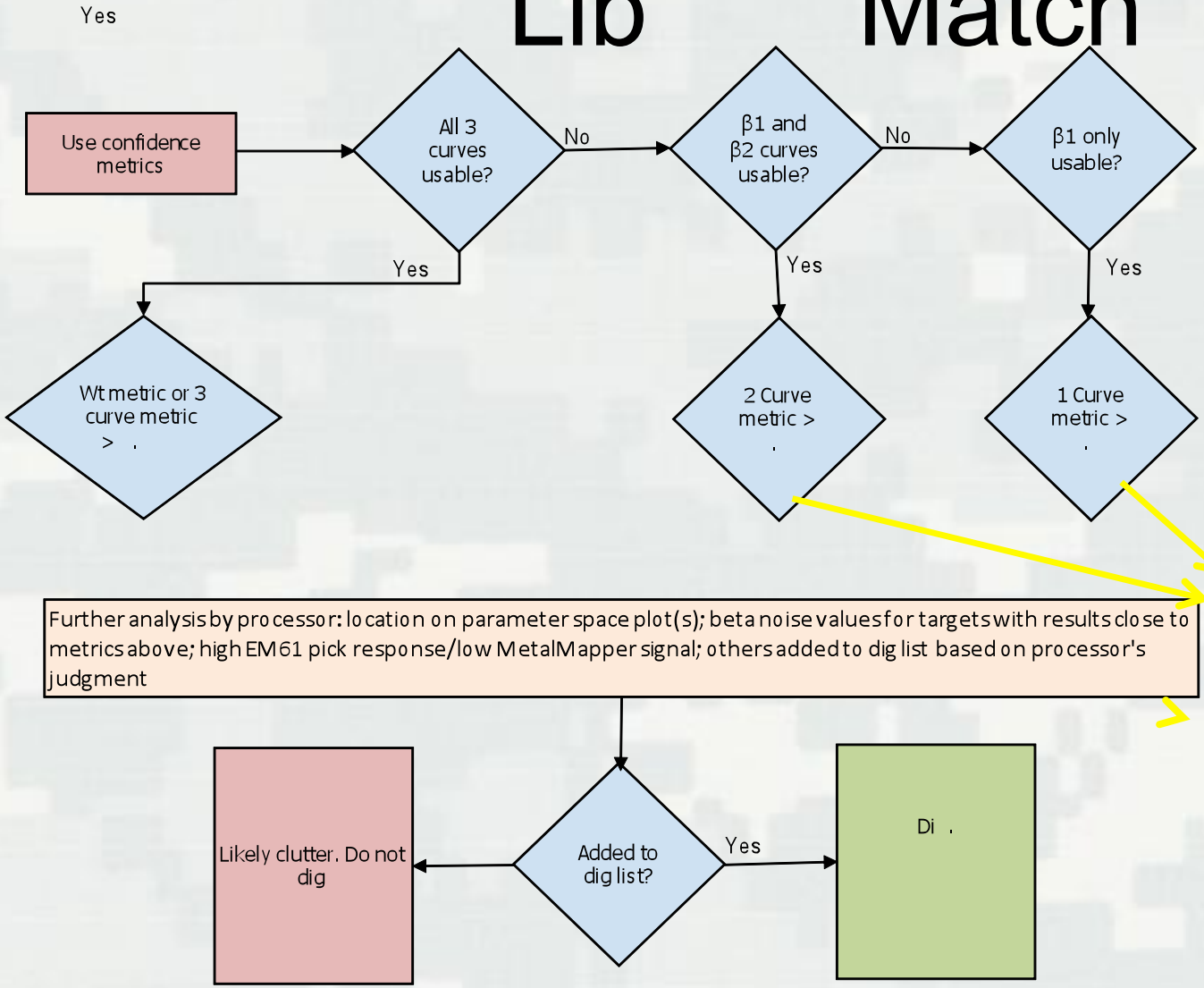
Next most likely TOI based on Lib Match



Preliminary Summary of Proposed Verification Digs

- Total MetalMapper Non-TOI digs: Somewhere around 300
- Total TEMTADS Non-TOI digs: Somewhere around 250
- Will use these anomalies plus all TOI digs to test Inversion Process Verification:
  - Lateral deltas metric: ±0.3m
  - Depth deltas metric: ±0.15m
  - Predicted Shape metric: 75% correct calls
  - Predicted Size: 75% correct calls

Beale 2 Pilot Study

COST STATISTICS

(all include estimated 25% project management costs @ USACE)

MetalMapper: $562K

- Detection survey: $75K
- MetalMapper acquisition and analysis: $314K
- Dig 624 TOI + 300 Non-TOI @$150/dig: $173K

► If all 6,363 excavated @ $100/dig: **$870K = ~54% cost increase**

TEMTADS: $358K

- Detection survey: $75K
- TEMTADS acquisition and analysis: $175K
- Dig 550 TOI and 250 Non-TOI @$150/dig:$150K

► If all 2,934 excavated @ $100/dig: **$442K = ~23% cost increase**

Beale 2 Pilot Study

Lesson Being Learned

What if we paid for better detection survey (50cm line spacing rather than 75cm line spacing)?

Detection survey = 33% more work

- 205 flags per acre @ 5.2mV = **3,800 flags on 18 acres**
- instead of 341 flags/acre @ 4.5mV threshold in this study

You also get improved efficiency

- less time to hunting for source: at least 15% less time on target
- Number of re-shots goes way down: 8%→3% (from ESTCP demo)

Number of TOI = unchanged

- ~10% make it on the dig list = ~380

Number of Non-TOI for Verification= Goes Down

- ~5% make it on the verification dig list = ~170

Beale 2 Pilot Study
Lesson Being Learned

What if we paid for better detection survey (50cm line spacing rather than 75cm line spacing)?

Advanced Classification: **$355K**

- Detection survey (33% more work): $100K
- MetalMapper Acquisition and analysis: $152K
- Recover 380 TOI + 170 Non-TOI @ $150/dig: $103K
- **~37% decrease** in overall project cost (from slide #21)

Special Thanks

- SERDP/ESTCP
  - Anne Andrews and Herb Nelson
- DTSC
  - Ed Walker, Roman Racca, Steve Sterling
- USACE
  - Andrew Schwartz and James Austreng

Stay Tuned…anticipate publishing Pilot Study Report in early FY14