

# THE FS

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ENVIRONMENTAL QUALITY

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TECHNICAL GUIDANCE FOR  
MILITARY MUNITIONS RESPONSE ACTIONS

**COMING  
SOON!**  
(Hopefully?)  
(Optimistically Hopeful)

ENGINEER MANUAL



# THE OVERALL PROCESS



1. Establish RAOs ✓
2. Identify general response actions (GRA) that can satisfy the remediation goals of the RAO
3. Identify and screen technologies or process options applicable to each general response action
4. Evaluate process options for effectiveness (to achieve one or more remediation goals), implementability, and relative cost
5. Assemble technologies/process options into remedial alternatives
6. Screen remedial alternatives, if necessary
7. Detailed analysis of remedial alternatives, which is divided in to:
  - a. Analyze remedial alternatives against seven of the nine evaluation criteria
  - b. Compare remedial alternatives against each other



# SOME DEFINITIONS IN THE CONTEXT OF AN MMRP FS



## ❖ General Response Action

- What is it we'd be doing/achieving

## ❖ Method Of Action

- Overall grouping of what we have at our disposal

## ❖ Technology

- Label for a group of common clean-up methods; general categories of technologies

## ❖ Process Option

- Specific processes within each technology type

## ❖ “Containing the MEC”

## ❖ “Inspecting the ground surface to locate MEC”

## ❖ “Visual inspections”, or “Instrument aided visual inspections”

## ❖ “Person looking for MEC”, or “Person looking for MEC aided by a handheld instrument that produces an audio output”



# SOME MORE DEFINITIONS



## ❖ Treatment

- Making the MEC go away
- Think “detect/locate” and “remove”

## ❖ Containment

- Restricting access to, or otherwise making it difficult to interact with MEC
- Think “Engineering Controls”

## ❖ Institutional actions

- Things we can do in an effort to change people’s response to encountering MEC
- Think “Institutional Controls”

## ❖ Land Use Controls (in case I use the term as we go along)

- All things containment (engineering controls) and institutional actions (institutional controls)

## ❖ Protectiveness

- Meets or does not meet our remediation goals over the long term

## ❖ Effectiveness

- How well we anticipate a given technology or process option will achieve its method of action



# THERE ARE SEVEN GRAS THAT CAN BE ESTABLISHED TO ACHIEVE SITE-SPECIFIC REMEDIATION GOALS FOR AN MRS



*This is a team effort*

1. Treatment actions
2. Containment actions
3. Institutional actions
4. Treatment and containment actions
5. Treatment and institutional actions
6. Containment and institutional actions
7. Treatment, containment, and institutional actions

Types of Actions for Terrestrial Munitions Response Sites		
Actions	Common Methods	Commonly Associated Outcomes that Contribute to Managing Risk
Treatment Actions	Geophysical detection, excavation, MEC disposal	Substantially reduce the quantities of MEC to substantially decrease the number of possible encounters or interactions (note that this method can result in removing all MEC thereby eliminating the possibility of encounters)
	Surface geophysical and/or visual detection, MEC disposal	Reduce the quantities of or remove all the surface MEC to decrease the number of possible encounters or interactions (i.e., reduce quantities), or to prevent encounters altogether (i.e., remove all the surface MEC). Note that these actions do not address subsurface MEC.
	Geophysical detection in lifts, excavation, MEC disposal	Remove all MEC to preclude encounters (and thereby preclude interactions)
	Dig in lifts, sift/sort, MEC disposal	Remove all MEC to preclude encounters (and thereby preclude interactions)
	Dig in lifts, geophysical detection of excavated material, MEC disposal	Remove all MEC to preclude encounters (and thereby preclude interactions)
Containment Actions	Restrict or control access (e.g., fencing)	Impede a user's ability to interact with MEC
	Protective cover (usually soil, may include concrete, asphalt, or other material)	Control or preclude a user's ability to interact, either intentionally or unintentionally, with MEC
Institutional Actions	Change behavior via passive measures (e.g., via signage or pamphlets)	Land users take appropriate actions if they encounter MEC
	Change behavior via active measures (e.g., explosives safety training)	Land users take appropriate actions if they encounter MEC
	Manage access via permits or deed restrictions	Manage user's ability to interact with MEC during normal usage activities that do not include intrusive actions
	Manage exposure via onsite MEC support (e.g., MEC escort, anomaly avoidance)	Active measure to limit user's ability to interact with MEC during normal usage activities that include intrusive actions
	Periodic evaluations/inspections	Verification that a remedy component remains in place and functional

The overall process:  
 Starting from the RAO  
 → Identify GRAs  
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     → Technology Types/Method of Action  
     → Process Options/Technology Type  
 → Screen Tech Types/Options  
 → Evaluate Tech Types/Options  
 → Combine Tech Types/Options to achieve the RG  
 → Each combo = an alternative



# GRAs → METHODS OF ACTION → TECHNOLOGY TYPES



Media	Example of Generalized RAO	General Response Actions	Method Of Action		
Soil	RAOs where prevention of exposure is the goal: "The ASSESSMENT AREA(S) is(are) anticipated to have CONTAMINATION (MEC Types) in MEDIA throughout the assessment area(s), with MEC expected to exist within DEPTH PROFILE(S). RECEPTORS in the assessment area could be exposed to MEC via EXPOSURE PATHWAY(S) to EXPOSURE DEPTH(S). The remediation goal for the assessment area(s) is(are) to PREVENT RECEPTORS from TYPE OF EXPOSURE with MEC. The remedy is subject to the following CONSTRAINTS."	Treatment Actions (sometimes referred to as "physical removals")	Inspections of the ground surface	<p>The overall process: Starting from the RAO → Identifv GRAs → <b>Method(s) of Action/GRA</b> → Technology Types/Method of Action → Process Options/ Technology Type → Screen Tech Types/Options → Evaluate Tech Types/Options → Combine Tech Types/Options to achieve the RG → Each combo = an alternative</p>	
			Subsurface geophysical detection & excavation		
			Dig & sift/sorting		
			Disposal		
		Containment Actions	Restrict or control access		excavation & recovery
		Institutional Actions	Protective Covers		Sift/Sort
			Change Behavior		Intentional Detonation
			Restrict or control access		Engineering Solutions
		Treatment & Containment Actions	Treatment Component Methods		Physical Barriers Mechanisms
			Containment Component Methods		Physical Barriers Mechanisms
		Treatment & Institutional Actions	Treatment Component Methods		Public Awareness Mechanisms
			Institutional Component Methods		education mechanisms
			Containment Component Methods		Legal Mechanisms
			Institutional Component Methods		Administrative Mechanisms
			Treatment Component Methods		Same as above
	Containment Component Methodos	Same as above			
	Institutional Component Methods	Same as above			



# TECHNOLOGY TYPES TO PROCESS OPTIONS



Method of Action	Common Technology Types	Common Process Options
Inspections of the ground surface	Visual inspection	Person looking for MEC
	Instrument aided visual inspection	Person using hand-held instruments w/ audio output and looking for MEC
	Systematic geophysical systems	Dynamic AGC
Subsurface geophysical detection & excavation	Systematic geophysical systems	Advanced geophysical classification
		Airborne mag
		Land borne mag man-portable
		Land borne magnetometer towed array
		Airborne non-AGC DGM array
		Land borne non-AGC DGM man-portable
		Land borne non-AGC DGM towed
	Uncontrolled geophysical systems	Hand-held instruments w/ audio or needle deflection output

Method of Action	Common Technology Types	Common Process Options
Subsurface geophysical detection & excavation Excavation & recovery	Sensor Positioning	RTK-DGPS
		LiDAR-SLAM
		RTS
	Excavation & recovery	Line & Fiducial
		Manual
		Mechanized-rol
		Mechanized-op
		Electro-magnet
		Rake & separat.
		Mechanized-robotic
Mechanized-operator		
Dig & sift/sorting	Sift/Sort	Conveyor line-manual sort
		Conveyor line-electromagnet
		Rotary Sift
		Shaker Sift
Disposal	Intentional Detonation	BIP
		BIP with engineering controls (e.g., open front barricade)
		Consolidated detonations
		Contained detonation chamber
	Engineering Solutions	Thermal neutralization
		Cut & Capture
		Explosively generated plasma jet neutralization
		Shredding

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# MORE EXAMPLES OF GRA, TECHNOLOGY TYPES, AND PROCESS OPTIONS



GRA =	Containment	Common Technology Types	Common Process Options
		Physical Barriers Mechanisms	Fencing
	Physical Barriers Mechanisms	Cover / fill	
GRA = Institutional Actions	Public Awareness Mechanisms	Signage	
		Pamphlets	
		Internet Information web site	
	Education mechanisms	School programs	
		Town meetings	
		Anomaly Avoidance	
		On-Call UXO support	
	Legal Mechanisms	Local ordinances	
		Restrictive Covenants	
		Deed restrictions	
Administrative Mechanisms	Use permits		
	Public Notices		

## Example of a GRA combo

GRAs	Method Of Action	Common Technology Types	Common Process Options
Treatment & Institutional Actions	Inspections of the ground surface	Human visual assisted	Person walking a path w/ AGC
		Systematic geophysical systems	Person-portable
	Geophysical detection & excavation	Systematic geophysical systems	AGC, non-AGC DGM Person-portable or towed by person
		Sensor Positioning	SLAM
		Excavation & recovery	RTS Manual or small mechanized excavator
	Disposal	Intentional Detonation	BIP, BIP w/ engineering controls, consolidated detonations
		Engineering Solutions	Explosively generated plasma jet neutralization
	Change Behavior	Public Awareness Mechanisms	Signage, pamphlets, internet web site
		Education mechanisms	School programs & Town meetings
			Anomaly Avoidance
	On-Call UXO support		
Restrict or control access	Administrative Mechanisms	Monitoring & public notices	

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# SCREENING DECISION PROCESS



- ❖ Screening should be constrained to **Technical Implementability**
- ❖ Who should be involved?
  - Decision makers (i.e., everyone)
    - Not just the contractor!
    - Getting the team on board now saves time later
- ❖ When should it be done?
  - After the draft FS? **NO!**
  - **BEFORE** the FS is drafted
- ❖ Discussions may result in revisions of Remediation Goals
  - Might need to be more complex
  - Might actually be able to simplify

The overall process:  
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Media	Example of Generalized Remediation Goal	General Response Actions	Method Of Action	Technology Types	Process Options	Description					
RAOs where prevention of exposure is the goal: "The ASSESSMENT AREA(S) is(are) anticipated to have CONTAMINATION (MEC Types) in MEDIA throughout the assessment area(s), with MEC expected to exist within DEPTH PROFILE(S). RECEPTORS in the assessment area could be exposed to MEC via EXPOSURE PATHWAY(S) to EXPOSURE DEPTH(S). The remediation goal for the assessment area(s) is(are) to PREVENT RECEPTORS from TYPE OF EXPOSURE with MEC. The remediation goal is subject to the following CONSTRAINTS:	Treatment Actions (sometimes referred to as "physical removals")		Inspections of the ground surface	Visual inspection Instrument aided visual inspection Systematic geophysical systems	For each Technology Type, list all the Process Options (e.g. technology combinations) that are available for remedial actions. See Table L-7	Describe what they could achieve at the MRS.	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. If not feasible or viable, provide brief justification.				
			Subsurface geophysical detection & excavation	Systematic geophysical systems Uncontrolled geophysical systems Sensor Positioning Excavation & recovery							
			Dig & sift/sorting	excavation & recovery Sift/Sort							
			Disposal	Excavation, Detonation Engineering Solutions							
			Containment Actions	Restrict or control access Protective Covers				Physical Barriers Mechanisms	For each, list the Process Options available for remedial actions. See Table L-7	Describe what they could achieve at the MRS.	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. If not feasible or viable, provide brief justification.
			Institutional Actions	Change Behavior Restrict or control access				Public Awareness education mechanisms Legal Mechanisms Administrative	For each, list the Process Options available for remedial actions. See Table L-7	Describe what they could achieve at the MRS.	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. If not feasible or viable, provide brief justification.
			Treatment & Containment Actions	Containment Component Methods				Same as above	Same as above	Same as above	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. State how Treatment and Containment components work in concert to achieve the remediation goals.
			Treatment & Institutional Actions	Treatment Component Methods Institutional Component Methods				Same as above Same as above	Same as above Same as above	Same as above Same as above	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. State how Treatment and Institutional components work in concert to achieve the remediation goals.
			Containment & Institutional Actions	Containment Component Methods Institutional Component Methods				Same as above Same as above	Same as above Same as above	Same as above Same as above	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. State how Containment and Institutional components work in concert to achieve the remediation goals.
			Treatment & Containment & Institutional Actions	Treatment Component Methods Containment Component Methods Institutional Component Methods				Same as above Same as above Same as above	Same as above Same as above Same as above	Same as above Same as above Same as above	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. State how Treatment, Containment and Institutional components work in concert to achieve the remediation goals.

This is a team effort!



# SCREENING TECHNOLOGY TYPES & PROCESS OPTIONS

## OPTIONS



Media	Example of Generalized Remediation Goal	General Response Actions	Method Of Action	Technology Types	Process Options	Description	
See RAO Table Handout		Treatment Actions (sometimes referred to as "physical removals")	Inspections of the ground surface	Visual inspection	For each Technology Type, list all the Process Options (e.g., technology methods) that are available for remedial actions. See Table I-7	Describe what they could achieve at the MRS.	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. If not feasible or viable, provide brief justification.
				Instrument aided visual inspection			
				Systematic geophysical systems			
			Subsurface geophysical detection & excavation	Systematic geophysical systems			
				Uncontrolled geophysical systems			
				Sensor Positioning			
		Dig & sift/sorting	Excavation & recovery				
			excavation & recovery				
		Disposal	Sift/Sort				
			Intentional Detonation				
Containment Actions	Restrict or control access	Physical Barriers Mechanisms	For each, list the Process Options available for remedial actions. See Table I-7	Describe what they could achieve at the MRS.	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. If not feasible or viable, provide brief justification.		
	Protective Covers	Physical Barriers Mechanisms					
Institutional Actions	Change Behavior	Public Awareness Mechanisms	For each, list the Process Options available for remedial actions. See Table I-7	Describe what they could achieve at the MRS.	If "Potentially Applicable", state any pros and/or cons as they relate to achieving the remediation goals. If not feasible or viable, provide brief justification.		
						education mechanisms	
		Restrict or control access				Legal Mechanisms	
Treatment & Containment Actions	Treatment Component Methods	Same as above	Same as above	Same as above	Same as above	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. State how Treatment and Containment components work in concert to achieve the remediation goals.	
							Containment Component Methods

The overall process:  
 Starting from the RAO  
 → Identify GRAs  
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 → **Screen Tech Types/Options**  
 → Evaluate Tech Types/Options  
 → Combine Tech Types/Options to achieve the RG  
 → Each combo = an alternative



# SCREENING TECHNOLOGY TYPES & PROCESS OPTIONS



Media	Example of Generalized Remediation Goal	General Response Actions	Method Of Action	Technology Types	Process Options	Description	Screening
		Treatment & Institutional Actions	Treatment Component Methods	Same as above	Same as above	Same as above	If "Potentially Applicable", state any pros and/or cons as they relate to the remediation goals. State how Treatment, Containment and Institutional components work in concert to achieve the remediation goals.
			Institutional Component Methods	Same as above	Same as above	Same as above	
		Containment & Institutional Actions	Containment Component Methods	Same as above	Same as above	Same as above	
			Institutional Component Methods	Same as above	Same as above	Same as above	
		Treatment & Containment & Institutional Actions	Treatment Component Methods	Same as above	Same as above	Same as above	
			Containment Component Methods	Same as above	Same as above	Same as above	
			Institutional Component Methods	Same as above	Same as above	Same as above	

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# ...BUT BUILDING ALTERNATIVES BECOMES PRETTY EASY

~~The contractor does this~~  
Just kidding, still a team effort

Table usage: X=included as a component of the alternative			Alternative Name									
General Response Actions	Method Of Action	Common Process Options	#1 No Action <sup>2</sup>	#2-AGC on trails, surface only in woods <sup>3</sup>	#4-AGC Non-AGC DGM on trails, surface only w/ analog in woods <sup>3</sup>	#3-AGC on trails and in woods <sup>3</sup>	#5-AGC on trails, surface only in woods, Public Awareness & anomaly avoidance <sup>3</sup>	#6-AGC on trails and in woods & Anomaly Avoidance for new trail construction <sup>3</sup>	#7-AGC on trails and in woods & UXO support for new trail construction <sup>3</sup>	#8-AGC on trails and in woods to depth of detection w/ Search under tree root balls <sup>4</sup>	#9-Instructional Actions Only	
Not Applicable			X									
Treatment Actions	Surface Removal	Instrument-aided visual inspections		X	X							
	Geophysical detection & excavation	Advanced geophysical classification		X	X	X				X		
		Land borne non-AGC DGM man-portable (mag or EMI)								X		
		LiDAR-SLAM		X	X	X				X		
Disposal	Manual & Mechanized-		X	X	X				X			
	BIP or Explosively generated plasma jet		X	X	X				X			
Treatment & Institutional Actions	Surface Removal	Instrument-aided visual inspections					X					
	Geophysical detection & excavation	AGC Person-portable or towed by person					X	X	X			
		SLAM					X	X	X			
		Manual or small mechanized excavator					X	X	X			
	Disposal	BIP or Explosively generated plasma jet					X	X	X			
		Change Behavior	Signage, pamphlets, internet web site					X				
			School programs					X				
Anomaly Avoidance							X	X				
Institutional Actions	Change Behavior	UXO support							X			
		Signage, pamphlets, internet web site									X	
		School programs									X	
		Anomaly Avoidance									X	
	Restrict or control access	UXO support									X	
		Local ordinances									X	
		Deed restrictions									X	
		Use permits									X	

<sup>1</sup> DERP Requirement  
<sup>2</sup> Required by the NCP  
<sup>3</sup> Excludes search under tree root balls  
<sup>4</sup> Can support UUIE

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**THAT'S THE PROCESS**

**Let's look at some details**



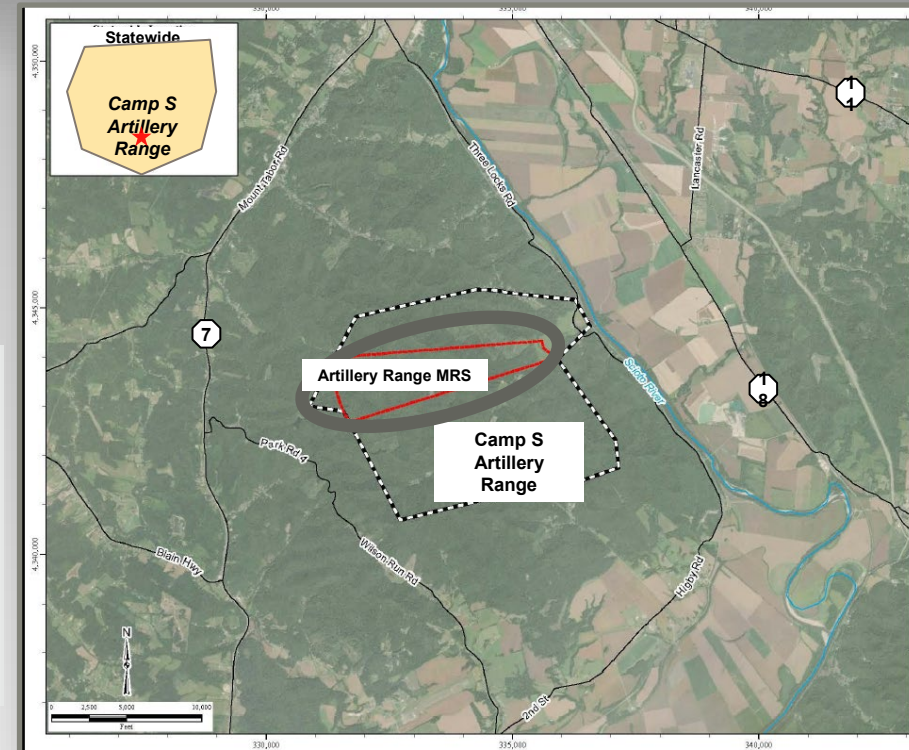
# SOME DETAILS WHEN LOOKING AT GRAs



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- ❖ Treatment-only GRAs do not equate to unlimited use/unrestricted exposure
  - But they may be able to get you there
  - In most scenarios, treatment only (or treatment with interim containment/ICs) is the only way to meet the DERP requirement for a UU/UE alternative

- MEC In Soil:**
- Projectile, 4.7", HE, Mk4 (to 53cm bgs)
  - Projectile, 3", HE and shrapnel (to 60cm bgs)
  - Projectile, 37mm, cast iron (to 10cm bgs)



REMEDIAL ACTION OBJECTIVE					
POTENTIAL EXPOSURE PATHWAY(S)			REMEDIATION GOAL		
Assessment Area(s)	Receptors and Exposure Pathways	Depth of Exposure	Prevent / Limit?	Type of Exposure	Acceptable Exposures
✓ <b>State Forest Lands: off trail lands</b> HUA	Recreational users: off trail hiking or walking <i>Off-trail use is rare, and is discouraged by the park owner</i>	Surface only	Prevent	Interactions	0
✓ <b>State Forest Lands: off trail lands</b> LUA	Recreational users: hiking, walking <i>Off-trail use is rare, and is discouraged by the park owner</i>	Surface only	Limit	Interactions	2/year



# SOME DETAILS WHEN SCREENING TECHNOLOGY TYPES & PROCESS OPTIONS



The overall process:

Starting from the RAO

→ Identify GRAs

→ Method(s) of Action/GRA

→ Technology Types/Method of Action

→ Process Options/  
Technology Type

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## ❖ Screening should be constrained to *Technical Implementability*

– “Screen-out process options or entire technology types that are clearly ineffective or unworkable at a site” (EPA/540/G-89/004, chapter 4 section 4.2.5.2.)

– Cost & effectiveness will be addressed when screening or evaluating alternatives

❖ Difficult to implement does not mean impossible to implement

❖ Look to the Institutional Analysis for constraints to what will be the selected remedy

– Don't make assumptions

– Don't make broad-brush declarations that are not supported in the IA







# SOME DETAILS WHEN EVALUATING TECHNOLOGY TYPES & PROCESS OPTIONS



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**This is where we start helping the decision makers understand the fundamental differences between alternatives.**

- ❖ Most, or all process options are evaluated in detail for MEC FSs (less common for non-MEC FSs)
- ❖ May need preliminary analyses or treatability studies to estimate the effectiveness
  - E.g., assess whether RGs can be achieved in variable geophysical noise regimes for DGM or analog methods
  - Limited conceptual design of the process option can be developed and additional field data collected
- ❖ Effectiveness evaluated relative to other processes/methods having the same purpose
  - Potential effectiveness in meeting the remediation goals
  - Potential impacts to human health and the environment during implementation
  - How proven and reliable the process is with respect to site conditions
- ❖ Implementability evaluated for technical and administrative feasibility
  - Built upon technical descriptions from the screening phase
  - Greater emphasis on institutional aspects (think exclusion zones & evacuations)
- ❖ Cost has limited role in this phase
  - Relative capital and O&M costs, not detailed estimates
  - Based on engineering judgment, e.g., high, low or medium relative to other process options
  - **Choice of process option can present significant differences** (think: acres to be mapped & numbers of anomalies to be dug for AGC vs. non-AGC DGM)



# SOME DETAILS WHEN ASSEMBLING ALTERNATIVES



The overall process:

Starting from the RAO

→ Identify GRAs

→ *Method(s) of Action/GRA*

→ *Technology Types/Method of Action*

→ *Process Options/Technology Type*

→ *Screen Tech Types/Options*

→ *Evaluate Tech Types/Options*

→ *Combine Tech Types/Options to achieve the RG*

→ *Each combo = an alternative*

- ❖ Combine process options that, when viewed as a whole, address all potential manner of interaction, and if appropriate, all manner of encounter that comprise the MRS exposure profile
  - All else being equal, if choice of process option presents significant effectiveness or cost advantages, present all viable choices as separate alternatives
- ❖ Provide detailed, **site specific**, descriptions
  - Explain how, where, by whom, and as appropriate-when, each process option (or grouping of process options) will be implemented
  - Logic behind assembly of various process options
  - Clean-up goals and anticipated outcomes or products
    - Must see differences among alternatives
    - Which volumes will be treated & which will not
    - Target audience/population/group for each IA process option
    - How each IA process option or group of process options prevents or limits exposure
    - Different detection depth performance = different volumes of soil investigated



# SOME MORE DETAILS WHEN ASSEMBLING ALTERNATIVES: MUST BE SITE SPECIFIC

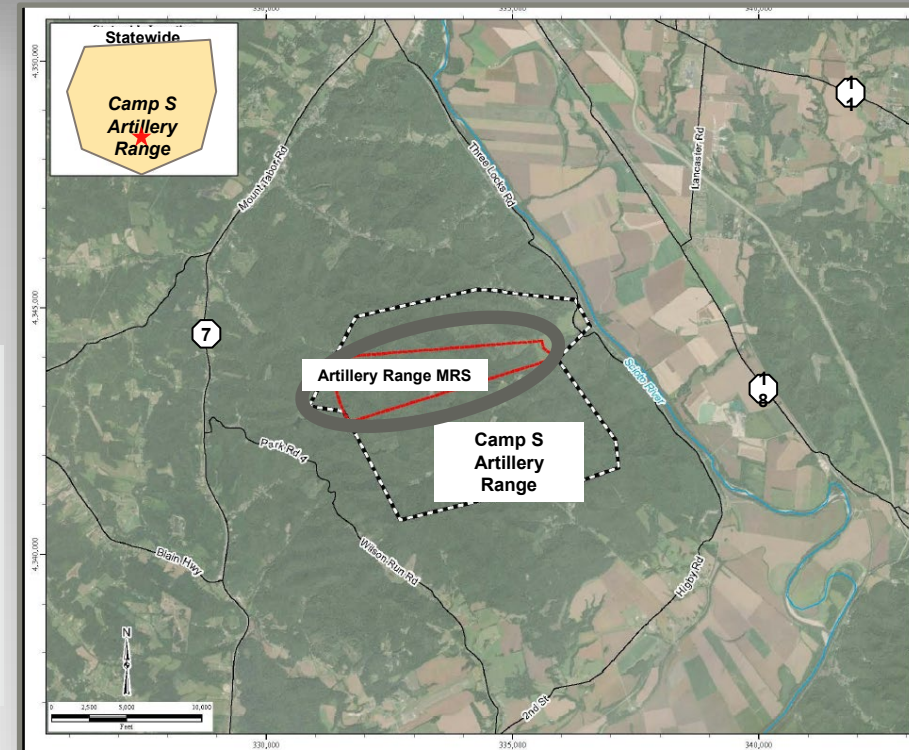


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- ❖ Different treated volumes or different IA/IA groupings = different alternatives
- ❖ DERP requires
  - No Action alternative
  - Alternative that incorporates LUCs
    - Does not mean must be LUCs only
  - Alternative that is anticipated to support UU/UE determination
    - In most cases, the clean-up goals will exceed the needs of the RAO

**MEC In Soil:**

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- Projectile, 3", HE and shrapnel (to 60cm bqs)
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REMEDIAL ACTION OBJECTIVE					
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State Forest Lands: off trail lands HUA	Recreational users: off trail hiking or walking <i>Off-trail use is rare, and is discouraged by the park owner</i>	Surface only	Prevent	Interactions	0
State Forest Lands: off trail lands LUA	Recreational users: hiking, walking <i>Off-trail use is rare, and is discouraged by the park owner</i>	Surface only	Limit	Interactions	2/year



# Example alternatives for Range MRS– recreational area (GRA=Treatment)



ALTERNATIVE	ANTICIPATED END STATE(S)	HOW THE ANTICIPATED END STATE(S) ACHIEVE THE RG
<p>AGC Source Removal-100% of the trails and entire footprint of the HUA within the woods; surface removal all remaining woods</p>	<p>Advanced geophysical classification performed throughout 100% of the areas where most activities occur as well as the whole of the HUA footprint will recover all UXO within the volume of soil to 45cm.</p> <p>Surface removal will recover all UXO on, or protruding above, the ground throughout the remainder of the MRS.</p> <p>Disposal via BIP will destroy all recovered MEC</p>	<p>Interactions by all users would be prevented everywhere as all potentially existing MEC within all interaction zones will be detected and removed. The assumption is that 100% of areas identified for subsurface removal are searched (e.g., under trees, roads, etc.)</p> <p>Potential interactions by recreational users in those portions of the woods in the LUA would be limited to not more than twice per year based on assumptions that a) all surface MEC are removed and that b) institutional actions are not necessary to limit encounters for items that are no longer present in the interaction zone (i.e., on or protruding above the surface).</p>



# Example alternatives for Range MRS – recreational area (GRA=Treatment & Institutional Actions)



ALTERNATIVE	ANTICIPATED END STATE(S)	HOW THE ANTICIPATED END STATE(S) ACHIEVE THE RG
AGC Source Removal-100% of the trails and entire footprint of the HUA within the woods and Education Actions	Advanced geophysical classification performed throughout 100% of the areas where most activities occur as well as the whole of the HUA footprint will recover all UXO within the volume of soil to 45cm 3Rs signage at all access points and at 200m intervals along all trail systems and along park boundaries will inform users of potential hazards.	Interactions by all users would be prevented on trails and in the woods portion of the HUA as all potentially existing MEC will be detected and removed. The assumption is that 100% of areas identified for subsurface removal would be searched (e.g., under trees, roads, etc.)  The potential for an interaction in the portions of the woods in the LUA would be limited to not more than twice per year (recreational use) by the extensive signage warning of the potential dangers of going off-trail (see note).



**THOSE ARE SOME DETAILS ABOUT THE PROCESS**

**Let's pause for some questions**

**Now let's look at the detailed analysis**



# DETAILED ANALYSIS



## Two Major Components

- Individual alternative analysis against the NCP 9 criteria
- Comparative analysis between alternatives against the NCP 9 criteria

It is a presentation of the relevant information needed to allow decision makers to select a site remedy

- It is not the decision-making process itself
- Provide decision makers with sufficient information to compare alternatives, select an appropriate remedy, and demonstrate satisfaction of the CERCLA remedy selection requirements in the ROD

The ROD's statutory requirements must be supported by the FS

- Be protective of human health and the environment.
- Attain ARARs (or provide grounds for invoking a waiver).
- Be cost-effective.
- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.
- Satisfy the preference for alternatives that use treatment to reduce toxicity, mobility, or volume as a principal element or provide an explanation in the ROD as to why it does not



# DETAILED ANALYSIS



## Overall Protection of Human Health and the Environment NCP § 300.430(e)(9)(iii)(A)

- ❖ This is essentially the answer to the question, “Would the outcome of implementing this alternative result in MEC exposure profiles that are protective of human health and the environment (i.e., achieve the remediation goal(s))?”
- ❖ The answer can only be yes or no

## Compliance with ARARs (NCP § 300.430(e)(9)(iii)(B))

- ❖ Compliance is a threshold criterion
- ❖ Can only be rated as compliant or not compliant
- ❖ Must discuss how the alternative will achieve compliance with each identified ARAR







# DETAILED ANALYSIS



## Long-term Effectiveness and Permanence (NCP § 300.430(e)(9)(iii)(C))

- ❖ Treated volumes
  - Generally a permanent solution except treatment via analog geophysical methods
  - Use of some process options can anticipate proving where MEC will no longer exist
- ❖ LUCs manage potentially remaining MEC
  - We cannot estimate “residual” MEC quantities
- ❖ LUCs effectiveness & permanence over the long term
  - Extent(s)/Quantities
  - Adequacy
  - Reliability



## Reduction of Toxicity, Mobility, or Volume Through Treatment (NCP § 300.430(e)(9)(iii)(D))

- ❖ Is a statutory preference
- ❖ Two key elements to discuss
  - Quantitative discussion on the reduction in total volume of soil potentially contaminated
  - Qualitative discussion on the reduction in the number of MEC within an interaction zone
- ❖ Specify where it is anticipated MEC could remain if the alternative were to be implemented
  - Inaccessible locations
  - Deeper than detection capability if supported by the CSM’s vertical MEC profile



# DETAILED ANALYSIS



## Short-term Effectiveness (NCP § 300.430(e)(9)(iii)(E))

- ❖ During construction and implementation phase until remedial response is complete
- ❖ Protect affected public and response workers
  - Exclusion zones & evacuations
  - Worker safety essentially the same for all treatment
- ❖ Nature of or potential for short-term adverse environmental impacts
  - Define “adverse”



## Implementability NCP § 300.430(e)(9)(iii)(F))

- ❖ Few unknowns for treatment methods
  - Performance and efficiencies are well documented & understood
- ❖ Institutional analysis
  - For all LUCs
  - Owner or local/county/state government willingness



# DETAILED ANALYSIS



## ❖ Cost (NCP § 300.430(e)(9)(iii)(G))

- ❖ Three major treatment drivers
  - Total acres
  - Anomaly densities & estimated quantities
  - Vertical profile
- ❖ Most other treatment factors apply equally
- ❖ Should address 5 elements
  - Capital costs
  - Annual operations and maintenance
  - Accuracy of estimates
  - Present worth analysis
  - Sensitivity analysis → mostly for treatment options

## ❖ State Acceptance (NCP § 300.430(e)(9)(iii)(H))

- Completed when comments on the RI/FS and the proposed plan are received

## ❖ Community Acceptance (NCP § 300.430(e)(9)(iii)(I))

- Completed when comments to the proposed plan are received





## Individual Analysis

- ❖ Assess each alternative individually against the first 7 of the criteria
  - Not in relation to other alternatives
- ❖ Common elements should be presented before the detailed description of each alternative
- ❖ Only elements or combinations of elements that are unique should be discussed individually
  - If a unique element changes an aspect of one of the common element, it must be described

## Comparative Analysis

- ❖ Identify advantages & disadvantages
  - Identify key trade-offs
- ❖ Narrative required
  - Table may be useful
- ❖ Focus comparative narrative to:
  - Anticipated treatment performance & which areas will be searched
  - Underlying assumptions of LUCs
  - Contribution of LUCs when paired with treatment compared to treatment only alternative(s)
  - Cumulative cost break-even points



Highlight those elements that are likely to become deciding factors in proposing a preferred alternative



# PARTING THOUGHTS



- Both are protective
- Which is more effective?

## ALTERNATIVE 1

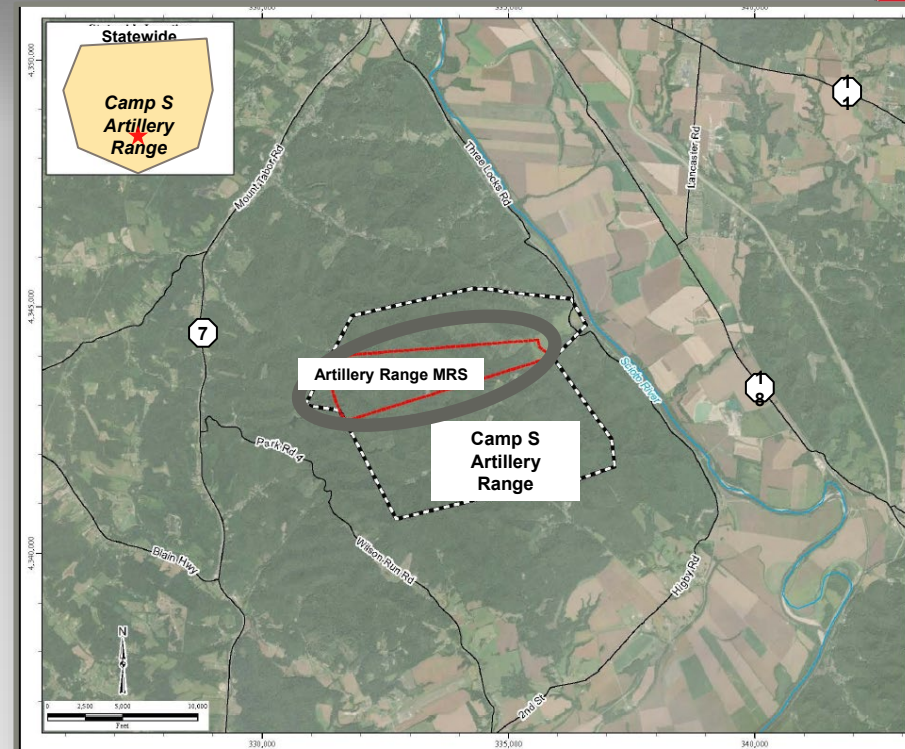
AGC Source  
Removal-100% of the trails and entire footprint of the HUA within the woods; **surface removal all remaining woods**

## ALTERNATIVE 2

AGC Source  
Removal-100% of the trails and entire footprint of the HUA within the woods; **and Education Actions**

### MEC In Soil:

- Projectile, 4.7", HE, Mk4 (to 53cm bgs)
- Projectile, 3", HE and shrapnel (to 60cm bgs)
- Projectile, 37mm, cast iron (to 10cm bgs)



REMEDIAL ACTION OBJECTIVE					
POTENTIAL EXPOSURE PATHWAY(S)			REMEDIATION GOAL		
Assessment Area(s)	Receptors and Exposure Pathways	Depth of Exposure	Prevent / Limit?	Type of Exposure	Acceptable Exposures
State Forest Lands: off trail lands HUA	Recreational users: off trail hiking or walking <i>Off-trail use is rare, and is discouraged by the park owner</i>	Surface only	Prevent	Interactions	0
State Forest Lands: off trail lands LUA	Recreational users: hiking, walking <i>Off-trail use is rare, and is discouraged by the park owner</i>	Surface only	Limit	Interactions	2/year



ANY  
QUESTIONS?

