



# **Munitions Response Site Prioritization Protocol**

## **Module 6. Health Hazard Evaluation**

April 2007



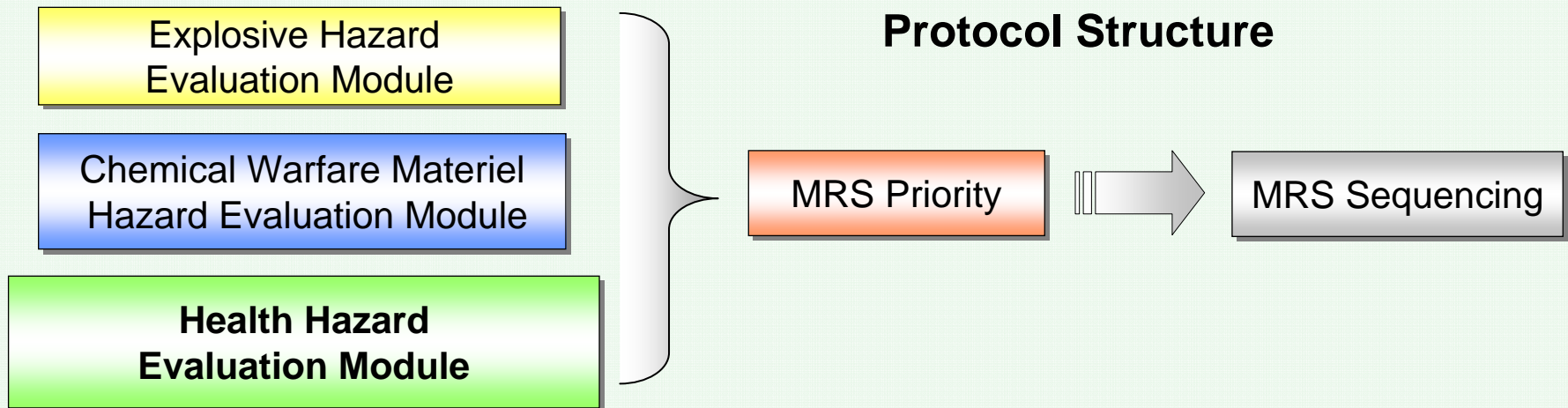
# HHE Outline

- Health Hazard Evaluation (HHE) Module
  - ◆ Relative Risk Site Evaluation (RRSE)
  - ◆ Module Factors
  - ◆ Media
- Structure of the HHE Module
- Groundwater Evaluation
- Surface Water and Sediment Evaluation
- Surface Soil Evaluation
- Determining HHE Module Rating



# HHE Module

- Provides a consistent DoD-wide approach for assigning a relative priority to munitions response sites (MRSs) where munitions constituents (MC) and any incidental nonmunitions-related contaminants are known or suspected to be present
- Considers the environmental media and their corresponding receptors that are most likely to be affected by MC at MRSs
- The HHE Module may be used to evaluate MC and other chemical contaminants present at an MRS





# Munitions Constituents Review

MC are any materials originating from unexploded ordnance (UXO); discarded military munitions (DMM); or other military munitions, including explosive and nonexplosive materials; and emission, degradation, or breakdown elements of such ordnance or munitions

– 10 USC 2710(e)(3)

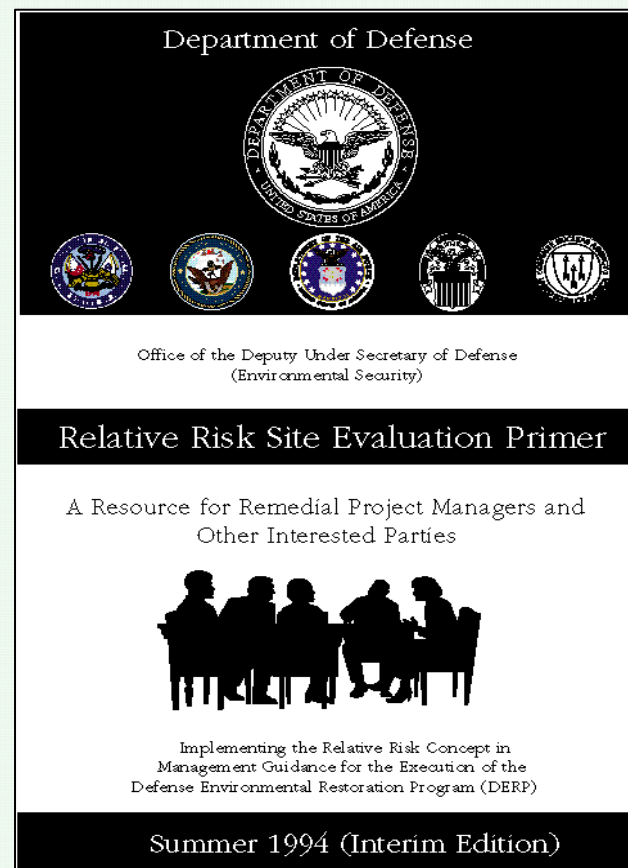
**Is this an example of MC?**





# RRSE Framework

- The Relative Risk Site Evaluation (RRSE) framework serves as the basis for the HHE Module
  - ◆ Methodology used by DoD to evaluate the relative risk posed at an Installation Restoration Program (IRP) site in relation to other IRP sites
  - ◆ Based on the nature and extent of contamination at an IRP site, the potential for contaminants to migrate, and the populations and ecosystems that could be impacted
  - ◆ Ranks IRP sites as High, Medium, or Low relative-risk





# HHE and RRSE Frameworks

- HHE uses the same data and process as the RRSE, but modifies the RRSE framework in several areas to address the unique requirements of MRSs –
  - ◆ The use of three outcomes (like in RRSE) would cause the HHE Module to influence the overall priority assignment greater than EHE and CHE Modules. To ensure balance between the three hazard modules, DoD designed the HHE Module with seven outcomes
  - ◆ Only MRSs with significant health hazards, an identified receptor, and evident migration pathways are assigned the highest HHE Module Rating
- The RRSE Comparison Value Tables have been updated for the Protocol and are provided in the Primer





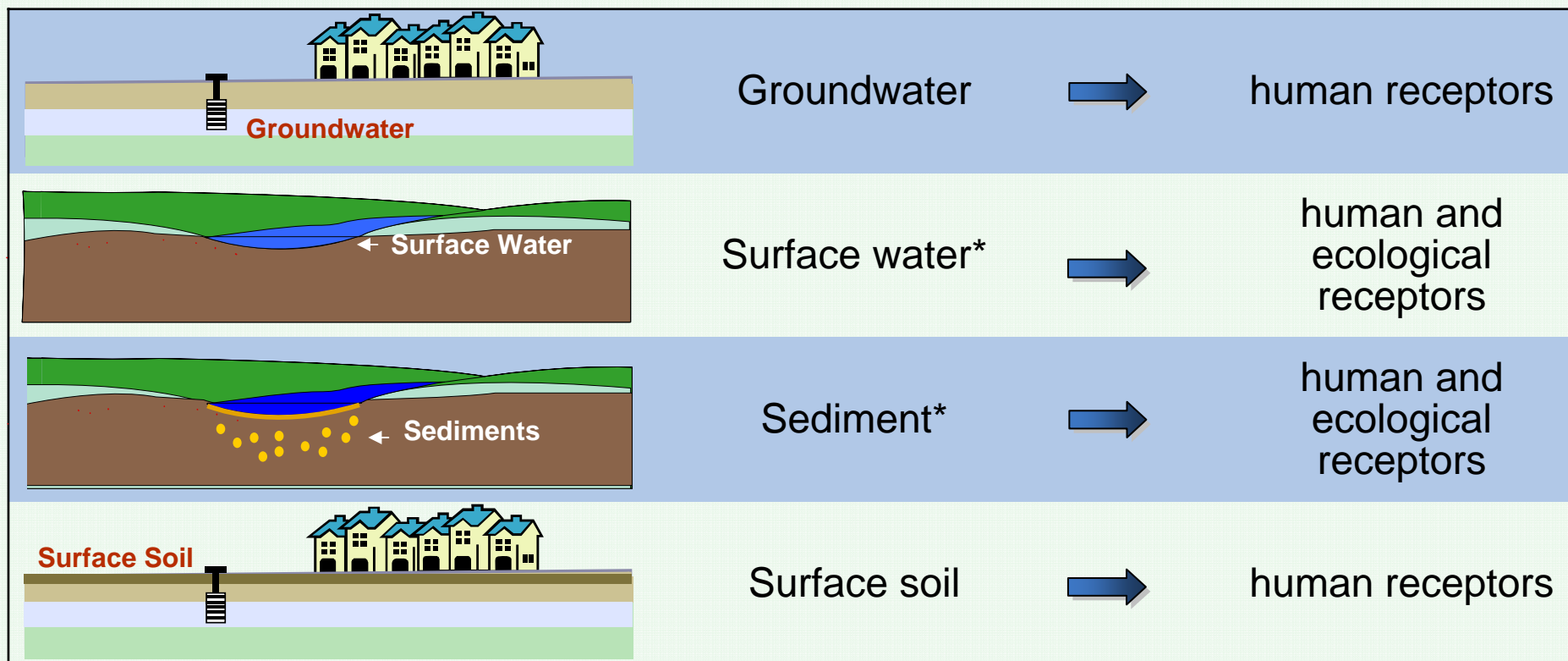
# HHE Module Factors

- Similar to EHE and CHE Modules, the HHE Module Rating is determined using three factors
  - ◆ Contaminant Hazard Factor (CHF) – characterizes the type of contamination
  - ◆ Migration Pathway Factor (MPF) – characterizes the potential for a receptor to encounter the hazard
  - ◆ Receptor Factor (RF) – characterizes the impact the hazard may have on human and ecological populations
- The HHE's structure limits the influence of any one factor on the HHE Module Rating
- Unlike EHE and CHE Modules, the three factors are used to evaluate four distinct environmental media





# Environmental Media in the HHE Module



*\*Surface water and sediment can be evaluated together because the contaminants potentially share the same migration pathway*





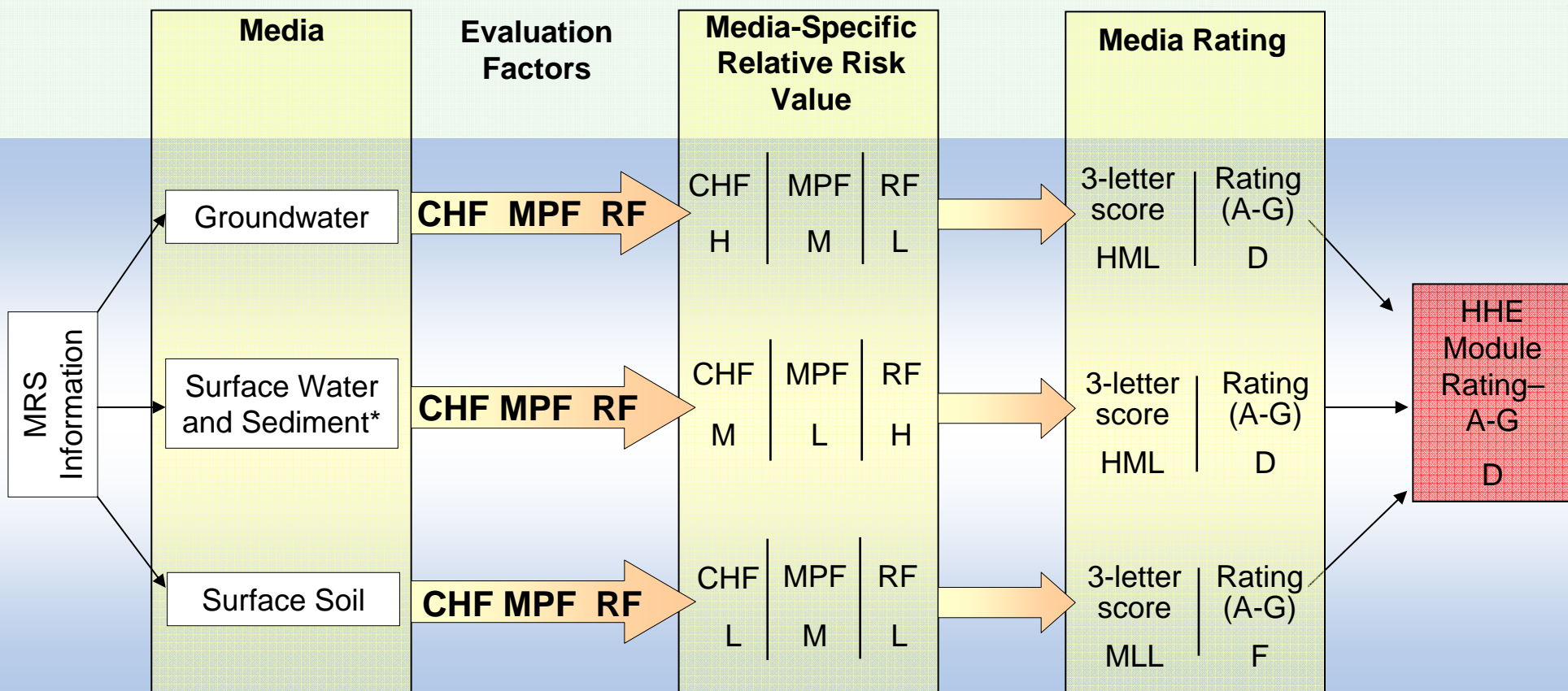
# Environmental Media Defined

|               | Definition  | Human Receptors   | Ecological Receptors  |
|---------------|---|---|---|
| Groundwater   | Groundwater is precipitation or water from surface water bodies (e.g., lakes or streams) that soaks into the soil/bedrock and is stored underground               | Individuals that may be exposed to contamination via on-site and downgradient water supply wells                    | Not evaluated   |
| Surface water | Surface water is precipitation that collects in surface water bodies (e.g., oceans, lakes, or streams) or groundwater that discharges to the surface from springs | Individuals that may be exposed to contamination via on-site and downgradient water supplies and recreational areas | Critical habitats and other habitats found in Figure 7.14 in the Primer |
| Sediment      | Sediments are formed from the deposition of solid material that include the clay and silts on the bottom of a water body (e.g., ocean, lake, or stream)           |   |   |
| Surface soil  | The layer of soil on the surface (with a depth of 0 to 6 inches)  | Residents, people in schools and daycare, and workers who have direct access to contamination frequently            | Not evaluated   |





# Structure of the HHE Module



CHF - Contaminant Hazard Factor  
 MPF - Migration Pathway Factor  
 RF - Receptor Factor  
 \*Includes human and ecological endpoints

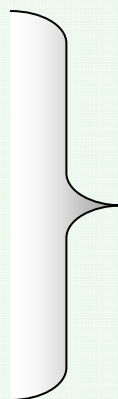




# HHE Module Scoring

- Factors are valued High (H), Medium (M), or Low (L) based on established categories within the factor
- Values for the three evaluation factors (CHF, MPF, RF) are grouped into a three-letter combination
- The three-letter combinations are distributed across seven categories, permitting only the most and least hazardous combinations in the highest and lowest categories. The other combinations are spread across the five remaining categories in a bell curve based on frequency of the combination

|                    |  |
|--------------------|--|
| Contaminant Hazard | Significant (H)<br>Moderate (M)<br>Minimal (L) |
| Migration Pathway  | Evident (H)<br>Potential (M)<br>Confined (L)   |
| Receptor           | Identified (H)<br>Potential (M)<br>Limited (L) |



| HHE Module Ratings |        |
|--------------------|--------|
| Combination        | Rating |
| HHH                | A      |
| HHM                | B      |
| HHL                | C      |
| HMM                |        |
| HML                | D      |
| MMM                |        |
| HLL                | E      |
| MML                | F      |
| MLL                |        |
| LLL                | G      |





# HHE Module Scoring

- Each medium has a specific table associated with it (see Primer, Appendix A)
- Human and ecological receptors are evaluated on separate tables
- Each table assigns values to the Contaminant Hazard, Migration Pathway, and Receptor Factors





# Contaminant Hazard Factor

- The CHF is evaluated differently than any other factor in the Protocol
- The CHF evaluates the potential hazards to receptors from MC and any incidental nonmunitions-related contaminants in the four distinct environmental media.
- The CHF is based on the ratio of the maximum concentration of a contaminant detected in an environmental medium to a risk-based comparison value for that contaminant in that medium
- The CHF does not include naturally occurring compounds that are detected within the established background concentration





# Contaminant Hazard Factor (cont)

- For each medium and receptor (human and/or ecological), the contaminants present at the MRS are evaluated against appropriate comparison values from the Comparison Value Tables (see Primer, Appendix B)

## Human

- Carcinogenic chemicals – compared to preliminary remediation goals (PRGs) that represent a 1-in-10,000 lifetime cancer risk
- Non-carcinogenic chemicals – compared to daily reference doses (RfD)

## Ecological

- Compared to ambient water quality criteria for surface water or sediment screening values





# Contaminant Hazard Factor (cont)

- The CHF Value is based on the sum of contaminant ratios –

|                         |                 |
|-------------------------|-----------------|
| Sum of Ratios > 100     | Significant (H) |
| Sum of Ratios = 2 - 100 | Moderate (M)    |
| Sum of Ratios < 2       | Minimal (L)     |

- Each contaminant ratio is calculated by dividing the concentration of each contaminant found at the MRS by the corresponding reference value
- DoD uses the  $1 \times 10^{-4}$  carcinogen reference value (CRV) instead of the  $1 \times 10^{-6}$  value to assign a relative priority for action, *not* to assign a value for cleanup. DoD's use of  $1 \times 10^{-4}$  as the CRV will not change the relative ranking of any individual MRS as all MRSs would shift equally if a different endpoint were used



**Table 21**

**HHE Module: Groundwater Data Element Table**

Contaminant Hazard Factor (CHF)

**DIRECTIONS:** Record the **maximum concentrations** of all contaminants in the MRS's groundwater and their **comparison values** (from Appendix B of the Primer) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the CHF by adding the contaminant ratios together, including any additional groundwater contaminants recorded on Table 27. Based on the CHF, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the groundwater, select the box at the bottom of the table.

| Contaminant               | Maximum Concentration (µg/L)   | Comparison Value (µg/L)  | Ratios      |
|---------------------------|--|--|-------------|
| <b>Arsenic</b>            | <b>24 µg/L</b>   | <b>4.5 µg/L</b>  | <b>5.33</b> |
| CHF Scale                 | CHF Value  | Sum The Ratios   |             |
| CHF > 100                 | H (High)   | $CHF = \sum \frac{[\text{Maximum Concentration of Contaminant}]}{[\text{Comparison Value for Contaminant}]}$ |             |
| 100 > CHF > 2             | M (Medium)   |  |             |
| 2 > CHF                   | L (Low)  |  |             |
| CONTAMINANT HAZARD FACTOR | <b>DIRECTIONS:</b> Record the <b>CHF Value</b> from above in the box to the right (maximum value = H). |  |             |

List all chemicals present in the medium that are attributable to the MRS and the maximum concentration

Do not include naturally occurring compounds that are detected within the established background concentration

Record the comparison values for each chemical present (see Primer, Appendix B)

Calculate the contaminant ratio by dividing the concentration by the comparison value



# What is the Contaminant Hazard Factor for this example?

| Table 21<br>HHE Module: Groundwater Data Element Table   |  |  |             |
|--|--|--|-------------|
| Contaminant Hazard Factor (CHF)  |  |  |             |
| DIRECTIONS: Record the maximum concentrations of all contaminants in the MRS's groundwater and their comparison values (from Appendix B of the Primer) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the ratios for each contaminant by dividing the maximum concentration by the comparison value. Determine the CHF by adding the contaminant ratios together, including any additional groundwater contaminants recorded on Table 27. Based on the CHF, use the CHF Scale to determine and record the CHF Value. If there is no known or suspected MC hazard present in the groundwater, select the box at the bottom of the table. |  |  |             |
| Contaminant  | Maximum Concentration (µg/L)   | Comparison Value (µg/L)  | Ratios      |
| <b>Arsenic</b>   | <b>24 µg/L</b>   | <b>4.5 µg/L</b>  | <b>5.33</b> |
| <b>TCE</b>   | <b>175 µg/L</b>  | <b>140 µg/L</b>  | <b>1.25</b> |
| CHF Scale  | CHF Value  | Sum The Ratios   | <b>6.58</b> |
| CHF > 100  | H (High)   | $CHF = \sum \frac{[\text{Maximum Concentration of Contaminant}]}{[\text{Comparison Value for Contaminant}]}$ |             |
| 100 > CHF > 2  | <b>M (Medium)</b>  |  |             |
| 2 > CHF  | L (Low)  |  |             |
| CONTAMINANT HAZARD FACTOR  | DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H). |  | <b>M</b>    |

Record the sum of the ratios

Use the sum of the ratios to determine the CHF Value





# Migration Pathway Factor

- The Migration Pathway Factor assesses the potential for nonmunitions-related contaminants to migrate from the MRS
- Definitions, which differ slightly by media, are grouped into three possible classifications –

|                               |  |
|-------------------------------|--|
| <b>Evident<br/>(High)</b>     | <b>There is analytical data or observable evidence that contamination is present at, is moving toward, or has moved to a point of exposure</b>   |
| <b>Potential<br/>(Medium)</b> | <b>Contamination has moved only slightly beyond the source, could move but is not moving appreciably, or information is not sufficient to select <i>Evident</i> or <i>Confined</i></b> |
| <b>Confined<br/>(Low)</b>     | <b>Low possibility for contamination to be present at or migrate to a point of exposure</b>  |



# Receptor Factor

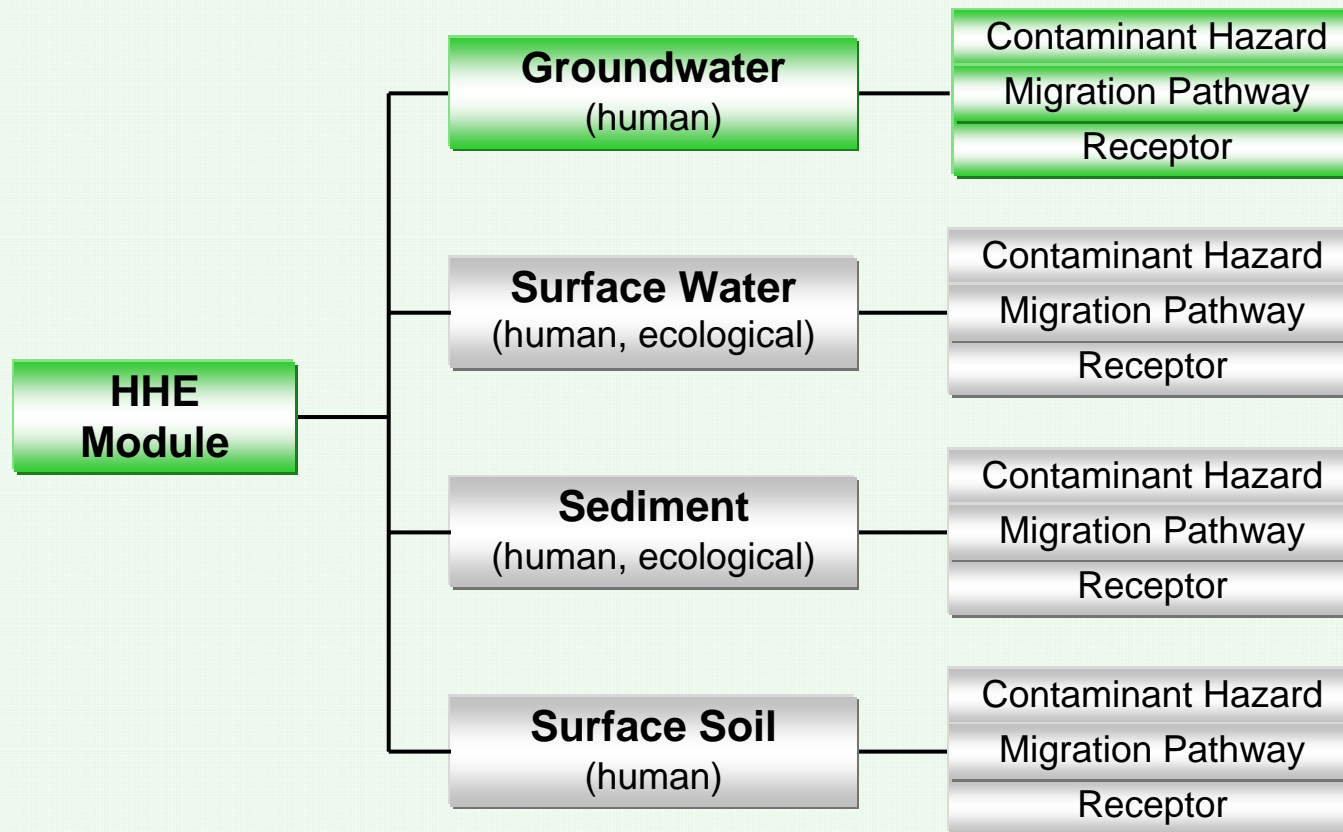
- The Receptor Factor assesses the present or future likelihood that receptors will encounter MRS-specific contamination
- Definitions, which differ slightly by media, are grouped into three possible classifications –

|                               |   |
|-------------------------------|---|
| <b>Identified<br/>(High)</b>  | <b>Identified receptors</b> have access to a medium to which contamination has moved or can move                    |
| <b>Potential<br/>(Medium)</b> | <b>Potential for receptors</b> to have access to a medium to which contamination has moved or can move              |
| <b>Limited<br/>(Low)</b>      | <b>Little or no potential for receptors</b> to have access to a medium to which contamination has moved or can move |



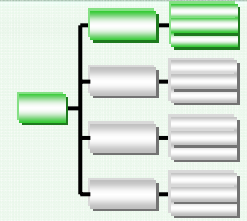


# Groundwater Evaluation Structure



# Groundwater Evaluation Data

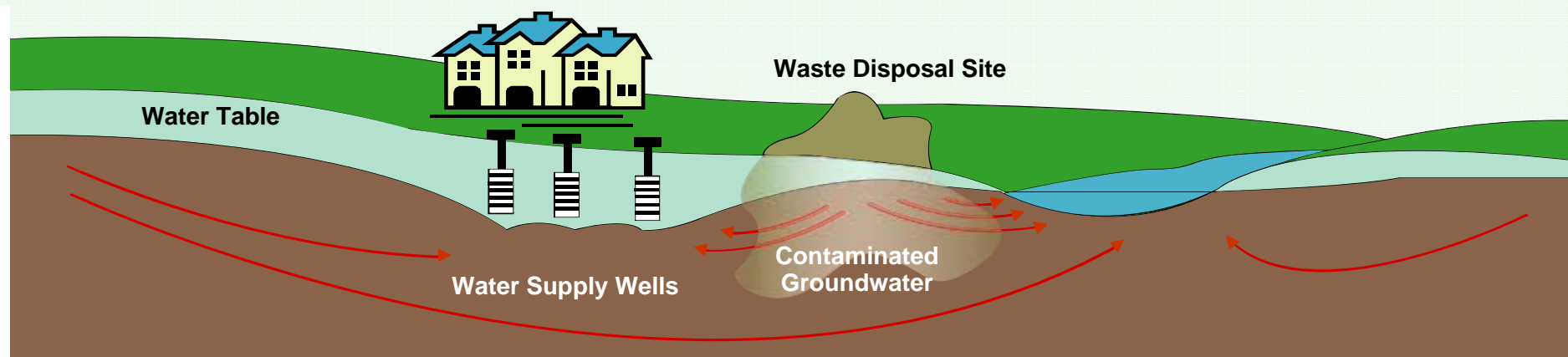
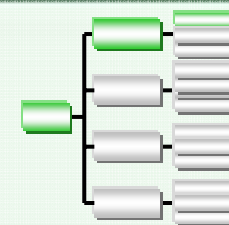
- Groundwater is precipitation or water from surface water bodies, like lakes or streams, that soaks into the soil and bedrock and is stored underground
- Considers human receptors that may be exposed to groundwater contamination
- Data do not have to be collected at the MRS, but any samples to be evaluated should be attributable to the MRS
- If groundwater is thought to be influenced by more than one MRS, assign the contaminant concentration to the MRS most likely to contain the contaminant source





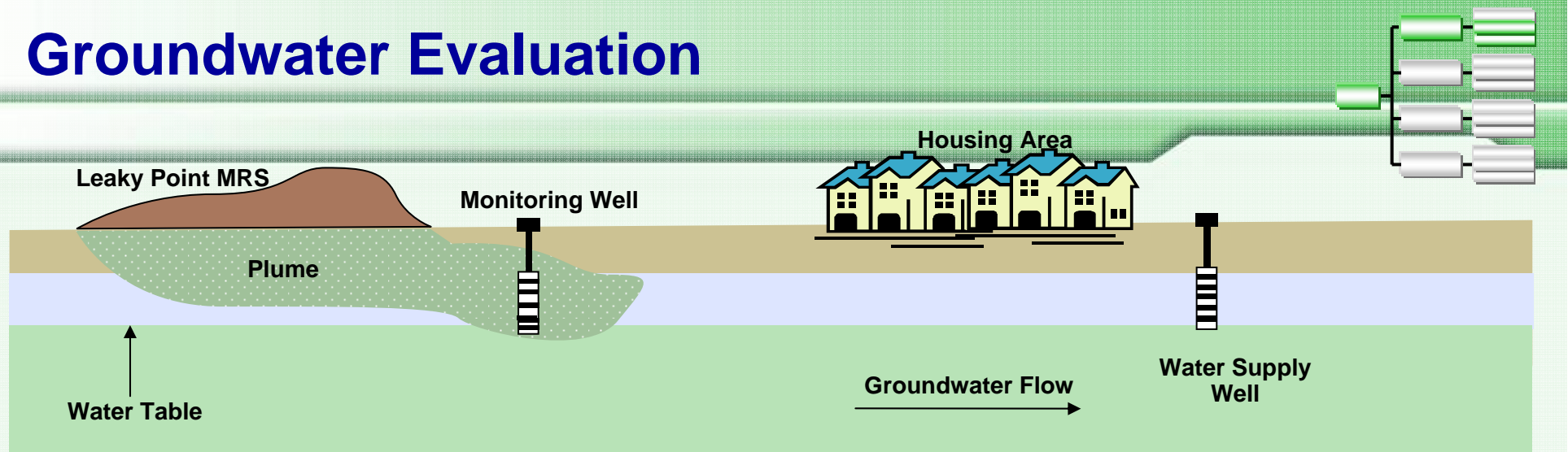
# Groundwater – Contaminant Hazard Factor

- Some MC have the potential to contaminate groundwater and can pose a risk to humans
- If MC are present, all chemicals present in the medium that are attributable to the MRS and their current concentrations should be recorded
- Naturally occurring compounds that are detected within the established background ranges should not be included in the analysis





# Groundwater Evaluation

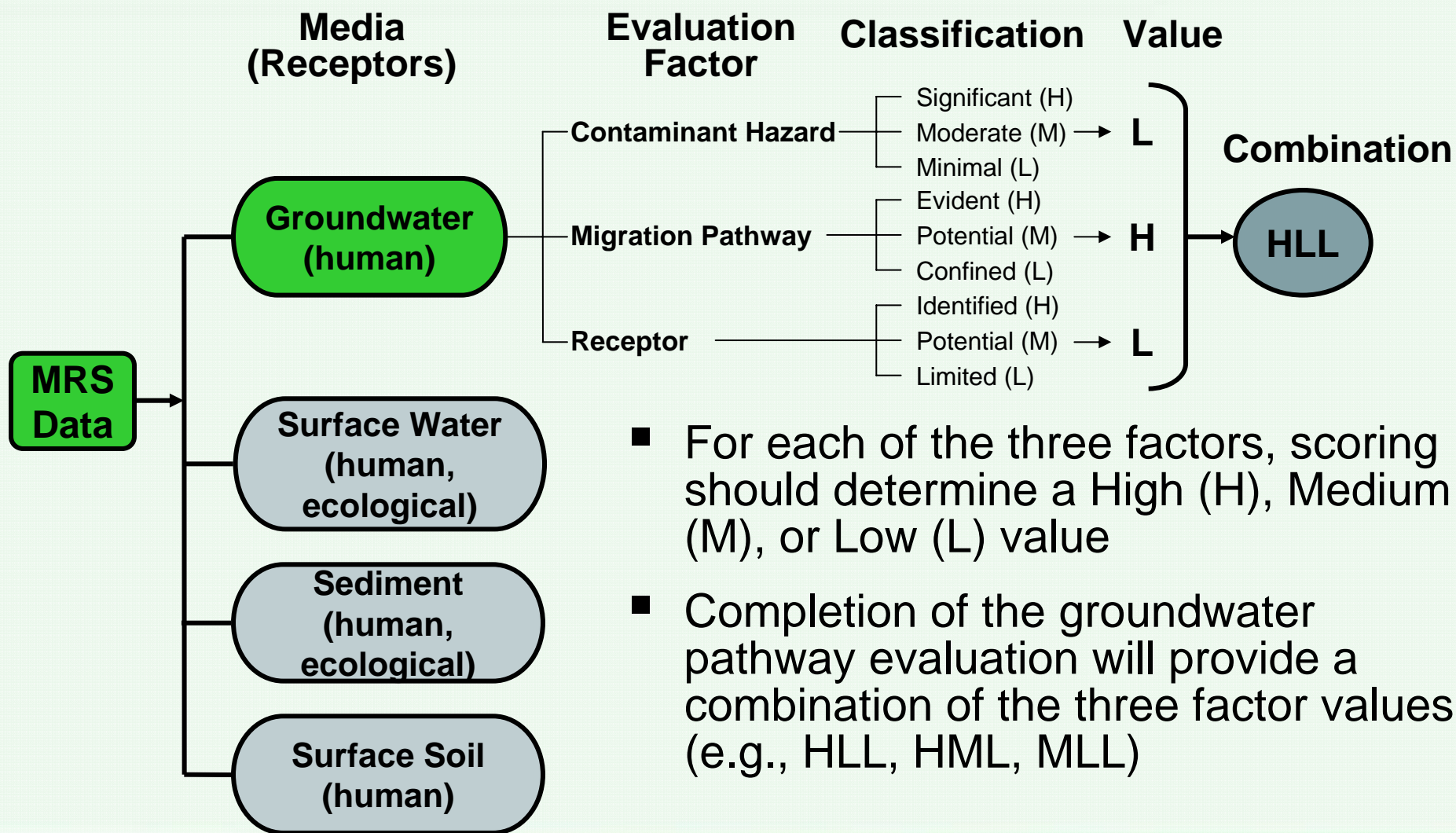


|        | Contaminant Hazard Factor                                     | Migration Pathway Factor   | Receptor Factor   |
|--------|---|--|---|
| High   | <b>Significant Contaminant Levels</b><br>Sum of Ratios > 100  | <b>Evident Migration</b> – Analytical data or observable evidence indicates that contamination in the groundwater is moving or has moved away from the source area   | <b>Identified Receptor</b> – There is a threatened water supply well downgradient of the source and the groundwater is a current source of drinking water or source of water for other beneficial uses such as irrigation/agriculture |
| Medium | <b>Moderate Contaminant Levels</b><br>Sum of Ratios = 2 – 100 | <b>Potential Migration</b> – Contamination in the groundwater has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined | <b>Potential Receptor</b> – There is no threatened water supply well downgradient of the source and the groundwater is currently or potentially usable for drinking water, irrigation, or agriculture                                 |
| Low    | <b>Minimal Contaminant Levels</b><br>Sum of Ratios < 2        | <b>Confined Migration</b> – Information indicates that the potential for contaminant migration from the source via the groundwater is limited  | <b>Limited Receptor</b> – There is no potentially threatened water supply well downgradient of the source and the groundwater is not considered a potential source of drinking water and is of limited beneficial use                 |





# Groundwater Evaluation Scoring

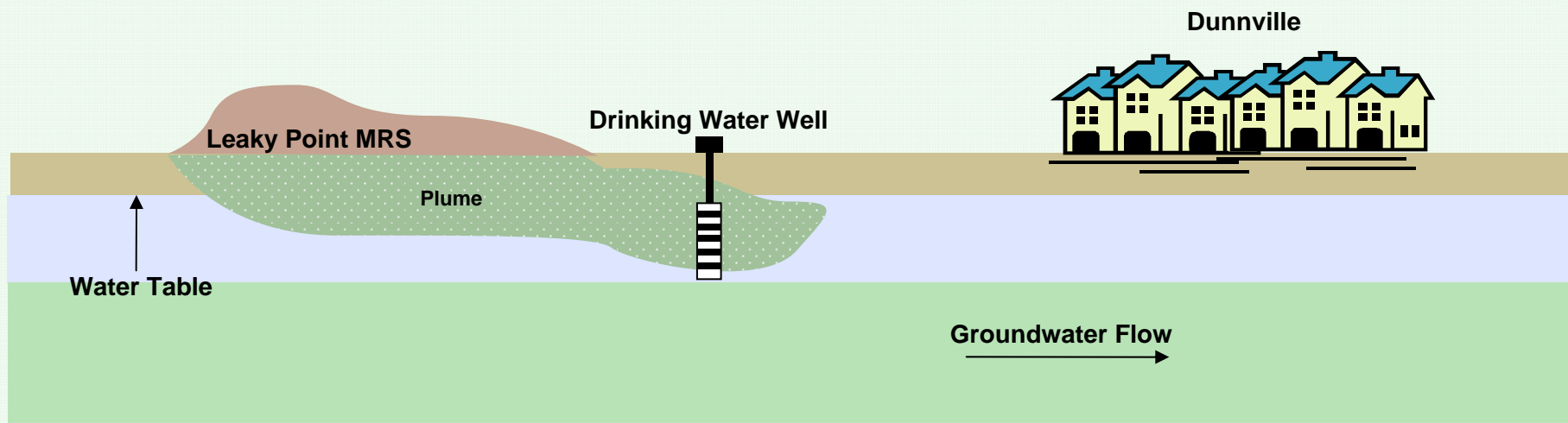
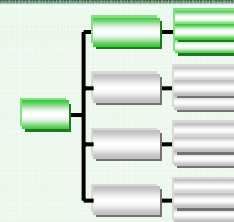


- For each of the three factors, scoring should determine a High (H), Medium (M), or Low (L) value
- Completion of the groundwater pathway evaluation will provide a combination of the three factor values (e.g., HLL, HML, MLL)



# Groundwater Evaluation – Example

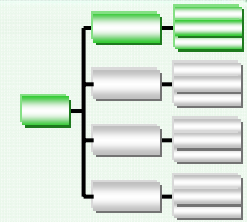
- Leaky Point MRS is a former range where UXO, DMM, and MC are known to be present
- The closest town (Dunnville - population 1,534) is one mile downgradient. Groundwater pumped from two nearby wells is the sole source of water supply for the entire population





# Groundwater Evaluation – Example (cont)

- Groundwater monitoring wells installed 100 feet downgradient of the landfill boundary contain the following –
  - ◆ Arsenic – 9.00  $\mu\text{g/L}$
  - ◆ PCBs – 4.08  $\mu\text{g/L}$
  - ◆ RDX – 38.0  $\mu\text{g/L}$
- Arsenic occurs naturally in the local groundwater at concentrations of 5-15  $\mu\text{g/L}$
- The comparison values (See Primer, Appendix B) for the contaminants present at the MRS are as follows –
  - ◆ Arsenic – 4.50  $\mu\text{g/L}$
  - ◆ PCBs – 3.30  $\mu\text{g/L}$
  - ◆ RDX – 61.0  $\mu\text{g/L}$



**How should we complete Table 21?**



**Table 21**

**HHE Module: Groundwater Data Element Table**

**Contaminant Hazard Factor (CHF)**

**DIRECTIONS:** Record the **maximum concentrations** of all contaminants in the MRS's groundwater and their **comparison values** (from Appendix B of the Primer) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the CHF by adding the contaminant ratios together, including any additional groundwater contaminants recorded on Table 27. Based on the CHF, use the CHF Scale to determine and record the CHF Value. If there is no known or suspected MC hazard present in the groundwater, select the box at the bottom of the table.

| Contaminant   | Maximum Concentration (µg/L)  | Comparison Value (µg/L)  | Ratios                   |
|---|---|--|--------------------------|
| PCBs  | 4.08 µg/L   | 3.30 µg/L  | 1.24                     |
| RDX   | 38.0 µg/L   | 61.0 µg/L  | 0.623                    |
| CHF Scale   | CHF Value   | Sum The Ratios   | 1.86                     |
| CHF > 100   | H (High)  | $CHF = \sum \frac{[\text{Maximum Concentration of Contaminant}]}{[\text{Comparison Value for Contaminant}]}$ |                          |
| 100 > CHF > 2   | M (Medium)  |  |                          |
| 2 > CHF   | L (Low)   |  |                          |
| CONTAMINANT HAZARD FACTOR   | DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H).  |  | L                        |
| <b>Migratory Pathway Factor</b>   |   |  |                          |
| DIRECTIONS: Circle the value that corresponds most closely to the groundwater migratory pathway at the MRS. |   |  |                          |
| Classification  | Description   | Value  |                          |
| Evident   | Analytical data or observable evidence indicates that contamination in the groundwater is present at, moving toward, or has moved to a point of exposure.   | H  |                          |
| Potential   | Contamination in groundwater has moved only slightly beyond the source (i.e., tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.   | M  |                          |
| Confined  | Information indicates a low potential for contaminant migration from the source via the groundwater to a potential point of exposure (possibly due to the presence of geological structures or physical controls).  | L  |                          |
| MIGRATORY PATHWAY FACTOR  | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).   |  | H                        |
| <b>Receptor Factor</b>  |   |  |                          |
| DIRECTIONS: Circle the value that corresponds most closely to the groundwater receptors at the MRS.         |   |  |                          |
| Classification  | Description   | Value  |                          |
| Identified  | There is a threatened water supply well downgradient of the source and the groundwater is a current source of drinking water or source of water for other beneficial uses such as irrigation/agriculture (equivalent to Class I or IIA aquifer).                              | H  |                          |
| Potential   | There is no threatened water supply well downgradient of the source and the groundwater is currently or potentially usable for drinking water, irrigation, or agriculture (equivalent to Class I, IIA, or IIB aquifer).   | M  |                          |
| Limited   | There is no potentially threatened water supply well downgradient of the source and the groundwater is not considered a potential source of drinking water and is of limited beneficial use (equivalent to Class IIIA or IIIB aquifer, or where perched aquifer exists only). | L  |                          |
| RECEPTOR FACTOR   | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).   |  | H                        |
| No Known or Suspected Groundwater MC Hazard   |   |  | <input type="checkbox"/> |

List the names and maximum concentrations of all MC and associated contaminants

List the associated comparison values from Appendix B of Primer

Calculate the ratio for each contaminant

Calculate the sum of the ratios

Circle the CHF Value that corresponds to the sum of ratios

Record the value

Circle the value for the Migration Pathway Factor

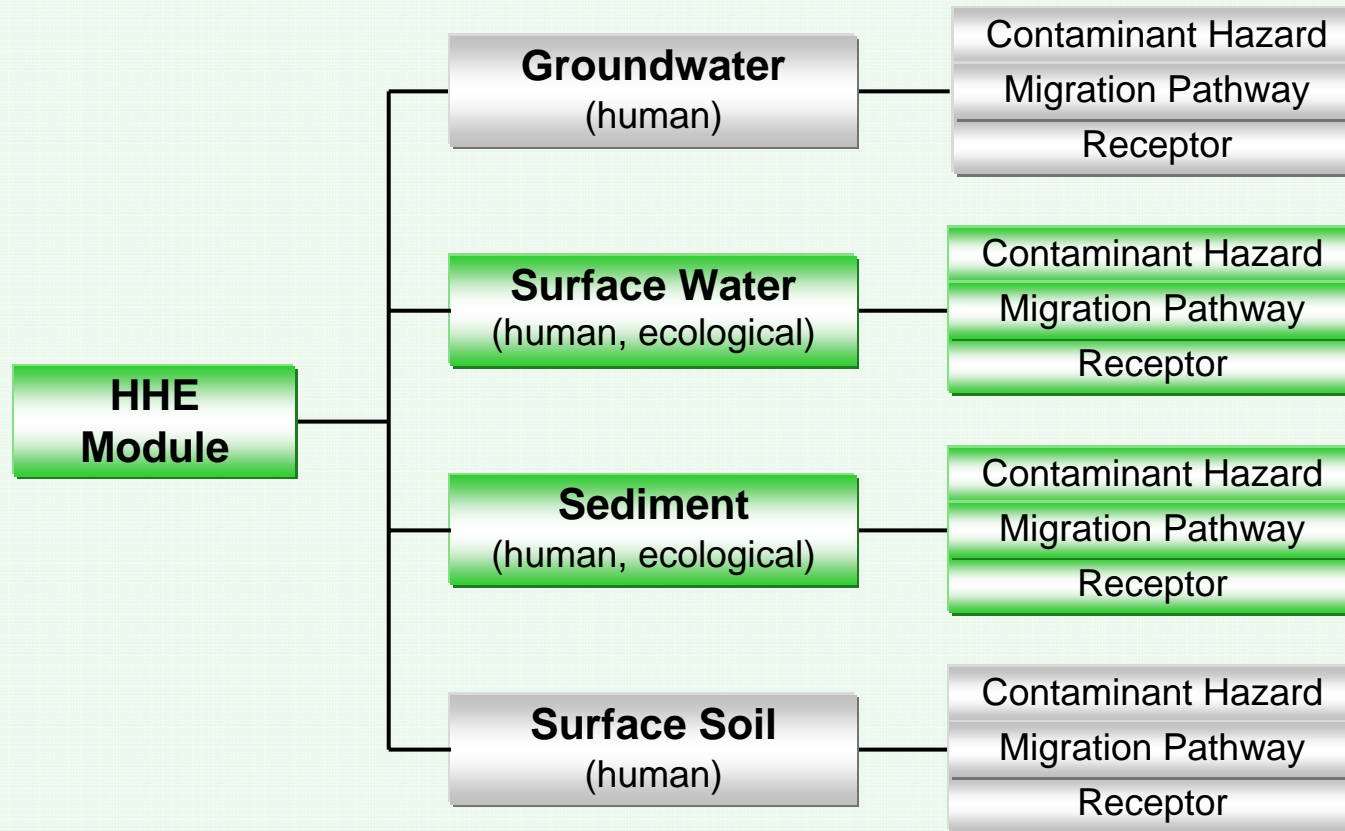
Record the value

Circle the value for the Receptor Factor

Record the value

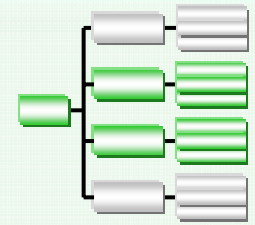


# Surface Water/Sediment Evaluation Structure



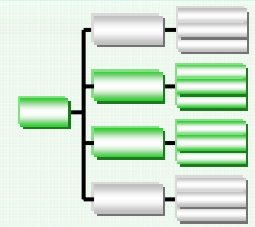
# Surface Water/Sediment Evaluation (cont)

- Definitions revisited –
  - ◆ Surface water is precipitation that collects in surface water bodies, like oceans, lakes, or streams, or groundwater that discharges to the surface from springs
  - ◆ Sediments form from the deposition of solid material, including the clays and silts on the bottom of an ocean, lake, or stream
- Use either surface water or sediment, which potentially affect the same receptors, to document the presence and migration of contaminants
- Data do not have to be collected at the MRS, but any samples to be evaluated should be attributable to the MRS





# Surface Water/Sediment Evaluation (cont)



- Review the most representative analytical MRS data to determine MC and other contaminants attributable to the MRS and detected in the surface water or sediment at or near the MRS
- Utilize available documentation such as topographical maps, preliminary assessments, or site inspections of the MRS and surrounding area to identify –
  - ◆ Surface water or topographic features potentially affected by MRS
  - ◆ Human and/or ecological receptors
  - ◆ Migration pathways to human and ecological receptors



# Surface Water/Sediment Tables

- The process for completing the module scoring tables for surface water/sediment is identical to that described for groundwater
  - ◆ Enter surface water data for human receptors on Table 22, and ecological receptors on Table 23
  - ◆ Enter sediment data for human receptors on Table 24, and ecological receptors on Table 25

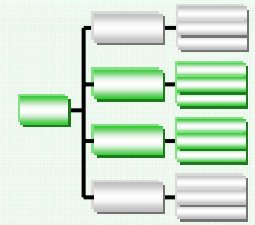




# Surface Water/Sediment Evaluation Hints

## ■ Contaminant Hazard Factor –

- ◆ Comparison values are based on ambient water quality criteria for ecological receptors
- ◆ Sediment screening values were developed in part by EPA's Equilibrium Partitionary Sediment Benchmarks



## ■ Migration Pathway Factor –

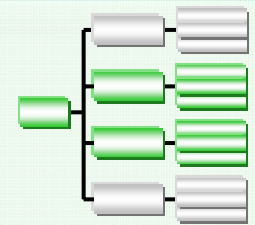
- ◆ Contaminants are confined when transport from the MRS is restricted
  - Engineered controls effectively interrupt transport of contamination to surface water
  - Implemented removal or remedial actions restrict the movement of contaminants away from the source
  - Contaminant source is below ground surface and not subject to erosion or interaction with surface water
  - Topographic conditions prevent surface water from leaving the immediate area of the MRS
- ◆ Man-made structures (e.g., a lake) may separate the source from the receptor, but do not imply confined condition



# Surface Water/Sediment Evaluation Hints (cont)

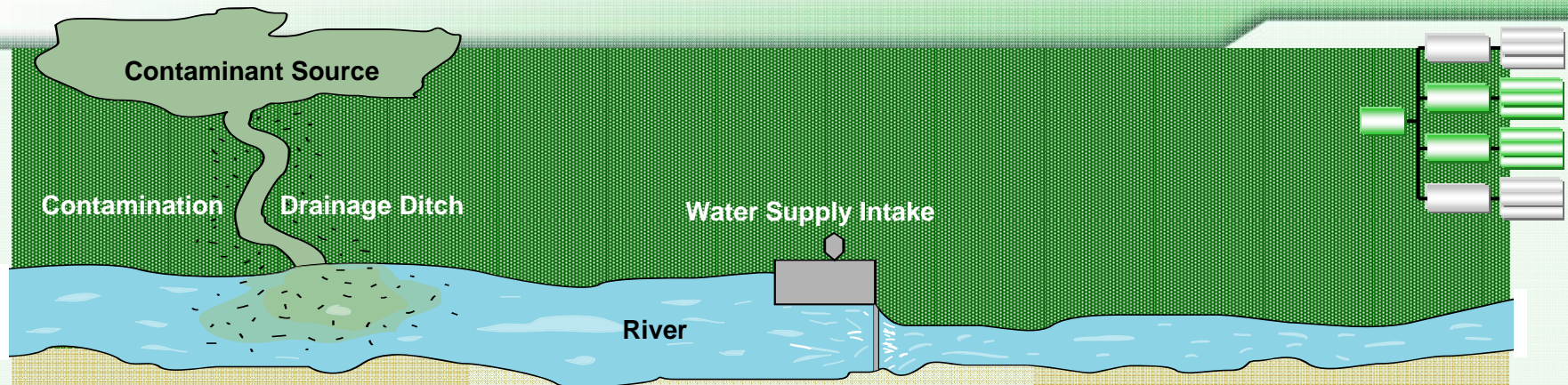
## ■ Receptor Factor –

- ◆ Ecological receptors are limited to critical habitats and other environments that could reasonably be impacted by the MRS (see Primer, Figure 7.14)
- ◆ Human exposure to contaminated surface water/sediment can occur via –
  - Drinking water
  - Ingestion during recreational activities
  - Dermal contact
  - Consumption of aquatic species
  - Watering livestock or irrigating food crops





# Surface Water/Sediment Evaluation



## Contaminant Hazard Factor –

## Migration Pathway Factor –

## Receptor Factor –

**High**

**Significant Contaminant Levels**  
Sum of Ratios > 100

**Evident Migration** – Analytical data or observable evidence indicates that contamination is present at a point of exposure

**Identified Receptor** – Identified receptors have access to media to which contamination has moved or can move

**Medium**

**Moderate Contaminant Levels**  
Sum of Ratios = 2 – 100

**Potential Migration** – Information suggests that contamination has moved slightly beyond the source area but is not moving appreciably; there is insufficient information to support *Evident* or *Confined* ratings

**Potential Receptor** – Potential for receptors to have access to media to which contamination has moved or can move

**Low**

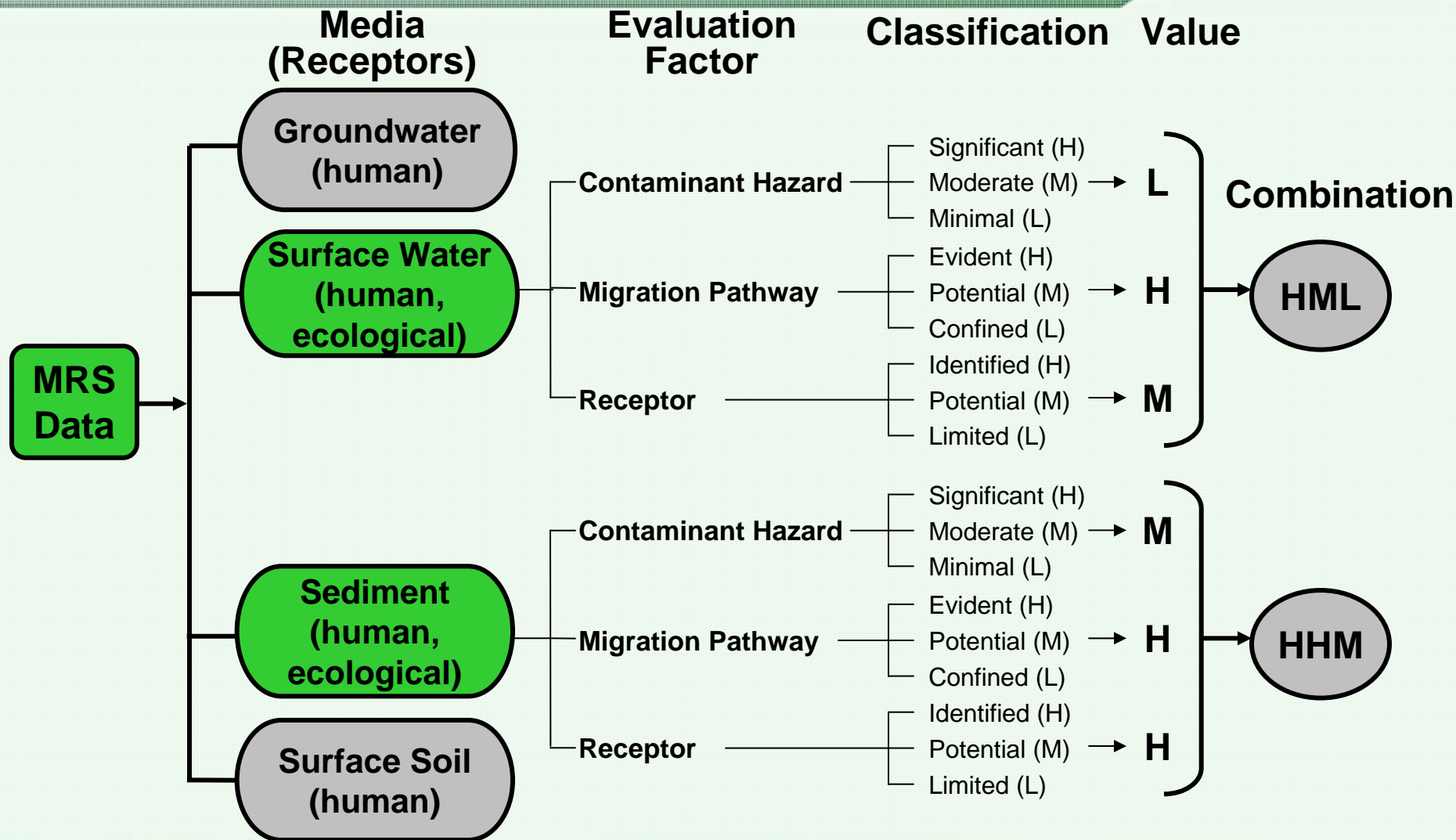
**Minimal Contaminant Levels**  
Sum of Ratios < 2

**Confined Migration** – Information indicates a low potential for contaminant migration from the source to a potential point of exposure

**Limited Receptor** – Little or no potential for receptor to have access to media to which contamination has moved or can move

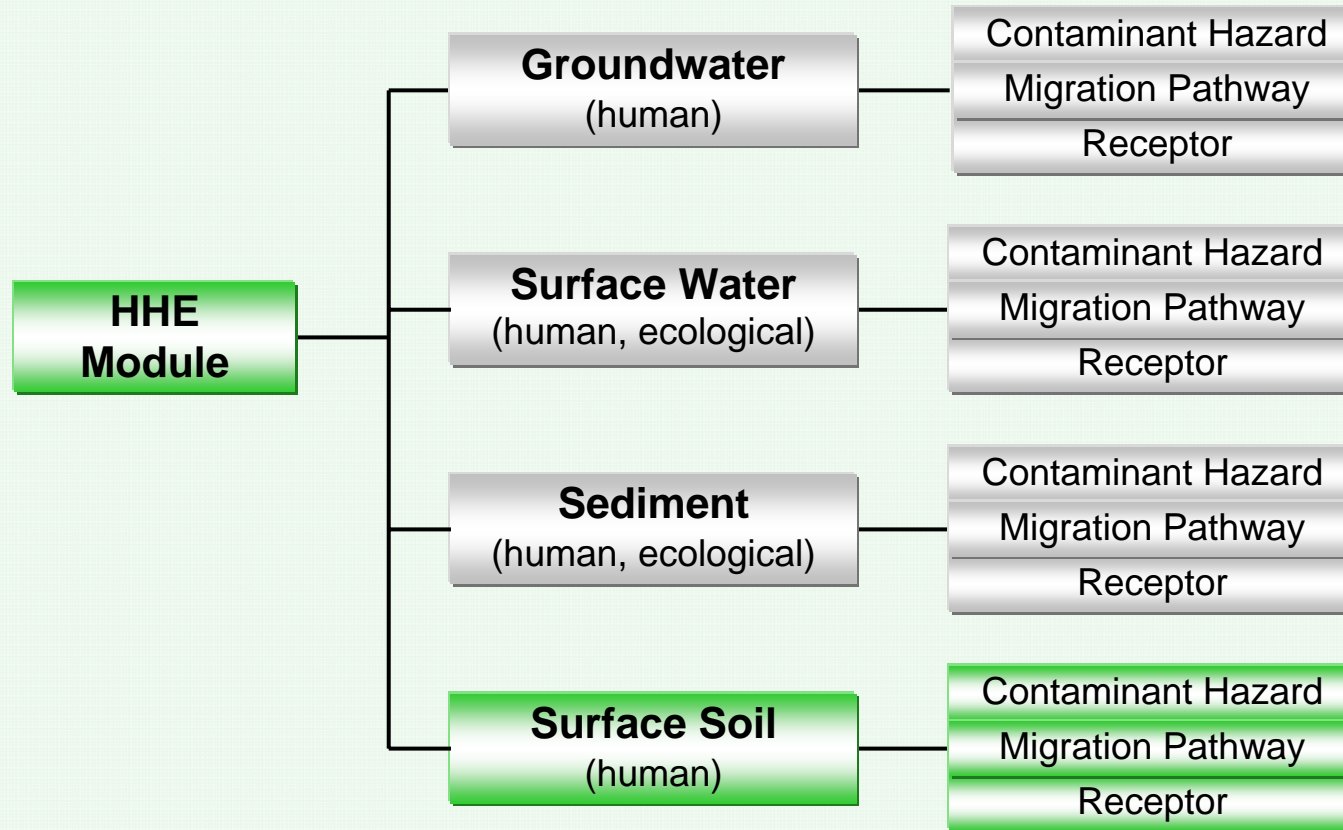


# Surface Water/Sediment Scoring



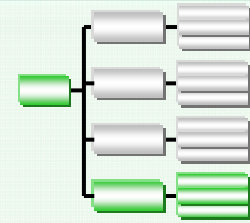


# Surface Soil Evaluation Structure



# Surface Soil Evaluation

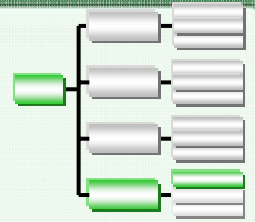
- Surface soil is the layer of soil on the surface
- Soil receptors include only those humans with the potential to come into contact with contaminated surface soils
- Samples collected from a depth of 0-6 inches should be used for this evaluation
  - ◆ Use results from up to 24 inches below ground surface (bgs), if no surface soil results are available
  - ◆ Contaminated soil that comes to the surface or is exposed so that humans can come into contact with it is treated as surface soil (e.g., through frost heave)
- Complete the module scoring tables the same way as groundwater and surface water/sediment



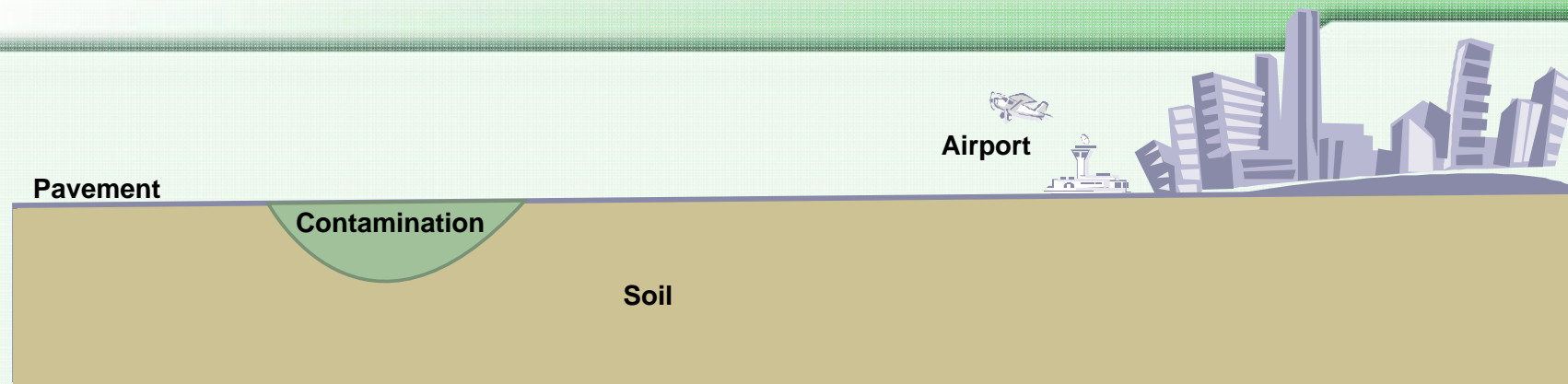
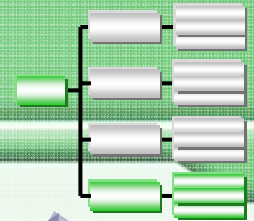


# Surface Soil Contaminant Hazard Factor

- Use the most representative analytical data to compare contaminant levels in surface soils with a potential for human exposure to the screening levels (see Primer, Appendix B)
- To attribute the contaminants to the MRS, observed concentrations must be distinguished from background concentrations
- Contaminants in soils with a potential for ecological exposure are not evaluated because comparison values for these contaminants are generally not available



# Surface Soil Evaluation

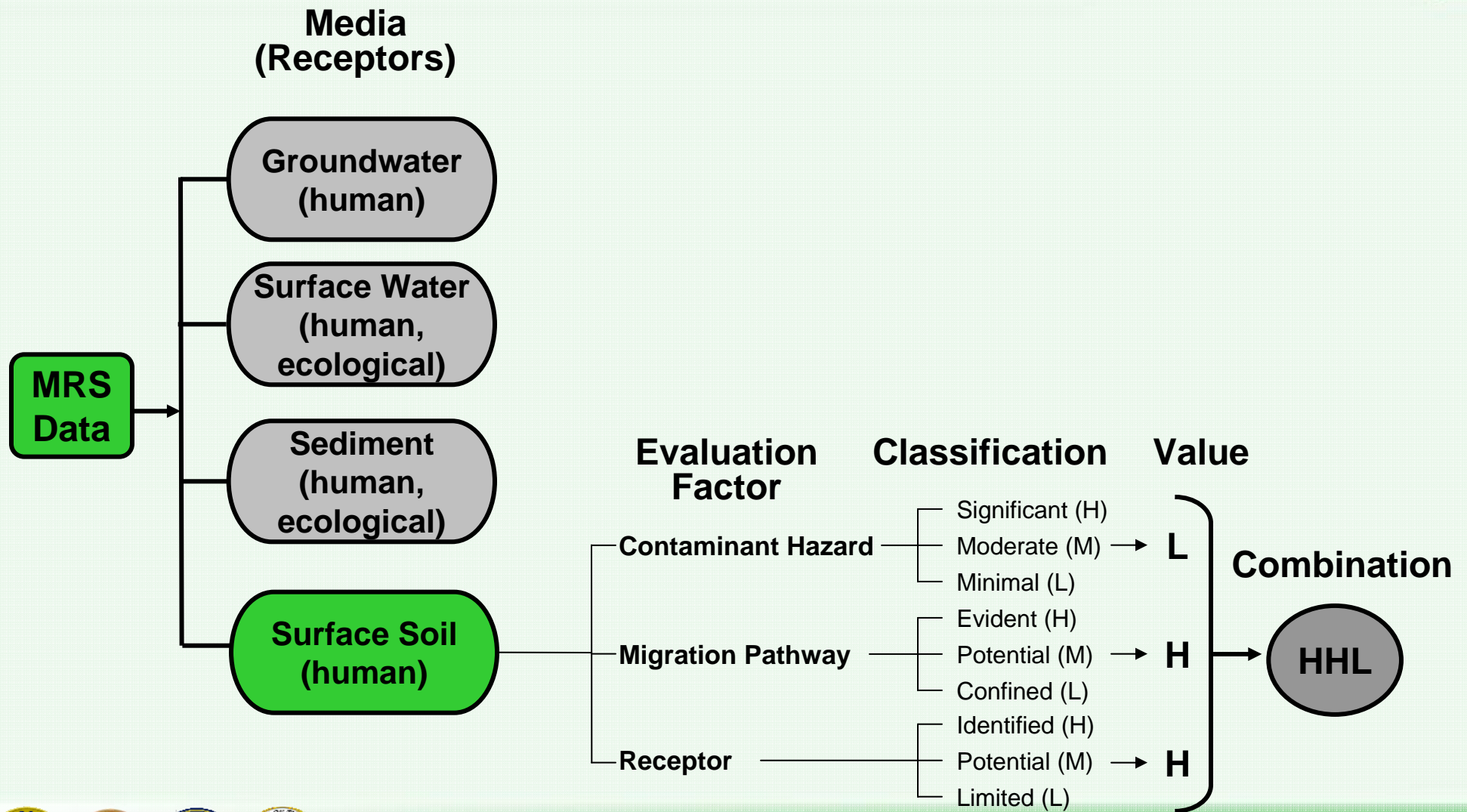


|               | <b>Contaminant Hazard Factor –</b>                            | <b>Migration Pathway Factor –</b>   | <b>Receptor Factor –</b>   |
|---------------|---|---|--|
| <b>High</b>   | <b>Significant Contaminant Levels</b><br>Sum of Ratios > 100  | <b>Evident Migration</b> – Analytical data or observable evidence indicates that contamination in the surface soil is present, moving toward or has moved to a point of exposure                                    | <b>Identified Receptor</b> – Receptors identified have access to contaminated soil                 |
| <b>Medium</b> | <b>Moderate Contaminant Levels</b><br>Sum of Ratios = 2 – 100 | <b>Potential Migration</b> – Contamination has moved slightly beyond the source, could move but is not moving appreciably or there is insufficient information to support <i>Evident</i> or <i>Confined</i> ratings | <b>Potential Receptor</b> – Potential for receptors to have access to contaminated soil            |
| <b>Low</b>    | <b>Minimal Contaminant Levels</b><br>Sum of Ratios < 2        | <b>Confined Migration</b> – Low possibility for contamination to be present or migrate to a point of exposure   | <b>Limited Receptor</b> – Little or no potential for receptors to have access to contaminated soil |



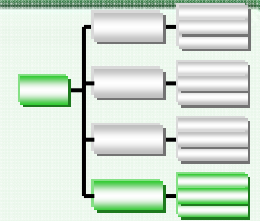


# Surface Soil Scoring

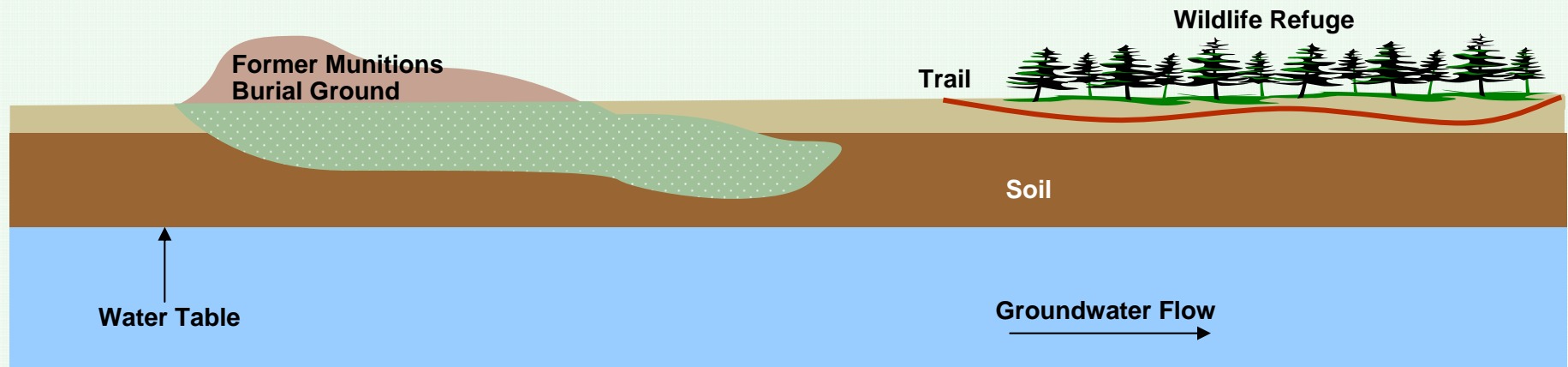


# Surface Soil Evaluation – Example

- At a former munitions burial ground, HMX has been identified in the surface soil (3,000 mg/kg)
- This area is part of the wildlife refuge and is habitat for the Simpson's deer, an endangered species
- Contamination has spread slightly toward a nearby popular hiking trail that follows the wildlife refuge



## How should we complete Table 26?





**Table 26**

**HHE Module: Surface Soil Data Element Table**

**Contaminant Hazard Factor (CHF)**

**DIRECTIONS:** Record the maximum concentrations of all contaminants in the MRS's surface soil and their comparison values (from Appendix B of the Primer) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the ratios for each contaminant by dividing the maximum concentration by the comparison value. Determine the CHF by adding the contaminant ratios together, including any additional surface soil contaminants recorded on Table 27. Based on the CHF, use the CHF Scale to determine and record the CHF Value. If there is no known or suspected MC hazard present in the surface soil, select the box at the bottom of the table.

| Contaminant | Maximum Concentration (mg/kg) | Comparison Value (mg/kg) | Ratio       |
|-------------|-------------------------------|--------------------------|-------------|
| <b>HMX</b>  | <b>3000 mg/kg</b>             | <b>1800 mg/kg</b>        | <b>1.67</b> |

| CHF Scale     | CHF Value      | Sum the Ratios |
|---------------|----------------|----------------|
| CHF > 100     | H (High)       | <b>1.67</b>    |
| 100 > CHF > 2 | M (Medium)     |                |
| 2 > CHF       | <b>L (Low)</b> |                |

**CONTAMINANT HAZARD FACTOR** DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H). **L**

**Migratory Pathway Factor**

**DIRECTIONS:** Circle the value that corresponds most closely to the surface soil migratory pathway at the MRS.

| Classification | Description  | Value    |
|----------------|--|----------|
| Evident        | Analytical data or observable evidence indicates that contamination in the surface soil is present at, moving toward, or has moved to a point of exposure.   | H        |
| Potential      | Contamination in surface soil has moved only slightly beyond the source (i.e., tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined. | <b>M</b> |
| Confined       | Information indicates a low potential for contaminant migration from the source via the surface soil to a potential point of exposure (possibly due to the presence of geological structures or physical controls).      | L        |

**MIGRATORY PATHWAY FACTOR** DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H). **M**

**Receptor Factor**

**DIRECTIONS:** Circle the value that corresponds most closely to the surface soil receptors at the MRS.

| Classification | Description   | Value    |
|----------------|---|----------|
| Identified     | Identified receptors have access to surface soil to which contamination has moved or can move.                    | <b>H</b> |
| Potential      | Potential for receptors to have access to surface soil to which contamination has moved or can move.              | M        |
| Limited        | Little or no potential for receptors to have access to surface soil to which contamination has moved or can move. | L        |

**RECEPTOR FACTOR** DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H). **H**

No Known or Suspected Surface Soil MC Hazard

List the names and maximum concentrations of all MC and associated contaminants

List the associated comparison values from Appendix B of Primer

Calculate the ratio for each contaminant

Calculate the sum of the ratios

Circle the value for CHF that corresponds to the sum of the ratios

Record the value

Circle the value for the Migration Pathway Factor

Record the value

Circle the value for the Receptor Factor

Record the value

# Determining the HHE Module Rating

- Each three-letter combination of the environmental media corresponds to a letter rating
- The A-G ratings represents the HHE relative risk at the MRS with 'A' having the highest risk and 'G' having the lowest risk
- The highest pathway (medium) rating is the HHE Module Rating
- The module can also receive one of three alternative module ratings –
  - ◆ Evaluation Pending
  - ◆ No Longer Required
  - ◆ No Known or Suspected MC Hazard

| HHE Module Ratings |        |
|--------------------|--------|
| Combination        | Rating |
| HHH                | A      |
| HHM                | B      |
| HHL                | C      |
| HMM                | C      |
| HML                | D      |
| MMM                | D      |
| HLL                | E      |
| MML                | E      |
| MLL                | F      |
| LLL                | G      |





**Table 28**  
**Determining the HHE Module Rating**

**DIRECTIONS:**

1. Record the letter values (H, M, L) for the **Contaminant Hazard, Migration Pathway, and Receptor Factors** for the media (from Tables 21–26) in the corresponding boxes below.
2. Record the media's three letter combinations in the **Three Letter Combination** boxes below (three letter combinations are arranged from Hs to Ms to Ls).
3. Using the **HHE Ratings** provided below, determine each media's rating (A–G) and record the letter in the corresponding **Media Rating** box below.

| Media (Source)                               | Contaminant Hazard Factor Value | Migratory Pathway Factor Value | Receptor Factor Value | Three Letter Combination (HsMs Ls) | Media Rating (AG) |
|--|---------------------------------|--------------------------------|-----------------------|------------------------------------|-------------------|
| Groundwater (Table 21)                       |                                 |                                |                       |                                    |                   |
| Surface Water/Human Endpoint (Table 22)      | L                               | H                              | H                     | HHL                                | C                 |
| Sediment/Human Endpoint (Table 23)           |                                 |                                |                       |                                    |                   |
| Surface Water/Ecological Endpoint (Table 24) | M                               | H                              | H                     | HHM                                | B                 |
| Sediment/Ecological Endpoint (Table 25)      |                                 |                                |                       |                                    |                   |
| Surface Soil (Table 26)                      |                                 |                                |                       |                                    |                   |

Record the scores for each factor of each relevant medium

Arrange the factor values for each medium from highest (H) to lowest (L) to determine the three-letter combination

Use the HHE Module Rating reference section below to determine the appropriate Media Rating

Record the highest Media Rating from above. This is the HHE Module Rating

**DIRECTIONS (cont.):**

4. Select the single highest Media Rating (A is highest; G is lowest) and enter the letter in the **HHE Module Rating** box.

**Note:**

An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more media, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.

| HHE MODULE RATING                |                                 |
|----------------------------------|---------------------------------|
| B                                |                                 |
| HHE Ratings (for reference only) |                                 |
| Combination                      | Rating                          |
| HHH                              | A                               |
| HHM                              | B                               |
| HHL                              | C                               |
| HMM                              |                                 |
| HML                              | D                               |
| MMM                              |                                 |
| HLL                              | E                               |
| MML                              |                                 |
| MLL                              | F                               |
| LLL                              | G                               |
| Alternative Module Ratings       | Evaluation Pending              |
|                                  | No Longer Required              |
|                                  | No Known or Suspected MC Hazard |

# Health Hazard Evaluation Module

## Questions?





# Camp Swampy Example

- Former Camp Swampy is located about four miles from the Gulf of Mexico. The Swampy River flows through the Camp and discharges into the Gulf. The river is frequently used for recreational purposes
- The MRS is located on the eastern portion of the former Camp Swampy. The MRS is a state wildlife refuge containing three endangered species. The MRS is partially fenced and unmonitored
- The western half of Camp Swampy was sold to Swampy Inc. in 1993 and is surrounded by an electric fence
- The northern half of the Camp Swampy MRS contains 12 unused buildings, but a town with 600 houses and a population density of 125 people per square mile is only 1 mile away



# Camp Swampy Example

- The following MC contaminants were identified in the Swampy River and attributed to the OB/OD site—
  - ◆ White Phosphorous – 0.50 µg/L
  - ◆ Copper – 20.2 µg/L
- No other contamination was found in samples taken from groundwater, sediments, or surface soils
- Potential for human and wildlife exposure is high because the Swampy River flows through a state wildlife refuge





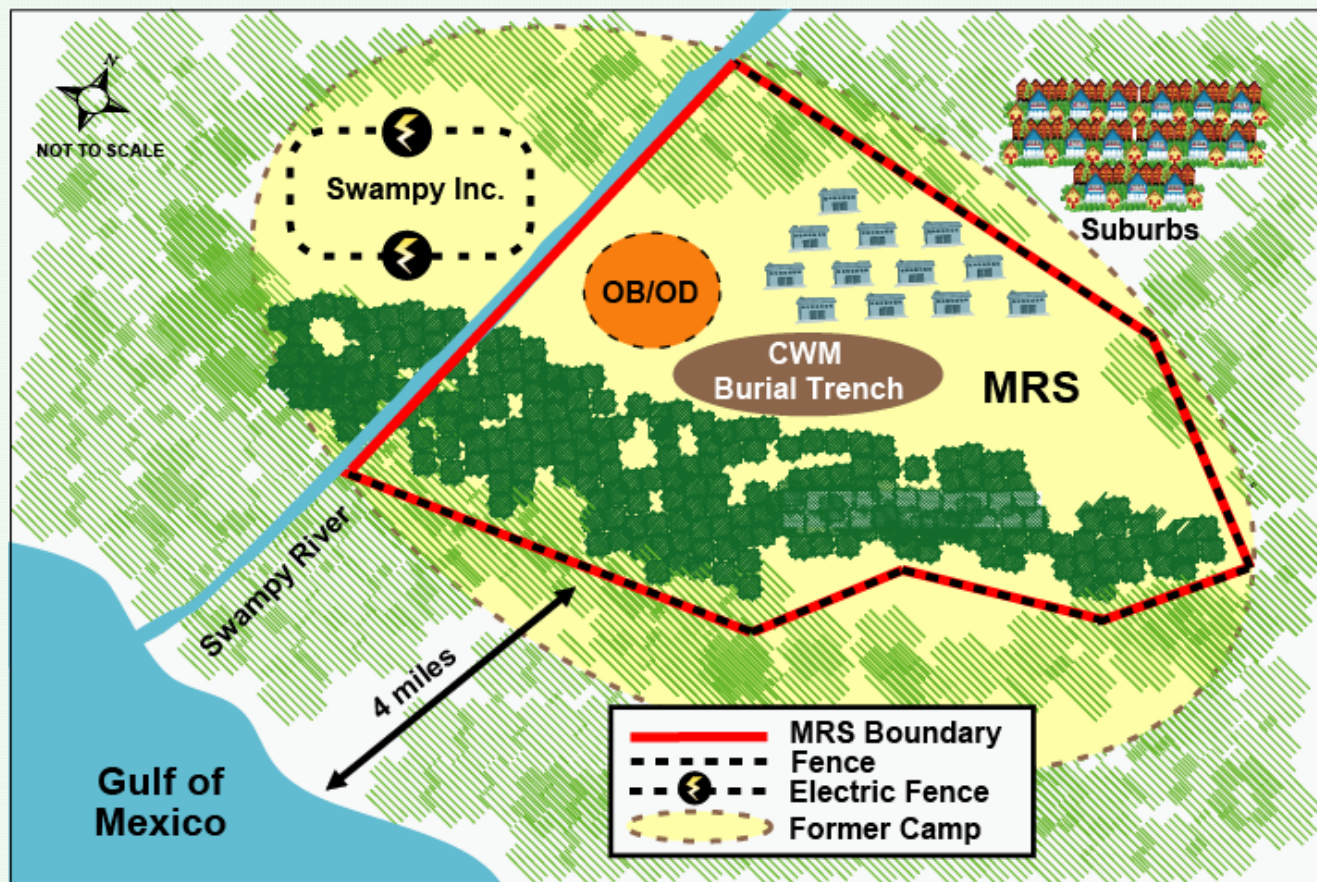
# Camp Swampy Example

- Comparison values for freshwater exposure of MC contaminants to human receptors
  - ◆ White Phosphorus – 0.73  $\mu\text{g/L}$  (water)\*
  - ◆ Copper – 1500.0  $\mu\text{g/L}$  (water)\*
- Comparison values for freshwater exposure of MC contaminants to ecological receptors
  - ◆ White Phosphorus – 0.10  $\mu\text{g/L}$  (water)\*
  - ◆ Copper – 3.10  $\mu\text{g/L}$  (water)\*





# Camp Swampy Example



Evaluating surface water for human and ecological receptors, what is the HHE Module Rating at Camp Swampy?





**Table 22**

**HHE Module: Surface Water – Human Endpoint Data Element Table**

Contaminant Hazard Factor (CHF)

**DIRECTIONS:** Record the **maximum concentrations** of all contaminants in the MRS's surface water and their **comparison values** (from Appendix B of the Primer) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the CHF by adding the **contaminant ratios** together, including any additional surface water contaminants recorded on Table 27. Based on the CHF, use the CHF Scale to determine and record the CHF Value. If there is no known or suspected MC hazard with human endpoints present in the surface water, select the box at the bottom of the table.

| Contaminant      | Maximum Concentration (µg/L) | Comparison Value (µg/L) | Ratios |
|------------------|------------------------------|-------------------------|--------|
| White Phosphorus | 0.50 µg/L                    | 0.73 µg/L               | 0.68   |
| Copper           | 20.2 µg/L                    | 1500.0 µg/L             | 0.01   |

| CHF Scale     | CHF Value  | Sum The Ratios   | CHF Value |
|---------------|------------|--|-----------|
| CHF > 100     | H (High)   | $CHF = \sum \frac{[\text{Maximum Concentration of Contaminant}]}{[\text{Comparison Value for Contaminant}]}$ | 0.69      |
| 100 > CHF > 2 | M (Medium) |  |           |
| 2 > CHF       | L (Low)    |  |           |

|                                  |  |          |
|----------------------------------|--|----------|
| <b>CONTAMINANT HAZARD FACTOR</b> | <b>DIRECTIONS:</b> Record <u>the CHF Value</u> from above in the box to the right (maximum value = H). | <b>L</b> |
|----------------------------------|--|----------|

Migratory Pathway Factor

**DIRECTIONS:** Circle the value that corresponds most closely to the surface water migratory pathway at the MRS.

| Classification | Description   | Value |
|----------------|---|-------|
| Evident        | Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.   | H     |
| Potential      | Contamination in surface water has moved only slightly beyond the source (i.e., tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined. | M     |
| Confined       | Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to the presence of geological structures or physical controls).      | L     |

|                                 |   |          |
|---------------------------------|---|----------|
| <b>MIGRATORY PATHWAY FACTOR</b> | <b>DIRECTIONS:</b> Record <u>the single highest value</u> from above in the box to the right (maximum value = H). | <b>H</b> |
|---------------------------------|---|----------|

Receptor Factor

**DIRECTIONS:** Circle the value that corresponds most closely to the surface water receptors at the MRS.

| Classification | Description  | Value |
|----------------|--|-------|
| Identified     | Identified receptors have access to surface water to which contamination has moved or can move.                    | H     |
| Potential      | Potential for receptors to have access to surface water to which contamination has moved or can move.              | M     |
| Limited        | Little or no potential for receptors to have access to surface water to which contamination has moved or can move. | L     |

|                        |   |          |
|------------------------|---|----------|
| <b>RECEPTOR FACTOR</b> | <b>DIRECTIONS:</b> Record <u>the single highest value</u> from above in the box to the right (maximum value = H). | <b>H</b> |
|------------------------|---|----------|

|  |  |                          |
|--|--|--------------------------|
| No Known or Suspected Surface Water (Human Endpoint) MC Hazard |  | <input type="checkbox"/> |
|--|--|--------------------------|

Surface water for human receptors:

$$0.50 \mu\text{g/L} + 20.2 \mu\text{g/L} = 0.69$$

$$0.73 \mu\text{g/L} \quad 1500.0 \mu\text{g/L}$$

$$L = 2 > CHF$$

Contaminants are moving toward human receptors

Human receptors have access to surface water

**Table 24**

**HHE Module: Surface Water – Ecological Endpoint Data Element Table**

Contaminant Hazard Factor (CHF)

**DIRECTIONS:** Record the maximum concentrations of all contaminants in the MRS's surface water and their comparison values (from Appendix B of the Primer) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the ratios for each contaminant by dividing the maximum concentration by the comparison value. Determine the CHF by adding the contaminant ratios together, including any additional surface water contaminants recorded on Table 27. Based on the CHF, use the CHF Scale to determine and record the CHF Value. If there is no known or suspected MC hazard with ecological endpoints present in the surface water, select the box at the bottom of the table.

| Contaminant   | Maximum Concentration (µg/L)  | Comparison Value (µg/L)  | Ratios                   |
|---|---|--|--------------------------|
| White Phosphorus  | 0.50 µg/L   | 0.1 µg/L   | 5.0                      |
| Copper  | 20.2 µg/L   | 3.1 µg/L   | 6.5                      |
| CHF Scale   | CHF Value   | Sum the Ratios   | 11.5                     |
| CHF > 100   | H (High)  | $CHF = \sum \frac{[\text{Maximum Concentration of Contaminant}]}{[\text{Comparison Value for Contaminant}]}$ |                          |
| 100 > CHF > 2   | M (Medium)  |  |                          |
| 2 > CHF   | L (Low)   |  |                          |
| CONTAMINANT HAZARD FACTOR   | DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H).  |  | M                        |
| <u>Migratory Pathway Factor</u>   |   |  |                          |
| DIRECTIONS: Circle the value that corresponds most closely to the surface water migratory pathway at the MRS. |   |  |                          |
| Classification  | Description   | Value  |                          |
| Evident   | Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.   | H  |                          |
| Potential   | Contamination in surface water has moved only slightly beyond the source (i.e., tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined. | M  |                          |
| Confined  | Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to the presence of geological structures or physical controls).      | L  |                          |
| MIGRATORY PATHWAY FACTOR  | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).   |  | H                        |
| <u>Receptor Factor</u>  |   |  |                          |
| DIRECTIONS: Circle the value that corresponds most closely to the surface water receptors at the MRS.         |   |  |                          |
| Classification  | Description   | Value  |                          |
| Identified  | Identified receptors have access to surface water to which contamination has moved or can move.   | H  |                          |
| Potential   | Potential for receptors to have access to surface water to which contamination has moved or can move.   | M  |                          |
| Limited   | Little or no potential for receptors to have access to surface water to which contamination has moved or can move.  | L  |                          |
| RECEPTOR FACTOR   | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H).   |  | H                        |
| No Known or Suspected Surface Water (Ecological Endpoint) MC Hazard   |   |  | <input type="checkbox"/> |

Surface water for ecological receptors:

$$0.50 \mu\text{g/L} + 20.2 \mu\text{g/L} = 11.5$$

$$0.10 \mu\text{g/L} \quad 3.1 \mu\text{g/L}$$

$$M = 100 < CHF > 2$$

Contaminants are moving toward ecological receptors

Ecological receptors have access to surface water



**Table 28**  
Determining the HHE Module Rating

**DIRECTIONS:**

1. Record the letter values (H, M, L) for the **Contaminant Hazard, Migration Pathway, and Receptor Factors** for the media (from Tables 21–26) in the corresponding boxes below.
2. Record the media's three letter combinations in the **Three Letter Combination** boxes below (three letter combinations are arranged from Hs to Ms to Ls).
3. Using the **HHE Ratings** provided below, determine each media's rating (A–G) and record the letter in the corresponding **Media Rating** box below.

| Media (Source)                               | Contaminant Hazard Factor Value | Migratory Pathway Factor Value | Receptor Factor Value | Three Letter Combination (HsMs Ls) | Media Rating (AG) |
|--|---------------------------------|--------------------------------|-----------------------|------------------------------------|-------------------|
| Groundwater (Table 21)                       |                                 |                                |                       |                                    |                   |
| Surface Water/Human Endpoint (Table 22)      | L                               | H                              | H                     | HHL                                | C                 |
| Sediment/Human Endpoint (Table 23)           |                                 |                                |                       |                                    |                   |
| Surface Water/Ecological Endpoint (Table 24) | M                               | H                              | H                     | HHM                                | B                 |
| Sediment/Ecological Endpoint (Table 25)      |                                 |                                |                       |                                    |                   |
| Surface Soil (Table 26)                      |                                 |                                |                       |                                    |                   |

Record the scores for each factor of each relevant medium

Arrange the factor values for each medium from highest (H) to lowest (L) to determine the three-letter combination

Use the HHE Rating reference section below to determine the appropriate Media Rating

Record the highest Media Rating from above. This is the HHE Module Rating

**DIRECTIONS (cont.):**

4. Select the single highest Media Rating (A is highest; G is lowest) and enter the letter in the **HHE Module Rating** box.

**Note:**

An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more media, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.

| HHE MODULE RATING                |                                 |
|----------------------------------|---------------------------------|
| B                                |                                 |
| HHE Ratings (for reference only) |                                 |
| Combination                      | Rating                          |
| HHH                              | A                               |
| HHM                              | B                               |
| HHL                              | C                               |
| HMM                              |                                 |
| HML                              | D                               |
| MMM                              |                                 |
| HLL                              |                                 |
| MML                              | E                               |
| MLL                              |                                 |
| LLL                              | F                               |
| Alternative Module Ratings       | Evaluation Pending              |
|                                  | No Longer Required              |
|                                  | No Known or Suspected MC Hazard |