



Munitions Response Site Prioritization Protocol

Health Hazard Evaluation Module

2 February 2006



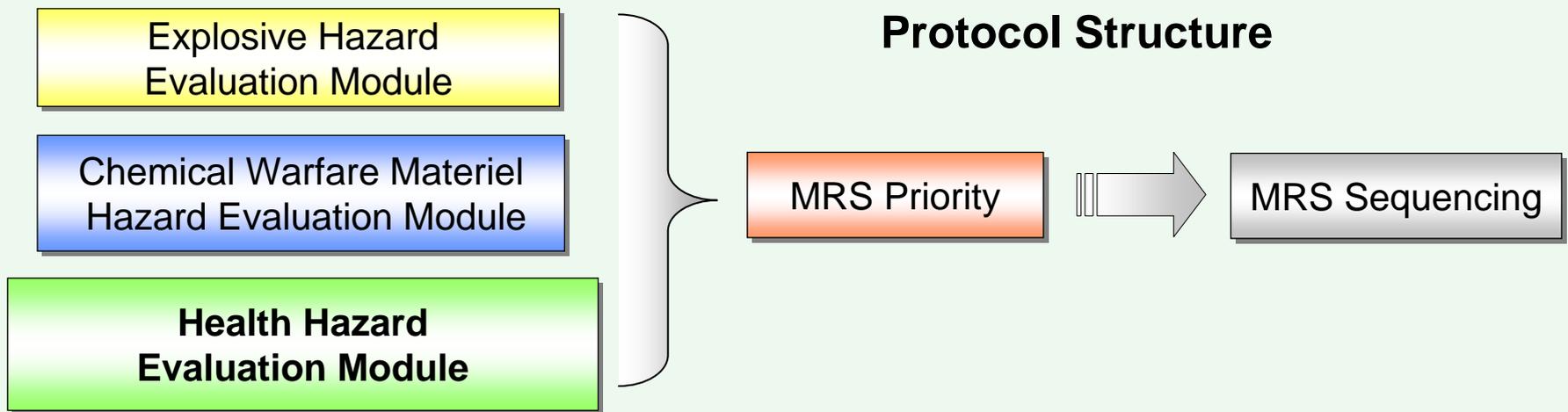
HHE Outline

- 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 Score, Rating, and Priority
- Camp Swampy – (fictitious site example)



HHE Module

- Provides a consistent DoD-wide approach for assigning a relative priority to munitions response sites (MRSs) where MC and any non-munitions related incidental 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

Munitions Constituents (MC) are any materials originating from UXO; 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)(4)]

Are these examples of munitions constituents?

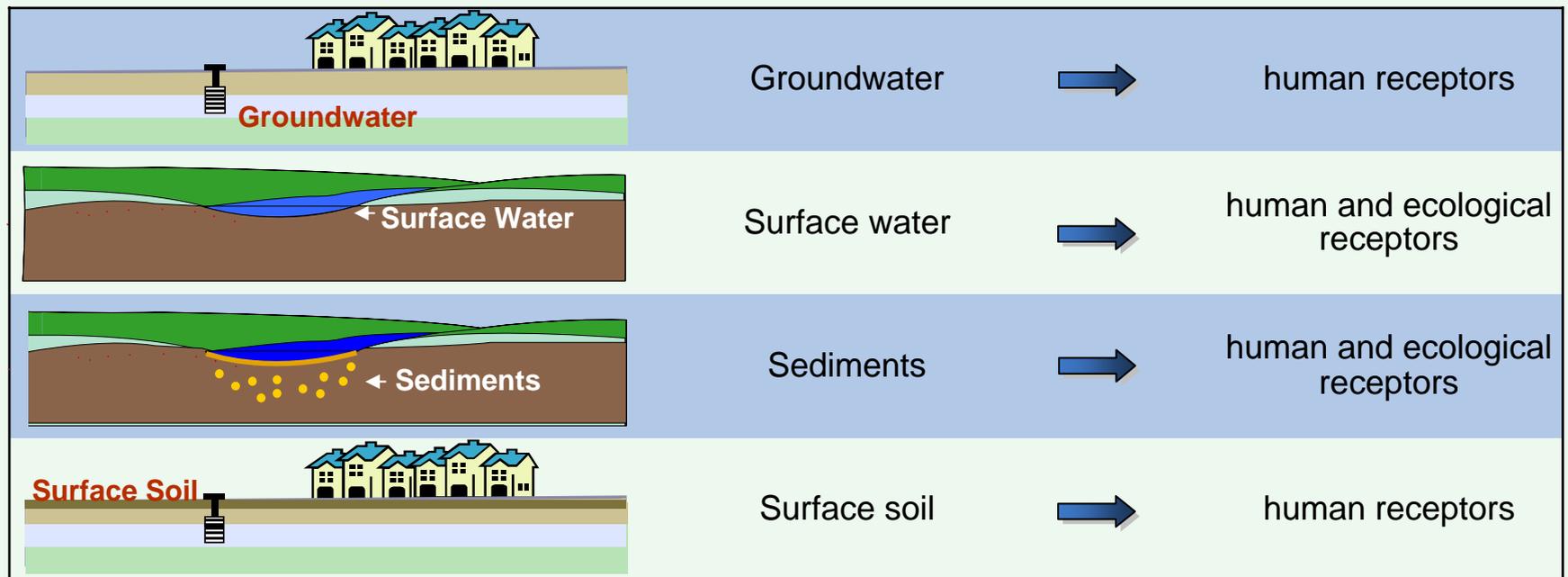


UXO Stockpile



Environmental Media in the HHE Module

- The HHE Module evaluates four environmental media and their receptor endpoints
- Surface water and sediment can be evaluated together because the contaminants potentially share the same migration pathway
- Without soil contamination, risk associated with air is considered minimal, therefore it is not considered in this module

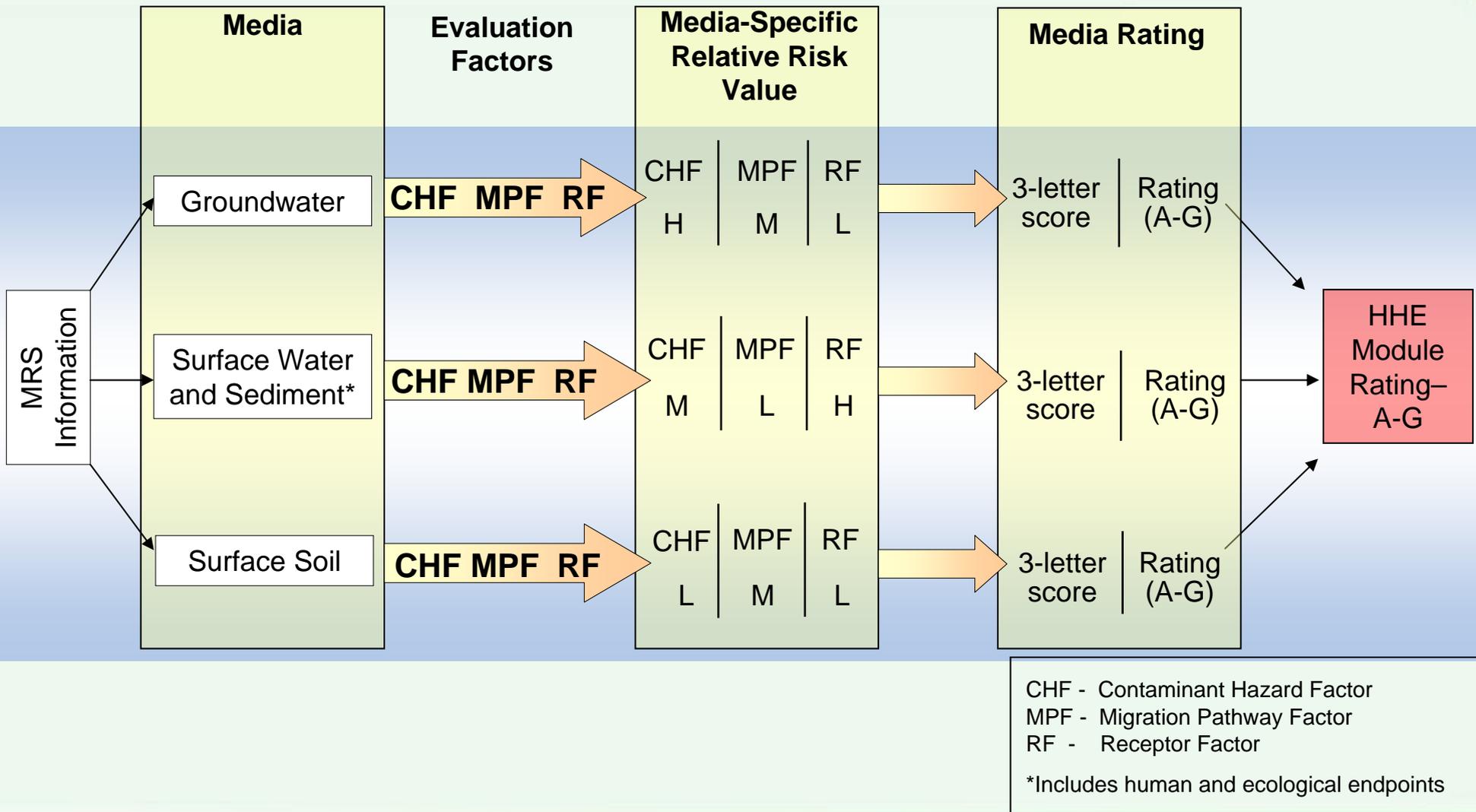


Environmental Media Defined

| | Definition | Human Receptors | Ecological Receptors |
|---------------|--|---|---|
| Groundwater | Groundwater is rain water 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 rain water 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 7.13 in the Primer |
| Sediment | Sediments are formed from the deposition of solid material that include the sand and soils 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



HHE Module Scoring

- Factors are valued High (H), Middle (M), or Low (L) based on established categories within the factor
- Values for the three evaluation factors (CF, 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) Moderate (M) Minimal (L) |
| Migration Pathway | Evident (H) Potential (M) Confined (L) |
| Receptors | Identified (H) Potential (M) Limited (L) |



**Table 23
HHE Module Ratings**

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



Contaminant Hazard Factor

- The CHF assesses the hazards to receptors from MC and any non-munitions related incidental contaminants in the four environmental media
- 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 1×10^{-4} carcinogen reference value (CRV) instead of the 1×10^{-6} value to assign a relative priority for action, *not* to assign a value for cleanup. DoD's use of 1×10^{-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

Table 21 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) 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 **ratios** for each medium together, including additional 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.

Note: Use dissolved, rather than total, metals analyses when both are available.

| Contaminant | Maximum Concentration (µg/l) | Comparison Value (µg/l) | Ratios |
|----------------------------------|--|--|--------|
| Arsenic | 24 µg/L | 4.5 µg/L | 5.33 |
| 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 (Middle) | | |
| 2 > CHF | L (Low) | | |
| CONTAMINANT HAZARD FACTOR | DIRECTIONS: Record the CHF Value 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

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) 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 **ratios** for each medium together, including additional 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.

Note: Use dissolved, rather than total, metals analyses when both are available.

| Contaminant | Maximum Concentration (µg/l) | Comparison Value (µg/l) | Ratios |
|----------------------------------|--|--|--------------|
| Arsenic | 24 µg/L | 4.5 µg/L | 5.333 |
| TCE | 1.75 µg/L | 2.8 µg/L | 0.625 |
| 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 (Middle) | | |
| 2 > CHF | L (Low) | | |
| CONTAMINANT HAZARD FACTOR | DIRECTIONS: Record <u>the CHF Value</u> from above in the box to the right (maximum value = H). | | M |

Record the sum of the ratios

Use the sum of the ratios to determine the CHF Value

Migration Pathway Factor

- The MPF assesses the likelihood of contaminant transport from the MRS
- Definitions, which differ somewhat by media, are grouped into three possible outcomes –

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



Receptor Factor

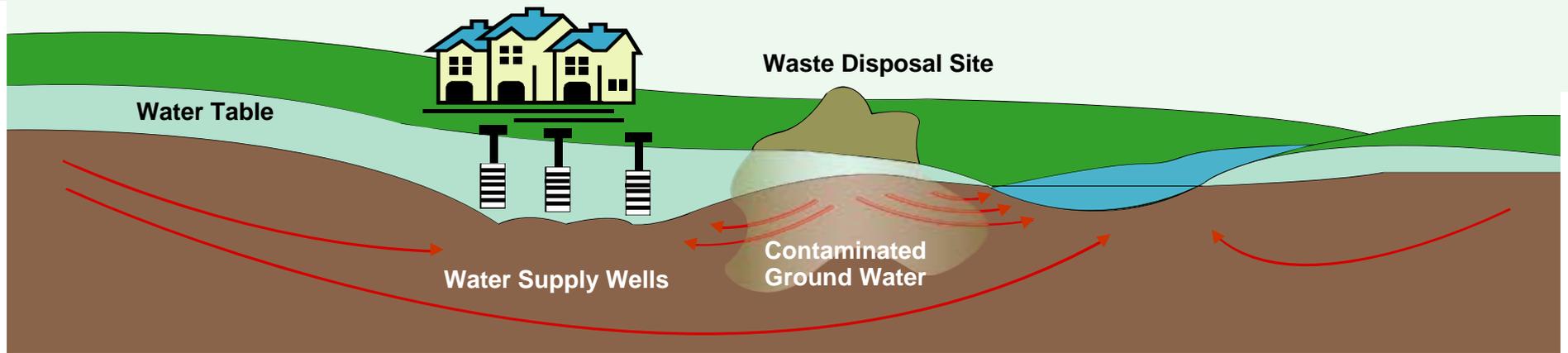
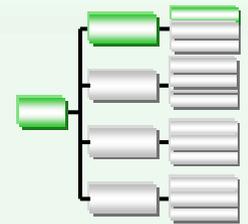
- The RF assesses the present or future likelihood that receptors will encounter MRS-specific contamination
- Definitions, which differ somewhat by media, are grouped into three possible outcomes –

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

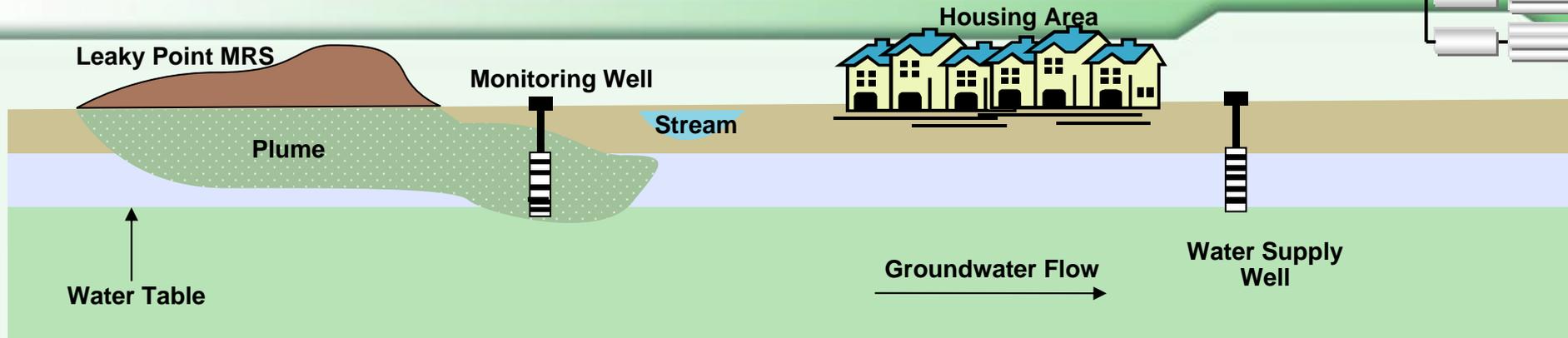


Groundwater – Contaminant Hazard Factor

- Some MC have the potential to contaminate groundwater and can pose a risk to humans
- 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

| | |
|---------------|--|
| High | Significant Contaminant Levels Sum of Ratios > 100 |
| Medium | Moderate Contaminant Levels Sum of Ratios 2 – 100 |
| Low | Minimal Contaminant Levels Sum of Ratios < 2 |

Migration Pathway Factor

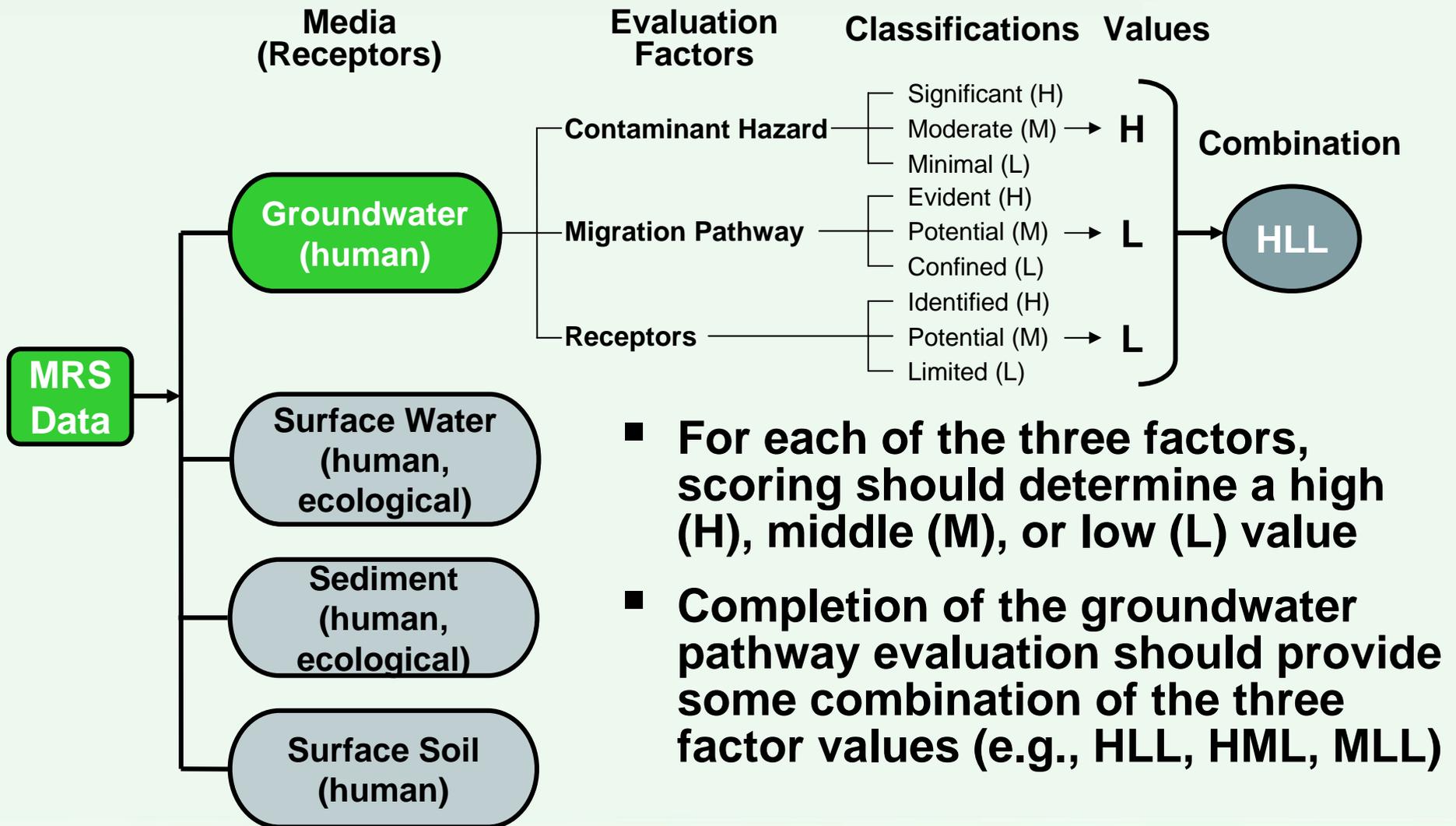
| |
|--|
| Evident Migration – Analytical data or observable evidence indicates that contamination in the groundwater is moving or has moved away from the source area |
| Potential Migration – Contamination in the groundwater has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined |
| Confined Migration – Information indicates that the potential for contaminant migration from the source via the groundwater is limited |

Receptor Factor

| |
|---|
| Identified Receptor – 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 |
| Potential Receptor – 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 |
| Limited Receptor – 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

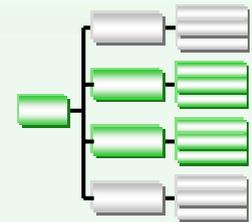


- For each of the three factors, scoring should determine a high (H), middle (M), or low (L) value
- Completion of the groundwater pathway evaluation should provide some combination of the three factor values (e.g., HLL, HML, MLL)

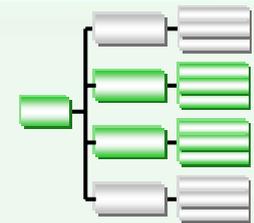


Surface Water/Sediment Evaluation

- Definitions revisited –
 - ◆ Surface water is rain water 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 sand and soils 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. These two media can be evaluated together because they potentially affect the same receptors
- 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 recent representative analytical MRS data to determine MC and other chemical 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



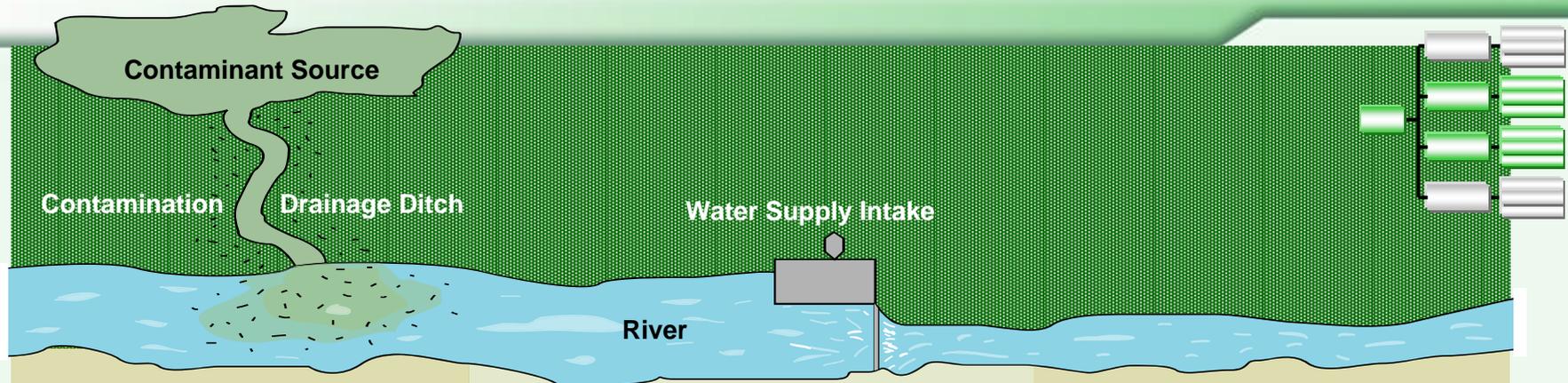
Surface Water/Sediment Tables

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



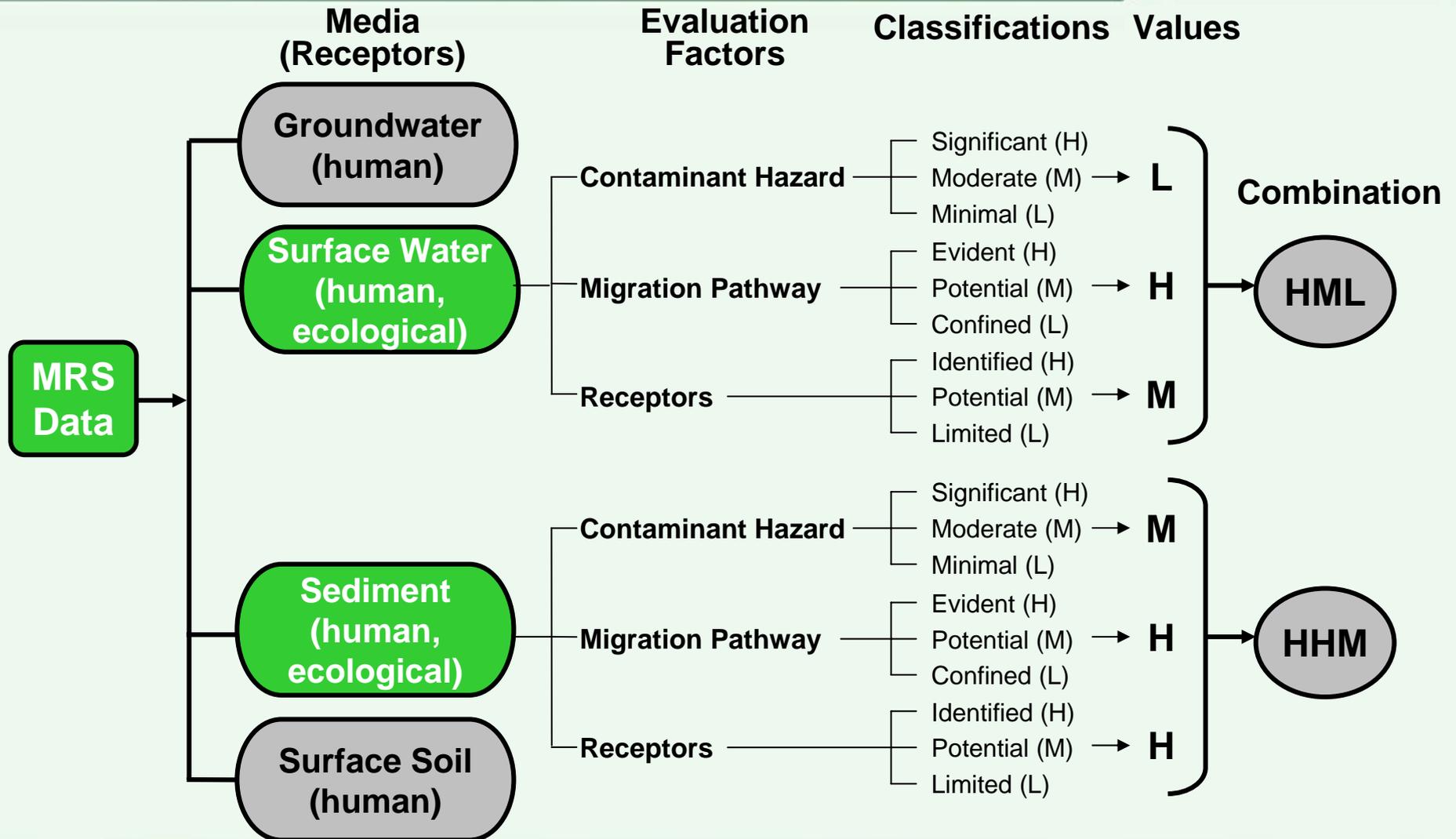
Surface Water/Sediment Evaluation



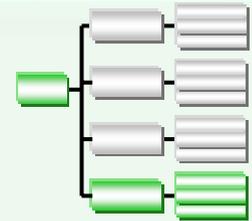
| | Contaminant Hazard Factor – | Migration Pathway Factor – | Receptor Factor – |
|---------------|---|---|---|
| High | <p>Significant Contaminant Levels Sum of Ratios > 100</p> | <p>Evident Migration – Analytical data or observable evidence indicates that contamination is present at a point of exposure</p> | <p>Identified Receptor – Identified receptors have access to media to which contamination has moved or can move</p> |
| Medium | <p>Moderate Contaminant Levels Sum of Ratios 2 – 100</p> | <p>Potential Migration – Information suggests that contamination has moved slightly beyond the source area but is not moving appreciably; there is insufficient information to support <i>Evident</i> or <i>Confined</i> ratings</p> | <p>Potential Receptor – Potential for receptors to have access to media to which contamination has moved or can move</p> |
| Low | <p>Minimal Contaminant Levels Sum of Ratios < 2</p> | <p>Confined Migration – Information indicates a low potential for contaminant migration from the source to a potential point of exposure</p> | <p>Limited Receptor – Little or no potential for receptor to have access to media to which contamination has moved or can move</p> |



Surface Water/Sediment Scoring



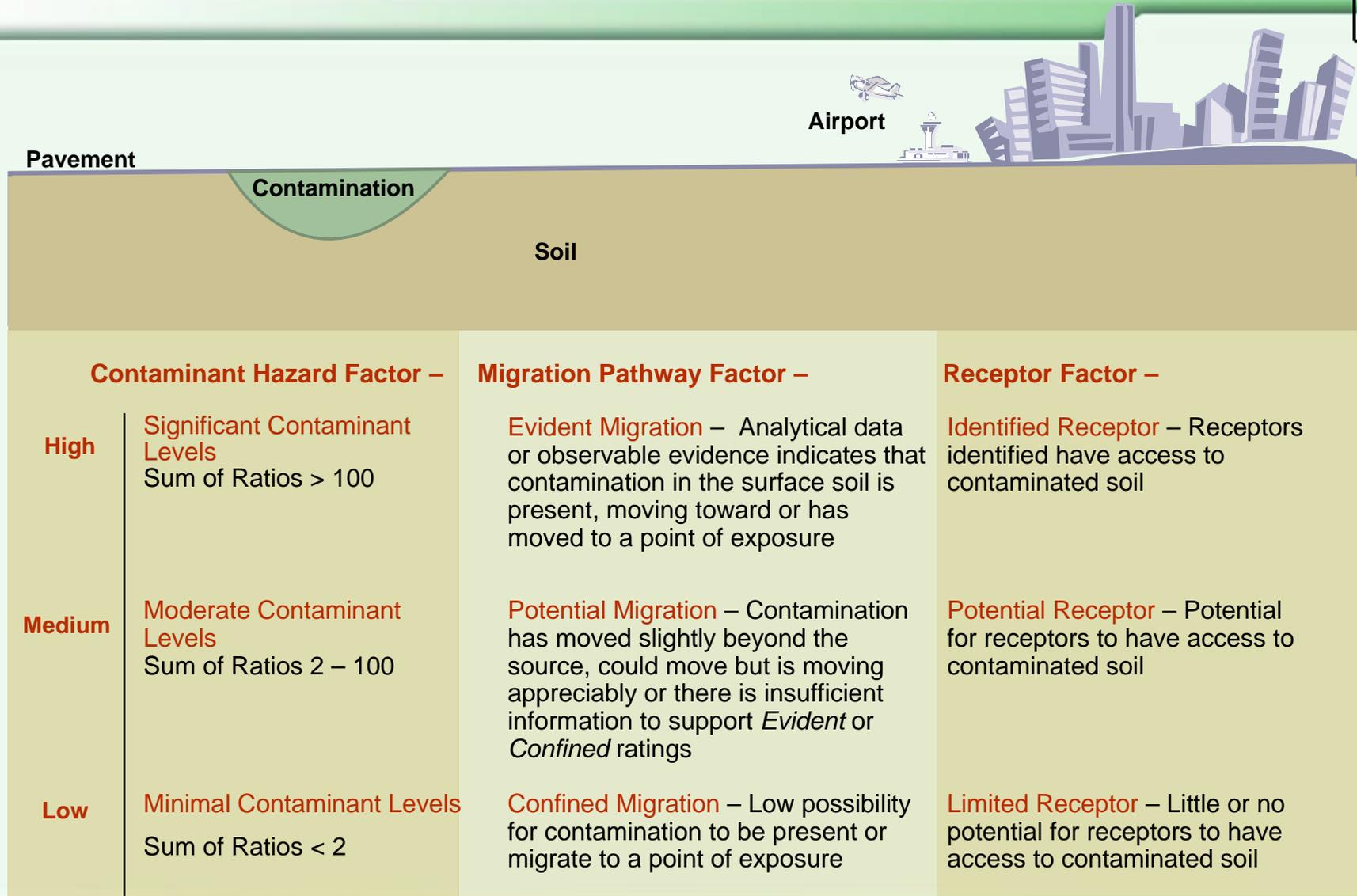
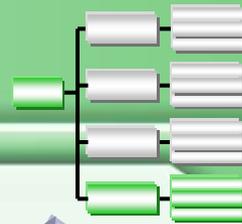
Surface Soil Evaluation



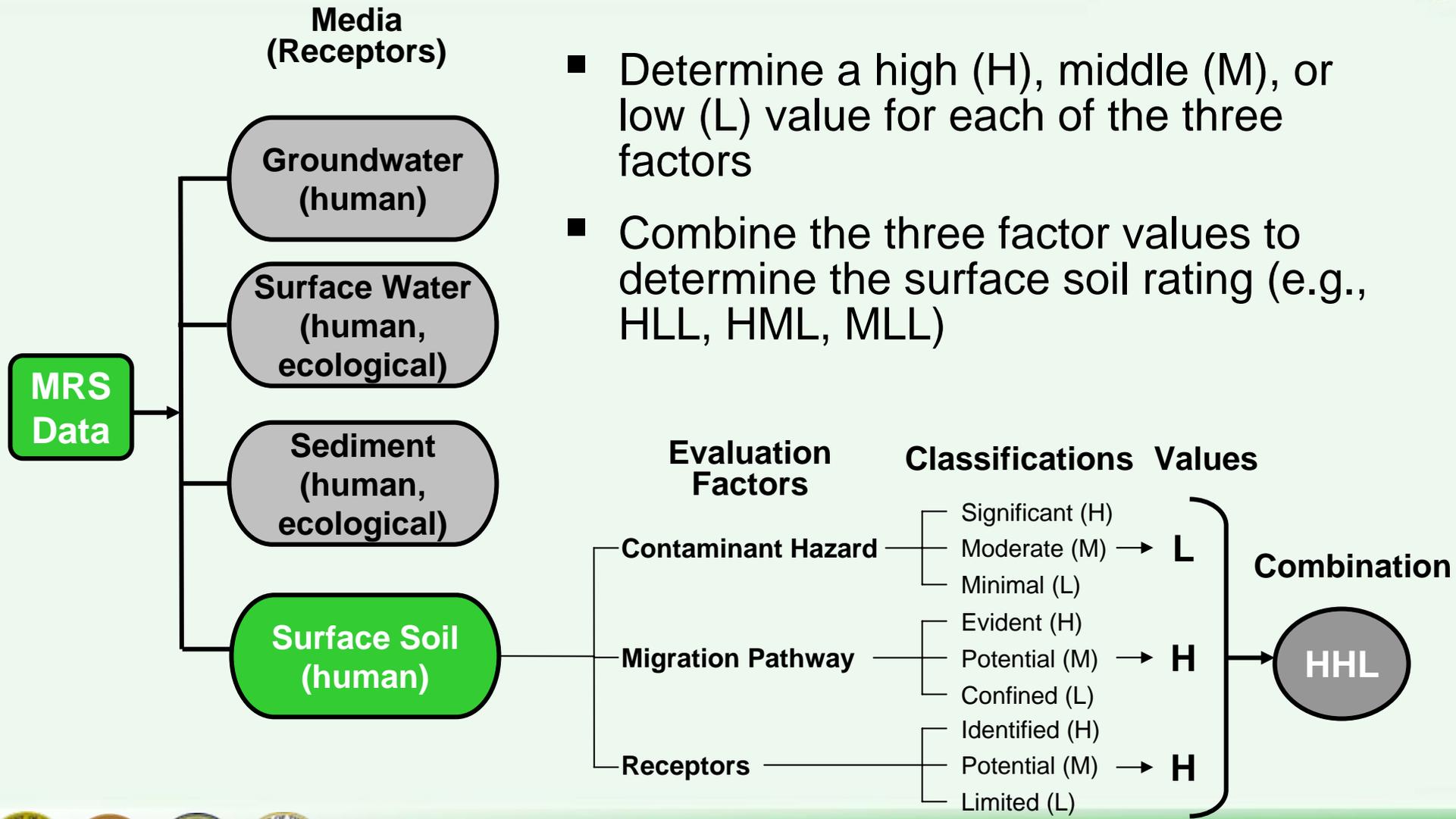
- Surface soil is the layer of soil on the surface
- Soil receptors include only those humans with the potential to come into contact with contaminated surface soils
- Samples collected from a depth of 0-6 inches should be used for this evaluation
 - ◆ Use results from up to 24 inches below ground surface (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 Evaluation



Surface Soil Scoring



- Determine a high (H), middle (M), or low (L) value for each of the three factors
- Combine the three factor values to determine the surface soil rating (e.g., HLL, HML, MLL)



Table 26

HHE Module: Surface Soil – Data Element Table

DIRECTIONS: Record the **maximum concentrations** of all contaminants in the MRS's surface soil and their **comparison values** (from Appendix B) 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 **ratios** for each medium together, including additional 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 |
|---|--|--|--------------------------|
| HMX | 3000 mg/kg | 3100 mg/kg | 0.968 |
| CHF Scale | CHF Value | Sum the Ratios | 0.968 |
| CHF > 100 | H (High) | $CHF = \sum \frac{[Maximum\ Concentration\ of\ Contaminant]}{[Comparison\ Value\ for\ Contaminant]}$ | |
| 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 |
| 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. | M | |
| 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 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 receptor factor at the MRS. | | | |
| Classification | Description | Value | |
| Identified | Identified receptors have access to surface soil to which contamination has moved or can move. | H | |
| 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 | | | <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 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

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 HHE module rating corresponds to EHE and CHE module ratings

**Table 23
HHE Module Ratings**

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



Table 28
Determining the HHE Module Rating

DIRECTIONS:

1. Record the letter values (H, M, L) for the **Contaminant Hazard Factor**, **Migratory Pathway Factor**, and **Receptor Factors** for the media (from Tables 21-26) in the corresponding boxes below.
2. Record the media's 3-letter combinations in the **3-Letter Combination** boxes below (3-letter combinations are arranged from H to Ms to Ls).
3. Using the reference 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 | 3-Letter Combination (Hs-Ms-Ls) | Media Rating (A-G) |
|--|---------------------------------|--------------------------------|-----------------------|---------------------------------|--------------------|
| Groundwater (Table 21) | M | H | H | HHM | B |
| Surface Water/Human Endpoint (Table 22) | | | | | |
| Sediment/Human Endpoint (Table 23) | | | | | |
| Surface Water/Ecological Endpoint (Table 24) | | | | | |
| Sediment/Ecological Endpoint (Table 25) | | | | | |
| Surface Soil (Table 26) | L | M | H | HML | D |

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 below.

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 | |
|----------------------------------|---------------------------------|
| 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 |

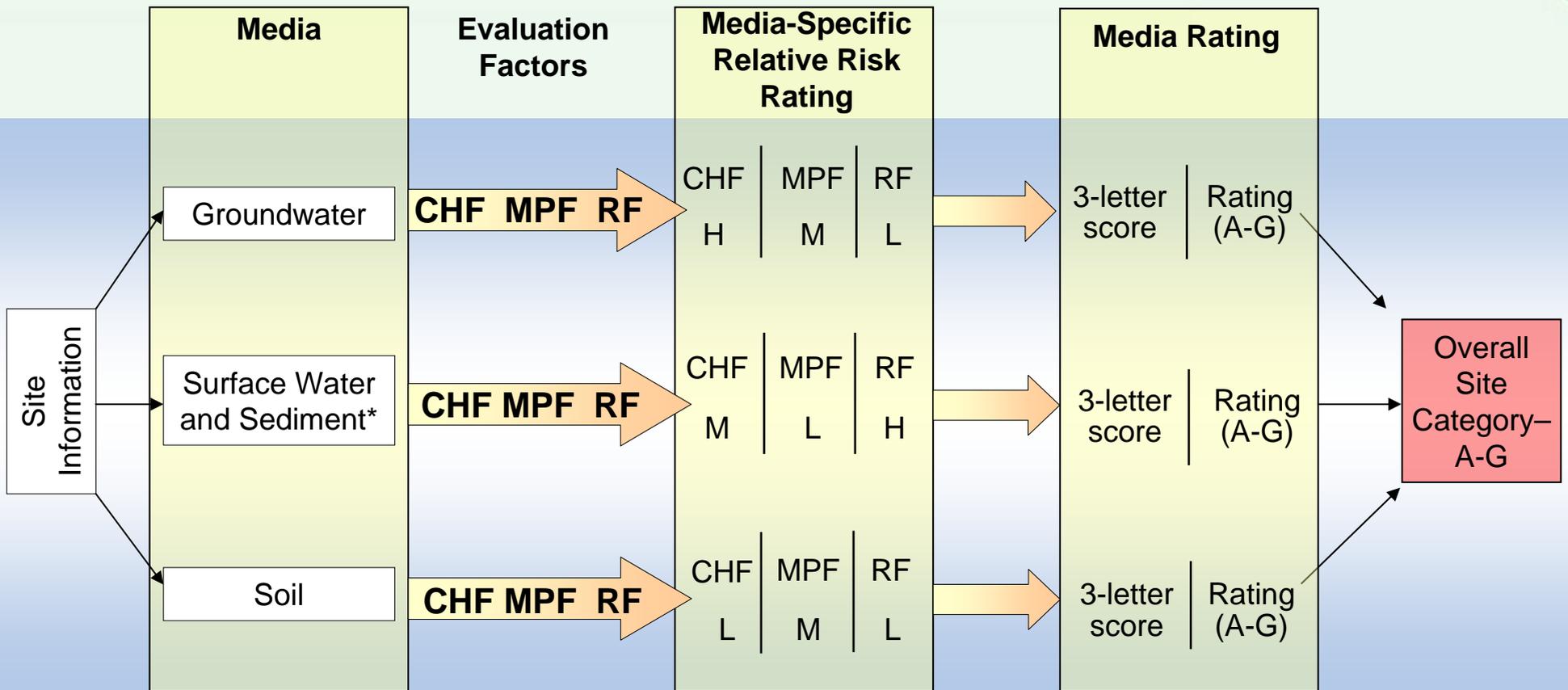
Record the values for each factor of each medium

Arrange the factor values for each medium from highest (H) to lowest (L) to determine the 3-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

Determining the HHE Module Rating (cont)



CHF - Contaminant Hazard Factor
 MPF - Migration Pathway Factor
 RF - Receptor Factor

*Includes human and ecological endpoints



Table 29
MRS Priority

DIRECTIONS: In the chart below, circle the letter **rating** for each module recorded in Table 10 (EHE), Table 20 (CHE), and Table 28 (HHE). Circle the corresponding numerical **priority** for each module. If information to determine the module rating is not available, choose the appropriate alternative module rating. The MRS priority is the single highest priority; record this number in the **MRS or Alternative Priority** box at the bottom of the table.

Note: An MRS assigned Priority 1 has the highest relative priority; an MRS assigned Priority 8 has the lowest relative priority. Only an MRS with CWM known or suspected to be present can be assigned Priority 1; an MRS that has CWM known or suspected to be present cannot be assigned Priority 8.

| EHE Rating | | Priority | | CHE Rating | | Priority | | HHE Rating | | Priority | |
|--|---|----------|--|----------------------------------|---|----------|--|---------------------------------|----------|----------|--|
| | | | | A | 1 | | | | | | |
| A | 2 | | | B | 2 | | | A | 2 | | |
| B | 3 | | | C | 3 | | | B | 3 | | |
| C | 4 | | | D | 4 | | | C | 4 | | |
| D | 5 | | | E | 5 | | | D | 5 | | |
| E | 6 | | | F | 6 | | | E | 6 | | |
| F | 7 | | | G | 7 | | | F | 7 | | |
| G | 8 | | | | | | | G | 8 | | |
| Evaluation Pending | | | | Evaluation Pending | | | | Evaluation Pending | | | |
| No Longer Required | | | | No Longer Required | | | | No Longer Required | | | |
| No Known or Suspected Explosive Hazard | | | | No Known or Suspected CWM Hazard | | | | No Known or Suspected MC Hazard | | | |
| MRS or ALTERNATIVE PRIORITY | | | | | | | | | | | |

Circle the HHE Rating and select corresponding Priority

Health Hazard Evaluation Module

Questions?



Camp Swampy Fictitious 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 Fictitious Example

- The following MC contaminants were identified in the Swampy River and attributed to the OB/OD site—
 - ◆ White Phosphorous – 0.50 $\mu\text{g/L}$
 - ◆ Copper – 20.2 $\mu\text{g/L}$
- 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



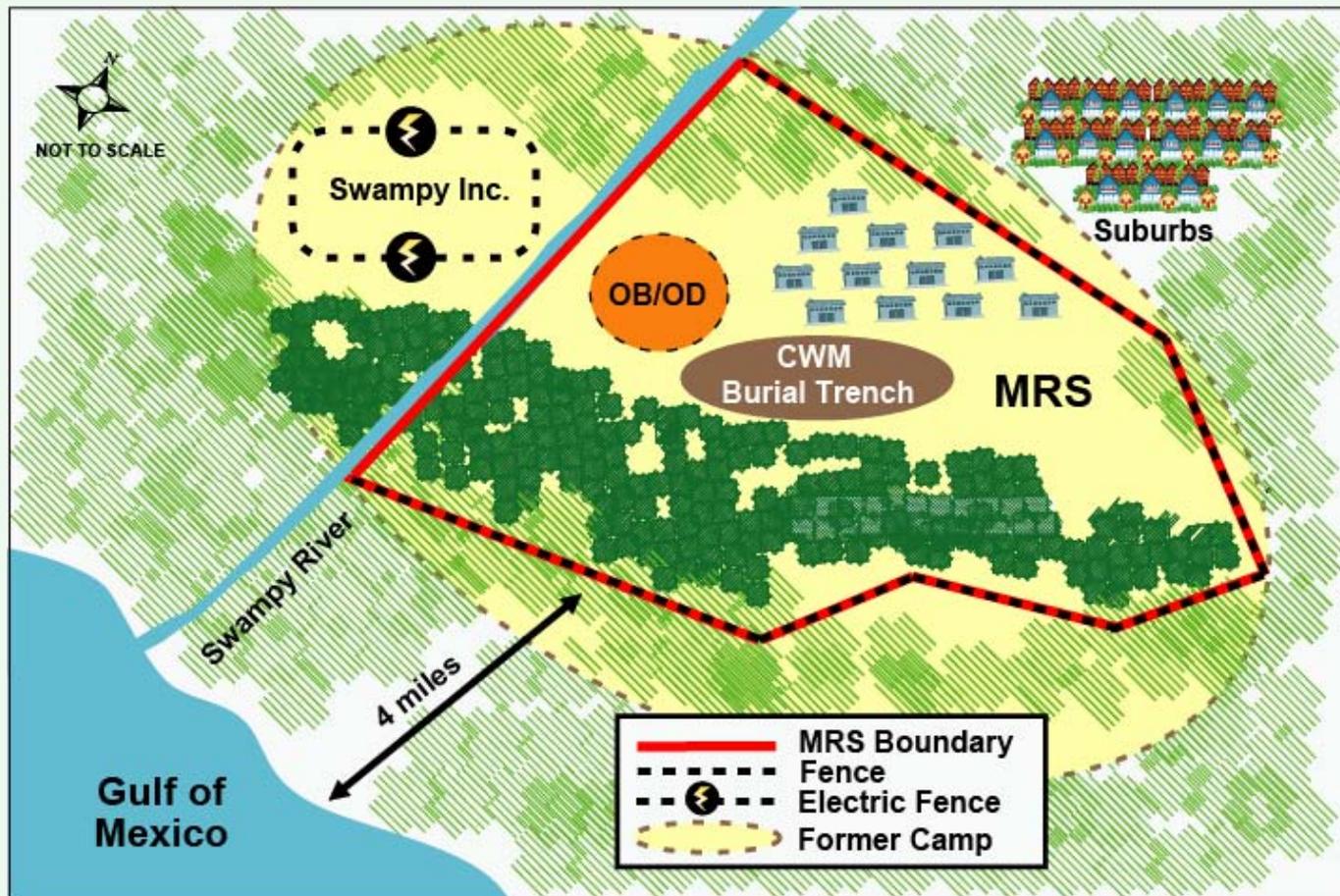
Camp Swampy Fictitious Example

- 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 – 0.60 $\mu\text{g/L}$ (water)*
 - ◆ Copper – 11.0 $\mu\text{g/L}$ (water)*

* These comparison values are taken from draft updated RRSE tables that are not currently publicly available.



Camp Swampy Fictitious Example



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



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) 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 ratios for each medium together, including additional 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.

Note: Use dissolved, rather than total, metals analyses when both are available.

| Contaminant | Maximum Concentration (µg/L) | Comparison Value (µg/L) | Ratios |
|--|---|--|--------------|
| | | | |
| | | | |
| | | | |
| | | | |
| 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 | DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H). | | |
| Migratory Pathway Factor | | | |
| 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 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). | | |
| Receptors Factor | | | |
| 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 |
| RECEPTORS FACTOR | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H). | | |

No Known or Suspected Groundwater MC Hazard



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) 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 **ratios** for each medium together, including additional 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 for human endpoints present in the surface water, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

| 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 | 0.69 |
| 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 <u>the CHF Value</u> 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 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 presence of geological structures or physical controls). | L | |
| MIGRATORY PATHWAY FACTOR | DIRECTIONS: Record <u>the single highest value</u> from above in the box to the right (maximum value = H). | | H |
| 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 | |
| RECEPTOR FACTOR | DIRECTIONS: Record <u>the single highest value</u> from above in the box to the right (maximum value = H). | | H |
| No Known or Suspected Surface Water (Human Endpoint) MC Hazard | | | <input type="checkbox"/> |

Table 23

HHE Module: Sediment – Human Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

DIRECTIONS: Record the maximum concentrations of all contaminants in the site's sediment and their comparison values (from Appendix B) 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 ratios for each medium together, including additional 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 for human endpoints present in the sediment, select the box at the bottom of the table.

| Contaminant | Maximum Concentration (mg/kg) | Comparison Value (mg/kg) | Ratios |
|--|--|--|--------|
| | | | |
| | | | |
| | | | |
| | | | |
| 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 | DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H). | | |
| 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 sediment is present at moving toward, or has moved to a point of exposure. | H | |
| Potential | Contamination in sediment 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 sediment to a potential point of exposure (possibly due to presence of geological structures or physical controls). | L | |
| MIGRATORY PATHWAY FACTOR | DIRECTIONS: Record <u>the single highest value</u> from above in the box to the right (maximum value = H). | | |
| Receptors 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 sediment to which contamination has moved or can move. | H | |
| Potential | Potential for receptors to have access to sediment to which contamination has moved or can move. | M | |
| Limited | Little or no potential for receptors to have access to sediment to which contamination has moved or can move. | L | |
| RECEPTORS FACTOR | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H). | | |

No Known or Suspected Sediment (Human Endpoint) MC Hazard



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) 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 ratios for each medium together, including additional 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 for ecological endpoints present in the surface water, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

| Contaminant | Maximum Concentration (µg/L) | Comparison Value (µg/L) | Ratios |
|--|---|--|--------------------------|
| White Phosphorus | 0.50 µg/L | 0.60 µg/L | 0.83 |
| Copper | 20.2 µg/L | 11.0 µg/L | 1.84 |
| CHF Scale | CHF Value | Sum the Ratios | 2.67 |
| 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 |
| 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 presence of geological structures or physical controls). | L | |
| MIGRATORY PATHWAY FACTOR | DIRECTIONS: Record the <u>single highest value</u> from above in the box to the right (maximum value = H). | | H |
| Receptors 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 | |
| RECEPTORS FACTOR | DIRECTIONS: Record the <u>single highest value</u> 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"/> |

Table 25

HHE Module: Sediment– Ecological Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

DIRECTIONS: Record the maximum concentrations of all contaminants in the MRS's sediment and their comparison values (from Appendix B) 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 ratios for each medium together, including additional 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 for ecological endpoints present in the sediment, select the box at the bottom of the table.

| Contaminant | Maximum Concentration (mg/kg) | Comparison Value (mg/kg) | Ratios |
|--|--|--|--------------|
| | | | |
| | | | |
| | | | |
| | | | |
| 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 | DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H). | | |
| <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 sediment is present at, moving toward, or has moved to a point of exposure. | | H |
| Potential | Contamination in sediment 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 sediment to a potential point of exposure (possibly due to 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). | | |
| <u>Receptors 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 sediment to which contamination has moved or can move. | | H |
| Potential | Potential for receptors to have access to sediment to which contamination has moved or can move. | | M |
| Limited | Little or no potential for receptors to have access to sediment to which contamination has moved or can move. | | L |
| RECEPTORS FACTOR | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H). | | |

No Known or Suspected Sediment (Ecological Endpoint) MC Hazard



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) 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 ratios for each medium together, including additional 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 |
|---|--|--|--------------|
| | | | |
| | | | |
| | | | |
| | | | |
| 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 | DIRECTIONS: Record the CHF Value from above in the box to the right (maximum value = H). | | |
| 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. | | M |
| 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 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). | | |
| Receptors 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. | | H |
| 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 |
| RECEPTORS FACTOR | DIRECTIONS: Record the single highest value from above in the box to the right (maximum value = H). | | |

No Known or Suspected Surface Soil MC Hazard



Table 28
Determining the HHE Module Rating

DIRECTIONS:

- 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.
- 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).
- Using the reference 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 (Hs-Ms-Ls) | Media Rating (A-G) |
|--|---------------------------------|--------------------------------|-----------------------|-------------------------------------|--------------------|
| 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) | | | | | |

DIRECTIONS (cont.):

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

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