upon chemical analysis of the appropriate tissues or organs (such as leaves, lungs, stomach, intestine, or their contents) that were directly exposed to the oil or hazardous substance.

(4) If the oil or hazardous substance was assimilated, the areal dispersion may be determined based upon one or more of the following alternative procedures:

(i) If direct exposure to the biological resource has occurred, chemical analysis of the organisms that have been exposed may be performed.

(ii) If indirect exposure to the biological resource has occurred, either chemical analysis of free-ranging biological resources using one or more indicator species as appropriate, or laboratory analysis of one or more in situ placed indicator species as appropriate may be performed.

(A) *Indicator species,* as used in this section, means a species of organism selected consistent with the following factors to represent a trophic level of a food chain:

(*1*) General availability of resident organisms in the assessment area;

(*2*) Potential for exposure to the oil or hazardous substance through ingestion, assimilation, or inhalation;

(*3*) Occurrence of the substance in a chemical form that can be assimilated by the organism;

(*4*) Capacity of the organism to assimilate, bioconcentrate, bioaccumulate, and/or biomagnify the substance;

(*5*) Capacity of the organism to metabolize the substance to a form that cannot be detected through available chemical analytical procedures; and

(*6*) Extent to which the organism is representative of the food chain of concern.

(B) Collection of the indicator species should be limited to the number necessary to define the areal dispersion and to provide sufficient sample volume for chemical analysis.

(C) When in situ procedures are used, indicator species that behave comparably to organisms existing under free-ranging conditions shall be collected. The indicator species used in this procedure shall be obtained either from a control area selected consistent with provisions of § 11.72 of this part or obtained from a suitable supply of wild-strain organisms reared in a laboratory setting. Appropriate chemical analysis shall be performed on a representative subsample of the indicator species before in situ placement.

(iii) In situ placement procedures shall be used where the collection of samples would be inconsistent with the provisions of § 11.17(b) of this part.

(5) Sampling sites and the number of replicate samples to be collected at the sampling sites shall be consistent with the quality assurance provisions of the Assessment Plan.

(6) Chemical analysis of biological resource samples collected for the purpose of this section shall be conducted in accordance with the quality assurance provisions of the Assessment Plan.

§ 11.64 Injury determination phase—testing and sampling methods.

(a) *General.* (1) The guidance provided in this section shall be followed for selecting methodologies for the Injury Determination phase.

(2) Before selecting methodologies, the objectives to be achieved by testing and sampling shall be defined. These objectives shall be listed in the Assessment Plan. In developing these objectives, the availability of information from response actions relating to the discharge or release, the resource exposed, the characteristics of the oil or hazardous substance, potential physical, chemical, or biological reactions initiated by the discharge or release, the potential injury, the pathway of exposure, and the potential for injury resulting from that pathway should be considered.

(3) When selecting testing and sampling methods, only those methodologies shall be selected:

(i) For which performance under conditions similar to those anticipated at the assessment area has been demonstrated;

(ii) That ensure testing and sampling performance will be cost-effective;

(iii) That will produce data that were previously unavailable and that are needed to make the determinations; and

(iv) That will provide data consistent with the data requirements of the Quantification phase.

(4) Specific factors that should be considered when selecting testing and sampling methodologies to meet the requirements in paragraph (a)(3) of this section include:

(i) Physical state of the discharged or released substance;

(ii) The duration, frequency, season, and time of the discharge or release;

(iii) The range of concentrations of chemical compounds to be analyzed in different media;

(iv) Detection limits, accuracy, precision, interferences, and time required to perform alternative methods;

(v) Potential safety hazards to obtain and test samples;

(vi) Costs of alternative methods; and

(vii) Specific guidance provided in paragraphs (b), (c), (d), (e), and (f) of this section.

(b) *Surface water resources.* (1) Testing and sampling for injury to surface water resources shall be performed using methodologies described in the Assessment Plan.

(2) Chemical analyses performed to meet the requirements of the Injury Determination phase for surface water resources shall be conducted in accordance with methods that are generally accepted or have been scientifically verified and documented.

(3) The term ''water sample'' shall denote a volume of water collected and preserved to represent the bulk water and any dissolved or suspended materials or microorganisms occurring in the surface water resource.

(4) Sampling of water and sediments from surface water resources shall be conducted according to generally accepted methods.

(5) Measurement of the hydrologic properties of the resource shall be conducted according to generally accepted methods.

(6)(i) Interpretation of surface-water flow or estimation of transport of oil or hazardous substance in surface water through the use of models shall be based on hydrologic literature and current practice.

(ii) The applicability of models used during the assessment should be demonstrated, including citation or description of the following:

(A) Physical, chemical, and biological processes simulated by the model;

(B) Mathematical or statistical methods used in the model; and

(C) Model computer code (if any), test cases proving the code works, and any alteration of previously documented code made to adapt the model to the assessment area.

(iii) The validity of models used during the assessment should be established, including a description of the following:

(A) Hydraulic geometry, physiographic features, and flow characteristics of modeled reaches or areas;

(B) Sources of hydrological, chemical, biological, and meteorological data used in the model;

(C) Lists or maps of data used to describe initial conditions;

(D) Time increments or time periods modeled;

(E) Comparison of predicted fluxes of water and solutes with measured fluxes;

(F) Calibration-verification procedures and results; and

(G) Types and results of sensitivity analyses made.

(c) *Ground water resources.* (1) Testing and sampling for injury to ground water resources shall be performed using methodologies described in the Assessment Plan.

(2) Chemical analyses performed to meet the requirements of the Injury Determination phase for ground water resources shall be conducted in accordance with methods that are generally accepted or have been scientifically verified and documented.

(3)(i) The term ''water sample'' shall denote a volume of water collected and preserved to represent the bulk water and any dissolved or suspended materials or microorganisms occurring in the ground water resource.

(ii) The source of ground water samples may be from natural springs, in seeps, or from wells constructed according to generally accepted methods.

(4) Sampling of ground water or of geologic materials through which the ground water migrates shall be conducted according to generally accepted methods.

(5) Measurement of the geohydrologic properties of the resource shall be conducted according to generally accepted practice.

(6) Description of lithologies, minerals, cements, or other sedimentary characteristics of the ground water resource should follow generally accepted methods.

(7) Interpretation of the geohydrological setting, including identifying geologic layers comprising aquifers and any confining units, shall be based on geohydrologic and geologic literature and generally accepted practice.

(8)(i) Interpretation of ground-water flow systems or estimation of transport of oil or hazardous substances in ground water through the use of models shall be based on geohydrologic literature and current practice.

(ii) The applicability of models used during the assessment should be demonstrated, including citation or description of the following.

(A) Physical, chemical, and biological processes simulated by the model;

(B) Mathematical or statistical methods used in the model; and

(C) Model computer code (if any), test cases proving the code works, and any alteration of previously documented code made to adapt the model to the assessment area.

(iii) The validity of models used during the assessment should be established, including a description of the following:

(A) Model boundary conditions and stresses simulated;

(B) How the model approximates the geohydrological framework of the assessment area;

(C) Grid size and geometry;

(D) Sources of geohydrological, chemical, and biological data used in the model;

(E) Lists or maps of data used to describe initial conditions;

(F) Time increments or time periods modeled;

(G) Comparison of predicted fluxes of water and solutes with measured fluxes;

(H) Calibration-verification procedures and results; and

(I) Type and results of sensitivity analyses made.

(d) *Air resources.* (1) Testing and sampling for injury to air resources shall be performed using methodologies that meet the selection and documentation requirements in this paragraph. Methods identified in this section and methods meeting the selection requirements identified in this section shall be used to detect, identify, and determine the presence and source of emissions of oil or a hazardous substance, and the duration, frequency, period of exposure (day, night, seasonal, etc.), and levels of exposure.

(2) The sampling and analysis methods identified in this paragraph are the primary methods to be used for determining injury to the air resource. Air modeling methods may be used for injury determination only when air sampling and analysis methods are not available or the discharge or release occurred with no opportunity to monitor or sample the emissions.

(3)(i) Methods developed, evaluated, approved, and published by the U.S. Environmental Protection Agency may be used for sampling and analysis to determine injury to the air resource.

(ii) Methods selected for air sampling and analysis may include those methods that have been formally reviewed, evaluated, and published by the following government and professional organizations: the National Institute for Occupational Safety and Health, the American Society for Testing and Materials, and the American Public Health Association.

(iii) Methods selected for air sampling and analysis shall be methods that are documented for each of the following:

(A) The range of field conditions for which the methods are applicable;

(B) Quality assurance and quality control requirements necessary to achieve the data quality the methods are capable of producing;

(C) Operational costs of conducting the methods; and

(D) Time required to conduct the methods.

(iv) The determination of concentrations in excess of emission standards for hazardous air pollutants established under section 112 of the Clean Air Act, 42 U.S.C. 7412, shall be conducted in accordance with the primary methods or alternative methods as required in ''National Emission Standards for Hazardous Air Pollutants: Source Test and Analytical Methods,''

40 CFR 61.14, and as may be applicable to the determination of injury to air resources.

(4) In selecting methods for testing and sampling for injury to air resources, the following performance factors of the sampling and analysis methods and the influencing characteristics of the assessment area and the general vicinity shall be considered:

(i) Method detection limits, accuracy, precision, specificity, interferences, and analysis of time and cost;

(ii) Sampling area locations and frequency, duration of sampling, and chemical stability of emissions; and

(iii) Meteorological parameters that influence the transport of emissions and the spatial and temporal variation in concentration.

(e) *Geologic resources.* (1) Testing and sampling for injury to geologic resources shall be performed using methodologies described in this paragraph.

(2) Testing pH level in soils shall be performed using standard pH measurement techniques, taking into account the nature and type of organic and inorganic constituents that contribute to soil acidity; the soil/solution ratio; salt or electrolytic content; the carbon dioxide content; and errors associated with equipment standardization and liquid junction potentials.

(3) Salinity shall be tested by measuring the electrical conductivity of the saturation extraction of the soil.

(4) Soil microbial respiration shall be tested by measuring uptake of oxygen or release of carbon dioxide by bacterial, fungal, algal, and protozoan cells in the soil. These tests may be made in the laboratory or in situ.

(5) Microbial populations shall be tested using microscopic counting, soil fumigation, glucose response, or adenylate energy charge.

(6) Phytotoxicity shall be tested by conducting tests of seed germination, seedling growth, root elongation, plant uptake, or soil-core microcosms.

(7) Injury to mineral resources shall be determined by describing restrictions on access, development, or use of the resource as a result of the oil or hazardous substance. Any appropriate health and safety considerations that led to the restrictions should be documented.

(f) *Biological resources.* (1) Testing and sampling for injury to biological resources shall be performed using methodologies provided for in this paragraph.

(2)(i) Testing may be performed for biological responses that have satisfied the acceptance criteria of §11.62(f)(2) of this part.

(ii) Testing methodologies that have been documented and are applicable to the biological response being tested may be used.

(3) Injury to biological resources, as such injury is defined in §11.62(f)(1)(ii) of this part, may be determined by using methods acceptable to or used by the Food and Drug Administration or the appropriate State health agency in determining the levels defined in that paragraph.

§11.70 Quantification phase—general.

(a) *Requirement.* (1) Upon completing the Injury Determination phase, the authorized official shall quantify for each resource determined to be injured and for which damages will be sought, the effect of the discharge or release in terms of the reduction from the baseline condition in the quantity and quality of services, as the phrase is used in this part, provided by the injured resource using the guidance provided in the Quantification phase of this part.

(2) The Quantification phase consists of §11.70—general; §11.71—service reduction quantification; §11.72—baseline services determination; and §11.73—resource recoverability analysis, of this part.

(b) *Purpose.* The purpose of the Quantification phase is to quantify the effects of the discharge or release on the injured natural resources for use in determining the appropriate amount of compensation.

(c) *Steps in the Quantification phase.* In the Quantification phase, the extent of the injury shall be measured, the baseline condition of the injured resource shall be estimated, the baseline services shall be identified, the recoverability of the injured resource shall be determined, and the reduction in services that resulted from the discharge or release shall be estimated.