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OIL CONSERVATION DIV.
SANTA FE

GENERIC RELEASE INVESTIGATION WORKPLAN
RCRA FACILITIES INVESTIGATION
GIANT REFINERY
GALLUP, NEW MEXICO

A REPORT PREPARED FOR
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AES PROJECT NO. 5202

MAY 31, 1989
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1.0 INTRODUCTION

Release verification is the initial step in the RFI program. In general, the purpose of the verification is to evaluate the potential for contaminant migration from a SWMU. The verification procedure contains elements of source characterization, media for potential release, and implementation of investigations (if necessary) to evaluate the nature, extent, and rate of migration of the verified releases.

The verification procedures that will be employed at Giant Refinery is based upon Section 3 of the RFI Guidance Document (EPA 530/SW-87-001). A copy of that section is attached to this document is Appendix A.

The investigation will be conducted in phases. The initial phase will develop data on the unit, including waste and source classification.

At that time, sufficient data may be present to document that no release has occurred and the RFI may be stopped for this unit. If a release has been verified, the information will be used to develop a plan for assessment of the potentially impacted media (soil, ground water, surface water, air). Data will be collected, analyzed, and interpreted to evaluate the concentration and extent of contamination. If the extent is not adequately documented, a second phase of field investigation will be undertaken.

APPENDIX A

General Strategy for Release Verification

RFI Guidance Document
Section 3
EPA 530/SW-87-001

OSWER DIRECTIVE 9502.00-6C

RCRA FACILITY INVESTIGATION (RFI) GUIDANCE

VOLUME I OF IV

DEVELOPMENT OF AN RFI WORK PLAN AND GENERAL CONSIDERATIONS FOR RCRA FACILITY INVESTIGATIONS

EPA 530/SW-87-001

DRAFT

JULY 1987 *

WASTE MANAGEMENT DIVISION
OFFICE OF SOLID WASTE
U.S. ENVIRONMENTAL PROTECTION AGENCY

* Includes Revised Section 8 (12/87)

SECTION 3

GENERAL STRATEGY FOR RELEASE INVESTIGATION

3.1 Introduction

An investigation of releases from solid waste management units requires various types of information. This information is specific to the waste managed, unit type, design, and operation, the environment surrounding the unit or facility, and the medium to which contamination is being released. Although each medium will require specific data and methodologies to investigate a release, a general strategy for this investigation can be described. This strategy can be considered to consist of two elements:

- Collection and review of data to be used in developing a conceptual model of the release that can be used to plan and develop monitoring procedures. These data could include existing information on the facility/unit or related monitoring data, data which can be gathered from outside sources of information on parameters affecting the release, or the gathering of new information through such mechanisms as aerial photography or waste characterization.

- Formulation and implementation of field investigations, sampling and analysis, and/or monitoring procedures designed to verify suspected releases (if necessary), and to evaluate the nature, extent, and rate of migration of verified releases.

As stated in Section 2, two components of the RFI Work Plan will address these elements. These are:

- Procedures to characterize the contaminant source and the environmental setting; and

- Monitoring procedures.

Sections 3.4 and 3.5 provide general guidance on these procedures. First, Section 3.2 outlines the general strategy suggested for all release investigations and Section 3.3 briefly discusses concepts concerning data quality designed to ensure that the data collected during the investigation will adequately support the decisions that will eventually be made regarding the need for corrective measures. Section 3.6 provides guidance for formulating methods and monitoring procedures, and addresses monitoring constituents and indicator parameters, use of EPA and other methods, sampling considerations, and analytical methods and detection limits. Section 3.7 provides information concerning various decisions that may be made based on monitoring data and other information that is collected during the RFI process.

3.2 Phased Strategy for Release Investigations

Varying amounts of information will exist on specific releases and units at the start of the RFI process. In some instances, suspected releases may have been identified based on strong evidence that releases have occurred, but with little or no direct data confirming their presence. On the other end of the spectrum, there may be enough existing data at the start of the RFI to begin considering whether some form of corrective measure may be necessary.

This potentially broad spectrum of situations which may exist at the beginning of the RFI may call for a flexible, phased approach for the release investigation, begining with an evaluation of existing data and collecting additional data, as necessary to characterize the release source and the environmental setting. From such data a conceptual model of the release can be formulated in order to design a monitoring program capable of release verification and/or characterization.

The release characterization may be conducted in phases, if appropriate, with each monitoring phase building on the findings and conclusions of the previous phase. The overall level of effort and the number of phases for any given characterization effort depends on various factors including:

- The level of data and information available on the site;

- The complexity of the release (e.g., number of units, release pathways, affected media); and

- The overall extent of the release.

Given that many situations are likely to be unique with respect to the above factors, the number and intensity of each of the phases of the RFI process leading to eventual characterization and assessment against health and environmental criteria is also likely to be unique. Even though some RFI's may have several phases, it is important to make sure that the establishment of a phased approach does not result in undue delay of the RFI process.

Case Study No. 4 in Volume IV (Case Study Examples) provides an illustration of a phased characterization.

3.3 Data Quality and Use

Throughout the RFI process, it should be kept in mind that the data will be used in making comparisons to health and environmental criteria to determine whether a Corrective Measures Study or interim corrective measures may be necessary. Therefore, the data collected during the investigation needs to be of sufficient quality to support decisions as to the need for corrective measures. The data can also be used to help establish the scope and types of corrective measures to be considered in the Corrective Measures Study.

Qualitative or quantitative statements that outline the decision making process and specify the quality and quantity of data required to support decisions should be made early in the planning stages of the RFI. These "data quality objectives" are then used to design sampling and analytical plans, and to determine the appropriate level of quality assurance and control (QA/QC). As this subject is normally considered a QA/QC function, it is presented in more detail in the QA/QC Section (Section 4) of this document. It is discussed briefly here to stress the importance of defining the objectives of the investigation, and designing data gathering efforts to meet these objectives throughout the investigation.

3.4 Procedures for Characterizing the Contaminant Source and the Environmental Setting

Prior to establishing monitoring procedures, information on the contaminant source (i.e., waste and unit) and environmental setting may be required. The owner or operator should identify necessary data and formulate procedures to gather these data.

Data on the unit that may be required for release investigation includes such parameters as the physical size of the unit, the amount of waste in the unit, operational schedules, age, operational lifetime, and release controls. Data concerning the environmental setting that may be necessary is specific to the medium affected, and may include such information as climate, hydrogeologic setting, vegetation and topography. These and other important elements are described below, starting with a discussion of the importance of existing information.

Case Study Numbers 13, 20, 22, 23, 24 and 31 in Volume IV (Case Study Examples) provide examples of the techniques discussed below.

3.4.1 Sources of Existing Information

Useful existing data may be found in the following sources:

- The RCRA FAcility Assessment report. This report should provide information on the unit(s) known to be or suspected of causing a release to the environment and the affected media. It may also include data supporting the regulatory agency's release determinations. The owner or operator may wish to obtain the RFA report from the regulatory agency for use in scoping the RFI.

- Facility records and files. Other useful information may be available in facility records and files. This information may include data from required ground-water monitoring activities, results of required waste analyses, and other analytical results (e.g., tests run on wastes to determine such parameters as liner compatibility or free liquid composition). The owner or operator may have information on the characteristics of the waste in the units of concern from other in-house sources, such as waste reduction and engineering studies on the process(es) feeding the units, or from analyses performed in conjunction with other regulatory programs, such as the National Pollutant Discharge Elimination System permitting process or Clean Air Act Standards. Design and construction information may also be contained within facility files. For example, design and construction information for advanced wastewater treatment sysems may contain information on inactive units.

- RCRA Permit Application. Under current requirements, a RCRA permit application should include a description of the waste being managed at the facility (although not necessarily for all of the units of concern), descriptions of the units relevant to the permit, descriptions of the general environment within and surrounding the facility (including, descriptions of the subsurface stratigraphy), and design and operating information such as runon/runoff controls. A companion rule to the July 15, 1985, codification rule for Section 3004(u) will expand the information requirements under §270.14(d) for all solid waste management units to be located on the facility topographic map, and to contain information on unit type, dimensions and design, dates operated, and waste managed, to the extent available.

- State Construction Permit (e.g., industrial wastewater) files.

- Environmental or other studies conducted in conjunction with ownership changes.

- Interviews with facility personnel (current or retired).

- Environmental audit reports.

- Investigations for environmental insurance policies.

3.4.2 Waste and Unit Characterization

In addition to obtaining waste data on general parameters such as pH, density, and viscosity which may be needed to characterize a release to specific media (and which may also be useful in evaluating corrective measure technologies), the owner or operator should characterize the unit's waste to the compound-specific level. This characterization may serve as a basis for identifying monitoring constituents and indicator parameters for the media of concern. It should be noted that the owner or operator may be required to monitor for all potential constituents of concern for a given medium, unless it can be shown that only certain constituents could be released from the waste source. A detailed waste characterization, through the use of facility records and/or additional waste sampling and analysis, can be utilized to limit the number of constituents for which release monitoring must be performed during the RFI (See also Section 3.6.1).

Waste and unit characterization procedures should address:

- Existing sources of information on the unit and waste and their utility in characterizing of the waste source; and

- Methods for gathering data that are not presently available on the waste and unit.

In some cases the location of disposal areas (units) may not be obvious. Some of these disposal areas or units may have been buried and overgrown by trees or covered by structures such as buildings or parking lots. In such cases, use of geophysical techniques (e.g., ground-penetrating radar - See Appendix C) may be useful in locating old disposal areas containing materials such as discarded drums or buried tanks.

After evaluating existing data, the owner or operator may propose to collect additional waste and unit characterization information. In such cases, the owner or operator should propose procedures in the RFI Work Plan for:

- Sampling--This should include sampling locations, schedules, numbers of samples to be taken, and methods for collecting and storing samples.

- Analysis--This should include a listing of analytical constituents or parameters and the rationale for their selection, analytical methods, and identification of detection limits.

- QA/QC--This should include specific steps to be taken to ensure the viability and validity of data produced during a waste sampling effort.

- Data management--The owner or operator should describe data management procedures, including the format(s) by which data on the contaminant source will be presented to the regulatory agency and the various reports that will be submitted.

Further guidance on the types of information and methods to be used in gathering waste and unit data is given in Section 7.

3.4.3 Characterization of the Environmental Setting

Data on the environmental setting will generally be necessary for characterizing the release, and may also be helpful for evaluating various corrective measure technologies. The information necessary is specific to the site and medium receiving the release and is described in the media-specific sections (Sections 9 through 13). Some examples of the methods and techniques that may be used are:

- Direct media measurements--Direct media measurements can provide important information that can be used to determine the rate and extent of contaminant releases. For example, hydraulic conductivity measurements are essential in determining ground-water flow rates. Wind roses and patterns can be used in determining how far air contamination may migrate and is essential input for air dispersion models. Specific measurements that are helpful for investigating the rate and extent of releases are discussed in the media-specific sections (Sections 9 through 13) of this Guidance.

- Aerial photography--Aerial photography can provide information which can be helpful in determining the extent of contamination at a site.

Aerial photographic interpretation can aid in describing past and present contaminant sources, pathways, and effects. Information obtained can include ecological impacts (e.g., decaying vegetation), topography, drainage patterns, fracture traces, and other erosional features. The usefulness of aerial photography is discussed further in Appendix A.

- Geophysical techniques--Geophysical techniques can aid in characterizing subsurface conditions fairly rapidly with minimal disturbance of the site. Such characterization can provide information on physical (e.g., stratigraphy) and chemical (e.g., contaminant extent) conditions and can also be used to locate buried drums, tanks and other wastes. Geophysical techniques include electromagnetic induction, seismic refraction, electrical resistivity, ground penetrating radar, magnetic borehole methods, and other geophysical methods. These techniques can be particularly useful in determining appropriate sampling locations. However, these geophysical techniques are not always applicable at a particular site and do not provide detailed contaminant concentration data. Therefore, sampling will generally be necessary to provide data needed for adequately characterizing the release. Further details on these techniques are available in Section 10 on Ground Water, and in Appendix C (Geophysical Techniques).

- Surveying and mapping--Accoridng to the 40 CFR Part 270 requirements for RCRA permit applications, the owner or operator must provide a topographic map and associated information regarding the site. If an adequate topographic map does not exist, a survey may be necessary to measure and plot land elevations. Site-specific surveying and mapping can provide an effective means of expressing topographic features of an area useful in characterizing releases (e.g., subtle elevation changes and site drainage patterns). Surveying and mapping are discussed in further detail in Appendix A.

The owner or operator should describe in the RFI Work Plan:

- Specific techniques to be used in defining the environmental setting for the releases of concern at the facility;

- A rationale for the use of these techniques;
- Specific QA/QC procedures applicable to the proposed techniques;
- Procedures for managing and presenting the data; and
- The potential uses of the information obtained from this characterization.

3.4.4 Assembling Available Monitoring Data

The owner or operator should compile and assess available media-specific monitoring data as a means of determining additional data needs. It is conceivable, in certain instances, that available data will be sufficient to characterize a release and provide the basis for making a determination on the need for corrective measures. However, this conclusion would be valid only if available data are current, comprehensive, accurate, and supported by reliable QA/QC methods. Otherwise, the use of available data should be limited to planning additional monitoring efforts.

3.5 Use of Models

Mathematical and/or computer modeling may provide information useful to the owner or operator during the RFI and in the design of corrective measures. The information may prove useful in refining conceptualizations of the environmental setting, defining likely contaminant release pathways, and designing corrective measures (e.g., pumping and treating of contaminated ground water).

Because a model is often a mathematical representation of a complex physical system, simplified assumptions must be made about the physical system, so that it may fit into the more simplistic mathematical framework of the model. Such assumptions are especially appropriate, since the model assumes a detailed knowledge of the relevant input parameters (e.g., permeability, porosity, etc.) everywhere in the area being modeled. This is a limitation that must be considered because it would be impossible to obtain all the input parameters without disturbing and altering the physical system.

Because a model uses assumptions as to both the physical processes involved and the spatial and temporal variations in field data, the results produced by the model at best provide a qualitative assessment of the nature, extent, and rate of migration of a contaminant release. Because of the assumptions made, a large degree of uncertainty is inherent in most modeling simulations. Thus, modeling results should not be unduly relied upon in selecting precise monitoring locations or in designing corrective measures.

Use of predictive models during the RFI may be appropriate for guiding the general development of monitoring networks. Each of the media-specific sections identify where and how such predictive models may be used, and identify references containing specific models. For example, models are identified in the Surface Water Section (Section 13) for use in determining the extent of a monitoring system which may be required in a stream. Modeling results are generally not acceptable for expressing release concentrations in a RFI. An exception to this is the air medium (Section 12). Atmospheric dispersion models are suggested for use (especially when downwind monitoring is not feasible) in conjunction with emission rate monitoring in order to predict downwind release concentrations and to define the overall extent of a release.

Where a model is to be used, site-specific measurements should be collected and verified. The nature of the parameters required by a model varies from model to model and is a function of the physical processes being simulated (e.g., ground-water flow and/or contaminant transport), as well as the complexity of the model. In simulating ground-water flow, for example, the hydrogeologic parameters that are usually required include: hydraulic conductivity (vertical and horizontal); hydraulic gradient; specific yield (unconfined aquifer) or specific storage (confined acquifer); water levels in wells and nearby surface water bodies; and estimates of infiltration or recharge. In simulating contaminant transport in ground water, the physical and chemical parameters that are usually required include: ground-water velocity; dispersivity of the aquifer; adsorptive characteristics of the aquifer *(retardation)*; degradation characteristics of the contaminants; and the amount of each contaminant entering the aquifer (source definition).

Model input parameters that can be determined directly should be measured with consideraiton given to selecting representative samples. Because the parameters cannot be measured continuously over the entire region but only at discrete locations, care should be taken when extrapolating over regions where there are no data. These considerations are especially important where the parameters vary significantly in space or time. The sensitivity of the model output both to the measured and assumed input parameters should be determined when evaluating modeling results. In addition, the ability of the model to be adequately calibrated (i.e., the ability of the model to reproduce current conditions), and to reproduce past conditions should be carefully evaluated in assessing the reliability of model predictions. Model calibration with observed physical conditions is critical to any successful modeling exercise.

Many models exist that may be applicable for use in the RFI. Since EPA is a public agency and models used by or for EPA may become part of a judicial action, EPA approval of model use should be restricted to those models that are publicly available (i.e., those models that are available to the public for no charge or for a small fee). The subset of models that are publicly available is quite large and should be sufficient for many applications. Publicly available models include those models developed by or for government agencies (e.g., EPA, USGS, DOE, NRC, etc.) and national laboratories (e.g., Sandia, Oak Ridge, Lawrence Berkeley, etc.), as well as models made publicly available by private contractors. Any publicly available model chosen should, however, be widely used, well documented, have its theory published in peer-reviewed journals, or have some other characteristics reasonably assuring its credibility. For situations where publicly available models are not appropriate, proprietary models (i.e., models not reasonably accessible for use or scrutiny by the public) should only be used where the models have been well documented and have undergone substantial peer review. Where these minimal requirements have not been met, the model will not be considered reliable.

The Graphical Exposure Modeling System (GEMS) may be particularly useful for various aspects of the RFI. GEMS is an interactive computer system developed by EPA's Office of Pesticides and Toxic Substances, that provides a simple interface to environmental modeling, physiochemical property estimation, statistical analysis, and graphic display capabilities, with data manipulation which supports all of these functions. Fate and transport models are provided for soil, ground water, air and surface water, and are supported by various datasets, including demographic, hydrologic, pedologic, geologic, climatic, economic and many others. Further information on GEMS may be obtained by calling EPA at (202) 382-3397 or 3929 or writing to EPA at the following address:

U.S. EPA
Office of Pesticides and Toxic Substances
Exposure Evaluation Division (TS-798)
401 M Street, S.W.
Washington, D.C. 20460

If the use a model is proposed to guide the development of a monitoring network, the owner or operator should describe how the model works, as well as to explain all assumptions used in calibrating and applying the model to the site in question. In addition, the model and all related documentation should be made available to the regulatory agency for review and scrutiny.

Case Study Numbers 6, 9, 14 and 29 in Volume IV (Case Study Examples) illustrate the use of various models that may be applied during the RFI.

3.6 Formulating Methods and Monitoring Procedures

The RFI Work Plan should describe monitoring procedures which address the following items on a release-specific basis:

- Monitoring constituents of concern and other monitoring parameters (e.g., indicators);
- Sampling locations and frequency;
- Sampling methods;
- Types of samples to be collected;
- Analytical methods; and

- Detection limits.

These items are discussed below.

3.6.1 Monitoring Constituents and Indicator Parameters

The selection and use of monitoring constituents and indicator parameters is a site-specific process and depends on several factors, including the following:

- The phase of the release investigation (e.g., verification, characterization);
- The medium or media being investigated;
- The degree to which verifiable historical information exists on the unit or release being investigated;
- The degree to which the waste in the unit(s) has been characterized through sampling and analysis;
- The extent of the release;
- The concentration of constituents within the contaminated media; and
- The potential for physical, chemical, or biological transformations (e.g., degradation) of waste or release constituents.

The general strategy for the selection of specific monitoring constituents starts with a large universe list of constituents (i.e., 40 CFR Part 261, Appendix VIII). Based on site-specific considerations (e.g., the contaminated media, sampling and analysis of waste from the unit or industry-specific information), this list may be shortened to an appropriate set of monitoring constituents. Constituents initially deleted as a result of this process may have to be analyzed at selected locations during and/or following the RFI, especially if a Corrective Measures Study is found to be necessary.

The discussion below explains the use of the three lists presented in Appendix B for selecting monitoring constituents and supplemental indicator parameters:

List 1 in Appendix B identifies indicator parameters that are recommended for release verification or characterization for the five environmental media discussed in this Guidance. They can be useful regardless of site-specific considerations. This list was developed based on a review of RCRA and CERCLA guidances, as well as information obtained during RCRA and CERCLA site investigations. These indicator parameters should be used in the RFI unless the owner or operator can show that their use will not be helpful. For example, although total organic carbon (TOC) and total organic halogen (TOX) are listed as indicator parameters for ground water, their use may not be warranted for releases consisting primarily of inorganic (e.g., heavy metal) contamination.

List 2 in Appendix B is a master list of potential hazardous constituents that may, at one time or another, have to be monitored during an RFI. It contains the 40 CFR Part 261, Appendix VIII list of hazardous constituents in the left-hand column. The five environmental media columns contain X's where there is a reasonable probability, based on physical or chemical characteristics, of a particular constituent being present in the given medium. However, constituents not containing an X for a particular medium may still be present in that medium, despite a relatively low probability of their presence. Therefore, the regulatory agency may add such constituents for monitoring when appropriate. List 2 was derived through consultation with various EPA program offices and through examination of existing regulations. The rationale for identifying specific Appendix VIII constituents for the various media is explained below:

- Reactivity with water. Those constituents that react with or decompose in water were not marked with an X in the water-related columns.

- Existence of viable analytical techniques for a constituent in a specific medium. In many cases, constituents were not included for a specific medium because valid analytical methodologies are not currently available for that particular constituent/medium combination. In some cases, standard reference materials are not available for the analysis.

[Note that the above two criteria describe the primary rationale used to develop the 40 CFR Part 264, Appendix IX list of ground-water monitoring constituents. Hence, the ground and surface water columns in List 2 are based on the final Appendix IX constituent list.]

- Recommendations from other EPA program offices. Offices concerned with the release of hazardous constituents to various media were consulted for recommendations on the analytes of primary concern. Appendix VIII hazardous constituents regarded by EPA's Office of Air Quality Planning and Standards (OAQPS) as being of primary concern for release to air are identified in the air column in List 2.

- Background information. Analytes recommended for subsurface gas releases were chosen due to their predominance in past studies of this problem. The primary sources used for the subsurface gas medium are:

  U.S. EPA. Technical Guidance for Corrective Measures -Subsurface Gas. Prepared by SCS Engineers for U.S. EPA, Office of Solid Waste. Washington, D.C. 20460.

  South Coast Air Quality Management District. December 1986. Hazardous Pollutants in Class II Landfills. U.S. EPA, Region IX. San Francisco, CA 94105.

- The soil column includes constituents that may be present in both saturated and unsaturated soil. The column generally identifies constituents that are also identified for the ground and surface water media, but contains additional constituents which are normally analyzed during soil contamination investigations (e.g., hydrogen sulfide and other gasses) and certain other compounds that can be highly attenuated in soil (e.g., polyaromatic hydrocarbons).

An RFI may involve the investigation of waste which is hazardous by characteristic, as well as containing specific hazardous constituents. For example, methane, which is not an Appendix VIII hazardous constituent, is shown as an indicator parameter in List 1 for releases of subsurface gas. Because methane at sufficient concentrations possesses explosive or reactive properties, it can be hazardous based on the reactivity characteristic (40 CFR 261.23). Hence, subsurface gas may be the subject of an RFI even if specific hazardous constituents are not identified in the release.

List 3 in Appendix B is an industry-specific list. This list identifies categories of constituents, based on the classification presented in the 3rd Edition of EPA's Test Methods for Evaluating Solid Waste (EPA/SW-846), that may be present if wastes from a given industry are contained in the releasing unit. The EPA/SW-846 chemical classifications for these categories are reprinted as a supplement to List 3. List 3 applies to all media and may be used in conjunction with List 2 to identify industry-specific constituents that have a reasonable probability of being present in a particular medium. List 3 was derived from a review of the Development Documents for Effluent Guidelines Limitations prepared for various industries under EPA's National Pollutant Discharge Elimination System, information received from several EPA Regional Office Hazardous Waste Programs, and other references, as indicated in Appendix B. It does not cover all industries which may be subject to an RFI. The Development Documents for Effluent Guidelines Limitations are available for the 30 industries identified in List 3, and may be obtained from the National Technical Information Service (NTIS).

[Note that the chemical categories upon which List 3 are based are not mutually exclusive. If a category is identified as being appropriate for an industry, all constituents within the category should be monitored regardless of whether the constituent is contained in other categories.]

The use of the Appendix B lists in developing and implementing the general investigation strategy is described below.

The phase of the release investigation is a very important consideration. For example, the use of indicator parameters along with specific hazardous constituents, can be helpful in verifying the presence of a suspected release. However, indicators alone are not adequate in showing the absence of a release, partially because of their relatively high detection limits (i.e., generally 1000 ug/l versus 10 to 20 ug/l for specific constituent analyses), and because indicator parameters do not account for all classes of constituents that may be present. Verification of the absence of a release should therefore always be supported by specific hazardous constituent analyses.

For the same reasons, indicator parameters should not form the sole basis for release characterization, especially at locations in the release where indicator concentrations are close to detection limits. Indicator parameters may be particularly useful in mapping large releases, but should always be used in conjunction with specific monitoring constituents.

Specific monitoring constituents and indicator parameters may also need to be modified as the investigation progresses, because physical, chemical, and biological degradation may transform constituents as the release ages or advances. When chemicals degrade, they usually degrade into less toxic, more stable species. However, this is not always the case. For example, one of the degradation products of trichloroethylene is vinyl chloride. Both of these chemicals are carcinogens. Information on degradation can be found in the environmental literature. Particular references include:

> U.S. EPA. 1985. Atmoshperic Reaction Products from Hazardous Air Pollutant Degradation. NTIS PB85-185841. Washington, D.C. 20460.
>
> U.S. EPA. 1984. Fate of Selected Toxic Compounds Under Controlled Redox Potential and pH Conditions in Soil and Sediment Water Systems. NTIS PB84-140169. Washington, D.C. 20460.

This topic is discussed in more detail later in this section and in each of the media-specific sections.

After a release is adequately characterized in terms of concentrations of hazardous constituents (or hazardous characteristics), a comparison of these concentrations to EPA-verified health and environmental criteria will be made (see Section 8). Although this comparison may involve a shortened list at this stage of the investigation, all potential monitoring constituents (even those that were *deleted earlier in the process) may need to be analyzed at selected monitoring* locations to verify their presence or absence.

The medium or media being investigated is also an important consideration in the identification of monitoring constituents. For example, non-volatile constituents may be poor candidates for monitoring of an air release, unless wind-blown particulates are of concern. List 2 in Appendix B has been developed to aid in identifying those constituents most likely to be measurable in each medium of concern.

Historical information (e.g., records indicating the industry from which wastes originated) may be useful in selecting monitoring constituents. List 3 in Appendix B may be helpful in identifying classes of constituents that may be of concern if a particular industry can be identified.

Waste sampling and analysis (see Section 7) may be performed to tailor the initial list of monitoring constituents. Although complete waste characterization is recommended in most cases, this may not always be possible or desirable (e.g., for a large unit in which many different wastes were managed over a long period of time or in cases where wastes have undergone physical and/or chemical changes over a long time period). A complete historical waste characterization in such cases would not be possible. Other cases where waste sampling and analysis would generally be inadvisable are where the waste is highly toxic (e.g., nerve gas) or explosive (e.g., disposed munitions). In these cases, it may be more appropriate to sample the environmental medium of concern at locations expected to indicate the highest concentrations. Such sampling activities should be performed following appropriate health and safety procedures (see Section 6).

The extent of the release may also dictate, to some degree, the selection of monitoring constituents. For apparently small releases (e.g., five square yards of contaminated soil), it may be reasonable to base all analyses on specific monitoring constituents. For larger releases, the use of indicator parameters along with specific monitoring constituents may be a better approach. In this case, an appropriate balance between indicator parameters and monitoring constituents is advisable.

The concentrations of hazardous constituents within a contaminated medium may affect the usefulness of indicator parameters. For example, TOC and TOX may not be useful where their detection limits are not sensitive enough to detect the presence of the specific hazadous constituents of concern. In such cases, monitoring for specific constituents using more sensitive methods (e.g., GC/MS) is advisable.

In addition, the potential for physical, chemical, or biological transformations (e.g., degradation) of constituents should also be considered in identifying monitoring constituents. Biodegradation may be of particular importance for the soil and surface water media. For example, trichloroethylene present in a waste unit or medium for an adequate period of time, can degrade to vinyl chloride and other products. Such products may be present at higher concentrations than the parent trichloroethylene and may also be more toxic. Therefore, the selection of monitoring constituents should consider the potential for constituents to be transformed over time and space. Each of the media-specific sections contains a discussion of physical, chemical, and biological transformation mechanisms.

Another approach that may be taken in selecting monitoring constituents for a particular medium is to use physical and chemical property data, such as the octanol/water partition coefficient or solubility, to predict which constituents may be present in a given medium. Further guidance on the use of this approach, including tables presenting data on relevant physical and chemical properties of various constituents, is presented in the following reference:

U.S. EPA. October, 1986. Superfund Public Health Evaluation Manual. EPA 540/1-86/060. Office of Emergency and Remedial Response. Washington, D.C. 20460.

Case Study Numbers 2, 16, 18, 21 and 22 in Volume IV (Case Study Examples) illustrate application of the concepts discussed above.

3.6.2 Use of EPA and Other Methods

As described in the proceeding sections of this document, and in the media-specific Sections (Sections 9 through 13), many different types of methods may be employed in conducting the RFI. These include methods for sampling, quality assurance and control, and field operations, as well as methods for physical, biological, and chemical analyses. These methods were developed by various organizations, including EPA, other Federal and State Agencies, and from "standard-setting" organizations (e.g., ASTM, American Society for Testing and Materials). Some of these methods are final, while others are in draft or proposed status. As discussed previously, the RFI Work Plan should propose methods which best suit the needs of the situation under investigation. Guidance in the following sections, and in the media-specific sections, is given on methods which are recommended in certain situations, including appropriate references. The following discussion highlights some general guidelines to follow in the selection of methods:

- Use of EPA Methods:

  EPA recently published the 3rd Edition of its testing manual for solid waste (U.S. EPA. 1986. Test Methods for Evaluating Solid Waste. EPA/SW-846, GPO No. 955-001-00000-1), generally known as SW-846. This manual provides quality assurance and control methods, analytical methods, physical and chemical property test methods, sampling and monitoring methods. These methods are acceptable for the RFI and contain guidance on unique problems which may be encountered during solid and hazardous waste investigations. Where possible, it is recommended that SW-846 (or equivalent) methods be used over other available methods. SW-846, however, may not provide all methods that may be applicable in certain situations. In such cases, other EPA methods manuals (including EPA Regional Office methods manuals) may be used. One such document that should be particularly useful is EPA's Compendium of Field Operations Methods, developed by the Office of Emergency and Remedial Response (OSWER Directive No. 9355.0-14, 1987). This document provides discussions of various methods which can be applied in field investigations, and includes general considerations for project planning, quality assurance and control, and sampling design. Specific methods presented include:

  - Rapid field screening procedures (e.g., OVA meters, HNu detectors);

  - Drilling in soils;

- Test pits and excavation;
- Geological reconnaissance;
- Geophysics;
- Ground-water monitoring;
- Physical and chemical properties;
- Surface hydrology;
- Meteorology;
- Biology and Ecology/Bioassay and Biomonitoring; and
- Surveying, Photography, and Mapping.

- Use of Other Federal or State Methods:

  The Occupational Safety and Health Administration (OSHA), the Food and Drug Administration (FDA), and several other Federal agencies have developed methods and methods manuals for specific applications. In addition State and EPA Regional Offices have also developed methods and methods manuals. These methods may also be used during release investigations, if appropriate. The media-specific sections of this Guidance identifies where such methods may be particularly applicable.

- Use of other Methods:

  There are several "standard-setting" organizations involved in the development of test methods for various applications. One such organization, the American Society for Testing and Materials (ASTM), publishes test methods and other standards in their Annual

Book of ASTM Standards, which is updated yearly. Many of ASTM's methods may be applicable for use in the RFI; however, if comparable EPA methods exist, these methods are preferred.

Many ASTM and EPA methods are similar and some are identical. The primary reason for this is that many EPA methods are derived from ASTM Methods. Some of ASTM's methods are adopted by EPA in toto. EPA's Compendium of Field Operations Methods, for example, contains many ASTM methods. Many ASTM methods are contained in that compendium and can be used during a RFI. Where comparable, but not identical, EPA and ASTM methods exist, EPA methods should be used because they often contain important information which is necessary for regulatory purposes.

Although ASTM's Committee D-34 on Waste Disposal, has only published several final methods (ASTM. 1986 Annual Book of ASTM Standards. Volume 11:04), it has many other methods currently in various stages of development. Several methods under development which may be applicable to the RFI process are expected to be finalized and available shortly.

Other organizations are also involved in the development and standardization of test methods. Many industrial and environmental association methods can also be used during an RFI. EPA's Compendium of Field Operations Methods identifies several of these.

All methods proposed for use by the owner or operator should be clearly described and adequately referenced.

3.6.3 Sampling Considerations

This section discusses several considerations important in designing a sampling plan, including sample types, and pertains to sampling of the waste source and the affected environmental media. Section 7 contains additional guidance on waste source sampling. A general discussion of sampling equipment and procedures is presented in EPA's SW-846. Other guidances containing general information that can be used in designing a sampling plan include the following:

U.S. EPA. 1987. Compendium of Field Operations Methods. Office of Emergency and Remedial Response. OSWER Directive No. 9335.0-14. Washington, D.C. 20460.

U.S. EPA. July 24, 1981. RCRA Inspection Manual. Section V. Office of Solid Waste. Washington, D.C. 20460.

U.S. EPA. June, 1985. Guidance on Remedial Investigations Under CERCLA. Office of Emergency and Remedial Response. NTIS PB85-238616. Washington, D.C. 20460.

U.S. EPA. May, 1984. Soil Sampling Quality Assurance Users Guide. CR810550-01. NTIS PB84-198621. Washington, D.C. 20460.

3.6.3.1 General Sampling Considerations

Various methods exist for obtaining acceptable samples of waste and for each medium described in this document. Each of the media-specific sections (Sections 9 through 13) describes appropriate methods. The RFI Work Plan should propose methods which best suit the needs of the sampling effort. The following criteria should be considered in choosing such methods:

- Representativeness--The selected methods should be capable of providing a true representation of the situation under investigation.

- Compatibility with Analytical Considerations--Sample integrity must be maintained to the maximum extent possible. Errors induced by poorly selected sampling techniques or equipment can result in poor data quality. Special consideration should be given to the selection of sampling methods and equipment to prevent adverse effects during analysis. Materials of construction, sample or species loss, and chemical reactivity are some of the factors that should receive attention.

- Practicality--The selected methods should stress the use of simple, practical, proven procedures capable of being used in or easily adapted to a variety of situations.

- Simplicity and Ease of Operation--Because of the nature of the material to be sampled, the physical hazards which may be encountered during sampling, and the wearing of safety equipment, the proposed sampling procedures should be relatively easy to follow and equipment simple to operate. Ideally, equipment should be portable, lightweight, and rugged.

- Safety--The risk to sampling personnel and others, intrinsic safety of instrumentation, and safety equipment required for conducting the sampling should be carefully evaluated.

3.6.3.2 Sample Locations and Frequency

Because conditions present in the unit or in the contaminant release will change both temporally and spatially, the design of the monitoring network should be developed accordingly. Spatially, sufficient samples should be collected to adequately define the extent of the contamination. Temporally, the plan should address spreading of the release with time and variation of concentrations due to factors such as changes in unit operations, the environment surrounding the unit, and in the composition of the waste. For example, sampling and supplemental measurements (e.g., wind speed) should be conducted when releases are most likely to be observed, when possible.

Selection of specific sampling locations and times will be site and release-dependent. Three general approaches can be used in selecting specific sampling locations. Selection of a particular approach depends on the level of knowledge regarding the release. Judgmental sampling involves selection of sampling locations based on existing knowledge of the release configuration (e.g., visual evidence or geophysical data). A systematic approach involves taking samples from locations established by a predetermined scheme, such as a line or grid. Such samples can help to establish the boundaries of a contaminated area. Random sampling involves use of a "randomizing scheme," such as a random number table, to select locations within the study area. Random sampling can be useful when contaminant spatial distribution is expected to be highly variable. Regardless of the sampling approach taken, it is recommended that a coordinate (grid) system be established at the site to accurately describe and record sampling locations. As a release investigation progresses, and as more information regarding a release is gathered, the sampling approach may be varied as appropriate. Application of judgmental, systematic, and random sampling are discussed below.

3.6.3.3 Judgmental Sampling

Judgmental sampling is appropriate when specific information exists on the potential configuration of a release. Many releases are likely to fall into this category, since site layout or unit characteristics will often indicate areas of potential contamination. Examples of judgemental sampling include:

- .Taking air samples at areas generally downwind of a unit;

- Taking grab samples of surface soils from a drainage channel that receives surface run-off from a known contaminated area; and

- Obtaining soil cores downslope from a known waste burial site.

Judgemental sampling will generally bias the data obtained toward higher contaminant concentrations. For example, samples taken only from areas of suspected contamination would generally be biased toward higher concentrations. In many cases, this approach will suit the needs of the RFI.

3.6.3.4 Systematic or Random Grid Sampling

Systematic or random grid sampling allows for the collection of a set of unbiased samples at the area of concern. These samples can be used for detection of contamination, for calculation of averages (e.g., for characterizing the contents of surface impoundments when it is expected to be fairly homogeneous), and for modeling purposes. *The size and shape of the grid should consider site-specific factors. However, some general recommendations can be made for effective grid* planning. The following steps are recommended in establishing a grid system:

(1) Choose the study area to be included in the grid. This area should be larger than the suspected extent of contamination, in order to define the full extent of the contaminated area.

(2) Select the shape and spacing of the grid. The shape may vary (e.g., rectangular, triangular or radial), depending on the needs of the investigation. The grid spacing should be based on consideration of the appropriate density of sampling points. For example, an initial sampling effort in an area of widespread, homogeneous contamination may use a 200 foot grid, whereas a search for "hot spots" in a poorly defined contaminated area might require a 50 foot or smaller spacing.

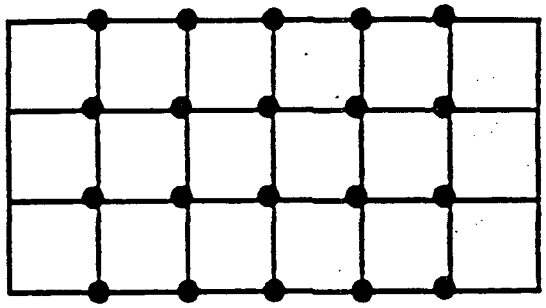
(3) Draw (or overlay) the sampling grid on a plan of the site. To minimize sampling bias, a random number table may be used to choose sampling cells.

(4) Transfer the grid onto the study area by marking grid line intersections with wooden stakes. The exact location of the sample within each grid cell may be chosen systematically (e.g., at each node) or randomly (i.e., anywhere within each cell).

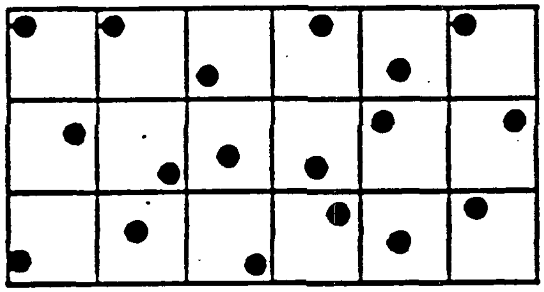
Figure 3-1a shows a systematic grid with samples taken at each node. Random grid sampling produces a sampling distribution such as that shown in Figure 3-1b. A limitation of systematic grid sampling is that if contaminants are distributed in a regular pattern, the sampling points could all lie within the "clean" areas (Figure 3-1c). This possibility should be considered in proposing a sampling approach.

3.6.3.5 Types of Samples

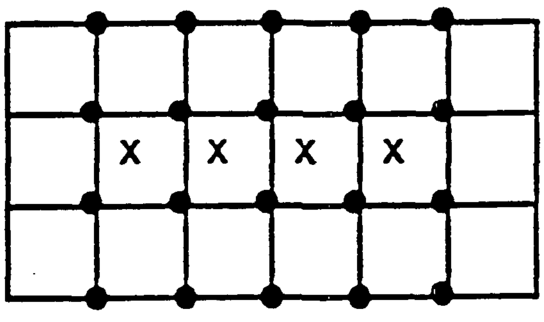
The owner or operator should propose the types of samples to be collected with the monitoring procedures. In general, there are three basic sample types: grab, composite, and integrated.



a) SYSTEMATIC GRID SAMPLING



b) RANDOM GRID SAMPLING



X = BURIED WASTE

c) CASE IN WHICH SYSTEMATIC GRID SAMPLING MISSES WASTES BURIED IN REGULAR PATTERN

FIGURE 3-1. GRID SAMPLING.

- Grab sampling--A grab sample is an individual sample taken at a specific location at a specific time. If a contaminant source or release is known to be fairly constant in composition over a considerable period of time or over substantial distances in all directions, then the sample may serve to represent a longer time period or a larger volume (or both) than the specific point and time at which it was collected.

  When a contaminant source or release is known to vary with time, grab samples collected at suitable intervals and analyzed separately can indicate the magnitude and duration of variations. Sampling intervals should be chosen on the basis of the frequency with which variations may be expected. It may not always be desirable to take samples at equal intervals (e.g., subsurface gas releases are sensitive to seasonal influences). If sample composition is likely to show significant variation with time and space, grab samples from appropriate locations are recommended.

- Composite samples--Composites are combinations of more than one sample collected at various sampling locations and/or different times. Analysis of composites generally yields average values which may not accurately describe the distribution of release concentrations or identify hotspots. Compositing does not reflect peak concentrations and can reduce some concentrations to below detection limits. Composites may, in limited instances, be used to reduce the number of individual grab samples (e.g., when calculating an average value is appropriate). For example, compositing of waste samples from a surface impoundment may be performed to determine an average value over several different locations. Compositing may also be useful in determining the overall extent of a contaminated area, but should not be used as a substitute for characterizing individual constituent concentrations. Therefore, compositing should be highly limited and should always be done in conjunction with an adequate number of grab samples.

- Integrated samples--An integrated sample is typically a continously collected single sample taken to describe a population in which one or more parameters vary either with time or space. An integrated sampling technique can account for such variations by collecting one sample over an extended time period, such that variations can be averaged out over that period. The most common parameter over which sampling periods are integrated is time. Time integrated samples can provide an average of varying concentrations over the period sampled.

  Integrated sampling may be appropriate under limited circumstances. For example, process stream flows often change with variations in the process itself or environmental conditions, such as wind speed. A flow integrated sampling device can collect a sample over a period of time as the sampling rate increases or decreases with the rise and fall of the stream flow. The device automatically biases sample collection towards those periods of high flow, with sampling rates decreasing during low flow periods.

  Integrated samples can particularly useful for air and surface water investigations where continuous changes in environmental conditions can effect constituent concentrations. See Sections 12 and 13 (air and surface water, respectively) for more information.

3.6.4 Analytical Methods and Use of Detection Limits

Analytical methods should be appropriate for the constituents and matrices being sampled. As indicated previously, the EPA publication Test Methods for Evaluating Solid Waste, (EPA/SW-846), should be used as the primary reference for analytical methods. This document contains analytical methods that can be applied to solid, liquid, and gaseous matrices, and also presents detection limits generally associated with these methods. It is important to understand that detection limits can vary significantly depending on the medium (e.g., air, water or soil) and other matrix-specific factors. In addition to SW-846 the following reference provides detection limit information for water and soil matrices:

U.S. EPA. March, 1987. Data Quality Objectives for Remedial Response Activities. Volume 1 (Development Process) and Volume 2 (Example Scenario). Office of Emergency and Remedial Response and Office of Waste Programs Enforcement. EPA 540/G-78/003a. OSWER Directive No. 9335.0-7b. Washington, D.C. 20460.

Detection limits should be stated along with the proposed analytical methods in the RFI Work Plan. Analytical values determined to be at or below the detection limit should be reported numerically (e.g., $\leq$0.1 mg/l).

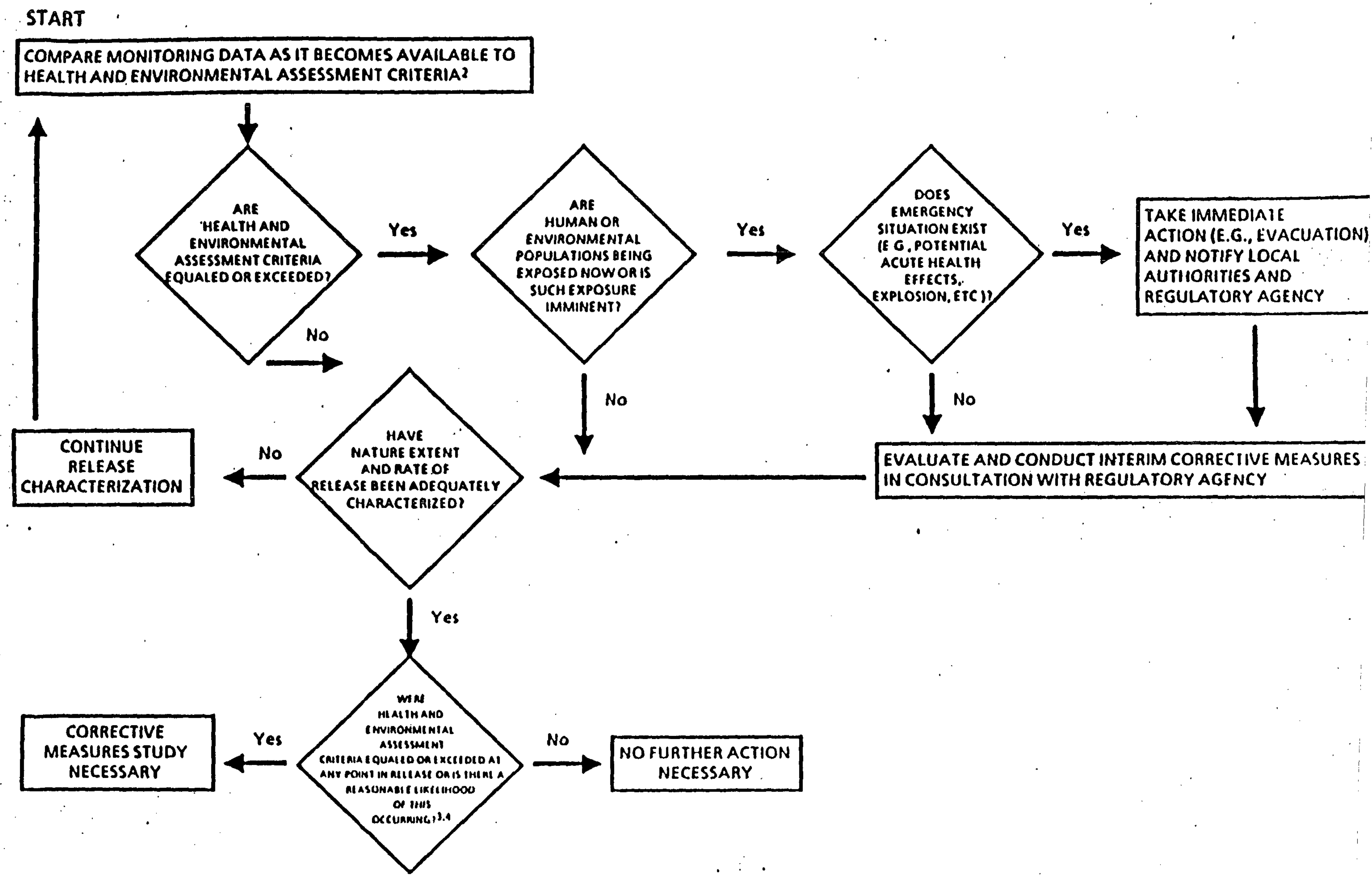
3.7 RFI Decision Points

As monitoring data become available, both within and at the conclusion of discrete investigation phases, it should be reported to the regulatory agency as directed. The regulatory agency will compare the monitoring data to applicable health and environmental criteria to determine the need for (1) interim corrective measures; and (2) a Corrective Measures Study. In addition, the regulatory agency will evaluate the monitoring data with respect to adequacy and completeness to determine the need for any additional monitoring efforts. The health and environmental criteria and a general discussion of how the regulatory agency will apply them are supplied in Section 8. A flow diagram illustrating RFI decision points is provided in Figure 3-2.

Not withstanding the above process, the owner or operator has a continuing responsibility to identify and respond to emergency situations and to define priority situations that may warrant interim corrective measures. For these situations, the owner or operator is directed to obtain and follow the RCRA Contingency Plan requirements under 40 CFR Part 264, Subpart D.

RE 3-2
RFI DE...ON POINTS[1]

(See Following Page for Footnotes)



FOOTNOTES FOR FIGURE 3-2

1 Although the health and environmental assessment is conducted by the regulatory agency, the owner or operator has a continuing responsibility to identify and respond to emergency situations and to define priority situations that may warrant interim corrective measures.

2 If sufficient monitoring data indicate that a release identified as "suspected" by the RFA has actually not occurred, no further action is necessary unless the regulatory agency determines that the occurrence of a release is or may be iminent.

3 For the air medium, the health and environmental assessment criteria are applied at receptor locations at and beyond the facility boundary. For all other media, these criteria are applied at the unit or waste management area boundary and beyond.

4 A Corrective Measures Study or interim corrective measures may still be required based on qualitative criteria. (See Section 8 for discussion).