MARSSIM Revision 2

SCIENCE ADVISORY BOARD

RADIATION ADVISORY COMMITTEE

DECEMBER 3, 2020

Topics

MARSSIM Background

Revision 2 Introduction

Review of Draft Charge

MARSSIM Background

MARSSIM (Multi-Agency Radiation Survey and Site Investigation Manual)

- Covers real property (surface soils and building surfaces)
- Provides defensible and rigorous surveys for sites, especially final status surveys
- Uses a graded approach starting with a historical site assessment
- Based on the Data Quality Objectives (DQO) process

MARSSIM Background

Family of Three Multi-Agency Documents

- MARSSIM – Published 1997, Updated 2001
- MARLAP – Published 2004
- MARSAME – Published 2009

Technical Documents - Not Policy

MARSSIM Background

Site Identification

Historical Site Assessment

Scoping Survey

Characterization Survey

Remedial Action Support Survey

Final Status Survey

- Focus of MARSSIM

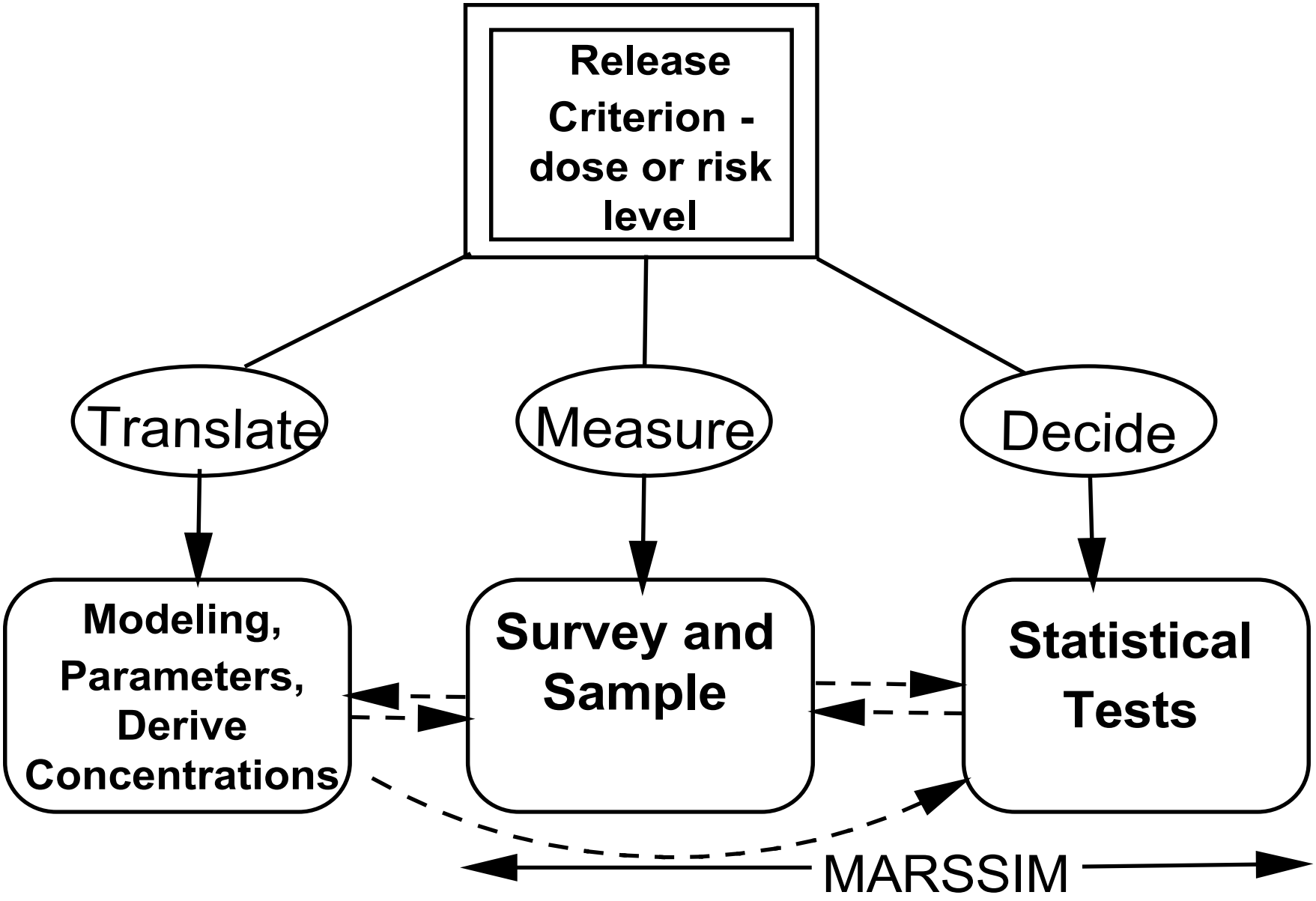
MARSSIM Background

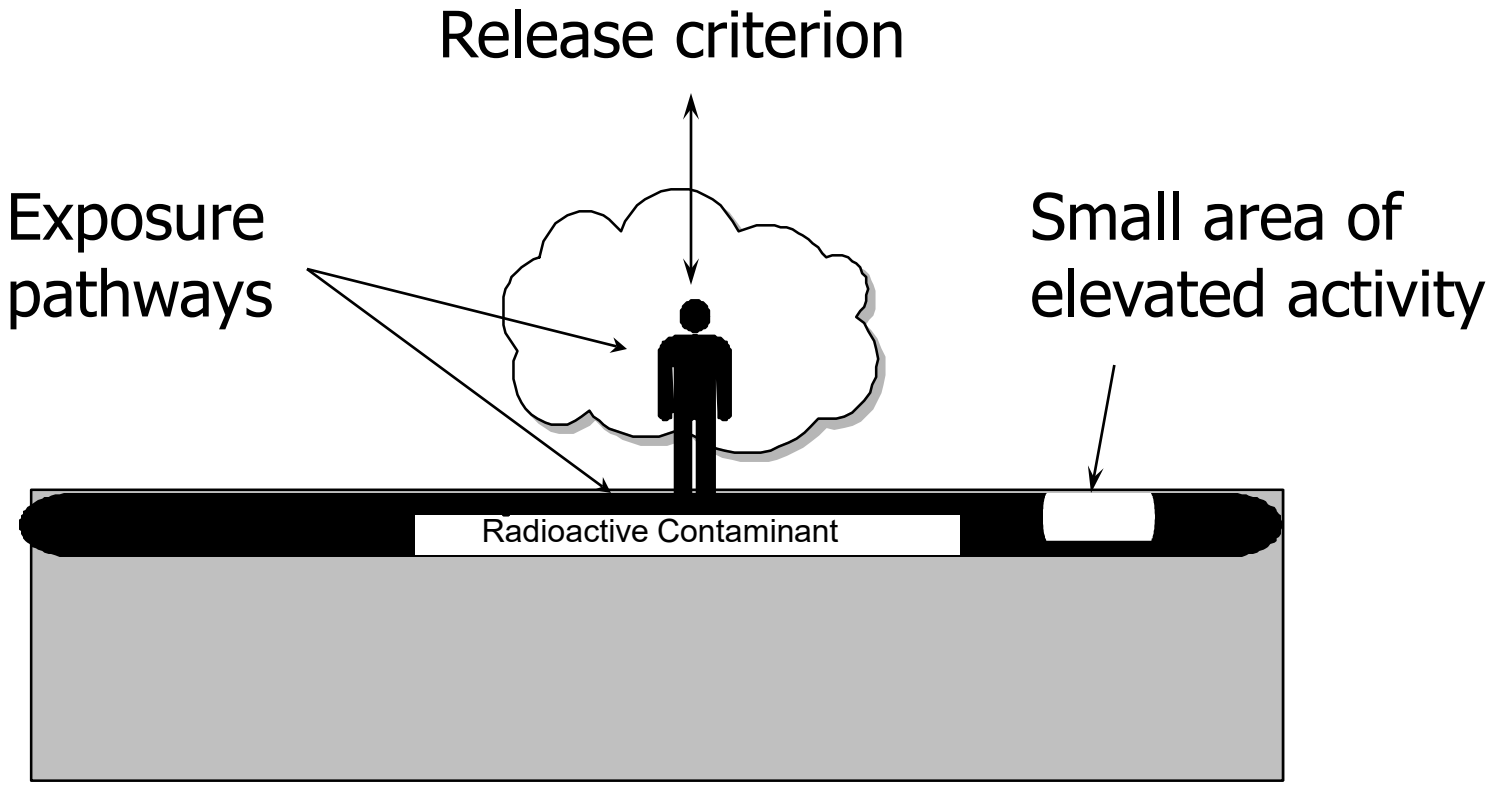
Scope

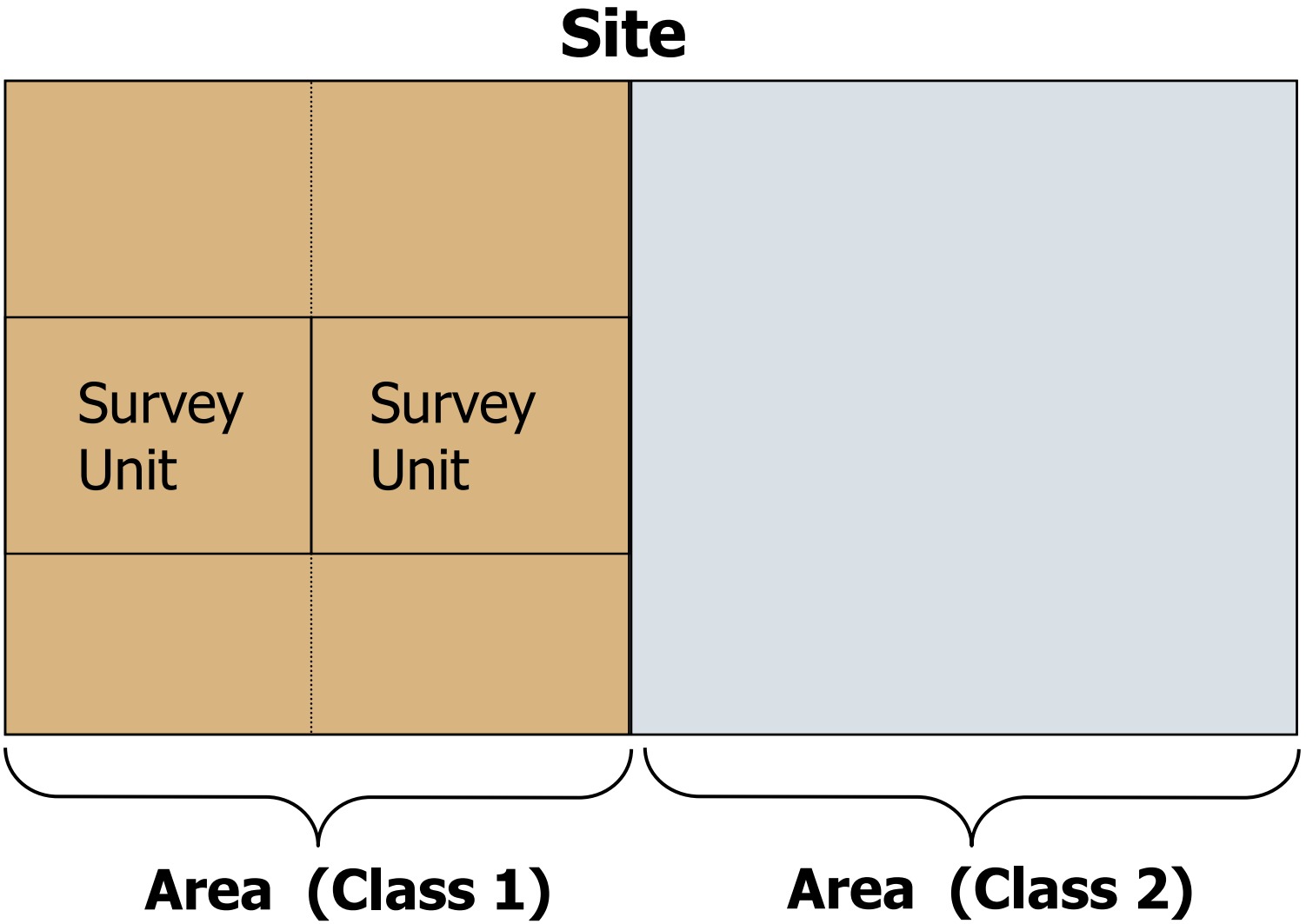
- Assessing Compliance with Release Criteria
- Building Surfaces and Surface Soils

Not in Scope

- Selecting the Release Criteria
- Translating Dose or Risk into Concentrations
- Groundwater and Drinking Water Compliance
- Evaluation of Remedial Alternatives
- Public Involvement
- Subsurface Soils
- Release of Materials or Components


Release Criterion - dose or risk level
Translate
Measure
Decide
Modeling, Parameters, Derive Concentrations
Survey and Sample
Statistical Tests
MARSSIM


Release criterion
Exposure pathways
Small area of elevated activity
Radioactive Contaminant


Site
Survey Unit
Survey Unit
Area (Class 1)
Area (Class 2)

Introduction to Revision 2

MARSSIM not updated since 2001

- Mostly errata and typos corrected before that date

Request for Public Input in 2010

Initial Consultation with SAB-RAC in 2011

Internal Agency Review in 2016

Availability for Public Comment (2021)

Charge Question #1

Are the revisions to MARSSIM concepts and methodologies technically accurate and do they provide a practical and implementable approach to performing environmental radiological surveys of surface soil and building surfaces?

1.1 Please identify whether the inclusion and proposed implementation of scan-only surveys (Section 5.3.6.1 and Section 8.5) is appropriate, adequate and clear, especially the discussion on sampling for scan-only measurement method validation or verification.

Scan-Only Surveys

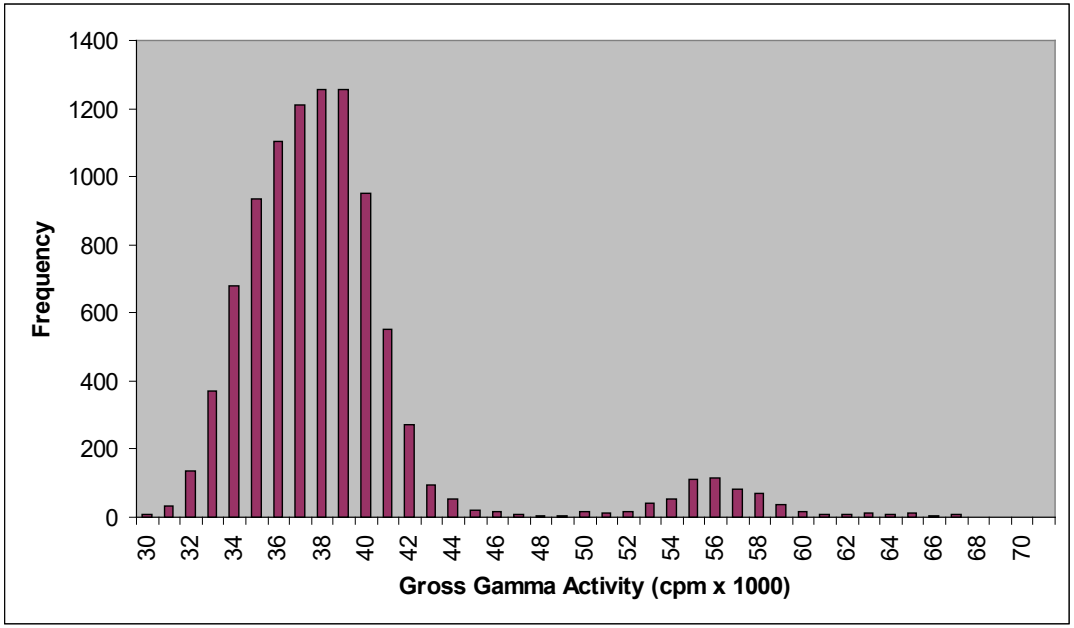
Expanded measurement methods to include scan-only surveys

- MARSSIM written with the current (~1995) measurement techniques in mind
- The state of radiation instrumentation

Charge Question #1

Are the revisions to MARSSIM concepts and methodologies technically accurate and do they provide a practical and implementable approach to performing environmental radiological surveys of surface soil and building surfaces?

1.2 Please comment on the inclusion and proposed implementation of Scenario B (Chapter 4, Section 5.3, and Chapter 8). Is it appropriate to recommend that Scenario B be used only for those situations where Scenario A is not feasible? Are methods for considering background variability in assessing whether the site is indistinguishable from background reasonable and technically accurate? Is the inclusion and proposed implementation of added requirements for retrospective power analysis and the Quantile Test while using Scenario B technically appropriate and discussed adequately and clearly?



Scenario B

Included Scenario B: "assumed to meet the criteria until proven otherwise"

- MARSAME allows the use of Scenario B
- Already used in some states for MARSSIM

Charge Question #1

Are the revisions to MARSSIM concepts and methodologies technically accurate and do they provide a practical and implementable approach to performing environmental radiological surveys of surface soil and building surfaces?

1.3 Is the proposed implementation of the of the concept of Measurement Quality Objectives adequately and correctly described, including the concept of measurement uncertainty (Chapter 4 and Appendix D)? In particular, please comment on the concerns of stakeholders that calculating measurement uncertainty for field measurements makes the survey process difficult to implement. In addition, please comment on whether recommendations provided by NIST, ANSI/IEEE and MARLAP for measurement quantifiability should be incorporated further into MARSSIM, Revision 2, or whether the current recommendations should be left as is (e.g., the original MARSSIM requirement that the MDC/MDA should be set at 10-50% of the action level).

ISO Guide to the Expression of Uncertainty in Measurement

First edition 1995

NIST Technical Note 1297
1994 Edition

Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results

September 1994

MQOs

Included measurement quality objectives (MQOs) and measurement uncertainty

- MARSAME and MARLAP in line with the state of the science regarding MQOs and measurement uncertainty
- Complies with current guidance from ISO and NIST

Charge Question #1

Are the revisions to MARSSIM concepts and methodologies technically accurate and do they provide a practical and implementable approach to performing environmental radiological surveys of surface soil and building surfaces?

1.4. Is the discussion of survey requirements for areas of elevated activity technically accurate, appropriate and clear? In particular, please comment on the decision to maintain the use of the unity rule for multiple areas of elevated activity (Section 5.3.5, Section 8.6 and Appendix O.4).

Areas of Elevated Activity

Discussion of survey requirements for areas of elevated activity

- Alter language to address concerns about the current hotspot procedure

$$\frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \cdots + \frac{C_i}{DCGL_i} + \cdots + \frac{C_n}{DCGL_n} \leq 1$$

Charge Question #1

Are the revisions to MARSSIM concepts and methodologies technically accurate and do they provide a practical and implementable approach to performing environmental radiological surveys of surface soil and building surfaces?

1.5. Is the discussion of the use of MARSSIM surveys for addressing sites containing discrete radioactive particles technically accurate, appropriate and clear? In particular, please comment on the rule-of-thumb for determining when use of MARSSIM may not be appropriate for survey units containing discrete radioactive particles (Section 4.12.8 and Appendix O.5).

Discrete Radioactive Particles

Included information on survey requirements for discrete radioactive particles

- MARSSIM addresses areas of elevated activity
- Methodology becomes unwieldy at certain small sizes
- Modeling pathways are different for discrete radioactive particles

Charge Question #2

Does MARSSIM, Revision 2 provide useful and accurate examples and descriptions of technical approaches to implementing surveys and the statistics by which they are interpreted?

2.1 Please comment on the usefulness and accuracy of updated measurement methods and instrumentation information (Chapter 6 and Appendix H).

Updated Instruments

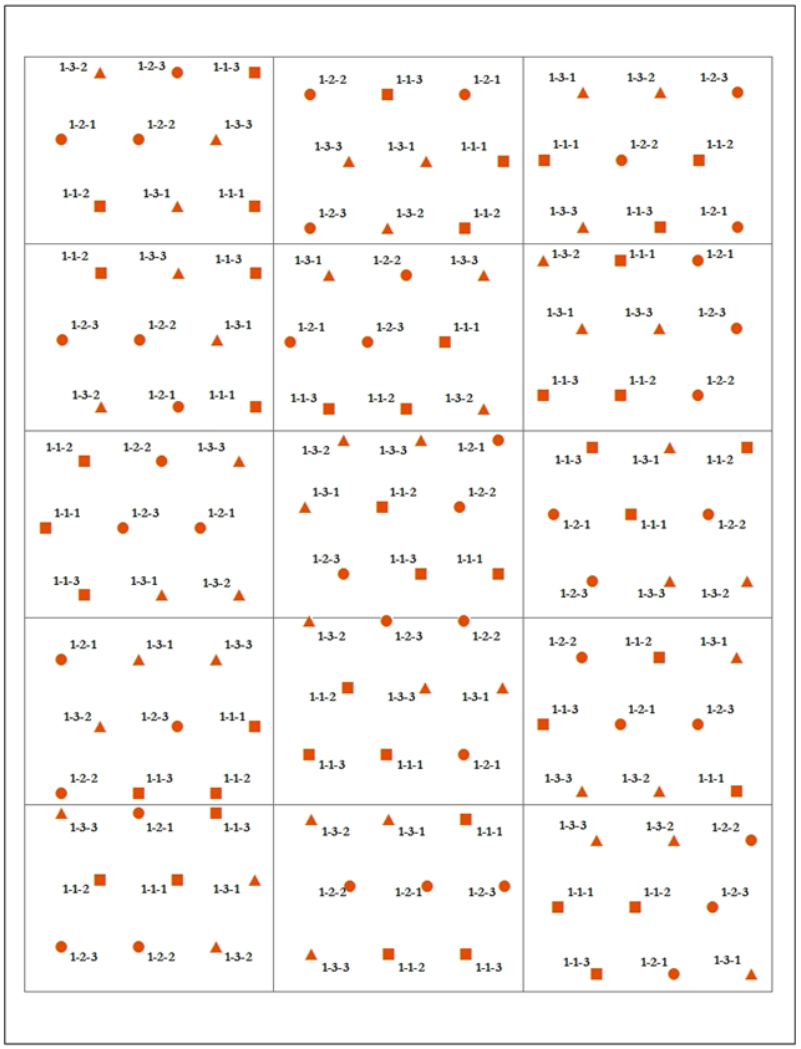
Updated survey instrumentation information

- Chapter 6 on Field Surveys
- Appendix H on Survey Instrumentation

Charge Question #2

Does MARSSIM, Revision 2 provide useful and accurate examples and descriptions of technical approaches to implementing surveys and the statistics by which they are interpreted?

2.2. Please comment on the usefulness and accuracy of the additional optional methodology for the use of Ranked Set Sampling for hard-to-detect radionuclides.



Ranked Set Sampling

Added an appendix on Ranked Set Sampling for hard-to-detect radionuclides

- Including Ranked Set Sampling technique proposed by ORAU as an appendix

Charge Question #2

Does MARSSIM, Revision 2 provide useful and accurate examples and descriptions of technical approaches to implementing surveys and the statistics by which they are interpreted?

2.3 Please comment on the usefulness and accuracy of new and additional examples provided in Chapter 5.

Example 5: Use of WRS Test under Scenario B

A site has 14 survey units and 1 reference area in a building, and the same measurement method is used to perform measurements in each survey unit and the reference area. The radionuclide is present in background at a level of 100 ± 15 becquerels/meter squared (Bq/m^2) (1σ). The standard deviation of the radionuclide in the survey area is 40 Bq/m^2, based on previous survey results for the same or similar radionuclide distribution. When the estimated standard deviation in the reference area and the survey units are different, the larger value, 40 Bq/m^2 in this example, should be used to calculate the relative shift. During the Data Quality Objective process, Scenario B is selected because the release criterion for the site is no residual radioactive material above background. The discrimination limit is selected to be 220 Bq/m^2 as a stakeholder agreed-upon starting point for developing an acceptable survey design, and Type I and Type II error values (α and β) of 0.05 are selected. Determine the number of data points to be obtained from the reference area and from each of the survey units for the statistical tests.

The value of the relative shift for the reference area, Δ/σ, is $(220 - 100)/40$, or 3.0. The number of data points can be obtained directly from Table 5.2. For $\alpha = 0.05$, $\beta = 0.05$, and $\Delta/\sigma = 3.0$, a value of 10 is obtained for $N/2$. The table value has already been increased by 20 percent to account for missing or unusable data.

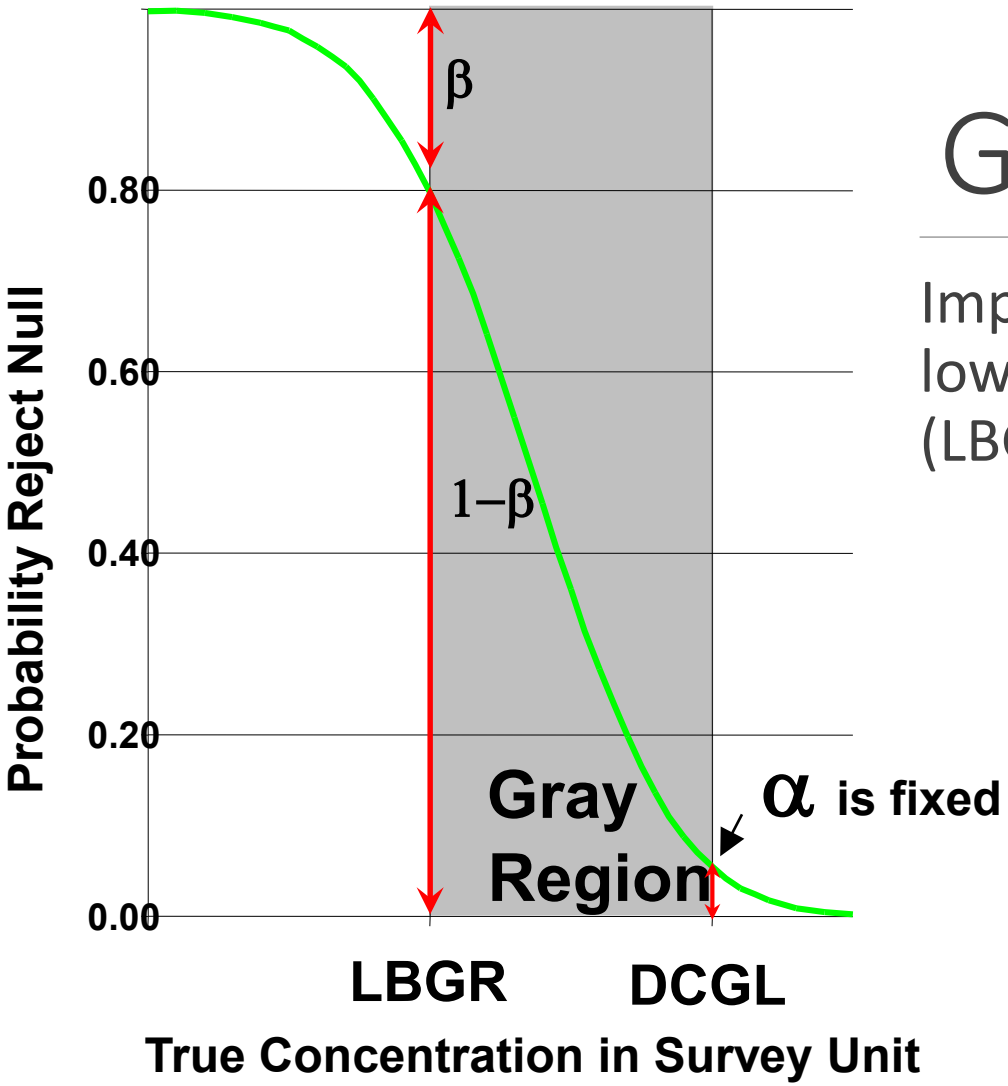
Examples

Added additional examples to Chapter 5, specifically to address Scenario B

Charge Question #3

Is the information in MARSSIM, Revision 2 clear, understandable and presented in a logical sequence? How can the presentation and content of material be modified to improve the understandability of the manual?

3.1. Please comment on the revised description of how to set the Lower Bound of the Grey Region (LBGR) and its likely effectiveness in encouraging users to rely on site-specific information for doing so (Chapter 4 and Section 5.3).



Gray Region

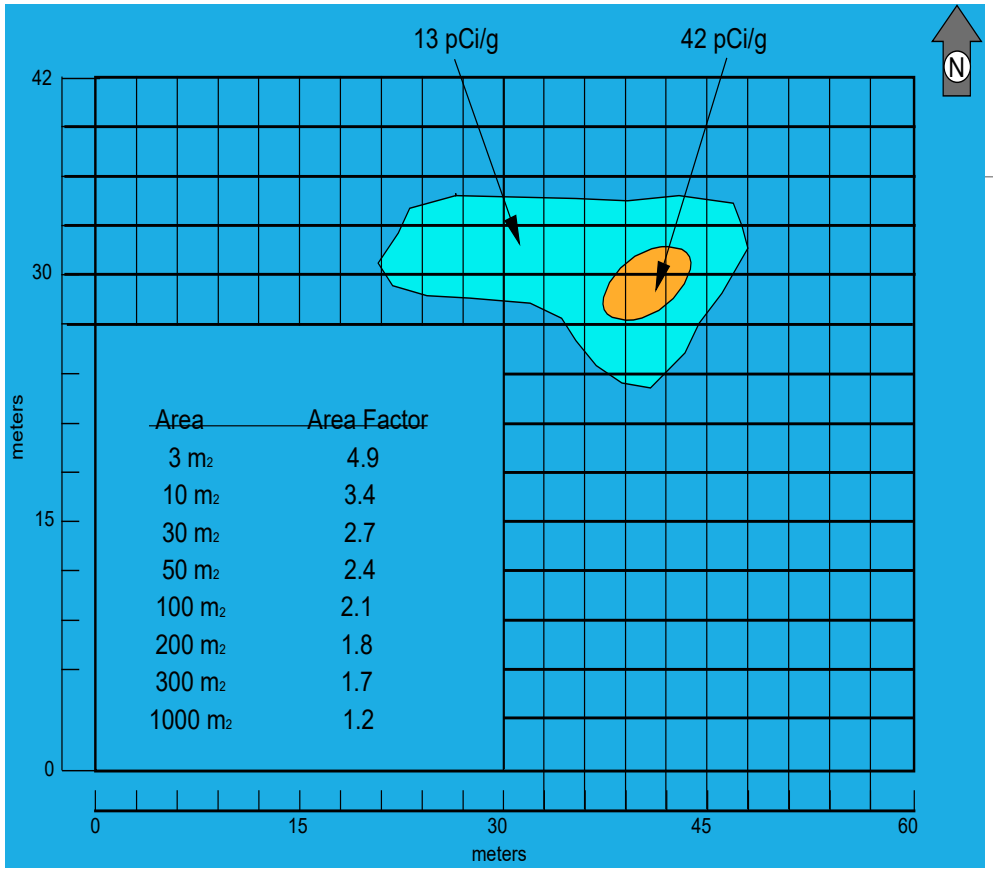
Improved description of the lower bound of the gray region (LBGR)

- Re-phrased from statistical language
- "represents a conservative estimate of the remaining residual radioactive material in the survey unit"

Charge Question #3

Is the information in MARSSIM, Revision 2 clear, understandable and presented in a logical sequence? How can the presentation and content of material be modified to improve the understandability of the manual?

3.2. Please comment on whether avoiding the use of the term “area factor” improves understandability of the elevated measurement comparison concept (Section 8.6.1).



Area Factor

Avoided the use of the term “area factor”

- Describe the process in plain language
- Avoids misapplication of published values

Charge Question #3

Is the information in MARSSIM, Revision 2 clear, understandable and presented in a logical sequence? How can the presentation and content of material be modified to improve the understandability of the manual?

3.3 Please comment on the effectiveness of the new organization of Chapter 4 (Considerations for Planning Surveys) to improve the understandability of the Chapter.

4 CONSIDERATIONS FOR PLANNING SURVEYS

4.1 Introduction

4.1.1 Purpose

This chapter is intended to introduce the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) user to general considerations for planning MARSSIM-based surveys by presenting areas of consideration common to Radiation Surveys and Site Investigations (RSSIs) with an emphasis on final status surveys (FSSs).[1] Detailed technical information about planning surveys will follow in the subsequent chapters. For the purposes of this chapter, it is assumed that a Historical Site Assessment (HSA) has been performed, and the results are available to the survey design team.

4.1.2 Scope

The emphasis in MARSSIM is on FSSs of surface soil and surfaces of buildings and outdoor areas to demonstrate compliance with cleanup regulations. However, MARSSIM discusses four types of surveys:

- Scoping
- Characterization
- Remedial Action Support (RAS)
- Final status

These survey types are discussed in more detail in **Chapter 5.** The emphasis on FSSs should be kept in mind during the design phase of all surveys. The topics discussed in this chapter focus on planning the FSS.

4.1.3 Overview of Survey Planning

In the following sections of this chapter, you will be introduced to many potentially unfamiliar concepts, terms, definitions, etc., specifically related to planning surveys. Informal definitions will be given in this chapter; however, the reader should refer to the **Glossary** for complete definitions. The following topics related to survey planning are discussed in this chapter:

- ***Data Quality Objectives (DQO) process:*** The DQO process is used to develop performance and acceptance criteria that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

- ***Survey types:*** There are four MARSSIM survey types: scoping, characterization, RAS, and final status. The emphasis of this chapter will be on FSSs.

[1] MARSSIM uses the word 'should' as a recommendation, not as a requirement. Each recommendation in this manual is not intended to be taken literally and applied at every site. MARSSIM's survey planning documentation will address how to apply the process on a site-specific basis.

Chapter 4 Organization

Charge Question #3

Is the information in MARSSIM, Revision 2 clear, understandable and presented in a logical sequence? How can the presentation and content of material be modified to improve the understandability of the manual?

3.4. Please comment on the effectiveness of moving derivations from Chapter 5 to Appendix O to improve the understandability of the Chapter.

O DETAILED CALCULATIONS FOR STATISTICAL TESTS AND ILLUSTRATIVE EXAMPLES FOR THE DETERMINATION OF DCGLS

O.1 Introduction

The first part of this appendix explains the method used to determine the number of data points (direct measurements or samples) for the WRS test and Sign test. The WRS test is used when residual radioactive material is present in the background or when measurements are not radionuclide-specific or if the net concentration of radioactive material at each location cannot be obtained. The Sign test is used when residual radioactive material is not in the background or when measurements are radionuclide-specific or if background levels are a small fraction of the Derived Concentration Guideline Level (DCGL).

The second part of the appendix provides illustrative examples of the determination of DCGLs for the elevated measurement comparison (DCGL$_{EMC}$) for outdoor and indoor survey units. Exposure pathway modeling is used to calculate the DCGL$_{EMC}$ as a function of the area of radioactive material. The final two parts of the appendix include information for the release of discrete radioactive particles and areas covered by the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA).

O.2 The WRS Test

The steps required to determine the number of data points for the WRS test are described below. The WRS test can be used for Scenario A or B. When Scenario B is used, the Quantile test also is required. Finally, the data must meet the requirements necessary to use the statistical tests, including required statistical power, especially for Scenario B.

O.2.1 Determine P_r

The probability that a random measurement from the survey unit exceeds a random measurement from the background reference area by less than the DCGL$_W$ when the survey unit median is equal to the Lower Bound of the Gray Region (LBGR) above background is defined as P_r. P_r is used in **Equation O-1** for determining the number of measurements to be performed during the survey (see also **Section 5.5.2**). **Table O.1** lists relative shift values and values for P_r. Using the relative shift, described in **Section 5.5**, the value of P_r can be obtained from **Table O.1**. Information on calculating individual values of P_r is available in NUREG-1505 (NRC 1998a). If the actual value of the relative shift is not listed in Table O.1, always select the next lower value that appears in the table. For example, $\Delta/\sigma = 1.67$ does not appear in **Table O.1**. The next lower value is 1.6, so the value of P_r would be 0.871014.

Table O.1: Values of P_r for Given Values of the Relative Shift, Δ/σ, When the Radionuclide Is Present in Background[1]

Δ/σ	P_r	Δ/σ	P_r
0.1	0.528192	1.4	0.838864
0.2	0.556223	1.5	0.855541
0.3	0.583985	1.6	0.871014

[1] If $\Delta/\sigma > 4.0$, use $P_r = 1.000000$

Appendix O

Questions