Chapter 1
The Sampling Plan

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1.1 Introduction

There are a wide variety of reasons for collecting samples and various sampling strategies for different situations. It is important that the purpose of the sampling and associated data quality objectives be identified before fieldwork begins. For example, samples may be collected to determine the existence and/or to define the extent of contamination at a site, to allow waste characterization and classification for disposal or recovery, or to determine compliance with existing regulations. Once the objective is known, decisions about analytical parameter selection, NJ certified laboratory selection, quality control samples, sample location and frequency; etc. can be made more confidently. In sampling to assess permit compliance, some of these selections may have been mandated by the Department. Here, the permit applicant has the responsibility of assuring that any proposed requirements will be achievable if made mandatory. Defining sampling and data quality objectives is important to assure that the sampling plan is complete. Environmental sampling is often conducted to gather data that will be the basis for remedial decisions. Because of the potential threat to health and environment and high costs usually associated with site remediation, strict adherence to quality assurance measures are strongly recommended. In such a case, the objective of the sampling helps to dictate what should be prescribed in the sampling plan.

An integral part of any sampling program is planning. Before a plan can be written, site-specific information must be gathered to insure that the plan is logical, will meet the required objectives and the course of action is achievable.

The purpose of developing a sampling plan is to detail a “plan of action.” The person writing the plan must be very familiar with the site specific conditions and those implementing the plan must be very familiar with the plan’s contents. A properly prepared sampling plan that is correctly implemented will allow the sampling objectives to be met, help avoid confusion in the field, preserve health and safety, and ultimately save time and money. In the development of the sampling plan other pre-sampling activities must be heavily relied upon. Some factors to be taken into account include the following.

1.2 The Triad Approach

The New Jersey Department of Environmental Protection is committed to streamlining the site investigation and remediation process at contaminated sites without compromising data quality and reliability. This goal can sometimes be better achieved by implementing the Triad approach, a process that integrates systematic planning, dynamic work plans, and real-time measurements to achieve more reliable, timely and cost-effective site characterization and cleanup. The Triad approach seeks to recognize and manage the uncertainties involved in generating representative data from heterogeneous environmental matrices. The Department supports and encourages the use of the Triad approach for sites undergoing investigation and remediation within the Site Remediation and Waste Management Program. The Department has evaluated the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, in the context of Triad approach, and has determined that the concepts embodied in Triad approach can be implemented within the framework of the rules. The Department encourages persons interested in using the Triad approach to enter into Memoranda of Agreement, as described in N.J.A.C. 7:26C, because successful implementation of the Triad approach requires close interaction with the Department to ensure that appropriate considerations have been addressed. More information and details on the Triad approach may be found at http://www.nj.gov/dep/srp/triad.

Detailed information on application of real-time measurements may be found in Chapter 7 of this Manual.

1.3 Site History – Evaluating Existing Data/File Information

The first step in a site investigation should be the gathering of background information. Information concerning the history of activity at a site (including locations and age of buildings, drainage pathways, contours, building layout, foundations, septic systems, tanks, etc.; processes and materials for manufacture, storage and disposal both past and present, or historical spills) can be extremely useful in planning sampling events. A file search may reveal areas of a site used for specific processes (aerial site history, site plans, area land use may also be useful) and will help in the logical placement of sampling locations. Data from the DEP's Geographic Information System (GIS) are a valuable resource that can provide additional background information to investigators, enabling the ability to analyze mapped datasets on computer. GIS datasets relevant to the history of activity at a site include statewide land use, soils, geology, and digital aerial orthophotography. Visit the NJDEP GIS website for more information and data downloads at http://www.state.nj.us/dep/gis and the New Jersey Spatial Data Clearinghouse at http://njgeodata.state.nj.us/. For more specific information go to http://www.state.nj.us/dep/srp/regs/guidance.htm#techgis2.

By revealing what materials were handled on site, a file search may provide guidance in choosing which parameters to include for analysis. Additionally, while caution must still be used, judgments regarding health and safety requirements can be made. When no information is available, field personnel must consider that worst case conditions may exist and take proper precautions to insure safety.

The following is a list of federal, state, local and other agencies or sources where additional information regarding site history may be obtained. Addresses and phone numbers can be found in the Blue Pages of Governmental Listings in the Verizon Yellow Pages.

U.S. Government

U.S. Department of Justice
U.S. Geological Survey
U.S. DOA - Soil Conservation Service
U.S. DOA - Forest Service
U.S. DOI - Fish and Wildlife Agencies
U.S. Army Corps of Engineers
U.S. Nuclear Regulatory Commission
Federal Emergency Management Agency
National Oceanic and Atmospheric Administration
U.S. Environmental Protection Agency

State of New Jersey

NJ State Library
NJ State Attorney General Office
NJ Geological Survey
NJ Department of Transportation
NJ Department of Agriculture
NJ Department of Health

NJ Department of Environmental Protection
Division of Watershed Management
Division of Water Quality
Regional Enforcement (Northern, Central and Southern)
Bureau of Freshwater and Biological Monitoring (see 305b report, STORET)
Bureau of Case Management
Bureau of Site Management
Bureau of Air Pollution Control
Bureau of Emergency Response
Bureau of Environmental Evaluation and Responsibility Assessment
Bureau of Environmental Evaluation and Risk Assessment
Bureau of Environmental Measurements and Site Assessment
Information Resource Center
Bureau of Geographic Information and Analysis
(Digital aerial orthophotography and other GIS data sets) at http://www.state.nj.us/dep/gis and http://njgeodata.state.nj.us
Bureau of Tidelands (Hard copy historical aerial photography)
Radiation Protection Programs
Pesticide Control Program
Office of Community Relations
Office of Brownfields Remediation

County Government

County Health Department
County Planning Board
County Library

Local Government

Local Health Department
Tax Assessors Office
Economic Development Officer
Environmental Commission
Local Planning Board
Town Engineer
Local Chamber of Commerce
Local Airport
Local Library
Local Well Drillers
Local Historical Society

Other Sources

Facility Records
Employee Records
Citizens residing nearby
Local and regional waste haulers and generators
New Jersey Environmental Digital Library (http://njedl.rutgers.edu)
Non-profit environmental organizations (e.g., nature conservancies, watershed associations etc.)

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1.4 Defining the Physical Environment

Equal in importance to finding out what may be on-site is determining where it is most likely to be located. A pre-sampling site visit should be conducted to gather additional background information. Labels and DOT numbers on drums and tanks may be useful. Files found on-site may include information about materials that were manufactured, stored or disposed of on-site. Product names may be determined from shipping labels or manifests. Any and all information will be useful in sampling plan preparation, and in formulating a site-specific Health and Safety Plan (see Chapter 4, *Site Entry Activities*).

The fate of environmental contaminants is dictated by the source, the characteristics of the contaminant itself, (i.e., persistency and toxicity) and perhaps most importantly, by the physical environmental system into which it is released. Contaminants move at varying rates and to varying degrees when released into different kinds of matrices. Defining what kind of environmental system the site is a part of is extremely important to the success of achieving the sampling objectives. An investigation into the local geology, hydrology (including flow rates of nearby surface waters, average depth to ground water and flow direction, identification of areas of recharge, etc.), and climatology is necessary. The biological system should also be assessed. The flora and fauna of the area (including identification of sensitive environments and/or species, stressed vegetation, potential for bioaccumulation and biotransformation in the plant and animal life, especially agricultural) are definite factors to be taken into account. Stressed vegetation may serve as an indicator for contaminant migration to a particular area. A GIS system and GIS data can assist investigators in defining both the environmental and biological systems. Specific NJ based GIS data is available for download at no charge can be found at http://www.state.nj.us/dep/gis and http://njgeodata.state.nj.us/. These data elements include CAFRA, Pinelands boundary, soil type, hydrography, landuse, wetland delineation, surface contours and more. Overall, by defining the physical environment, the fate of contaminants can be predicted. Migration pathways should also be identified assuring that samples will be collected in the most appropriate area.

The factors addressed above offer an overview of considerations that must be evaluated for a sampling plan to be complete. The more information that is obtained, the more that will be known about the source, movement, and concentrations of contaminants in the media to be sampled. With this knowledge, it will be easier to write a complete, site specific sampling plan.

Along with the historical and physical information needed prior to sampling plan development, the following topical areas of basic information are necessary components for an inclusive sampling plan.

1.5 Sample Locations and Numbers

The objective of the sampling event is important when choosing the location of sampling points. Samples are sometimes collected to characterize a site for which limited background information is available and/or obvious contaminated areas do not exist. In such a case, a random sampling scheme may be useful. Random sampling depends on the theory of random chance probabilities to choose the most representative sample. This process is utilized when there are numerous available sampling locations and there are no satisfactory reasons for choosing one location over another.

Tables of random numbers are readily available from many sources and should be used to eliminate any possible bias generated by those collecting the sample, assuming a random approach is used.

Also important when choosing sample locations is consideration of the site's physical environmental setting and how these factors can influence the concentration and movement of the material of concern. Sampling at hazardous waste sites is usually conducted in an attempt to discover contamina-

tion and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. Here, judgment (or biased) sampling should be employed. Biased samples are those collected at locations that were chosen based on historical information, knowledge about the location and behavior of the contaminant(s), and/or knowledge about the effects of the physical system on the contaminants' fate.

Both biased and random sampling techniques can be used together to thoroughly address an entire site. Some samples may be biased to potentially contaminated areas (e.g., stained soil, former process or disposal areas) or potentially impacted areas (e.g., areas of stressed vegetation, sediment downstream from discharge pipe). In areas less likely to be contaminated or areas with little available background information, random samples may be used to allow adequate assessment of the entire site.

There are seven factors that determine the number of samples required for site characterization:

1. Exposure pathways
2. Statistical performance objectives
3. Data quality objectives
4. Quality assurance objectives
5. Background samples
6. Sampling objectives
7. Site specific conditions

For example, if the objective of the event is to determine whether the site is contaminated, a limited number of samples, from properly chosen locations, will yield useful information. A greater number of samples may be needed however, if the site is known to be contaminated and delineation of the contamination is the objective. In many cases statistical considerations can be helpful in determining sampling strategy. For site suspected of having contamination caused by radioactive material, refer to Chapter 12, *Radiological Assessments*, for specific sampling considerations.

An additional consideration should be made if the sampling locations and result are to be analyzed or modeled in GIS with other spatial data. Accurate sampling locations (NJ State Plane Coordinates) must be determined in order to reference the data spatially. Depending on the accuracy requirements of the analysis, these locations could be determined through high accuracy surveys (including elevation), the use of Global Positioning System (GPS) receivers or from digital aerial orthophotography data on the GIS. General NJDEP GPS Standards and GIS Mapping and Digital Data Standards can be reviewed at http://www.state.nj.us/dep/gis. Review of the SRPs *Guidance for the Submission and Use of Data in GIS Compatible Formats Pursuant to Technical Requirements for Site Remediation* (TECHGIS2) at http://www.state.nj.us/dep/srp/regs/guidance.htm#techgis2. Sampling points inside a structure should be identified by physical and logical connections and relative locations with respect to other fixed structures and equipment.

1.6 Sample Methodology and Matrix

Once the appropriate numbers and locations have been chosen, consideration must be given to what collection method will be used to assure that representative samples of site conditions are obtained. The selected sampling methodology will be matrix dependent. In some instances, there may be several acceptable options available for collecting a sample. In other instances, site-specific conditions may dictate that only one approach will work, even though that method may not be the preferred method. In all cases, the construction material of the sampling device, its design, decontamination, and proper use are critical factors and should be included in the proposed sampling plan.

Use of a device constructed of undesirable material may compromise sample quality by the material leaching into the sample or absorbing materials from the sample after repeated use and decontamination. Sampler design is also important. For example, a ground water sampling device that aerates the sample during collection may yield a sample that is not representative of actual aquifer conditions. Finally, even the most well designed, constructed and cleaned sampling device will yield a non-representative sample if used improperly. All personnel involved in sample collection must receive training on the use, care and limitations of different sampling equipment.

Further, decontamination of the chosen device must be considered. The sampling device must be resistant to the decontamination solutions and should be constructed to allow ease of cleaning and assure thorough decontamination. (See Chapter 2. *Quality Assurance*, for decontamination procedures).

1.7 Laboratory Selection

Prior to submitting samples to a laboratory for analysis, the certification status of the laboratory must be determined. Laboratories submitting analytical data to the State of New Jersey must hold current certification where applicable under the *Regulations Governing the Certification of Laboratories and Environmental Measurements* N.J.A.C. 7:18 and/or under the National Environmental Laboratory Accreditation Program (NELAP). The Office of Quality Assurance offers certification in the following categories:

- Drinking Water Program
- Water Pollution Program
- Radon/Radon Progeny in Air
- Solid and Hazardous Waste Programs
- CERCLA-CLP Programs

The State of New Jersey Certification Program requires certification for the "Analyze Immediately" parameters under the Safe Drinking Water, Water Pollution, and the Solid and Hazardous Water Programs. Certification for those parameters can be obtained from the Office of Quality Assurance. Additionally, immunoassay methods that are considered laboratory or field methods require certification under the Solid and Hazardous Waste Program. Regardless of whether a company or organization is or is not a laboratory, certification must be obtained. This includes but is not limited to responsible parties, contractors and facilities.

The Office of Quality Assurance may be contacted to obtain additional information regarding laboratory certification requirements. Current Information on the NELAP and the National Environmental Laboratory Accreditation Conference can be found on the USEPA website at http://www.epa.gov/quality/qa_docs.html.

1.8 Electronic Submission of Data for Site Remediation and Waste Management

1.8.1 General Requirements

According to the Technical Requirements for Site Remediation (N.J.A.C. 7:26E) herein called the Tech Regs, the results of environmental sample analysis must be submitted to NJDEP Site Remediation and Waste Management (SRWM) in an electronic format. This requirement is first mentioned in the section addressing with the Site Investigation Report (3.13(c)3v), and applies to all subsequent phases of the remedial process. Furthermore, every sample point must be geographically referenced using approved accuracy standards. NJDEPs GIS compatibility requirements can be re-

viewed at http://www.state.nj.us/dep/gis link to *Digital Data Standards* and *Guidance for the Submission and Use of Data in GIS Compatible Formats Pursuant to Technical Requirements for Site Remediation* (TECHGIS2) at http://www.state.nj.us/dep/srp/regs/guidance.htm#techgis2. Prior to conducting sampling, it is important to consider the type and format of data that will be required when the results are submitted to SRP, as well as other information that must be gathered while in the field, such as geographic location of sampling points.

The current requirements call for the submission of three files. HZSAMPLE contains field sampling information; HZRESULT contains analytical results; DTST identifies the data submission. The complete requirements are outlined in detail at http://www.state.nj.us/dep/srp/hazsite. This site contains numerous guidance documents and related software to assist in the preparation of an electronic data submission. Both the *Getting Started Guide* and the *SRP Electronic Data Interchange Manual (SRP-EDI)* will assist in this effort. The SRP-EDI, in particular, specifies the three data tables that must be submitted, the fields in each of those tables, and the data requirements, such as field length and valid values, etc. Note that the SRP-EDI is updated periodically. The website should be accessed prior to preparing data to ensure that the latest requirements are met. Another important tool available at the website is the "Environmental Data Submittal Application Checking" (EDSA) program. Once samples have been collected and data prepared, the data should be run through EDSA to determine compliance with data requirements.

1.8.2 Consistency in Data Fields Among Data Tables

In DEP's system, three fields are used to link together the three data tables that comprise a complete submission. The fields are SRP ID, Sample Date, and Sample Number. Therefore, it is imperative that these fields are created per the SRP-EDI definitions, and are reproduced EXACTLY the same in each of the tables. Consistency among these fields is particularly important when one party, such as a consultant, is preparing the part of the submission related to sample collection, and a second party, such as a laboratory, is providing the analytical results information. Please review the definitions of the three fields SRP ID, Sample Number, and Sample Date that are in the most current version of the SRP-EDI prior to collecting samples, supplying samples to the laboratory for reference in the result table, and preparing a submission.

1.8.3 Securing Laboratory Services

Prior to securing the services of a laboratory, it is important to know what services they provide for meeting these electronic data requirements. Several laboratories already have exports from their Information Management Systems that meet the required results format. Ensure that the laboratory has submitted results successfully in the past and that they will run the SRP data checker program, called EDSA, on the result file to ensure that it meets the required data format.

1.8.4 Geographically Referenced Points

All sample results must be submitted with a geographically referenced location associated with them. Locations should be provided in State Plane Feet, using North American Datum 1983. Additional accuracy standards are defined in the NJDEP, Mapping and Digital Data Standards, at http://www.state.nj.us/dep/gis.

Detailed instructions outlining the specific map elements, support data and metadata requirements for GIS compatible digital map submissions for SRP are included in, *Guidance for the Submission and Use of Data in GIS Compatible Formats* at http://www.state.nj.us/dep/srp/regs/guidance.htm#techgis2.

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1.8.5 Permit Application and Compliance

Several permitting programs have provided for permit application data and/or sampling data required by permits to be submitted electronically. Since software development is an ongoing process, interested persons should contact the appropriate permitting bureaus for current capabilities and procedures.

1.9 Quality Assurance Considerations

Quality assurance measures must be associated with each sampling and analysis event as an additional measure of control to assure that the sample delivered to the lab for analysis is representative of site conditions. The sampling plan should outline how the representative quality of the samples will be assured. This will include, but not be limited to: data quality objectives, laboratory SOPs, field SOPs, sample bottle preparation, equipment decontamination, trip blanks, field blanks, duplicates, split samples, performance evaluation samples, sample preservation and handling, chain of custody, analysis request, analytical methods, parameters, and deliverables (See Chapter 2. for further quality assurance information).

1.10 Health and Safety Concerns

Prior to any work being performed at a hazardous waste site, as defined by 29 CFR 1910.120, the organization, or company, engaged for the work must develop a written Health and Safety Program for its employees. As part of the overall Health and Safety Program, a site-specific safety and health plan, which addresses the safety and health hazards at a particular site, must be developed and kept available at the site during the duration of all site work. Typically, a Health and Safety Program will address the following areas: organizational responsibilities, risk analysis, underground utility markouts, employee training, personnel protection, medical surveillance, air surveillance, site control, decontamination, site standard operating procedures, contingency planning, confined space operations, and spill containment. Depending on the types of contaminants and other hazards present and the type of work that is anticipated some of these concern areas may not be applicable all aspects of a particular sampling episode. (See Chapter 4 for more information on Site Entry Activities.)

1.11 Schedule

Scheduling information may or may not be applicable for your particular sampling plan development. If it were necessary, the type of information to include would be time frames for various milestone-sampling episodes.

References

National Environmental Laboratory Accreditation Conference USEPA/ORD EPA600/R-99-068.

New Jersey Department of Environmental Protection (NJDEP), *Remedial Investigation Guide*, March 1990, Prepared by the Division of Responsible Party Site Remediation (DRPSR), CN 028, Trenton, NJ 08625.

NJDEP, *Environmental Cleanup Responsibility Act (ECRA) Cleanup Plan Guide*, Prepared by the DRPSR, Industrial Site Evaluation Element, CN 028, Trenton, NJ 08625.

NJDEP, *Regulations Governing the Certification of Laboratories and Environmental Measurements*, N.J.A.C. 7:18.

USEPA *Guidance for Choosing a Sampling Design for Environmental Data*, QA/G5S).

USEPA *Guidance for Data Quality Objectives Process* (G-4).

USEPA *Guidance for the Data Quality Objectives for Hazardous Waste Sites* (G-4HW) EPA/600/R-00-007 January 2000.

USEPA *Requirements for QA Project Plans*(QA/R-5).

USEPA *Guidance on Quality Assurance Project Plans* (G-5) EPA /600/R-98/-18.

USEPA *Guidance for Data Quality Assessment: Practical Methods for Data Analysis* (G-9) QA00 Version EPA/600/R-96/084 July 2000.

The Final Rule for Hazardous Waste Operations and Emergency Response, Part 1910.120 of Subpart H of 29 CFR, Occupational Safety and Health Administration, U.S. Department of Labor effective March 6, 1990.

USEPA, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, 1989.

USEPA, *Risk Assessment Guidance for Superfund*, EPA/540/I-89/002, 1989.

USEPA, *Interim Final Guidance for Data Usability in Risk Assessment*, Office of Solid Waste and Emergency Response (OSWER), Directive #9285.

URLs

http://www.epa.gov/quality/qa_docs.html

http://www.state.nj.us/dep/gis

http://www.state.nj.us/dep/srp/hazsite

http://www.state.nj.us/dep/srp/regs/guidance.htm#techgis2

http://njgeodata.state.nj.us/