4.0 Planning and Designing the Final Status Survey

The purpose of the final status survey is to demonstrate that the release criteria established by the NRC have been met. Demonstrating that this has been achieved requires collection of data for determining surface activity levels, direct exposure rates, and radionuclide concentrations in soil. In addition, supplemental information, such as radionuclide concentrations in ground water and total site inventory of radioactive material, may be required by the NRC. The data should be accurate and reliable and should be adequate to satisfy other conditions and considerations which the NRC may impose. A well-documented, statistically based survey plan will be the basis for meeting these objectives.

The survey plan should describe the survey design in detail. The plan should include:

- A list of the types, numbers, and locations of measurements and samples to be obtained;
- Information on the equipment and techniques to be used for measuring, sampling, and analyzing data;
- The methods to be used to interpret and evaluate the survey data; and;
- Quality control procedures for ensuring the validity of the data.

This section discusses considerations for developing such a plan, including quality control procedures, and site information required to plan and design the survey. This section also describes how to select measurement/sampling locations and to determine the sampling frequency that will be required to assure the statistical significance of the data. A general flow chart for a radiological survey supporting license termination is provided in Figure 4-6; detailed flow charts for various activities related to the survey process are provided in Section 6.0. Appendix B provides a sample survey plan for a hypothetical reference fuel fabrication facility.

4.1 General Considerations for Survey Planning

4.1.1 Quality Assurance

Because the purpose of the final status survey is to demonstrate that a facility meets the established release criteria, the survey should be performed in a manner that assures the results are accurate and that uncertainties have been adequately considered. An effective QA program will define the data quality objectives of the survey and thereby determine, to a significant extent, the survey design. This program will operate in all stages of the survey through final validation of the data and the interpretation of the results.

The consensus nuclear industry standard for quality assurance is ANSI/ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities (ANSI 1989). The NRC has also issued guidance for an acceptable QA program in Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Program — Effluent Streams and the Environment (NRC 1979). A quality assurance program, consistent with the information contained in these documents, should be developed.

Surveys should be performed by trained individuals who are following standard, written procedures, and are using properly calibrated instruments which are sensitive to the suspected contaminant. The custody of samples should be tracked from collection to analysis. Data should be recorded in an orderly and verifiable way and reviewed for accuracy and consistency. Every step of the decommissioning process, from training personnel to calculating and interpreting the data, should be documented in a way that lends itself to audit. These requirements are achieved through a formal program of quality assurance. Failure to follow such requirements may limit the usefulness of portions of the survey data.

<u>QA Plans</u>

The decommissioning plan should include a written QA plan that describes the organizational structure under which the decommissioning efforts — and particularly the final status survey — will be conducted. Functional and administrative responsibilities and interfaces of key individuals should be clearly delineated. Education, experience, and any other requirements for each key position should be specified. The size and complexity of the organizational structure will be determined by the magnitude of the decommissioning action.

QA Coordination

One individual should be designated as the QA officer or QA coordinator. This individual should not be involved in survey activities that generate data and should report directly to the project manager. The QA officer/coordinator should be responsible for ensuring that all QA objectives of the survey are met, should review selected field and analytical data to ensure adherence to procedures, and should approve the quality of data before it us used to test hypotheses regarding attainment of cleanup standards. Specifically, this individual:

- Serves as the focal point for survey QA activities and ensures that they are conducted in accordance with established policies and procedures

- Oversees survey activities by conducting internal audits and/or surveillance.

Documentation Requirements

All aspects of the survey should be documented in detail. For certain field or laboratory activities, consensus or industry-wide procedures, such as those developed by the Environmental Protection Agency (EPA), American Society of Testing and Materials (ASTM), DOE's Environmental Measurements Laboratory (EML), or other such organizations may be either adopted in whole or adapted to meet the requirements of the specific decommissioning action. These procedures become part of the administrative record of the survey. The procedures should be approved by the individual responsible for the decommissioning project and the effective date of the procedure should be indicated. Changes or exceptions to established procedures are likely to be required; and these also should be properly documented, signed, and dated.

Training/Certification of Survey Staff

All personnel conducting the surveys should receive training to qualify in the procedures being performed. The extent of training and qualifications should be commensurate with the education, experience, and proficiency of the individual and the scope, complexity, and nature of the activity. Training should be designed to achieve initial proficiency and to maintain that proficiency at least over the course of the decommissioning process. Records of training, including testing to demonstrate qualification, should be maintained.

Equipment Maintenance and Calibration

Measuring equipment should be maintained, calibrated, and tested to assure the validity of the survey data. Further, the procedures, responsibilities, and schedules for calibrating and testing equipment should be documented.

Proper maintenance of equipment varies, but maintenance information and use limitations should be provided in the vendor documentation. All measurement and analytical equipment should be tested and calibrated before initial use and should be recalibrated if maintenance or modifications could invalidate earlier calibrations. Field and laboratory equipment should be calibrated based on standards traceable to the National Institute of Standards and Technology (NIST). In those cases where NIST-traceable standards are not available, standards of an industry-recognized organization (for example, the New Brunswick Laboratory for various uranium standards) may be used. Minimum frequencies for calibrating equipment should be established and documented.

Measuring equipment should be tested at least once each day the equipment is used. Test results should be recorded in tabular or graphic form and compared to predetermined, acceptable performance ranges. Equipment that does not conform to the performance criteria should be immediately removed from service until the deficiencies can be resolved.

Data Management

A consistent method of data generation, handling, computations, evaluation, and reporting should be developed and documented as part of the survey plan. In general, information and data should be recorded in bound logs or on standardized field and laboratory record forms. Analytical data should not be obliterated by erasing or the use of whiteout. Incorrect entries should be corrected by striking a single line across the entry and entering new data. The correction or change should be initialed and dated by the person making the entry.

A system of data review and validation is important to ensure consistency, thoroughness, and acceptability. This begins with regular (daily or weekly) reviews of calculations based on field data; and reviews of final reports by survey and laboratory supervisors, QA officials, and project managers. All reviews should be signed and dated. Any questionable or invalid data should be identified in project records and in the survey report. Active records should remain under direct control of a designated individual during report preparation; inactive records should be protected from loss or destruction by storage in access-controlled areas or files and in facilities with fire protection. It is also recommended that copies (microfilm, computer disc, photostats, etc.) of critical data be produced and stored at a separate location.

Sample Chain-of-Custody

One of the most important aspects of sample management is to ensure that the integrity of the sample is maintained; that is, that there is an accurate record of sample collection, transport, analysis, and disposal. This ensures that samples are neither lost nor tampered with and that the sample analyzed in the laboratory is actually and verifiably the sample taken from a specific location in the field.

Sample custody should be assigned to one individual at a time. This will prevent confusion of responsibility. Custody is maintained when (1) the sample is under direct surveillance by the assigned individual, (2) the sample is maintained in a tamper-free container, or (3) the sample is within a controlled-access facility.

A chain-of-custody record (a standard form) should be initiated by the individual collecting or overseeing the collection of samples. A copy of this form should accompany the samples throughout transportation and analyses; and any break in custody or evidence of tampering should be documented.

Audits

Periodic audits should be performed to verify that survey activities comply with established procedures and other aspects of the QA plan and to evaluate the overall effectiveness of the QA program. The audits should be conducted in accordance with written guidelines or checklists, and should be performed by individuals not actively participating in the activities being audited. Audit results are reported to responsible management in writing, and actions to resolve identified deficiencies should be tracked and appropriately documented.

4.1.2 Health and Safety

Consistent with the approach for any operation, decommissioning activities should be planned and monitored to assure the health and safety of the worker and other personnel, both on- and off-site, are adequately protected.

Contamination control and radiation control support surveys are conducted for protection of personnel performing decontamination activities. These surveys are operational in nature, as opposed to determining the radiological status of a facility, and are typically conducted as part of a licensee's ongoing radiation protection program. However, at the stage of determining the final status of the site, residual radioactivity is expected to be below the guideline values for unrestricted release; therefore, the final status survey should not require radiation protection controls.

The primary health and safety concerns during a final survey are the common potential industrial hazards typically found at a construction site. These include exposed electrical circuitry, excavations, enclosed work spaces, sharp objects or surfaces, falling objects, tripping hazards, and working at heights. The survey plan should incorporate requirements and procedures for eliminating, avoiding, or minimizing these potential safety hazards.

4.1.3 Physical Characteristics of Site

The physical characteristics of the site will have a significant impact on the complexity, schedule, and cost of a survey. These characteristics include the number and size of buildings, type of building construction, building condition, total area of grounds, topography, and ground cover.

Building Interiors

Building design and condition will have a marked influence on the survey efforts. The time required to conduct a survey of building interior surface is essentially directly proportional to the total surface area. For this reason the degree of survey coverage is decreased as the potential for residual activity decreases.

Building construction features such as ceiling height and incorporation of ducts, piping, and certain other services into the construction will determine the ease of accessibility of various surfaces. Scaffolding, cranes, manlifts, or ladders may be necessary to reach some surfaces. Accessing some locations may actually require dismantling portions of the building. If the building is constructed of porous materials, such as wood or concrete, and the surface was not sealed, contamination may have found its way into the walls, floors, and other surfaces. It may be necessary to obtain cores for laboratory analysis. Another common difficulty is the presence of contamination beneath tile or other floor coverings. This occurs because the covering placed over contaminated surfaces or the joints in tile were not sealed to prevent penetration. It has been the practice in some facilities to "fix" contamination (particularly alpha emitters) by painting over the surface of the contaminated area. All this should be addressed in surveys.

The condition of surfaces after decontamination may affect the survey process. Removing contamination that has penetrated a surface usually involves removing the surface as well. As a result, the floors and walls of decontaminated facilities are frequently badly scarred or broken up and are often very uneven. Such surfaces are more difficult to survey, because it is not possible to maintain a fixed distance between the detector and the surface and pitted or porous surfaces may significantly attenuate radiations — particularly alpha and low-energy beta particles. Use of monitoring equipment on wheels is precluded by rough surfaces, and such surfaces also pose an increased risk of damage to fragile detector probe faces.

The presence of furnishings and equipment will restrict access to building surfaces and add additional items which the survey should address. Equipment that was used directly for processes or activities involving radioactive materials will likely have been removed; however, in cases where such equipment remains, relatively inaccessible surfaces may require evaluation. It may also become necessary to remove or relocate certain furnishings such as lab benches and hoods, to obtain access to potentially contaminated floors and walls.

Piping, drains, sewers, sumps, tanks and other components of liquid handling systems present special difficulties because of the inaccessibility of interior surfaces. Process information, operating history, and preliminary monitoring at available access points will assist in evaluating the extent of sampling and measurements that will be required. Evaluation of inaccessible surfaces is addressed in Sections 6.4.3 - 6.4.5

Expansion joints, stress cracks, and penetrations into floors and walls for piping, conduit, anchor bolts, etc. are potential sites for accumulation of contamination and pathways for migration into subfloor soil and hollow wall spaces. Wall/floor interfaces are also likely locations for residual contamination. Coring, drilling, or other such methods may be necessary to gain access for survey.

Building Exteriors

Exterior building surfaces will typically have a low potential for residual contamination; however, there are several locations which should be surveyed. If there were roof exhausts or the facility is in proximity to the air effluent discharge points, the possibility of roof contamination should be considered. Because roofs are periodically resurfaced, contaminants may have been trapped in roofing material, and samples of this material may have to be obtained. Wall penetrations for process equipment, piping, and exhaust ventilation are potential locations for exterior contamination. Roof drainage points such as driplines along overhangs, downspouts, and gutters are also important survey locations. Window ledges and outside exits (doors, doorways, landings, stairways, etc.) from former contamination control areas are also building exterior surfaces which should be addressed.

Grounds

Depending upon site processes and operating history, the radiological survey may include varying portions of the land areas. At a minimum, those areas immediately adjacent to facilities where radioactive materials were handled should be surveyed. Other potentially contaminated open land or paved areas to be considered include equipment, product, waste, and raw material storage areas; liquid waste collection lagoons; areas downwind (based on predominant wind directions on an average annual basis, if possible) of stack release points; surface drainage pathways; and roadways that may have been used for transport of radioactive or contaminated materials.

Buried piping and underground tanks, spills, and septic leach fields which may have received contaminated liquids are locations of possible contamination that will require sampling of subsurface soil. Information regarding soil type (e.g. clay, sand, etc.) may provide insight into the retention or migration characteristics of specific radionuclides. The need for special sampling by coring or split-spoon equipment, usually by a commercial firm, should be anticipated.

Disposition of on-site, low-level waste burials, authorized under AEC/NRC regulations, will require a decision by the NRC following review of the licensee's decommissioning plan. If radioactive waste has been removed, surveys of excavations will be necessary before backfilling. If such material is to be left in place, the NRC may request subsurface sampling around the burial site perimeter to assess the potential for future migration.

If ground cover should be removed or if there are other obstacles that limit access by either survey personnel or by any needed special equipment (electromagnetic scanners and subsurface sampling rigs) the time and expense of making land areas accessible should be considered. In addition, precautionary procedures should be developed to prevent spreading surface contamination during ground cover removal and/or the use of heavy equipment.

4.2 Designing the Survey

4.2.1 Classification of Areas by Contamination Potential

All areas of the site will not have the same potential for residual contamination and therefore do not require the same level of survey coverage to achieve an acceptable level of confidence that the site satisfies the established release criteria. By designing the survey such that areas with higher potential for contamination receive a higher degree of survey effort, the process will be both effective and efficient.

Two classifications of areas are used in this Manual; these are termed **affected** and **unaffected** areas. These classifications are defined as follows:

- **affected areas:** Areas that have potential radioactive contamination (based on plant operating history) or known radioactive contamination (based on past or preliminary radiological surveillance). This would normally include areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in spread of contamination, and where radioactive materials were buried. Areas immediately surrounding or adjacent to locations where radioactive materials were used or stored, spilled, or buried are included in this classification because of the potential for inadvertent spread of contamination.

- **unaffected areas:** All areas not classified as affected. These areas are not expected to contain residual radioactivity, based on a knowledge of site history and previous survey information.

Segregation of the site into these two classifications should be justified by the licensee in the decommissioning plan (in those cases where a decommissioning plan is required to be submitted) and in the final survey report. It should be emphasized that review and concurrence by the NRC of the classification of areas is to the advantage of the licensee at the early stages of planning the final survey. It should also be recognized that as the final survey progresses, an area's classification may require changing, based on accumulated survey data.

4.2.2 Establishing Reference Grid Systems

Grid systems are established at the site to:

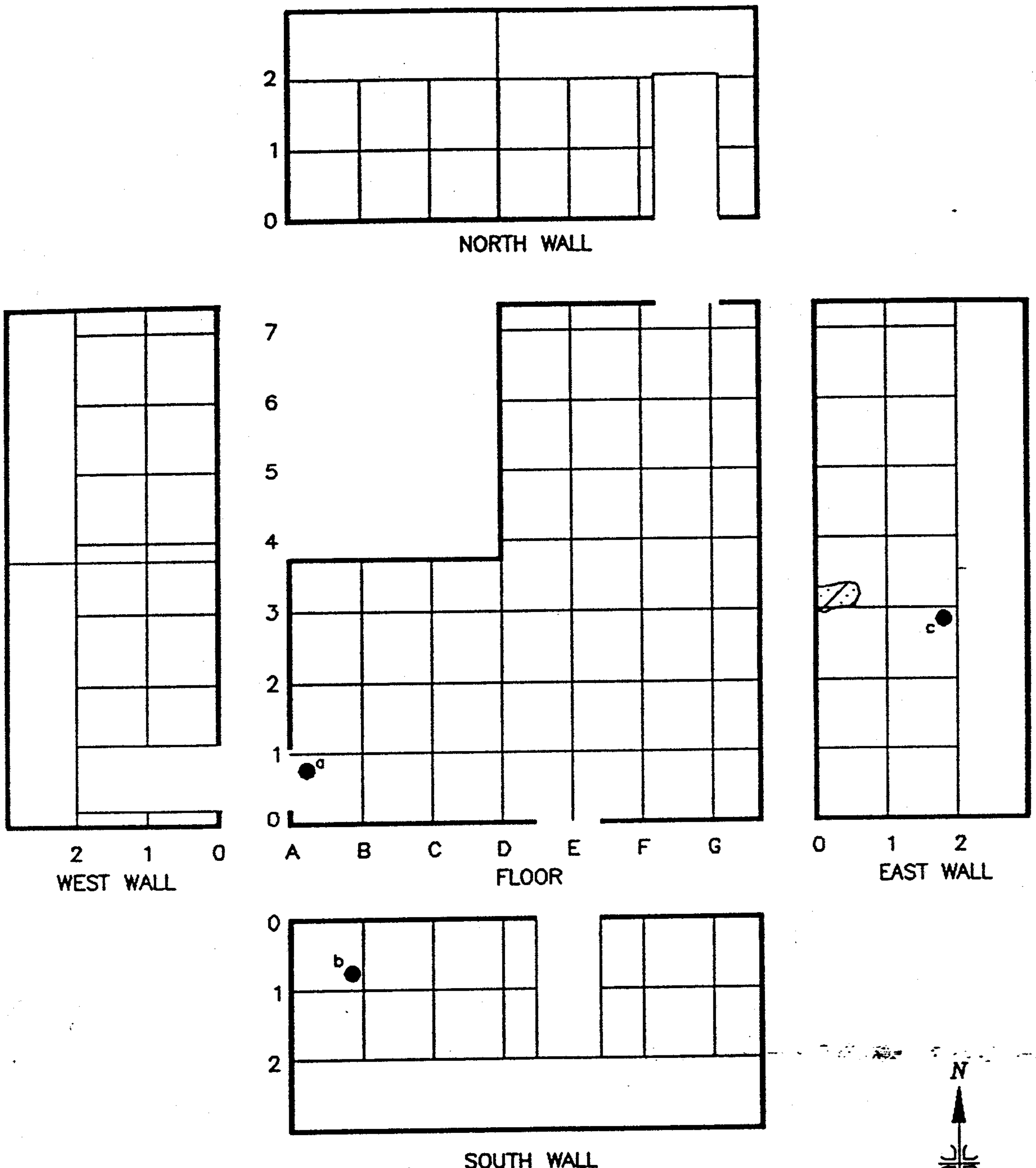
- Facilitate systematic selection of measuring/sampling locations,

- Provide a mechanism for referencing a measurement/sample back to a specific location so that the same survey point can be relocated, and

- Provide a convenient means for determining average activity levels.

A **grid** consists of a system of intersecting lines, referenced to a fixed site location or bench mark. Typically, the grid lines are arranged in a perpendicular pattern, dividing the survey location into squares or blocks of equal area; however, other types of patterns (triangular, rectangular, hexagonal) have been used for survey reference purposes.

Grid patterns on horizontal surfaces are usually identified numerically on one axis and alphabetically on the other axis or in distances in different compass directions from the grid origin. Examples of building interior and land area grids are shown in Figures 4-1 and 4-2, respectively. Grids on vertical surfaces include a third designator, indicating position relative to floor or ground level. Figure 4-1 provides examples of designating grid locations in three dimensions.



EXAMPLE OF GRID POINT DESIGNATION

POINT	GRID DESIGNATION
a	A+0.2, 0.8
b	A+0.8, 0, 0.8
c	G+0.6, 2.9, 1.9

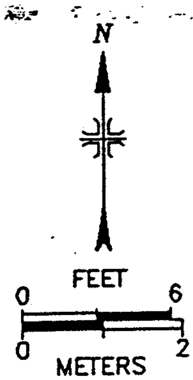
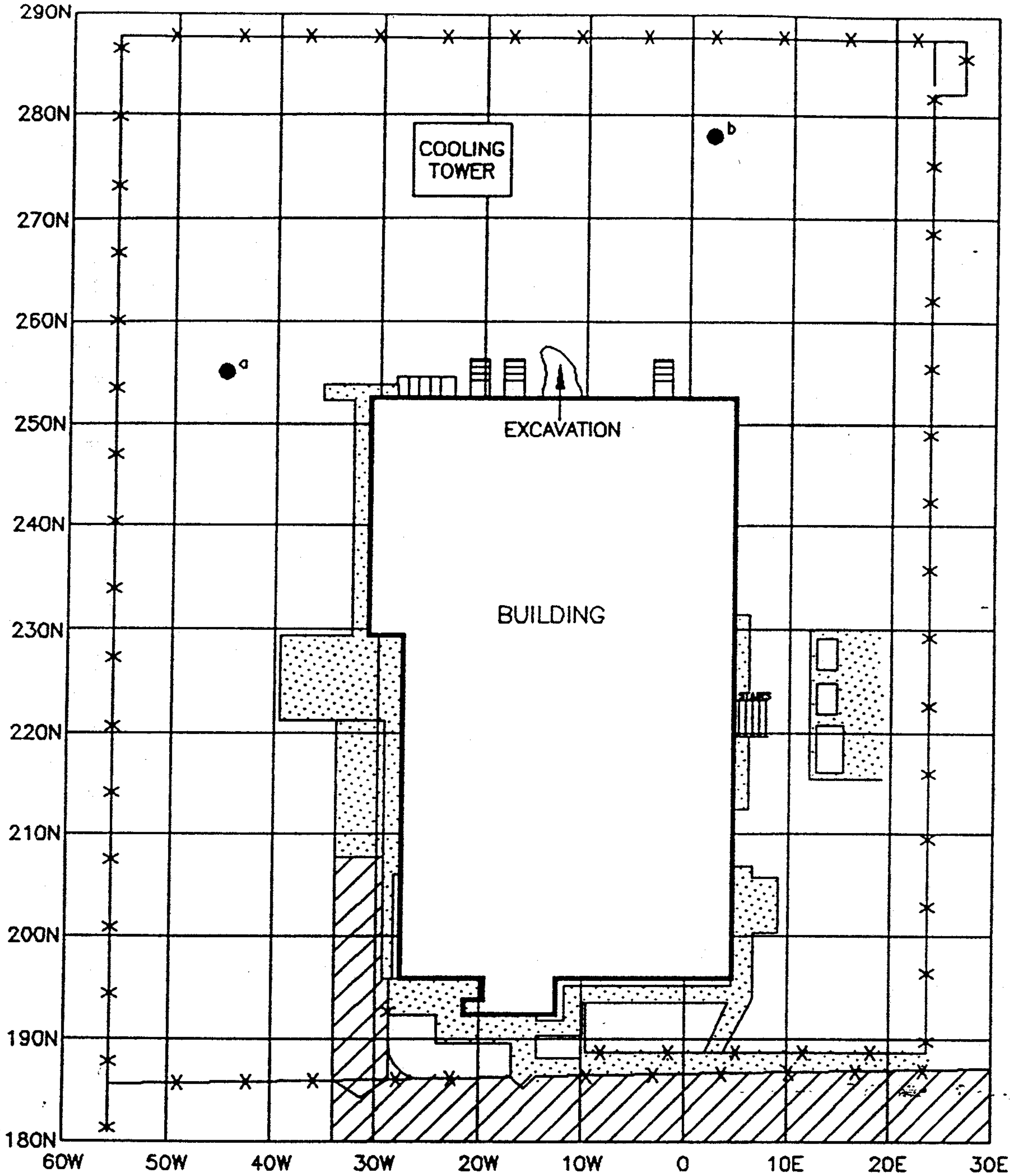


FIGURE 4–1: Example of a Grid System Used for Building Interior Survey



EXAMPLE OF GRID POINT DESIGNATION

POINT	GRID DESIGNATION
a	255N, 45W
b	278N, 2E

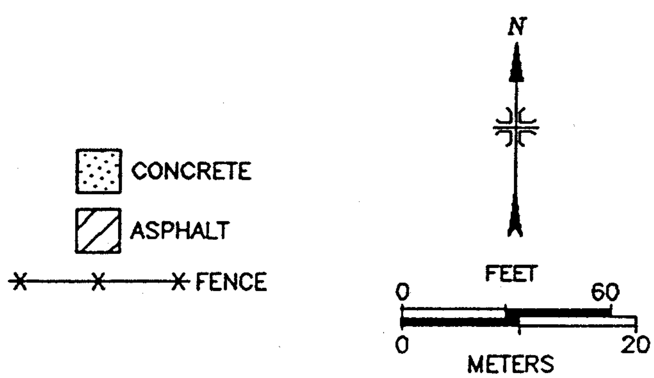


FIGURE 4–2: Example of Grid System for Survey of Site Grounds

For surveys of structures the basic grid system for affected areas is 1 m. Gridding may be limited to the floor and lower (up to 2 m height) walls, unless there is also a potential for upper wall and ceiling area contamination. Survey locations are referenced to the grid system; surveys of ungridded surfaces are referenced to the floor grid (if one exists) or to prominent building features.

Grounds and open land areas classified as affected areas are gridded at 10 meter intervals.

Unaffected areas do not require gridding for the purposes of establishing measurement or sampling locations; however, grids systems of larger spacing, e.g. 5 to 10 m for large structural surfaces and 20 to 50 m for land areas, may be helpful to the licensee by facilitating the referencing of survey locations in those areas to a common site reference system.

The grids described above are intended primarily for reference purposes and do not necessarily dictate the spacing of survey measurements or sampling. Closer spaced survey locations may be required to demonstrate that average and *elevated area* guideline values are met to the required level of confidence. Larger spacing may be acceptable, based on the capabilities of survey techniques. Considerations for determining measurement/sampling spacing are provided in Sections 4.2.3 and 8.5.

To facilitate survey design and assure that the number of survey data points from an area is sufficient to enable statistical evaluation, the area may be divided into survey "units" which have common history or other characteristics or are naturally distinguishable from other portions of the site. Such **survey units** may combine contiguous rooms or land areas having the same potential contamination classification. The size of a survey unit should be chosen to assure that the total number of data points and/or the spacing (frequency) of measurement/sampling satisfy the requirements of Section 4.2.3. The maximum survey unit size for building surface areas classified as affected, limited to 100 m^2. A survey unit cannot include both affected and unaffected areas.

4.2.3 Selecting Measurement/Sampling Locations

It is not possible to perform measurements or conduct sampling at the theoretically infinite number of locations on a site. Instead, a survey should have as its objective the collection of quality radiological data from sufficient representative site locations, such that a statistically sound conclusion regarding the radiological status of the entire site can be developed. Meeting this objective requires a statistically based plan for selecting measurement and sampling locations.

Experience has indicated that residual contamination on a former radioactive material site is typically concentrated in a relatively small portion of the site. The pattern is asymmetrical, with much of the activity often located in small isolated hot-spots. If the licensee's cleanup efforts have been effective, however, essentially all locations will have residual activity below the guideline levels, and many areas will contain levels in the range of natural background and/or below the measurement sensitivities of the survey and analytical procedures. After cleanup, the pattern of residual activity will therefore likely approximate a normal distribution; the approach to survey design described below assumes such a distribution. If, based on site operating history or the results of preliminary surveys, there is reason to believe there may be unusual localized contamination patterns, the licensee should supplement the survey with samples from randomly selected points in the area of suspect localized contamination.

Structure Surveys

Affected Areas

At a minimum, the floors and lower walls of affected areas should receive 100% coverage during the final status survey. The coverage provided for upper walls and ceilings will be dependent upon the contamination potential for these surfaces. The survey measurements for surface activity will consist of a combination of surface scans, direct measurements, and measurements of removable activity. Procedures for performing these measurements are described in Section 6.4

Scans of 100% of affected area floor and lower wall surfaces are performed for all radiations which may be emitted from the radionuclides of interest. Locations of areas of elevated activity are identified and direct measurements are performed to define their extent and activity levels. Residual activity which exceeds 3 times the guideline value results in external radiation in excess of 2 times the guideline value above background at 1 m from the surface, or results in an average activity above the guideline value in any contiguous 1 m^2 area (refer to Section 8.5.2 for averaging procedures) should be remediated until these conditions are satisfied.

Once all identified elevated areas are evaluated and cleaned up as necessary, systematic measurements of surface activity are performed. If the scanning technique has been demonstrated to have a detection sensitivity for the radionuclide or radiations of interest at $\leq$ 25% of the guideline level, systematic measurements are performed at a spacing of 2 m or less to provide at least 30 data point locations. A recommended approach is to obtain data from grid line intersections (see Figure 4-3) or grid block centers. If the detection sensitivity of the scanning technique is not $\leq$ 25% of the guideline value, systematic measurements are performed at 1 m intervals.

Assuming random placement of grid corners

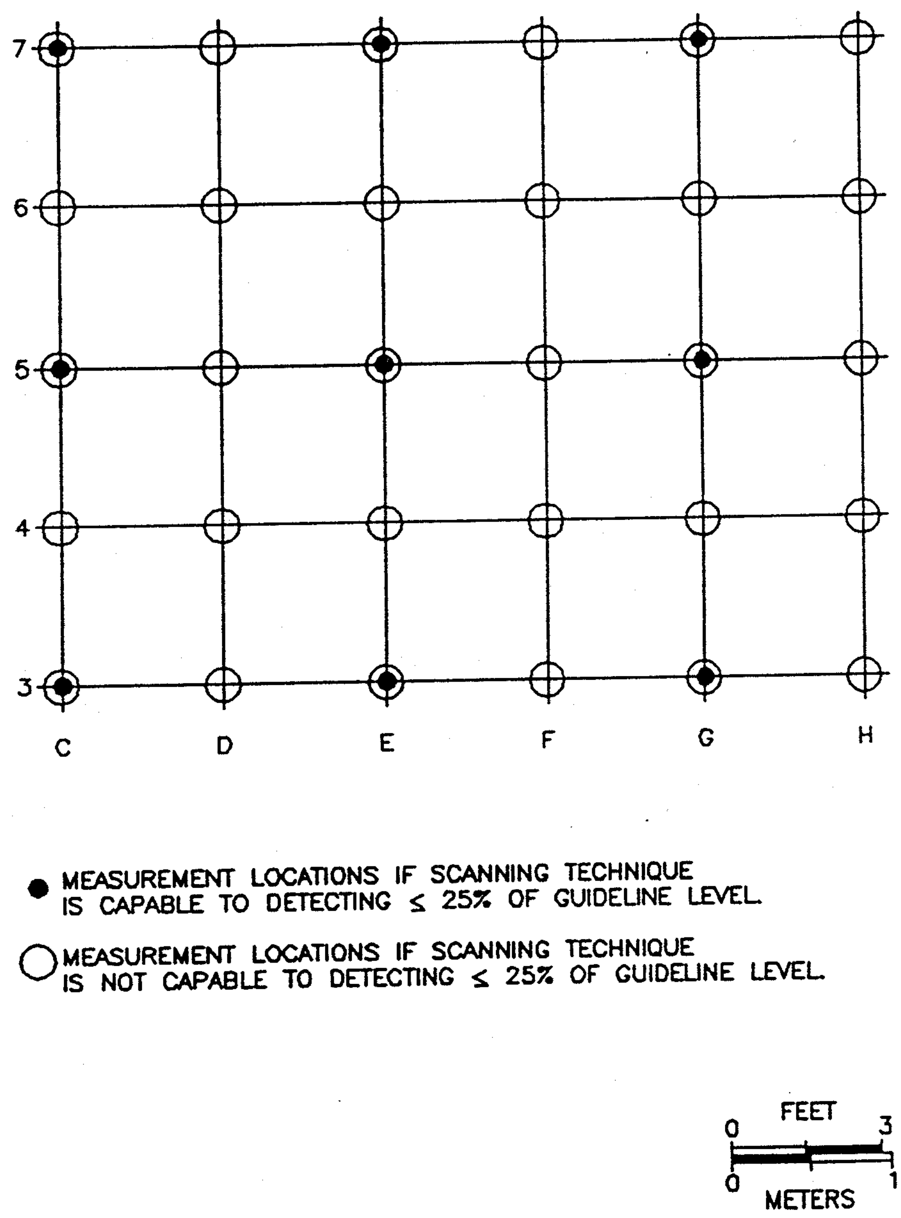


FIGURE 4–3: Standard Measurement/Sampling Pattern For Systematic Grid Survey of Structure Surfaces

The number of data points required to demonstrate that the confidence level of the survey satisfies the 95% objective for a survey unit, is a function of the average and variance of the data. Following the procedures in Sections 8.5 and 8.6, the need for any additional measurements is determined; if additional measurements are required, they should be obtained at approximately evenly-spaced intervals throughout the survey unit.

Upper walls, ceilings, and other overhead surfaces which are suspected of having residual activity at greater than 25% of the guideline value, based on operating history and previous surveys, are surveyed in the same manner as floors and lower walls. If there is no reason to suspect residual activity exceeding 25% of the guideline value on these surfaces, a minimum of 30 measurement locations each, on vertical and horizontal surfaces where radioactive material would likely accumulate, (air exhaust vents and horizontal surfaces where dust would settle) is selected. To assure a reasonable coverage of these surfaces, an average of at least 1 measurement location per 20 m^2 of surface area should be selected. At each location a scan of the immediate area is performed to identify the presence of any elevated activity levels, followed by the measurement. If scans or measurements indicate residual activity exceeding 25% of the guideline, the area is considered potentially contaminated and the surface exhibiting such levels should be surveyed in the same manner as floors and lower walls of affected areas.

If gamma emitting radionuclides are among the potential contaminants, exposure rate measurements at 1 m from floor and lower wall surfaces are performed at a frequency of 1 systematic measurement per every 4 m^2. If potential contaminants did not include gamma emitters, exposure rate measurements should be performed at a minimum spacing of 1 measurement per 10 m^2.

Unaffected Areas

Scans of unaffected surfaces should cover a minimum of 10% of the floor and lower wall surface area. At least 30 randomly selected measurement locations or an average measurement of 1 per 50 m^2 of building surface area, whichever is greater, for total and removable activity, should be performed for each survey unit. These locations should include all building surfaces. Identification of activity levels in excess of 25% of the guideline, either by scans or measurements, will require reclassification of the area to the "affected" category. Testing of the data relative to the confidence level objective is performed in the same manner as for affected areas and any additional measurement locations required should be selected randomly. Exposure rate measurements at 1 m from the floor are performed at each location of surface activity measurement.

Open Land Surveys

Affected Areas

As with structure surfaces, 100% coverage of affected open land areas (paved surfaces and soil) is necessary. Scanning is performed to identify locations of elevated activity levels. Areas of suspected elevated activity, identified in this manner, are evaluated by sampling and analyses to determine their activity level and area 1 extent, and results are compared with criteria (see Sections 2.2 and 8.5); cleanup is performed, as required, and scanning repeated. After scanning has indicated the guidelines and conditions have been satisfied, systematic soil sampling of each affected area grid block is performed at locations equidistant between the center and each of the four grid block corners (see Figure 4-4). If scanning is not capable of detecting surface areas with activity levels ≤ 75% of the guideline values for the radionuclides of interest, additional sampling will be required to provide an acceptable level of confidence that locations of elevated activity have been identified. An EPA procedure (EPA 1989) recommends a triangular grid with a sampling interval of 5 m on a side (enclosed area of approximately 10.8 m^2) for a 95% assurance that elevated areas in excess of 10 m^2 surface area are identified. By beginning with the standard systematic pattern and including additional sampling points, located along the 10 m grid lines, at block corners and centers, and midway between grid block corners (Figure 4-5), a triangular sampling pattern with spacing of 5 m or less (enclosed area of approximately 6.3 m^2) is obtained.

Paved surfaces are surveyed in the same manner as described above for structure surfaces.

For both soil sampling and paved surface measurements, a minimum of 30 data locations should be used. Data for each of these surface types are tested relative to the guideline value and the confidence level objective, and additional systematic sampling/measurement locations that may be required are obtained at approximately uniformly spaced intervals throughout the survey unit.

Exposure rates are measured at 1 m above the surface on the pattern shown in Figure 4-4.

Unaffected Areas

Unaffected open land area should be uniformly scanned for radiations from the radionuclides of interest. Spacing intervals between scanning paths should be such that a minimum of 10% of the surface is scanned. Soil sampling is performed at a minimum of 30 randomly selected locations. Surface activity measurements on paved areas are also performed at 30 randomly selected locations. Identification of hot-spots or individual locations with activity levels

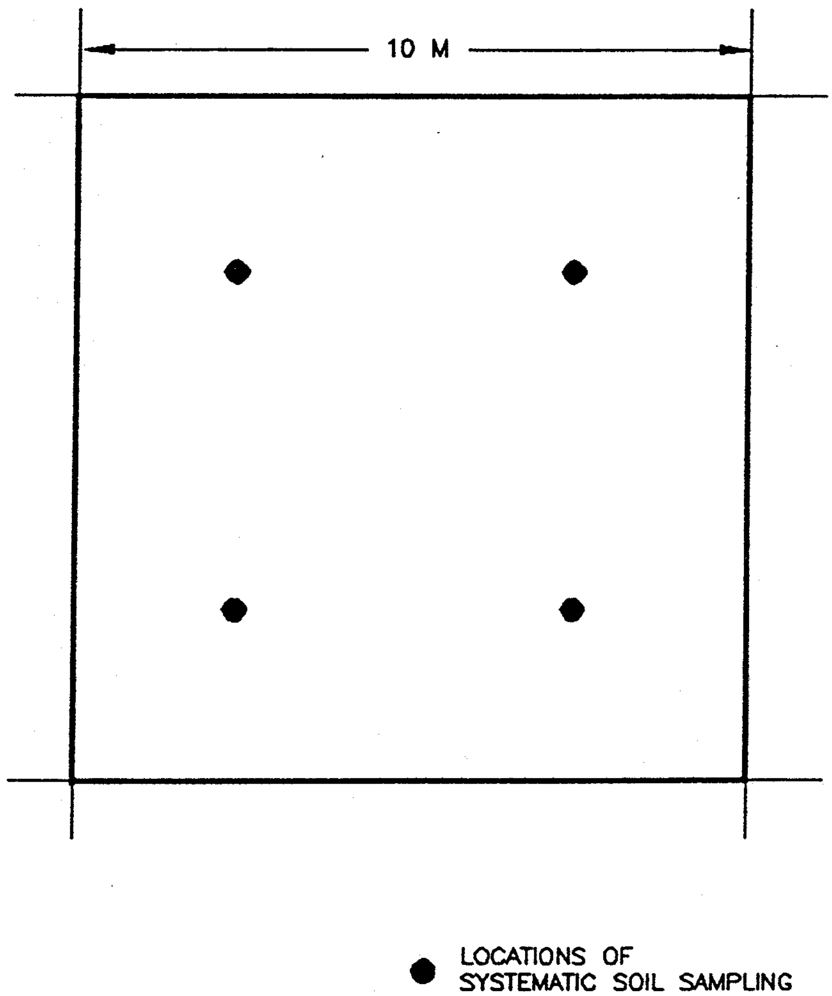
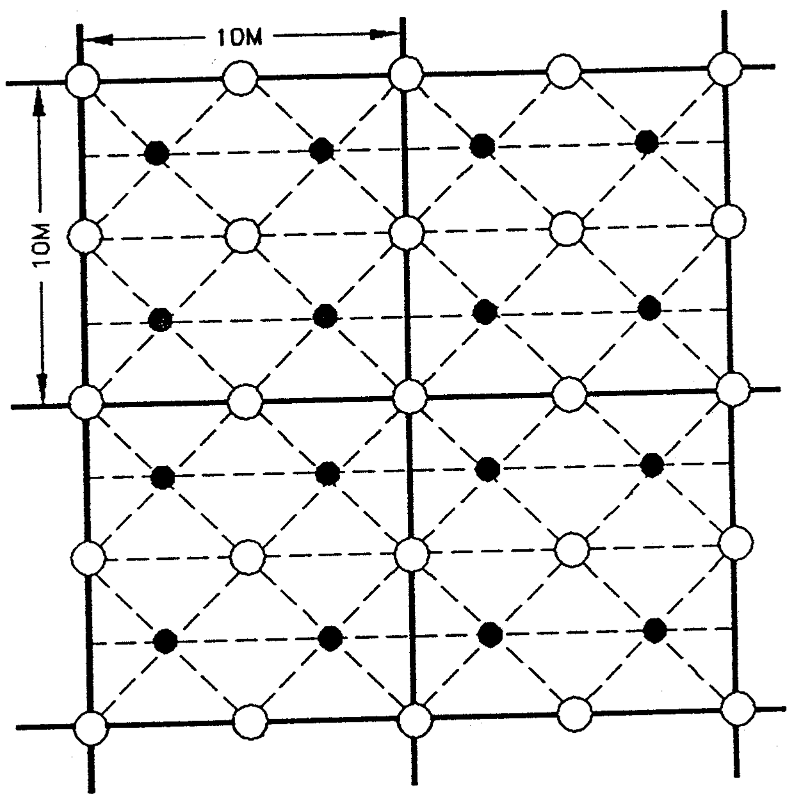


FIGURE 4—4: Standard Sampling Pattern for Systematic Grid Survey of Soil



● SYSTEMATIC SAMPLING LOCATIONS

○ ADDITIONAL SAMPLING LOCATIONS TO PROVIDE CLOSE-SPACED TRIANGULAR GRID PATTERNS

FIGURE 4-5: Sampling Pattern to Identify Soil Areas of Elevated Activity in excess of 75% of the guideline value requires reclassification of the area as "affected".

Testing of results, relative to guidelines and confidence level objectives is performed according to Section 8.6 and any additional samples/measurements required are obtained at randomly selected locations in the survey unit.

<u>Other Measurement/Sampling Locations</u>

In addition to the building and land surface areas described above, there are numerous other locations where measurements and/or sampling should be performed. Examples include items of equipment and furnishings, building fixtures, drains, ducts, and piping. Many of these items or locations have both internal and external surfaces, requiring evaluation.

Each such location classified as affected should be scanned and individual measurements and/or samples obtained at representative points. Unaffected locations can, as with the building and land surfaces in such areas, be surveyed at lower frequencies, consistent with the contamination potential, the capability of scanning techniques to identify activity levels at or above guidelines, and findings as the survey progresses. Surveys of these types of locations are discussed in more detail in Section 6.0.

4.2.4 Subsurface Sampling

At the stage where the final status survey is being conducted, contaminated subsurface soil should already have been identified, characterized, and remediated, if necessary. Subsurface activity data may be required for determination of residual site inventory. In addition, if there is potential for residual activity below the surface layer, the survey plan should include subsurface sampling. The number and locations of samples should follow the same pattern as described above in section 4.2.3 sampling depth of surface soil. As an initial evaluation, samples may be collected at 1 m intervals, starting at the surface and continuing to at least 1 m below the suspected or potential region of activity. Shallow sampling may be conducted using manual equipment (post-hole diggers, small-diameter split barrel or Shelby tube samplers, and portable hand-operated or motorized augers). For depths below several meters, heavier equipment, such as a drill rig with an auger and/or a core sampler will be required. Use of electromagnetic sensing techniques, such as ground penetrating radar and magnetrometry will assist in locating potential sampling areas and also should be a safety consideration if buried utilities or containers of potentially hazardous material (radiological or chemical) may be present. Use of a subsurface sampling technique which results in a borehole or soil face, accessible with a gamma sensitive detector, also enables scanning of the exposed soil surface to identify the presence and distribution of subsurface activity.

If a potential exists for activity to enter subsurface water, samples of water should be collected (if available) from the same locations as the subsurface soil samples. Knowledge of expected constituents is necessary when collecting subsurface water to determine whether special precautions for sample handling and collection are required to ensure representative samples. Expertise of hydrology specialists and those knowledgeable in subsurface water sampling technique should be sought, when such conditions are anticipated.

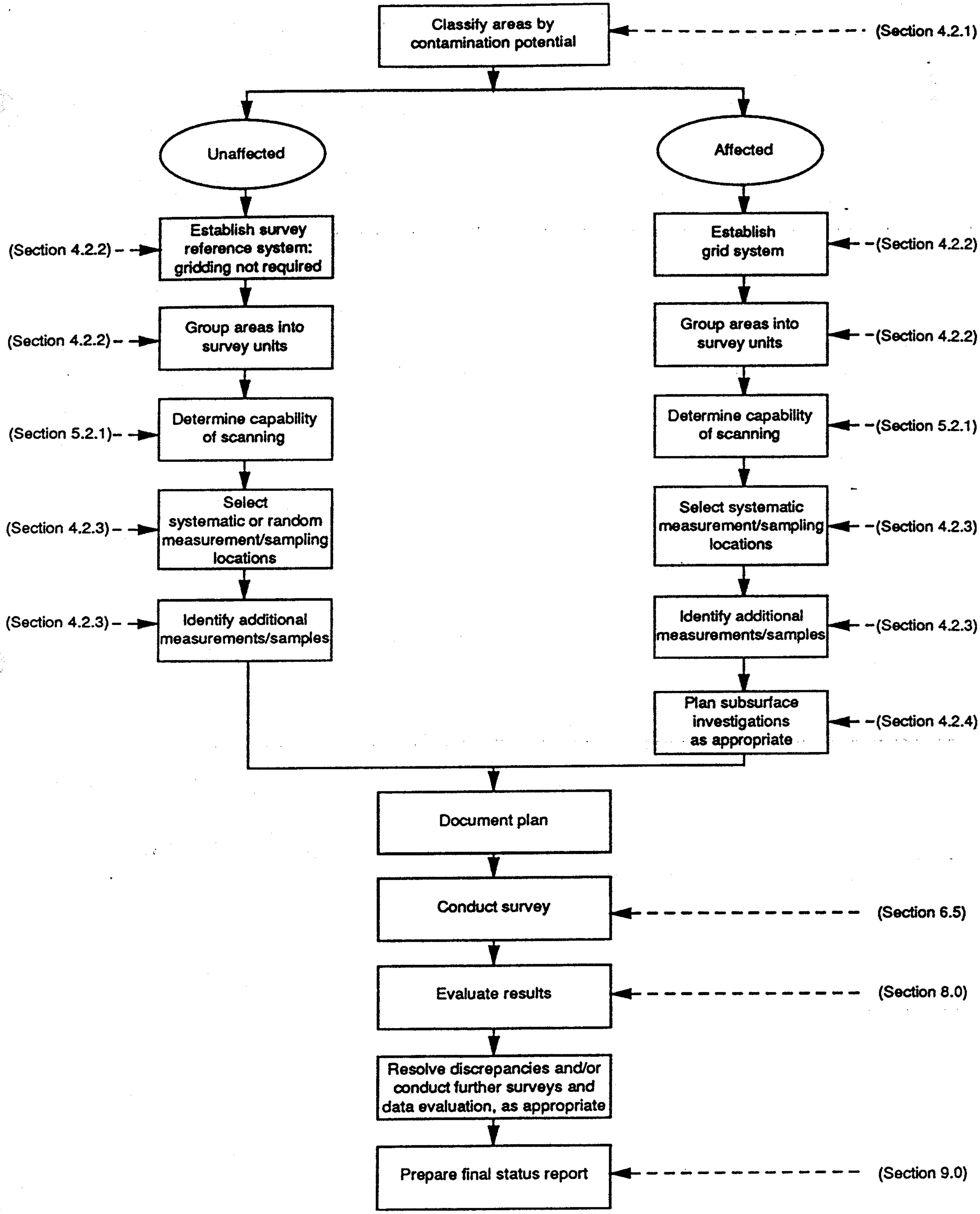


FIGURE 4.6: Flow Diagram for Planning Final Status Surveys