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14. ABSTRACT
This Test Operations Procedure (TOP) describes a process for collecting environmental effects data from Army weapon systems and materiel during the developmental test and evaluation process. Environmental quality data requirements are identified, along with data collection methods and data analysis tools.

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TEST OPERATIONS PROCEDURE

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ENVIRONMENTAL EFFECTS DATA COLLECTION

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1. SCOPE.

This Test Operations Procedure (TOP) describes a process for collecting environmental quality data from Army weapon systems and materiel during the developmental test and evaluation process. Environmental quality data requirements are identified, along with data collection methods and data analysis tools. The target audience for the data collected by this TOP is both the materiel developer and the military installation where the materiel system will be fielded. Some of the environmental quality data generated from this TOP are common to both the materiel developer and the fielding location, while other data may be unique to only one area. Not all media areas are relevant to all materiel systems; so, careful scrutiny regarding a materiel system's need to collect data for a specific media area should be considered.

1.1 Background.

The US Army Environmental Command (USAEC), Acquisition Branch, assists Army Installations, Program Executive Offices (PEOs), and Program Managers (PMs) through the Deputy Assistant Secretary of the Army for Environment, Safety, and Occupational Health (DASA (ESOH)) and the Environmental Support Office (ESO) with identifying environmental quality issues associated with new materiel systems, to include environmental life-cycle costs. Effects on the environment associated with materiel systems are not being collected, reported, or compiled on a consistent basis by the US Army. These effects are often experienced and possibly measured during the course of developmental testing, but the data are not normally recorded and reported unless they are part of a specific performance requirement for the commodity under test. Even then, they may not be reported to a central environmental management office nor stored in any organized fashion in a manner to assist environmental planners.

In accordance with Army Regulation 73-1[1*], Test and Evaluation Policy (T&E), the Deputy Under Secretary of the Army (Operations Research) will establish, review, and integrate environmental policies into Army Regulation 200-2[2] (32 CFR 651/AR 200-2), and ensure assessment of the environmental consequences of T&E support actions within and outside the United States (See DODD 6050.7[3]). The 32 CFR 651/AR-200-2 requires that the Army ensures that all major actions fully comply with the National Environmental Policy Act (NEPA)[4]. The NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences and take actions that protect, restore, and enhance the environment. A flowchart of a typical NEPA process can be found at http://www.section4f.com/nepa_flowchart.htm. The Council on Environmental Quality (CEQ)[5] issued regulations to implement the procedural provisions of NEPA. Implementing procedures to CEQ regulations are contained in DOD Directive 6050.1[6] (applicable in the continental United States (CONUS)) and DOD Directive 6050.7 (applicable outside the continental United States (OCONUS)).

[*] Superscript numbers correspond to those in Appendix D, References.

In addition, The Army Sustainable Range Program (Army Regulation 350–19) can both benefit from environmental quality data as well as be a source for the data. The SRP maximizes the capability, availability, and accessibility of ranges and training lands to support doctrinal requirements, mobilization, and deployments under normal and surge conditions. The SRP core programs are the Range and Training Land Program (RTLP) and the Integrated Training Area Management (ITAM) Program.

This document describes the requirements and processes for collecting environmental data during test operations. This TOP assumes that the testing is performed in accordance with all applicable Federal, state, and local laws and permits and with Installation Management Plans (e.g., Integrated Natural Resources Management Plans (INRMP), Integrated Cultural Resources Management Plans (ICRMP), Installation Hazardous Material Management Programs (HMMP), Environmental Noise Management Plans (ENMP), and Integrated Solid Waste Management Plans (ISWMP)). Further, this TOP does not address if and when a test operation may require a permit or may be subject to an Installation's existing permit program (e.g., air permit or stormwater discharge permit). It is also assumed that all environmental management plans, permits and other applicable requirements have been updated, as necessary. It is the responsibility of the Installation's Environmental Manager and the Test Officer to ensure that test operations are conducted in compliance with all applicable permit requirements.

1.2 Purpose.

a. This document addresses the need to evaluate materiel for environmental quality effects during developmental testing. Environmental effects data collected during developmental testing could:

(1) Assist Installations in preparing NEPA documents and analysis, in an accurate and timely manner.

(2) Assist materiel developers in reducing adverse environmental effects from a specific materiel system; and

(3) Assist the program office in conducting environmental quality life cycle cost estimates.

b. This document is organized to address the commodities in TOPs Volumes 2, 3, 4, 5, 6, 9, and 10. Volume 1 (Background Documents and Miscellaneous Common Test Documents), Volume 7 (Aviation, Air Delivery Equipment, Aircraft Weapon Subsystems, and UAV's), and Volume 8 (Chemical, Biological, and Radiological Equipment) are not addressed in this document. Volume 1 is not included because it discusses background information pertinent to all TOPs and does not address testing of specific commodities. Volumes 7 and 8 are not discussed because the unique nature of these commodities and the special environmental controls applicable to them require them to be addressed in specific, not general, procedures.

1.3 Responsibilities.

1.3.1 Commanders, DTC Test Centers.

a. Ensure that the procedures contained in this TOP reflect current test methodology.

b. Use information from this TOP in conducting tests and compiling environmental effects data.

c. Ensure that the Installation Environmental Plan and permits reflect the most current information collected according to the procedures identified in this TOP.

1.3.2 Test Center Test Officers.

Responsible for developing and executing the test plans, obtaining applicable environmental data requirements from test sponsor, and collecting environmental effects data as described in this TOP. The test officer must coordinate with subject matter experts to determine specific environmental data requirements and methodologies.

2. FACILITIES AND INSTRUMENTATION.

Test facilities are described in the TOPs that address individual subtests for each commodity type. For test operations, it is necessary to consider the effects that testing could have on the environment. Environmental considerations for each commodity type are provided in Environmental Data Matrix (Appendix A) and discussed in paragraph 5. Environmental data collection procedures are addressed in the Data Collection Methods (Appendix B) of this document. Test instrumentation is described in the TOPs that address individual subtests for each commodity type.

3. REQUIRED TEST CONDITIONS.

Specific test conditions are presented in the TOPs that address individual subtests for each commodity type. However, specific guidance for the collection of environmental data is presented within this TOP in the Data Collection Methods (Appendix B).

4. TEST PROCEDURES.

Test procedures are described in the TOPs that address individual subtests for each commodity type. Environmental data collection procedures are addressed in the Data Collection Methods (Appendix B) of this document.

5. DATA REQUIRED.

This section provides a general description of the types of environmental information that should be gathered before, during, and after a test operation. The collection of environmental effects data can be used in a variety of ways as outlined in paragraph 1.2. Primarily, these data can be used in the NEPA process (discussed in paragraph 1.1) to provide hard data to support the systematic examination of possible and probable environmental consequences of implementing or fielding Army weapon systems or materiel. For each commodity category, general consideration areas have been identified (paragraphs 5.3.1 through 5.3.7). An effort has been made to subdivide each commodity category even further to support the decision making process to determine which subsets are applicable. This commodity categorical detail can be found in the Environmental Data Matrix (Appendix A). The matrix is a good guide for the program team to use for the determination of subtests required to gather the necessary environmental effects data.

During basic research and development actions, environmental data collected would also be used by PEOs, PMs, and the environmental community to assess the potential for adverse environmental impacts from operation of the systems. Environmental effects should be considered during all stages of the test operation, including setup, storage, disposal, repair and maintenance, and breakdown of equipment under test.

5.1 Preliminary Activities.

This section provides an overall guideline of environmental considerations and data gathering that may be relevant during testing. Specific information on the type of environmental data that should be gathered is provided in Paragraph 5.2.

5.1.1 Equipment and Material Usage.

a. Plan to characterize the equipment being tested (size, length, weight, width, height).

b. Plan to characterize the testing location, time and length of testing, and climatic conditions (temperature, wind direction, precipitation, etc.).

c. Plan to identify materials (fuel, chemicals, aerosols, metals, etc.) required for testing.

d. Plan to estimate and measure the types and quantities, storage, and disposal of hazardous and non-hazardous materials used during preparation, testing, maintenance, and inspection of the items under test.

e. Plan to estimate and measure the compositions and quantities of all emissions (gaseous, fluids, and solids), effluents, and wastes generated during preparation, testing, maintenance, and inspection of the items under test.

f. Plan to estimate and measure the fate of fired munitions, associated with firing/impact conditions during testing, and the amounts and conditions of munitions recovered and abandoned on each firing range.

g. Plan to estimate and measure any electromagnetic emissions resulting from test items, test instrumentation, and communications equipment used during testing.

5.1.2 Affected Environment.

In accordance with 32 CFR 651/AR 200-2, information about existing conditions in the affected areas must be considered prior to implementing an action. Affected elements could include, for example, biophysical characteristics (ecology and water quality), land use, architectural structures, and utilities and services.

a. Plan to define the test area in terms of area of potential effect.

b. Plan to characterize the testing site's natural condition (vegetated, wooded, paved, etc.) prior to commencement of testing.

c. Plan to characterize physical structures at the test site.

d. Plan to identify utilities and services at the test site.

5.1.3 Environmental and Socioeconomic Consequences.

In accordance with 32 CFR 651/AR 200-2, data should be collected to identify any impacts to human health and welfare and to the natural environment.

a. Plan to identify any impacts to human health and welfare and to the natural environment. The type of data collected might include noise levels, soil erosion, and disturbance to natural resources such as surface water bodies, vegetation, or wildlife.

b. Plan to estimate and measure any habitat damage or toxic uptake relevant to flora/fauna and the soil erosion effects of proposed testing.

c. Plan to identify any modifications/alternatives implemented or considered to reduce adverse environmental effects.

5.1.4 Mitigation Measures.

In accordance with 32 CFR 651/AR 200-2, when feasible, mitigation measures should be identified to lessen the potential for adverse environmental effects from an action. There are several ways that mitigation measures can be implemented.

a. Avoidance. This type of action avoids environmental impact by not performing certain activities, for example, allowing tracked vehicles to cross only at designated improved stream crossings. This restriction would reduce the effects on a stream resulting from random access, such as increased turbidity caused by bank erosion and bottom disturbance caused by the tracks.

b. Limitation of Action. The extent of an impact can be reduced by limiting the degree or magnitude of the action, for example, changing the firing time or the number of rounds fired on artillery ranges to reduce the noise impact on nearby residents. In the example above, the number of authorized stream crossings would have been limited or minimized.

c. Restoration of the Environment. This would restore the environment to its previous condition or better. Movement of troops and vehicles across vegetated areas often destroys vegetation. This impact can be mitigated by either reseeding or replanting the areas with native plants after the exercise. In some instances, restoration of the environment is not economically or physically possible. In these cases, stabilization is a feasible option to support natural restoration.

d. Preservation and Maintenance Operations. This designs the action so as to reduce adverse environmental effects. Examples include maintaining erosion control structures, using air pollution control devices, and encouraging car pools to reduce transportation effects such as air pollution, energy consumption, and traffic congestion.

e. Replacement. This method replaces the resource or environment that will be impacted by the action. Replacement can occur in-kind or otherwise; for example, replace deer habitat in the project area with deer habitat in another area or replace fisheries habitat with deer habitat. This replacement can occur either on the site of impact or at another location. Plan to adopt mitigation measures such as those described above whenever feasible during a test operation.

5.2 Environmental Data/NEPA Considerations.

This section describes the actual data gathering that should be performed, when applicable, as part of a testing operation.

5.2.1 Background Data/Location.

Characterizing the equipment under test, test location, materials used, and storage of the equipment and materials before test operations begin provides a baseline of the existing conditions at a testing site and is an essential part of characterizing the potential for environmental effects to occur. Before testing begins, the physical components of the equipment under test, the test location, time and length of testing, climatic conditions, and storage requirements should all be described.

a. Test Items Description. Record a general description of the equipment under test that includes the size of the equipment and its overall dimensions (length, width, weight, and height). Where applicable, also record the gross weight as tested, ground clearance, truck/wheel width, ground pressure, center of gravity, speed profile, and fuel capacity and types.

b. Test Location and Characterization. Define the test area in terms of area of potential effect. Provide a physical description of the natural characteristics (vegetated, wooded, paved, etc.) of the testing site. Record the type of terrain, vegetation, waterways (if present), presence of buildings or other structures, and utilities and services. Record if the testing will be conducted on-road, off-road, or in a trench or waterway. Record use of any specialized or standardized test facilities.

c. Time and Length of Test. Record the time that testing commenced and the length of time that test operations were performed (minutes, hours, or days as appropriate). This should include the time period that equipment was stored at the test site prior to and after testing was conducted.

d. Meteorological Conditions. Record the temperature, wind direction, and precipitation during test period, including during setup, storage, and breakdown of equipment and materials to support the test operation.

e. Storage Conditions. Estimate and measure the types and quantities of materials that require storage during setup, testing, maintenance, inspection, and breakdown of the items under test. Storage requirements should consider solid, liquid, and containerized gaseous materials (i.e., equipment, fuel, chemicals, aerosols, and metals) required for the test.

5.2.2 Geology, Topography, and Soils.

This information is necessary to determine if the testing disturbs the soils at the test site. For purposes of this TOP, impacts to soil only (i.e., not to the local geology and topography) should be considered and recorded, as necessary.

a. Ground disturbance and soil erosion. Record evidence of soil erosion or disturbance. Record if grading is performed and the extent of grading required.

b. Soil compaction rates. Record soil compaction and effects. Where appropriate, soil compaction should be measured in accordance with procedures contained in the Data Collection Methods (app B).

5.2.3 Water Resources.

Water resources need to be characterized to determine if any adverse effects would occur as a result of test operations that could degrade water resources, making them unsafe for drinking, fishing, swimming, or other activities. In addition to recording the observations listed below, if any contamination of water resources should occur, it will be necessary to collect and analyze appropriate water samples. Procedures for sampling and analyzing surface water and ground water are detailed in the Data Collection Methods (Appendix B).

a. Surface Water. The protection of surface water bodies and any associated floodplains and wetlands are regulated under several Federal regulations, including the Clean Water Act, as amended (Public Law 95-217[7]); the Watershed Protection and Flood Prevention Act of 1954 (16 U.S.C. 1101, et seq.[8]); the Wetlands Conservation Act (Public Law 101-233[9]); Floodplain Management (Executive Order 11988[10]); and Protection of Wetlands (Executive Order 11990[11]).

(1) Background.

(a) Record if test will be done within or adjacent to a surface water body (stream, river, lake, etc.).

(b) Record if test will be conducted within or adjacent to a wetland area. (Note: An INRMP may be referenced to locate potential wetland areas.)

(c) Record the depth of a surface water body, slope, or bank along the waterway, type of bottom (rocky, sandy, gravel, etc.), and water clarity (murky, clear).

(2) Impact.

(a) Record if there is a potential for impacts to a surface water body such as turbidity or release of oil (oil sheen) or other fluids to surface water.

(b) Record any alteration to the current or direction of flow.

(c) Record any impact to stream banks and evidence of erosion along stream banks.

b. Ground Water. The Safe Drinking Water Act and the Resource Conservation and Recovery Act (RCRA) establish ground water protection programs to prevent un-permitted injections into ground water sources, protect aquifers that serve as drinking water sources, and protect wellheads.

(1) Background.

(a) Record known aquifers that may exist under the test area.

(b) Record the type of overburden (soil and rock above the ground water) and depth to the aquifer.

(2) Impact. Record if there is a potential for affecting a ground water source.

5.2.4 Stormwater.

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Stormwater runoff can also represent a non-point source of contamination. In addition to recording the observations listed below, if stormwater contamination of surface water resources is a concern, it may be necessary to collect and analyze appropriate stormwater runoff samples. Procedures for sampling and analyzing stormwater are detailed in the Data Collection Methods (Appendix B).

a. Background.

(1) Record if there are any point sources or non-point sources within or adjacent to the test site, including any staging or storage areas.

(2) Record if any activity is occurring upgradient of a waterbody and if there are any routes or conveyances for contamination to enter a waterbody.

b. Impact. Record if there is a potential for any solid or liquid material to enter a point source.

5.2.5 Process Water.

General pretreatment standards are applicable to all the non-domestic discharges to publicly-owned treatment works (POTWs) or Federally-owned treatment works (FOTWs) facilities. All discharges to POTWs are regulated by general pretreatment standards and, in many cases, local sewer use ordinances. FOTWs may set pretreatment requirements to ensure compliance with their NPDES permit. Regulatory agencies may implement further limitations or pretreatment standards for internal discharges. In addition to recording the observations listed below, if process water contamination of surface water resources is a concern, it may be necessary to collect and analyze appropriate process water samples. Procedures for sampling and analyzing process water are described in the Data Collection Methods (app B). Army pretreatment programs for all wastewater treatment systems must record the following:

a. Quantity and chemical characteristics of process water generated.

b. Disposal/treatment method for process water.

5.2.6 Vegetation.

Impacts to the existing vegetation from a proposed action must be considered under NEPA. After a test has been performed, identify any damage or potential damage to vegetation (including trampled, fire damage, or vegetation removal) that resulted from the test operations, including setup, staging, storage, and breakdown of equipment under test. This will be based on visual observations made before, during, and after the test is complete.

a. Background. Record the type of vegetation (grass, trees, etc.). The type of vegetation should be provided (e.g., White Oak, 30 feet tall, diameter 2 ft). If the type of vegetation is not known, as much detail as possible should be provided to describe the affected vegetation. In some instances, photographs may be helpful.

b. Impact.

(1) Record the amount of vegetation impacted (measured in acres, feet, or by the number of plants or trees, whichever is appropriate).

(2) Identify other potential impacts to vegetation.

5.2.7 Terrestrial and Aquatic Wildlife.

Impacts to resident and transitory wildlife that inhabit the area or use the area for food and cover must be considered under NEPA. The Test Officer should identify if any damage to animals resulted from the test operations, (including during setup, staging, storage, and breakdown of equipment under test). Examples of fauna damage would include damage or removal of animal(s), animal nests, or burrows, from the test area, or injury or death of animal(s) as a result of the test. The number and type of animal(s) affected should be recorded and, if known, the species of animal(s) observed.

a. Background. Prior to testing, the test site should be informally surveyed for evidence of wildlife.

(1) Record observed nests or burrows.

(2) Record any animal sighting or animal tracks. As much detail should be provided as possible and, if known, the type of animal should be recorded.

b. Impacts. Any damage to animals that occurred as a result of the test operations, including setup, storage, and breakdown of equipment under test should be recorded. Record the following data:

(1) Removal of animal nests, burrows, or animal(s) from test area.

(2) Injury or death of animal(s) as a result of the test.

(3) Type of animal(s) affected. Include the type of wildlife affected (e.g., male Red Cardinal or rodent-sized mammal). If the species is not known, as much detail as possible should be provided to describe the animal(s).

(4) Identify items that have potential to damage habitat.

5.2.8 Air Quality.

The Clean Air Act (CAA), as amended (Public Law 88-206[12]) regulates pollutants in the air and sets standards for air quality. Air pollutants can injure health and harm the environment. The U.S. Environmental Protection Agency (EPA[11]) recognizes six principal air pollutants including carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide (SO_2) under the Clean Air Act to protect public health and the environment. For each of these six criteria pollutants, the EPA has established primary and secondary National Ambient Air Quality Standards (NAAQS). Primary standards are set at levels to protect public health including the most sensitive individuals, such as the elderly and those with respiratory ailments. Secondary standards are established to protect public welfare (e.g., structures, crops, animals, and fabrics). Areas are designated as either attainment areas (have met or exceed primary standards that protect human health) or nonattainment areas (areas that have not met the standards to protect human health).

In addition to the criteria air pollutants, other air pollutants are Federally regulated and should be considered during testing operations. Emissions of the following compounds should be considered: airborne pollutants and aerosols and hazardous air pollutants (HAPs) including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and heavy metals. To determine the potential for air pollutants to impact the environment, the following parameters should be considered and recorded.

a. NAAQS Pollutants.

(1) Record if any materials listed as NAAQS pollutants are generated during testing.

(2) If NAAQS pollutants are used or generated, measure and record the amount of the pollutants generated and emitted in accordance with Data Collection Methods (Appendix B). Typically, there would be little value in monitoring for ozone or SO_2. However, for many test operations, there would be great value in obtaining data on $PM_{2.5}$, PM_{10}, lead, NO_x, and/or CO. Appendix B provides guidance for direct sampling of particulates and lead in ambient air. There is also guidance in Appendix B for estimating air pollutants (such as NO_x and CO) using published emission factors.

b. Airborne Pollutants and Aerosols. The use of aerosols, paints, cleaners, and other materials can result in the release of airborne pollutants and aerosols.

(1) Record the use of aerosols, paints, and cleaning materials used.

(2) Measure and record the amount of aerosols, paints, and cleaning materials used for testing and the percent content of air pollutants in the materials used.

c. HAPs. HAPs are chemicals that cause serious health and environmental hazards. Title III of the Clean Air Act lists 188 HAPs for which EPA must establish source lists and emission control standards. Measure and record the amount of HAPs used for testing, determine if there is a potential for a release to the air, and if necessary, measure the release of air pollutants (volatile organic compounds, semivolatile organic compounds, and heavy metals) in accordance with Data Collection Methods (Appendix B).

5.2.9 Noise Quality.

The level, frequency, and duration of noise levels should be considered to assess the potential impact of environmental noise on the public and on the natural environment during test operations.

a. Noise Level (decibels). Measure and record the noise level (decibels) during the test operation at the point of test and at other appropriate distances in accordance with the Data Collection Methods (Appendix B).

b. Steady-State or Impulse Noise. Record if the noise is a steady-state noise (e.g., vehicle engines or generator running) or an impulse noise (e.g., explosion).

c. Measure and record the blast overpressure in accordance with the Data Collection Methods (Appendix B), the duration of the noise, the type and source, range, and pitch of the noise.

5.2.10 Hazardous Materials/Hazardous Waste.

The use, storage, and disposal of system-specific hazardous materials for testing should be recorded to determine the potential for a release of hazardous materials to the environment. In addition, the generation of hazardous waste and the storage and disposal method for hazardous waste generated should be recorded. The collection of data pertaining to lead-based paint, material containing asbestos, and polychlorinated biphenyls, although considered, is not included in this TOP because these materials are not expected to be present during test operations.

a. Hazardous Materials Used. To determine what hazardous materials are required for a test operation, record all hazardous materials (i.e., solvents, paints, acids, and cleaners) used. Include the quantity used and the storage and containment of hazardous materials before, during, and after test operations are performed.

b. Alternative (Non-Hazardous) Materials Used or Considered/Pollution Prevention.

(1) Record alternative (less toxic) materials used or considered for use to replace hazardous material usage. Include the quantity used and the storage and containment of these materials before, during, and after test operations are performed.

(2) 32 CFR 650/AR 200-1[13] establishes the procedures necessary to meet the pollution prevention goals and requirements. Pollution prevention is any practice which reduces the amount of a hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released to the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and any practice that reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

c. Hazardous Waste Generated. The management of hazardous waste is Federally regulated and the handling, storage, and disposal of hazardous waste must comply with Federal, state, and local regulations.

(1) Record the quantity and type (ignitable, reactive, corrosive, toxic) of hazardous waste generated.

(2) In some cases, it may be necessary to test the material to determine whether it exhibits hazardous characteristics. In these instances, the Toxic Characteristic Leaching Procedure (TCLP) test should be conducted in accordance with the Data Collection Methods (Appendix B).

d. Ozone-depleting compounds (ODCs). ODCs are chemicals that contribute to the deterioration of the ozone in the earth's upper atmosphere. ODCs are often found in solvents and cleaners. The chemicals that contribute to this problem include chlorofluorocarbons (CFCs) and halons. CFCs, halons, hydrochlorofluodcarbons (HCFCs), and other ozone-destroying chemicals

were listed in the 1990 CAA and must be phased out of production and use. The CAA requires recycling of CFCs and proper labeling of ODCs. A complete list of regulated ODCs can be found in 40 CFR 82[14].

(1) Record if materials used contain ODCs.

(2) Record the quantity of ODCs used, and the storage and disposal of ODCs and releases.

e. Petroleum, Oils, and Lubricants (POL) (Type, Storage, Disposal).

(1) POL Used. Record the type of POL (including fuels) used to operate equipment. Include the type of storage (e.g., drum, tank), capacity of storage container, and containment provided.

(2) Characterize the wastes from fluids replacement and replenishment. If hazardous, see Hazardous Waste Generated (paragraph 5.2.10c).

f. Potential for Releases of Hazardous Materials, Hazardous Waste, Fuel, POL.

(1) Identify spill prevention measures in place during the test.

(2) Record and notify appropriate Installation personnel if a release to the environment does occur. Include the material released, the quantity released, emergency response action taken, and disposal of materials cleaned up.

g. Batteries. Record the type, quantity, storage, and disposal of batteries used for test purposes.

h. Toxic Organic Compounds.

(1) Record toxic organic compounds present in test materials.

(2) Record the quantity, toxicity, and disposition of any toxic organic compounds released during testing. Determine the concentration of these compounds in soil or waste in accordance with Data Collection Methods (Appendix B).

(3) Record the storage and disposal (including recycling) of toxic organic compounds.

i. Heavy Metals.

(1) Record heavy metals (primarily arsenic, barium, cadmium, chromium, lead, mercury, silver, and selenium) present in test materials.

(2) Record the quantity, toxicity, and disposition of any heavy metals released during testing. Determine the concentration of heavy metals in soil or waste in accordance with the Data Collection Methods (Appendix B).

(3) Record the storage and disposal (including recycling) of heavy metals.

j. Explosive Residue.

(1) Estimate and measure the amount of explosive and propellant residue, including the residue constituents, toxicity, concentration, and quantity.

(2) Record the type and amount of reaction products generated during testing.

(3) Measure and record the amount of explosive residue released and/or recovered. Determine the concentration of explosive compounds in soil or waste in accordance with the Data Collection Methods (Appendix B).

k. Fired Munitions.

(1) Record the quantity and description of fired munitions, if they were destroyed, and the destruction method.

(2) Record the percent of fired munitions that fail to fully function.

(3) Record the percent of failed fired munitions recovered. Include the condition of fired projectiles when recovery is required.

(4) Record factors preventing the retrieval of failed fired munitions.

l. Electromagnetic Emissions.

(1) Measure non-ionizing radiation emanating from electronic, avionic, and communications equipment, such as lasers and radar, in accordance with the Data Collection Methods (Appendix B).

(2) Measure ionizing radiation emanating from equipment, such as X-ray machines and radioactive sources, in accordance with Data Collection Methods (Appendix B).

5.2.11 Solid Waste.

a. Record the type, quantity, and storage of solid waste generated.

b. Record the disposal or recycling method for solid waste generated.

c. Record if alternatives were used or considered to reduce the amount of solid waste generated.

d. Identify potential reuse, recycling, or other diversion options for solid waste generated.

e. Identify end-of-life reuse, recycling, and disposal options.

5.3 Commodity Categories.

5.3.1 Wheeled, Tracked, and Special Purpose Vehicles.

This section addresses the environmental data to be collected when testing, maintaining, and repairing land-based military vehicles, materials handling equipment, armored vehicles (both combat and combat-support), amphibious and special purpose vehicles, automatic equipment, commercial land vehicles, and other vehicles addressed in TOP Volume 2, Wheeled, Tracked, and Special Purpose Vehicles. Environmental data collection that should be considered for wheeled, tracked and special purpose vehicles equipment testing is listed below. Information pertaining to the environmental considerations should be recorded in accordance with paragraphs 5.1 and 5.2 and Environmental Data Matrix (Appendix A).

a. Geology, Topography, And Soils.

b. Water Resources.

c. Stormwater.

d. Wastewater.

e. Vegetation.

f. Terrestrial and Aquatic Wildlife.

g. Air Quality.

h. Noise Quality.

i. Hazardous Materials/Hazardous Waste.

(1) Hazardous materials used, type, quantity, storage.

(2) Alternative (non-hazardous) materials used or considered/pollution prevention.

(3) Hazardous waste generated (quantity, type, storage, and disposal).

(4) ODCs.

(5) POL (type, storage, disposal).

(6) Potential for releases of hazardous materials, hazardous waste, fuel, POL.

(7) Batteries (quantity, storage, and disposal).

(8) Electronic emissions.

j. Solid waste.

5.3.2 Armament and Individual Weapons and Equipment.

This section includes the environmental data that should be collected when testing small arms and infantry weapons and medium and large caliber weapons addressed in TOP Volume 3, Armament and Individual Weapons and Equipment. Environmental data collection that should be considered for armament and individual weapons equipment testing is listed below. Information pertaining to the environmental considerations should be recorded in accordance with paragraphs 5.1 and 5.2 and Environmental Data Matrix (Appendix A).

a. Geology, Topography, and Soils (including ground disturbance from successful and failed fired munitions).

b. Water Resources.

c. Vegetation.

d. Terrestrial and Aquatic Wildlife.

e. Air Quality.

f. Noise Quality.

g. Hazardous Materials/Hazardous Waste.

(1) Hazardous materials used (type, quantity, storage).

(2) Alternative (non-hazardous) materials used or considered/pollution prevention.

(3) Hazardous waste generated (quantity, type, storage, and disposal).

(4) ODCs.

(5) POL (type, storage, disposal).

(6) Potential for releases of hazardous materials, hazardous waste, fuel, POL.

(7) Batteries (quantity, storage, and disposal).

(8) Heavy metals.

(9) Residue.

(10) Fired munitions.

(11) Electronic emissions.

h. Solid Waste.

5.3.3 Ammunition and Explosives.

This section includes the environmental data that should be collected when testing the ammunition, explosives, and propelling charges addressed in TOP Volume 4, Ammunition and Explosives. Environmental data collection that should be considered for ammunition and explosives equipment testing is listed below. Information pertaining to the environmental considerations should be recorded in accordance with paragraphs 5.1 and 5.2 and Environmental Data Matrix (Appendix A).

a. Geology, Topography, and Soils.

b. Water Resources.

c. Vegetation.

d. Air Quality.

e. Noise Quality.

f. Hazardous Materials/Hazardous Waste.

(1) Hazardous materials used (type, quantity, storage).

(2) Alternative (non-hazardous) materials used or considered/pollution prevention.

(3) Hazardous waste generated (quantity, type, storage, and disposal).

(4) ODCs.

(5) POL (type, storage, disposal).

(6) Potential for releases of hazardous materials, hazardous waste, fuel, POL.

(7) Batteries (quantity, storage, and disposal).

(8) Heavy metals.

(9) Residue.

(10) Fired munitions.

h. Solid Waste.

5.3.4 Missile and Rocket Systems.

This section includes the environmental data that should be collected when testing missile and rocket systems addressed in TOP Volume 5, Missile and Rocket Systems. Environmental data collection that should be considered for missile and rocket systems equipment testing is listed below. Information pertaining to the environmental considerations should be recorded in accordance with paragraphs 5.1 and 5.2 and Environmental Data Matrix (Appendix A).

a. Geology, Topography, and Soils.

b. Water Resources.

c. Vegetation.

d. Air Quality.

e. Noise Quality.

f. Hazardous Materials/Hazardous Waste.

(1) Hazardous materials used (type, quantity, storage).

(2) Alternative (non-hazardous) materials used or considered/pollution prevention.

(3) Hazardous waste generated (quantity, type, storage, and disposal).

(4) ODCs.

(5) POL (type, storage, disposal).

(6) Potential for releases of hazardous materials, hazardous waste, fuel, POL.

(7) Batteries (quantity, storage, and disposal).

(8) Toxic organic compounds

(9) Heavy metals.

(10) Residue.

(11) Fired munitions.

(12) Electronic emissions.

g. Solid Waste.

5.3.5 Electronic, Avionic, and Communications Equipment.

This section includes the environmental data that should be collected when testing electronic, avionic, and communications equipment, including communication equipment, meteorological equipment, radar, and smoke and obscurants addressed in TOP Volume 6, Electronic, Avionic and Communications Equipment. Environmental data collection that should be considered for electronic, avionic, and communications equipment testing is listed below. Information pertaining to the environmental considerations should be recorded in accordance with paragraphs 5.1 and 5.2 and Environmental Data Matrix (Appendix A).

a. Water Resources.

b. Terrestrial and Aquatic Wildlife.

c. Hazardous Materials/Hazardous Waste.

(1) Hazardous materials used (type, quantity, storage).

(2) Alternative (non-hazardous) materials used or considered/pollution prevention.

(3) Hazardous waste generated (quantity, type, storage, and disposal).

(4) Batteries (quantity, storage, and disposal).

(5) Toxic organic compounds

(6) Heavy metals.

(7) Electromagnetic emissions.

d. Solid Waste.

5.3.6 Construction, Support and Service Equipment.

This section includes testing for bridges and bridging equipment, cranes, earthmoving equipment, and service equipment addressed in TOP Volume 9, Construction, Support, and Service Equipment. Environmental data collection that should be considered for construction, support, and service equipment testing is listed below. Information pertaining to the environmental considerations should be recorded in accordance with paragraphs 5.1 and 5.2 and Environmental Data Matrix (Appendix A).

a. Geology, Topography, and Soils.

b. Water Resources.

c. Stormwater.

d. Wastewater.

e. Vegetation.

f. Air Quality.

g. Noise Quality.

h. Hazardous Materials/Hazardous Waste.

(1) Hazardous materials used (type, quantity, storage).

(2) Alternative (non-hazardous) materials used or considered/pollution prevention.

(3) Hazardous waste generated (quantity, type, storage, and disposal).

(4) ODCs.

(5) POL (type, storage, disposal).

(6) Potential for releases of hazardous materials, hazardous waste, fuel, POL.

(7) Batteries (quantity, storage, and disposal).

(8) Toxic organic compounds

(9) Electronic emissions.

i. Solid Waste.

5.3.7 General Supplies and Equipment.

This section includes testing that involves material other than that addressed above (e.g., individual Soldier equipment, food service systems, shelter systems, radios, optics, armor materials, etc.) found in TOP Volume 10, General Supplies and Equipment. Environmental data collection that should be considered for general supplies and equipment testing is listed below. Information pertaining to the environmental considerations should be recorded in accordance with paragraphs 5.1 and 5.2 and Environmental Data Matrix (Appendix A).

a. Geology, Topography, and Soils (ground disturbance).

b. Wastewater.

c. Air Quality.

d. Noise Quality.

e. Hazardous Materials/Hazardous Waste.

(1) Hazardous materials used (type, quantity, storage).

(2) Alternative (non-hazardous) materials used or considered/pollution prevention.

(3) Hazardous waste generated (quantity, type, storage, and disposal).

(4) POL (type, storage, disposal).

(5) Potential for releases of hazardous materials, hazardous waste, Fuel, POL.
(6) Batteries (quantity, storage, and disposal).

f. Solid Waste.

6. PRESENTATION OF DATA.

Environmental effects data, although collected during most subtests, have not normally been included in the primary test report. This data can be useful to Test Officers and other decision makers in determining the environmental impacts from test operations. Compiling the environmental effects data into a database will also provide a reference for Test Officers on future test operations. The data can be compiled into a central database for use in identifying environmental effects associated with test operations of various commodities.

APPENDIX A. ENVIRONMENTAL DATA MATRIX

This appendix contains a matrix that relates NEPA environmental data categories to the types of Army materiel to be tested. The matrix is organized in the form of a spreadsheet, and it is best viewed using the electronic spreadsheet application.

APPENDIX
A - ENVIRONMENTAL DATA MATRIX

COMMODITY CATEGORIES	A. WHEELED, TRACKED, AND SPECIAL PURPOSE VEHICLES (VOL. 2) *	Wheeled Vehicles	Forklifts, Trailers, and Mobile Weapons	Tracked Vehicles	Tanks, Self-Propelled Artillery, Armored Personnel Carriers, and Recovery Vehicles	Other Categories	Airborne	Amphibious	Boats	Armor Materials and Systems	B. ARMAMENT AND INDIVIDUAL WEAPONS AND EQUIPMENT (VOL 3)	Small Arms and Infantry Weapons	Machine and Subcaliber Guns, Hand, and Shoulder Weapons	Grenade Launchers and Recoilless Rifles	Night Vision Devices	Radioactive Components	Medium and Large Caliber Weapons	Artillery Cannons, Tank Cannons, and Mortars	C. AMMUNITION AND EXPLOSIVES (VOL. 4)	Ammunition	Close-Support Rockets and Missiles and Anti-Tank Missiles	Mortar Ammunition	Small Arms Ammunition	Tank Ammunition	Fuzes	Explosives	Insensitive Munitions and Flamethrowers	Grenades, Flares & Pyrotechnics, Mines & Demolitions, Shaped Charges	Underwater Explosive Charges	Propelling Charges	Artillery Ignition Systems	Propellant-Actuated Devices	D. MISSILE and ROCKET SYSTEMS (VOL. 5)	Liquid Propellant Systems	Guidance Components and Systems	Missile Aerodynamics Components	IR Seekers	Rocket Sleds	Warheads	Gas-Operated Power Supplies
	X	=	Observational Data Requirement Only - No additional S&A or Measurment Required								X	=	Additional S&A or Measurements Data Required Specific to TOP Considerations										X	=	Potenital for both Observational and S&A or Measurements Data Requirement Specific to Top Considerations															
ENVIRONMENTAL DATA/NEPA CONSIDERATIONS																																								
Background Data/Location																																								
Equipment Testing Description (size, length, width, height, weight)			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Testing Location & Characterization (on-road, off-road, trench, waterway. paved, disturbed soil, barren, vegetation, wildlife)			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Time & Length of Testing			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Meteorological Conditions			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Storage Conditions			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Geology/Topography/Soils																																								
Ground Disturbance (e.g., from vehicles, munition impacts to ground surface)			X		X			X		X			X	X				X			X	X	X	X	X		X	X				X	X				X	X	
Soil Erosion			X		X			X	X	X			X	X							X	X	X	X	X				X	X									
Soil Compaction Rates and Effects			X		X			X		X																														
Water Resources (Clean Water Act/Safe Drinking Water Act)																																								
Surface Water Characterization (e.g., Wetlands, Coastal Primary Sand Dune, Submerged Land, Drinkin Water Source)			X		X			X	X	X			X	X				X			X	X	X	X	X		X	X	X			X	X			X	X	X	X
Release to Surface Water (Quantity/Quality)																														X										
Waterway Altered (current, direction of flow, banks)								X																																
Groundwater (Depth to Ground Water, Aquifer Characteristics, Ground-Water Quality)																						X	X	X	X	X		X	X	X			X	X			X	X	X	X
Stormwater																																								
Stormwater Collection, Conveyance and Discharge (NPDES Permit)			X		X			X	X	X			X	X				X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Wastewater																																								
Wastewater Effluent - Quantity, Collection, Disposal, and Discharge (NPDES Permit)			X		X			X	X	X																														
Vegetation																																								
Vegetation Disturbance/Damage (incl. singed, damaged, removed vegetation)			X		X		X	X	X	X			X	X				X			X	X	X	X	X		X	X	X			X	X			X	X		
Terrestrial and Aquatic Wildlife																																								
Impacts to Terrestrial and Aquatic Species			X		X		X	X	X	X			X	X				X			X	X	X	X	X		X	X	X			X	X			X	X		
Air Quality (Clean Air Act)																																								
NAAQS Criteria Pollutants (PM10, PM2.5, Pb, CO, Nox)			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Airborne Pollutants and Aerosols			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
HAPs (including VOCs, SVOCs, metals)			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Noise Quality																																								
Noise Level (decibels) (at source & at appropriate distances)			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X		X	X	X	X	X
Steady-State or Impulse Noise			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X		X		X	X	X
Duration, Type, Frequency Range, Pitch, Periodicity			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X		X		X	X	X
Hazardous Materials/ Hazardous Waste (RCRA, TSCA, CERCLA, EPCRA)																																								
Hazardous Materials Used, Quantity, Storage			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Alternative (non-Hazardous) Materials Used or Considered			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
Quantity and Type of Hazardous Waste Generated, Storage, Disposal			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X
ODCs																		X								X						X		X						
POLs (incl. fuel) (type, storage, disposal)			X		X		X	X	X	X			X	X				X			X	X	X	X	X		X					X							
Potential for Release of Hazardous Materials, Fuel, POLs			X		X		X	X	X	X			X	X				X			X	X	X	X	X		X					X							
Batteries (Quantity, Storage, Disposal)			X		X		X	X	X							X																			X	X	X			
Toxic Organic Compounds Concentrations and Quantities Generated																																					X	X	X	X	X	X	X
Heavy Metals Concentrations and Quantities Generated										X			X											X	X											X				X	
Residue (Explosive and Propellant Products) Concentrations and Quantities Released and Recovered										X			X	X				X			X	X	X	X	X		X	X	X			X	X						X	
Fired munitions (Amount Fired, Recovered and Abandoned; Condition of Fired Projectiles Recovered)										X			X	X				X			X	X	X	X	X		X	X	X			X	X						X	
Electromagnetic Emissions																																									
Solid Waste																																								
Type of Waste, Quantity, Storage, Disposal/Recycle			X		X		X	X	X	X			X	X	X	X		X			X	X	X	X	X		X	X	X			X	X	X		X	X	X	X

APPENDIX A - ENVIRONMENTAL DATA MATRIX	COMMODITY CATEGORIES	E. ELECTRONIC, AVIONIC, AND COMMUNICATIONS EQUIPMENT (VOL. 6)	Communications Security Equipment and Data Transmission Equipment	Laser Rangefinders, Infared Equipment and Target & Ranging Radar	**Meteorological Equipment**	Balloons	Sounding Systems	Weather Radar	**Countermeasures Equipment**	Communications	Non-Communications	Smoke and Obscurants	F. CONSTRUCTION, SUPPORT, AND SERVICE EQUIPMENT (VOL. 9)	Bridges and Bridge Equipment	Conveyor Equipment	Warehouse Cranes	Earth Loading and Earth Moving Equipment	Paving Equipment	Road Graders	Cable Reel Trailers	Air Compressions	Pumps	Hoists and Cutters	Lathes and Sanders	Liquid Storage Tanks	Waterway Equipment	Water Supply and Treatment Equipment	Dust Control Material	Generators	POL Support Equipment	Radiographic Equipment	G. General Supplies and Equipment (Vol. 10)	Bakery Equipment	Field Heating and Cooking Equipment	Combat Uniforms and Protective Equipment	Cold Weather Clothing and Footwear	Individual Load-Carrying Equipment	Tents and Shelters	Fire-Fighting Equipment	Boilers and Steam Generators	Air Conditioners	Diving Equipment	Body Armor
ENVIRONMENTAL DATA/NEPA CONSIDERATIONS																																										
Background Data/Location																																										
Equipment Testing Description (size, length, width, height, weight)			X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Testing Location & Characterization (on-road, off-road, trench, waterway. paved, disturbed soil, barren, vegetation, wildlife)			X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Time & Length of Testing			X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Meteorological Conditions			X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Storage Conditions			X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Geology/Topography/Soils																																										
Ground Disturbance (e.g., from vehicles, munition impacts to ground surface)												X		X			X	X	X	X				X			X		X									X				
Soil Erosion														X			X	X	X	X					X																	
Soil Compaction Rates and Effects														X			X	X	X	X																						
Water Resources (Clean Water Act/Safe Drinking Water Act)																																										
Surface Water Characterization (e.g., Wetlands, Coastal Primary Sand Dune, Submerged Land, Drinkin Water Source)												X		X	X		X								X	X	X			X				X	X				X		X	X
Release to Surface Water (Quantity/Quality)														X											X	X	X												X			X	
Waterway Altered (current, direction of flow, banks)														X												X																
Groundwater (Depth to Ground Water, Aquifer Characteristics, Ground-Water Quality)																											X															
Stormwater																																										
Stormwater Collection, Conveyance and Discharge (NPDES Permit)												X		X	X	X	X	X	X	X					X	X	X	X	X	X								X	X	X		
Wastewater																																										
Wastewater Effluent - Quantity, Collection, Disposal, and Discharge (NPDES Permit)														X			X	X	X								X												X	X	X		
Vegetation																																										
Vegetation Disturbance/Damage (incl. singed, damaged, removed vegetation)												X		X			X	X	X	X					X	X		X		X								X				
Terrestrial and Aquatic Wildlife																																										
Impacts to Terrestrial and Aquatic Species												X		X			X	X	X	X					X	X		X		X								X				
Air Quality (Clean Air Act)																																										
NAAQS Criteria Pollutants (PM10, PM2.5, Pb, CO, Nox)												X		X	X	X	X	X	X	X	X							X	X	X			X	X					X	X			
Airborne Pollutants and Aerosols												X		X	X	X	X	X	X	X	X				X			X	X	X			X	X					X	X			
HAPs (including VOCs, SVOCs, metals)												X		X	X	X	X	X	X	X	X			X	X			X	X				X	X					X	X			
Noise Quality																																										
Noise Level (decibels) (at source & at appropriate distances)												X		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X			X						X	X	X		
Steady-State or Impulse Noise												X		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X			X						X	X	X		
Duration, Type, Frequency Range, Pitch, Periodicity												X		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X			X						X	X	X		
Hazardous Materials/ Hazardous Waste (RCRA, TSCA, CERCLA, EPCRA)																																										
Hazardous Materials Used, Quantity, Storage			X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Alternative (non-Hazardous) Materials Used or Considered			X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Quantity and Type of Hazardous Waste Generated, Storage, Disposal			X	X		X	X	X		X	X	X		X							X			X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	
ODCs																	X		X																				X	X		X		
POLs (incl. fuel) (type, storage, disposal)														X	X	X	X	X	X	X	X	X	X	X	X			X	X	X									X	X			
Potential for Release of Hazardous Materials, Fuel, POLs												X		X	X	X	X	X	X	X	X	X	X		X			X	X	X									X	X	X		
Batteries (Quantity, Storage, Disposal)			X	X		X	X	X		X				X	X	X	X	X	X	X									X					X						X	X		
Toxic Organic Compounds Concentrations and Quantities Generated												X													X			X		X													
Heavy Metals Concentrations and Quantities Generated			X							X																					X												
Residue (Explosive and Propellant Products) Concentrations and Quantities Released and Recovered																																										
Fired munitions (Amount Fired, Recovered and Abandoned; Condition of Fired Projectiles Recovered)																																										
Electromagnetic Emissions			X	X				X		X	X																				X											
Solid Waste																																										
Type of Waste, Quantity, Storage, Disposal/Recycle						X				X	X	X		X			X	X	X	X		X			X	X	X			X		X						X	X	X		X

APPENDIX B. DATA COLLECTION METHODS

MEASUREMENT PROCEDURES FOR DETERMINING SOIL COMPACTION……..... B-2

PROCEDURE FOR ESTIMATING SOIL EROSIVITY UTILZING THE REVISED UNIVERSAL SOIL LOSS EQUATION (RUSLE) PREDICTION MODEL……..... B-6

SAMPLING AND ANALYSIS PROCEDURE FOR CHARACTERIZING SOIL CONTAMINANT CHEMISTRY…….. B-19

SAMPLING AND ANALYSIS PROCEDURES FOR AQUEOUS MEDIA…….. B-27

SAMPLING AND ANALYSIS PROCEDURE FOR MONITORING PM2.5 IN AMBIENT AIR…… B-40

SAMPLING AND ANALYSIS PROCEDURES FOR MONITORING PM10 AND METALS IN AMBIENT AIR……. B-50

SAMPLING AND ANALYSIS PROCEDURES FOR MONITORING VOC IN AMBIENT AIR …… B-63

SAMPLING AND ANALYSIS PROCEDURES FOR MONITORING SVOC IN AMBIENT AIR……. B-71

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MEASUREMENT PROCEDURES FOR DETERMINING SOIL COMPACTION

1. SCOPE AND APPLICATION.

The objective of this procedure is to outline the equipment and methods used for determining soil compaction. Compaction is the densification of a soil by mechanical means. Compaction increases the shear strength, decreases the compressibility, and decreases the permeability of soil. To measure the compaction of soil, the relationship of moisture and density must be determined. There are two prevailing methods for measuring compaction, involving either a nuclear density gauge or an electrical density gauge. These gauges allow quick and efficient checking of both the moisture and density of the in-place soil. The non-destructive nature of the test allows repetitive measurements to be made in a single location.

The procedure may be varied or changed as required, dependent on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

This procedure does not address any of the safety concerns associated with its use. It is the responsibility of the user of this guidance document to establish appropriate safety and health practices. This procedure is also not project-specific. A project-specific Sampling and Analysis Plan (SAP) should be developed for each project, when soil compaction testing is necessary.

Soil compaction should be measured at the beginning of the test to determine the baseline condition and then at the end of the test. Examples of the types of developmental testing that may require determining soil compaction include:

a. Automotive Testing:

   Cross-country test courses

b. Ballistic Testing:

   Detonation areas/burning areas/impact areas

2. REFERENCES.

Several sources were used to develop this procedure, primarily the following:

American Association of State Highway and Transportation Officials (AASHTO) Test Method T238. http://www.aashto.org

AASHTO Test Method T239. http://www.aashto.org

Humboldt Electrical Density Gauge Pamphlet. http://www.humboldtmfg.com

United States Department of Agriculture. Guidelines for Soil Quality Assessment in Conservation Planning. January 2001.

3. EQUIPMENT.

Determining soil compaction requires the following equipment and supplies.

a. Nuclear gauge with instrument manual and reference standard (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

b. Electrical density gauge which includes an instrument manual, 4-tapered electrodes, hammer, soil sensor and cables, template, temperature probe, and battery charger (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

c. Leveling device

d. Safety equipment, as specified in the project-specific Health and Safety Plan

e. Survey equipment or global positioning system (GPS) to locate sampling points

f. Tape measure

g. Survey stakes or flags

h. Camera and film

i. Logbook

j. Field data sheets

4. PROCEDURES.

Nuclear Density Gauge.

Measurement parameters can include: wet density, percent moisture, dry density, percent compaction, and percent air voids.

a. Standardize the instrument according to the instrument manual.

b. Select a test location. If the instrument will be closer than 250 mm (10 in) to any vertical mass that might influence the result, such as in a trench or alongside a pipe, follow the manufacturer's correction procedure.

c. Remove all loose and disturbed material. Remove additional material as necessary to reach the material that represents the zone or stratum to be tested.

d. Scrape a smooth horizontal surface so as to obtain maximum contact between the instrument and the material being tested. The optimum condition in all cases is total contact

between the bottom surface of the instrument and the surface of the material being tested. To correct for surface irregularities, use of native fines or fine sand as a filler may be necessary. The depth of the filler should not exceed approximately 3 mm (1/8 inch) and the total area filled should not exceed 10% of the bottom area of the instrument. The maximum depth of any void beneath the instrument that can be tolerated without filling shall not exceed approximately 3 mm (1/8 inch).

e. Seat the instrument firmly on the prepared test site.

f. Keep all other radioactive sources away from the instrument to avoid affecting the measurement so as not to skew the reading.

g. Secure and record one or more readings for the normal measurement period. Follow the instrument manufacturer's instructions regarding apparatus set up. Typical testing time is 1 minute.

Electrical Density Gauge.

Measurement parameters can include: wet and dry density, gravimetric moisture content, and percent compaction.

a. Select a test location.

b. Remove all loose and disturbed material. Remove additional material as necessary to reach the material that represents the zone or stratum to be tested.

c. Hammer the four tapered electrodes or darts into the ground in a cross pattern using the template provided with the instrument.

d. Measurements are made and averaged between the two sets of two tapered electrodes. Measurements typically take between two to three minutes.

e. The length of the tapered darts positively determines the depth of measure.

5. INTERFERENCES.

The nuclear gauge density measurements are somewhat biased to the surface layers of the soil being tested. The chemical composition of the soil may also affect the measurement. Oversize rocks or large voids in the source-detector path may cause higher or lower density determination. The nuclear gauge density measurements may be skewed in areas that non-uniformity in the soil due to layering, rocks, or voids is suspected.
Typical testing depth is up to 30 cm (12 inches) from the surface for the nuclear density gauge. The sample volume is approximately 0.0028 m^3 (0.10 ft^3) when the test depth is 15 cm (6 inches). The actual sample volume is indeterminate and varies with the apparatus and the density of the material. In general, the higher the density, the smaller the volume.

The electrical density gauge accuracy is achieved using point-to-point radio frequency, measuring directly between electrodes driven in the soil, ensuring positive measurement through the soil at full depth of the electrodes. There is no need to make sure that the soil is homogeneous or to rely on radio frequency waves to penetrate soil materials from the surface. For the electrical density gauge, the depth is determined by the length of the tapered darts. The darts are available in different lengths.

6. SAMPLING STRATEGY.

Since measurements for both the nuclear and non-nuclear density gauges are quick (less than 5 minutes), and the set-up of the instrument is relatively easy, a large number of readings can be performed in a short period of time. It is recommended that three readings be taken at each location for more reliable results. For each mile of track or disturbed area, it is recommended that four sets of samples be taken.

Some guidelines for taking measurements include:

a. Collect readings from areas that have similar soil types;

b. Avoid taking readings in non-representative areas such as those that are uncharacteristically wet or dry, extremely hilly, or eroded;

c. Collect readings from “problem” areas (vehicle tracks), and for comparison, from nearby “normal” areas within the same soil type; and

d. Measure consistently - preferably using the same operator.

7. QUALITY ASSURANCE/QUALITY CONTROL.

For the nuclear density gauge, special training and a license are required for safe handling of the instrument because of the nuclear material enclosed in the device. The nuclear density gauge utilizes radioactive materials that may be hazardous to the health of the users unless proper precautions are taken. Users of this equipment must become familiar with applicable safety procedures and Government regulations. Effective user instructions together with routine safety procedures, such as source leak tests, recording and evaluation of film badge data, and so forth, are recommended parts of the operation and storage of this instrument. The electrical density gauge does not require a highly trained or licensed technician.

All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer. Equipment calibration, standardization, and reference checks must occur prior to sampling/operation in accordance with the instrument manual, and they must be documented.

PROCEDURE FOR ESTIMATING SOIL EROSIVITY UTILZING THE REVISED UNIVERSAL SOIL LOSS EQUATION (RUSLE) PREDICTION MODEL

Erosivity is just as important as soil compaction. Operations using tracked and wheeled vehicles can change the erosivity of an area through tilling the soil and devegetation. This procedure will help determine periods of time at a particular site will have the greatest potential for erosivity.

8. SCOPE AND APPLICATION.

The objective of this procedure is to outline the methods used for estimating soil erosivity. Erosivity is the potential for soil to wash off disturbed, devegetated earth into waterways during storms. The potential for erosion is in part determined by the soil type and geology of the site. Another important factor is the amount and force of precipitation expected during the time the earth will be exposed. While it is impossible to predict the weather several months in advance of weapon system operation with potential to disturb soils, for many areas of the country, there are definite optimal periods, such as a dry season when rain tends to fall less frequently and with less force. When feasible, this is the time to disturb the earth, so that the site is stabilized by the time the seasonal wet or dry weather returns. There are many other important factors to consider in determining erosivity, such as freeze/thaw cycles and snow pack.

Erosivity can be predicted though the use of established empirical erosion models. This prediction modeling can be used to help range land managers plan and choose practices and strategies to reduce erosion rates. Erosion models can also be used for engineering and conservation purposes, such as predicting rates of sediment loading and regulating range sustainment initiatives. Models can be used wherever the costs or time involved in making soil erosion measurements are prohibitive.

9. REFERENCES.

Several sources were used to develop this procedure, primarily the following:

Agricultural Handbook Number 703, Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE), Chapter 2, pp. 21-64, January 1997.

Storm Water Phase II Final Rule Fact Sheet Series.
cfpub.epa.gov/npdes/stormwater/swfinal.cfm

Storm Water Phase II Final Rule (64 *FR* 68722). www.epa.gov/npdes/regulations/phase2.pdf

Wischmeier, W.H. Smith, D.D. 1960. A universal soil-loss equation to guide conservation farm planning. Trans. Int. Congr. Soil Sci., 7th, p. 418-425.

Wischmeier, W.H. and D.D. Smith. 1965. Predicting rainfall erosion losses in the Eastern U.S. – a guide to conservation planning. Agricultural Handbook No. 282 US Government Printing Office, Washington, D.C.

Wischmeier, W.H. and D.D. Smith. 1978. Predicting Rainfall Erosion Losses. A guide to conservation planning. Agriculture Handbook No. 537. USDA-SEA, US. Govt. Printing Office, Washington, DC. 58pp.

10. EQUIPMENT.

No equipment is need for application of this procedure.

11. ESTIMATION DESCRIPTION

The prime example of an empirically based model is the Universal Soil Loss Equation (USLE) developed by the US Department of Agriculture (USDA). The USLE has been updated to the Revised USLE (RUSLE). Using a computer model supported by multiple decades of soil and rainfall data, the USDA established estimates of annual erosivity values (R) for sites throughout the United States. These "R Factors" are used as surrogate measures of the impact that rainfall had on erosion from a particular site. They have been mapped using isoerodent contours, as shown in Figures 2 through 5.

The USDA developed the Erosivity Index Table (Table 1), to show how the annual erosivity factor is distributed throughout the year in two-week increments. Table 1 is based on 120 rainfall distribution zones for the continental U.S. National Pollutant Discharge Elimination System (NPDES) permit requirements for construction projects can be a useful tool in determining optimal periods to conduct weapon system operations that have soil disturbance potential. NPDES permit requirements can be waived for a construction project with an erosivity value (R) of less than 5 during a certain activity period. Weapon system operation can also be planned using these R value calculations. When possible, soil disruptive operations should be planned during periods of time yielding an R value of less than 5 to decrease potential for erosion. Steps for calculating these values are below.

12. ESTIMATION PROCEDRUE

a. Estimate the operation start date. This is the expected day to begin disturbing soils, including tracked and wheeled vehicle operations, location preparation, vegetation removal, excavating, and grading activities. Pick the 15-day period for the operation start date (e.g., June 1-15.)

b. Estimate the operation completion date or the predicted date that permanent vegetation will cover of at least 70%, or as defined by the local permitting authority, all areas disturbed by the activity. Round to the nearest 15-day period.

c. Refer to Figure 1 to find the Erosivity Index (EI) Zone based on geographic event location.

d. Refer to Table 1, the Erosivity Index (EI) Table. Find the number of the applicable EI Zone in the left column. Locate the EI values for the 15-day periods that correspond to the operation start and end periods you identified in Steps 1 and 2. Subtract the start value from the end value to find the % EI for your site. The maximum annual EI value for a project is 100%.

e. Refer to the appropriate Isoerodent Map (Figures 21 through 5). Interpolate the annual isoerodent value for the event location. This is the annual R Factor for the site.

f. Multiply the percent value obtained in Step 4 by the annual isoerodent value obtained in Step 5. This is the R Factor for the scheduled operation.

13. EXAMPLE

Find the R value of off- road vehicle maneuvers on Perryman Test Area Cross Country Course #2, Aberdeen Proving Ground, Maryland. Assume the site will be disturbed from February 16 to March 31.

The EI distribution zone is 115 (Figure 1). Referring to Table 1, the operation period will span from February 16 to March 31. The difference in values between these two periods is 2.0 % (5.0 – 3.0 = 2.0). Since the annual erosion index for this location is 175 (interpolated from Figure 2), the R Factor for the scheduled construction project is 2.0% of 175, or 3.5. Because 3.5 is less than 5, the operation planner would be working during a period classified as having low soil erosivity.

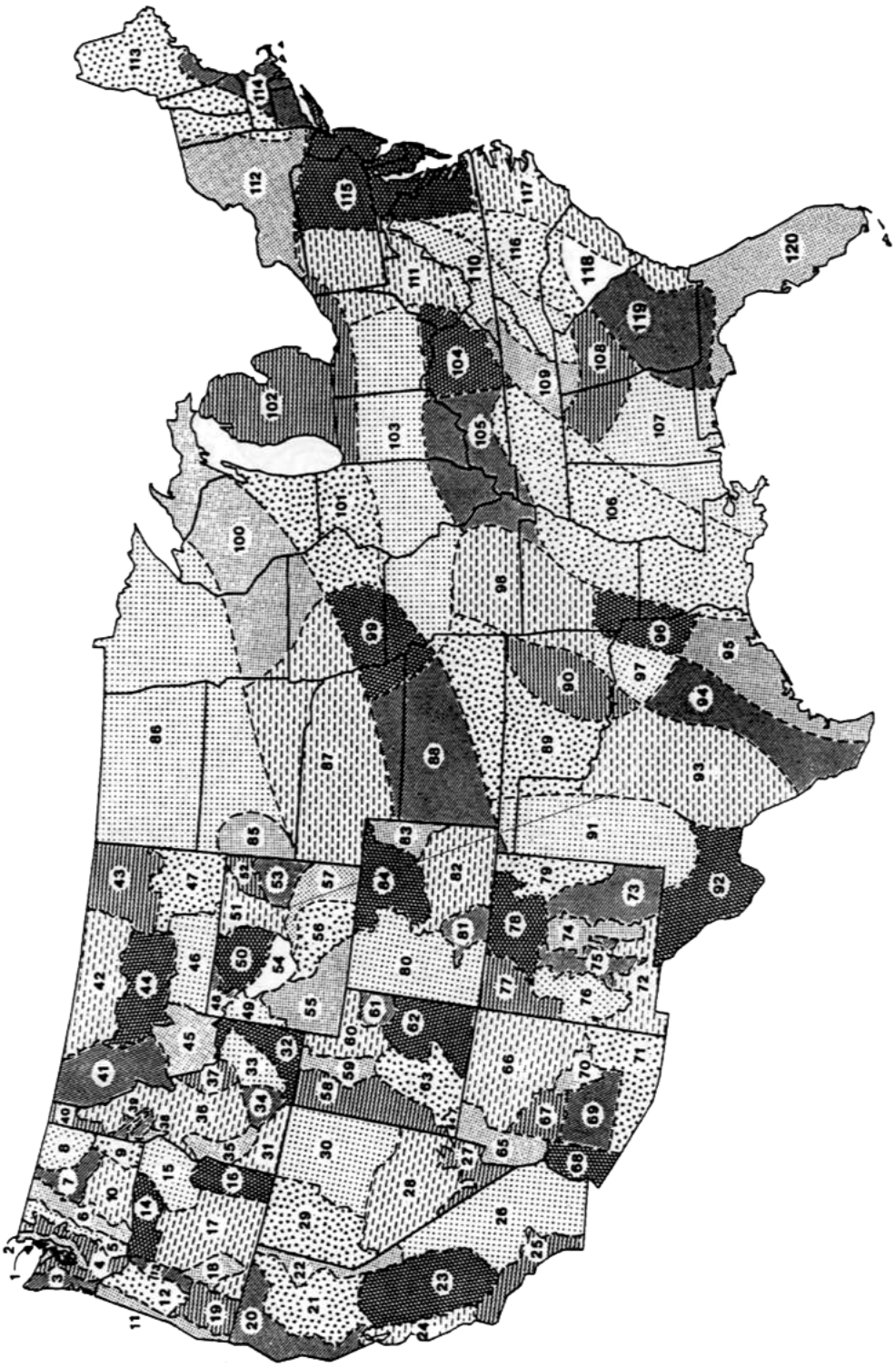


Figure 1. Erosivity Index Zone Map.

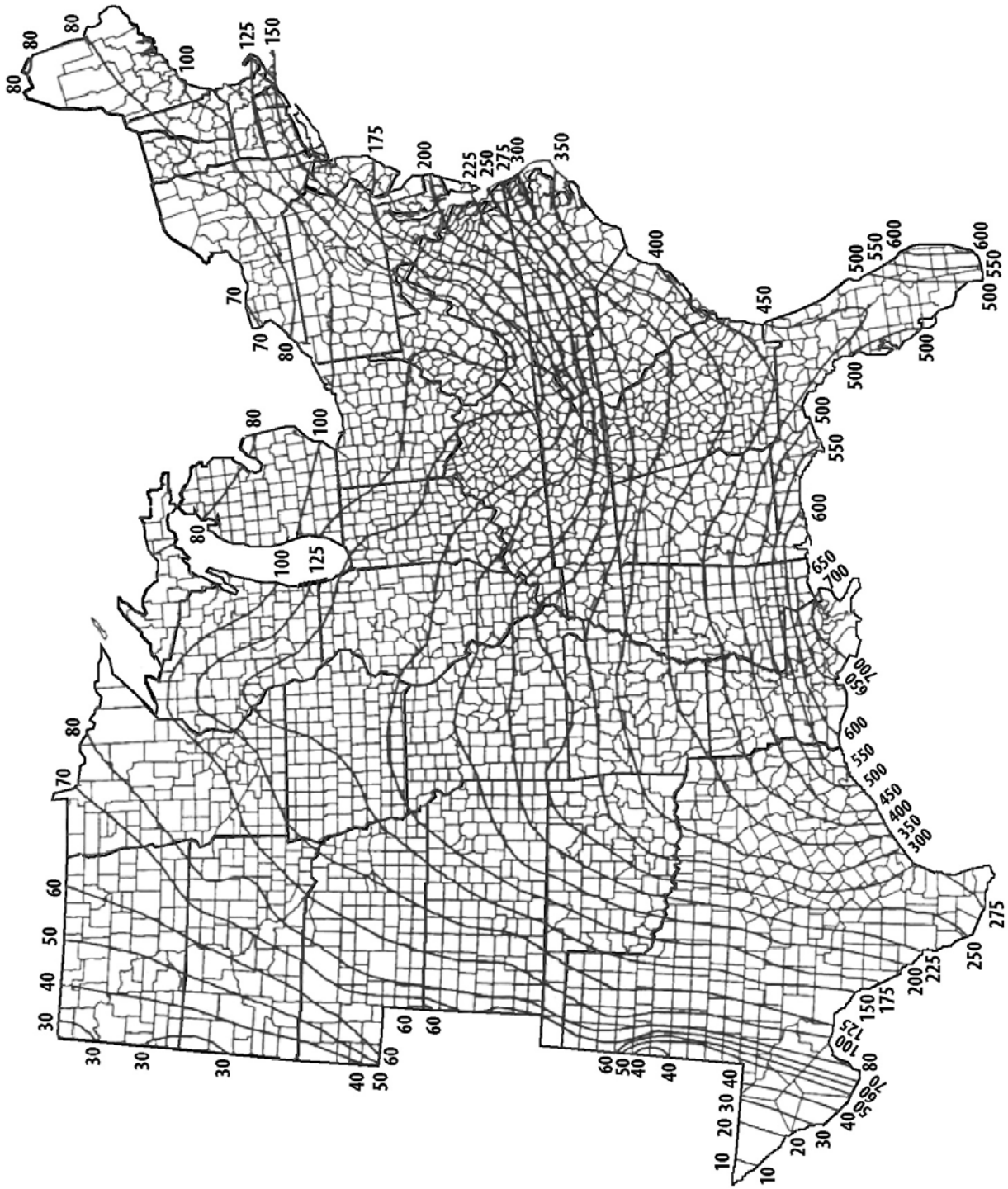


Figure 2. Isoerodent Map of the Eastern United States.



Figure 3. Isoerodent Map of the Western United States.

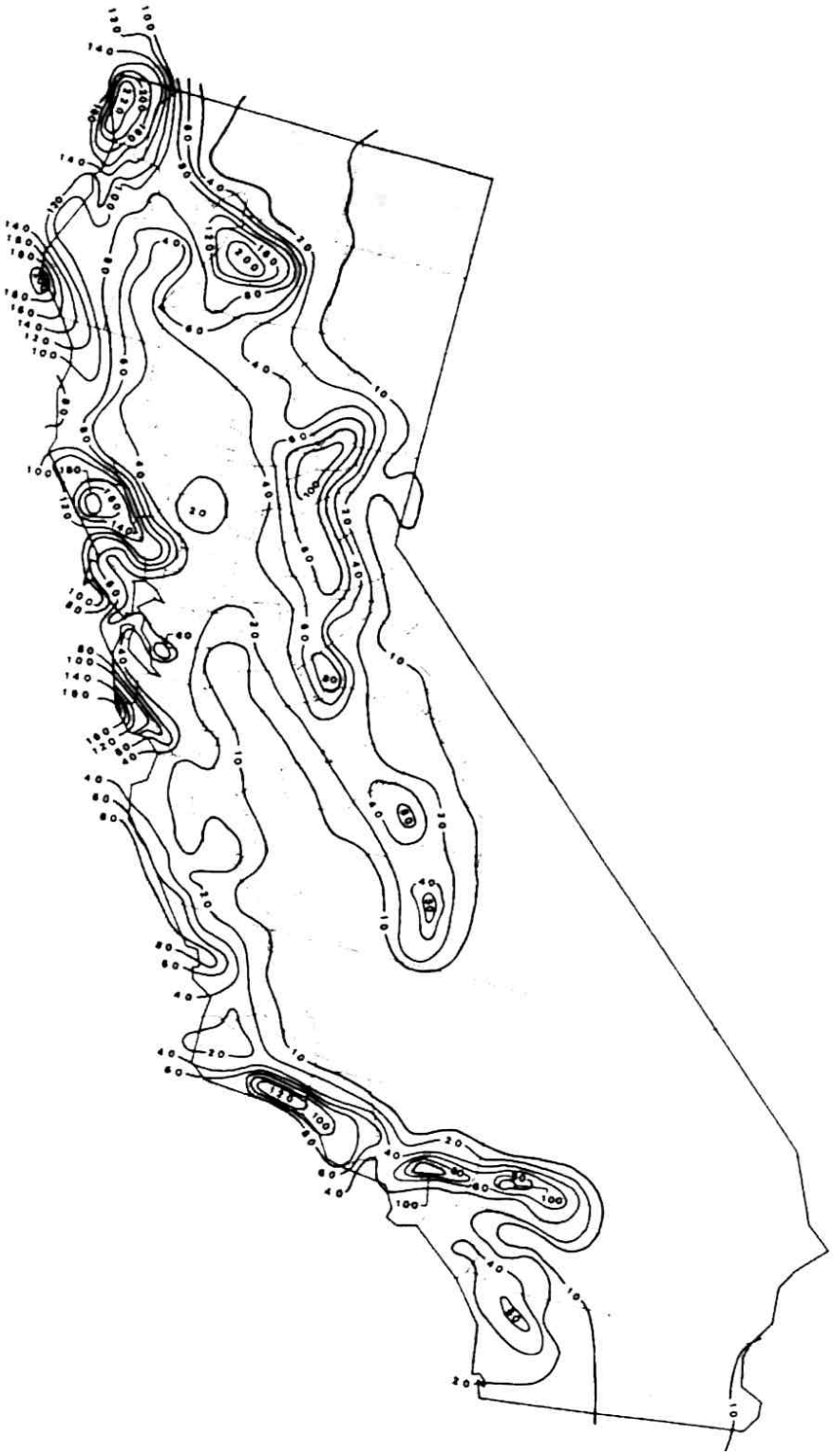


Figure 4. Isoerodent Map of California.

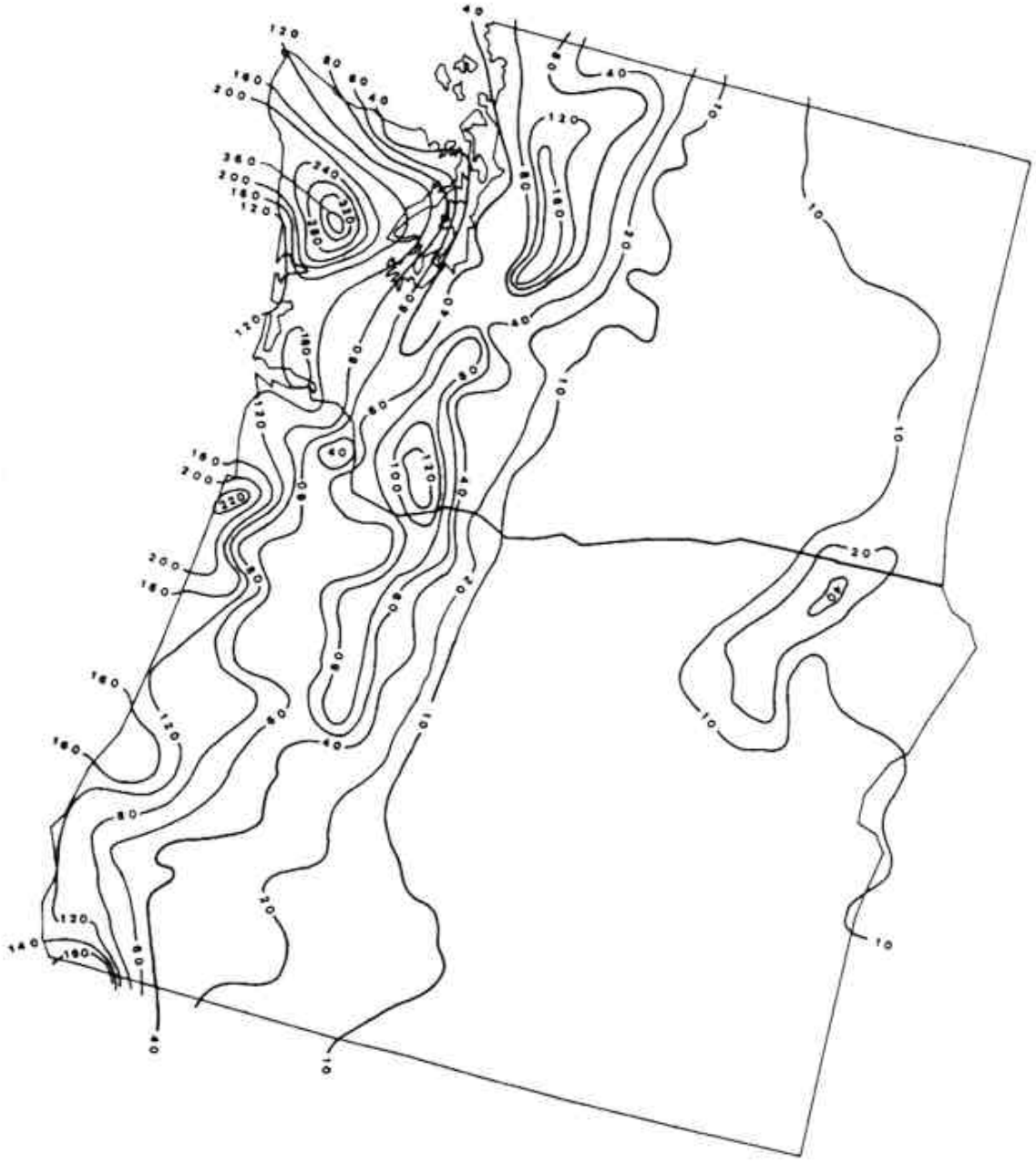


Figure 5. Isoerodent Map of Oregon and Washington.

TABLE 1. EROSIVITY INDEX.

EI as a percentage of Average Annual R Value Computed for Geographic Areas Shown in Figure 1

	Jan	Jan	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Nov	Dec	Dec
EI#	1-15	16-31	1-15	16-29	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31
1	0.0	4.3	8.3	12.8	17.3	21.6	25.1	28.0	30.9	34.9	39.1	42.6	45.4	48.2	50.8	53.0	56.0	60.8	66.8	71.0	75.7	82.0	89.1	95.2
2	0.0	4.3	8.3	12.8	17.3	21.6	25.1	28.0	30.9	34.9	39.1	42.6	45.4	48.2	50.8	53.0	56.0	60.8	66.8	71.0	75.7	82.0	89.1	95.2
3	0.0	7.4	13.8	20.9	26.5	31.8	35.3	38.5	40.2	41.6	42.5	43.6	44.5	45.1	45.7	46.4	47.7	49.4	52.8	57.0	64.5	73.1	83.3	92.3
4	0.0	3.9	7.9	12.6	17.4	21.6	25.2	28.7	31.9	35.1	38.2	42.0	44.9	46.7	48.2	50.1	53.1	56.6	62.2	67.9	75.2	83.5	90.5	96.0
5	0.0	2.3	3.6	4.7	6.0	7.7	10.7	13.9	17.8	21.2	24.5	28.1	31.1	33.1	35.3	36.2	43.2	48.7	57.3	67.8	77.9	86.0	91.3	96.9
6	0.0	0.0	0.0	0.5	2.0	4.1	8.1	12.6	17.6	21.6	25.5	29.6	34.5	40.0	45.7	50.7	55.6	60.2	66.5	75.5	85.6	95.9	99.5	99.9
7	0.0	0.0	0.0	0.0	0.0	1.2	4.9	8.5	13.9	19.0	26.1	35.4	43.9	48.8	53.9	64.5	73.4	77.5	80.4	84.8	89.9	96.6	99.2	99.7
8	0.0	0.0	0.0	0.0	0.0	0.9	3.6	7.8	15.0	20.2	27.4	38.1	49.8	57.9	65.0	75.6	82.7	86.8	89.4	93.4	96.3	99.1	100.0	100.0
9	0.0	0.8	3.1	4.7	7.4	11.7	17.8	22.5	27.0	31.4	36.0	41.6	46.4	50.1	53.4	57.4	61.7	64.9	69.7	79.0	89.6	97.4	100.0	100.0
10	0.0	0.3	0.5	0.9	2.0	4.3	9.2	13.1	18.0	22.7	29.2	39.5	46.3	48.8	51.1	57.2	64.4	67.7	71.1	77.2	85.1	92.5	96.5	99.0
11	0.0	5.4	11.3	18.8	26.3	33.2	37.4	40.7	42.5	44.3	45.4	46.5	47.1	47.4	47.8	48.3	49.4	50.7	53.6	57.5	65.5	76.2	87.4	94.8
12	0.0	3.5	7.8	14.0	21.1	27.4	31.5	35.0	37.3	39.8	41.9	44.3	45.6	46.3	46.8	47.9	50.0	52.9	57.9	62.3	69.3	81.3	91.5	96.7
13	0.0	0.0	0.0	1.8	7.2	11.9	16.7	19.7	24.0	31.2	42.4	55.0	60.0	60.8	61.2	62.6	65.3	67.6	71.6	76.1	83.1	93.3	98.2	99.6
14	0.0	0.7	1.8	3.3	6.9	16.5	26.6	29.9	32.0	35.4	40.2	45.1	51.9	61.1	67.5	70.7	72.8	75.4	78.6	81.9	86.4	93.6	97.7	99.3
15	0.0	0.0	0.0	0.5	2.0	4.4	8.7	12.0	16.6	21.4	29.7	44.5	56.0	60.8	63.9	69.1	74.5	79.1	83.1	87.0	90.9	96.6	99.1	99.8
16	0.0	0.0	0.0	0.5	2.0	5.5	12.3	16.2	20.9	26.4	35.2	48.1	58.1	63.1	66.5	71.9	77.0	81.6	85.1	88.4	91.5	96.3	98.7	99.6
17	0.0	0.0	0.0	0.7	2.8	6.1	10.7	12.9	16.1	21.9	32.8	45.9	55.5	60.3	64.0	71.2	77.2	80.3	83.1	87.7	92.6	97.2	99.1	99.8
18	0.0	0.0	0.0	0.6	2.5	6.2	12.4	16.4	20.2	23.9	29.3	37.7	45.6	49.8	53.3	58.4	64.3	69.0	75.0	86.6	93.9	96.6	98.0	100.0
19	0.0	1.0	2.6	7.4	16.4	23.5	28.0	31.0	33.5	37.0	41.7	48.1	51.1	52.0	52.5	53.6	55.7	57.6	61.1	65.8	74.7	88.0	95.8	98.7
20	0.0	9.8	18.5	25.4	30.2	35.6	38.9	41.5	42.9	44.0	45.2	48.2	50.8	51.7	52.5	54.6	57.4	58.5	60.1	63.2	69.6	76.7	85.4	92.4
21	0.0	7.5	13.6	18.1	21.1	24.4	27.0	29.4	31.7	34.6	37.3	39.6	41.6	43.4	45.4	48.1	51.3	53.3	56.6	62.4	72.4	81.3	88.9	94.7
22	0.0	1.2	1.6	1.6	1.6	1.6	1.6	2.2	3.9	4.6	6.4	14.2	32.8	47.2	58.8	69.1	76.0	82.0	87.1	96.7	99.9	99.9	99.9	99.9
23	0.0	7.9	15.0	20.9	25.7	31.1	35.7	40.2	43.2	46.2	47.7	48.6	49.4	49.9	50.7	51.8	54.1	57.7	62.8	65.9	70.1	77.3	86.8	93.5
24	0.0	12.2	23.6	33.0	39.7	47.1	51.7	55.9	57.7	58.6	58.9	59.1	59.1	59.2	59.2	59.3	59.5	60.0	61.4	63.0	66.5	71.8	81.3	89.6
25	0.0	9.8	20.8	30.2	37.6	45.8	50.6	54.4	56.0	56.8	57.1	57.1	57.2	57.6	58.5	59.8	62.2	65.3	67.5	68.2	69.4	74.8	86.6	93.0
26	0.0	2.0	5.4	9.8	15.6	21.5	24.7	26.6	27.4	28.0	28.7	29.8	32.5	36.6	44.9	55.4	65.7	72.6	77.8	84.4	89.5	93.9	96.5	98.4
27	0.0	0.0	0.0	1.0	4.0	5.9	8.0	11.1	13.0	14.0	14.6	15.3	17.0	23.2	39.1	60.0	76.3	86.1	89.7	90.4	90.9	93.1	96.6	99.1
28	0.0	0.0	0.0	0.0	0.2	0.5	1.5	3.3	7.2	11.9	17.7	21.4	27.0	37.1	51.4	62.3	70.6	78.8	84.6	90.6	94.4	97.9	99.3	100.0
29	0.0	0.6	0.7	0.7	0.7	1.5	3.9	6.0	10.5	17.9	28.8	36.6	43.8	51.5	59.3	68.0	74.8	80.3	84.3	88.8	92.7	98.0	99.8	99.9
30	0.0	0.0	0.0	0.0	0.0	0.2	0.8	2.8	7.9	14.2	24.7	35.6	45.4	52.2	58.7	68.5	77.6	84.5	88.9	93.7	96.2	97.6	98.3	99.6

TABLE 1. (CONT'D)

	Jan	Jan	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Nov	Dec	Dec
El#	1-15	16-31	1-15	16-29	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31
31	0	0	0	0	0	0.2	1	3.5	9.9	15.7	26.4	47.2	61.4	65.9	69	77.2	86	91.6	94.6	98.7	100	100	100	100
32	0	0.1	0.1	0.1	0.1	0.6	2.2	4.3	9	14.2	23.3	34.6	46.3	54.2	61.7	72.9	82.5	89.6	93.7	98.2	99.7	99.9	99.9	99.9
33	0	0	0	0	0	0.6	2.3	4.2	8.8	16.1	30	46.9	57.9	62.8	66.2	72.1	79.1	85.9	91.1	97	98.9	98.9	98.9	98.9
34	0	0	0	0	0	1.8	7.3	10.7	15.5	22	29.9	35.9	42	48.5	56.9	67	76.9	85.8	91.2	95.7	97.8	99.6	100	100
35	0	0	0	0	0	2.5	10.2	15.9	22.2	27.9	34.7	43.9	51.9	56.9	61.3	67.3	73.9	80.1	85.1	89.6	93.2	98.2	99.8	99.8
36	0	0	0	0	0	0.9	3.4	6.7	12.7	18.5	26.6	36.3	46	53.5	60.2	68.3	75.8	82.6	88.3	96.3	99.3	99.9	100	100
37	0	0	0	0	0	0	0	1	3.9	9.1	19.1	26.7	36.3	47.9	61.4	75.1	84.5	92.3	96	99.1	100	100	100	100
38	0	0	0	1.1	4.3	7.2	11	13.9	17.9	22.3	30.3	43.1	55.1	61.3	65.7	72.1	77.9	82.6	86.3	90.3	93.8	98.4	100	100
39	0	0	0	0	0	1.6	6.5	11	17.8	24.7	33.1	42.8	50.3	54.9	59.7	68.9	78.1	83.6	87.5	93	96.5	99.2	100	100
40	0	0	0	0	0	1.5	6.2	10.1	16.3	23.3	32.5	42.2	50.1	55.6	60.5	67.5	74.3	79.4	84.1	91.1	95.8	99.1	100	100
41	0	0.1	0.2	0.2	0.2	0.2	0.2	0.4	1.1	6.8	22.9	40.1	54.9	63.8	70.7	81.5	89.8	96.3	98.7	99.2	99.3	99.4	99.4	99.7
42	0	0	0	0	0	0	0	0.2	0.9	5.2	17.3	33.8	53.2	66.5	75.9	87.6	93.7	97.5	99	99.7	100	100	100	100
43	0	0	0	0	0	0	0	0.1	0.4	2.7	9.5	21.9	42.7	58.6	71.1	84.6	91.9	97.1	99	99.8	100	100	100	100
44	0	1.7	2.3	2.4	2.4	2.4	2.4	2.7	3.5	7.6	18.5	34.3	52.5	64	72.3	83.3	90	95.1	97.3	98.5	98.9	98.9	98.9	99.2
45	0	0.2	0.2	0.3	0.3	0.4	0.6	0.8	1.4	3.7	10.2	22.6	41.8	54	64.5	78.7	88.4	96	98.7	99.4	99.7	99.7	99.8	99.9
46	0	0	0	0	0	0	0	0.6	2.6	7.5	19.6	32.9	48.9	63	73.5	83.3	89.5	95.6	98.3	99.6	100	100	100	100
47	0	0	0	0	0	0	0	0.4	1.6	5.8	17	33	52.5	66.4	75.7	85.5	91.3	96.5	98.8	100	100	100	100	100
48	0	0	0	0	0	0	0	0	0	2	8.1	15.4	27.8	40.7	52.6	61.1	69.3	82.6	92	98	100	100	100	100
49	0	0	0	0	0	0	0	0.7	2.7	8.3	20	27.5	35.6	44.6	56	70.2	81.3	89.2	93.6	98.5	100	100	100	100
50	0	0	0	0	0	0.1	0.4	2.4	8.2	13.7	23.8	38.8	55.1	66.1	73.6	81.8	87.7	93.8	97	99.4	100	100	100	100
51	0	0	0	0	0	0.3	1	3.1	8.7	18.8	35.8	49.6	60.4	70.2	77	84	88.8	93.8	96.6	99.1	100	100	100	100
52	0	0	0	0	0	0	0	0.6	2.5	6.8	17.5	29.8	46.1	60.5	72.7	86	92.8	96.8	98.4	99.7	100	100	100	100
53	0	0	0	0	0	0	0	0.8	3	9.5	24.2	35.3	48	63.1	76.1	87.7	93.5	97.2	98.6	99.5	99.8	99.9	100	100
54	0	0	0	0	0	0.2	0.7	2.4	7.2	14.7	27.2	37.2	47.3	58.8	67.6	74	79.2	86.7	92.6	97.9	99.8	99.9	100	100
55	0	0	0	0	0	0	0	1.3	5.4	13.3	25.5	31.6	38.8	52.5	66.8	75.5	81.2	87.9	92.8	98.3	100	100	100	100
56	0	0	0	0	0	0	0	1.3	5.1	11.4	22.3	29.5	38.5	51.1	65.2	77.8	85.6	91.7	95	98.7	100	100	100	100
57	0	0	0	0	0	0	0.1	1	3.5	9.2	21.5	31	43.5	60.4	75.1	86.1	91.6	96.2	98.1	99.4	99.9	99.9	100	100
58	0	0	0	0	0	0.2	0.9	2.9	8	13.2	21	29.1	38	45.9	54.5	65.4	74.8	82.1	87.5	95.4	98.8	99.7	100	100
59	0	0	0	0	0	0	0	2.2	8.9	15.6	24.2	31.1	38.3	46	54.9	64.2	73.2	81.9	88.5	95.7	98.6	99.4	99.7	99.7
60	0	0	0	0	0	0	0	0.4	1.5	4	9.5	13.3	20.5	33.6	52.8	66.5	76.7	88.1	94.2	98.6	100	100	100	100

TABLE 1. (CONT'D)

	Jan	Jan	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Nov	Dec	Dec
El#	1-15	16-31	1-15	16-29	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31
61	0	0	0	0	0	0	0	1.3	5	8.5	15.5	29.8	41.8	46	49.2	56	65.1	71.6	78.6	91.1	97.3	99.3	100	100
62	0	0	0	0.1	0.3	0.8	2.1	3.6	6.5	9.7	13.7	16.5	20.8	27.3	40.1	56.9	72.6	83.4	89.4	95.5	98.1	99.6	100	100
63	0	0	0	0	0	0	0	0.9	3.7	7.8	13.3	15.8	19.9	29	46.8	64.7	78.3	88.8	93.9	98.5	100	100	100	100
64	0	0	0	0.7	2.8	7.4	12.4	14.4	15.6	17.3	19.4	21	24.4	32.3	48	61.4	72.1	81.9	87	90.1	92.4	98.1	100	100
65	0	3.6	7	9.6	11.4	13	14.4	16.3	17.7	18.4	19.3	20.5	23.6	32	50	66.2	77.2	85.4	88.8	90.4	91.3	92.7	94.8	97
66	0	0	0	0	0	0.1	0.5	1.1	2.2	3.6	6	7.6	11.1	19.8	38.9	59.7	74.4	83.2	88.1	94.6	97.7	99.4	100	100
67	0	0	0	0	0	0.1	0.4	0.9	1.6	1.9	2.4	5	12.1	24.8	48.3	73.6	86.5	92	94.3	96.6	97.9	99.5	100	100
68	0	2.3	4.5	7.8	10.4	12	13.3	16.3	17.7	18.1	18.2	18.3	18.4	19.9	24.5	35	54.4	69.4	78.6	85.7	89.2	91.9	93.9	97
69	0	2	3.7	5.7	7.8	10.5	12.4	13.7	14.3	14.7	15.1	15.7	17.1	22.7	36.7	50.4	63.6	75	81.8	87.8	90.8	93.2	94.9	97.5
70	0	0.5	0.7	1	1.3	1.7	2.2	2.8	3.4	3.9	4.7	5.4	7.4	15.7	36.5	55.8	70.3	80.9	86.4	90.9	93.4	96.4	98.1	99.4
71	0	0.7	1.2	1.6	2.1	2.8	3.3	3.6	4	4.5	5.6	6.5	9.1	18.5	40.6	59.7	74	86.3	91.7	94.7	96	96.7	97.3	98.8
72	0	0	0	0	0	0	0.1	0.2	0.7	0.8	1.3	3.5	9.9	24.7	51.4	71.5	83.6	93.8	97.7	99.2	99.8	99.9	99.9	100
73	0	0	0.1	0.1	0.2	0.2	0.3	0.6	1.3	4.1	11.5	18.1	28.3	40.2	54.1	67	77.2	87.7	93.3	97.5	99.1	99.6	99.8	100
74	0	0	0	0	0	0.1	0.2	0.5	1.2	2.7	6.4	10.2	18.4	31	50.7	68.7	81.2	91.6	96.1	98.4	99.2	99.8	100	100
75	0	0.1	0.1	0.1	0.2	0.5	1.3	1.9	3	4.1	6.6	10	17.6	28.3	44.7	59.4	71.6	83.9	90.3	94.7	96.7	98.8	99.6	99.9
76	0	0	0	0	0	0.1	0.2	0.6	1.3	2	3.5	4.9	8.4	17.4	37.3	57.5	72.9	83.7	89.5	95.8	98.4	99.6	100	100
77	0	0.2	0.3	0.3	0.4	0.8	1.5	2	2.8	3.9	5.9	7.2	10.3	21.5	46.5	66.3	78.3	86.5	90.8	96	98.2	99.1	99.5	99.8
78	0	0	0	0	0	0	0.2	0.5	1.6	3.8	8.9	13.2	21.8	35.8	56.6	75.4	86	92.9	95.9	98.2	99.2	99.8	100	100
79	0	0	0	0	0	0.2	0.7	1.3	2.7	5.8	12.7	18.8	28.8	41.6	58.4	75.7	86.5	94.2	97.3	98.9	99.5	99.9	100	100
80	0	0.6	1.2	1.6	2.1	2.5	3.3	4.5	6.9	10.1	15.5	19.7	26.6	36.4	51.7	67.5	79.4	88.8	93.2	96.1	97.3	98.2	98.7	99.3
81	0	0.1	0.1	0.2	0.4	0.5	0.8	0.9	1.5	3.9	9.9	12.8	18.2	30.7	54.1	77.1	89	94.9	97.2	98.7	99.3	99.6	99.7	99.9
82	0	0	0.1	0.1	0.2	0.2	0.5	1.2	3.1	6.7	14.4	20.1	29.8	44.5	64.2	83.1	92.2	96.4	98.1	99.3	99.7	99.8	99.8	99.9
83	0	0	0.1	0.1	0.1	0.3	0.9	1.6	3.5	8.3	19.4	30	44	59.2	72.4	84.6	91.2	96.5	98.6	99.5	99.8	99.9	100	100
84	0	0	0.1	0.1	0.2	0.3	0.6	1.7	4.9	9.9	19.5	27.2	38.3	52.8	68.8	83.9	91.6	96.4	98.2	99.2	99.6	99.8	99.8	99.9
85	0	0	0	0	0	0	1	2	3	6	11	23	36	49	63	77	90	95	98	99	100	100	100	100
86	0	0	0	0	0	0	1	2	3	6	11	23	36	49	63	77	90	95	98	99	100	100	100	100
87	0	0	0	0	1	1	2	3	6	10	17	29	43	55	67	77	85	91	96	98	99	100	100	100
88	0	0	0	0	1	1	2	3	6	13	23	37	51	61	69	78	85	91	94	96	98	99	99	100
89	0	0	1	1	2	3	4	7	12	18	27	38	48	55	62	69	76	83	90	94	97	98	99	100
90	0	1	2	3	4	6	8	13	21	29	37	46	54	60	65	69	74	81	87	92	95	97	98	99

TABLE 1. (CONT'D)

	Jan	Jan	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Nov	Dec	Dec
EI#	1-15	16-31	1-15	16-29	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31
91	0	0	0	0	1	1	1	2	6	16	29	39	46	53	60	67	74	81	88	95	99	99	100	100
92	0	0	0	0	1	1	1	2	6	16	29	39	46	53	60	67	74	81	88	95	99	99	100	100
93	0	1	1	2	3	4	6	8	13	25	40	49	56	62	67	72	76	80	85	91	97	98	99	99
94	0	1	2	4	6	8	10	15	21	29	38	47	53	57	61	65	70	76	83	88	91	94	96	98
95	0	1	3	5	7	9	11	14	18	27	35	41	46	51	57	62	68	73	79	84	89	93	96	98
96	0	2	4	6	9	12	17	23	30	37	43	49	54	58	62	66	70	74	78	82	86	90	94	97
97	0	1	3	5	7	10	14	20	28	37	48	56	61	64	68	72	77	81	86	89	92	95	98	99
98	0	1	2	4	6	8	10	13	19	26	34	42	50	58	63	68	74	79	84	89	93	95	97	99
99	0	0	0	1	1	2	3	5	7	12	19	33	48	57	65	72	82	88	93	96	98	99	100	100
100	0	0	0	0	1	1	2	3	5	9	15	27	38	50	62	74	84	91	95	97	98	99	99	100
101	0	0	0	1	2	3	4	6	9	14	20	28	39	52	63	72	80	87	91	94	97	98	99	100
102	0	0	1	2	3	4	6	8	11	15	22	31	40	49	59	69	78	85	91	94	96	98	99	100
103	0	1	2	3	4	6	8	10	14	18	25	34	45	56	64	72	79	84	89	92	95	97	98	99
104	0	2	3	5	7	10	13	16	19	23	27	34	44	54	63	72	80	85	89	91	93	95	96	98
105	0	1	3	6	9	12	16	21	26	31	37	43	50	57	64	71	77	81	85	88	91	93	95	97
106	0	3	6	9	13	17	21	27	33	38	44	49	55	61	67	71	75	78	81	84	86	90	94	97
107	0	3	5	7	10	14	18	23	27	31	35	39	45	53	60	67	74	80	84	86	88	90	93	95
108	0	3	6	9	12	16	20	24	28	33	38	43	50	59	69	75	80	84	87	90	92	94	96	98
109	0	3	6	10	13	16	19	23	26	29	33	39	47	58	68	75	80	83	86	88	90	92	95	97
110	0	1	3	5	7	9	12	15	18	21	25	29	36	45	56	68	77	83	88	91	93	95	97	99
111	0	1	2	3	4	5	6	8	11	15	20	28	41	54	65	74	82	87	92	94	96	97	98	99
112	0	0	0	1	2	3	4	5	7	12	17	24	33	42	55	67	76	83	89	92	94	96	98	99
113	0	1	2	3	4	5	6	8	10	12	17	22	31	42	52	60	68	75	80	85	89	92	96	98
114	0	1	2	4	6	8	11	13	11	13	21	26	32	38	46	55	64	71	77	81	85	89	93	97
115	0	1	2	3	4	5	6	8	10	14	19	26	34	45	56	66	76	82	86	90	93	95	97	99
116	0	1	3	5	7	9	12	15	18	21	25	29	36	45	56	68	77	83	88	91	93	95	97	99
117	0	1	2	3	4	5	7	9	11	14	17	22	31	42	54	65	74	83	89	92	95	97	98	99
118	0	2	4	6	8	12	16	20	25	30	35	41	47	56	67	75	81	85	87	89	91	93	95	97
119	0	1	2	4	6	7	9	12	15	18	23	31	40	48	57	63	72	78	88	92	96	97	98	99
120	0	8	16	25	33	41	46	50	53	54	55	56	56.5	57	57.75	58	58.75	60	61	63	66.5	72	80	90

TABLE 1. (CONT'D)

0	Jan	Jan	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Nov	Dec	Dec
El#	1-15	16-31	1-15	16-29	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31	1-15	16-31
121	0	7	14	20	25.5	33.5	38	43	46	50	52.5	54.5	56	58	59	60	61.5	63	65	68	72	79	86	93
122	0	4	8	12	17	23	29	34	38	44	49	53	56	59	62	65	69	72	75	79	83	88	93	96
123	0	4	9	15	23	29	34	40	44	48	50	51	52	53	55	57	60	62	64	67	72	80	88	95
124	0	7	12	17	24	30	39	45	50	53	55	56	57	58	59	61	62	63	64	66	70	77	84	92
125	0	9	16	23	30	37	43	47	50	52	54	55	56	57	58	59	60	62	64	67	71	77	86	93
126	0	8	15	22	28	33	38	42	46	50	52	53	53	53	53	54	55	57	59	63	68	75	83	92
127	0	8	15	22	29	34	40	45	48	51	54	57	59	62	63	64	65	66	67	69	72	76	83	91
128	0	9	16	22	27	32	37	41	45	48	51	53	55	56	57	57	58	59	61	64	68	73	79	89
129	0	10	20	28	35	41	46	49	51	53	55	56	56	57	58	59	60	61	62	65	69	74	81	90
130	0	8	15	22	28	33	38	41	44	47	49	51	53	55	56	58	59	60	63	65	69	75	84	92
131	0	10	18	25	29	33	36	39	41	42	44	45	46	47	48	49	51	53	56	59	64	70	80	90
132	0	8	16	24	32	40	46	51	54	56	57	58	58	59	59	60	60	61	62	64	68	74	83	91
133	0	12	22	31	39	45	49	52	54	55	56	56	56	56	57	57	57	57	58	59	62	68	77	88
134	0	7	15	22	30	37	43	49	53	55	57	58	59	60	61	62	63	65	67	70	74	79	85	92
135	0	11	21	29	37	44	50	55	57	59	60	60	60	60	61	61	61	62	63	64	67	71	78	89
136	0	10	18	25	30	39	46	51	54	57	58	59	59	60	60	60	61	62	63	64	67	72	80	90
137	0	11	22	31	39	46	52	56	58	59	60	61	61	61	61	62	62	62	63	64	66	71	78	89
138	0	8	14	20	25	32	37	42	47	50	53	55	56	58	59	61	63	64	66	68	71	76	85	93
139	0	10.6	21.2	28.6	36	41.4	46.8	49.3	51.8	52.5	53.2	53.5	53.7	53.9	54	54.3	54.7	55.7	56.8	61.6	65.3	73.9	82.5	91.2
140	0	0.2	0.3	0.3	0.3	0.3	0.3	0.8	1.3	5.3	9.3	30.1	50.8	56.8	62.9	67.5	72.2	75.8	79.4	85.6	91.7	95.9	100	100
141	0	10.7	21.4	28.7	36	41.7	47.3	50.3	53.2	54.5	55.7	56.2	56.7	56.9	57	57.4	57.8	59	60.2	64.1	67.9	76.1	84.2	92.1
142	0	2.7	5.5	5.7	5.9	7.1	8.4	10	11.7	15.3	19	22.6	26.1	29	31.9	36.6	41.2	46	50.7	62.3	73.9	83.5	93.1	96.6
143	0	8.7	17.5	25.2	33	39.9	46.7	50.8	54.8	56.2	57.6	58	58.4	58.9	59.4	60.8	62.3	64.1	65.9	68.8	71.7	78.6	85.5	92.7
144	0	4.3	8.6	9.3	10.1	11.1	12	15.3	18.6	22.7	26.7	28.7	30.7	31.3	32	34	36	44.4	52.9	60.1	67.3	78.2	89.2	94.6
145	0	11.7	23.3	33.5	43.7	50.7	57.6	60.3	63	63.5	64.1	64.2	64.2	64.5	64.8	66.1	67.3	68.6	69.8	70.7	71.6	79.2	86.7	93.4
146	0	4.8	9.6	13.1	16.5	22.6	28.7	30.8	32.8	33.3	33.8	34	34.2	36.4	38.6	43	47.5	56	64.5	66.2	67.9	77.9	88	94
147	0	0	4.7	9.4	10.8	12.2	13.2	14.3	14.9	15.5	24.2	32.8	45.5	58.2	67.9	77.6	86.3	95.1	95.6	96.1	98	100	100	100
148	0	5.5	11	19.2	27.5	36.6	45.7	47.8	50	50.9	51.7	52.1	52.5	54.2	55.9	60.1	64.4	70.5	76.7	81.2	85.7	90.4	101	97.6
149	0	2.4	4.9	7.4	9.9	11.7	13.6	14.6	15.6	16.2	16.8	17.2	17.7	24.7	31.7	46.9	62.1	67	72	80.7	89.3	92.3	95.3	97.7

SAMPLING AND ANALYSIS PROCEDURE FOR CHARACTERIZING SOIL CONTAMINANT CHEMISTRY

1. SCOPE AND APPLICATION.

The objective of this procedure is to outline the equipment and methods used to collect representative soil samples for laboratory analysis to determine the presence of potential contaminants related to a specific developmental test. Sampling depths are assumed to be those that can be reached (i.e., surface or near-surface samples) without the use of a drill rig, direct-push, or other mechanized equipment. Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment.

The procedure may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

This procedure does not address any of the safety concerns associated with its use. It is the responsibility of the user of this guidance document to establish appropriate safety and health practices. This procedure is also not project-specific. A project-specific Sampling and Analysis Plan (SAP) should be developed for each project, when soil sampling is necessary.

Examples of the types of developmental testing that may require sampling and analysis of soil to determine the presence of potential contaminants include:

a. Automotive Testing:

   (1) Wash rack drainage areas.

   (2) Cross-country test courses.

b. Ballistic Testing:

   (1) Detonation areas/burning areas/impact areas

   (2) Firing points

c. Operations and Miscellaneous:

   (1) Industrial operations testing.

   (2) POL storage or support equipment.

   (3) Dust suppression/control.

2. REFERENCES.

Several sources were used to develop this procedure, primarily the following:

Code of Federal Regulations, Title 40 Part 261 Section 24.

U.S. Environmental Protection Agency (U.S. EPA). 1986. *Test Methods for Evaluating Solids Waste, Physical/Chemical Methods, Updates I, II, IIA, IIB, III, and IIIA, SW846.* NTIS publication No. PB97-156111 or GPO publication no. 955-001-00000-1. Office of Solid Waste. Washington, DC. http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm

U.S. EPA. April 1, 1984. *Characterization of Hazardous Waste Sites – A Methods Manual: Volume II. Available Sampling Methods, Second Edition.* EPA-600/4-84-043. Office of Solid Waste. Washington, DC. http://www.epa.gov/osw

U.S. EPA. 1995. *Superfund Program – Representative Sampling Guidance: Volume I: Soil.* EPA540/R-95/141. Environmental Response Team

U.S. EPA. 2000. "Soil Sampling." Environmental Response Team SOP #2012, Revision #0.0. Edison, NJ. http://www.ert.org/

3. EQUIPMENT.

Soil sampling equipment may include the following:

a. Maps/plot plan

b. Safety equipment, as specified in the project-specific Health and Safety Plan

c. Survey equipment or global positioning system (GPS) to locate sampling points

d. Tape measure

e. Survey stakes or flags

f. Camera and film

g. Pre-cleaned stainless steel, plastic, or other appropriate homogenization bucket or bowl

h. Plastic sheet

i. Spade or shovel

j. Plastic or stainless steel scoop

k. Plastic or stainless steel spoons

l. Plastic or stainless steel spatula

m. Trowel

n. Bucket auger (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations)

o. Extension rods (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations)

p. T-handle (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations)

q. Plug extractor (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations)

r. Appropriately sized sample jars

s. Sealable plastic bags

t. Logbook

u. Field data sheets

v. Labels

w. Chain of Custody records and seals

x. Coolers

y. Ice

z. Decontamination supplies/equipment (refer to Sampling Equipment Decontamination Procedure)

Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is common with implements such as garden trowels.

4. SAMPLE COLLECTION.

Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample. Typically, samples will be collected at the surface or near-surface depths although some samples might need to be collected at greater depths. Examples of when soils should be sampled at greater depths include when soil staining (irregular color is seen in the soil) or odor shows that contamination is deeper than the surface, or when impacts from ranges have forced contamination deeper in the soil. Surface and near-surface soils may be easily sampled using a spade, trowel, and a scoop. Sampling at slightly greater depths may be performed using a hand-auger.

Two types of soil samples can be collected: a “discrete” or a “composite” sample. A discrete sample is defined as a single sample collected at a single location. A composite sample is one comprised of a mixture of the target media collected from two or more specific collection points within the same decision unit. Analysis of this type of sample produces an average value and can be used in certain instances as an alternative to analyzing a number of individual discrete samples and calculating an average value. It should be noted, however, that compositing can mask hot spots by diluting isolated concentrations of some compounds below detection limits. Also, if volatile compounds are a contaminant of concern, then discrete sample should be collected.

Preparation:

a. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required. Typically, soil samples are collected both before a developmental test begins to determine the concentrations of naturally occurring constituents in the soil, and after the testing is completed. The exact locations of soil samples should be based on professional judgment. Typically, they are collected from the areas where the highest concentrations of contaminants would be expected to occur, to represent the worst-case scenario.

b. Obtain necessary sampling and monitoring equipment.

c. Decontaminate or pre-clean equipment, and ensure that it is in working order.

d. Use stakes or flagging to identify and mark all sample locations. Specific site factors, including extent and nature of potential contaminants, should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations should be utility-cleared by the property owner prior to soil sampling; and utility clearance should always be confirmed before beginning work.

Sample Collection:

Surface and Near-Surface Soil Samples:

Collection of samples can be accomplished with tools such as spades, shovels, trowels, and scoops. This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member.

The following procedure is used to collect surface soil samples:

a. Clear away surface material to the desired depth with a pre-cleaned spade. When collecting a surface soil sample for energetics and propellants, only remove large surface debris (i.e., rocks and large sticks). Smaller surface debris such as vegetation should not be cleared away since contaminants are usually found with the first few inches.

b. Carefully remove the top layer of material to the desired sample depth with a pre-cleaned spade and place on a plastic sheet or use a plug type extractor to directly take the sample.

c. Using a pre-cleaned stainless steel scoop or equivalent, remove and discard a thin layer of material from the area which came in contact with the spade.

d. If analysis for volatile organic compounds (VOCs) is to be performed, transfer the sample into an appropriate, labeled, sample container with a stainless steel spoon or equivalent, and secure the cap tightly. If analyses other than VOCs are required, place the remainder of the sample (preferably dried) into a stainless steel, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample. Then, either place the sample into appropriate, labeled containers and secure the caps tightly, or, if composite samples are to be collected, place a sample from another sampling location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly. At a minimum, each container should be labeled with the date, time of sample collection, a sample identification number, person performing the sample collection, and the sample type.

e. Place the labeled containers into plastic bags and seal. Place the sample into a cooler of ice to maintain a 4°C±2º temperature during the storage and transport of samples to the laboratory.

f. Chain of custody forms must be completed and must accompany the samples to the laboratory.

Sampling at Depth with Augers:

This system consists of an auger, a series of extensions, and a T-handle. The auger is used to bore a hole to a desired sampling depth, and then is withdrawn. The sample is collected directly

from the auger. Bucket type augers are useful for direct sample recovery because they provide a large volume of sample in a short time.

The following procedure is used to collect soil samples with an auger:

a. Attach the auger bit to a drill rod extension, and attach T-handle to the drill rod.

b. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first 3 to 6 inches of surface soil for an area approximately 6 inches in radius around the drilling locations.

c. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

d. After reaching the desired depth, slowly and carefully remove the auger from the hole. Collect the sample after the auger is removed from the hole.

e. If analysis for VOCs is to be performed, transfer the sample into an appropriate, labeled, sample container with a stainless steel spoon or equivalent, and secure the cap tightly. If analyses other than VOCs are required, place the remainder of the sample into a stainless steel, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sample interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly, or, if composite samples are to be collected, place the sample(s) from the other location(s) into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly. At a minimum, each container should be labeled with the date, time of sample collection, a sample identification number, person performing the sample collection, and the sample type.

f. Place the labeled containers into plastic bags and seal. Place the sample into a cooler of ice to maintain a 4°C±2º temperature during the storage and transport of samples to the laboratory.

g. Chain of custody forms must be completed and must accompany the samples to the laboratory.

h. Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

5. DETERMINATION OF NUMBER OF SAMPLES.

Soils to be sampled may be homogenous or heterogeneous. Homogenous soil may not require an extensive sampling protocol although homogeneous soils are rare. Heterogeneous soils require more extensive sampling and analysis to ensure that a representative samples are collected.

As mentioned previously, a “discrete” sample is defined as a single sample collected at a single location and a “composite” sample is one comprised of a mixture of more than one sample collected from the same decision unit, such that multiple samples can be analyzed as a single sample. Using the composite sampling method when characterizing soil contaminated with volatile organics is not recommended because the process of homogenization may volatize the organics.

Soil samples should be collected both before a developmental test begins, to determine the baseline concentrations of constituents in the soil, and after the testing is completed. The number of samples that should be collected and analyzed depends on the objective of the investigation and should be outlined in the Sampling and Analysis Plan (SAP). There are three basic sampling strategies: random, systematic, and judgmental sampling. The sample set needs to be large enough to calculate a statistically accurate data.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of the site. Systematic sampling involves collection of samples based on a grid or a pattern which has been established in the SAP. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often a combination of these strategies is the best approach depending on the type of the contamination, uniformity, and the size of the site.

6. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC).

There are no specific QA activities which apply to the implementation of this sampling procedure. However, the following general QA procedures apply:

a. All data must be documented on field data sheets or within site logbooks.

b. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified. Equipment checkout activities must occur prior to sampling/operation, and they must be documented.

c. Several field QA samples must be collected to ensure that cross-contamination is not occurring and to determine if there are any matrix interferences. The required QA samples are site specific, and may include field blanks, field duplicates, matrix spike/matrix spike duplicates, equipment rinsate blanks, etc.

7. ANALYSIS.

During testing, soils have the potential to be contaminated with toxic organic compounds, heavy metals, and explosive residue. In some cases, it may be necessary to test soil samples if the affected soils have the potential to leach contaminants into an underlying aquifer. Analytical methods can be found in the EPA Publication SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, for each potential contaminant. Table 7-1 presents the analytical methods used for the suite of contaminants including: VOCs, SVOCs, explosives compounds, and metals. All analytical data should be kept in the project file.

Table 7-1. Analytical Methods

Potential Contaminant	Analysis	Analytical Method
Toxic Organic Compounds	Volatile Organic Compounds (VOCs) by Gas Chromatography/Mass Spectrometry (GC/MS)	SW846: 8260B
	Semivolatile Organic Compounds (SVOCs) by GC/MS	SW846: 8270C
Heavy Metals	Metals by Inductively Coupled Plasma-Atomic Emission Spectrometry/ Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique)	SW846: 6010B/7471A
Explosives and Propellant Compounds	Nitroaromatics and Nitramines by High Performance Liquid Chromatography	SW846: 8330

8. SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE.

Chemical preservation of solids is generally not recommended. Refrigeration to 4°C±2º and protection from sunlight to minimize any potential reactions is usually the best approach, supplemented by a minimal holding time prior to extraction or analysis, depending on contaminants of concern. Wide mouth glass containers with Teflon® lined caps are typically used for collecting soil samples. Details are presented in Table 8-1.

Table 8-1. Analytical Methods, Container, Sample Volume, Preservative, and Holding Times for Basic Analytes

Analytes	Analytical Method	Container	Sample Volume	Preservative	Holding Time
VOCs	SW846: 8260B	1000-mL amber glass jar with Teflon lined lid	100 grams	Cool to 4°C±2º	14 days
SVOCs	SW846: 8270C				14 days until extraction/40 days from extraction to analysis
Metals	SW846: 6010B/7471A				6 months, except mercury, which is 28 days
Explosives and Propellant Compounds	SW846: 8330				14 days until extraction/40 days from extraction to analysis

SAMPLING AND ANALYSIS PROCEDURE FOR AQUEOUS MEDIA

1. SCOPE AND APPLICATION.

The objective of this procedure is to provide general reference information on sampling aqueous media including ground water from a monitoring well, surface water, stormwater, and process water from a treatment facility.

These are procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

This procedure does not address any of the safety concerns associated with its use. It is the responsibility of the user of this guidance to establish appropriate safety and health practices. This procedure is also not project-specific. A project-specific Sampling and Analysis Plan (SAP) should be developed for each project.

Examples of the types of developmental testing that may require sampling and analysis of water to determine the presence of potential contaminants include:

a. Automotive Testing:

(1) Wash rack drainage.

(2) Periodic sampling of water runoff from paved test courses.

(3) Water sampling from fording/swimming tests.

b. Ballistic Testing:

Water sampling along the firing line and the target area for direct-fire ranges.

c. Range Operations and Miscellaneous:

Water sampling in conjunction with facility repairs following flash floods (desert regions).

2. REFERENCES.

Several sources were used to develop this procedure, primarily the following.

U.S. Environmental Protection Agency (U.S. EPA). 1986. *Test Methods for Evaluating Solids Waste, Physical/Chemical Methods, Updates I, II, IIA, IIB, III, and IIIA, SW846.* NTIS publication No. PB97-156111 or GPO publication no. 955-001-00000-1. Office of Solid Waste. Washington, DC. http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm

U.S.EPA. 1992. "NPDES Storm Water Sampling Guidance Document." http://www.epa.gov/npdes/pubs/owm0093.pdf.

U.S.EPA. 1994. "Surface Water Sampling." Environmental Response Team SOP #2013, Revision #0.0. Edison, NJ. http://www.ert.org/.

U.S.EPA. 1995. Interim Final Superfund Program Representative Sampling Guidance – Volume 5: Water and Sediment. Part I – Surface Water and Sediment. OSWER Directive 9360.4-16. December.

U.S.EPA. 1995. Interim Final Superfund Program Representative Sampling Guidance – Volume 5: Water and Sediment. Part II – Groundwater. OSWER Directive 9360.4-16. December.

U.S.EPA. 1995. "Groundwater Well Sampling." Environmental Response Team SOP #2007, Revision #0.0. Edison, NJ. http://www.ert.org/.

U.S.EPA. 1996. "Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells", Region 1. SOP GW 0001, Revision Number 2.

U.S.EPA. 2002. Groundwater Sampling Guidelines for Superfund and RCRA Project Managers Groundwater Forum Paper. EPA-542-S-02-001, May.

U.S. Geological Survey. 1977. National Handbook or Recommended Methods for Water Data Acquisition. Office of Water Data Coordination, Reston, VA.

3. SAMPLING PROCEDURES.

This section includes the sampling procedures for ground water from a monitoring well, surface water, stormwater, and process water. Each section includes equipment needed, sampling procedure, determination of number of samples, and sample handling.

Ground-Water Samples

The objective of this procedure is to provide general reference information on sampling of ground-water wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of ground-water contaminants (i.e., volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], metals, and explosives and accelerants).

Equipment

a. Disposable bailer – preferably Teflon™ (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

b. Adjustable rate, submersible pumps (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon) (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

c. Teflon or Teflon-lined polyethylene tubing - 1/4 inch or 3/8 inch (inner diameter) tubing (dual bonded if necessary).

d. Water level measuring device(s), capable of measuring to 0.01-foot accuracy (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

e. Flow measurement supplies (e.g., graduated cylinder and stop watch).

f. Interface probe, if needed (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

g. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

h. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature – and a flow-through-cell (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

i. Logbook(s) and other forms (for example, well purging forms).

j. Sample bottles.

k. Sample preservation supplies (as required by the analytical methods).

l. Sample tags or labels.

m. Well construction data, location map, field data from last sampling event.

n. Well keys.

o. Coolers and ice.

p. Sealable plastic bags.

q. Chain of Custody records and seals.

r. Decontamination supplies/equipment (refer to Sampling Equipment Decontamination Procedure).

s. Safety Equipment.

Sample Collection.

There are two procedures to sample ground water within a well. If volatile organics are a contaminant of concern, then the low flow sampling method is preferred. If volatile organics are not a contaminant of concern, the ground-water monitoring well can be sampled by the bailer method.

- Bailer Method.

The following summarizes the sampling procedure to be used.

a. Obtain a disposable bailer. A new bailer shall be obtained for each sample event.

b. Secure bailer with nylon cord.

c. Place and lower bailer into the pre-existing well. Allow sufficient time for the bailer to fill with water.

d. Retrieve bailer and discard the contents into appropriate container (i.e., 55-gallon drum or similar); do this until three borehole volumes have been bailed from the well.

e. Lower and retrieve bailer again and, this time, fill appropriate bottles for analyses being requested.

f. Cap the bottles and wipe any moisture from outside the bottles.

g. Place a sample label, completed with the sample information, on the bottle.

h. Place sample bottle in a cooler with ice for shipment to the analytical laboratory.

- Low-Flow Purging and Sampling Procedure.

a. Install the pump. Lower pump, safety cable, tubing, and electrical lines slowly (to minimize disturbance) into the well to the zone to be sampled (typically the uppermost saturated zone). If possible, keep the pump intake at least 2 feet above the bottom of the well, this will minimize mobilization of particulates present in the bottom of the well.

b. Measure water level before starting pump.

c. Purge the well.

(1) Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs.

(2) Check water level.

(3) Adjust pump speed until there is little or no water level drawdown (less than 0.3 foot). If the minimal drawdown that can be achieved exceeds 0.3 foot but remains stable, continue purging until indicator field parameters stabilize.

(4) Monitor and record water level and pumping rate every 3 to 5 minutes (or as appropriate) during purging.

(5) Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of indicator parameters. Adjustments are best made in the first 15 minutes of pumping in order to help minimize purging time.

(6) Purge volume calculations should utilize the stabilized drawdown value, not the initial drawdown.

(7) Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen).

(8) The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

(9) Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder), and/or the use of dedicated equipment.

(10) If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples. Samples may then be collected even though the indicator field parameters have not stabilized.

d. Monitor indicator field parameters.

(1) During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every 3 to 5 minutes (or less frequently, if appropriate). Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments.

(2) Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized.

(3) Stabilization is considered to be achieved when three consecutive readings, taken at 3 to 5 minute intervals, are within the following limits:

(a) turbidity (10% for values greater than 1 NTU),

(b) DO (10%),

(c) specific conductance (3%),

(d) temperature (3%),

(e) pH (± 0.1 unit), and

(f) ORP/Eh (± 10 millivolts).

(4) All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

(5) The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell.

(6) When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out.

(7) Monitoring probes must be submerged in water at all times.

(8) If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

e. Collect water samples.

(1) Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

(2) Samples to be analyzed for VOCs should be collected first and placed directly into pre-preserved sample containers.

(3) Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

(4) During purging and sampling, strive to keep the tubing filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere.

f. Post sampling activities.

(1) If recording the water level using a pressure transducer, remeasure the water level with tape.

(2) After collection of the samples, the pump tubing may either be dedicated to the well for resampling, decontaminated, or properly discarded.

(3) Secure the well.

Determination of Number of Samples.

Ground-water flow is normally much, much slower than surface water flow. Therefore, to detect any substantial change in ground-water quality at a particular point (based on movement of a contaminant plume or leachate percolating to the water table from the land surface, leaking tank, wastewater lagoon, or waste pile), a sample should not need to be collected from a monitoring well more often than once a month or once a quarter. The number of monitoring wells installed upgradient and downgradient of the site of concern will dictate the number of samples collected per sampling event.

Sample Preservation, Containers, Handling, and Storage.

All liquid samples should be collected in the appropriate sample bottles, jars, or vials with the cap secured tightly. At a minimum, each sample must be appropriately preserved and should be labeled with the date and time of sample collection, a sample identification number, the person performing the sample collection, and the sample type. Samples should then be sealed in a plastic bag and placed on ice within a cooler immediately after collection. All samples must be kept between 4°C±2º until the
laboratory receives the sample cooler. Chain of custody forms must be completed and must accompany the samples to the laboratory.

<u>Surface Water Samples.</u>

The objective of this sampling and analysis procedure is to ensure that the surface water field sampling protocol is implemented, documented, and reviewed in a consistent manner. For the purpose of this sampling plan, the term “surface water” refers to streams, rivers, or any other surface water body from which samples may be collected.

Equipment.

a. Sample bottles/preservatives.

b. Coolers.

c. Ice.

d. Sealable plastic bags.

e. Labels.

f. Latex protective gloves.

g. Chain of Custody records and seals.

h. Decontamination supplies/equipment (refer to Sampling Equipment Decontamination Procedure).

i. Field data sheets.

j. Maps.

k. Safety Equipment.

Sample Collection.

The technique for collecting surface water samples outlined in this sampling and analysis procedure is known as the *direct method*. To utilize this method of sampling, the sampling personnel, equipped with adequate protective clothing, accesses the sampling location by whatever means that appear safe and appropriate.

The collector obtains the aqueous sample from the source by either filling a non-preserved sampling container directly, or by first filling a pre-cleaned or sterile container and then transferring the aqueous sample into the appropriate preserved sample container(s). Samples should never be collected directly from the source using preserved bottles as the collection method may dilute the concentration of the preservative necessary for proper sample preservation.

When collecting samples from a shallow stream environment, the sample must be collected under the water while pointing the appropriate sample container upstream. Disturbance within the substrate must be limited while the sample is obtained upstream of the collector. When collecting samples from lakes and other impoundments, the sample should be collected under the water surface, avoiding surface debris and boat wake.

Determination of Number of Samples.

Prior to sampling, the stream system or impoundment should be fully understood both to enable collection of a representative sample and also to determine an appropriate number of sample locations. Within impoundments, the water may settle out into separate layers. If impoundments

exist, water quality parameters (DO, temperature, pH) should be collected at 1-meter intervals to determine if stratification exists in the system. These water quality parameters can also aid in the selection of the sampling locations, as well as assist in the interpretation of the laboratory analytical data.

Several key factors are important when selecting a sampling location.

a. Is the sample going to be collected from the shore, or by boat?

b. From what depth is the sample being collected?

c. What is this overall depth of the surface water body?

d. What type of body of water will be sampled (e.g., stream or lagoon)?

Sample Preservation, Containers, Handling, and Storage.

All liquid samples should be collected in the appropriate sample bottles, jars, or vials with the cap secured tightly. At a minimum, each sample must be appropriately preserved and should be labeled with the date and time of sample collection, a sample identification number, the person performing the sample collection, and the sample type. Samples should then be sealed in a plastic bag and placed on ice within a cooler immediately after collection. All samples must be kept between 4°C±2º until the laboratory receives the sample cooler. Chain of custody forms must be completed and must accompany the samples to the laboratory.

Stormwater Samples.

The purpose of this sampling and analysis procedure is to provide guidelines on sampling of stormwater discharges. Stormwater sampling is sometimes difficult due to the unpredictability of storm events and the variable nature of stormwater discharges. This sampling and analysis procedure is primarily designed to assist in basic stormwater sampling needs. Samples are analyzed for the most common types of stormwater contaminants (i.e., VOCs, SVOCs, metals, and explosives and accelerants).

Equipment.

a. Sample bottles/preservatives.

b. Coolers.

c. Ice.

d. Sealable plastic bags.

e. Labels.

f. Latex protective gloves.

g. Chain of Custody records and seals.

h. Decontamination supplies/equipment (refer to Sampling Equipment Decontamination Procedure).

i. Field data sheets.

j. Maps.

k. Safety Equipment.

Sample Collection.

Using the *grab method*, a stormwater sample is collected at an uninterrupted interval (i.e., grabbed at one time). A grab sample provides information on the characterization of stormwater at a given time and may be collected manually.

A manual grab is collected by inserting a container under or downcurrent of a discharge with the container opening facing upstream. In most cases, the sample container itself may be used to collect the sample. Less accessible outfalls may require the use of poles and buckets to collect grab samples. To ensure that manual grab samples are representative of the stormwater discharged, the following procedures should be followed.

a. Label sample containers before sampling event.

b. Take cooler with ice to the sampling point.

c. Take the grab from the horizontal and vertical center of the channel.

d. Avoid stirring up the bottom sediments in the channel.

e. Hold the container so the opening faces upstream.

f. Avoid touching the inside of the container to prevent contamination.

g. Keep the sample free from uncharacteristic floating debris.

h. Transfer samples into proper containers (e.g., from buckets to sample container).

i. If taking numerous grabs, keep the samples separate and labeled clearly.

j. Use safety precautions.

All equipment and containers that may come into contact with the sample must be clean to avoid contamination. Additionally, sample collection equipment and container materials should be totally unreactive to prevent leaching of pollutants.

Sample Preservation, Containers, Handling, and Storage.

All liquid samples should be collected in the appropriate sample bottles, jars, or vials with the cap secured tightly. At a minimum, each sample must be appropriately preserved and should be labeled with the date and time of sample collection, a sample identification number, the person performing the sample collection, and the sample type. Samples should then be sealed in a plastic bag and placed on ice within a cooler immediately after collection. All samples must be kept between 4°C±2º until the laboratory receives the sample cooler. Chain of custody forms must be completed and must accompany the samples to the laboratory.

Process Water Samples.

Process water samples would need to be collected when testing the quality of influent to and effluent from a package wastewater treatment plant.

Equipment and Sample Collection.

The equipment and sample collection procedures for collecting a *grab sample* from the outfall of a treatment facility are essentially equivalent to those described above for stormwater sample collection.

Sample Preservation, Containers, Handling, and Storage.

All liquid samples should be collected in the appropriate sample bottles, jars, or vials with the cap secured tightly. At a minimum, each sample must be appropriately preserved and should be labeled with the date and time of sample collection, a sample identification number, the person performing the sample collection, and the sample type. Samples should then be sealed in a plastic bag and placed on ice within a cooler immediately after collection. All samples must be kept between 4°C±2º until the laboratory receives the sample cooler. Chain of custody forms must be completed and must accompany the samples to the laboratory.

4. QUALITY ASSURANCE/QUALITY CONTROL.

QC samples are required to verify that the sample collection and handling process has not compromised the quality of the aqueous samples. The following general QA procedures apply.

a. All data must be documented on field data sheets or within site log books.

b. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified. Equipment checkout and calibration activities must occur prior to sampling/operation, and must be documented.

c. All field QC samples must be prepared in the same manner as investigation samples with regard to sample volume, containers, and preservation.

d. The following QC samples shall be collected for each batch of samples (a batch may not exceed 20 samples).

(1) Field duplicate. Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect a duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

(2) Matrix spike.

(3) Matrix spike duplicate.

(4) Equipment blank (refer to Sampling Equipment Decontamination Procedure, a companion document within this appendix). An equipment blank should include water from a ground-water pump and associated tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds. Collect equipment blanks after sampling from potentially contaminated wells.

(5) Trip blank (VOCs). Trip blanks are required when VOCs are to be analyzed. They should be collected at a frequency of one set per VOC sample cooler.

(6) Temperature blank (one per sample cooler).

e. As much as feasible, collect samples in order from sample points with lowest suspected contaminant concentration to highest suspected concentration.

f. When initial field measurements such as pH, conductivity, and dissolved oxygen are taken on site, they should always be made using a separate sample which is then discarded after the measurements are taken. They should never be made on a water sample that is sent to the analytical laboratory for further chemical analysis.

5. ANALYSIS.

Aqueous samples may be analyzed for VOCs, SVOCs, metals, and/or explosives and accelerants. Table 5-1 outlines the type of compounds each analytical method is designed to detect.

Further information for each potential contaminant, including all analytical methods, can be found in the EPA Publications SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* All analytical data should be kept in the project file.

Table 5-1. Analytical Methods

Potential Contaminant	Analysis	Analytical Method
Toxic Organic Compounds	VOCs by Gas Chromatography/Mass Spectrometry (GC/MS)	SW846: 8260B
	SVOCs by GC/MS	SW846: 8270C
Heavy Metals	Metals by Inductively Coupled Plasma-Atomic Emission Spectrometry/ Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique)	SW846: 6010B/7471A
Explosive Residue	Nitroaromatics and Nitroamines by High Performance Liquid Chromatography (HPLC)	SW846: 8330

6. SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE.

Due to the fact that the bottles and preservatives (if needed) required for each separate analytical analysis may vary from method to method, it is very important that the collector is informed of what samples are needed to be collected *before* the field activities begin. The collector should always verify the sample containers to be used with the laboratory contracted to analyze the samples.

For each of the EPA analytical methods, the required preservatives, sampling container(s), and the sample holding times are shown in Table 6-1.

Table 6-1. Sample Containers, Holding Times, and Preservation Methods for Aqueous Samples

EPA Method	**Parameters**	**Preservation**	**Container**	**Holding Time**
6010B	Total Metals	Cool, 4°C±2º	1-Liter, Plastic	Analyze within 6 months
				Hg – (within 28 days)
8270C	SVOCs	Cool, 4°C±2º	1-Liter, Glass	Extract within 7 days / Analyze within 40 days of extraction
8260B [(a)]	VOCs	pH<2, 1:1 HCl, Cool, 4°C±2º	Three 40 mL, Glass	Analyze within 14 days
8330	Explosives and Accelerants	Cool, 4°C±2º	1-Liter, Amber Glass	Extract within 7 days / Analyze within 40 days of extraction

(a) Note: Zero headspace (no air bubbles) is required for this method.

SAMPLING AND ANALYSIS PROCEDURE FOR MONITORING $PM_{2.5}$ IN AMBIENT AIR

1. SCOPE AND APPLICATION.

This document provides procedures for the use of an EPA-equivalent Federal reference method monitor (as described in 40 CFR 50, Appendix L) to collect ambient air samples of fine particulate matter 2.5 microns and smaller in size ($PM_{2.5}$). This type of monitoring might be needed when a test operation releases particulates that cannot be easily captured at the point of release and the tester wishes to determine the amount of $PM_{2.5}$ released. Such releases, referred to as fugitive releases, may occur as a re-entrained dust from paved or unpaved roads or from some other operation that is not confined by a stack. Typically, however, fine particulate matter is released by combustion sources as opposed to mineral sources such as unpaved roads. Because they are not contained within a stack or duct, direct measurement using a stack testing method would not be possible. An alternate approach would be to use a published emission factor, as discussed in a companion document within this appendix, entitled Environmental Effects Data Collection Test Operations Procedure, Procedure for Estimating Air Pollutants Using Emission Factors.

The purpose of this procedure is to provide field operators with guidance to ensure that air samples are appropriately collected, stored, shipped, and analyzed. The procedures described in this document are based on the guidelines provided in the Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ (40 CFR 50, Appendix L) and manufacturers' Operating Manuals. The essential activities and required documentation are highlighted in Table 1. A project-specific Sampling and Analysis Plan (SAP) should be developed for each test activity.

Table 1. Ambient $PM_{2.5}$ Monitoring Activities

Activity	Documentation
Sampler Calibration	Sampler Calibration Form
Sampler Operation	Sample Data Form
Sample Storage and Shipment	Chain-of-Custody Record
Quality Control	Flow Check Form
Quality Assessment	Co-Located Sampler Data Form Quarterly Audit
Maintenance	Maintenance Records

2. REFERENCES.

Several sources were used to develop this procedure, primarily the following:

U.S. Environmental Protection Agency (U.S. EPA). 1998. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Part 1, EPA-454/R-98-004, August.

Code of Federal Regulations, Title 40, Part 50, Appendix L, Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$.

3. DEFINITIONS.

a. Blank. For the purpose of $PM_{2.5}$ sampling, a blank is a filter which is not exposed to ambient air, but which is otherwise handled in the same manner as a sample. The purpose of the blank is to verify that the analytical system is free from contamination.

b. Duplicate (From Co-Located Sampler). A duplicate is a replicate of the original sample that is analyzed in the same manner as the original sample. The relative percent difference between the results obtained for the original sample and the duplicate is calculated to assess the precision.

4. EQUIPMENT.

a. Sampler. EPA-equivalent Federal reference method samplers are used to collect samples for gravimetric analysis to determine $PM_{2.5}$ concentrations in ambient air. The sampler must consist of a PM_{10} sample inlet followed by a $PM_{2.5}$ impactor and a 47 mm sample filter. A mass flow controller downstream of the filter maintains a constant volumetric flow rate of 16.7 liters per minute (lpm). The sampler must meet 40 CFR 50, Appendix L requirements for $PM_{2.5}$ sampling and be designated as a manual reference method in accordance with 40 CFR 53. (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

b. Calibrator. A National Institute of Standards and Technology (NIST) traceable flow calibrator can be used to calibrate the $PM_{2.5}$ samplers and to conduct sampler flow checks. (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

c. Pre-weighed and pre-numbered 47 mm Teflon® filters in individual Petri dishes. (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

d. Data forms and chain-of-custody forms.

e. Powder-less gloves.

5. SAMPLING PROCEDURE.

$PM_{2.5}$ sampler calibration, filter handling, sampler operation, software, and sample shipping are addressed in this section.

$PM_{2.5}$ Sampler Flow Calibration.

a. The $PM_{2.5}$ sampler should be flow-calibrated once every 3 months and after maintenance that may impact the calibration integrity.

b. Ensure that the sampler is not collecting a sample prior to performing a calibration.

c. Remove the PM_{10} inlet from the sampler.

d. Install a loaded filter cassette into the filter holder mechanism. This filter will be discarded upon completion of the calibration.

e. Follow the procedure outlined in the manufacturer's Operating Manual to access the flow calibration menu and perform a multi-point flow calibration. Record calibration data on the calibration data form (Figure 2).

f. Remove the flow meter and filter cassette.

g. Reinstall the PM_{10} inlet.

Filter Installation/Recovery.

Routine operations consist of filter installation, filter recovery, and sample shipping. All sampling information must be documented on the $PM_{2.5}$ Field Sample Form (Figure 1).

a. Enter the site location, sampler identification number, sample date, and filter number at the top of the field data form. Note that the sample day is the day that the sample is to be collected and, if collecting data to compare with a particulate standard, must coincide with the EPA every sixth-day sample schedule.

b. Ensure that the sampler is not collecting a sample prior to filter installation or recovery.

c. Following the procedure outlined in the manufacturers operating manual, open the filter holder mechanism.

d. If conducting filter installation, remove the filter cassette carrier to be exposed from its filter transport container. Examine the filter for damage prior to insertion. If any damage is found (tears or holes), do not use the damaged filter. If no damage is found, insert the filter cassette carrier into the filter holder mechanism.

e. Following the procedure outlined in the manufacturers operating manual, close and seal the filter holder mechanism.

f. Close the front door on the housing unit.

g. Use the sampler's software to set up the newly deployed sample event. Start time and run time should be entered to program a sample event.

h. Follow any sampler specific instructions provided in the manufacturers operating manual to ensure that the sample is collected (i.e., sampler is in correct mode, or confirm event start).

i. Access the data from the most recently-completed run using the sampler interface. Record these data on the field data sheet. Minimum data to be recorded include: total volume sampled, flow rate coefficient of variation, total sampling time, largest difference between ambient and filter temperatures, and status codes.

j. Access and record power outage data and five-minute average data if desired.

k. If conducting filter removal, remove the exposed filter cassette carrier from the filter holder mechanism and place it in its filter transport container. Close and seal the filter transport container for transport to the laboratory.

Sample Shipping.

Sample filters, chain-of-custody forms, and field sample forms should be sent to the analytical lab at least once per month.

a. Complete a chain-of-custody form (Figure 3) listing all Teflon® filters that will be sent.

b. Make copies of completed field sample and chain-of-custody forms to keep at the field sites.

c. Place the sample filters, chain-of-custody forms, and field sample forms into a "small" shipping box and seal.

d. Fill out a shipper's Airbill to include sender, recipient, date, and account number. Ship using the "Standard Overnight" service. Typically, the package must be received before 12:00 p.m. to arrive at the lab the following business day.

Gravimetric Analysis.

Teflon® filters should be used to collect $PM_{2.5}$ samples. The filters should be pre-numbered with unique identification numbers. Disposable, powder-free gloves should be worn while handling filters both in the laboratory and in the field. Inspection of the individual filters should be conducted prior to use to ensure integrity of the filters. Care should be taken to ensure that the filters will not be broken or torn during handling and shipping operations.

Filters to be used for sampling should be equilibrated in a temperature- and humidity-controlled laboratory (15 to 30° C ± 3° C and 20 to 50% relative humidity) for at least 24 hours prior to both pre-sample and post-sample weighing. The filters should be weighed using an appropriate analytical balance (e.g., Mettler AE240), and the filter weights recorded on the Laboratory Weighing Form. After pre-weighing, the filters should be shipped to the field in their original

container, using tracing paper to separate the filters from each other. Field Sampling Forms and Chain-of-Custody Forms should be included with each filter shipment. Reinforced envelopes and manila folders should be supplied to provide protection during the shipment of the exposed filters back to the laboratory for analysis.

6. SAMPLING SCHEDULE.

a. Samples collected as part of a long-term monitoring program are normally collected from midnight to midnight following an EPA-published every sixth-day sampling schedule. When samples are collected as part of a specific study, the schedule will be established to coincide with the operating schedule of the system being tested. Typically, samples will be collected over a period of no less than 1-hour and no more than 24-hours. This will also depend on the purpose of the sampling and the operating schedule of the system being tested. The number of samples must be specified to allow valid statistical evaluation of the results, if possible. Therefore, no less than three samples should be collected, but more will often be required. When uncertainty exists concerning potential background levels of $PM_{2.5}$ in the area of the test, both upwind and downwind samples will need to be collected.

b. Samples collected with the co-located sampler (duplicates) for determination of long-term sampling precision can be collected from midnight to midnight following the twelfth-day sampling schedule.

c. Blanks are normally collected at a rate of 10% of the samples. That is one blank for every 10 samples taken and includes the duplicates.

7. ROUTINE MAINTENANCE.

Routine maintenance activities, such as sampler cleaning, leak checks, and impactor maintenance, must be done at the appropriate frequencies.

$PM_{2.5}$ Sampler Cleaning.

Inspect the filter cassettes and filter cassette seals for contamination after every sampling event and wipe with a clean, dry cloth as needed. During the summer months, be careful of spiders or wasps that might nest in the sampler. This should be done once a week or more if the sampler appears dusty.

Leak Checks.

Two types of leak checks (internal and external) may be performed for $PM_{2.5}$ reference method samplers. An external leak check should be performed after 5 days of inlet usage. An internal leak check should be performed after 1 month of inlet usage.

a. External Leak Check.

(1) Remove the PM_{10} inlet from the sampler.

(2) Install a loaded filter cassette.

(3) Install a flow audit adaptor on the end of the sample tube. Make sure the valve on the flow audit adaptor is in the open position.

(4) Perform an external leak check following the procedure outlined in the manufacturers operating manual.

(5) Perform a flow audit/calibration if desired.

(6) Remove the flow audit adaptor and filter cassette.

(7) Reinstall the PM_{10} inlet.

b. Internal Leak Check.

(1) Clean a filter cassette with alcohol to remove oil or other materials.

(2) Remove the PM_{10} inlet.

(3) Insert a leak check disk into the filter cassette and install the cassette in the sampler.

(4) Perform an internal leak check following the procedure in the manufacturers operating manual.

(5) Remove the flow audit adaptor and filter cassette.

(6) Remove the leak check disk from the filter cassette.

(7) Reinstall the PM_{10} inlet.

Impactor Maintenance.

a. The $PM_{2.5}$ impactor should be cleaned after 5 days of inlet use.

b. Open the filter exchange mechanism and remove the filter cassette.

c. Remove the impactor assembly following the procedure outlined in the manufacturers operating manual.

d. Disassemble the impactor assembly following the procedure outlined in the manufacturers operating manual.

e. Remove any filter which was previously installed in the impactor.

f. Remove the impactor assembly and wipe the interior surfaces of all impactor parts with a dry towel.

g. Place a new filter into the impactor assembly.

h. Grease the filter following the procedure in the manufacturers operating manual.

i. Reassemble the impactor assembly and adaptor.

j. Reinstall the impactor following the procedure outlined in the manufacturers operating manual.

k. Install a new sample filter following the procedure for filter installation.

$PM_{2.5}$ Field Sample Form

Site location _____ Sample date _____

Sampler ID _____ Filter No. _____

Filter Installation

Installation date _____ Operator _____

Sampling start time _____

Initial pressure drop across filter (P_{FI}) _____

Sample timer set to current time/date. ☐ Yes

Filter Retrieval

Retrieval date _____ Operator _____

Sampling stop time _____

Final pressure drop across filter (P_{FF}) _____

Average ambient temperature _____

Average barometric pressure _____

Status codes _____

Maximum temperature difference _____

Total sample volume _____

Total elapsed time _____

Flow rate coefficient of variation _____

Figure 1. Example of Field Data Form

$PM_{2.5}$ Volumetric Flow Controller Calibration Form

Site Location _____ Sample date _____

Sampler ID _____ Calibrated by _____

Calibration Start Time _____ External Flow Meter ID _____

Ambient Temperature _____°C Slope _____

Barometric Pressure (Pa) _____in. Hg Intercept _____

Last Certification Date _____

FIELD DATA

Calibration Point	External Flow Meter Reading, lpm	Sampler Flow Reading, lpm	Percent Difference
1			
2			
3			
4			
5			
6			
7			
8			

Figure 2. Example Field Calibration Form

CHAIN-OF-CUSTODY RECORD

Sample Number	Sample Location/Description	Sample Type	Comments/Conditions

SIGNATURES: (NAME, DATE, TIME)

1. Relinquished By: _____ **2. Relinquished By:** _____

Received By: _____ **Received By:** _____

Figure 3. Example Chain of Custody Form

SAMPLING AND ANALYSIS PROCEDURE FOR MONITORING PM_{10} AND METALS IN AMBIENT AIR

1. SCOPE AND APPLICATION.

This document provides procedures for the use of high-volume air samplers to collect ambient air samples of particulate matter 10 microns and smaller in size (PM_{10}). Ambient concentrations of metals in the particulate phase can also be monitored using this procedure. This type of monitoring might be needed when a test operation releases particulates or hazardous air pollutant (HAP) metals that cannot be easily captured at the point of release and the tester wishes to determine the amount of PM_{10} or HAP metals released. Such releases, referred to as fugitive releases, may occur as a re-entrained dust from paved or unpaved roads or from some other operation that is not confined by a stack. Because they are not contained within a stack or duct, direct measurement using a stack testing method would not be possible. An alternate approach would be to use a published emission factor, as discussed in a companion document within this appendix, entitled Environmental Effects Data Collection Test Operations Procedure, Procedure for Estimating Air Pollutants Using Emission Factors.

The purpose of this procedure is to provide field operators with guidance to ensure that air samples are appropriately collected, stored, shipped, and analyzed. The procedures described in this document are based on the guidelines provided in the Reference Method for the Determination of Fine Particulate Matter as PM_{10} (40 CFR 50, Appendix J), EPA Methods 450 and 454, and the PM_{10} sampler manufacturers' Operating Manuals. The essential activities and required documentation are highlighted in the Table 1. A project-specific Sampling and Analysis Plan (SAP) should be developed for each test activity.

Table 1. Ambient PM_{10} Monitoring

Activity	Documentation
Sampler Calibration	Sampler Calibration Form
Sampler Operation	Sample Data Form
Sample Storage and Shipment	Chain-of-Custody Record
Quality Control	Flow Check Form
Quality Assessment	Co-Located Sampler Data Form Quarterly Audit
Maintenance	Maintenance Records

2. REFERENCES.

Several sources were used to develop this procedure, primarily the following:

Code of Federal Regulations, Title 40, Part 50, Appendix J.

Code of Federal Regulations, Title 40, Part 53.

U.S. Environmental Protection Agency (U.S. EPA). 1987. Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-450/4-87-007, May.

U.S. EPA. 1998. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Part 1, EPA-454/R-98-004, August.

U.S. EPA, 1999. Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air (Method IO-3.1, Selection, Preparation, and Extraction of Filter Material; Method IO-3.5 Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS); and Method IO-5.0, Sampling and Analysis for Atmospheric Mercury), EPA/625/R-96/01a, July.

3. DEFINITIONS.

a. Blank. A blank is a filter which is not exposed to ambient air, but is otherwise treated in the same manner as a sample. The purpose of the blank is to verify that the analytical system is free from contamination.

b. Duplicate (From Co-Located Sampler). A duplicate is a replicate of the original sample that is analyzed in the same manner as the original sample. The relative percent difference between the results obtained for the original sample and the duplicate is calculated to assess the precision.

4. EQUIPMENT.

a. Sampler. EPA-equivalent Federal reference method samplers must be used to collect PM_{10} samples for gravimetric and metals analysis. Approved samplers must consist of a PM_{10} size-selective inlet, 8x10-inch filter cartridge, aluminum outdoor shelter, volumetric flow controller, 7-day mechanical on/off timer, elapsed time meter, and a continuous flow recorder. The sampler must meet 40 CFR 50, Appendix J requirements for PM_{10} sampling and be designated as a manual reference method in accordance with 40 CFR 53. (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

b. Calibrator. A National Institute of Standards and Technology (NIST) traceable flow calibrator can be used to calibrate the PM_{10} samplers and to conduct sampler flow checks. (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

c. Pre-weighed and pre-numbered 8x10-inch glass fiber filters. (see "Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

d. Manila folders.

e. Manila envelopes.

f. Data forms and chain-of-custody forms.

g. Powderless gloves.

5. SAMPLING AND ANALYSIS PROCEDURE.

PM_{10} sampler calibration, filter installation, filter recovery, sample volume calculation, and sample shipping are discussed in this section.

PM_{10} Sampler Calibration

a. The PM_{10} sampler should be calibrated once every 3 months and each time the brushes are changed.

b. Mount the calibrator orifice and top loading adapter plate to the sampler. This is done without a filter in place. Securely tighten the top-loading adapter with the nuts to assure that no leaks are present.

c. Turn on the sampler and allow it to warm up to its normal operating temperature.

d. Record the site location, date, sampler serial number, and name of person performing the calibration at the top of the calibration form (Figure 2). Document the calibration orifice serial number, orifice calibration slope and intercept, and date of last certification. At the completion of the calibration, record the ambient air temperature and ambient barometric pressure.

e. Conduct a leak test by covering the holes on top of the orifice and pressure tap on the orifice with your hands. Listen for a high-pitched squealing sound made by air escaping. If a leak is present, retighten the nuts.

f. Connect one side of the manometer to the pressure tap on the side of the orifice with the rubber vacuum tube. Leave the opposite side of the manometer open to the atmosphere.

g. Connect a second manometer to the quick disconnect located on the side of the aluminum outdoor shelter (this quick disconnect is connected to the pressure tap on the side of the filter holder).

h. Make sure the orifice is all the way open by turning the black knob on the top counter clockwise. Record both manometer readings on the calibration form.

i. Repeat this process for seven additional points by adjusting the knob on the variable orifice to seven different positions. Record manometer reading for each point on the calibration form.

j. Shut off sampler motor.

k. Remove calibration orifice from sampler.

Filter Installation

Routine operations consist of filter installation, filter recovery, and volume calculation. All sampling information must be documented on the PM_{10} Field Sample Form (Figure 1).

a. Enter the site location, sampler identification number, sample date, and filter number at the top of the field data form. Note that the sample day is the day that the sample is to be collected and, if collecting data to compare with a particulate standard, must coincide with the EPA every sixth-day sample schedule.

b. Remove the top cover from filter cartridges and wipe clean using a clean cloth or paper towel. Cleaning of cartridge and loading of filter should be done in a sampling shelter (trailer) or other clean area to prevent contamination.

c. Install a clean filter on the center of the cartridge's support screen. The filter should be placed with the rough side up (numbered side down). Write the filter number on the sample form.

d. Replace the top part of the cartridge over the filter and tighten down with brass bolts. Place the aluminum cartridge lid on the cartridge to protect the filter from debris.

e. Open the PM_{10} sampler head by opening the latches at the front, back, and sides of the sampler and raising the sampling head in the locking position.

f. Place filter cartridge on sampler, remove the protective aluminum lid, and tighten the cartridge down with the nuts. Do not over tighten.

g. Close the PM_{10} sampler head and fasten all latches securely.

h. Record minutes shown on the running time meter, located inside the housing, on the sample form. For blank samples, the set-up procedure ends here. Treat the blank as a sample, but do not set the timer to run the PM_{10} sampler.

i. Attach electric manometer to pressure tap on the side of the sampler and turn the sampler on.

j. Allow the sampler to warm up for a few minutes, read the pressure drop across filter, and record on sample form.

k. Turn off the sampler.

l. Set the 7-day timer, located inside the housing, to begin sampling at 00:01 of the sample day and off at 24:00 of the sample day. Instructions for setting the 7-day timer are given in the manufacturer's Operating Manual.

m. Close the front door on the housing unit.

Filter Recovery.

a. Document the sample recovery date and the name of person collecting the sample on the PM_{10} field sample form.

b. Attach electric manometer to pressure tap on the side of the sampler and turn the sampler on. Allow the sampler to warm up for a few minutes.

c. Read the pressure drop across the filter and record on the sample form.

d. Shut off the sampler.

e. Read and record the minutes from the time meter.

f. Place the protective aluminum cover on the cartridge to protect the filter from debris and remove the cartridge from sampler.

g. While wearing gloves, fold the filter lengthwise so sample touches sample. Remove the filter from the cartridge and verify that the filter number on the sampling form is correct. Place the filter in a labeled manila folder. The labeled folders should include the site location, PM_{10} serial number, sample date, and filter number.

h. Insert the manila folder containing the filter into a labeled manila envelope.

i. Collected samples should be kept in a closed bin or cabinet until shipped to a laboratory for accurate weight determination.

Sample Volume Calculation.

a. Record the person performing the calculation and the date the calculation was performed on the field sample form.

b. Obtain the average ambient temperature and barometric pressure from the meteorological station and record on the field sample form.

c. Calculate the average between the initial and final pressure drop across the sample filter and record.

d. Calculate P_o/P_a and record.

e. Using the calculated P_o/P_a and the average ambient temperature, determine the sample flow rate from the sampler look-up table.

f. Calculate the total sample time by subtracting the start time from the final time and record.

g. Calculate the total volume sampled by multiplying the sample time by the average flow rate. Record volume on field sample form.

Sample Shipping.

Sample filters, chain-of-custody forms, and field sample forms should be sent to the analytical lab

a. Complete a chain-of-custody form listing all glass fiber filters that will be sent.

b. Make copies of completed field sample and chain-of-custody forms to keep at the field sites.

c. Place the labeled manila envelopes containing sample filters, chain-of-custody forms, and field sample forms into a "small" FedEx shipping box and seal.

d. Fill out a shipper's airbill to include sender, recipient, date, and account number. Ship using the "Standard Overnight" service. Typically, the package must be received by the shipper before 12:00 p.m. to arrive at the lab the following business day.

Gravimetric Analysis.

Quartz fiber filters should be used to collect 24-hour PM_{10} samples. The filters should be pre-numbered with unique identification numbers. Disposable, powder-free gloves should be worn while handling filters both in the laboratory and in the field. Inspection of the individual filters should be conducted prior to use to ensure integrity of the filters. Care should be taken to ensure that the filters will not be broken or torn during handling and shipping operations.

Filters should be equilibrated in a temperature- and humidity-controlled laboratory (15-30° C ± 3° C and 20 to 50% relative humidity) for at least 24 hours prior to both pre-sample and post-sample weighing. The filters should be weighed using an appropriate analytical balance (e.g., Mettler AE240), and the filter weights recorded on the Laboratory Weighing Form. After pre-weighing, the filters should be shipped to the field in their original container, using tracing paper to separate the filters from each other. Field Sampling Forms and Chain-of-Custody Forms should be included with each filter shipment. Reinforced envelopes and manila folders should be supplied to provide protection during the shipment of the exposed filters back to the laboratory for analysis.

Metals Analysis.

The laboratory should prepare the sample for analysis in accordance with IO Method 3.1 Section 6.3. A 1"x 8" strip is cut from the 8" x 10" filter. The filter strip is placed in a beaker with HNO_3 and covered with a watch glass. The beaker is placed on a hot plate, heated for 30 minutes and then cooled. Once cool, 10 mL of reagent water is added to the beaker, and the sample is stirred and left to stand for 30 minutes. The sample is transferred to a 20-mL volumetric flask and brought to volume with reagent water. The sample is filtered and transferred to a 15-mL centrifuge tube. For each batch, the laboratory should prepare and analyze a method blank, a duplicate sample, and a matrix spike.

The sample can be analyzed for 26 different metals by Inductively Coupled Plasma Mass Spectrometer (ICPMS) following procedures based on IO Method 3.5. The list of metals that can be analyzed by this method include many of the commonly analyzed metals such as arsenic, nickel, manganese, barium, cadmium, lead, selenium, and chromium. The sample is introduced via a peristaltic pump by pneumatic nebulization into a radio frequency plasma where energy transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a pumped vacuum interface and separated on the basis of their mass-to-charge ratio by a quadrupole MS. The ions transmitted through the quadrupole MS are registered by a continuous dynode electron multiplier, and the ion information is processed by a data handling system.

The ICPMS is tuned, optimized, and calibrated daily with a minimum of five standards and a correlation coefficient of greater than 0.998. Internal standards are used to correct for instrument drift and physical interferences. They are introduced in line via the peristaltic pump and analyzed with all blanks, standards, and samples. If the absolute response of the internal standard deviates more than 60-123% of the original response, the samples will be diluted and reanalyzed. The calibration is verified with a Quality Control Sample (QCS) obtained from a source different than the calibration standards. The QCS is analyzed immediately after the calibration standards, after every 10 samples, and at the end of the analytical run. The analytically determined value of the QCS must agree with 10% of its known value, or the instrument must be recalibrated and the samples reanalyzed. The percent recovery of the analyte in the matrix spike must be between 75% and 125%. The relative percent difference of the duplicate samples must be less than 20%.

The sample can be analyzed for mercury through Cold Vapor Atomic Fluorescence Spectroscopy (CVAFS). The quartz fiber filter is extracted in acid as for ICPMS. After the extraction, BrCl is added to convert all mercury to Hg^{2+}, then $SnCl_2$ is added to reduce the mercury to Hg^0. The Hg^0 is liberated by purging with N_2 and is collected on a gold-coated bead trap which is then analyzed by CVAFS. The sample trap is heated to release the mercury which is subsequently collected on a second gold-coated bead trap. This analytical trap is then heated and the mercury is carried to the CVAFS. The resulting voltage peak is integrated to provide the peak area for the sample.

6. Sampling Schedule.

a. Samples collected as part of a long-term monitoring program are normally collected from midnight to midnight following an-EPA published every sixth-day sampling schedule. However, when samples are collected as part of a specific study, the schedule will be established to coincide with the operating schedule of the system being tested. Typically, samples will be collected over a period of no less than 1-hour and no more than 24-hours. This will also depend on the purpose of the sampling and the operating schedule of the system being tested. The number of samples must be specified to allow valid statistical evaluation of the results, if possible. Therefore, no less than three samples should be collected, but more will often be required. When uncertainty exists concerning potential background levels of PM_{10} or HAP metals in the area of the test, both upwind and downwind samples will need to be collected.

b. Samples collected with the co-located sampler (duplicates) for determination of sampling precision can be collected from midnight to midnight following the twelfth- day sampling schedule.

c. Blanks are normally collected at a rate of 10% of the samples. That is one blank for every 10 samples taken and includes the duplicates.

7. ROUTINE MAINTENANCE.

Routine maintenance activities, such as sampler cleaning and motor brush replacement, must be done at the appropriate frequencies.

PM_{10} Sampler Cleaning.

Wipe the inside and outside of the sampler with a dry cloth or paper towel to remove any surface dirt. During the summer months, be careful of spiders or wasps that might nest in the sampler. This should be done once a week or more if the sampler appears dusty.

Shim Plate Cleaning and Oiling.

The shim plate should be cleaned and oiled once a month or more if conditions have been unusually dusty.

a. To remove the shim plate, unlatch the four hooks located on the upper side of the head.

b. Slowly tilt back the head until the head is fully open and in a locked position, exposing the nine acceleration nozzles. Rotate the two shim plate slips on each side of the shim plate 90º. Lift the shim plate vertically until the vent tubes have been cleared and pulled out horizontally.

c. Use a clean cloth to wipe off the dirt and oil from the shim plate. Acetone or other solvent may be used if needed.

d. Clean the interior surfaces with a clean cloth to remove any dust or bugs.

e. Place shim plate on a clean flat surface away from the PM_{10} unit, and spray the shim plate with a coating of Dow Corning Silicone #316. This grease is available from Tisch Environmental or a Dow Corning Distributor. Apply a generous amount of the silicone spray after shaking the aerosol can. Spray holding the can 8 to 10 inches away. Allow 3 minutes for the sprayed solvent to evaporate.

f. Replace the shim plate with the greased side up into the sampler head in the reverse order of the removal procedure.

g. Close the head and latch the four hooks.

Motor Brush Replacement.

The motor brushes should be changed every 500 hours. Failure to do so will result in motor failure and lost sample. The armature of the motor should not be touched. When oil from your hands gets on the commutator, it disrupts the smooth operation of the motor. To prevent this, wear a set of powder-free gloves while changing the motor brushes.

a. Unplug the motor power cord and remove the motor housing from the sampler assembly.

b. Remove the motor mounting cover by removing the eight bolts. This will expose the flange gasket and the motor. Turn the motor over.

c. Remove ground wires from the back plate and carefully lift the housing from the motor.

d. With a screwdriver, carefully remove the plastic fan cover by prying between the brush and cover until both sides pop loose.

e. With a screwdriver, carefully pry the brass quick disconnect tabs away from the expanded brushes. The brass quick disconnect tabs tend to come out of the brushes easier if you squeeze across the top of the brush with a pair of pliers while gently pulling on the tab.

f. With a Phillips-head screwdriver, remove the brush holder and release the brushes.

g. With new brushes, carefully slide the quick disconnect tabs firmly into the tab slot until seated.

h. Push the brush carbon against the commutator until the plastic brush stops in place.

i. Replace the brush holder clamps onto brushes.

j. Assemble the motor after brush replacement: snap plastic fan cover back into place, feed ground wires back through back plate, put housing back onto motor, pull cord set back to

normal position, fasten ground wires to back plate, turn motor over, and tighten flange on top of housing and gasket.

Motor Brush Seating.

a. For the best performance from new brushes, they must be seated on the commutator before full voltage is applied to the motor.

b. Seat the brushes by applying 50 percent voltage for 10 to 15 minutes using a variac (A/C voltage regulator). Plug in the motor's power cord into a variac and plug in the variac. Set the variac to supply 50 percent power, and turn the variac on for 10 to 15 minutes.

c. For optimal performance, apply a low voltage to the motor and slowly increase over a 45-minute period.

d. The motor will sound rough at first, but will smooth out after the brushes are properly seated.

PM_{10} Field Sample Form

Site location _____ Sample date _____

Sampler ID _____ Filter No. _____

FILTER INSTALLATION

Installation date _____ Operator _____

Initial elapsed time meter reading (ET_I) _____

Initial pressure drop across filter (P_{FI}) _____

Seven-day timer set to current time/date. ☐ Yes

FILTER RETRIEVAL

Retrieval date _____ Operator _____

Final elapsed time meter reading (ET_F) _____

Final pressure drop across filter (P_{FF}) _____

VOLUME CALCULATION

Date _____ Performed by _____ Reviewed by _____

Average ambient temperature _____

Average barometric pressure _____

Average pressure drop across filter ($[P_{FF}-P_{FI}]/2$) _____

Calculated P_0/P_a _____

Sample flow rate from table _____

Total elapsed time (ET_F-ET_I) _____

Total sample volume _____

Figure 1. Example of Field Data Form

PM_{10} Volumetric Flow Controller Calibration Form

Site Location _____ Sample date _____

Sampler ID _____ Calibrated by _____

Calibration Start Time _____ Calibration Orifice ID _____

Ambient Temperature _____°C Slope _____

Barometric Pressure (Pa) _____in. Hg Intercept _____

Last Certification Date _____

FIELD DATA			***CALIBRATION PROGRAM DATA***		
Calibration Point	Calibration Orifice Pressure Drop, inch/H_2O	Sampler Pressure Drop, inch/H_2O	Pressure Ratio (from program)	Look Up Table Flow Rate, m^3/min	Percent Difference
1					
2					
3					
4					
5					
6					
7					
8					

Figure 2. Example Field Calibration Form

CHAIN-OF-CUSTODY RECORD

Sample Number	Sample Location/Description	Sample Type	Comments/Conditions

SIGNATURES: (NAME, DATE, TIME)

2. Relinquished By: _____ **2. Relinquished By:** _____

Received By: _____ **Received By:** _____

Figure 3. Example Chain of Custody Form

SAMPLING AND ANALYSIS PROCEDURE FOR MONITORING VOC IN AMBIENT AIR

1. SCOPE AND APPLICATION.

This document provides procedures for the collection of time-integrated whole air samples for determining the concentration of volatile organic compounds (VOCs) in ambient air when using a flow orifice and a stainless steel canister. This type of monitoring might be needed when a test operation releases hazardous air pollutant (HAP) VOCs that cannot be easily captured at the point of release and the tester wishes to determine the amount of HAP VOC released. Such releases, referred to as fugitive releases, may occur as evaporative losses from vessels or drums containing volatile organic materials or as a result of production or transformation of materials during a reaction or explosion. Because they are not contained within a stack or duct, direct measurement using a stack testing method would not be possible. An alternate approach would be to use a published emission factor, as discussed in a companion document within this appendix, entitled Procedure for Estimating Air Pollutants Using Emission Factors.

The purpose of this procedure is to provide field operators with guidance to ensure that air samples are appropriately collected, stored, shipped, and analyzed. The procedures described in this document are based on the guidelines provided in the U.S. Environmental Protection Agency's (EPA) Method TO-14A and Method TO-15 Guidance Documents. The procedure allows for the collection of time-integrated samples by incorporating a calibrated flow orifice at the inlet to an evacuated canister. The essential activities and required documentation are highlighted in Table 1. Targeted analytes for TO-15 are listed in Table 2. A project-specific Sampling and Analysis Plan (SAP) should be developed for each test activity.

Table 1. Ambient VOC Monitoring Activities

Activity	Documentation
Sampler Calibration	Sampler Calibration Form
Sampler Operation	Sample Data Form
Sample Storage and Shipment	Chain-of-Custody Record
Quality Control	Flow Check Form
Quality Assessment	Co-Located Sampler Data Form Quarterly Audit
Maintenance	Maintenance Records

2. REFERENCES.

U.S. EPA Methods TO14A and TO-15, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*.

A Guide to Passive Air Sampling Equipment Needed and Practical Techniques for Collecting Air Samples, from www.restek.com, Lit. Cat. # 59977B.

Table 2. Targeted TO-15 Analytes

Targeted TO-15 Analytes		
acetone	1,1-dichloroethene	methyl chloride
benzene	trans-1,2-dichloroethene	methyl ethyl ketone
benzyl chloride	1,2-dichloropropane	methyl isobutyl ketone
bromodichloromethane	trans-1,3-dichloropropene	methyl tert-butyl ether
bromoform	1,4-dioxane	methylene chloride
1,3-butadiene	ethyl acetate	o-xylene
carbon disulfide	ethyl chloride	Styrene
carbon tetrachloride	ethylbenzene	1,1,2,2-tetrachloroethane
chlorobenzene	4-ethyl toluene	Tetrachloroethene
chloroform	Freon-11	Tetrahydrofuran
cis-1,2-dichloroethene	Freon-113	Toluene
cis-1,3-dichloropropene	Freon-114	1,2,4-trichlorobenzene
cyclohexane	Freon-12	1,1,1-trichloroethane
dibromochloromethane	heptane	1,1,2-trichlorethane
1,2-dibromoethane	hexachlorobutadiene	Trichloroethene
1,2-dichlorobenzene	hexane	1,2,4-trimethylbenzene
1,3-dichlorobenzene	2-hexanone	1,3,5-trimethylbenzene
1,4-dichlorobenzene	isopropyl alcohol	vinyl acetate
1,1-dichloroethane	m&p-xylene	vinyl chloride
1,2-dichloroethane	methyl bromide	

3. DEFINITIONS.

a. VOCs. VOCs are volatile organic compounds with a vapor pressure greater than 0.1 mm Hg at 25° C.

b. sccm. Standard cubic centimeters per minute.

4. EQUIPMENT.

a. Sampler. A sampler for VOC analysis should consist of an inlet, a particle filter, a critical orifice, a flow controller, a vacuum gauge, a canister, and a timer. The particle filter, critical orifice, and vacuum gauge form the flow orifice assembly. Several sizes of canister can be used in conjunction with different orifices depending on the sample duration. All items listed are available from one of several suppliers of passive air monitoring equipment. (see “Reference Document for Various Sampling Equipment Associated with Data Collection Protocols,” a companion document within this appendix, for equipment illustrations).

b. Calibrator. A calibrated mass flow controller is used to pre-set the flow rate to the canister. (see “Reference Document for Various Sampling Equipment Associated with Data Collection Protocols,” a companion document within this appendix, for equipment illustrations).

c. A certified vacuum/pressure gauge is used to accurately record the vacuum after sample collection and the final pressure after the canister is filled with humidified zero air. (see

"Reference Document for Various Sampling Equipment Associated with Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

d. A source of humidified zero air is used to fill the canisters.

e. Data forms and chain-of-custody forms.

5. SAMPLING AND ANALYSIS PROCEDURES.

VOC sampler calibration, sampler operation, calculations, and sample shipping are discussed in this section.

VOC Sampler Calibration/Laboratory Preparation

a. The flow orifice is calibrated in the laboratory using a vacuum source and a calibrated mass flow meter. The orifice flow can be adjusted via the control valve. Table 5-1 can be used to select the correct orifice based on the sampling rate and desired sample duration.

Table 5-1. Critical Orifice Diameter vs. Flow Rate

Orifice Diameter (in.)	Flow Rate (sccm)	1-liter Sampling Time	3-liter Sampling Time	6-liter Sampling Time	15-liter Sampling Time
0.0008	0.5 to 2	24 hours	48 hours	125 hours	-
0.0012	2 to 4	4 hours	12 hours	24 hours	60 hours
0.0016	4 to 8	2 hours	6 hours	12 hours	30 hours
0.0020	8 to 20	1 hour	4 hours	8 hours	20 hours
0.0030	20 to 40	-	2 hours	3 hours	8 hours
0.0060	40 to 80	-	-	1 hour	3 hours

b. The sampling train should be leak tested in the laboratory prior to field deployment according to the manufacturer's Operating Manual.

c. The sampling train must be certified as clean prior to field deployment.

d. The sampling canister must be evacuated to final pressure before leaving the laboratory.

e. Prior to shipment of the canister to a field monitoring site, chain of custody forms and laboratory data forms must be filled out. An identification tag should be affixed to the canister for positive identification purposes.

Sampler Deployment.

a. Remove the plug from the canister valve.

b. Record the vacuum reading from either a test gauge or the vacuum gauge which is integrated into the sampling system.

c. Connect the canister to the sampling train.

d. Record the sample start time and any other required data (i.e., meteorological data or sampler information) on the field data form (Figure 1).

e. Open the canister valve to begin sampling.

f. Once sampling is complete, close the canister valve.

g. Check and record the final pressure reading from the vacuum gauge. Take appropriate data validation action based on the final pressure reading according to the manufacturer's Operating Manual.

h. Record the sampling stop time and any other required data on the field data form.

Calculations.

a. Sample volume collected is determined following equation (1).

(1) $$Sample\ volume = \frac{Initial\ \ pressure - Final\ \ pressure}{Atmospheric\ reference\ \ pressure} \cdot Canister\ volume$$

b. A dilution factor is obtained following equation (2).

(2) $$Dilution\ \ factor = \frac{\left(P_{after\ dilution} + P_{laboratory\ atmosphere}\right)}{\left(P_{laboratory\ atmosphere} - P_{before\ dilution}\right)}$$

Sample Shipping.

Sample canisters, chain-of-custody forms, and field sample forms should be sent to the analytical lab at least once per month and prior to exceeding the recommended 30-day holding time.

a. Complete a chain-of-custody form (Figure 2) listing all VOC sampling canisters that will be sent.

b. Make copies of completed field sample and chain-of-custody forms to keep at the field sites.

c. Place the VOC canisters, chain-of-custody forms, and field sample forms into a shipping container and seal.

d. Fill out a shipper's airbill to include sender, recipient, date, and account number. Ship using the "Standard Overnight" service. Typically, the package must be received by the shipper before 12:00 p.m. to arrive at the laboratory the following business day.

VOC Analysis.

Analysis of VOC samples collected with canisters is conducted via gas chromatography/mass spectrometry (GC/MS). A fused silica GC column coated with nonpolar 100% methylsilicone stationary phase (RTX-1 or equivalent) is used to separate the target compounds. The gas chromatograph/mass spectrometer can be operated in either the full-scan or selected ion monitoring mode. In the full-scan mode, the mass spectrometer scans all masses repeatedly during the GC run between a lower and an upper mass limit. This mode is best suited for analyzing unknown compounds because it provides a complete mass spectrum for each GC peak. The mass spectrum may then be used to identify the compound using a computer-based compilation of standard spectra along with a suitable library search algorithm. In the selective ion monitoring mode, the mass spectrometer monitors only pre-selected ions, rather than scanning all masses continuously between two mass limits. This procedure results in increased sensitivity but only analyzes for selected masses.

Upon receipt at the laboratory, the canisters are pressurized to ensure an adequate gas volume exists for all analyses and quality assurance procedures. This pressurization, in effect, dilutes the concentrations of pollutants in the sample and requires that a dilution factor be calculated using equation 2 above.

The GC initial temperature is set at -60° C for 2 minutes and is then ramped to 220° C at 10° C/minute and held at 220° C for 6 minutes. The average relative response factor is determined for each compound using peak areas and concentrations from daily calibration runs. The dilution factor for each canister is calculated based on the initial and final canister pressure. The peak area, canister dilution factor, and peak relative response factor are used to calculate a concentration for each mass peak.

6. SAMPLING SCHEDULE.

a. Since no ambient air standard exists for VOCs, VOC samples are usually collected as part of a specific study. As such, the schedule will be established to coincide with the operating schedule of the system or commodity being tested. Typically, samples will be collected over a period of no less than 1 hour and no more than 24 hours. This will also depend on the purpose of the sampling and the operating schedule of the system being tested. The number of samples must be specified to allow valid statistical evaluation of the results, if possible. Therefore, no less than three samples should be collected, but more will often be required. When uncertainty exists concerning potential background levels of HAP VOCs in the area of the test, both upwind and downwind samples will need to be collected.

b. Samples collected with the co-located sampler (duplicates) for determination of sampling precision are usually collected for at least 10% of the samples.

c. Blanks are normally collected at a rate of 10% of the samples. That is one blank for every 10 samples taken and includes the duplicates.

7. ROUTINE MAINTENANCE.

a. The sampling train must be cleaned thoroughly between sampling events. Several cleaning methods are available and are suitable for different sampling goals depending on the analytes of interest. Consult the manufacturer's Operating Manual to select the best cleaning procedure for a specific sampling task.

b. The particle filter should be cleaned by blowing clean air through the sintered metal frit. Additional cleaning can be conducted via sonication or methanol rinse followed by baking to remove residual organics. Consult the manufacturer's Operating Manual to select the best cleaning procedure for a specific sampling task.

c. The critical orifice and flow controller can be cleaned either by disassembly and rinsing with methanol followed by heat treatment of metallic parts to remove residual organics, or by placing the system in a heat jacket and purging the sampling train with nitrogen. Prior to cleaning the critical orifice and flow controller, consult the manufacturer's Operating Manual for any special cleaning requirements or recommendations for the specific sampler being used.

d. The vacuum gauge should not be rinsed with methanol or heated above 80° C.

e. Before a canister can be reused it must be cleaned in the laboratory and recertified as clean. Follow the instructions provided in the manufacturer's Operating Manual to clean and certify sampling canisters.

FIELD SAMPLING DATA SHEET

Canister Samplers

Date: _____ **Operator:** _____

Start: _____
STOP: _____

	Time of Day	Canister Vacuum
Sampler Location:	Start:	Start:
MFC ID#:	Stop:	Stop:
Canister ID#:		

Comments: _____

	Time of Day	Canister Vacuum
Sampler Location:	Start:	Start:
MFC ID#:	Stop:	Stop:
Canister ID#:		

Comments: _____

	Time of Day	Canister Vacuum
Sampler Location:	Start:	Start:
MFC ID#:	Stop:	Stop:
Canister ID#:		

Comments: _____

	Time of Day	Canister Vacuum
Sampler Location:	Start:	Start:
MFC ID#:	Stop:	Stop:
Canister ID#:		

Comments: _____

	Time of Day	Canister Vacuum
Sampler Location:	Start:	Start:
MFC ID#:	Stop:	Stop:
Canister ID#:		

Comments: _____

Figure 1. Example Field Data Sheet

CHAIN OF CUSTODY RECORD

Project No.		Project Title			Laboratory Address
Field Samplers: (Print and Signature)					
Date	**Time**	**Sample ID**	**Canister ID**	**Can Pressure** initial final	**Remarks/Location**
Relinquished by:		Date/Time	Received by:	Date/Time	Remarks:
Relinquished by:		Date/Time	Received by:	Date/Time	Remarks:
Relinquished by:		Date/Time	Received by:	Date/Time	Remarks:

Figure 2. Example Chain of Custody Form

SAMPLING AND ANALYSIS PROCEDURE FOR MONITORING SVOC IN AMBIENT AIR

1. SCOPE AND APPLICATION.

This document provides procedures for monitoring of semi-volatile organic compounds (SVOCs) in ambient air. This type of monitoring might be needed when a test operation releases hazardous air pollutants (HAPs) that cannot be easily captured at the point of release and the tester wishes to determine the amount of HAPs released. Such releases, referred to as fugitive releases, may contain one or more HAPs that fall into the SVOC category. Because they are not contained within a stack or duct, direct measurement using a stack testing method would not be possible. An alternate approach would be to use a published emission factor, as discussed in a companion document within this appendix, entitled Procedure for Estimating Air Pollutants Using Emission Factors.

The purpose of this procedure is to provide field operators with guidance to ensure that air samples are appropriately collected, stored, shipped, and analyzed. The procedures described in this document are based on the guidelines provided in the Environmental Protection Agency's (EPA) Method TO-13 Guidance Document. HAPS that are SVOCs include: hexachloroethane, nitrobenzene, isophorone, naphthalene, 2,6-dinitrotoluene, acenapthylene, acenapthene, 2,4-dinitrotoluene, dibenzofuran, fluorene, hexachlorobenzene, phenanthrene, anthracene, fluoranthene, pyrene, chrysene. The essential activities and required documentation are highlighted in the Table 1. A project-specific Sampling and Analysis Plan (SAP) should be developed for each test activity.

Table 1. Ambient SVOC Monitoring Activities

Activity	Documentation
Sampler Calibration	Sampler Calibration Form
Sampler Operation	Sample Data Form
Sample Storage and Shipment	Chain-of-Custody Record
Quality Control	Flow Check Form
Quality Assessment	Co-Located Sampler Data Form Quarterly Audit
Maintenance	Maintenance Records

2. REFERENCES.

The following source of information was used to develop this procedure:

U.S. EPA. Method TO13, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.*

3. DEFINITIONS.

a. Blank. A blank is a sampling substrate which is not exposed to ambient air, but which is otherwise handled in the same manner as a sample. The purpose of the blank is to verify that the analytical system is free from contamination.

b. Duplicate (from a co-located sampler). A duplicate is a replicate of the original sample that is analyzed in the same manner as the original sample. The relative percent difference between the results obtained for the original sample and the duplicate is calculated to assess the precision.

c. PUF. Polyurethane foam (a filter used to collect SVOC particles).

d. SVOC. Semi-volatile organic compounds.

e. XAD. A resin used to absorb SVOC compounds.

4. EQUIPMENT.

a. Sampler: An SVOC sampler consists of a sampling head, a venturi meter equipped with a magnehelic gauge to measure air flow, and a vacuum blower. For proper selection of equipment, the tester must refer to EPA equipment specifications provided in the Reference. Sample air flow of 200 liters per minute (lpm) is controlled by adjusting the speed of the vacuum blower using a voltage variator. The sampler is turned on and off using a 7-day timer, and the number of hours that the sampler operates is recorded with an elapsed time meter. Sampler setup is illustrated in Figure 1 and Figure 2. The sampling head is designed to hold a 4-inch diameter quartz-fiber filter (QFF) and a 2.3-inch diameter x 5-inch long glass sample cartridge containing a XAD/PUF sorbent trap that fit snugly into the cartridge. Particulates in the sample stream are collected on the filter, while any vapors that pass through the filter are collected by the XAD/PUF sorbent. A second XAD/PUF sorbent trap in a glass cartridge is provided as a field blank for quality assurance purposes.

b. Other Equipment:

(1) Calibration kit (calibration orifice and water manometer) (see “Reference Document for Various Sampling Equipment Associated with Data Collection Protocols,” a companion document within this appendix, for equipment illustrations).

(2) Thermometer (0° to 100° C)

(3) Screw driver (Phillips and bladed, medium size)

5. SVOC SAMPLING ANALYSIS PROCEDURES.

SVOC sampler calibration, sample collection and handling, calculations, maintenance, analysis, and shipping are discussed in this section.

SVOC Sampler Calibration.

a. The SVOC sampler must be calibrated prior to the start of a sampling program using a calibration kit consisting of a calibration orifice and a water manometer. The samplers must be recalibrated every 30 days (6 sampling days under normal operating conditions). The sampling head unit should contain an empty glass cartridge during the calibration process. If an empty glass cartridge is not available, use the glass cartridge containing the sample XAD/PUF for calibration and make note of this change on the field data calibration form (Figure 4).

b. Measure and record the ambient temperature.

c. Indicate on the field calibration data form whether new brushes have been installed on the blower motor or if a new motor has been installed. Do not proceed with the calibration prior to performing one of these tasks.

d. Calibration setup is shown in Figure 5. Place an empty glass cartridge in the sampling head making sure that there is a gasket at the top and bottom of the cartridge. Screw the filter holder onto the cartridge holder, making sure that the fit is snug, but do not over tighten. Install the sampling head onto the sampler vacuum blower inlet and secure it using the two ring clips at the side of the connector fitting.

e. Place the calibration orifice on the sampling head and secure it using the three wing nuts. Make sure no leaks exist. Note: No filter should be in place at this time.

f. Unwrap the manometer and hang it on the front of the air sampler housing. Open the shutoff valves on the top of the manometer. In the open position, the handles on the ports will face away from the air sampler. When the valves are open, the liquid level in the two sides of the manometer should be equal. If the liquid is not at the same level in both sides, check to make sure that the valves are open.

g. Attach one end of the rubber tubing provided with the calibrator to one of the manometer valves. Blow gently into the open end of the tubing until movement of the water column can be seen. If the blockage is not cleared, repeat on the opposite valve.

h. Adjust the ruler on the manometer so the “0” mark on the scale is level with the top of the liquid. This can be done by sliding the metal scale up or down. If the liquid level is low, add water to th e manometer.

i. Connect the tubing from one of the manometer inlet ports to the side port on the calibration orifice.

j. Turn the sampler on. With a flat blade screwdriver, adjust the sampler airflow using the voltage variator adjustment screw located to the right of the elapsed time indicator. The blower motor speed should increase when turned clockwise and decrease when turned counter-clockwise.

k. Adjust the motor speed until the sampler magnehelic gauge reads 70. Allow the motor to stabilize for approximately 1 minute. If this reading cannot be obtained when the adjustment screw is turned completely clockwise, use the highest flow rate obtained and document the new magnehelic reading by crossing out the 70 on the calibration form and writing in the new reading. Allow the system to run for approximately 1 minute at this speed. Record the difference in the inches of water from the manometer on the field calibration data form. This is achieved by reading the liquid level on each of the two sides of the manometer and documenting them on the field calibration data form.

l. Readjust the voltage variator counter-clockwise until the sampler magnehelic reads 60, then repeat the previous step documenting the manometer readings on the field calibration data form. This step is then repeated for magnehelic readings of 50, 40, 30, and 20. At the completion of the calibration, shut off the sampler.

m. Close the shutoff valves of the manometer by turning them clockwise. Remove the manometer and calibration orifice and return them to the carrying case.

n. Calculate the sampler calibration relationship and set point. Document the sampler's calibration slope, intercept, and correlation coefficient at the bottom of the field calibration data form.

o. The resulting correlation coefficient, R, of this calibration must be greater than or equal to 0.98. If R is less than 0.98 (R^2 less than 0.96), the calibration must be repeated.

p. Record the calculated magnehelic set point that corresponds to an airflow of 0.24 m^3/minute. This magnehelic set point is the setting at which the sampler is to be operated.

SVOC Sampler Operation

Sampler operation consists of an initial setup, sample collection, and sample recovery.

a. Initial Setup.

(1) Record the following information on the first page of the field test data form (Figure 6):

(a) XAD/PUF sample cartridge number.

(b) XAD/PUF blank cartridge number.

(c) Sampler calibration slope, intercept, and set point from the field calibration data form.

(2) Pre-Sampling Blank Collection.

(a) While wearing disposable gloves, remove the foil-wrapped glass cartridge containing the XAD/PUF blank from the glass blank jar. The blank jar is identified by the letter B at the end of the identification number and contains one XAD/PUF. Carefully remove the foil wrapper from the glass cartridge, placing the foil and brown cushion paper back into the jar.

(b) Inspect the inside of the sampling head cartridge holder to ensure that there is a gasket at the bottom. Insert the XAD/PUF blank glass cartridge into the cartridge holder. The glass cartridge is inserted so that the metal support screen is at the bottom. Place the second gasket on top of the PUF blank glass cartridge.

(c) Screw the filter support base onto the cartridge holder. Do not over-tighten.

(d) Place the Teflon® gasket on top of the filter support base. With the use of forceps, carefully place one filter from the foil pack on top of the gasket and place the second gasket on top of the filter. (The filter should be placed with the patterned side down.) Place the filter-retaining ring on top of the filter and gaskets and attach it to the filter support base with the three wing nuts.

(e) Remove the retaining ring and top gasket.

(f) With the forceps remove the filter from the support base, fold it in quarters, and place it into the filter blank jar.

(g) Put the lid back onto the blank jar. NOTE: Only collect one filter for the filter blank at this time.

(h) Remove the XAD/PUF blank glass cartridge from the cartridge holder and place the glass cartridge back into the XAD/PUF blank jar. Place the XAD/PUF blank jar on the shelf of the SVOC sampler with the lid off.

(i) The filter blank jar with the lid on is removed from the site and stored in the same freezer/refrigerator where the samples are stored. The filter blank jar should be brought back to the sampling site when the sample is recovered.

b. Sample Collection.

(1) While wearing disposable gloves, remove the foil-wrapped glass sample cartridge containing the sample XAD/PUF from the glass sample jar. The sample jar is identified by the letter S or SC for the co-located sampler at the end of the identification number and contains a XAD/PUF. Carefully remove the foil wrapper from the glass cartridge, placing the foil and brown cushion paper back into the jar. Replace the lid and retain the sample jar and bubble wrap in a safe place

(2) Inspect the inside of the sampling head cartridge holder to ensure that there is a gasket at the bottom. Insert the glass cartridge into the cartridge holder. The glass cartridge is

inserted so that metal support screen is at the bottom. Place the second gasket on top of the glass cartridge.

(3) Screw the filter support base onto the cartridge holder. Do not over- tighten.

(4) Place the Teflon® gasket on top of the filter support base. With the use of forceps, carefully place one quartz-fiber filter from the foil pack on top of the gasket and place the second gasket on top of the filter. (The filter should be placed with the patterned side down.) Place the filter-retaining ring on the top of the filter and gaskets and attach it to the filter support base with the three wing nuts. Caution: If the sampling head is assembled away from the sampling site, place the metal protective cover plate on the sampling head. The cover plate must be removed prior to the start of sample collection.

(5) Insert the ball fitting at the base of the sampling head into the connecter fitting at the top vacuum blower. Make sure that the sampling head is seated, then secure it using the two ring clips at the side of the connecter fitting.

(6) Start the vacuum blower and allow the sampler to run for at least 1 minute. Adjust the sampler airflow to the calculated magnehelic set point using the voltage variator adjustment. Once the flow is stable, record the magnehelic reading on the field test data form as Initial Reading. Also document the temperature, barometric pressure, time, and date that the reading was taken. Shut the sampler off. Note: If unable to obtain the calculated set point, adjust the voltage variator to get the highest magnehelic reading. If the maximum reading is less than 80 percent of the set point, a new sample XAD/PUF may be required. Do not use the blank XAD/PUF as a sample unless otherwise directed.

(7) Set the 7-day timer to the correct day and time by rotating the timer dial clockwise.

(8) Make sure timer tabs are set to turn the sampler on at midnight in the evening and off at midnight 1 day later.

(9) Record the time and date that the sampler is set to start and the time and date that the sampler is set to stop on the field test data form.

(10) Record the time indicated on the running time meter on the field test data form.

(11) After the sampler setup is completed, replace the lid on the XAD/PUF blank jar. The blank XAD/PUF jar will remain on the sampler shelf with the lid on throughout the duration of the entire sampling event.

c. Sample Recovery.

(1) Record the time indicated on the running time meter on the field test data form as Final Reading. Also document the temperature, barometric pressure, time, and date that the reading was taken.

(2) Restart the sampler motor using the on/off trip switch on the timer. Let the motor run for 1 minute, then record the magnehelic gauge reading on the field data form.

(3) Shut off the motor and remove the sample filter. Be sure to use forceps and to wear disposable gloves while handling the filter and XAD/PUF sample and blank.

(4) Disassemble the sampling head and remove the glass sample cartridge. Fold the sample filter in quarters with the particles on the inside, then place the filter into the top opening of the sample cartridge.

(5) Rewrap the sample cartridge with the aluminum foil previously removed. Carefully place the wrapped sample cartridge into the sample jar along with the paper cushions. Position the paper cushions in the same manner as received. Replace the caps on the PUF and filter sample jars.

(6) Keep the sample and blank jars refrigerated until shipped.

Sample Storage and Shipment

a. All samples should be stored at 4° C (39° F) or below immediately after removal from the sampler. The use of a freezer section of a refrigerator is preferred.

b. Complete all sampling information on enclosed chain-of-custody form (Figure 3) before packing the samples.

c. Rewrap all sample and blank jars in bubble wrap before being packed. Note: Check to make sure that the glass XAD/PUF cartridges have been rewrapped in foil and the brown paper cushions are in place before wrapping in bubble wrap.

d. Place the wrapped sample jars and frozen blue ice in the shipping container. Place the completed and signed chain-of-custody form and calibration and field test data forms into the shipping container. Seal the container with tape and affix the shipper's labeling form to the container. To assure that samples are received cold, do not ship samples on a Friday or the day before a holiday.

SVOC Analysis

The analytical methods used to determine the presence and concentrations of SVOCs are highly dependent on the compounds and/or compound classes to be identified and quantified. In general, any method will involve addition of compound class specific surrogate recovery standards (SRSs; usually C13-labelled compounds), extraction, cleanup to remove co-extractive compounds that might interfere with analyte detection, and analysis by a combined chromatographic and spectroscopic technique. An example method for non-polar to moderate polarity compounds such as PAHs, PCBs, BDEs, organochlorine pesticides, organophosphate pesticides, and phthalate esters would include addition of at least one SRS for each compound class, Soxhlet extraction of the filter and sorbent for 14-16 hrs with 1:1 hexane:acetone or

dichloromethane, concentration to a small volume by Kuderna-Danish or Turbovap evaporation, application of this extract to a conditioned 1 g silica or Florisil solid phase extraction (SPE) cartridge, elution of the SPE cartridge with solvents of increasing polarity, such as hexane, 5% ethyl ether in hexane, 10% ethyl ether in hexane, etc. until all analytes of interest are eluted, final concentration of the eluant to 1 mL, and addition of an appropriate internal standard (IS). Extracts are typically analyzed using multiple ion detection (MID) with gas chromatography/mass spectrometry (GC/MS) using the internal standard method of quantification. Extracts are analyzed together with calibration curve solutions of all analytes and SRSs in varying concentrations, with a constant concentration of the IS. Linear regression analysis is used to generate a calibration curve for each analyte, and detected analytes in the sample extracts are quantified against these calibration curves. Appropriate factors of volume, time, sampling rate, etc. are applied to the ng/mL concentration values measured to convert from the solution concentration to the air level. Due to the unstable nature of many of the compounds which may be of interest, SVOC analysis should be performed as soon as possible upon receipt of the sample at the laboratory.

6. SAMPLING SCHEDULE.

a. Samples collected as part of a long-term monitoring effort are normally collected from midnight to midnight following an EPA-published every sixth-day sampling schedule. When samples are collected as part of a specific study, the schedule will be established to coincide with the operating schedule of the system being tested. Typically, samples will be collected over a period of no less than 1 hour and no more than 24 hours. This will also depend on the purpose of the sampling and the operating schedule of the system being tested. The number of samples must be specified to allow valid statistical evaluation of the results, if possible. Therefore, no less than three samples should be collected, but more will often be required. When uncertainty exists concerning potential background levels of SVOCs in the area of the test, both upwind and downwind samples will need to be collected.

b. Samples collected with the co-located sampler (duplicates) for determination of sampling precision during a long-term sampling program can be collected from midnight to midnight following the twelfth-day sampling schedule. For special studies, duplicates are normally collected at a rate of 10% of the samples.

c. Blanks are normally collected at a rate of 10% of the samples. That is, one blank is collected for every 10 samples taken and includes the duplicates.

7. ROUTINE MAINTENANCE.

Routine maintenance activities, such as sampler cleaning and motor brush replacement, must be done prior to the start of each sampling day. Sampler cleaning consists of wiping the inside and outside of the sampler with a dry cloth or paper towel to remove any surface dirt. During summer months, be careful of spiders or wasps that might nest in the sampler. Consult the manufacturer’s Operating Manual for the procedure for motor brush replacement.

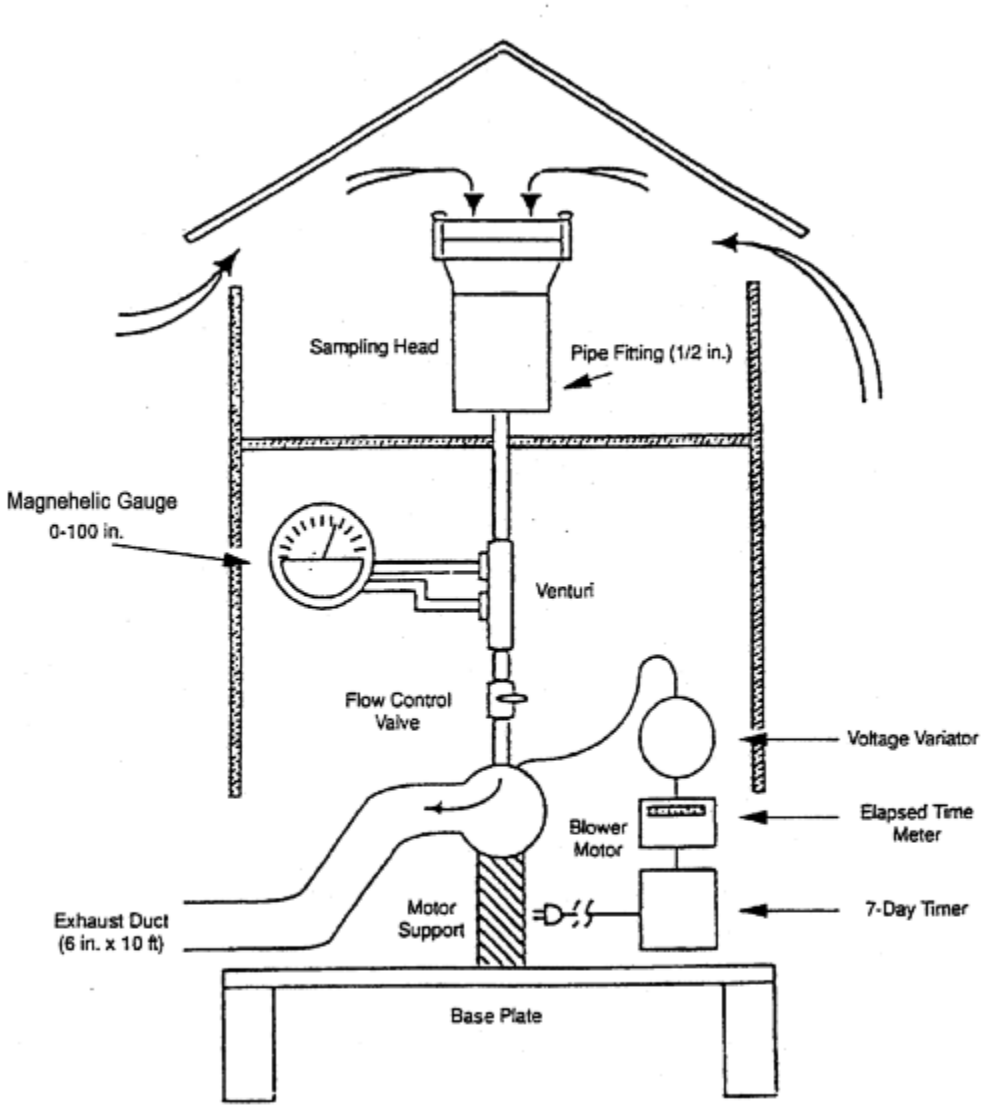


Figure 1. Typical SVOC Sampler Schematic

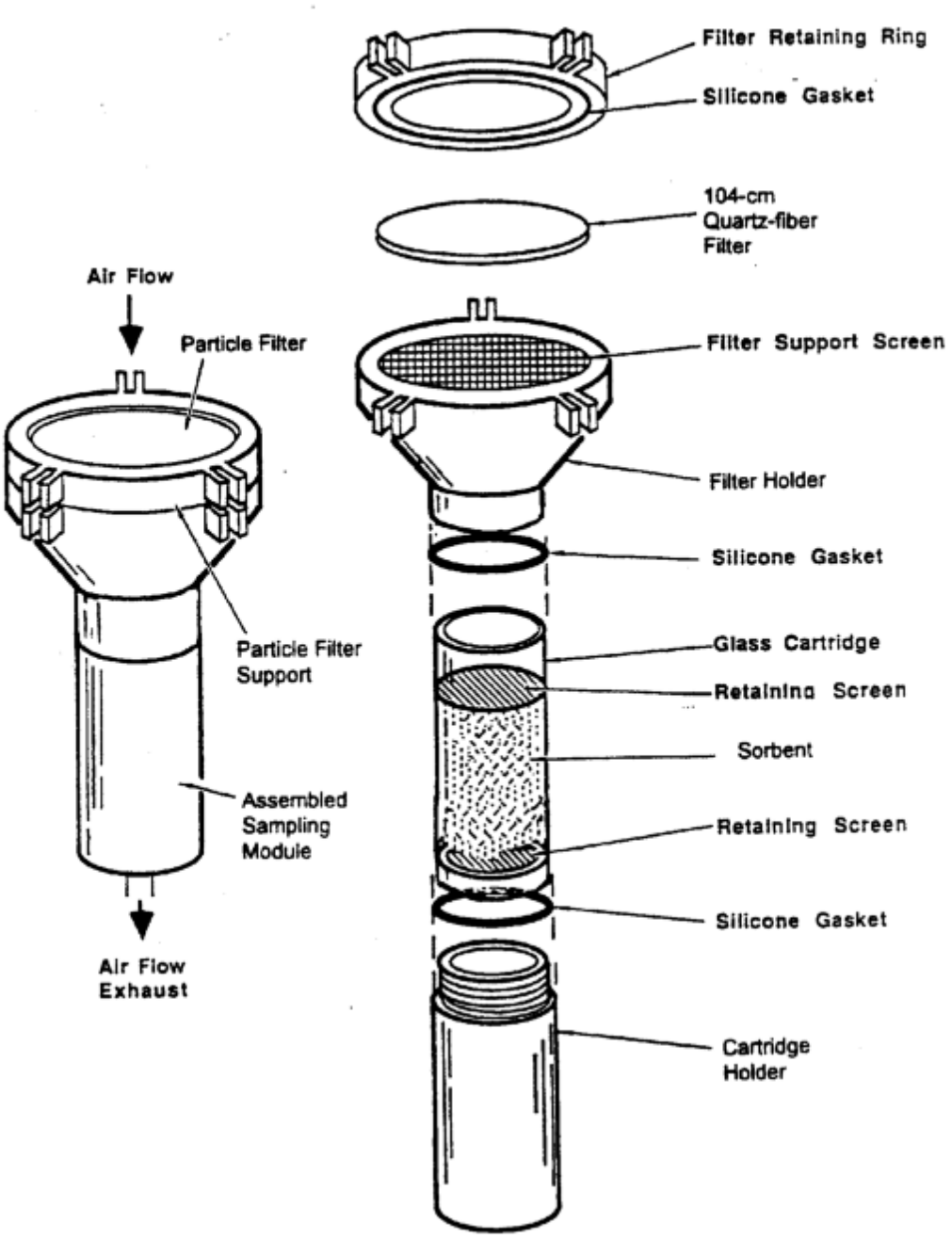


Figure 2. Typical SVOC Sampling Head

CHAIN-OF-CUSTODY FORM

Shipping Information: Laboratory to Sampling Station				
Samples Sent by (Name/Shipping Date):			**Shipping Conditions (e.g., dry ice, blue ice, etc.):**	
Shipping Information (Courier/Shipping #):		**Received by (Receipt Date/Name):**	**Receipt Condition:** **Melted** **Frozen**	
Sample ID	**Quantity**	**Remarks (Initial/Date)**	**Storage Location**	**Storage Temperature**
Shipping Information: Sampling Station to Laboratory				
Samples Sent by (Name/Shipping Date):				
Shipping Information (Courier/Shipping #):		**Received by (Receipt Date/Name):**	**Receipt Condition:** **Melted** **Frozen**	
Battelle Storage Conditions:		**Location:**	**Temp:**	

Figure 3. Example Chain-of-Custody Form

FIELD CALIBRATION DATA FORM

Site Number:_____

Site Location:_____ **Calibration Orifice ID:** _____

Slope _____

Intercept _____

Calibration Date: _____ **Time:** _____

Calibration Ambient Temperature: ___**°F** ___**°C**

Calibration Ambient Barometric Pressure: ___**inch Hg** ____**mm Hg**

New Brushes Installed Yes ___ **No** ___ **Calibrator's Signature**

New Motor Installed Yes ___ **No** ___ _____

Orifice Manometer Water Column, inches			Monitor Magnehelic, inches (Y2)	Calculated Value Orifice Flow, scm (X1)
Left	Right	Total (Y1)		
			70	
			60	
			50	
			40	
			30	
			20	

Sampler Calibration:

Slope _____

Intercept _____

Correlation Coefficient _____

Sampler Magnehelic Set Point _____

at 0.24 m^3/mln

Maintenance: Please record any maintenance that was performed on the sampler (e.g., change brushes in motor, installed new times, etc.) and date.

_____

_____

_____

_____

Figure 4. Example Field Calibration Data Form

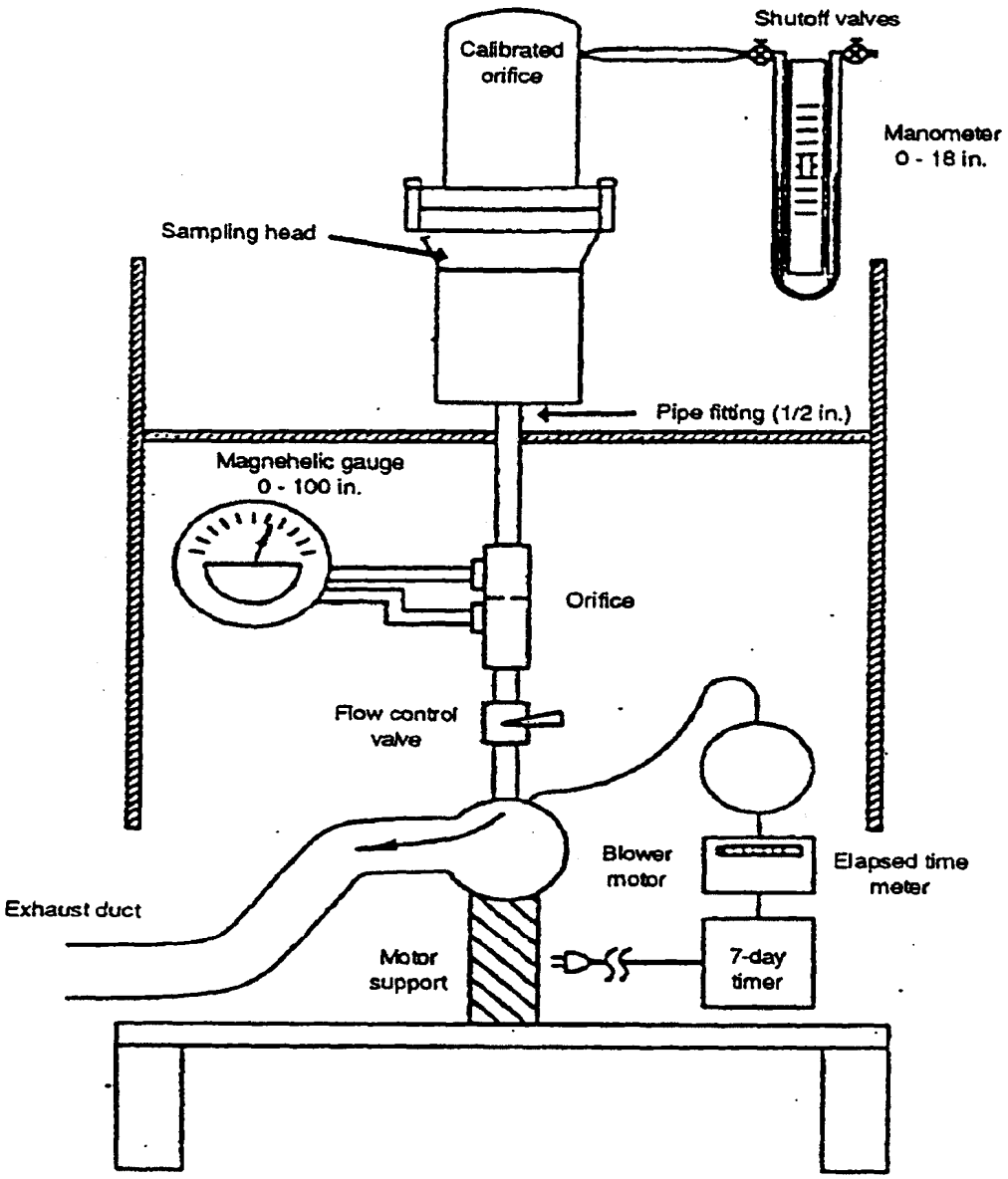


Figure 5. Calibration Setup.

FIELD TEST DATA FORM

Site Location: _____ **Sample Date:** _____

Site Number: _____

PUF Sample Cartridge Number: _____ **PUF Blank Cartridge Number:** _____

Date Installed: _____

Filter Sample Jar Number: _____

Filter Blank Jar Number: _____

Sampler Calibration:

Slope (m_2): _____ **Calculated Magnehelic Set**

Intercept (b_2): _____ **Point:**_____

Timer Set to Start at _____ **Date**

Timer Set to Stop at _____ **Date**

	Date	Time	Temp.	Bp	Magnehelic	Running Time
Initial Reading						
Final Reading						
					Average _____	Lapsed Time _____

(a) Mid-point reading is optional.

Observations: Please record any notable environmental conditions (e.g., dusty, inclement weather) that occur or have occurred before or during sampling period.

_____

_____

_____

Print Name_____ **Signature**_____

Figure 6. Example Field Test Data Form

PROCEDURE FOR ESTIMATING AIR POLLUTANTS USING EMISSION FACTORS

1. SCOPE AND APPLICATION.

Emission factors provide an alternative method of estimating emissions without conducting air quality monitoring with subsequent laboratory analysis of collected samples. A database of factors has been developed by the U.S. Environmental Protection Agency (EPA) Emission Factor and Inventory Group (EFIG). These emission factors are published in the series, *Compilation of Air Pollutant Emission Factors, AP-42*.

An emission factor is a representative value that can be used to estimate the amount of a specific pollutant that is released due to a specific activity. An individual pollutant may have several emission factors corresponding to processes that emit that pollutant. For example, particulate emission factors are available for fugitive dust sources such as paved and unpaved roads, combustion sources, and various material handling operations, among others. In the same way, one process may have separate emission factors for each pollutant that the process releases. For example, fuel combustion emission factors list all pollutants released during combustion, including sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter, carbon monoxide (CO), unburned organic compounds (HCs), and other inert materials such as lead. Emission factors, when combined with additional information such as activity rate of a process and pollution reduction rate information for any pollution control devices installed, are used to determine emissions of a specific pollutant from a given process.

Because of unique source configurations, quantifying emissions from a particular operation may involve very sophisticated and/or expensive testing. Often this degree of sophistication or expense makes it impractical or impossible to monitor for all pollutants of interest which may be generated from a specific process. In addition, emission factors from similar operations provide an alternative emission calculation method in situations when suitable test methods do not exist for a given monitoring purpose.

Emission factors can be used for a variety of purposes ranging from source-specific emission estimates to ambient dispersion modeling. Since emission factors are based on “average” emissions from many similar processes, there is some degree of uncertainty in emission estimates generated when applying a factor to a specific source. In many cases, however, this uncertainty is no more than would be produced by the test method used to quantify a specific source. As a result, however, approximately 50% of sources are expected to have emissions greater than the estimated rate, and 50% of sources are expected to have emissions less than the estimated rate. Some emission factors take into account pollution control equipment which may be installed on a pollution generating process. These factors represent the “typical” level of control generated by the specific pollution control device, not the optimal pollution control from such a device.

Table 1 at the end of this protocol presents a list of typical commodities and the associated AP-42 section(s) that could be used to estimate emissions from each commodity.

2. REFERENCES.

The following source of information was used to develop this protocol:

U.S. EPA AP-42, *Compilation of Air Pollutant Emission Factors.*

All or part of AP-42 can be downloaded either from the *CHIEF (ClearingHouse for Inventories and Emission Factors) BB* (http://www.epa.gov/ttn/chief/software/index.html) or *Fax CHIEF;*,it is available on the *Air CHIEF* CD-ROM (Compact Disc - Read Only Memory) and in conventional paper copy from the Government Printing Office and NTIS, as well as through the Fax CHIEF. The emission factors contained in AP-42 are available in the *Factor Information Retrieval System (FIRE).* Also, software has been developed for emission models such as *TANKS, WATER8,* the *Surface Impoundment Modeling System (SIMS),* and fugitive dust models. This software and the *FIRE* data base are available through the *CHIEF BB*. *FIRE* is also on the *Air CHIEF* compact disc.

3. DEFINITIONS.

Definitions are provided in each individual Chapter of AP-42.

4. EQUIPMENT.

No equipment is needed for application of emission factors.

5. CALCULATION PROCEDURE.

The general equation for emission estimation is:

$$E = A \times EF \times (1-ER/100)$$

where:

E = emissions,
A = activity rate,
EF = emission factor, and
ER = overall emission reduction efficiency, %.

ER is further defined as the product of the control device destruction or removal efficiency and the capture efficiency of the control system.

AP-42 emission factors are available for a number of pollutants and are referenced by the Chemical Abstract Service (CAS) number for the pollutant to eliminate confusion brought on by trade names or chemical synonyms. Some emission factors are defined for groups of pollutants rather than a single compound. Particulate matter emission factors refer to particle emissions without regard to chemical composition. There are various particulate matter designations based on particle size or properties (filterable or condensable particulates). In addition, Appendix B1 and

B2 in AP-42 present particle size distributions for selected source categories and general distributions, respectively.

Volatile organic compounds (VOCs) are a group of pollutants which may or may not have compound-specific emission factors associated with them. AP-42 emission factors with the term "total organic compounds" refer to all VOCs along with other organic compounds which are not defined as VOCs. Emission factors for total nonmethane organic compounds include all organics except for methane. This type of emission factor is usually used when methane is quantified independently of other organic compounds. When possible, hazardous air pollutants (HAPs) are assigned an individual emission factor (many organic compounds are also classified as HAPs).

Sulfur oxides (SO_2, along with other oxidation states) are often grouped together as SO_x with a single emission factor reported for the group. In the same way, nitrogen oxides are often grouped under a single NO_x emission factor.

6. QUALITY ASSURANCE.

Each published emission factor is based on data of differing quality. This discrepancy in the reliability of the data used to generate an emission factor means that emission factors should be used with differing levels of confidence. AP-42 emission factors are assigned one of five ratings (A through E) based on the expected quality of an emission estimate generated using the factor. "A" rated factors have been determined through established test methods over a large, random selection of the industry population with small variation in the results obtained from the tested sources. Lower graded factors are based on either less well established methods, a smaller sample population

7. COMBINING EMISSION FACTORS WITH DISPERSION MODELS.

When the ambient concentration of an air pollutant is desired, the emission rate obtained for a test operation can be combined with an atmospheric dispersion model and appropriate meteorological data to calculate ambient air concentrations. Because many of the empirical data generated for emission factor development were based on ambient measurements, the background information for many emission factors contains source characterization information that may be needed to operate the dispersion model. The user is advised to consult the background information documents for the sources in question if assistance is needed in characterizing the shape or behavior of the pollutant plume for use in a dispersion model.

Table 1. Typical AP-42 Sections for Various Commodities

Commodity	PM	SO2	NOX	CO	HAPs
A. WHEELED, TRACKED, AND SPECIAL PURPOSE VEHICLES					
Wheeled Vehicles	13.2.1/13.2.2				
Tracked Vehicles	13.2.1/13.2.2				
Engines	Volume II	Volume II	Volume II	Volume II	Volume II
B. ARMAMENT AND INDIVIDUAL WEAPONS AND EQUIPMENT					
Small Arms and Infantry Weapons	15.1	15.1	15.1	15.1	15.1
Medium Caliber Weapons	15.2	15.2	15.2	15.2	15.2
Large Caliber Weapons	15.3	15.3	15.3	15.3	15.3
C. AMMUNITION AND EXPLOSIVES					
Ammunition	15.4	15.4	15.4	15.4	15.4
Explosives	15.5/15.9	15.5/15.9	15.5/15.9	15.5/15.9	15.5/15.9
Propelling Charges	15.6	15.6	15.6	15.6	15.6
D. MISSILE and ROCKET SYSTEMS	15.6/15.11	15.6/15.11	15.6/15.11	15.6/15.11	15.6/15.11
E. ELECTRONIC, AVIONIC, AND COMMUNICATIONS EQUIPMENT					
Diesel-powered Generators	3.3/3.4	3.3/3.4	3.3/3.4	3.3/3.4	3.3/3.4
Smoke and Obscurants	15.7	15.7	15.7	15.7	15.7
F. CONSTRUCTION, SUPPORT, AND SERVICE EQUIPMENT					
Conveyor Equipment	13.2.4				
Earth Loading and Earth Moving Equipment	13.2.3				
Paving Equipment	13.2.3				
Road Graders	13.2.3				
Liquid Storage Tanks					5.2
Dust Control Material	Chapter 13				
POL Support Equipment					5.2
Diesel-fuel Fired Equipment	3.3/3.4	3.3/3.4	3.3/3.4	3.3/3.4	3.3/3.4
G. General Supplies and Equipment					
Bakery Equipment	Chapter 9				Chapter 9
Diesel Pumps and Generators	3.3/3.4	3.3/3.4	3.3/3.4	3.3/3.4	3.3/3.4
Boilers and Steam Generators	Chapter 1	Chapter 1	Chapter 1	Chapter 1	Chapter 1
Diving Equipment	Volume II	Volume II	Volume II	Volume II	Volume II

MEASUREMENT PROCEDURES TO DETERMINE NOISE EMISSIONS

1. SCOPE AND APPLICATION.

The objective of this procedure is to outline the equipment and methods used to measure sound levels of developmental and production materiel. This guidance may be modified as required, dependent on site conditions, weather conditions, equipment limitations, or other procedural limitations. In all instances, the ultimate procedures employed should be documented and associated with the final measurements and analysis report.

Examples of the types of developmental testing that may require measurements of noise emissions are included in the References below.

2. REFERENCES.

The following two Test Operations Procedures (TOPs) should be followed to measure noise emissions and airblast overpressure from development testing. They describe the equipment and calibration requirements; measurement techniques; and recommended number, frequency, and location of measurements which should be taken. These TOPs can be viewed and downloaded from the website <https://vdls.atc.army.mil>, under "Reference Library," in the folders, "Test Operating Procedures (TOPS)." Access can also be obtained through the website <www.atc.army.mil>; select "Vision Digital Library."

TOP 1-2-608, Sound Level Measurements

This TOP describes procedures for measuring the sound levels of developmental and production materiel as a means of evaluating personnel safety, recognition, and community annoyance (by a drive-by test). It covers tests for **steady-state noise** from military vehicles and general equipment, and impulse noise from weapon systems and explosive ordnance materiel.

International TOP (ITOP) 4-2-822, FR/GE/US Electronic Measurement of Airblast Overpressure and Impulse Noise

This ITOP describes methods for measuring airblast overpressures resulting from detonation of explosives, firing guns, and **impulse noise** from general equipment. The ITOP describes the direct pressure method and the shock wave velocity method for measuring airblast overpressure. It includes techniques for calibrating transducers used for measuring airblast overpressure, and describes overpressure-measuring devices.

U.S. Army Center for Health Promotion and Preventative Medicine's Operational Noise Program serves as the Center of technical expertise for the Army's operational noise issues using complex noise prediction models for aircraft, small arms, large caliber weapons and demolition activity. The noise models generate noise level contours used to support the Army's sustainability efforts, Army Campaign Plans and encroachment prevention labors. These contours are used to evaluate land use compatibility (both on and off-post), predict complaint

risk, and determine significance of noise levels for National Environmental Policy Act (NEPA) analyses. However, for the noise models to be utilized, the noise models must contain source data for the weapon system being assessed. The techniques referenced above will generate source data in the format necessary for inclusion in the databases of DoD noise models. Once the source data is incorporated into the DoD noise models, the models may be used for required NEPA noise analyses of acquisition and fielding of new Army weapon systems.

SAMPLING AND ANALYSIS PROCEDURE FOR CHARACTERIZING SOLID, LIQUID, AND/OR HAZARDOUS WASTE

1. SCOPE AND APPLICATION.

The objective of this procedure is to outline the equipment and methods used to collect representative samples to characterize solid, liquid and/or hazardous waste and laboratory analysis for potential contaminants. Within this particular protocol, wastes in both the solid state and the liquid state are addressed. This standard may be modified as required, dependent on site conditions, equipment limitations, or other procedural limitations. In all instances, the ultimate procedures employed should be documented and associated with the final sampling and analysis report.

Each site needs to develop a site-specific Sampling and Analysis Plan (SAP) which should include a section on sampling waste. In the SAP, the end use of the data should be outlined so that the correct sampling is performed.

Examples of the types of developmental testing that may require sampling and analysis for characterizing solid, liquid, and/or hazardous waste include:

a. Automotive Testing:

   (1) Wash rack sludge

   (2) Paint stripping residue

   (3) Sand blasting waste

   (4) Used oil and used antifreeze

   (5) Waste cleaning solvent

b. Ballistic Testing:

   (1) Munitions firing residue

   (2) Waste cleaning solvent

   (3) Waste recoil oil

   (4) Unburned propellant

2. REFERENCES.

Several sources were used to develop this procedure, primarily the following:

Code of Federal Regulations, Title 40 Part 261 Section 24.

New Jersey Department of Environmental Protection. 1988. *Field Sampling Procedures Manual*, February.

U.S. EPA. 1986. Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, Region IV, April.
U.S. Environmental Protection Agency (U.S. EPA). 1986. *Test Methods for Evaluating Solids Waste, Physical/Chemical Methods, Updates I, II, IIA, IIB, III, and IIIA, SW846.* NTIS publication No. PB97-156111 or GPO publication no. 955-001-00000-1. Office of Solid Waste. Washington, DC. http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm

U.S. EPA. 1994. "Waste Pile Sampling." Environmental Response Team SOP #2017, Revision #0.0. Edison, NJ. http://www.ert.org/

U.S. EPA. 2002. *RCRA Waste Sampling Draft Technical Guidance, Planning, Implementation, and Assessment.* EPA530-D-02-002. Office of Solid Waste. Washington, DC. http://www.epa.gov/osw

3. EQUIPMENT.

a. Pre-cleaned stainless steel, plastic, or other appropriate homogenization bucket or bowl.

b. Plastic sheet.

c. Spade or shovel.

d. Plastic or stainless steel scoop.

e. Plastic or stainless steel spoons.

f. Disposable bailer (see "Reference Document for Various Sampling Equipment Associated with Environmental Effects Data Collection Protocols," a companion document within this appendix, for equipment illustrations).

g. Nylon cord.

h. Appropriately sized sample jars.

i. Sealable plastic bags.

j. Labels.

k. Chain of Custody records and seals.

l. Coolers.

m. Ice.

n. Decontamination supplies/equipment (refer to Sampling Equipment Decontamination Procedure).

Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is common with implements such as garden trowels.

4. SAMPLE COLLECTION.

Solid Waste.

The actual solid waste sampling procedure is dependant on the end use of the data. Thus, the solid waste sampling procedure is site specific, and the sampling methods will be outlined prior to sampling.

The following outlines the general procedure used to collect solid waste samples:

a. Clear away surface material to a depth of approximately 1 inch where sample is to be collected.

b. Carefully remove the top layer of material to the desired sample depth with a pre-cleaned spade and place on a plastic sheet in preparation of sampling.

c. Using a pre-cleaned stainless steel scoop or equivalent, remove and discard a thin layer of material from the area which came in contact with the spade.

d. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled, sample container with a stainless steel spoon or equivalent, and secure the cap tightly. If analyses other than volatile organic compounds are required, the remainder of the sample (preferably dried) is to be placed into a stainless steel, or other appropriate homogenization container, and mixed thoroughly to obtain a homogenous sample. Then, either place the sample into appropriate, labeled containers and secure the caps tightly, or, if composite samples are to be collected, place a sample from another sampling location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly. At a minimum, each container should be labeled with the date, time of sample collection, a sample identification number, person performing the sample collection, and the sample type.

e. Place the labeled containers into plastic bags and seal. Place the sample into a cooler of ice to maintain a 4°C±2º temperature during the storage and transport of samples to the laboratory.

f. Chain of custody forms must be completed and must accompany the samples to the laboratory.

Liquid Waste.

The following procedure is used to collect liquid waste samples. Cleaning by-products and well purging activities may produce liquid waste, which is temporarily stored in an appropriate container (i.e., 55-gallon drum). Liquid waste needs to be sampled and analyzed prior to disposal. Depending on what type of container is used for the temporary storage of the liquid waste, either a grab method or a bailer method can be used. The grab method is typically used when the container is shallow and easy to collect a sample, while the bailer method is typically used when the container is large, such as a 55-gallon drum. The following summarizes the sampling procedure for both methods.

Grab Method.

a. Label sample containers before sampling event with water-proof ink.

b. Uncap sample bottle and dip into center of container and let sample bottle fill with water.

c. Avoid stirring up any sediment that might be on the bottom on the container.

d. Keep sample free from floating debris.

e. Cap the bottle and wipe any moisture from the outside of the bottle.

f. Place the labeled containers into plastic bags and seal. Place the sample into a cooler of ice to maintain a 4°C±2º temperature during storage and transport of samples to the laboratory.

g. Chain of custody forms must be completed and must accompany the samples to the laboratory.

Bailer Method.

a. Obtain a disposable bailer.

b. Secure bailer with nylon cord.

c. Lower bailer into temporary storage container. Allow sufficient time for the bailer to fill.

d. Retrieve bailer and fill appropriately labeled bottles for analyses being requested.

e. Cap the bottle and wipe any moisture from the outside of the bottle.

f. Place the labeled containers into plastic bags and seal. Place the sample into a cooler of ice to maintain a 4°C±2° temperature during storage and transport of samples to the laboratory.

g. Chain of custody forms must be completed and must accompany the samples to the laboratory.

5. DETERMINATION OF NUMBER OF SAMPLES.

There are several variables involved in solid waste sampling, including the shape and size of the piles, compactness, and structure of the waste material. Shape and size of solid waste material or solid waste piles vary greatly in aerial extent and height. Since state and Federal regulations often require a specified number of samples per volume of solid waste, the size and shape must be used to calculate volume and to plan for the correct number of samples. A sampling plan should be prepared that identifies the waste material, the number of samples to be collected, the sample locations, and the contaminants to be analyzed.

Solid material to be sampled may be homogenous or heterogeneous. Homogenous material resulting from known situations may not require an extensive sampling protocol. Heterogeneous and unknown wastes require more extensive sampling and analysis to ensure the different components (i.e., layers or strata) are being represented.

The term “representative sample” is commonly used to denote a sample that has the properties and composition of the population from which it was collected and in the same proportion as found in the population. This can be misleading unless one is dealing with a homogenous waste from which one sample can represent the whole population. Most often, simple random sampling is the best option to obtain the most “representative sample” from solid waste piles.

A “discrete” sample is defined as a single sample collected at a single location. A “composite” sample is one comprised of a mixture of the target media collected from two or more specific collection points. Some states do not accept composite samples for characterizing contaminated stockpiles. Those states only accept discrete samples because of fear of dilution of non-volatile contaminants. Although the types of environmental testing addressed within this Test Operations Procedure are not being performed primarily for compliance purposes, efforts should be made to follow the spirit of jurisdictional guidance. The Installation Environmental Manager can be of assistance in this regard.

Procedures in EPA Publication SW-846 provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to within a specified confidence level. General guidelines are provided below to generate a minimum number of samples/analyses. Additional sample analyses may be required to meet the confidence levels given in SW846.

a. Stockpiles less than 10 cubic yards: a minimum of two samples should be collected, one from each half of the stockpile. Select sample points randomly within each half.

b. Stockpiles from 10-20 cubic yards: a minimum of three samples should be collected, one from each third of the stockpile. Select sample points randomly within each third.

c. Stockpiles from 20-100 cubic yards: a minimum of four samples should be collected, one from each quarter of the stockpile. Select sample points randomly within each quarter.

d. Stockpiles greater than 100 cubic yards: a minimum of one sample for each 25 cubic yards or portion should be collected. Section the stockpile into 25-cubic yard portions and obtain a minimum of one sample from each 25-cubic yard section. Select the points randomly within each 25-cubic yard portion of the stockpile.

For liquid wastes, the number of samples is determined by the number of temporary storage containers that were used to collect the liquid waste. A sample should be collected from each container so proper disposal can be determined.

6. QUALITY ASSURANCE/QUALITY CONTROL.

There are no specific quality assurance (QA) activities which apply to the implementation of this sampling procedure. However, the following general QA procedures apply:

a. All data must be documented on field data sheets or within site logbooks.

b. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

7. ANALYSIS.

Possible solid and/or liquid waste that might be accumulated during testing includes wastes that are potentially contaminated with toxic organic compounds, heavy metals, and explosive residue. In some cases, it may be necessary to test the solid and/or liquid waste to see if it exhibits the characteristics of toxicity that would classify it as hazardous waste.

Analytical methods can be found in the EPA Publication SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* for each potential contaminant. Table 7-1 presents the analytical method for these analyses.

The Toxicity Characteristic Leaching Procedure (TCLP) is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphase wastes. A waste exhibits the characteristics of toxicity if the leachate extracted from a representative sample of the waste contains any of the contaminants listed in Table 7-2 at the concentration equal to or greater than the respective value given in that table.

Table 7-1. Analytical Methods

Potential Contaminant	Analysis	Analytical Method
Toxic Organic Compounds	Volatile Organic Compounds (VOCs) by Gas Chromatography/Mass Spectrometry (GC/MS)	SW846: 8260B
	Semivolatile Organic Compounds (SVOCs) by GC/MS	SW846: 8270C
Heavy Metals	Metals by Inductively Coupled Plasma-Atomic Emission Spectrometry/ Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique)	SW846: 6010B/7471A
Explosive Residue	Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)	SW846: 8330
Toxicity	Toxicity Characteristic Leaching Procedure (TCLP) for VOCs, SVOCs, metals including mercury, pesticides, and herbicides	SW846: 1311/8260B; 1311/8270C/; 1311/6010B/7471A; 1311/8081A/8082; 1311/8151A

The analytical results will determine if the waste material should be managed as a hazardous or a nonhazardous waste. Waste that exhibits the characteristics of toxicity is assigned an EPA Hazardous Waste Number, specified in Table 7-2, and is considered a hazardous waste that must be handled appropriately with respect to storage, transportation, and treatment or disposal. The Test Officer should coordinate the appropriate disposal method of waste material with the Installation Environmental Manager.

Test method EPA SW846 1311 is the method used to generate the leachate from the waste material. The leachate can be analyzed for the full TCLP suite of contaminants, or if there is sufficient knowledge about the source of the waste, just the contaminants of concern. Table 7-1 presents the analytical methods used for the full suite of contaminants including: VOCs, SVOCs, pesticides, herbicides, and metals. All analytical data should be kept in the project file.

Table 7-2. Maximum Concentration of Contaminants for the Toxicity Characteristic

EPA Hazardous Waste No.	Contaminant	CAS No. [a]	Regulatory Level (mg/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-2	0.5
D006	Cadmium	7440-43-9	1.0
D019	Carbon tetrachloride	56-23-5	0.5
D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	200.0
D024	m-Cresol	108-39-4	200.0
D025	p-Cresol	106-44-5	200.0
D026	Cresol [c]	-	200.0
D016	2,4-Dichlorophenoxyacetic acid	94-75-7	10.0
D027	1,4-Dichlorobenzene	106-46-7	7.5
D028	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethylene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	0.13 [b]
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8	0.008
D032	Hexachlorobenzene	118-74-1	0.13 [b]
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl ethyl ketone	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentrachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	5.0 [b]
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethylene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethylene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl chloride	75-01-4	0.2

a = Chemical abstracts service number
b = Quantitation limit is greater than the calculated regulatory level; therefore, the quantitation limit becomes the regulatory level.
c = If o-, m-, and p- Cresol concentration cannot be differentiated, the total cresol concentration is used.

8. SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE.

All liquid samples should be collected in the appropriate sample bottles, jars, or vials with the cap secured tightly. At a minimum, each sample must be appropriately preserved and should be labeled with the date and time of sample collection, a sample identification number, the person performing the sample collection, and the sample type. Samples should then be sealed in a plastic bag and placed on ice within a cooler immediately after collection. All samples must be kept between 4°±2° C until the laboratory receives the sample cooler. Chain of custody forms must be completed and must accompany the samples to the laboratory.

Chemical preservation of solid wastes is generally not recommended. Refrigeration to 4°C is usually the best approach, supplemented by a minimal holding time prior to extraction or analysis, depending on contaminants of concern. Wide mouth glass containers with Teflon® lined caps are typically used for containerizing waste samples. Details are presented in Tables 8-1 and 8-2.

Table 8-1. Analytical Methods, Container, Sample Volume, Preservative, and Holding Times for Basic Analytes

Analytes	Analytical Method	Container	Sample Volume	Preservative	Holding Time
Solid Waste					
VOCs	SW846: 8260B	1000-mL amber glass jar with Teflon lined lid	100 grams	Cool to 4°C±2º	14 days
SVOCs	SW846: 8270C				14 days until extraction/40 days from extraction to analysis
Metals	SW846: 6010B/7471A				6 months, except mercury, which is 28 days
Explosives	SW846: 8330				14 days until extraction/40 days from extraction to analysis
Liquid Waste					
VOCs	SW846: 8260B	glass vials with plastic Teflon-lined lid w/septa	three 40-mL	HCL to pH<2, Cool to 4°C±2º, No headspace	14 days
SVOCs	SW846: 8270C	1000-mL-amber glass jar with Teflon lined lid	Two 1-L bottles	Cool to 4°C±2º	7 days until extraction/40 days from extraction to analysis
Metals*	SW846: 6010B/7471A	plastic bottle w/polypropylene cap	500 mL	HNO_3 to pH<2	6 months, except mercury, which is 28 days
Explosives	SW846: 8330	1000-mL amber glass jar with Teflon lined lid	1000 mL	Cool to 4°C±2º	7 days until extraction/40 days from extraction to analysis

*metals should be field filtered prior to acidification

Table 8-2. Analytical Methods, Container, Sample Volumes, Preservative, and Holding Times for TCLP Analysis

Analytes	Analytical Method	Container	Sample Volume	Preservative	Holding Times	
					From field collection to TCLP extraction	From extraction to complete analysis
Solid Waste						
VOCs	SW846: 1311/8260B	1000-mL amber glass jar with Teflon lined lid	100 grams	Cool to 4°C±2º	14 days	14 days
SVOCs	SW846: 1311/8270C		200 grams		14 days	40 days
Pesticides	SW846: 1311/8081A/8082		200 grams		14 days	40 days
Herbicides	SW846: 1311/8151A				14 days	40 days
Mercury	SW846: 1311/7471A		200 grams		28 days	28 days
All Other Metals	SW846: 1311/6010B				180 days	180 days
Liquid Waste						
VOCs	SW846: 1311/8260B	1000-mL amber glass jar with Teflon lined lid	1000 mL	Cool to 4°C±2º	14 days	14 days
SVOCs	SW846: 1311/8270C				14 days	40 days
Pesticides	SW846: 1311/8081A/8082				14 days	40 days
Herbicides	SW846: 1311/8151A				14 days	40 days
Mercury	SW846: 1311/7471A				28 days	28 days
All Other Metals	SW846: 1311/6010B				180 days	180 days

MEASUREMENT PROCEDURES FOR ELECTROMAGNETIC EMISSIONS

1. SCOPE AND APPLICATION.

The objective of this procedure is to outline the equipment and methods used for electromagnetic emissions and Electromagnetic Interference (EMI) tests. This standard may be modified as required, dependent on site conditions, equipment limitations, or other procedural limitations. In all instances, the ultimate procedures employed should be documented and associated with the final measurements and analysis report.

Examples of the types of developmental testing that may require measurements of electromagnetic emissions are included in the References below.

2. REFERENCES.

The following two Test Operations Procedures (TOPs) should be followed to perform electromagnetic interference testing. They describe the equipment and calibration requirements; measurement techniques; and recommended number, frequency, and location of measurements that should be taken. These TOPs can be viewed and downloaded from the website <https://vdls.atc.army.mil>, under "Reference Library," in the folders, "Test Operating Procedures (TOPS)." Access can also be obtained through the website <www.atc.army.mil>; select "Vision Digital Library."

TOP 6-2-542, Electromagnetic Interference Tests

This TOP describes a general guideline for electromagnetic interference testing of electronic, electrical, and electromechanical equipment, subsystems, and systems. This TOP is applicable to the measurement of electromagnetic emissions and the identification of susceptibilities for all systems and in all test categories.

TOP 2-2-613, Electromagnetic Interference Testing for Vehicles and Electrical Subsystems – Non-Communication

This TOP describes procedures for conducting Electromagnetic Interference (EMI) tests of Non-Communication Electronic Equipment (NCEE) and Mobile Equipment Power (MEP) sources. This TOP also provides procedures for the measurement of radiated emissions.

SAMPLING EQUIPMENT DECONTAMINATION PROCEDURE

1. SCOPE AND APPLICATION.

Decontamination of sampling equipment refers to the physical and chemical steps taken to remove any chemical or material contamination. Equipment decontamination helps prevent sampling bias. All equipment that comes into contact with the sampled material should be free of components that could influence (contaminate) the true physical or chemical composition of the material. Besides the equipment used to collect the samples, any containers or equipment used for sample compositing or for field subsampling should be free of contamination.

Equipment decontamination also prevents cross-contamination of samples when the equipment is used to collect more than one sample. Dedicated disposable equipment provides the most effective means of avoiding cross-contamination; however, the use of such equipment is not always practical.

Equipment should be decontaminated to a level that meets the minimum requirements for the data collection effort. Decontamination steps should be selected based on the constituents present, their concentration levels in the waste or environmental material sampled, and their potential to introduce bias in the sample analysis results if not removed from the sampling equipment. In addition, items used to clean the equipment, such as brushes, should be free of contamination.

2. REFERENCES.

Several sources were used to develop this procedure, primarily the following:

Code of Federal Regulations, Title 40 Part 261 Section 24.

New Jersey Department of Environmental Protection. 1988. *Field Sampling Procedures Manual*, February.

U.S. EPA. 1986. Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, Region IV, April.

U.S. Environmental Protection Agency (U.S. EPA). 1986. *Test Methods for Evaluating Solids Waste, Physical/Chemical Methods, Updates I, II, IIA, IIB, III, and IIIA, SW846.* NTIS publication No. PB97-156111 or GPO publication no. 955-001-00000-1. Office of Solid Waste. Washington, DC. http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm
U.S. EPA. April 1, 1986. Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, Region IV.

U.S. EPA. 1994. "Waste Pile Sampling." Environmental Response Team SOP #2017, Revision #0.0. Edison, NJ. http://www.ert.org/

3. EQUIPMENT.

a. Soap (phosphate-free laboratory detergent such as Liquinox®).

b. Solvent (pesticide-grade isopropanol, acetone, methanol, or hexane).

c. Acid rinse (10% nitric or hydrochloric acid solution -- made from reagent grade nitric or hydrochloric acid and deionized water).

d. Tap water (from any municipal water treatment system).

e. Spray bottle.

f. Organic/analyte free water (deionized or distilled water).

g. Brushes.

h. Aluminum foil.

i. Plastic sheeting.

4. DECONTAMINATION PROCEDURE.

Clean the field equipment prior to field use. Depending on site conditions, it may be appropriate to contain wastewater from decontamination. If this is appropriate, the wastewater should be collected and stored for appropriate treatment or disposal. The handling of the wastewater should be addressed in the project-specific sampling plan.

The following procedure is for decontaminating a sampling device to be used for collecting a sample for organic or inorganic constituent analyses.

a. At a minimum, sample-contacting equipment should be washed with a detergent solution and rinsed with organic/analyte free water.

b. For projects that require more rigorous decontamination procedures, such as when looking for trace amounts of contaminants (i.e., water samples when results need to be compared to drinking water standards) or when first sampling at a contaminated area followed by sampling at a possibly clean area, the procedures outlined below should be followed.

(1) Clean the device with tap water and soap, using a brush if necessary to remove particulate matter and surface film. For equipment that, because of internal mechanism or tubing, can not be adequately cleaned with a brush, the decontamination solutions should be circulated through the equipment.

(2) Rinse thoroughly with tap water.

(3) Rinse thoroughly with analyte- or organic-free water.

(4) Rinse thoroughly with acid rinse (may be deleted if metals are not a concern).

(5) Rinse thoroughly with analyte- or organic-free water.

(6) Rinse thoroughly with solvent (may be deleted if organics are not a concern). Do not solvent-rinse PVC or plastic items.

(7) Rinse thoroughly with organic/analyte free water and allow equipment to dry completely.

(8) Remove the equipment from the decontamination area. Equipment stored overnight should be wrapped in aluminum foil and covered with clean, unused plastic.

5. QUALITY ASSURANCE/QUALITY CONTROL.

It is important to document the effectiveness of the decontamination procedure. There should be provisions within the project-specific sampling and analysis plan for the collection of samples to evaluate the completeness of a specific decontamination procedure. These could include:

a. Equipment rinsate – collection of the final rinse after the equipment decontamination.

b. Source water blank – collection of the organic/analyte free water used for the final rinse to confirm that the source water is free of target analytes.

REFERENCE DOCUMENT FOR VARIOUS SAMPLING EQUIPMENT ASSOCIATED WITH ENVIRONMENTAL EFFECTS DATA COLLECTION PROTOCOLS

1. INTRODUCTION.

This reference document contains images of equipment associated with the following data collection protocols contained in Appendix B of the Environmental Effects Data Collection Test Operations Procedure:

a. Sampling and Analysis Procedure for Aqueous Media.

b. Sampling and Analysis Procedure for Characterizing Soil Contaminant Chemistry.

c. Sampling and Analysis Procedure for Characterizing Solid, Liquid, and/or Hazardous Waste.

d. Sampling and Analysis Procedure for Monitoring $PM_{2.5}$ in Ambient Air.

e. Sampling and Analysis Procedure for Monitoring PM_{10} and Metals in Ambient Air.

f. Sampling and Analysis Procedure for Monitoring VOCs in Ambient Air.

g. Sampling and Analysis Procedure for Monitoring SVOCs in Ambient Air.

h. Measurement Procedures for Determining Soil Compaction.

2. AQUEOUS MEDIA.

The following equipment is associated with the collection of water samples (surface water, ground water, and wastewater):

a. Disposable Bailer.



b. Submersible Pumps

(1) Grundfos Pump



(2) Bladder Pump



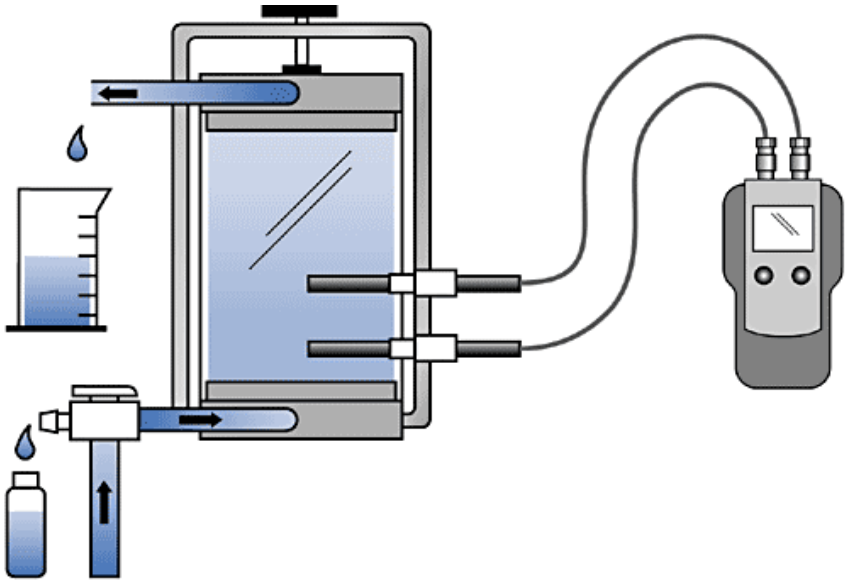
c. Water Level Monitoring Device/ Interface Probe.



d. Field Parameter Monitoring Instrument.



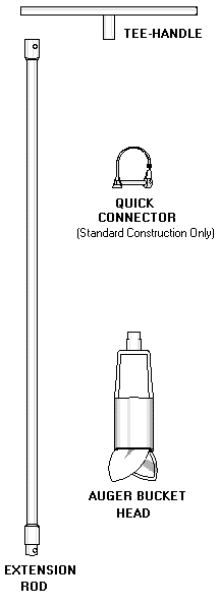
e. Flow Cell.



3. SOIL MEDIA.

The following equipment is associated with the collection of soil samples (surface soil, subsurface soil, waste soil):

a. Bucket Auger.
b. Extension Rods.
c. T-Handle.



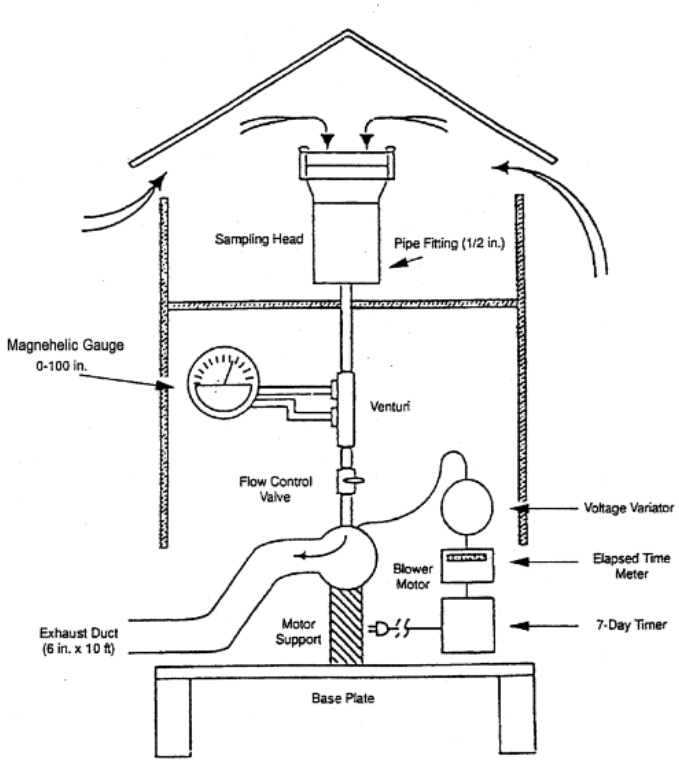
d. Plug Extractor.



4. AMBIENT AIR.

The following equipment is associated with the collection of ambient air samples:

a. Typical Sampler (VOC, SVOC, EPA equivalent Federal reference method PM_{10}, $PM_{2.5}$):

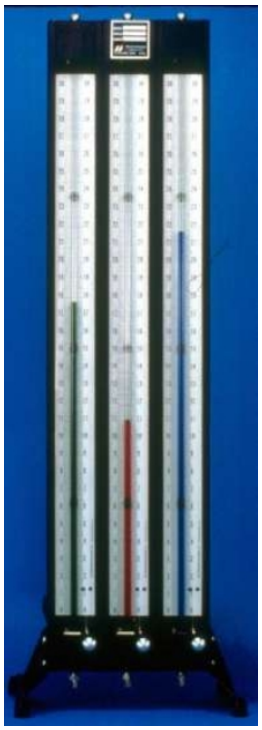


b. Air Flow Calibrators.

(1) N.I.S.T. Traceable Flow Calibrator.



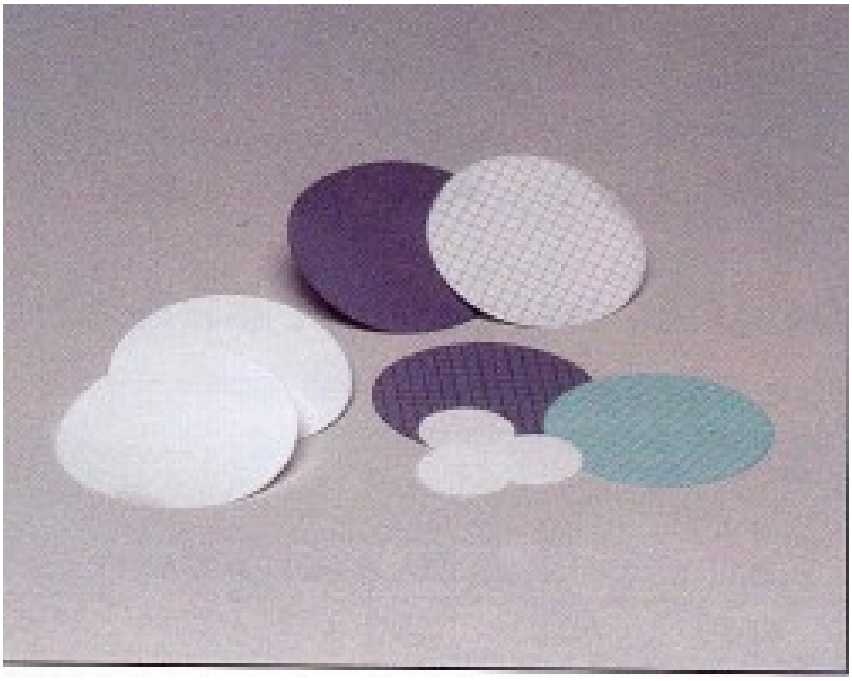
(2) Water Manometer.



c. Vacuum/Pressure Gauge.



d. Fiber Filter.



5. SOIL COMPACTION.

The following equipment is associated with soil compaction tests:

a. Nuclear Density Gauge.



b. Electric Density Gauge.



6. REFERENCES.

EPA Method TO13, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*.

APPENDIX C. ABBREVIATIONS

ASA (ALT)	=	Assistant Secretary of the Army (Acquisition, Logistics, and Technology)
CAA	=	1990 Clean Air Act
CEQ	=	Council on Environmental Quality
CFC	=	Chlorofluorocarbons
CO	=	carbon monoxide
CONUS	=	continental United States
DASA (ESOH)	=	Deputy Assistant Secretary of the Army for Environment, Safety, and Occupational Health
DTC	=	Developmental Test Command
ENMP	=	Environmental Noise Management Plan
EPA	=	U.S. Environmental Protection Agency
ESO	=	Environmental Support Office
FOTW	=	Federally Owned Treatment Works
HAPs	=	hazardous air pollutants
HCFC	=	Hydrochlorofluodcarbons
HMMP	=	Installation Hazardous Material Management Program
ICRMP	=	Integrated Cultural Resources Management Plan
INRMP	=	Integrated Natural Resources Management Plans
ISWMP	=	Integrated Solid Waste Management Plans
NAAQS	=	National Ambient Air Quality Standards
NEPA	=	National Environmental Policy Act
NO_2	=	nitrogen dioxide
NPDES	=	National Pollutant Discharge Elimination System
O_3	=	ozone
OCONUS	=	outside the continental United States
Pb	=	lead
PEO	=	Program Executive Office
PM	=	Program Manager
POL	=	Petroleum, Oils, and Lubricants
POTW	=	Publicly Owned Treatment Works
RCRA	=	Resource Conservation and Recovery Act
SO_2	=	sulfur dioxide
SVOC	=	semi-volatile compounds
T&E	=	test and evaluation
TCLP	=	Toxic Characteristic Leaching Procedure
TOP	=	Test Operations Procedure
USAEC	=	U.S. Army Environmental Command
VOC	=	volatile organic compounds

APPENDIX D. REFERENCES

1. Army Regulation 73-1, Test and Evaluation Policy, 10 November 2004.

2. Army Regulation, 200-2 (32 CFR 651/AR 200-2), Environmental Analysis of Army Actions, July 2002.

3. NEPA (Title 42 of the United States Code in Sections 4321-4347, generally referenced as 42 U.S.C. §§ 4321- 4347.

4. Council on Environmental Quality (CEQ) regulations codified in Title 40 of the Code of Federal Regulations in Parts 1500 through 1508.

5. Clean Water Act, as amended. 1977. Public Law 95-217. 33 U.S.C. 1251 et seq.

6. Watershed Protection and Flood Prevention Act. 1954. 16 U.S.C. §§ 1001 et seq; 33 U.S.C. § 701b.

7. North American Wetlands Conservation Act (103 Stat. 1968; 16 U.S.C. 4401-4412), Public Law 101-233, 13 December 1989.

8. Executive Order 11988. Floodplain Management, 24 42 Federal Register 26971, May 1977.

9. Executive Order 11990. Protection of Wetlands, 42 Federal Register 26961, 24 May l977.

10. Clean Air Act. 42 U.S.C. §§ 7401-7671g.

11. U.S. Environmental Protection Agency website. www.epa.gov.

12. Army Regulation, 200-1 (32 CFR 650/AR 200-1), Environmental Protection and Enhancement, January 2002.

13. Safe Drinking Water Act. 1974. 42 U.S.C.§ 300f et seq, 6939b; 15 U.S.C. § 1261 et seq.

Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Test Business Management Division (TEDT-TMB), US Army Developmental Test Command, 314 Longs Corner Road Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: US Army Aberdeen Test Center, APG, MD 21005-5059. Additional copies are can be requested through the following website: http://itops.dtc.army.mil/RequestForDocuments.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.