



Military Munitions Response Program (MMRP) Risk Management Methodology (RMM)

Brian Jordan, OSD, ODASD(E&ER)

James Salisbury, USACE, EM CX, Military Munitions Division



Agenda

- Overview
- Data Needs and Planning for Data Collection
- Applying the RMM
 - Gain Consensus on Conceptual Site Model (CSM)
 - Develop Risk Scenarios
 - Define Assessment Areas
 - Identify Receptor Activities
 - Define the Interaction Zones
 - Evaluate Using RMM Matrices
- Examples and Exercises





Ground Rules for Successful Training



Please pay attention because I can explain it to you.... but I can't understand it for you.

STAY ENERGIZED

- We'll take short breaks; feel free to stand up or move around, if needed

The complex block contains a blue rectangular area with white text and a black silhouette illustration of a man in a suit presenting to an audience. The text includes a quote, a bold heading "STAY ENERGIZED", and a bullet point about taking short breaks.

ANYTIME

please

ion!

The complex block shows a hand with a white card. The card has the word "ANYTIME" at the top, "please" in the middle, and "ion!" at the bottom. The background is a blurred image of a hand.



and welcome



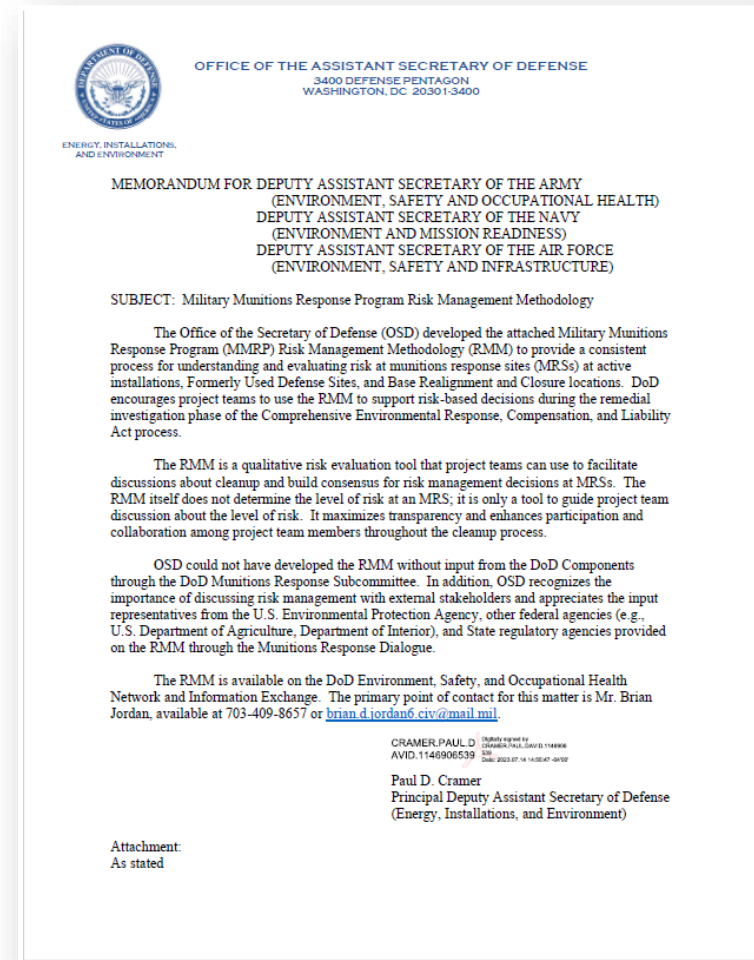
Overview

Let's Review the Basics



Background

- Developed by the Office of the Secretary of Defense (OSD)
 - Coordination w/ U.S. Army Corps of Engineers (USACE)
- RMM is a qualitative risk evaluation tool
 - Provides a framework to guide discussion and build consensus for risk management decisions at munitions response sites (MRSS)
- Project teams are determined on a site-specific basis but can include:
 - DoD agency project manager
 - DoD subject-matter experts such as explosives safety, geophysics, and public affairs personnel
 - Regulators
 - Major landowners
 - Contractors
 - Other Federal and state agency representatives





Why Use the RMM

- Why use the RMM?
 - Consistent tool to support risk-based decisions at MRSs
 - Evaluates Munitions and Explosives of Concern (MEC) exposure pathway
 - Source → Encounter → Interaction → Incident
 - and the likelihood receptors will
 - Encounter MEC
 - Interact with MEC
 - Experience a harmful incident
 - Considers site-specific factors that influence risks from MEC exposure
 - Uses them to guide the project team's risk management decisions





When and Where to Use the RMM

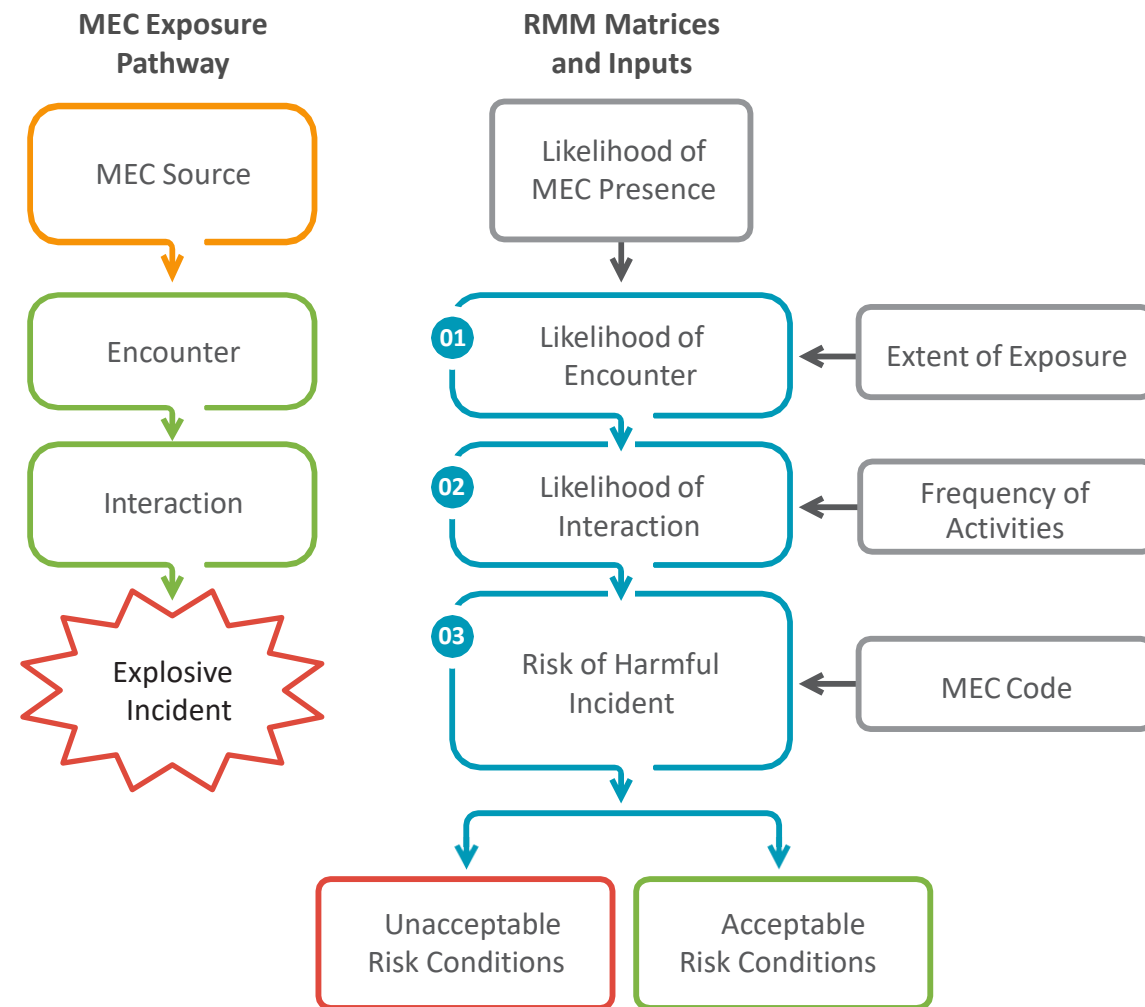
- When to use the RMM?
 - Remedial Investigation (RI)
 - Framework for the baseline MEC risk assessment
- Where is RMM information needed?
 - Feasibility Study (FS)
 - Risk scenarios help develop remediation goals
 - Risk scenarios help identify needed outcomes from different alternatives
- RMM is NOT a “black box”
 - Inputs do NOT drive precise outputs
 - Project teams must use the RMM to
 - Facilitate discussion
 - Build consensus on risk management decisions





The MEC Exposure Pathway and RMM Matrices

- Considers three primary risk factors
 - Likelihood of Encounter (Matrix 1)
 - Likelihood of MEC Presence
 - Extent of Exposure
 - Likelihood of Interaction (Matrix 2)
 - Likelihood of Encounter (from Matrix 1)
 - Frequency of Activities
 - Risk of Harmful Incident (Matrix 3)
 - Likelihood of Interaction (from Matrix 2)
 - MEC Code
- Based on these three factors, project teams determine whether there are **acceptable** or **unacceptable** risk conditions





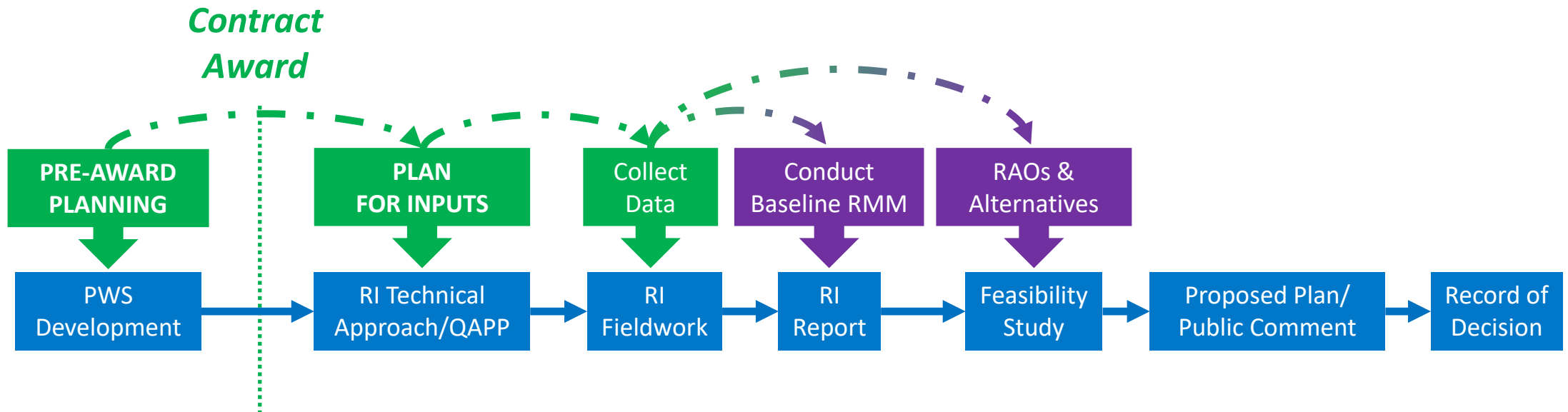
Things to do Before the Risk Assessment

RMM Data Needs and Planning for Data Collection



Planning for Data Collection

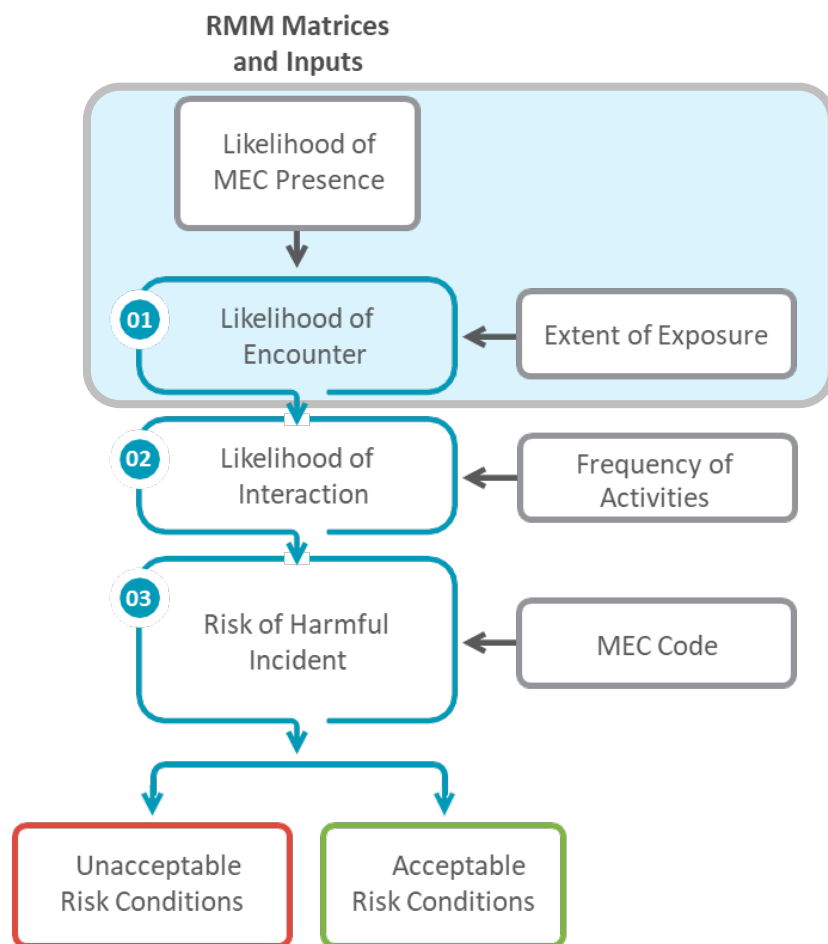
- Baseline risk assessment occurs after fieldwork
- But we must think about data collection *before* that...



PLANNING IS CRITICAL!



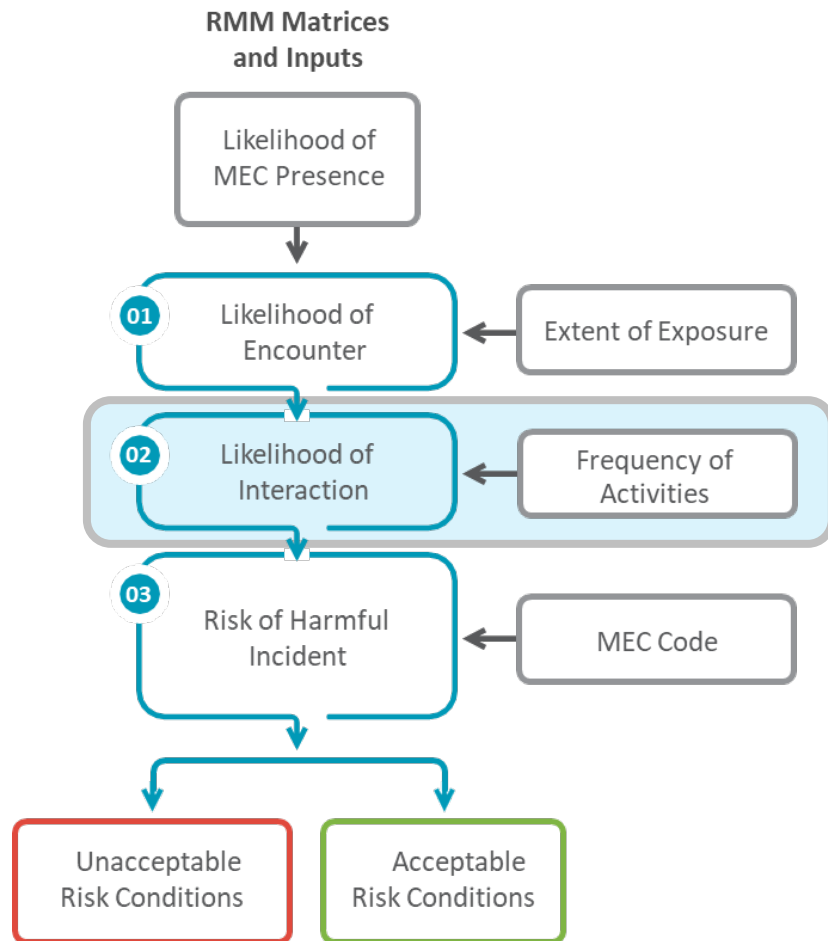
Data Needs – Matrix 1: Likelihood of MEC Presence



- Likelihood of MEC Presence
 - MEC presence and anomaly density
 - High use area (HUA), low use area (LUA), or no evidence of use (NEU)?
 - Intrusive results
 - MEC types and vertical profile
 - Other observations
 - **SOURCES:** RI results, site history
- Extent of Exposure
 - Land use information
 - Receptors and associated activities
 - Coverage and frequency
 - **SOURCES:** stakeholder interviews, institutional analysis



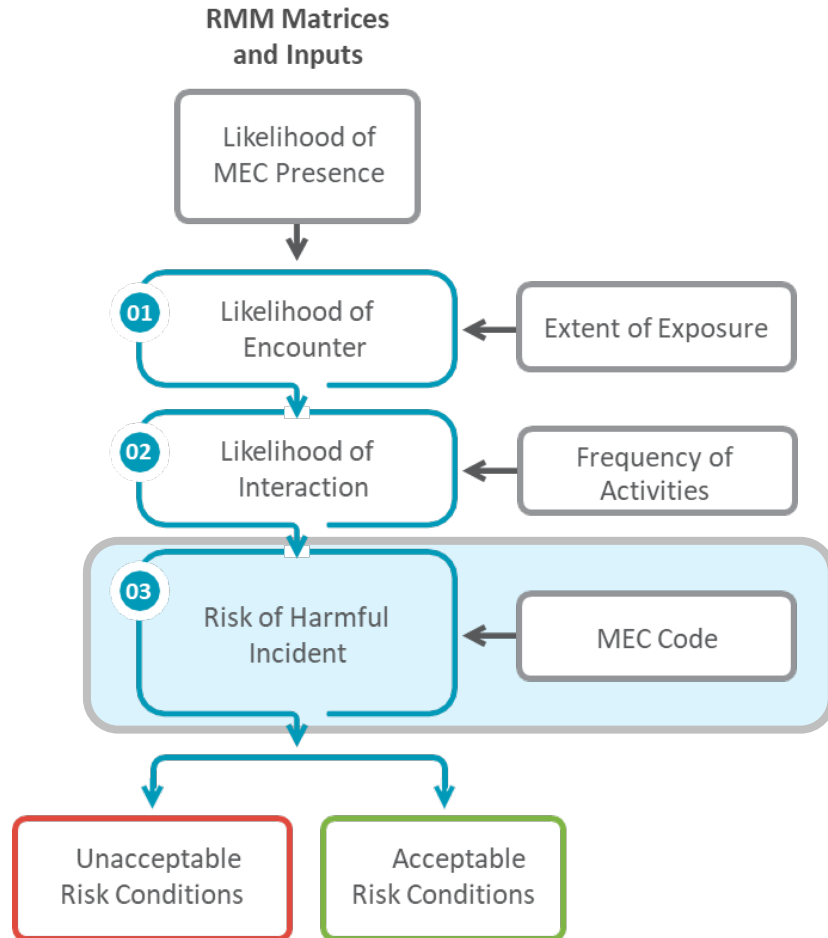
Data Needs – Matrix 2: Likelihood of Interaction



- Likelihood of Encounter
 - **SOURCE:** Output from Matrix 1
- Frequency of Activities
 - Land use information
 - Receptors and associated activities
 - Frequency of activities
 - Vertical CSM
 - **SOURCES:** stakeholder interviews, institutional analysis



Data Needs – Matrix 3: Risk of Harmful Incident

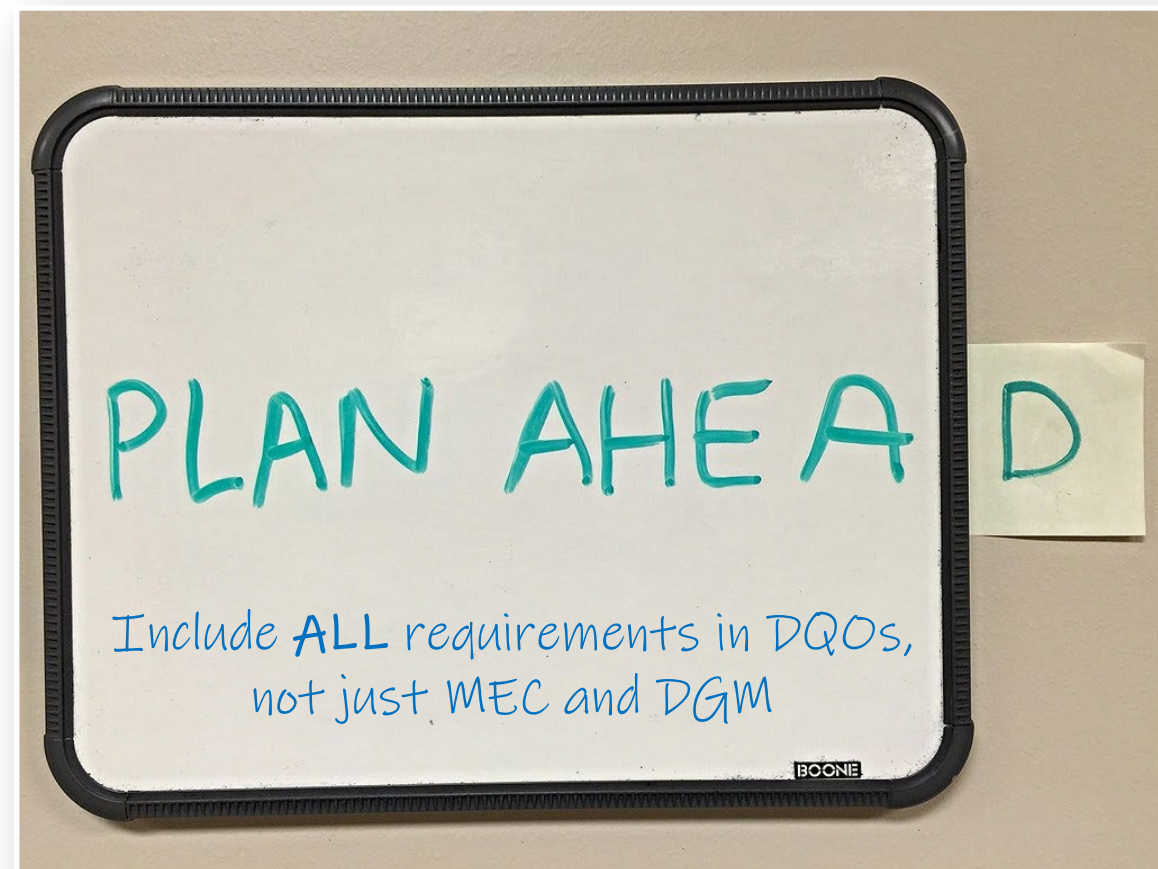


- Likelihood of Interaction
 - **SOURCE:** Output from Matrix 2
- MEC Code
 - Munitions data
 - **SOURCES:**
 - Ordnance and Explosives Safety Specialist and unexploded ordnance tech input
 - Munitions MEC code list



Final Thoughts on Planning for Data Collection

- Take advantage of SPP
 - Meetings give access to stakeholders
 - ROE process provides other opportunities
- **ALL data** required to complete RMM should be included in DQOs
 - Include data on possible receptors and activities (i.e., land use), as well as terrain and accessibility issues
- **AND** the plan for collecting these data should be documented in the QAPP
 - Include a definable feature of work for risk assessment data (i.e., land use)



Think about what the data needs are for the Risk Assessment



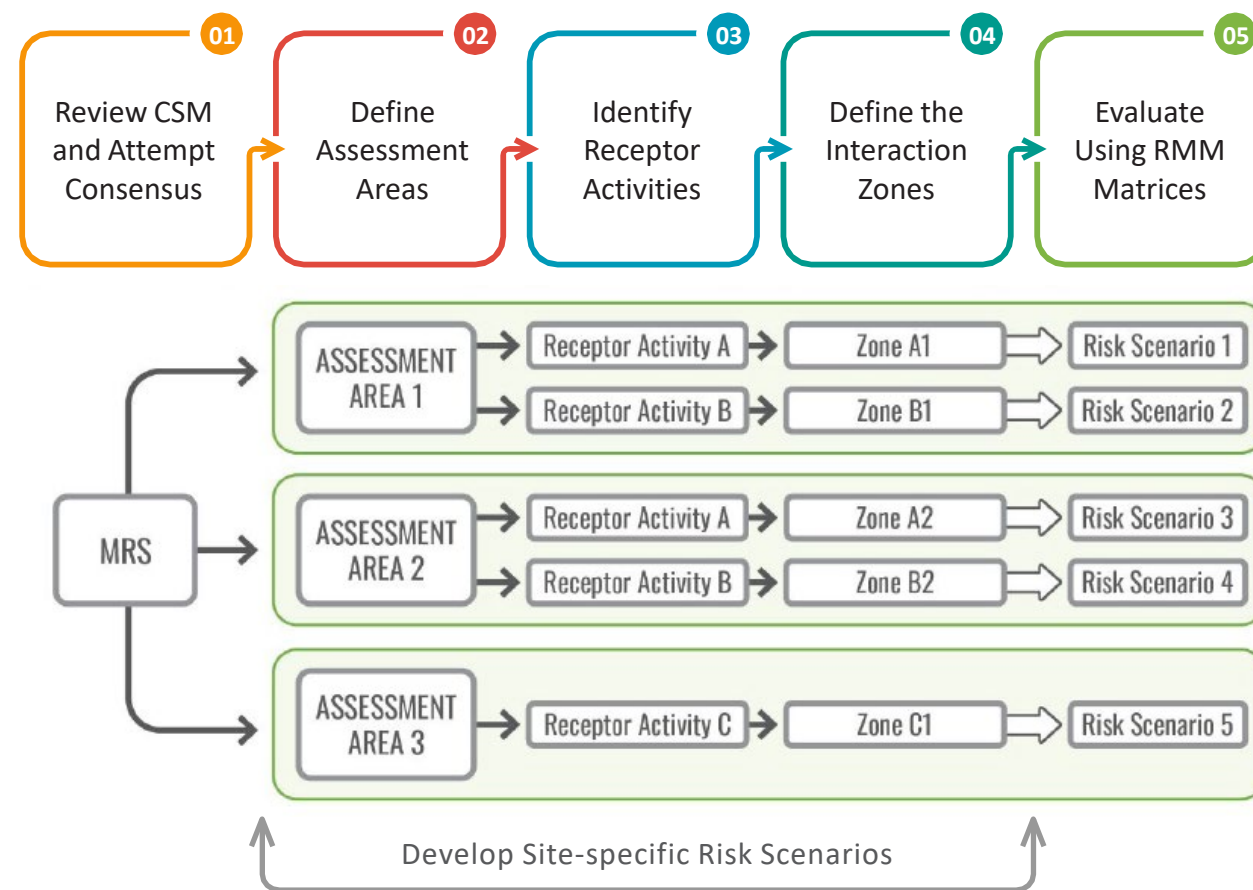
Using the Risk Management Methodology

The Five Basic Steps of RMM, including Developing Risk Scenarios



Steps of the Risk Management Methodology

- Review and discuss conceptual site model (CSM)
 - Attempt to get team consensus
- Develop site-specific **Risk Scenario**.
 - Define Assessment Areas
 - Identify Receptor Activities
 - Define the Interaction Zone
- Evaluate Using RMM Matrices
 - For each Risk Scenario





Step 1: Try to Achieve Consensus on the CSM

- The CSM is a comprehensive, current description of sources, pathways, and receptors at a site
 - Includes text, figures, and tables that illustrate current site conditions
- The CSM is the project foundation
 - What we know about the MRS guides the investigation AND our conclusions
- A well-defined CSM is critical for effectively applying the RMM
 - Achieving project team consensus on the CSM



If team members are still asking lots of “what if” questions, then you probably don’t have consensus



Step 1: Try to Achieve Consensus on the CSM, cont'd.

- CSM Data Relevant to RMM
 - Munitions characteristics
 - HUAs, LUAs, and NEUs
 - Known/suspected MEC
 - Estimated vertical extent of MEC
 - Land use information
 - Land use activities
 - Horizontal coverage and frequency
 - Intrusive activities, depth, and frequency
 - Depth profiles (i.e., vertical CSM)
 - Compare estimated vertical extent of MEC to depth of intrusive activities

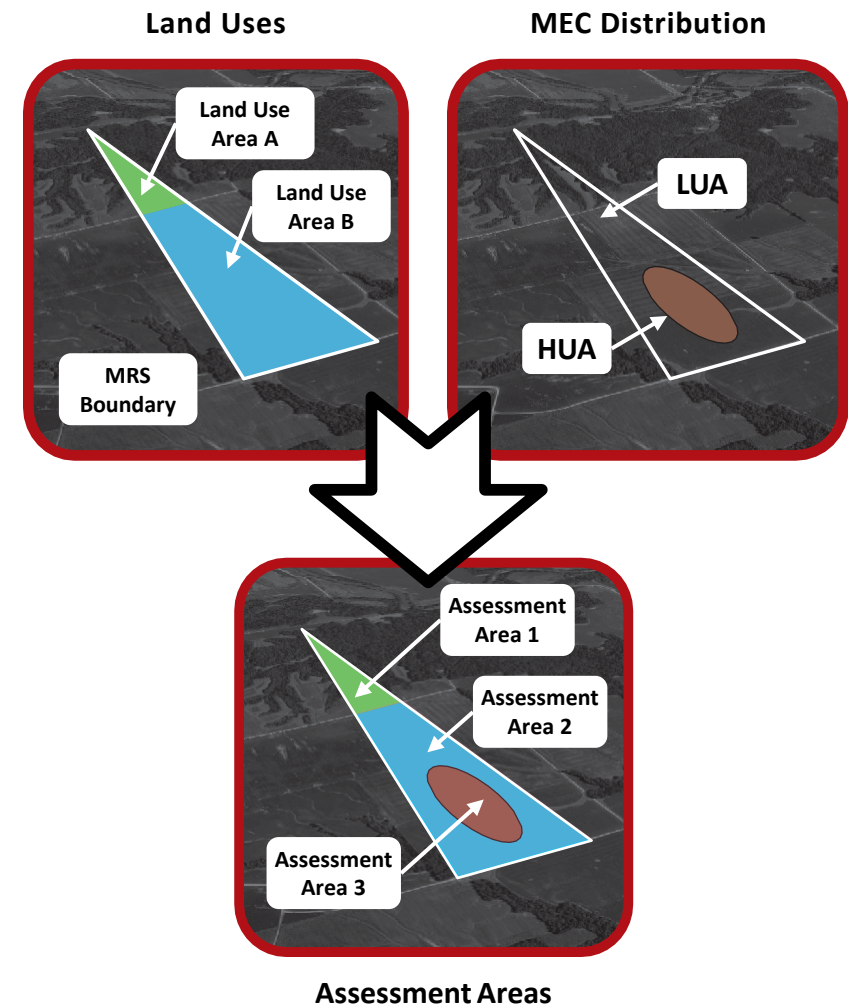
| CSM DATA |
|---|
| HORIZONTAL LAND USE AND ACTIVITIES <ul style="list-style-type: none">• Land uses within the MRS, including:<ul style="list-style-type: none">◦ Basic types of land use (residential, recreational, industrial, etc.) and their locations.◦ Natural and cultural resources affecting site use.◦ Access limitation/restrictions.• Description of receptors and potential activities:<ul style="list-style-type: none">◦ The type/nature of receptor activities (e.g., children at school with play area, recreators on hiking trails, industrial workers indoor/outdoor industrial complex, construction workers in construction footprint).◦ Horizontal coverage of those activities relative to the aerial extent of MEC.◦ The frequency of activities. |
| VERTICAL LAND USE AND ACTIVITIES <ul style="list-style-type: none">• Receptor-based type of interaction (farming, recreational):<ul style="list-style-type: none">◦ Nature of intrusive activity (type, depth, e.g., shovel, 10 feet, etc.).◦ Comparison of anticipated vertical MEC extent with the depth of land use activities.◦ Frequency of activities. |
| CHARACTERIZATION OF MEC DISTRIBUTION (HORIZONTAL AND VERTICAL) <ul style="list-style-type: none">• MRS munitions distribution characteristics, including:<ul style="list-style-type: none">◦ The horizontal extent of known and suspected MEC; high use area (HUA)/low use area (LUA) boundaries; no evidence of use (NEU) areas. Note that these and other key terms are defined in the glossary.◦ Known and suspected types of MEC.◦ Estimated vertical extent of known and suspected MEC. |



Step 2: Define Assessment Areas

- Risk of MEC exposure often varies in an MRS
- Assessment areas are areas in an MRS with different levels of risk
 - Different likelihoods of MEC presence
 - e.g., HUA, LUA, NEU
 - Different receptor activities
 - Types of activities AND frequencies
 - NOTE: There may be multiple receptor activities within a single assessment area

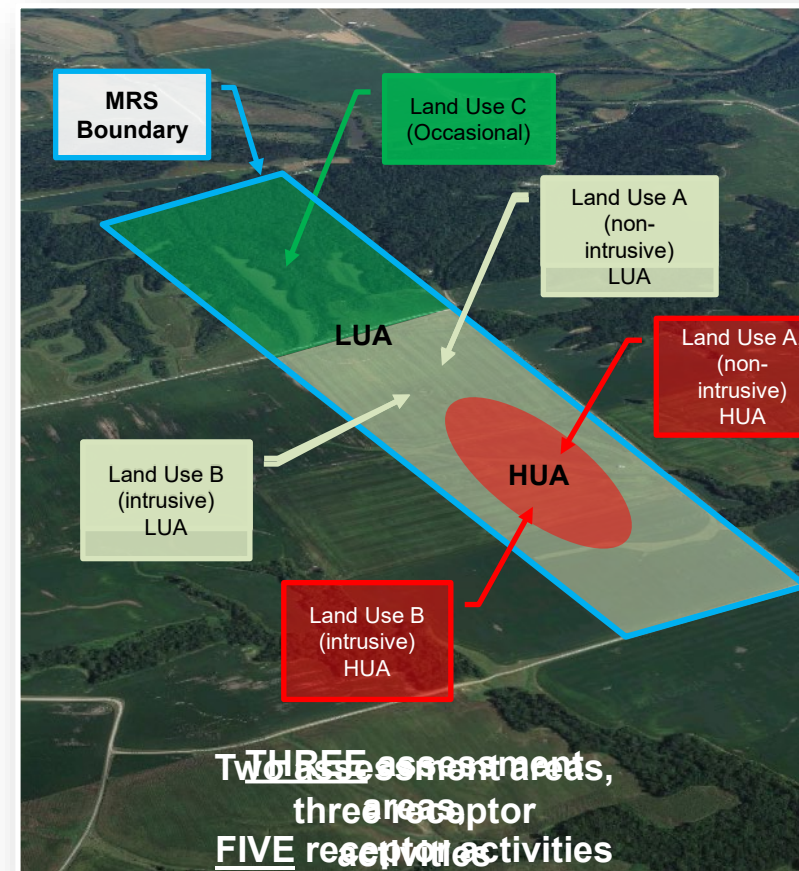
| Likelihood of MEC Presence | Types of Activities | |
|-------------------------------------|--|-------------------------------------|
| | HIGHER RISK High likelihood, Lots of activity | High likelihood, Little activity |
| Low likelihood, Lots of activity | Low likelihood, Little activity LOWER RISK | |





Step 3: Identify Receptor Activities

- Receptor Activities
 - Types and frequencies of land use activities
 - Driven by different activities in *different* areas
 - Address different activities occurring in the same area
 - Activities may have varied
 - Exposure “extents”
 - Frequencies
 - Different intrusive depths
 - Time periods (i.e., current/future)
- This may lead to further refinement of assessment areas
- May influence the remedial alternatives you design





Step 3: Identify Receptor Activities, cont'd.

General Site Description: Describe historic munitions use followed by the current site description. Include acreage, type of former site and describe general current and reasonably anticipated future use (residential, commercial/industrial, agricultural, recreational, etc.).

- 1. User Populations (Potential Receptors):** Onsite or adjacent populations, include current and reasonably anticipated future users, including seasonal users and visitors that could reasonably access and use the site.
- 2. Frequency and Duration of Site Use:** Describe the frequency of use; the potential duration (e.g., number of hours, days) of activities by user (e.g., residents, workers, recreational users) to estimate the potential contact hours at a site each year. This may include seasonal variations.
- 3. Outdoor Activities:** List potential current and future activities (e.g., gardening, farming, grazing) and/or recreational activities (e.g., swimming, boating, hiking, camping). Activities should match with the receptors (e.g., residents, maintenance crews, farmers, recreational users) identified in Factor 2.

Horizontal Coverage of Land Use

4. Coverage of potential site activities that would traverse the site

Describe scale of EACH receptor and activities identified. Discuss the likely coverage of the site over a year. Consider barriers (natural or manmade) to access; populations that could reasonably or are known to access the site and ease of access over a year.

Vertical Land Use

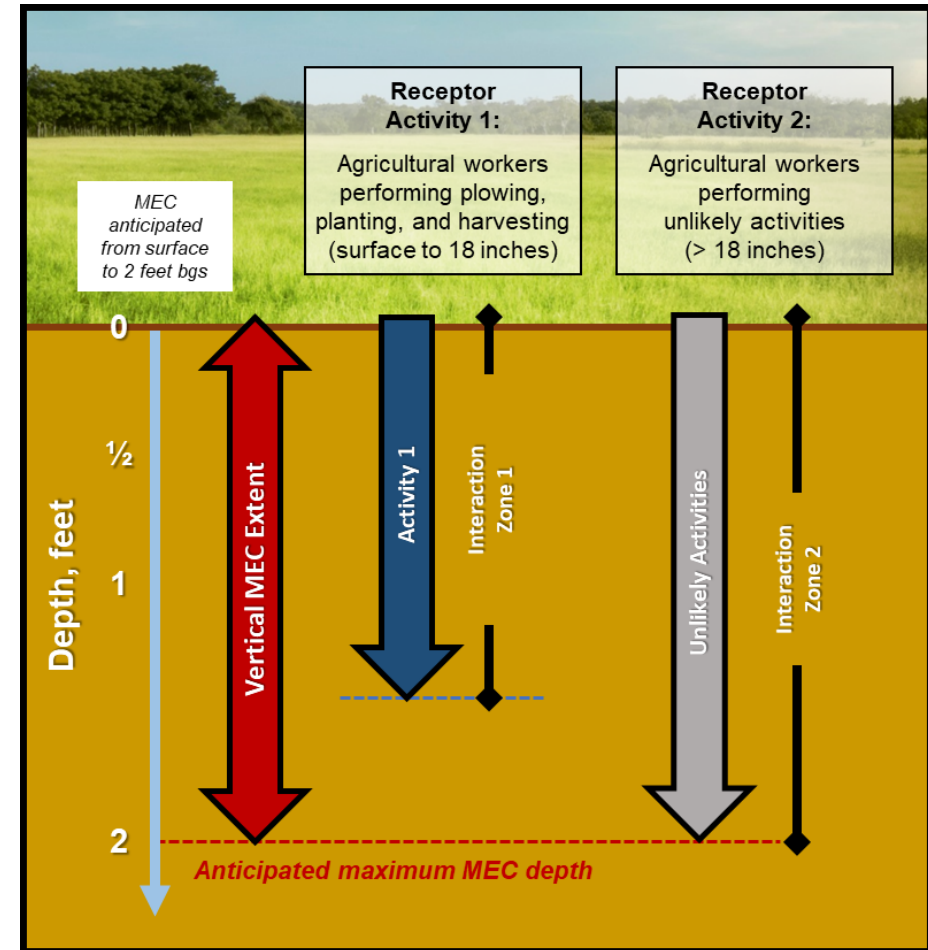
5. Depth associated with site activities that may interact with an item

Describe depth of activities identified in Factors 3. Consider use handheld trowels and shovels versus use of mechanical farming equipment. Think about installing fence posts, construction depth for water/sewer lines, etc.



Step 4: Define Interaction Zones

- Describe the depths of potential interaction for each receptor activity
 - May be “surface only”
- Unique interaction zones should be defined for each receptor activity
 - Anticipated vertical MEC extent
 - Land use depths *and frequencies*
- Note: interaction zone is a **volume**
 - Describes the interaction depth over an assessment area
 - (V = interaction depth x risk scenario area)





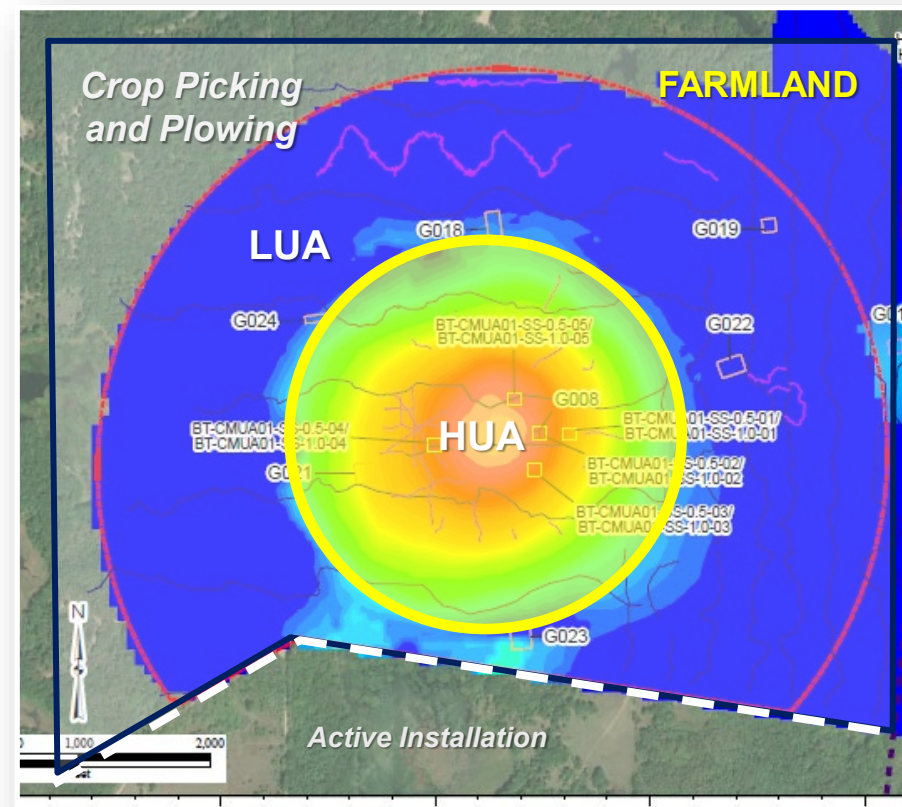
How the CSM Supports Steps 2-4 of the RMM

| RMM STEP | PURPOSE | SUPPORTING CSM DATA |
|---------------------------------|--|---|
| 2. Define Assessment Areas | Describe discrete parts of the MRS based on similar levels of risk using data on land use and known or suspected MEC | Land use data, including activities and coverage of those activities within the MRS MRS munitions distribution characteristics, specifically horizontal extent of known or suspected MEC and HUA and LUA boundaries; NEU areas |
| 3. Identify Receptor Activities | Describe the different land use activities taking place within each assessment area | Land use data, including activities, coverage of those activities within the MRS, and intrusive depths of land use and the frequency of activities conducted |
| 4. Define Interaction Zones | Look at the depths of potential interaction with known or suspected MEC for each receptor activity | Land use data, including activities, coverage of those activities within the MRS, and intrusive depths of land use and the frequency of activities Anticipated MEC depth |



Risk Scenarios - An Easy Example

- Example #1
 - Practice Bombing Range
 - HUA and LUA
 - Land use
 - Crops/agriculture
 - Crop picking
 - 30 people for one month/year
 - Surface use only
 - Crop Preparation/Plowing
 - Four people for three months/year
 - Intrusive to 60cm bgs



How many risk scenarios?

Consider Assessment Areas, Land Use Activities, and Interaction Zones



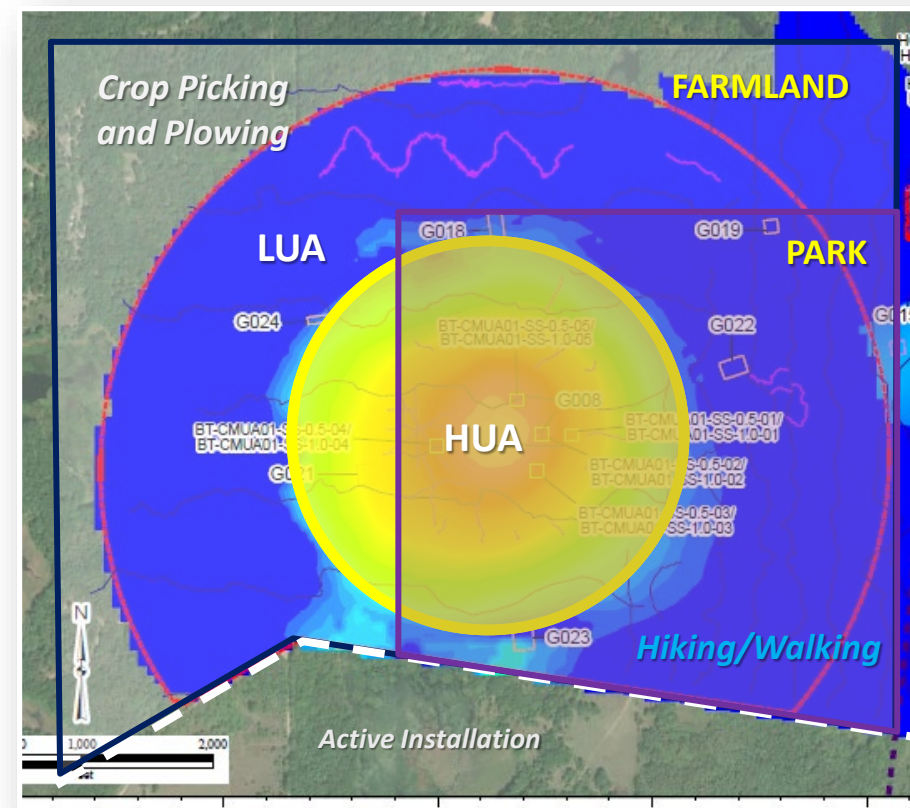
Possible Risk Scenarios

| Assessment Area <i>(MEC distribution/land use activities)</i> | Receptor Activity <i>(receptor type, activity, frequency)</i> | Interaction Zone <i>(depth assoc. with activity)</i> | Risk Scenario |
|---|---|--|----------------------|
| HUA, Crops/agriculture | Agricultural workers, crop picking, 30 people for one month/year | Surface only | 1 |
| | Agricultural workers, plowing, four people for two weeks/year | Surface to 60cm bgs | 2 |
| LUA, Crops/agriculture | Agricultural workers, crop picking, 30 people for one month/year | Surface only | 3 |
| | Agricultural workers, plowing, four people for two weeks/year | Surface to 60cm bgs | 4 |



Risk Scenarios – A Not So Easy Example

- Example #2
 - Practice Bombing Range
 - HUA and LUA
 - Land use
 - Crops/agriculture
 - Crop picking
 - 30 people for one month/year
 - Surface use only
 - Crop Preparation/Plowing
 - Four people for three months/year
 - Intrusive to 60cm bgs
 - Park/recreation
 - Hiking/walking
 - 500 people for four hours/year
 - Surface use only



How many risk scenarios?

Consider Assessment Areas, Land Use Activities, and Interaction Zones



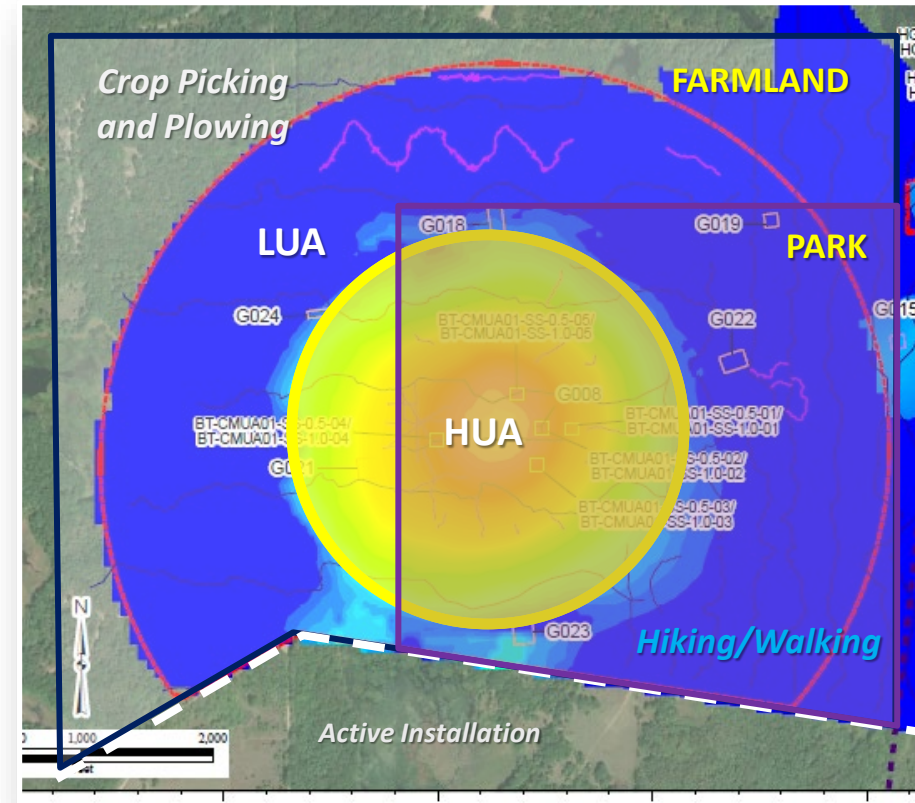
Possible Risk Scenarios

| Assessment Area <i>(MEC distribution/land use activities)</i> | Receptor Activity <i>(receptor type, activity, frequency)</i> | Interaction Zone <i>(depth assoc. with activity)</i> | Risk Scenario |
|---|---|--|----------------------|
| HUA, Crops/agriculture | Agricultural workers, crop picking, 30 people for one month/year | Surface only | 1 |
| | Agricultural workers, plowing, four people for two weeks/year | Surface to 60cm bgs | 2 |
| LUA, Crops/agriculture | Agricultural workers, crop picking, 30 people for one month/year | Surface only | 3 |
| | Agricultural workers, plowing, four people for two weeks/year | Surface to 60cm bgs | 4 |
| HUA, Park/recreation | Recreational users, hiking/walking, 25,000 people for four hours/year | Surface only | 5 |
| LUA, Park/recreation | Recreational users, hiking/walking, 25,000 people for four hours/year | Surface only | 6 |



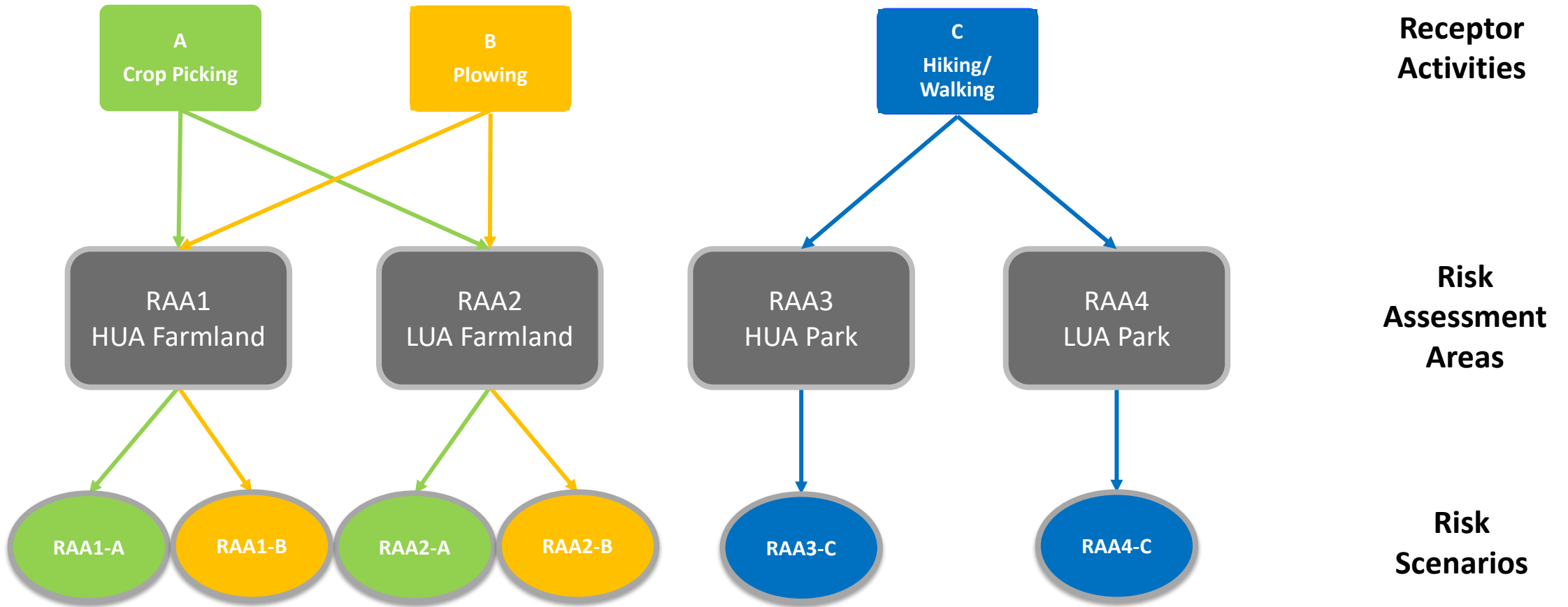
Another way to think about Risk Scenarios

- Example #2 again...
 - MEC Characterization
 - HUA
 - LUA
 - Assessment Areas
 - RAA1: HUA-Farmland
 - RAA2: LUA-Farmland
 - RAA3: HUA-Park
 - RAA4: LUA-Park
 - Receptor Activities
 - Crop Picking
 - Plowing
 - Hiking/walking





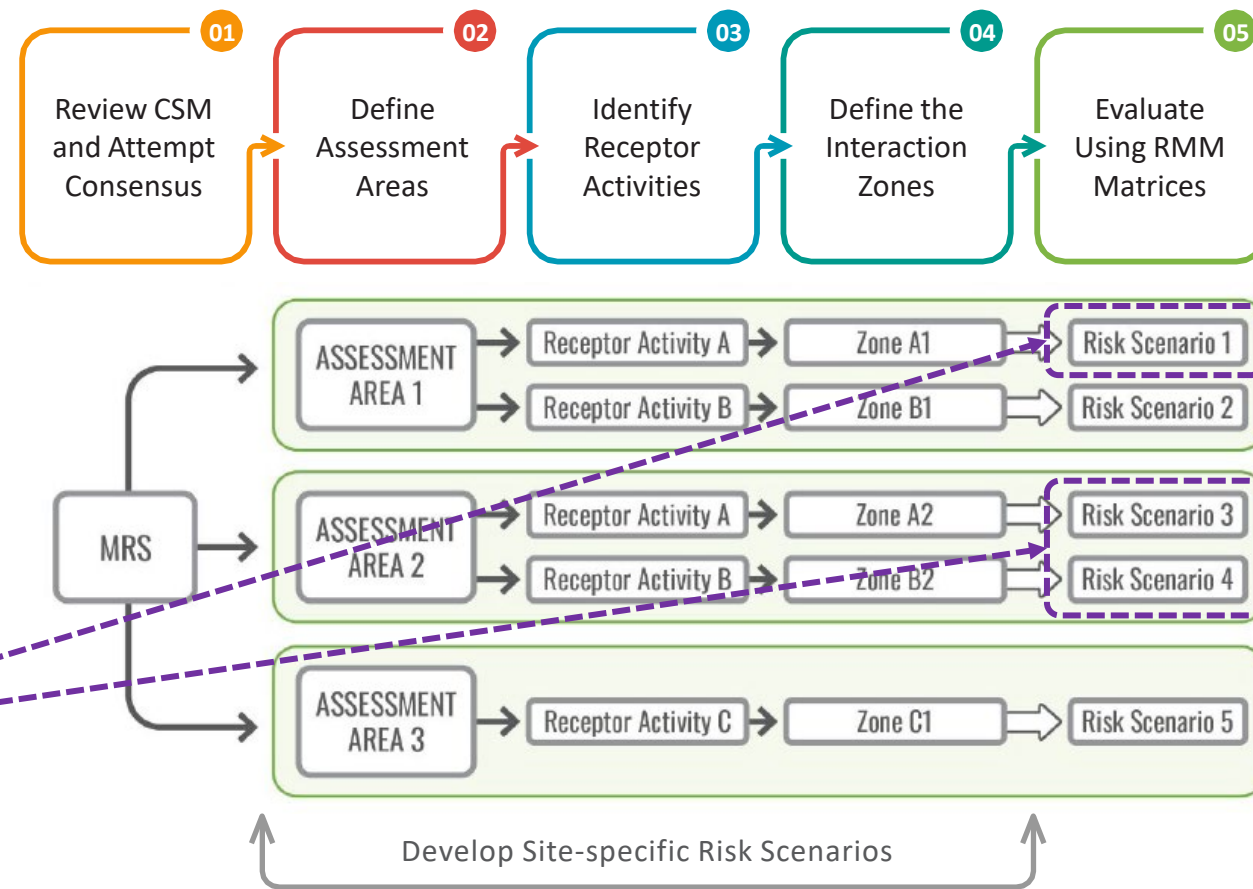
Another way to think about Risk Scenarios, cont'd.





Step 5: Perform Risk Assessment

- Step 5 is to evaluate risk using RMM matrices
- Perform the risk assessment for each risk scenario
 - Decide which scenarios result in unacceptable risks from MEC
 - Identifies the risk scenarios that need to be addressed in the FS
 - Also helps focus the remedial alternative components





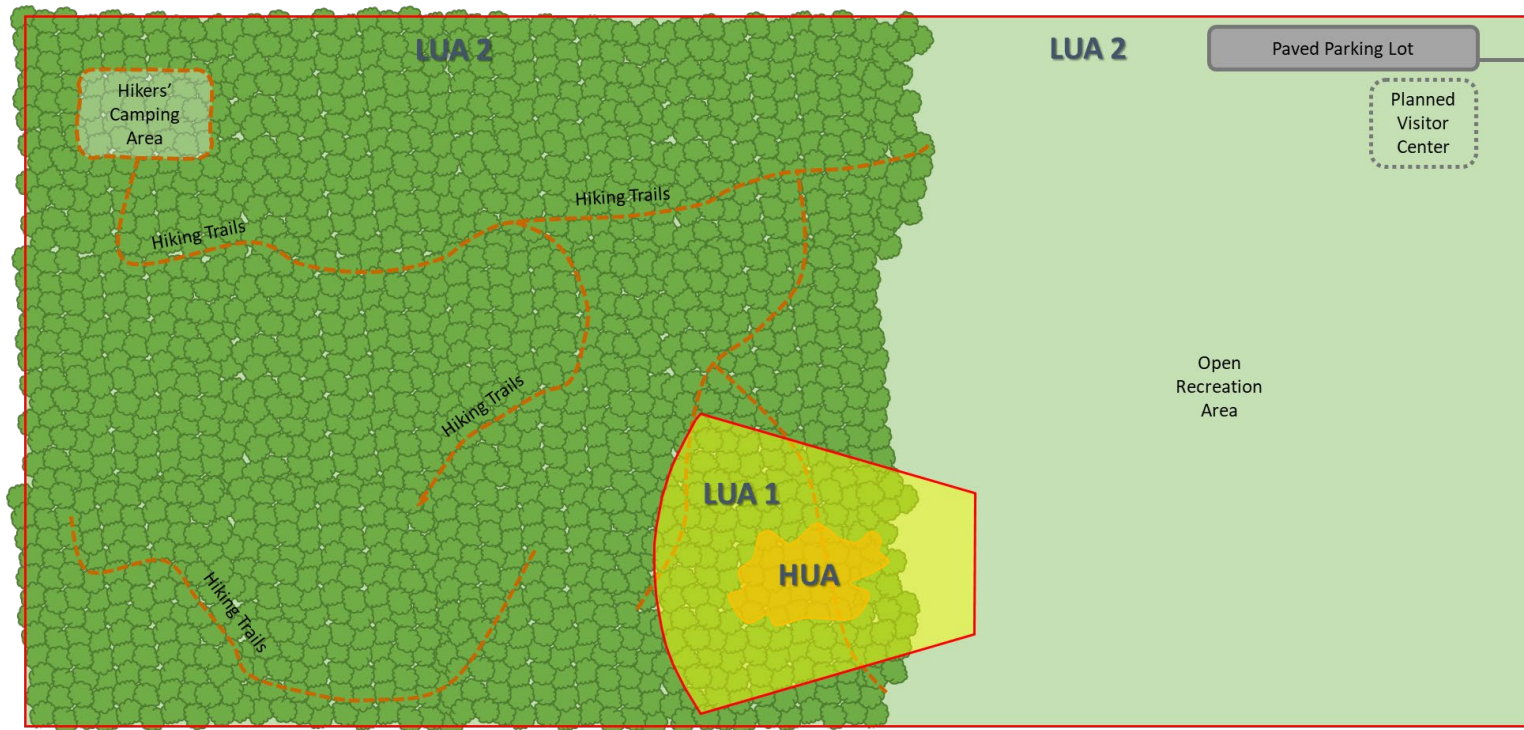
RMM Group Exercise 1

Developing Risk Scenarios for two Case Studies



Case Study Example 1

- Former maneuver area and AT rocket range
- Now a state park with open recreational areas as well as woods, hiking trails, a hikers' camp site, and a paved parking area
- Future plans to construct a small visitors' center
- Remedial Investigation identified
 - One HUA and two LUAs (rocket range safety buffer and the whole maneuver area)

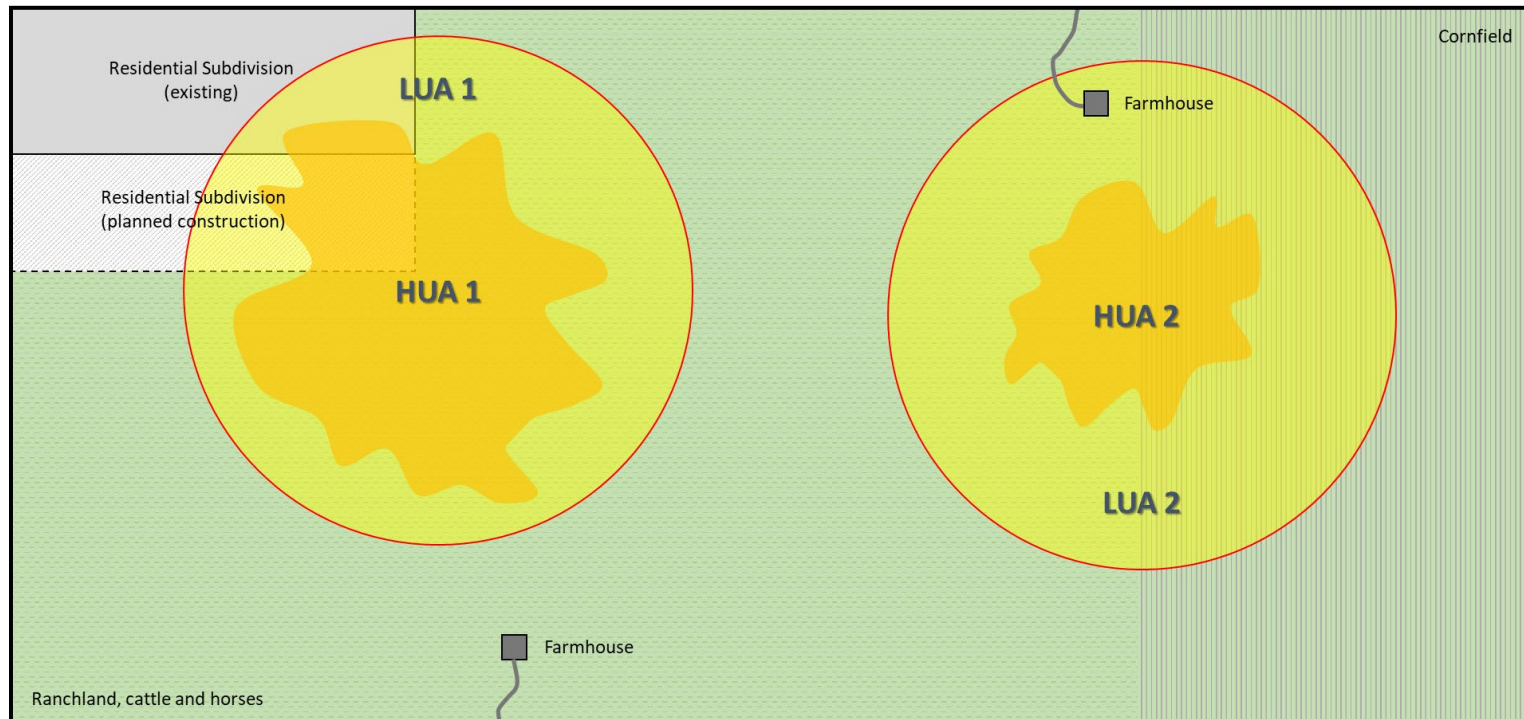


See handouts for more information



Case Study Example 2

- Former bombing range complex (two bombing range MRSs)
- Now residential and agricultural land uses
 - Agricultural land use involves cattle/horses and crops
- Additional residential development is planned
- Remedial Investigation identified
 - Two HUAs at target centers, with LUAs surrounding each
 - Evidence of HE munitions use at HUA 1



See handouts for more information



Conducting the MEC Risk Assessment

Using the RMM Matrices to Evaluate Risk Scenarios



Using the RMM Matrices

- **RECAP:**

Three matrices associated with the RMM

- **Likelihood of Encounter (Matrix 1)**

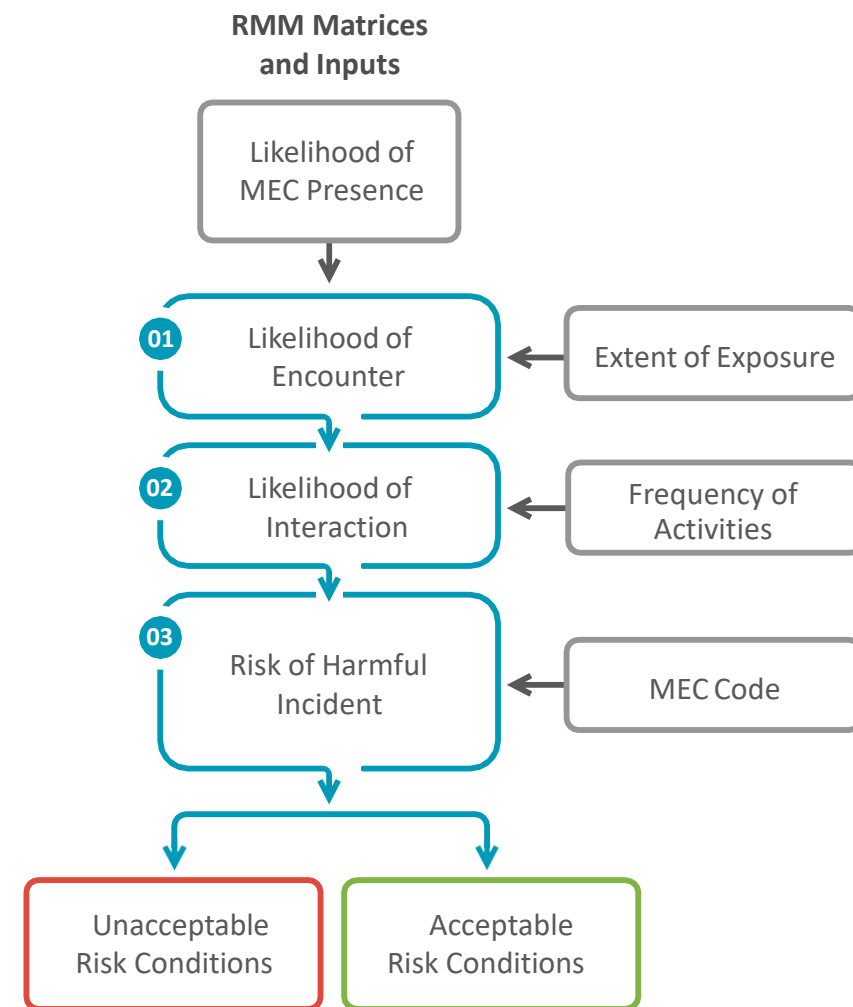
- Likelihood of MEC Presence
- Extent of Exposure

- **Likelihood of Interaction (Matrix 2)**

- Likelihood of Encounter (from Matrix 1)
- Frequency of Activities

- **Risk of Harmful Incident (Matrix 3)**

- Likelihood of Interaction (from Matrix 2)
- MEC Code





MATRIX 1: Likelihood of Encounter

- Goal
 - Understand the likelihood receptors will encounter MEC under each risk scenario
- Inputs
 - Likelihood of MEC Presence
 - HUA, LUA, or NEU?
 - Or No evidence MEC Remain
 - Anomaly density
 - Intrusive investigation results
 - Extent of Exposure
 - Annual areal coverage/use of the assessment area

| Likelihood of Encounter (Likelihood of MEC Presence vs. Exposure) | | Extent of Exposure | | | |
|--|---|-------------------------|---------|---------|----------------------------|
| | | Full (>90% coverage) | Partial | Limited | Minimal (<10% coverage) |
| Likelihood of MEC Presence | HUA: likelihood of MEC is HIGH . | 5 | 5 | 5 | 5 |
| | HUA: likelihood of MEC is MODERATE . | 5 | 5 | 4 | 4 |
| | LUA: likelihood of MEC is LOW . | 3 | 2 | 2 | 1 |
| | LUA: likelihood of MEC is VERY LOW . | 2 | 2 | 2 | 1 |
| | No evidence MEC Remain | 1 | 1 | 1 | 1 |
| | NEU: no evidence of munitions use | | | | |

ENCOUNTER:

A chance event during which a receptor gets sufficiently close to a MEC item that they might interact with it. This does not require the individual to interact with the MEC item.



Matrix 1: Likelihood of Encounter, cont'd.

- What do we mean by “extent of exposure”?
 - Receptors’ annual areal coverage/use of the assessment area
 - Higher likelihood to encounter a MEC item with greater coverage of the assessment area
 - Consider agricultural worker in field or hikers on or off trails



- Categories

- Full Coverage

- Receptors conduct activities on $\geq 90\%$ of the assessment area annually

- Partial Coverage

- Receptors conduct activities on $\geq 50\%$ and $< 90\%$ of the assessment area annually

- Limited Coverage

- Receptors conduct activities on $\geq 10\%$ and $< 50\%$ of the assessment area annually

- Minimal Coverage

- Receptors conduct activities on $< 10\%$ of the assessment area annually



MATRIX 2: Likelihood of Interaction

- Goal
 - Understand the likelihood receptors will interact with MEC under each risk scenario
- Inputs
 - Likelihood of Encounter
 - From Matrix 1
 - Frequency of Activities in the Interaction Zone
 - How often do people conduct the receptor activity each year?

| Likelihood of Interaction (Freq. of Activities in Interaction Zone vs. Likelihood of Encounter) | | Likelihood of Encounter (from Matrix 1) | | | | |
|--|--|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| Frequency of Activities in Interaction Zone | Frequent activities occur in interaction zone that may result in an interaction with munitions | A | A | B | B | D |
| | Occasional activities occur in interaction zone that may result in an interaction with munitions | A | B | B | B | D |
| | Infrequent activities occur in interaction zone that may result in an interaction with munitions | B | B | B | C | E |
| | Unlikely that activities occur in interaction zone that may result in an interaction with munitions | B | C | C | C | E |

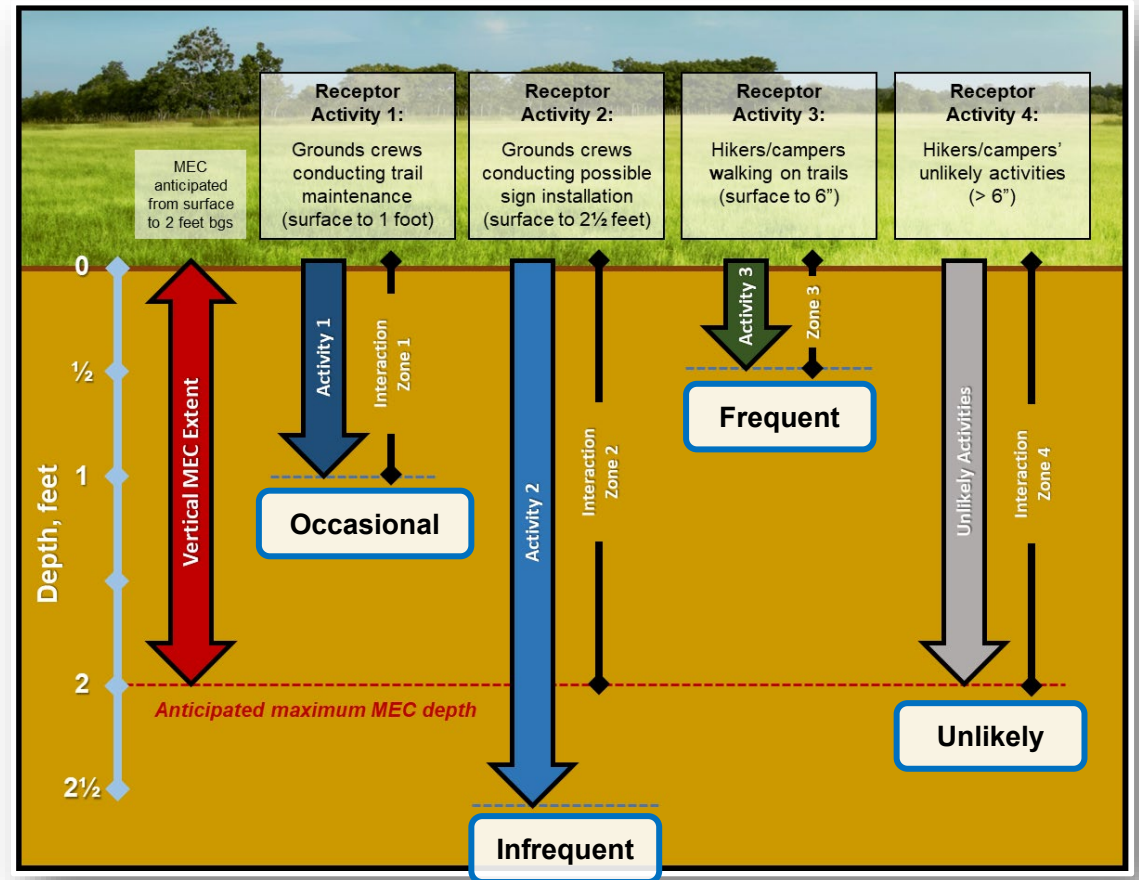
INTERACTION:

When, upon encounter a receptor imparts energy to a MEC item, either intentionally or unintentionally, such that the item might function. This does not require the receptor to come into direct contact with the item.



Matrix 2: Likelihood of Interaction, cont'd.

- Frequency of Activities in the Interaction Zone
 - PDT makes a qualitative estimate for frequency of activities
 - Under each risk scenario
 - Categories
 - Frequent
 - Occasional
 - Infrequent
 - Unlikely
- Consider this example...





MATRIX 3: Risk of Harmful Incident

- Goal
 - Evaluate the likelihood of an explosive incident
- Inputs
 - Likelihood of Interaction
 - From Matrix 2
 - MEC Code
 - List of MEC Codes included in RMM guidance
 - Codes based on fillers and fuzing of individual munitions
 - Can be adjusted by project team with input from explosives safety experts
- Output
 - Acceptable or unacceptable risk

| Risk of Harmful Incident (MEC Code vs. Likelihood of Interaction) | | Likelihood of Interaction (from Matrix 2) | | | | |
|---|--|---|--------------|--------------|--------------|------------|
| | | A | B | C | D | E |
| Munition MEC Code | High (MEC Code 3) | Unacceptable | Unacceptable | Unacceptable | Unacceptable | Acceptable |
| | Moderate (MEC Code 2) | Unacceptable | Unacceptable | Unacceptable | Acceptable | Acceptable |
| | Low (MEC Code 1) | Unacceptable | Unacceptable | Acceptable | Acceptable | Acceptable |
| | Inert (MEC Code 0) | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | No evidence MEC remain | | | | | |
| | NEU: no evidence of munitions use | | | | | |

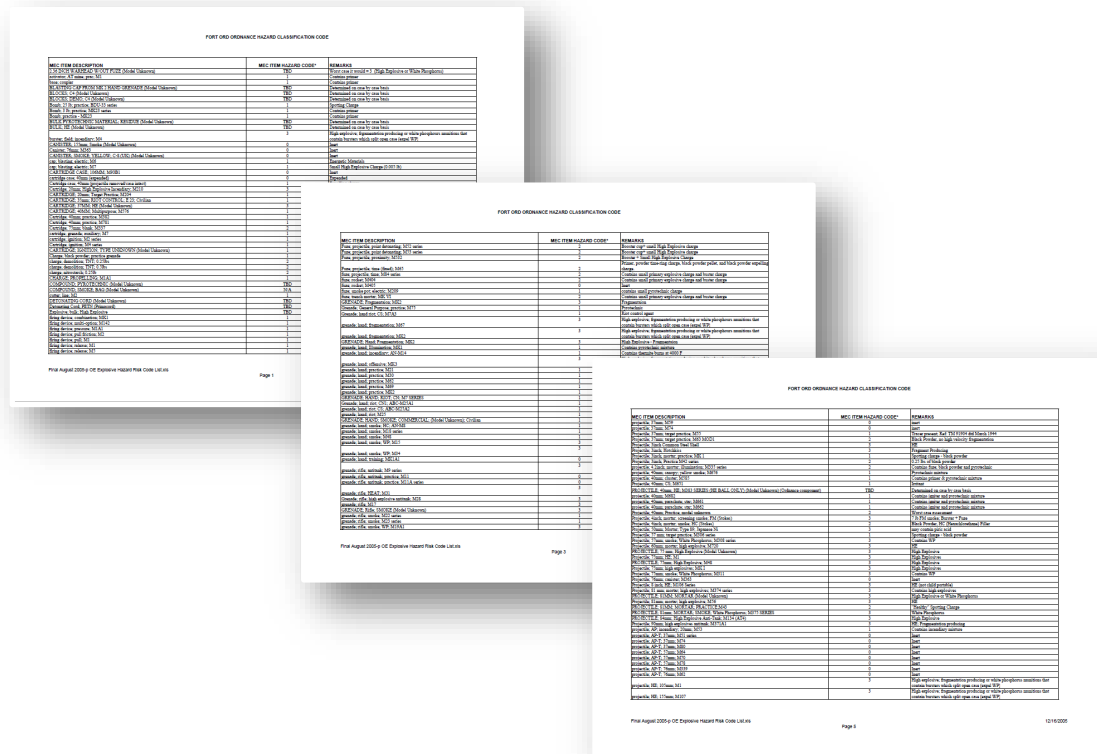
EXPLOSIVE INCIDENT:

When a receptor interacts with a MEC item and causes it to function or otherwise release energy, resulting in harm to one or more receptors. This includes events involving explosion or combustion.



Matrix 3: Risk of Harmful Incident

- Some examples...
 - (The list includes many, many more)



| MEC Item Description | MEC Code |
|--|----------|
| Projectile 75mm, High Explosive, M48 | 3 |
| Projectile, 37mm, High Explosive, M63 | 3 |
| Mortar, 60mm, High Explosive, M49 series | 3 |
| Grenade, Hand, Fragment, MK2 | 3 |
| Projectile, 105mm, Smoke, M84 series | 2 |
| Mortar, 60mm, Illumination, M83 series | 2 |
| Projectile, 40mm, Smoke, M680 | 1 |
| Mortar, 4-inch, Practice, MK1 (Stokes) | 1 |
| Grenade, Hand, Practice, M21 | 1 |
| Projectile, 76mm, AP-T, M62 | 0 |
| Projectile, 20mm, Target Practice, M220 | 0 |
| Grenade, Hand, Training, MK1A1 | 0 |



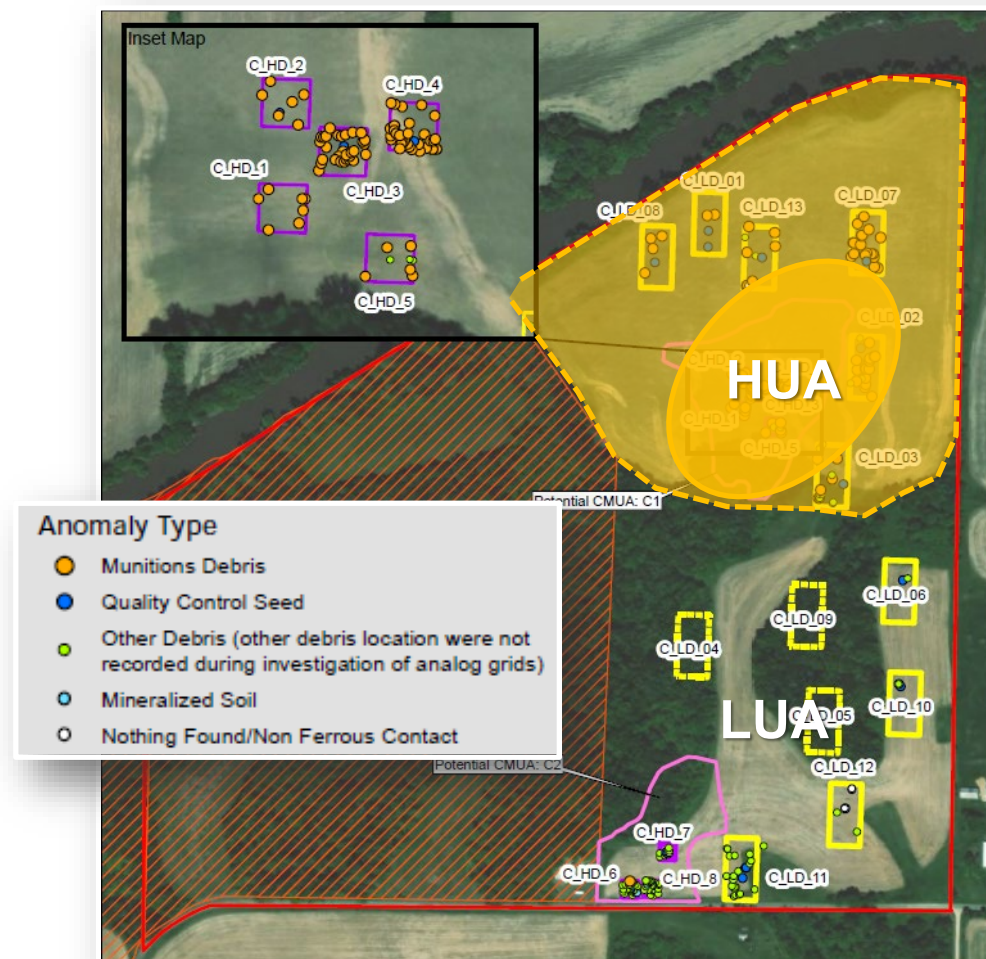
Case Study Examples

Using the RMM Matrices



Example, Former Rocket Range

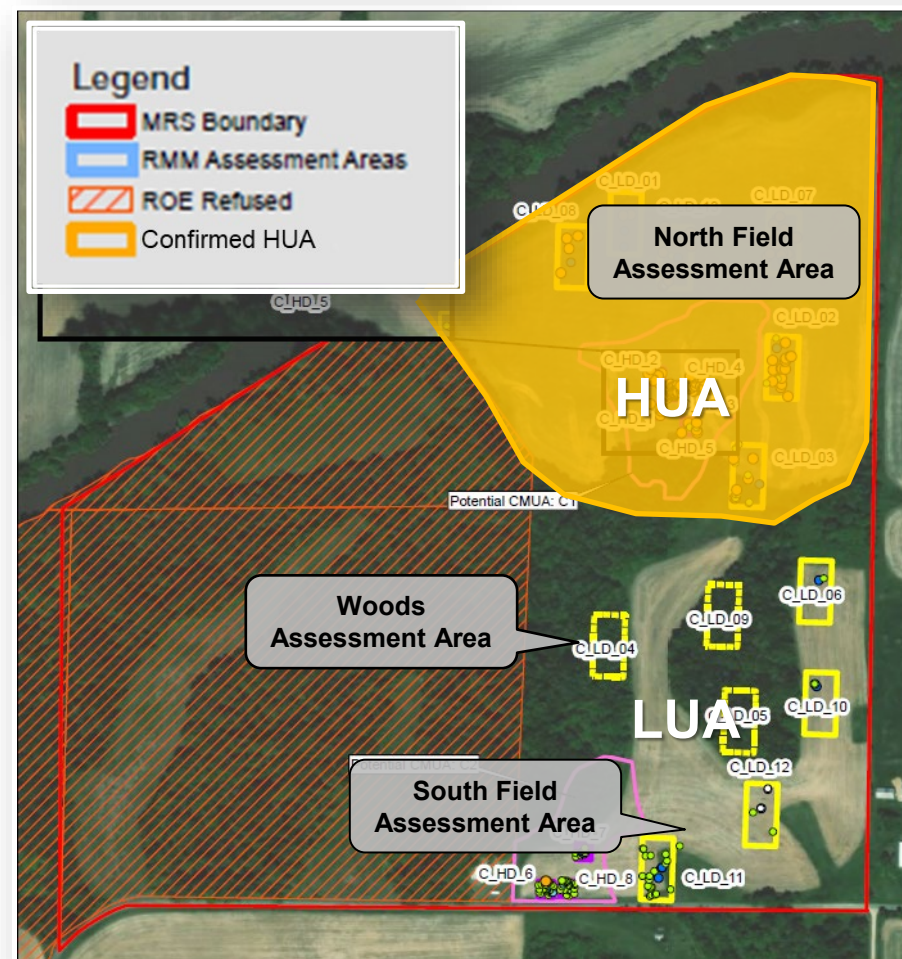
- Recorded use of
 - Rockets, 2.36-inch, HEAT and practice fillers
 - Possibly rifle grenades
- Land use
 - Agricultural; farmed two weeks a year
 - North and south fields
 - 24-inch intrusive depth
 - Wooded areas, seasonal hunting
 - 6-inch intrusive depth
 - Reasonably anticipated to remain the same in the future
- RI Results
 - Identified one HUA
 - Multiple pieces of 2.36-inch rocket MD found





Example, Former Rocket Range, cont'd.

- How many risk scenarios?
 - We have an HUA and an LUA
 - And two current and reasonably anticipated future land uses
 - Farming in the north and south fields
 - Hunting in the woods
- Project team identifies **three** risk scenarios
 - Risk Scenario 1
 - North Field Assessment Area (HUA), Farming (infrequent), 24" intrusive depth
 - Risk Scenario 2
 - Woods Assessment Area (LUA), Hunting (occasional), 6" intrusive depth
 - Risk Scenario 3
 - South Field Assessment Area (LUA), Farming (infrequent), 24" intrusive depth





Example 1, North Field, Matrix 1

| Likelihood of Encounter (Likelihood of MEC Presence vs. Exposure) | | Extent of Exposure | | | |
|---|--|-------------------------|---------|---------|----------------------------|
| | | Full (>90% coverage) | Partial | Limited | Minimal (<10% coverage) |
| Likelihood of MEC Presence | HUA: likelihood of MEC is HIGH . | 5 | 5 | 5 | 5 |
| | HUA: likelihood of MEC is MODERATE . | 5 | 5 | 4 | 4 |
| | LUA: likelihood of MEC is LOW . | 3 | 2 | 2 | 1 |
| | LUA: likelihood of MEC is VERY LOW . | 2 | 2 | 2 | 1 |
| | No evidence MEC Remain | 1 | 1 | 1 | 1 |
| | NEU : no evidence of munitions use | | | | |

- Matrix 1 – Likelihood of Encounter
 - Likelihood of MEC Presence
 - HUA, LUA, or NEU?
 - HUA
 - Investigation results?
 - Known or suspected in subsurface
 - Only MD found
 - Likelihood of MEC = Moderate
 - Extent of Exposure
 - Annual area coverage/use of the assessment area
 - Land is tilled periodically
 - Majority of area is covered
 - Extent of Exposure = Full
 - **OUTPUT: 4**



Example 1, North Field, Matrix 2

| Likelihood of Interaction (Freq. of Activities in Interaction Zone vs. Likelihood of Encounter) | | Likelihood of Encounter (from Matrix 1) | | | | |
|---|--|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| Frequency of Activities in Interaction Zone | Frequent activities occur in interaction zone that may result in an interaction with munitions | A | A | B | B | D |
| | Occasional activities occur in interaction zone that may result in an interaction with munitions | A | B | B | B | D |
| | Infrequent activities occur in interaction zone that may result in an interaction with munitions | B | B | B | C | E |
| | Unlikely that activities occur in interaction zone that may result in an interaction with munitions | B | C | C | C | E |

- Matrix 2 – Likelihood of Interaction
 - Likelihood of Encounter
 - From Matrix 1
 - 4
 - Frequency of Activities in the Interaction Zone
 - How often do people conduct the receptor activity in the interaction zone each year?
 - Farmed two weeks a year
 - Frequency = Infrequent
 - **OUTPUT: B**



Example 1, North Field, Matrix 3

| Risk of Harmful Incident (MEC Code vs. Likelihood of Interaction) | Likelihood of Interaction (from Matrix 2) | | | | |
|---|---|--------------|--------------|--------------|------------|
| | A | B | C | D | E |
| Munition MEC Code | High (MEC Code 3) | Unacceptable | Unacceptable | Unacceptable | Acceptable |
| | Moderate (MEC Code 2) | Unacceptable | Unacceptable | Acceptable | Acceptable |
| | Low (MEC Code 1) | Unacceptable | Unacceptable | Acceptable | Acceptable |
| | Inert (MEC Code 0) | Acceptable | Acceptable | Acceptable | Acceptable |
| | No evidence MEC remain | | | | |
| | NEU: no evidence of munitions use | | | | |

REMEMBER!

SPP Team discussed and concurred with all inputs

RMM IS NOT A “BLACK BOX”!

- Matrix 3 – Risk of Harmful Incident

- Likelihood of Interaction

- From Matrix 2
- B

- MEC Code

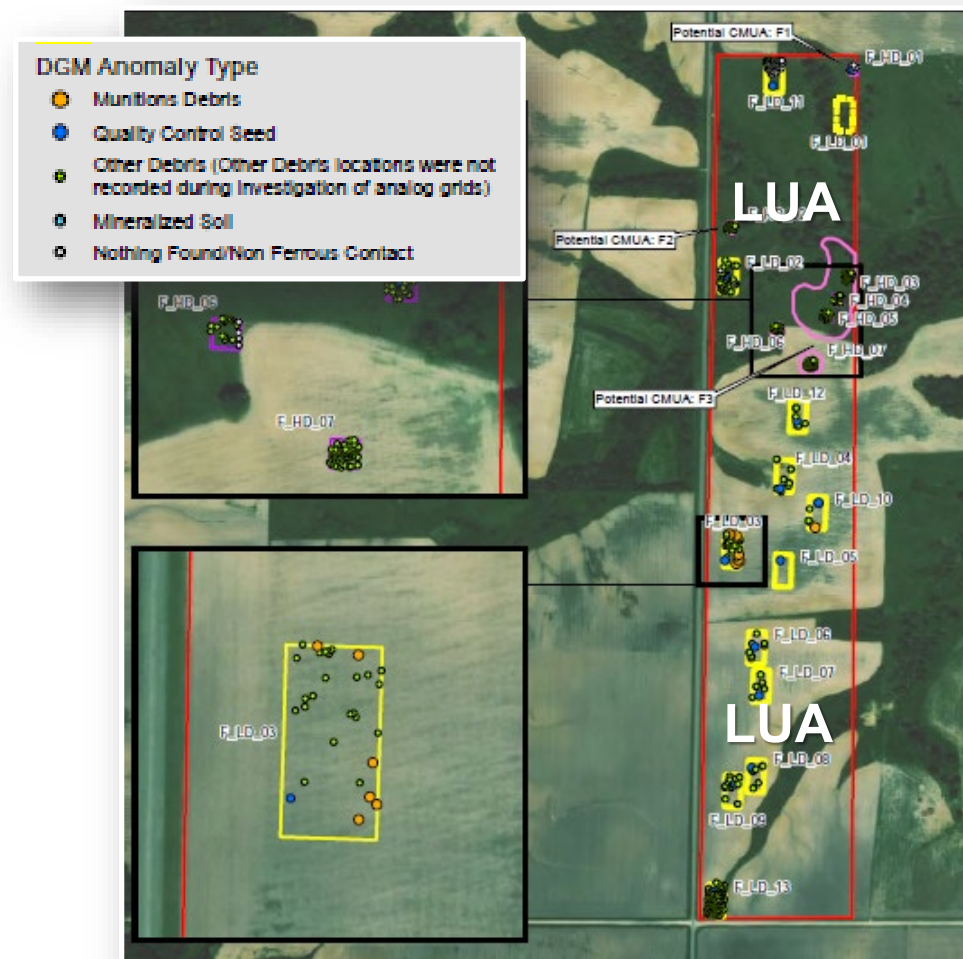
- Codes based on fillers and fuzing of individual munitions
 - 2.36-inch HEAT rockets
 - MEC Code = 3

- **OUTPUT = Unacceptable**



Example 2, Former Infantry Training Area

- Recorded use of
 - Smoke grenades, small arms ammunition
- Land use
 - Agricultural; farmed four weeks a year
 - 24-inch intrusive depth
 - Wooded areas; hiking
 - 6-inch intrusive depth
 - Reasonably anticipated to remain the same in the future
- RI Results
 - Identified one HD area (i.e., possible HUA)
 - But no evidence of MEC or MD; only building debris
 - No HUAs confirmed; only LUA
 - Very small quantities of expended smoke grenades, and SAA found





Example 2, Former Infantry Training Area

- How many risk scenarios?
 - We have one LUA
 - And two current and reasonably anticipated future land uses
 - Farming in the south field
 - Hunting in north field
- Project team identifies **two** risk scenarios
 - Risk Scenario 1
 - North Field Assessment Area (LUA), Hunting (occasional), 6" intrusive depth
 - Risk Scenario 2
 - South Field Assessment Area (LUA), Farming (infrequent), 24" intrusive depth





Example 2, South Field, Matrix 1

| Likelihood of Encounter (Likelihood of MEC Presence vs. Exposure) | | Extent of Exposure | | | |
|--|---|-------------------------|---------|---------|----------------------------|
| | | Full (>90% coverage) | Partial | Limited | Minimal (<10% coverage) |
| Likelihood of MEC Presence | HUA: likelihood of MEC is HIGH . | | 5 | 5 | 5 |
| | HUA: likelihood of MEC is MODERATE . | | 5 | 4 | 4 |
| | LUA: likelihood of MEC is LOW . | | 2 | 2 | 1 |
| | LUA: likelihood of MEC is VERY LOW . | 2 | 2 | 2 | 1 |
| | No evidence MEC Remain | 1 | 1 | 1 | 1 |
| | NEU: no evidence of munitions use | | | | |

- Matrix 1 – Likelihood of Encounter
 - Likelihood of MEC Presence
 - HUA, LUA, or NEU?
 - LUA
 - Investigation results?
 - Expended flares and SAA
 - Very small quantities found
 - Likelihood of MEC = Very Low
 - Extent of Exposure
 - Annual area coverage/use of the assessment area
 - Land is tilled periodically
 - Majority of area is covered
 - Extent of Exposure = Full
 - **OUTPUT: 2**



Example 2, South Field, Matrix 2

| Likelihood of Interaction (Freq. of Activities in Interaction Zone vs. Likelihood of Encounter) | | Likelihood of Encounter (from Matrix 1) | | | | |
|--|--|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 |
| Frequency of Activities in Interaction Zone | Frequent activities occur in interaction zone that may result in an interaction with munitions | A | A | B | B | D |
| | Occasional activities occur in interaction zone that may result in an interaction with munitions | A | B | B | B | D |
| | Infrequent activities occur in interaction zone that may result in an interaction with munitions | B | B | B | C | E |
| | Unlikely that activities occur in interaction zone that may result in an interaction with munitions | B | C | C | C | E |

- Matrix 2 – Likelihood of Interaction
 - Likelihood of Encounter
 - From Matrix 1
 - 2
 - Frequency of Activities in the Interaction Zone
 - How often do people conduct the receptor activity in the interaction zone each year?
 - Farmed four weeks a year
 - Frequency = Infrequent
 - **OUTPUT: C**



Example 1, North Field, Matrix 3

| Risk of Harmful Incident (MEC Code vs. Likelihood of Interaction) | | Likelihood of Interaction (from Matrix 2) | | | | |
|---|--------------------------|---|--------------|--------------|--------------|------------|
| | | A | B | C | D | E |
| Munition MEC Code | High (MEC Code 3) | Unacceptable | Unacceptable | Unacceptable | Unacceptable | Acceptable |
| | Moderate (MEC Code 2) | Unacceptable | Unacceptable | Unacceptable | Acceptable | Acceptable |
| | Low (MEC Code 1) | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Inert (MEC Code 0) | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | No evidence MEC remain | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| NEU: no evidence of munitions use | | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |

- Matrix 3 – Risk of Harmful Incident
 - Likelihood of Interaction
 - From Matrix 2
 - C
 - MEC Code
 - Codes based on fillers and fuzing of individual munitions
 - Smoke grenades only (SAA is not MEC)
 - MEC Code = 1
 - **OUTPUT = Acceptable**

REMEMBER!

SPP Team discussed and concurred with all inputs

RMM IS NOT A “BLACK BOX”!



RMM Group Exercise 2

Using the RMM Matrices to Evaluate Risk Scenarios for two Case Studies



Common Risk Assessment Mistakes

Things many project teams do... sub-optimally



Common Mistakes – Insufficient PDT discussion

- MEC risk assessment is QUALITATIVE!
 - RMM is a framework to help *the PDT evaluate* risks from explosive hazards
 - PDT must collaborate on the process, including inputs
- We're doing it **WRONG...**
 - ... if the **1st time** the DoD team sees the MEC risk assessment is the RI Report
 - ... if the **1st time** the regulator sees the MEC risk assessment is the RI Report
- Decision makers must be involved in the process in a meaningful way



***USE the SPP meetings
throughout the project!***



Common Mistakes – Only one risk scenario

- It is possible to evaluate risk using a single risk scenario
 - Must be absolute worst case
- **HOWEVER**
 - This is likely NOT the *best way* to do it
 - Potentially ignores multiple risk pathways
 - Does not tell the whole story
- Most MRSs likely should have at least two or three risk scenarios
 - Complex MRSs may have many more
- Risk scenarios help to support RAOs, which guides alternative development
 - It's *worth the time* to develop and evaluate a range of scenarios



Using too few risk scenarios may not describe the situation clearly enough to support sound risk management decisions



FACT: Risk Scenarios HELP Create Remedial Action Objectives!

- RAOs require
 - Contaminants and Media of Concern
 - Specific MEC types
 - Specified horizontal boundary
 - Depth related to current and future land use
 - Depth of MEC determined during characterization
 - Potential Exposure Pathways
 - Receptors
 - Pathways
 - Remediation Goals
- RMM input data requires
 - For MEC
 - MEC Types
 - Risk scenarios include
 - Assessment Areas
 - Receptor Activities
 - Interaction Zones

IT'S ALL IN THERE!



Common Mistakes – Not Enough Land Use Data

- Land use data included in PAs and/or SIs is typically general (and old)
 - e.g., “land use is recreational”
- This is insufficient for RMM evaluation with making multiple assumptions
- Critical to have data to support meaningful risk scenarios
 - Specific activity descriptions
 - Numbers of people involved
 - Horizontal coverage (areas)
 - Frequencies
 - Intrusive depths
- Plan to collect this data and collect it!

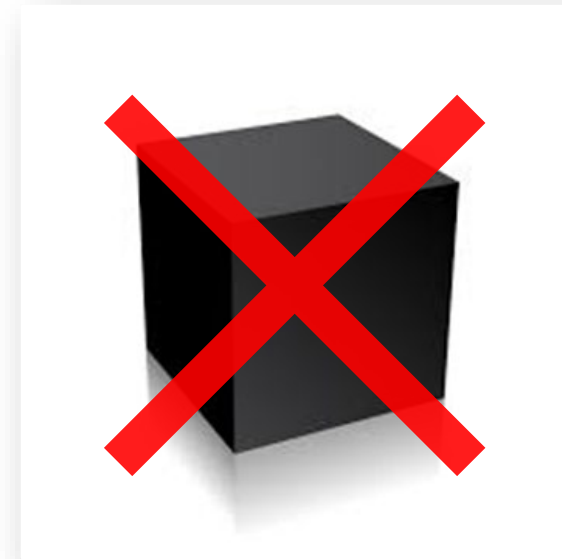


Insufficient Data



Common Mistakes – “RMM made me do it!”

- RMM does NOT have a will of its own
 - RMM does not *determine* risk
- RMM is a framework to help *the PDT evaluate* risks from explosive hazards
 - Tool to help the project team, including stakeholders
 - *Guides discussion and helps them reach consensus on risk*
 - The project team chooses the inputs
 - **The project team makes the decision** using RMM, *not the other way around*
- In other words...
 - ***RMM is NOT a “black box”!***





Final Thoughts



Final Thoughts

- Collect land use data
 - Detail is needed for risk assessment
 - *Include in data collection plan*
- Develop appropriate risk scenarios
 - Better risk assessments
 - Facilitates RAOs
 - Supports remedial alternative development
- RMM is NOT a black box!
 - The whole PDT must be involved in building consensus on inputs
 - That means the whole PDT is making the risk conclusions/decisions
 - Not just the contractor
 - Certainly not RMM itself!

