ROADMAP

Introduction to MARSAME

The *Multi-Agency Radiation Survey and Assessment of Materials and Equipment* manual (MARSAME) is a supplement to the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM 2002). MARSAME provides technical information on approaches for planning, implementing, assessing, and documenting surveys to determine proper disposition of materials and equipment (M&E).

The technical information in MARSAME is based on the data life cycle, similar to MARSSIM. Survey planning is based on the data quality objectives (DQO) process and is discussed in MARSAME Chapters 2, 3, and 4. Implementation of the survey design is described in MARSAME Chapter 5, with discussions on selection of instruments and measurement techniques as well as handling and segregating the M&E. MARSAME also includes the concept of measurement quality objectives (MQOs) for selecting and evaluating instruments and measurement techniques from the *Multi-Agency Radiological Laboratory Analytical Protocols* manual (MARLAP 2004). Assessment of the survey results uses data quality assessment (DQA) and the application of statistical tests as described in MARSAME Chapter 6. In addition to the first six chapters, which present the MARSAME process, the MARSAME manual contains the statistical basis for the DQOs, MQOs, and survey designs (Chapter 7) and illustrative examples of the information and process presented in MARSAME (Chapter 8).

The scope of MARSSIM was limited to surfaces soils and building surfaces. The scope of MARSAME is M&E potentially affected by radioactivity, including metals, concrete, tools, equipment, piping, conduit, furniture and dispersible bulk materials such as trash, rubble, roofing materials, and sludge. The wide variety of M&E requires additional flexibility in the survey process, and this flexibility is incorporated into MARSAME.

The Goal of the Roadmap

The increased flexibility of MARSAME comes with increased complexity. The goal of the roadmap is to assist the MARSAME user in negotiating the information in MARSAME and determining where important decisions need to be made on a project-specific basis, as summarized in Roadmap Figure 1. Roadmap Figure 2 provides additional detail and illustrates how the data life cycle is applied to disposition surveys. (Shaded blocks within the figures depict significant decisions or milestones.)

This roadmap is not designed to be a stand-alone document, but to be used as a quick reference to MARSAME for users already familiar with the process of planning, implementing, and assessing surveys. Roadmap users will find flowcharts summarizing major decision points in the survey process combined with references to sections in MARSAME with more detailed information. The roadmap assumes a familiarity with MARSAME terminology. Section 1.2 of MARSAME discusses key terminology, and a complete set of definitions is provided in the glossary.

Initial Assessment

The initial assessment (IA) is the first step in the investigation of M&E, similar to the historical site assessment (HSA) in MARSSIM. The purpose of the IA is to collect and evaluate information about the M&E to support a categorization decision and support potential disposition of the M&E (e.g., release or interdiction). Project managers are encouraged to use the IA to evaluate M&E for other hazards (e.g., lead, PCBs, asbestos) that could increase the complexity of the disposition survey design or pose potential risks to workers during subsequent survey activities (Section 5.2), or to human health and the environment following subsequent disposition of the M&E.

Categorization

MARSAME uses the term categorization to describe the decision of whether M&E are impacted or non-impacted. Non-impacted is a term that applies to M&E where there is no reasonable potential to contain radionuclide concentration(s) or radioactivity above background. Impacted is a term that applies to M&E that are not classified as non-impacted. Roadmap Figure 3 shows the categorization process as part of the IA.

Standardized Survey Designs

Most operating radiological facilities maintain standard operating procedures (SOPs) as part of a quality system. In many cases these SOPs include instructions for conducting disposition surveys. The first step in evaluating an existing SOP is to determine whether there is adequate information available to design a disposition survey. If the existing information is inadequate to design a disposition survey, it is inadequate for determining if an existing survey design is adequate either. Roadmap Figure 4 addresses assessing the adequacy of existing information for designing disposition surveys. Roadmap Figure 5 shows how implementing an existing SOP that is applicable to the M&E being investigated takes the user from MARSAME Chapter 2 to MARSAME Chapter 6. If a project-specific survey design needs to be developed, Roadmap Figure 5 directs the user to the information in MARSAME Chapter 3.

In some cases, it may be possible to modify the M&E to match the assumptions used to develop the existing SOP, or modify the existing SOP to address the M&E being investigated. M&E may be modified by changing the physical attributes described in Table 2.1 or the radiological attributes described in Table 2.2. Modifications to the SOP are most often associated with MQOs such as the measurement detectability (Section 5.7) or measurement quantifiability (Section 5.8). Modifying the MQOs may result in small changes such as an increased count time (e.g., to account for an increase in measurement uncertainty or a decrease in counting efficiency) or larger changes such as selecting a different instrument (e.g., a gas-proportional detector instead of a Geiger-Mueller detector) or a different measurement technique (e.g., in situ measurements instead of scan measurements). Information on evaluating an existing survey design to determine if it will meet the DQOs for the M&E being investigated is provided in Section 3.10.

Develop a Decision Rule

MARSAME Chapter 3 focuses on developing a decision rule by identifying inputs to the decision (see Roadmap Figure 6, which depicts the various inputs to the decision). A decision rule is a theoretical “if…then…” statement that defines how the decision maker would choose among alternative actions. There are three parts to a decision rule:

- An action level that causes a decision maker to choose between the alternative actions (see Roadmap Figure 7 and Section 3.3),
- A parameter of interest that is important for making decisions about the target population (see Section 3.4), and
- Alternative actions that could result from the decision (Section 3.5).

Other inputs to the decision that are discussed in MARSAME Chapter 3 include selecting radionuclides or radiations of concern (Section 3.2), developing survey unit boundaries (see Roadmap Figure 8 and Section 3.6), inputs for selecting provisional measurement methods (Section 3.8), and identifying reference materials if necessary (Section 3.9).

Survey Design

Once a decision rule has been developed, a disposition survey can be designed for the impacted M&E being investigated. The disposition survey incorporates all of the available information to determine the quality and quantity of data required to support a disposition decision. Roadmap Figure 9 shows how a disposition survey design is developed.

MARSAME, like MARSSIM, provides information on using a null hypothesis that radionuclide concentrations or activity levels associated with the M&E exceed the action level (i.e., Scenario A). MARSAME also incorporates additional technical information from NUREG-1505 (NRC 1998a) and MARLAP for designing surveys using Scenario B where the null hypothesis is that the radionuclide concentrations or activity levels are less than the action level. The assignment of values to the lower bound of the gray region (LBGR) and upper bound of the gray region (UBGR), specification of decision error rates, and classification are all similar to information provided in MARSSIM.

MARSAME provides information on four types of survey designs:

- Scan-only survey designs (Section 4.4.1),
- In situ survey designs (Section 4.4.2),
- Survey designs that combine scans and static measurements (MARSSIM-type surveys, Section 4.4.3), and
- Method-based survey designs (Section 4.4.4).

A method-based survey design is a special type of scan-only, in situ, or MARSSIM-type survey design that incorporates a required measurement method or combination of measurement technique and instrumentation, so Roadmap Figure 9 only depicts the first three. It will still need to address all of the required components, such as number, type, location, and sensitivity of measurements.

Scan-only survey designs use scanning techniques to measure the M&E. In general, scan-only survey designs may be applied to all types of M&E, from small individual items to large quantities of materials to large, complex machines. Scan-only surveys range from hand-held instruments moving over the M&E to conveyorized systems that move the M&E past the detectors. Scan-only survey designs often require the least amount of resources to design and implement, and are easy to incorporate into SOPs or project-specific survey designs. In many cases it is not necessary to document the results of individual scanning measurements because it is easy to identify results that exceed some threshold corresponding to the action level. With the real-time feedback available during Class 1 scan-only surveys, the user can implement a “clean as you go” practice by segregating M&E that exceed the threshold for additional investigation. Drawbacks to scan-only surveys include increased measurement uncertainty because of variations in scan speed and source to detector distance making it difficult to detect or quantify radionuclides with action levels close to zero or background.

In situ surveys are characterized by limited numbers of static measurements with long count times (relative to scan-only surveys) to measure the M&E. In situ surveys generally are applicable to situations where scan-only surveys are determined to be unacceptable. For example, variations in source-to-detector distance, scan speed, and surface efficiency that are commonly associated with scanning measurements can often be effectively controlled using an in situ survey design. There are a wide variety of in situ measurement techniques available including box counters, portal monitors, in situ gamma spectroscopy systems, and direct measurements with hand-held instruments. The primary difference between an in situ survey and a MARSSIM-type survey is that an in situ survey measures 10–100% of an item (using one or several measurements) to determine the average radionuclide concentration for that item. A MARSSIM-type survey uses a statistically based number of measurements (that generally do not measure 10% of the item or group of items being surveyed) to calculate an average radionuclide concentration for that item or group of items.

MARSSIM-type survey designs combine a statistically based number of static measurements or samples (Roadmap Figure 10) to determine average radionuclide concentrations with scanning to identify localized areas of elevated activity (Roadmap Figure 11). MARSSIM-type surveys are designed using the information in MARSSIM. The process of identifying survey unit sizes, laying out systematic or random measurement grids, and calculating project- and item-specific area factors requires significantly greater effort during planning and implementation than either scan-only or in situ survey designs. In general, MARSSIM-type surveys of M&E are only performed on large, complicated M&E with a high inherent value after scan-only and in situ survey designs have been considered and rejected as inappropriate or unacceptable.

Measurement Quality Objectives

Measurement quality objectives (MQOs) are characteristics of a measurement method required to meet the objectives of the survey. Additional information on MQOs can be found in MARSAME Section 3.8, Section 5.5, and Section 7.3 as well as MARLAP Chapter 3. MQOs are an important concept that was not presented in MARSSIM, and should be an important factor when evaluating existing survey designs and SOPs for applicability to surveying M&E.
MQOs for a project include, but are not limited to—

- The measurement method uncertainty at a specified concentration expressed as a standard deviation (Sections 3.8.1, 5.5, and 7.4);
- The measurement method's detection capability expressed as the minimum detectable concentration (MDC; see Sections 3.8.2, 5.7, and 7.5);
- The measurement method's quantification capability expressed as the minimum quantifiable concentration (MQC; see Sections 3.8.3, 5.8, 7.6, and 7.7);
- The measurement method's range, which defines the measurement method's ability to measure the radionuclide or radiation of concern over some specified range of concentration or activity (see Section 3.8.4 and Appendix D);
- The measurement method's specificity, which refers to the ability of the measurement method to measure the radionuclide or radiation of concern in the presence of interferences (Section 3.8.5); and
- The measurement method's ruggedness, which refers to the relative stability of measurement method performance for small variations in measurement method parameter values (see Section 3.8.6 and Appendix D).

Implement the Survey Design

The implementation phase of the data life cycle is when the activities described in the survey design are performed. Roadmap Figure 12 illustrates the process for implementing disposition surveys.

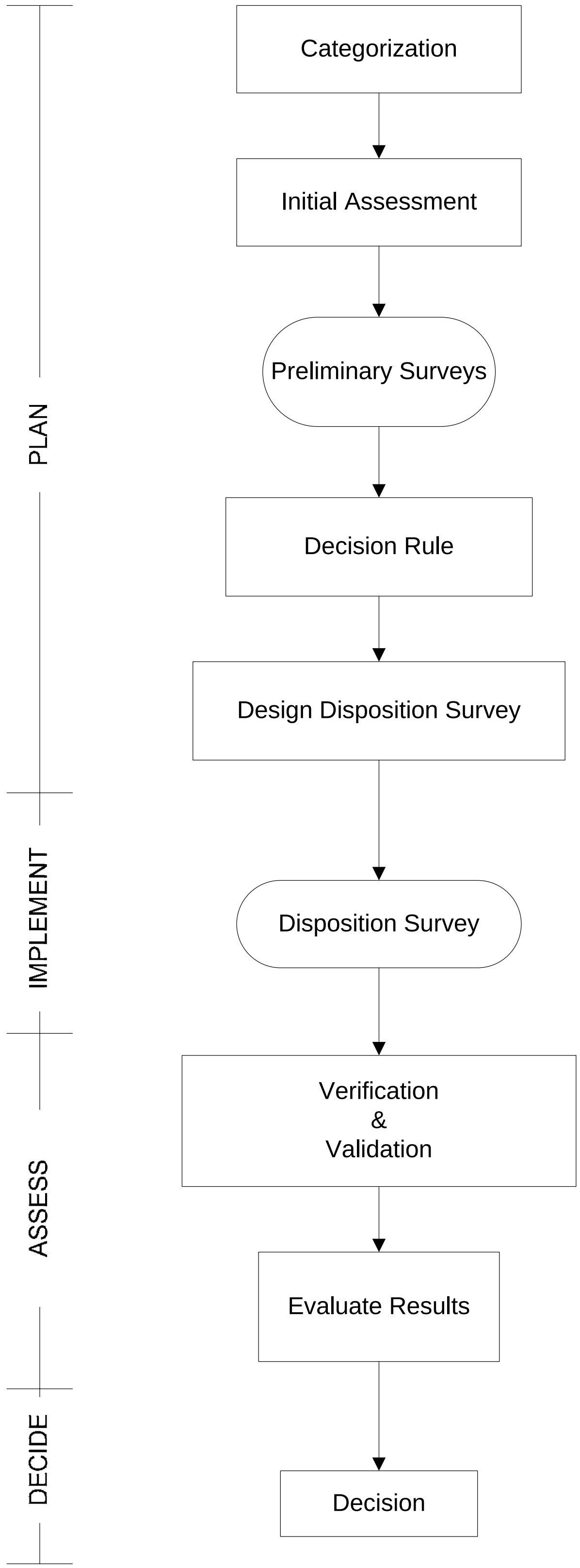
MARSAME, like MARSSIM, does not provide prescriptive guidance for implementing survey designs. Chapter 5 presents topics to be considered while implementing disposition surveys. This approach allows MARSAME users flexibility to use either existing or new and innovative techniques that meet the survey objectives.

Evaluate the Results

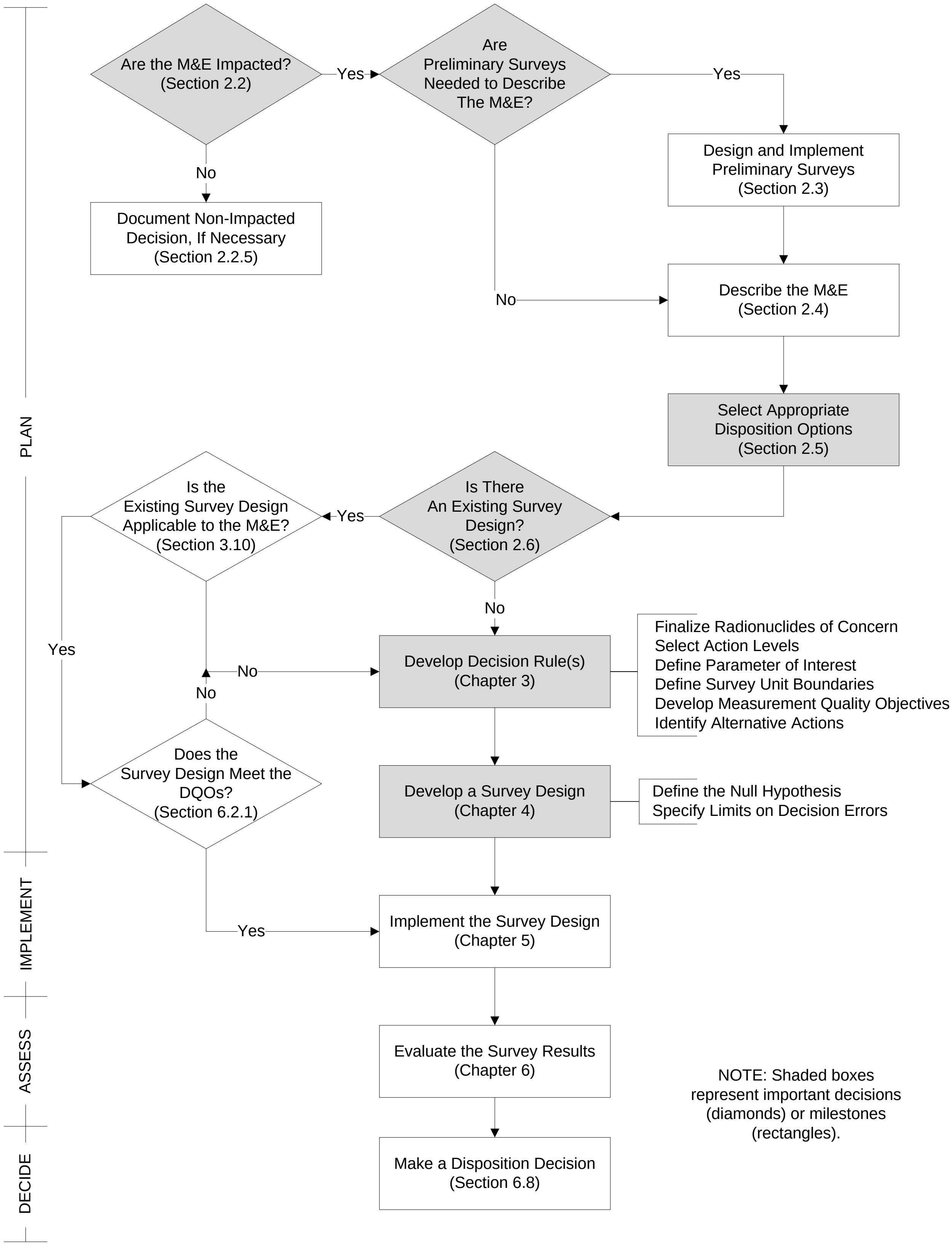
The assessment phase of the data life cycle involves evaluating the results of the survey as shown in Roadmap Figure 13. DQA is used to evaluate the survey results. DQA is a scientific and statistical evaluation that determines whether data are the type, quality, and quantity to support their intended use. When individual measurement results are not recorded, as allowed in some scan-only survey designs, the preliminary data review will be brief and based primarily on the results of quality control (QC) measurements. To increase the flexibility and general applicability of MARSAME, several evaluation methods have been incorporated in addition to the Sign test and Wilcoxon Rank Sum (WRS) test used in MARSSIM. Roadmap Figure 14 presents information on interpreting survey results for scan-only and in situ surveys. Roadmap Figure 15 presents information on interpreting survey results for MARSSIM-type surveys.

Summary

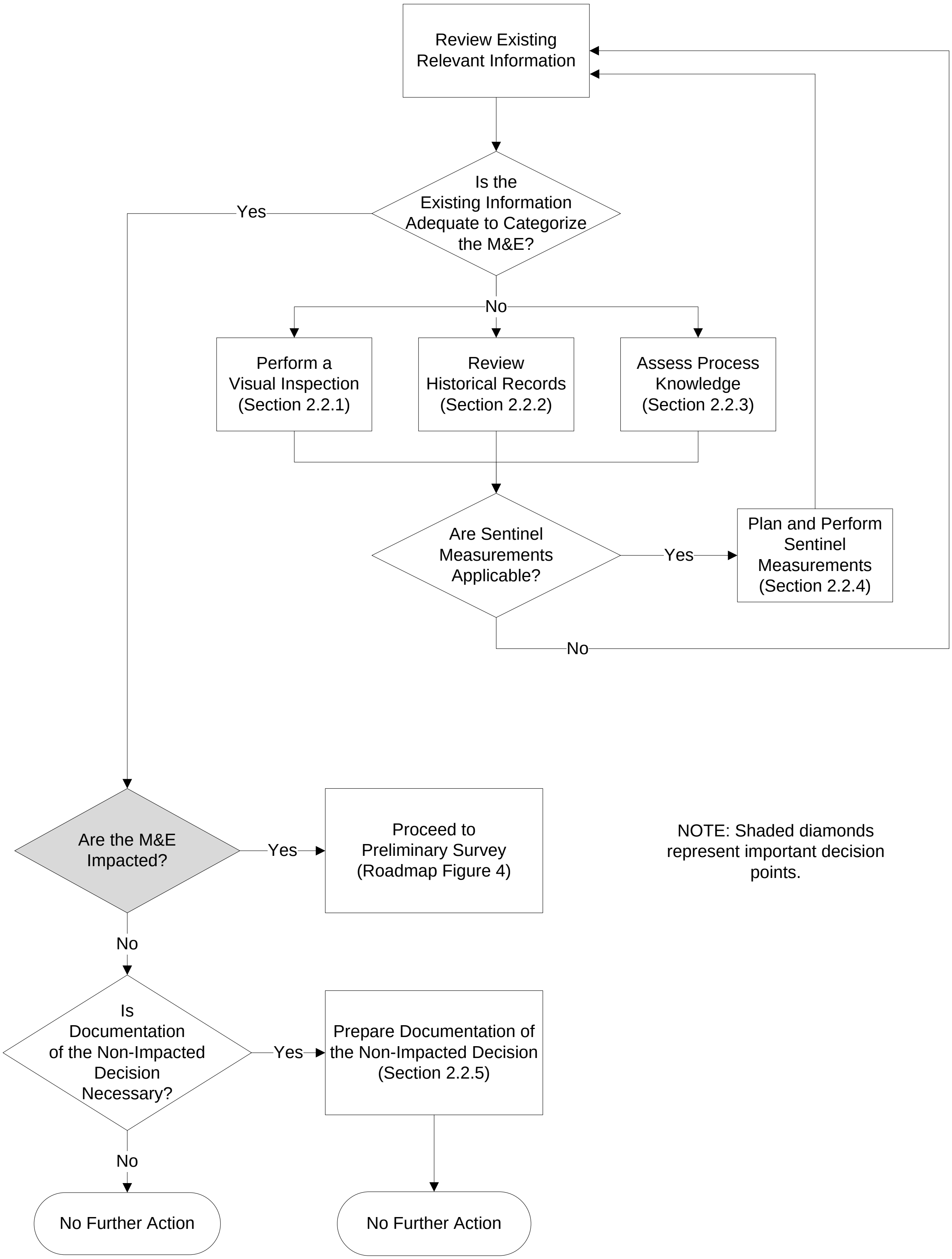
The roadmap presents a summary of the data life cycle as it applies to disposition surveys in MARSAME and identifies where information on important topics are located in MARSAME. Flow charts are provided to summarize major steps in the survey design process, again citing appropriate references in MARSAME.



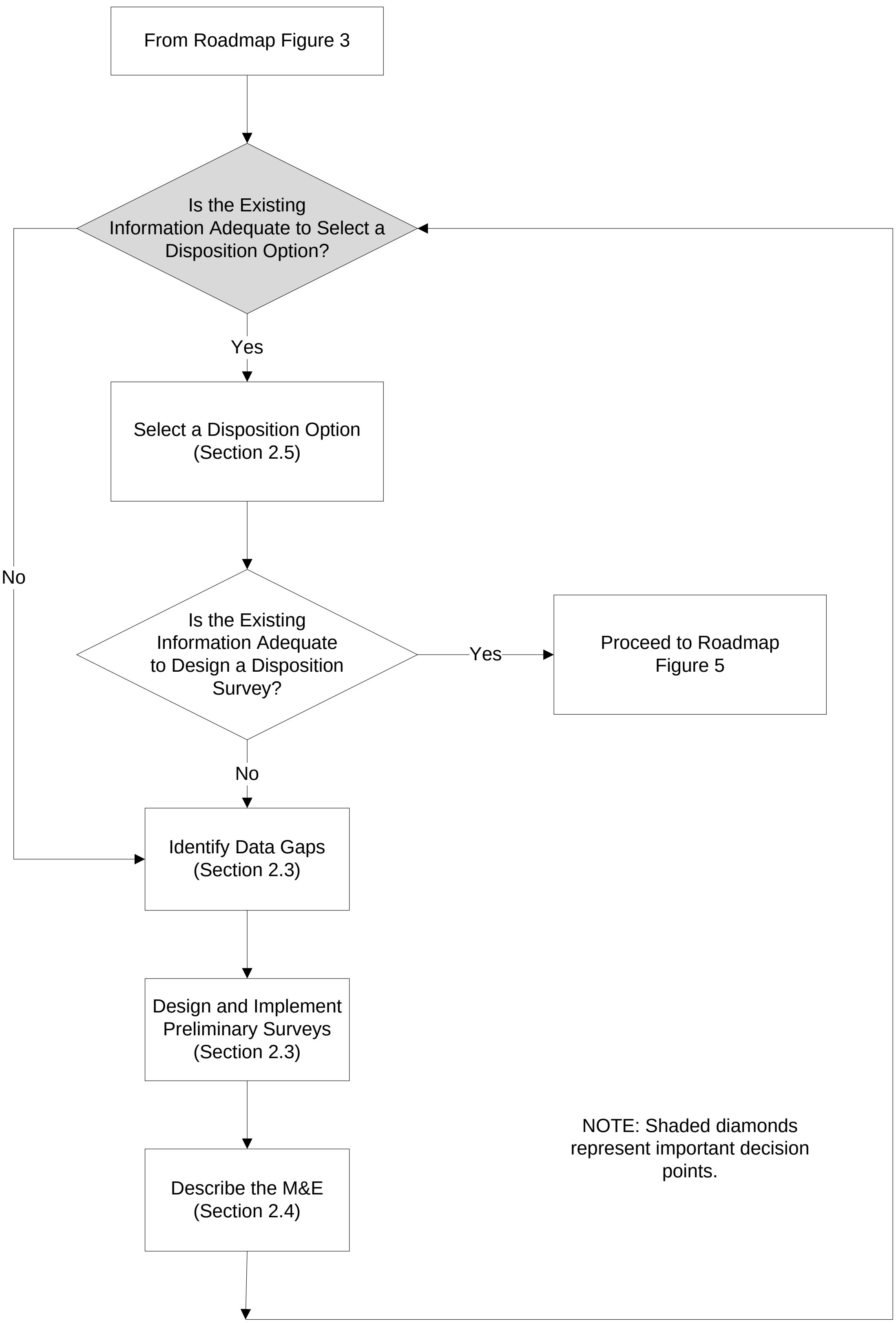
Roadmap Figure 1. Overview of MARSAME Process



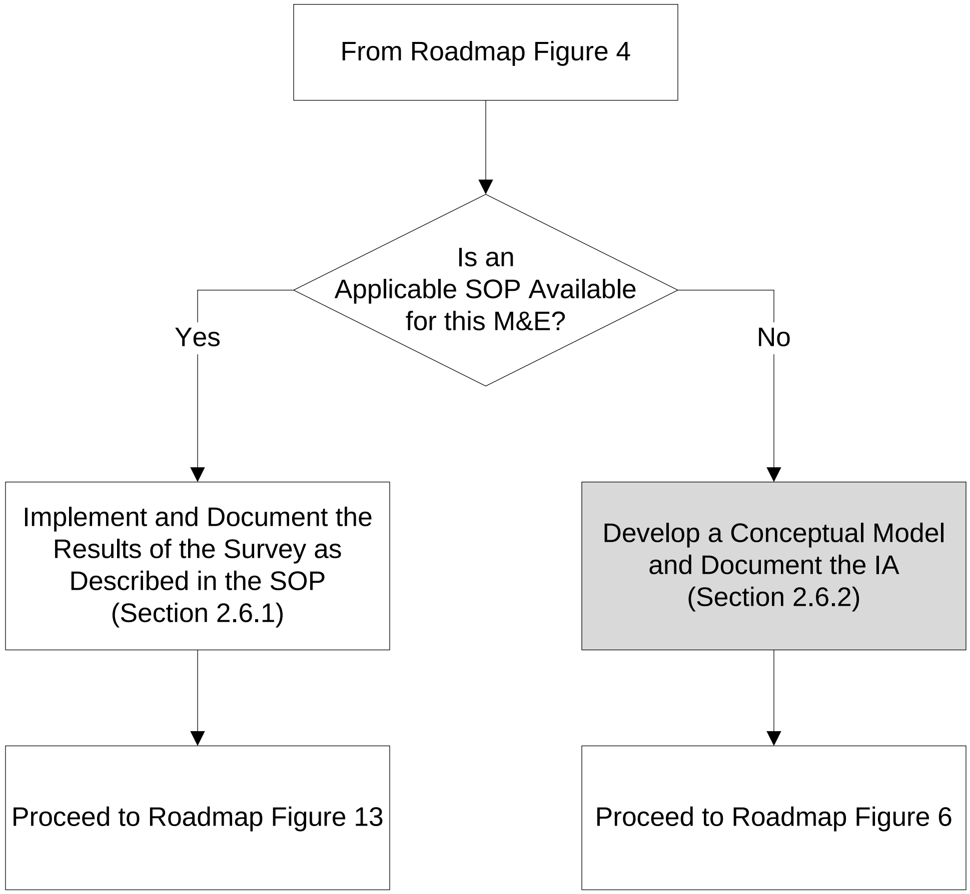
Roadmap Figure 2. The Data Life Cycle Applied to Disposition Surveys



Roadmap Figure 3. The Categorization Process as Part of Initial Assessment

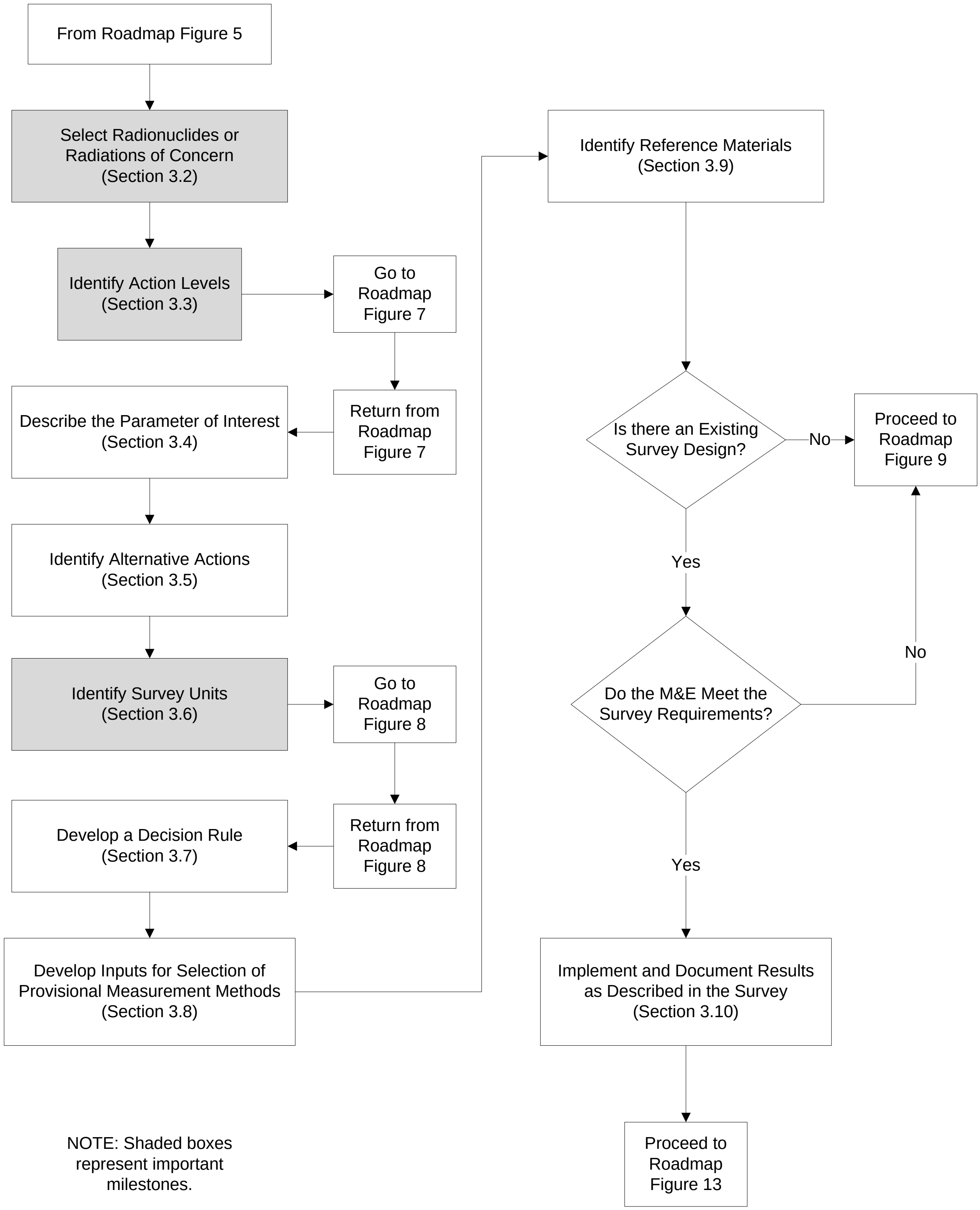


Roadmap Figure 4. Assessing Adequacy of Information for Designing

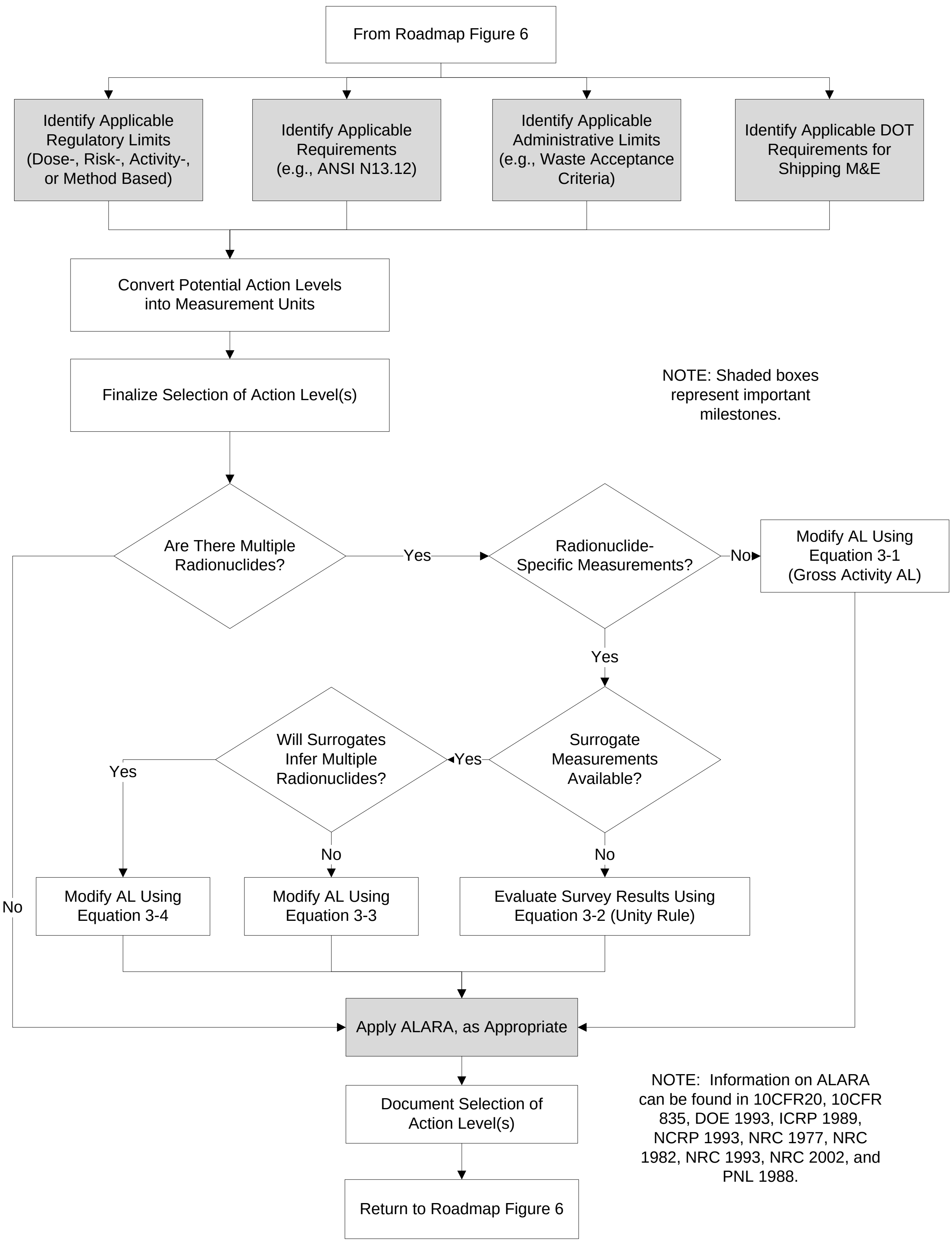


NOTE: Shaded box represents important milestone.

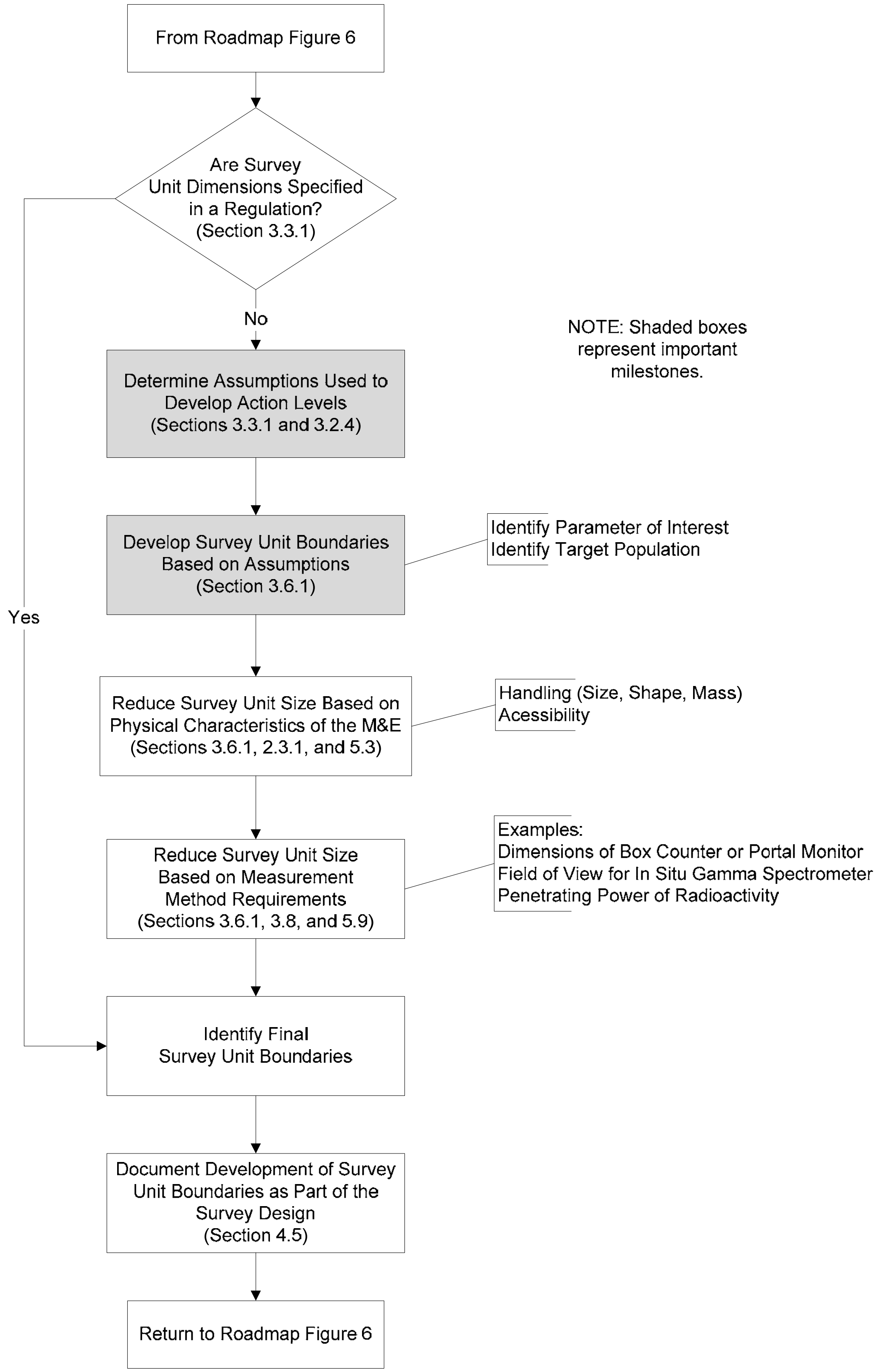
Roadmap Figure 5. Assessing the Applicability of Existing SOPs



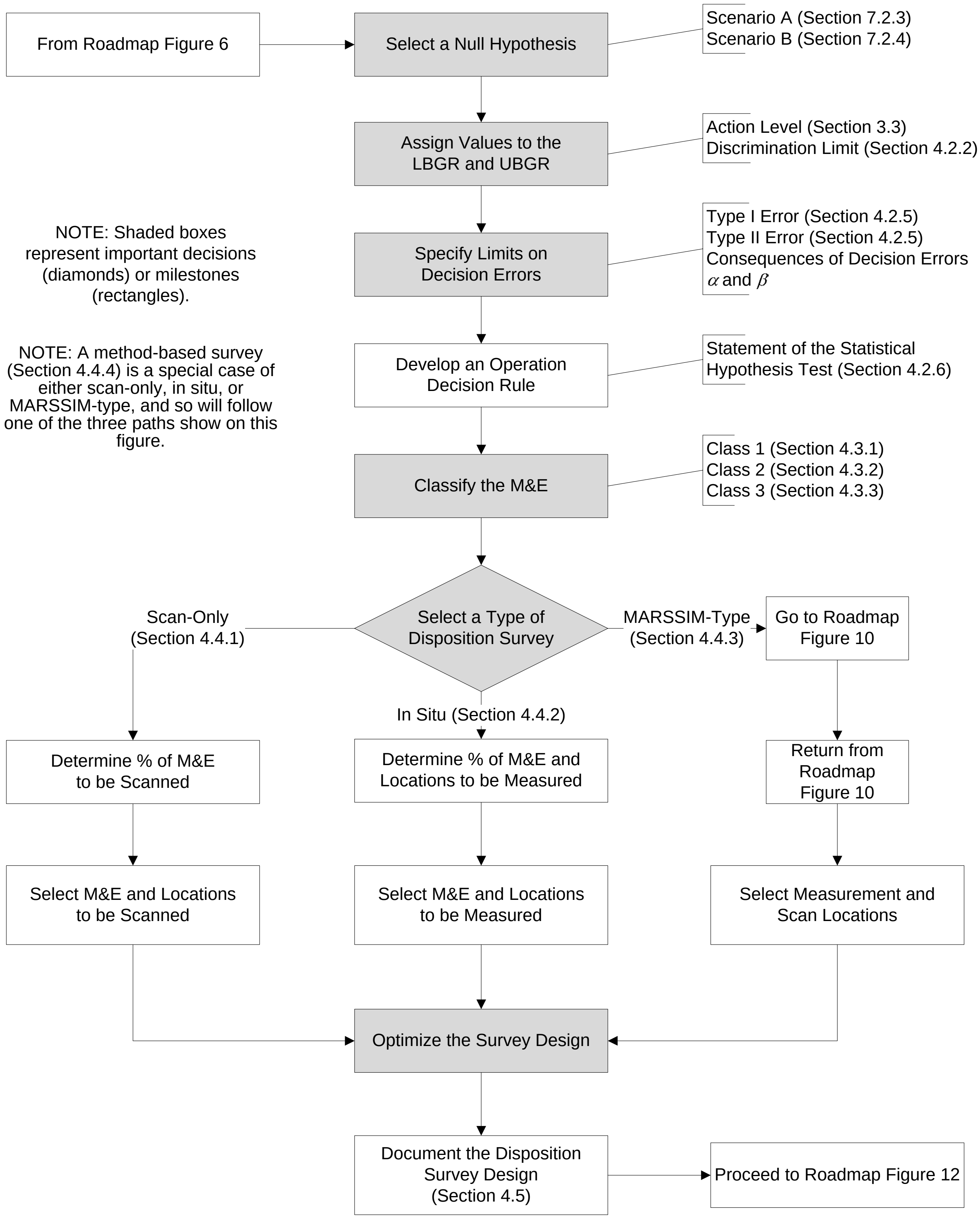
Roadmap Figure 6. Identify Inputs to the Decision



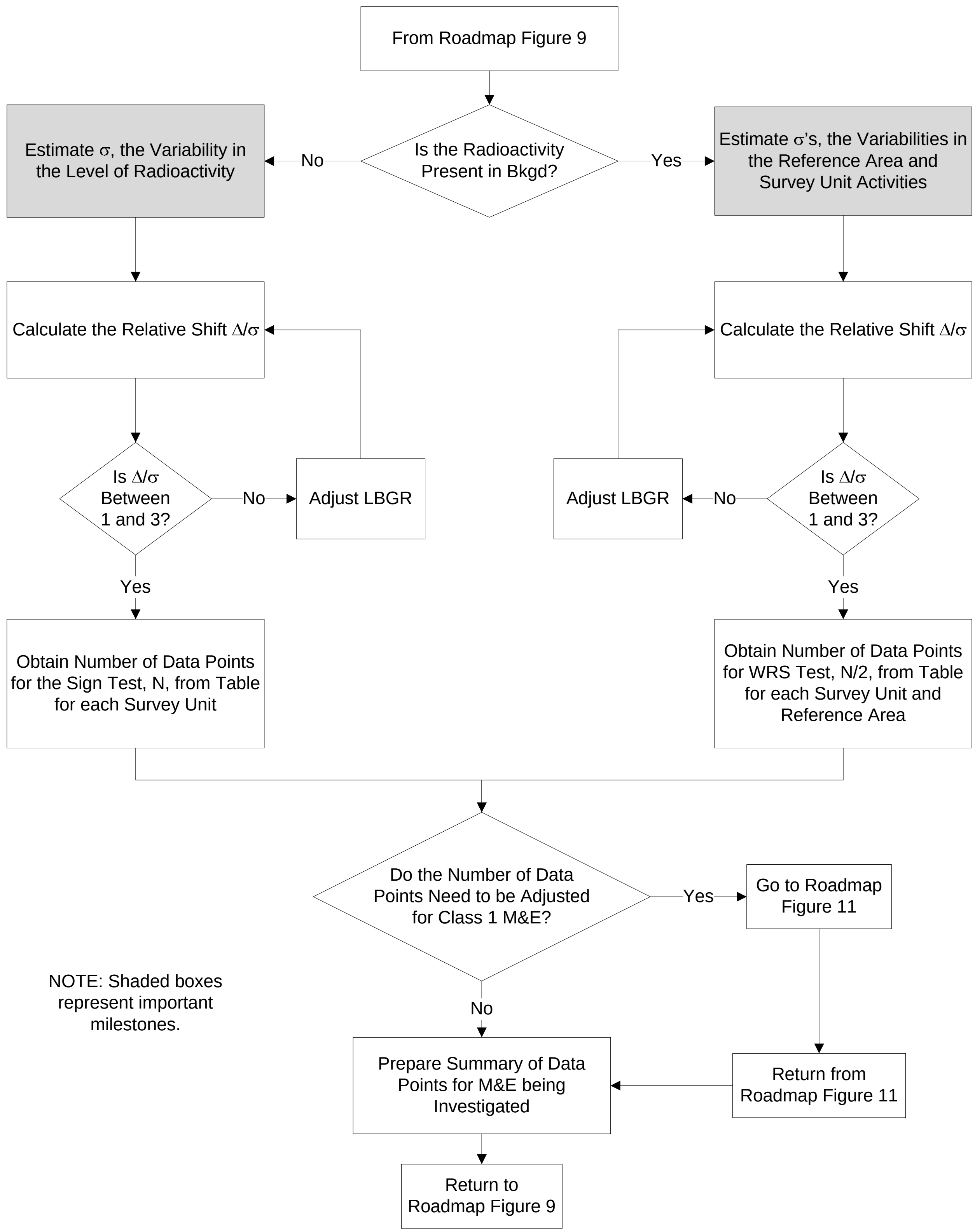
Roadmap Figure 7. Identify Action Levels



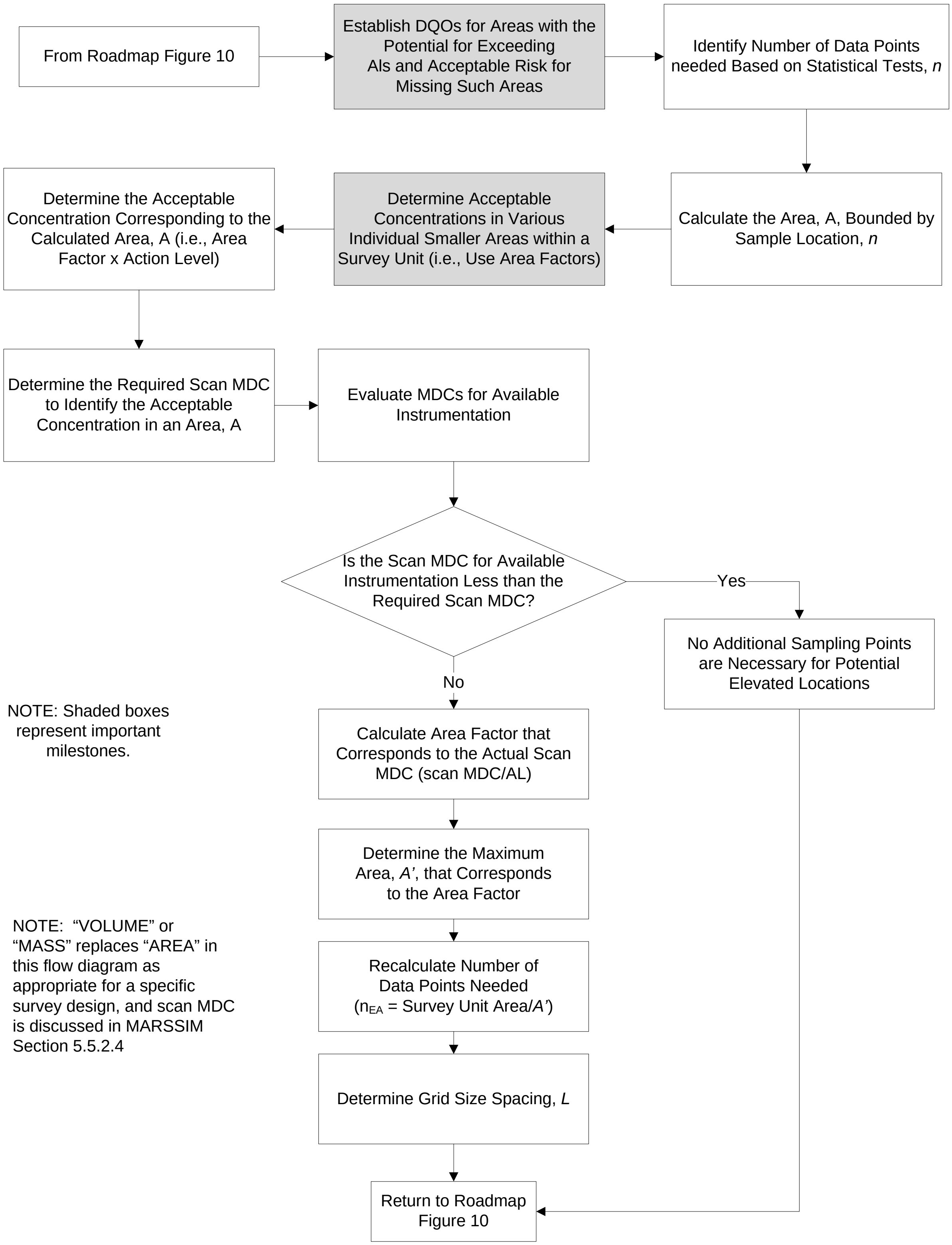
Roadmap Figure 8. Developing Survey Unit Boundaries (Apply to all Impacted M&E for each set of Action Levels Identified in Section 3.3)



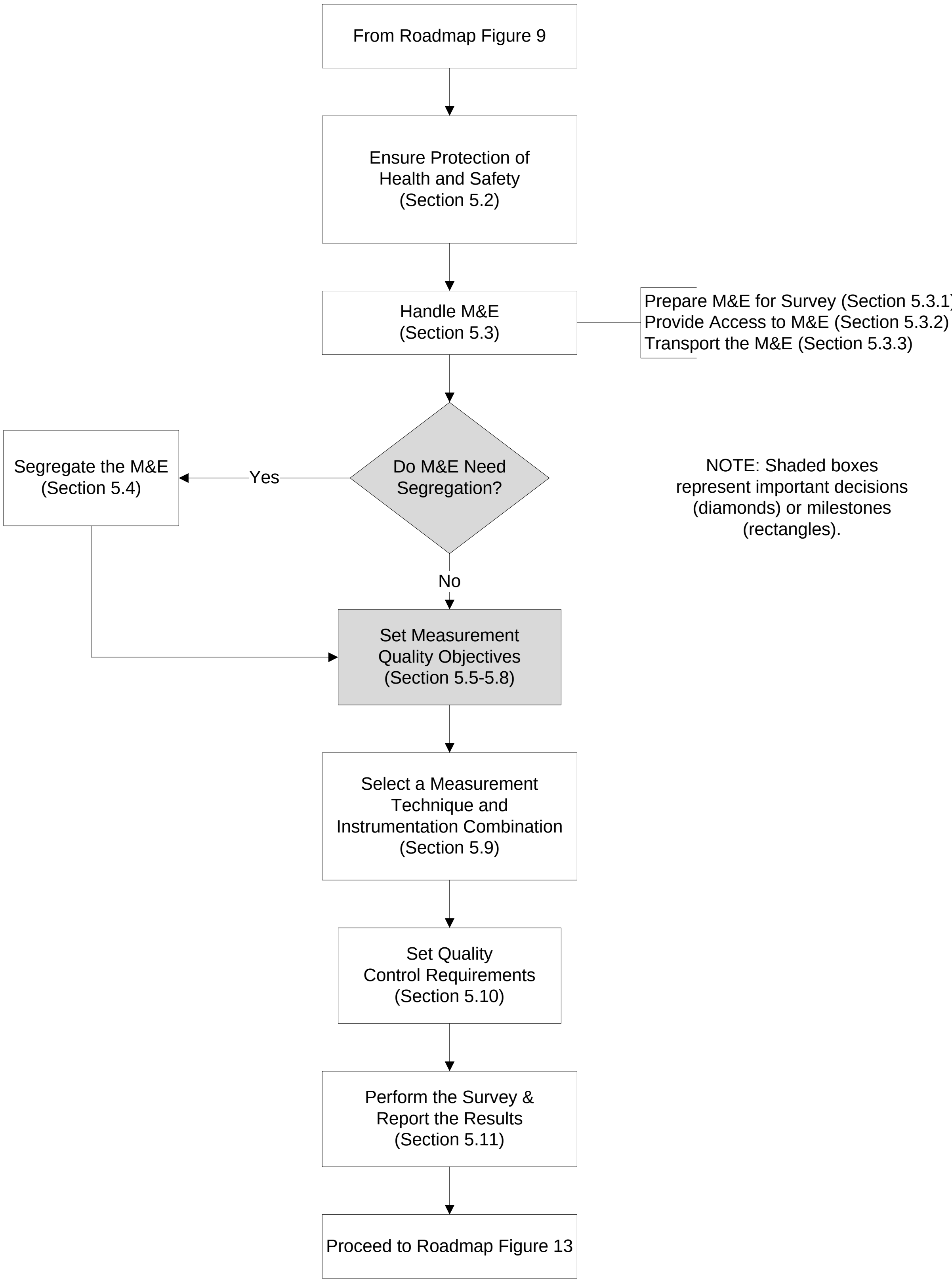
Roadmap Figure 9. Flow Diagram for Developing a Disposition Survey Design



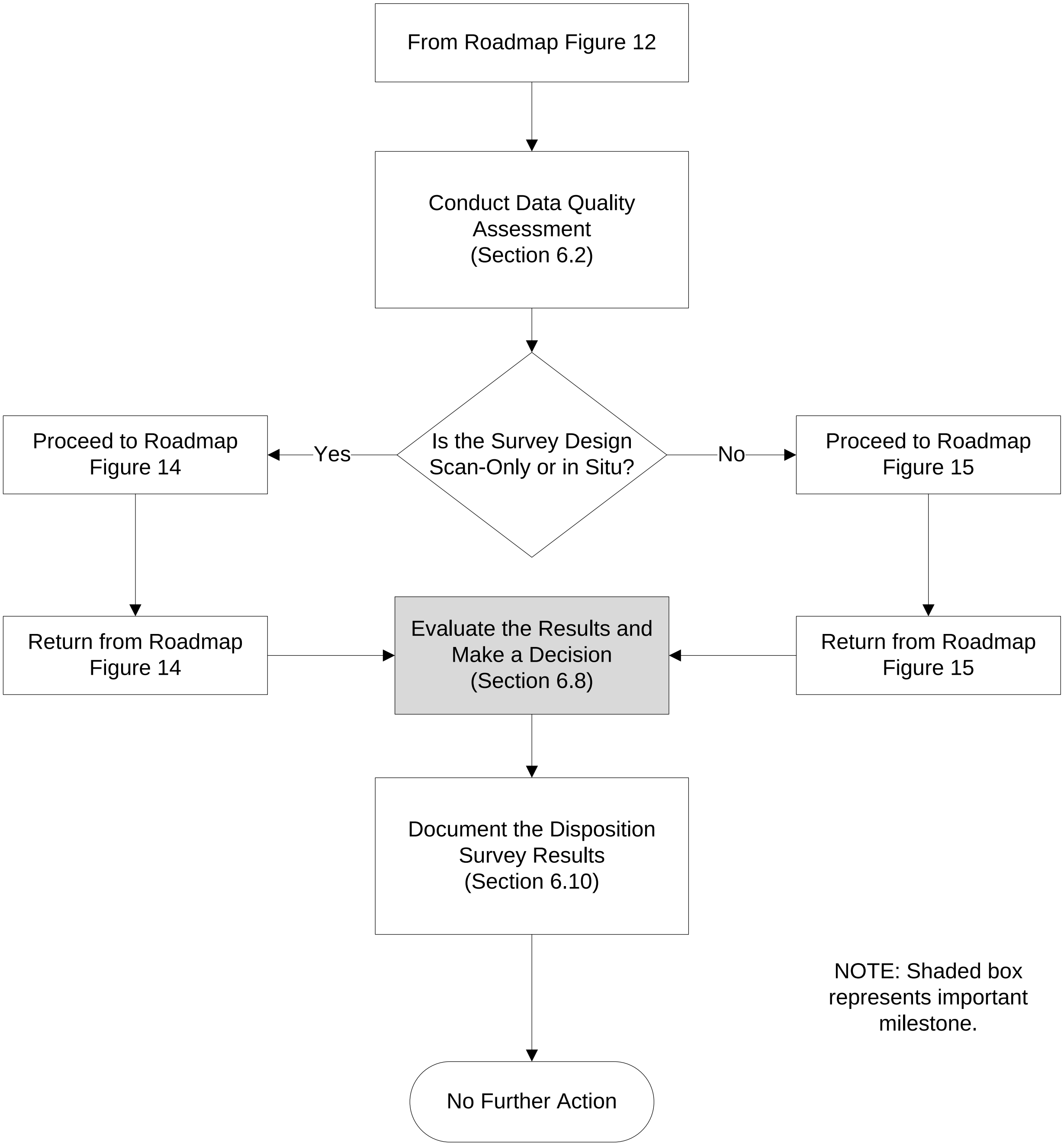
Roadmap Figure 10. Flow Diagram for Identifying the Number of Data Points for a MARSSIM-Type Disposition Survey



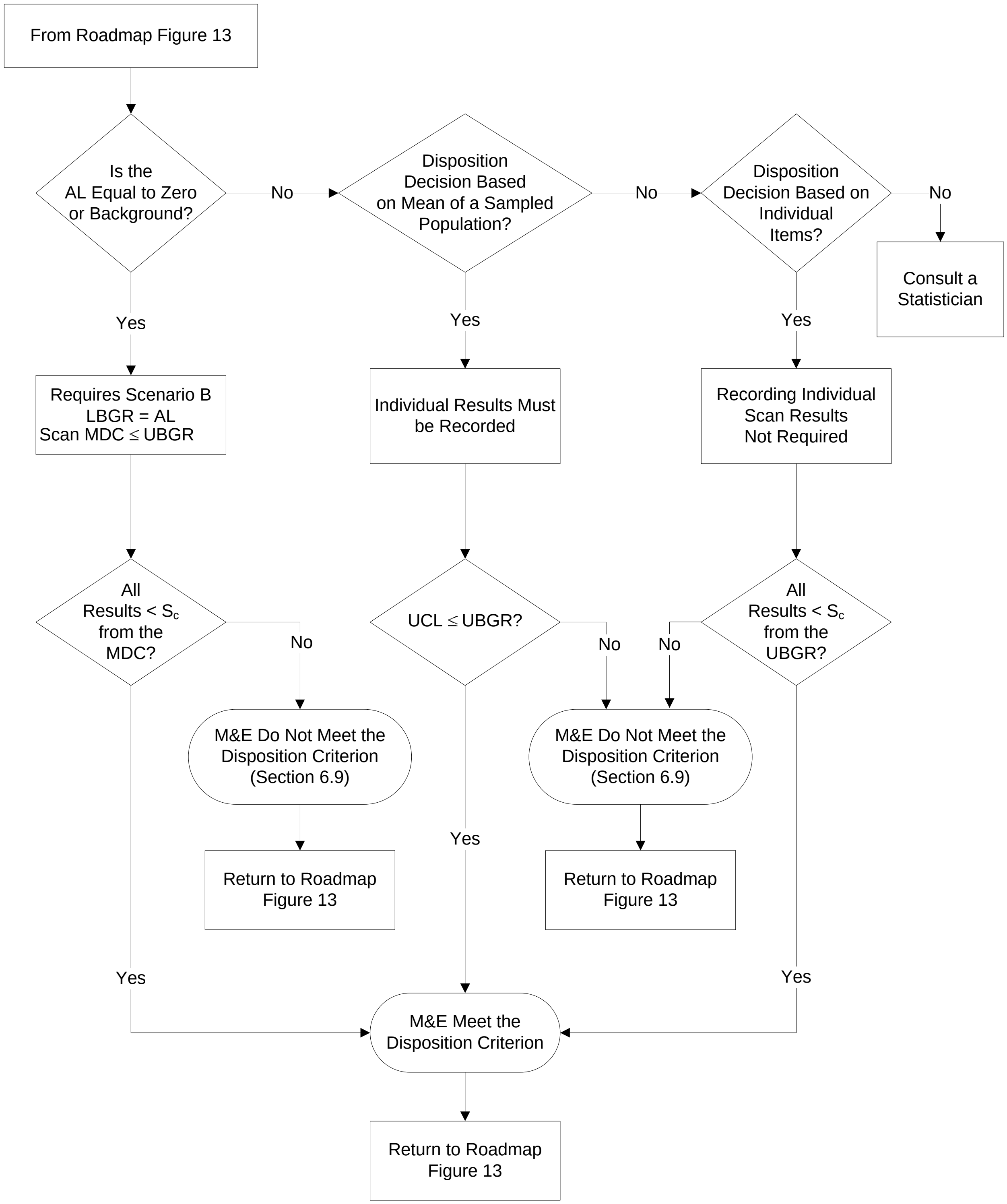
Roadmap Figure 11. Flow Diagram for Identifying Data Needs for Assessment of Potential Areas of Elevated Activity in Class 1 Survey Units for MARSSIM-Type Disposition Surveys



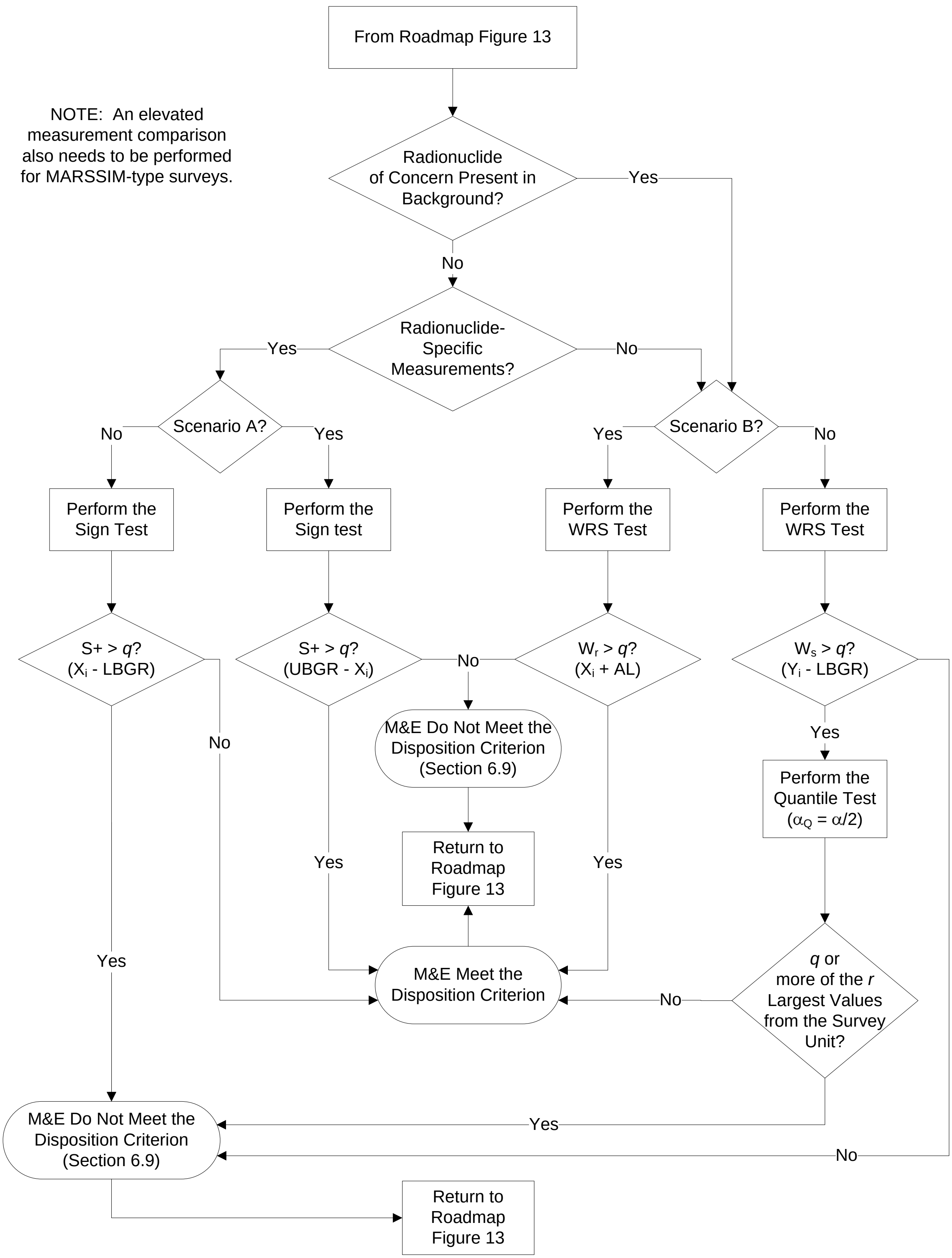
Roadmap Figure 12. Implementation of Disposition Surveys



Roadmap Figure 13. Assess the Results of the Disposition Survey



Roadmap Figure 14. Interpretation of Survey Results for Scan-Only and In Situ Surveys



Roadmap Figure 15. Interpretation of Survey Results for MARSSIM-Type Surveys