For the MRBCA process, the acceptable risk levels are as follows:

Carcinogenic Risk

- The total risk for each chemical, which is the sum of risk for all complete routes of exposure for each chemical, must not exceed 1×10^{-5}.
- The cumulative site-wide risk (sum of risk for all chemicals and all complete routes of exposure) must not exceed 1×10^{-4}.

Non-carcinogenic Risk

- The hazard index for each chemical, which is the sum of hazard quotients for all complete routes of exposure for each chemical (the total risk), must not exceed 1.0.
- The site-wide hazard index, which is the sum of hazard quotients for all chemicals and all complete routes of exposure, must not exceed 1.0.

If the hazard index exceeds 1.0, the hazard index corresponding to a specific toxicological end point may be calculated by a qualified toxicologist. In this case, the specific hazard indices for each toxicological end point must be less than unity (1.0).

If any of these acceptable risk levels are exceeded, a risk management plan is necessary to reduce the concentrations to acceptable levels. These acceptable risk criteria can be satisfied in several different ways that provide considerable flexibility to the remediating party. Due to this flexibility, the remediating party can select the risk management plan that is optimal for site-specific conditions.

To illustrate the above flexibility, an example is presented below.

Consider the following site that has four chemicals and three complete routes of exposure. Exhibit 1 presents the representative concentrations for each chemical and each route of exposure used to estimate the risk presented in Exhibit 2.

Exhibit 1. Representative Concentrations for Each Chemical and
Each Complete Route of Exposure

Chemicals	ROE 1 (mg/kg)	ROE 2 (mg/kg)	ROE 3 (mg/kg)
Chemical 1	1.5	1.0	1.0
Chemical 2	0.5	0.75	1.0
Chemical 3	0.25	0.5	0.5
Chemical 4	0.20	0.25	5.0

Exhibit 2. Risk Calculated Using Representative Concentrations in Exhibit 1

Chemicals	ROE 1	ROE 2	ROE 3	Total
Chemical 1	1.1×10^{-5}	4.0×10^{-6}	5.0×10^{-6}	2.0×10^{-5}
Chemical 2	5.0×10^{-6}	7.5×10^{-6}	2.0×10^{-6}	1.45×10^{-5}
Chemical 3	5.0×10^{-6}	2.0×10^{-6}	5.0×10^{-7}	7.5×10^{-6}
Chemical 4	3.9×10^{-5}	2.2×10^{-5}	7.0×10^{-6}	6.8×10^{-5}
Cumulative Site-Wide Risk				**1.1×10^{-4}**

Note that the following acceptable risks are exceeded:

- Total risk for chemical 1,
- Total risk for chemical 2,
- Total risk for chemical 4, and
- Cumulative site-wide risk.

To meet the acceptable risk criteria, the remediating party may select any one of the following three options for the risk management plan.

Example 1

The concentration of each chemical may be reduced by a factor of 6.8. This will result in total risk of each below 1.0×10^{-5} and cumulative site-wide risk below 1.0×10^{-4}. For this case the resulting cleanup levels and risks would be:

Chemicals	ROE 1 (mg/kg)	ROE 2 (mg/kg)	ROE 3 (mg/kg)
Chemical 1	0.22	0.15	0.15
Chemical 2	0.07	0.11	0.15
Chemical 3	0.04	0.07	0.07
Chemical 4	0.03	0.04	0.74

Chemicals	ROE 1	ROE 2	ROE 3	Total
Chemical 1	1.62×10^{-6}	5.88×10^{-7}	7.35×10^{-7}	2.94×10^{-6}
Chemical 2	7.35×10^{-7}	1.10×10^{-6}	2.94×10^{-7}	2.13×10^{-6}
Chemical 3	7.35×10^{-7}	2.94×10^{-7}	7.35×10^{-8}	1.10×10^{-6}
Chemical 4	5.74×10^{-6}	3.24×10^{-6}	1.03×10^{-6}	1.00×10^{-5}
Cumulative Site-Wide Risk				**1.62×10^{-5}**

Example 2

Activity and Use Limitations (AULs) may be used to eliminate two of the complete routes of exposure, resulting in the following risks:

Chemicals	ROE 1	ROE 2	ROE 3	Total
Chemical 1			5.0×10^{-6}	5.0×10^{-6}
Chemical 2	Eliminated	Eliminated	2.0×10^{-6}	2.0×10^{-6}
Chemical 3			5.0×10^{-7}	5.0×10^{-7}
Chemical 4			7.0×10^{-6}	7.0×10^{-6}
Cumulative Risk				**1.45×10^{-5}**

In the above, both the total risk for each chemical and the cumulative site-wide risk are acceptable.

Example 3

In this case the concentrations of different chemicals are reduced by different factors. For example, we could reduce the concentration of chemicals 1, 2 and 3 by a factor of 2 and reduce concentration of chemical 4 by a factor of 6.8. This would result in the following cleanup levels and risk:

Chemicals	ROE 1 (mg/kg)	ROE 2 (mg/kg)	ROE 3 (mg/kg)
Chemical 1	0.75	0.5	0.5
Chemical 2	0.25	0.375	0.5
Chemical 3	0.125	0.25	0.25
Chemical 4	0.029	0.037	0.74

Chemicals	ROE 1	ROE 2	ROE 3	Total
Chemical 1	5.5×10^{-6}	2.0×10^{-6}	2.5×10^{-6}	1.0×10^{-5}
Chemical 2	2.5×10^{-6}	3.75×10^{-6}	1.0×10^{-6}	7.25×10^{-6}
Chemical 3	2.5×10^{-6}	1.0×10^{-6}	2.5×10^{-7}	3.75×10^{-6}
Chemical 4	5.74×10^{-6}	3.24×10^{-6}	1.03×10^{-7}	1.0×10^{-5}
Cumulative Risk				**3.1×10^{-5}**

In this case the cumulative risk at the site is equal to 3.1×10^{-5} and it is therefore below acceptable risk levels.
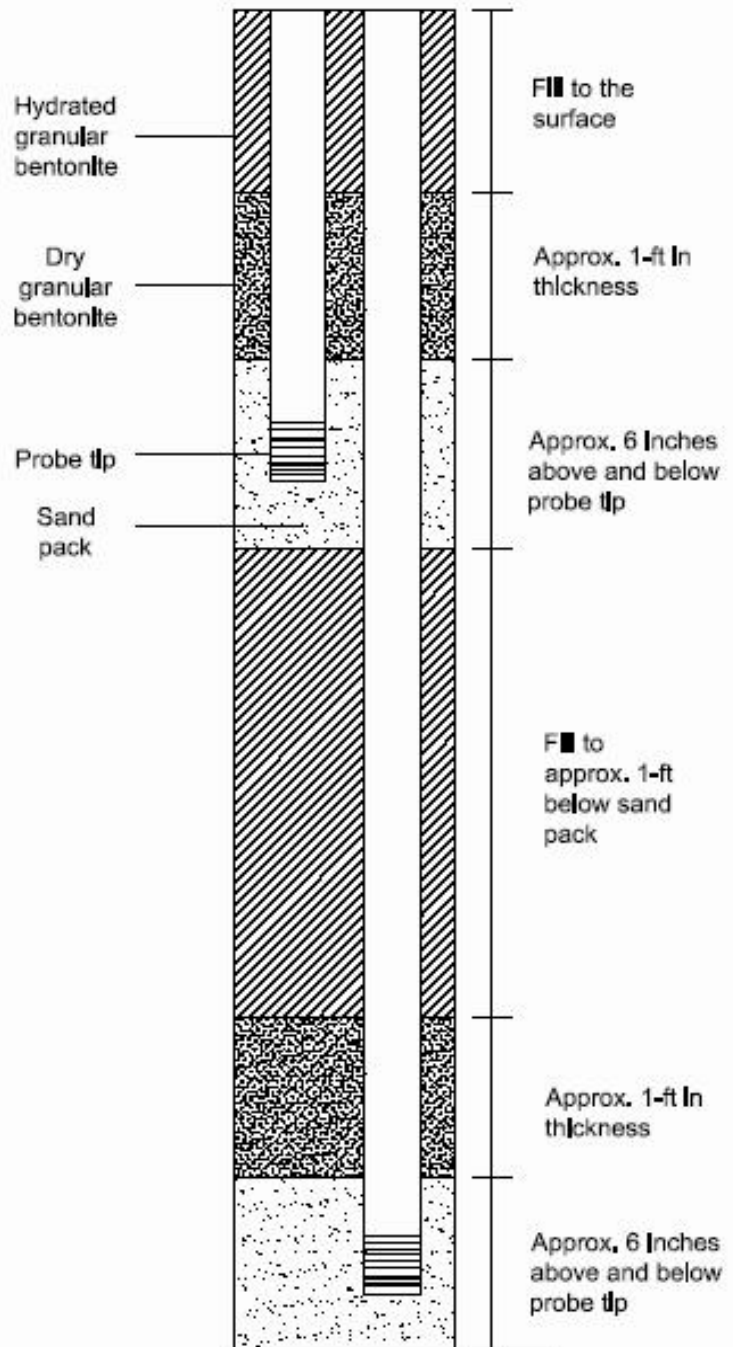
The example above illustrates a case where a selected remedial technology reduces the site-specific concentrations of different chemicals by different amounts. For example, soil

vapor extraction, depending on the volatility of chemical, would reduce the concentrations of the volatile chemicals by different amounts.

Single Depth Gas Probe

Multi-Depth Gas Probe

Fill to the surface

Hydrated granular bentonite

Fill to the surface

Approx. 1-ft in thickness

Dry granular bentonite

Approx. 1-ft in thickness

Approx. 6 inches above and below probe tip

Probe tip

Approx. 6 inches above and below probe tip

Sand pack

Fill to approx. 1-ft below sand pack

Approx. 1-ft in thickness

Approx. 6 inches above and below probe tip

TITLE:
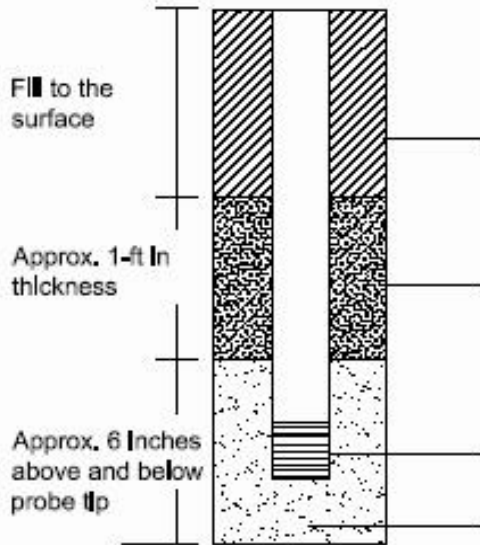
**FIGURE 1
SOIL GAS PROBE CONSTRUCTION DIAGRAM**

FROM
SAMPLE
PROBE

SHUT-OFF
VALVE

VACUUM GAUGE
UNITS: INCHES H2O
SCALE: 100 IN. NOM.

(P)

(R)

FLOW REGULATOR
UNITS: mL/MINUTE
(Need to adjust flow to
200 mL/min.
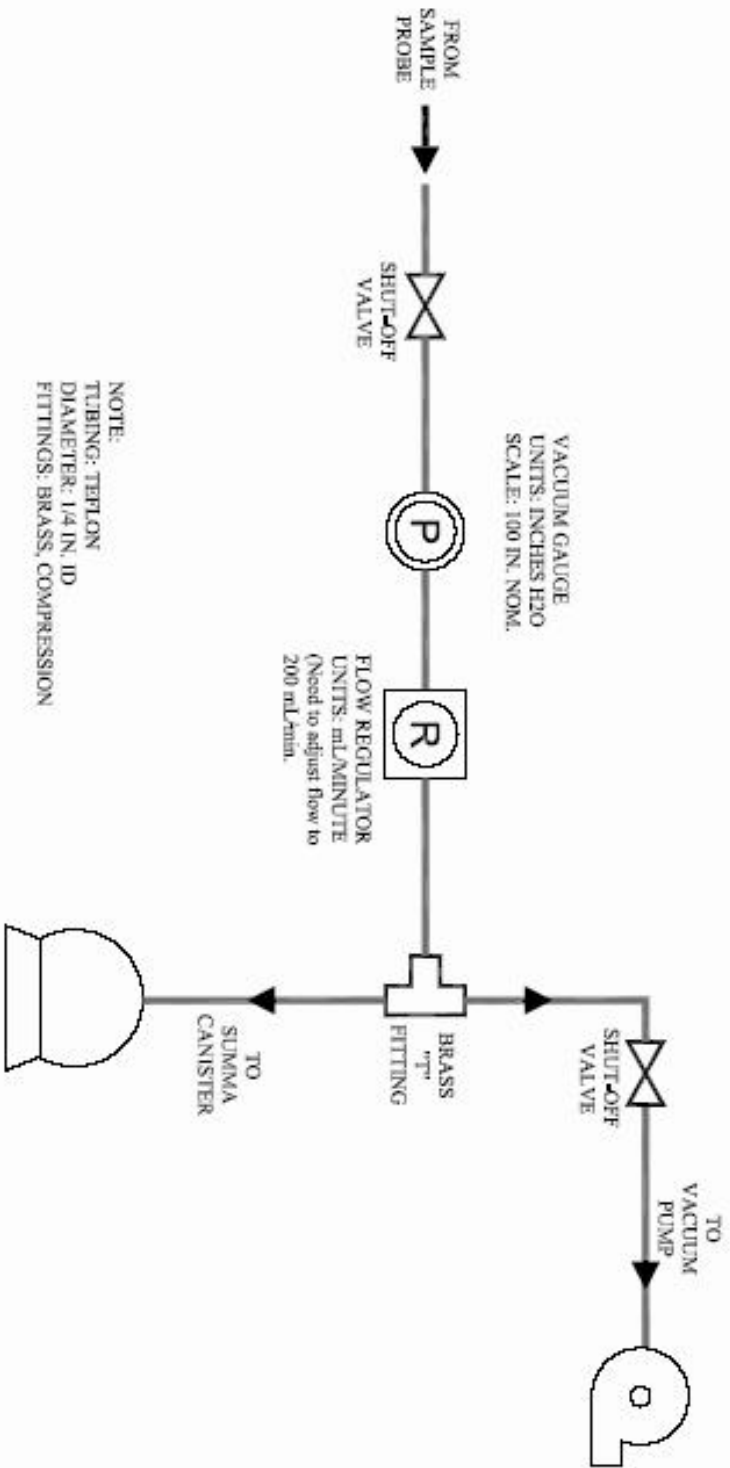
NOTE:
TUBING: TEFLON
DIAMETER: 1/4 IN. ID
FITTINGS: BRASS, COMPRESSION

TO
SUMMA
CANISTER

BRASS
"T"
FITTING

SHUT-OFF
VALVE

TO
VACUUM
PUMP

FIGURE 2
EXAMPLE SOIL GAS SAMPLING PLAN

Figure 3
Example Soil Gas Sampling Form

Date		Sampler	
Client		Project#:	
Container Type:		Container ID:	
Sample ID:			
Weather Conditions:	Temperature:	Precipitation:	
Sampling Device:			
Purge Start Time:		End Time:	
Sample Start Time:		End Time:	
Canister start pressure:		End pressure:	
Volume gas extracted:			

Field Measurements

Time	Flow (mL/min)	Pressure (in H20)	Comments

Comments: