Designation: E1689 − 95 (Reapproved 2014)

Standard Guide for Developing Conceptual Site Models for Contaminated Sites[1]

This standard is issued under the fixed designation E1689; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide is intended to assist in the development of conceptual site models to be used for the following: (*1*) integration of technical information from various sources, (*2*) support the selection of sample locations for establishing background concentrations of substances, (*3*) identify data needs and guide data collection activities, and (*4*) evaluate the risk to human health and the environment posed by a contaminated site. This guide generally describes the major components of conceptual site models, provides an outline for developing models, and presents an example of the parts of a model. This guide does not provide a detailed description of a site-specific conceptual site model because conditions at contaminated sites can vary greatly from one site to another.

1.2 The values stated in either inch-pound or SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 This guide is intended to apply to any contaminated site.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

2.2 *EPA Documents:*[3]

Guidance for Data Useability in Risk Assessment (Part A) Final, Publication 9285.7-09A, PB 92-963356, April 1992

Guidance for Data Useability in Risk Assessment (Part B), OSWER Directive 9285.7-09B, May 1992

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, OSWER Directive 9355.3-01, October 1988

3. Terminology

3.1 *Definitions:*

3.1.1 *background concentration, n*—the concentration of a substance in ground water, surface water, air, sediment, or soil at a source(s) or nearby reference location, and not attributable to the source(s) under consideration. Background samples may be contaminated, either by naturally occurring or manmade sources, but not by the source(s) in question.

3.1.2 *conceptual site model, n*—for the purpose of this guide, a written or pictorial representation of an environmental system and the biological, physical, and chemical processes that determine the transport of contaminants from sources through environmental media to environmental receptors within the system.

3.1.3 *contaminant, n*—any substance, including any radiological material, that is potentially hazardous to human health or the environment and is present in the environment at concentrations above its background concentration.

3.1.4 *contaminant release, n*—movement of a substance from a source into an environmental medium, for example, a leak, spill, volatilization, runoff, fugitive dust emission, or leaching.

3.1.5 *environmental receptor, n*—humans and other living organisms potentially exposed to and adversely affected by contaminants because they are present at the source(s) or along contaminant migration pathways.

3.1.6 *environmental transport, n*—movement of a chemical or physical agent in the environment after it has been released from a source to an environmental medium, for example, movement through the air, surface water, ground water, soil, sediment, or food chain.

3.1.7 *exposure route, n*—the process by which a contaminant or physical agent in the environment comes into direct contact with the body, tissues, or exchange boundaries of an environmental receptor organism, for example, ingestion, inhalation, dermal absorption, root uptake, and gill uptake.

---

[1] This guide is under the jurisdiction of ASTM Committee E50 on Environmental Assessment, Risk Management and Corrective Action and is the direct responsibility of Subcommittee E50.05 on Environmental Risk Management.

Current edition approved Jan. 1, 2014. Published May 2014. Originally approved in 1995. Last previous edition approved in 2008 as E1689–95(2008). DOI: 10.1520/E1689-95R14.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

3.1.8 *migration pathway, n*—the course through which contaminants in the environment may move away from the source(s) to potential environmental receptors.

3.1.9 *source, n*—the location from which a contaminant(s) has entered or may enter a physical system. A primary source, such as a location at which drums have leaked onto surface soils, may produce a secondary source, such as contaminated soils; sources may hence be primary or secondary.

4. Summary of Guide

4.1 The six basic activities associated with developing a conceptual site model (not necessarily listed in the order in which they should be addressed) are as follows: (*1*) identification of potential contaminants; (*2*) identification and characterization of the source(s) of contaminants; (*3*) delineation of potential migration pathways through environmental media, such as ground water, surface water, soils, sediment, biota, and air; (*4*) establishment of background areas of contaminants for each contaminated medium; (*5*) identification and characterization of potential environmental receptors (human and ecological); and (*6*) determination of the limits of the study area or system boundaries.

4.2 The complexity of a conceptual site model should be consistent with the complexity of the site and available data. The development of a conceptual site model will usually be iterative. Model development should start as early in the site investigation process as possible. The model should be refined and revised throughout the site investigation process to incorporate additional site data. The final model should contain sufficient information to support the development of current and future exposure scenarios.

4.3 The concerns of ecological risk assessment are different from those of human-health risk assessment, for example, important migration pathways, exposure routes, and environmental receptors. These differences are usually sufficient to warrant separate descriptions and representations of the conceptual site model in the human health and ecological risk assessment reports. There will be elements of the conceptual site model that are common to both representations, however, and the risk assessors should develop these together to ensure consistency.

5. Significance and Use

5.1 The information gained through the site investigation is used to characterize the physical, biological, and chemical systems existing at a site. The processes that determine contaminant releases, contaminant migration, and environmental receptor exposure to contaminants are described and integrated in a conceptual site model.

5.2 Development of this model is critical for determining potential exposure routes (for example, ingestion and inhalation) and for suggesting possible effects of the contaminants on human health and the environment. Uncertainties associated with the conceptual site model need to be identified clearly so that efforts can be taken to reduce these uncertainties to acceptable levels. Early versions of the model, which are usually based on limited or incomplete information, will identify and emphasize the uncertainties that should be addressed.

5.3 The conceptual site model is used to integrate all site information and to determine whether information including data are missing (data gaps) and whether additional information needs to be collected at the site. The model is used furthermore to facilitate the selection of remedial alternatives and to evaluate the effectiveness of remedial actions in reducing the exposure of environmental receptors to contaminants.

5.4 This guide is not meant to replace regulatory requirements for conducting environmental site characterizations at contaminated (including radiologically contaminated) sites. It should supplement existing guidance and promote a uniform approach to developing conceptual site models.

5.5 This guide is meant to be used by all those involved in developing conceptual site models. This should ideally include representatives from all phases of the investigative and remedial process, for example, preliminary assessment, remedial investigation, baseline human health and ecological risk assessments, and feasibility study. The conceptual site model should be used to enable experts from all disciplines to communicate effectively with one another, resolve issues concerning the site, and facilitate the decision-making process.

5.6 The steps in the procedure for developing conceptual site models include elements sometimes referred to collectively as site characterization. Although not within the scope of this guide, the conceptual site model can be used during site remediation.

6. Procedure

6.1 *Assembling Information*—Assemble historical and current site-related information from maps, aerial images, cross sections, environmental data, records, reports, studies, and other information sources. A visit(s) to the site by those preparing the conceptual site model is recommended highly. The quality of the information being assembled should be evaluated, preferably including quantitative methods, and the decision to use the information should be based on the data's meeting objective qualitative and quantitative criteria. For more information on assessing the quality and accuracy of data, see *Guidance for Data Useability in Risk Assessment (Part A)*and *Guidance for Data Useability in Risk Assessment (Part B)*. Methods used for obtaining analytical data should be described, and sources of information should be referenced. A conceptual site model should be developed for every site unless there are multiple sites in proximity to one another such that it is not possible to determine the individual source or sources of contamination. Sites may be aggregated in that case. A conceptual model should then be developed for the aggregate.

6.2 *Identifying Contaminants*—Identify contaminants in the ground water, surface water, soils, sediments, biota, and air. If no contaminants are found, the conceptual site model should be used to help document this finding.

6.3 *Establishing Background Concentrations of Contaminants*—Background samples serve three major functions: (*1*) to establish the range of concentrations of an analyte attributable to natural occurrence at the site; (*2*) to establish the range of concentrations of an analyte attributable to source(s) other than the source(s) under consideration; and (*3*) to help establish the extent to which contamination exceeds background levels.

6.3.1 The conceptual site model should include the naturally occurring concentrations of all contaminants found at the site. The number and location of samples needed to establish background concentrations in each medium will vary with specific site conditions and requirements. The model should include sufficient background samples to distinguish contamination attributable to the source(s) under consideration from naturally occurring or nearby anthropogenic contamination. The procedures mentioned in 6.2 and 6.3 are sometimes grouped under the general heading of contaminant assessment and may be performed as a separate activity prior to the development of a conceptual site model.

6.4 *Characterizing Sources*—At a minimum, the following source characteristics should be measured or estimated for a site:

6.4.1 Source location(s), boundaries, and volume(s). Sources should be located accurately on site maps. Maps should include a scale and direction indicator (for example, north arrow). They should furthermore show where the source(s) is located in relationship to the property boundaries.

6.4.2 The potentially hazardous constituents and their concentrations in media at the source.

6.4.3 The time of initiation, duration, and rate of contaminant release from the source.

6.5 *Identifying Migration Pathways*—Potential migration pathways through ground water, surface water, air, soils, sediments, and biota should be identified for each source. Complete exposure pathways should be identified and distinguished from incomplete pathways. An exposure pathway is incomplete if any of the following elements are missing: (*1*) a mechanism of contaminant release from primary or secondary sources, (*2*) a transport medium if potential environmental receptors are not located at the source, and (*3*) a point of potential contact of environmental receptors with the contaminated medium. The potential for both current and future releases and migration of the contaminants along the complete pathways to the environmental receptors should be determined. A diagram (similar to that in Fig. X1.4) of exposure pathways for all source types at a site should be constructed. This information should be consistent with the narrative portion and tables in the exposure assessment section of an exposure or risk assessment. Tracking contaminant migration from sources to environmental receptors is one of the most important uses of the conceptual site model.

6.5.1 *Ground Water Pathway*—This pathway should be considered when hazardous solids or liquids have or may have come into contact with the surface or subsurface soil or rock. The following should be considered further in that case: vertical distance to the saturated zone; subsurface flow rates; presence and proximity of downgradient seeps, springs, or caves; fractures or other preferred flow paths; artesian conditions; presence of wells, especially those for irrigation or drinking water; and, in general, the underlying geology and hydrology of the site. Other fate and transport phenomena that should be considered include hydrodynamic dispersion, interphase transfers of contaminants, and retardation. Movement through the vadose zone should be considered.

6.5.2 *Surface Water and Sediment Pathway*—This pathway should always be investigated in the following situations: (*1*) a perennial body of water (river, lake, continuous stream, drainage ditch, etc.) is in direct contact with, or is potentially contaminated by a source or contaminated area, (*2*) an uninterrupted pathway exists from a source or contaminated area to the surface water, (*3*) sampling and analysis of the surface water body or sediments indicate contaminant concentrations substantially above background, (*4*) contaminated ground water or surface water runoff is known or suspected to discharge to a surface water body, and (*5*) under arid conditions in which ephemeral drainage may convey contaminants to downstream points of exposure.

6.5.3 *Air Pathway*—Contaminant transport through the air pathway should be evaluated for contaminants in the surface soil, subsurface soil, surface water, or other media capable of releasing gasses or particulate matter to the air. The migration of contaminants from air to other environmental compartments should be considered, for example, deposition of particulates resulting from incineration onto surface waters and soil.

6.5.4 *Soil Contact Pathway*—Contaminated soils that may come into direct contact with human or ecological receptors should be investigated. This includes direct contact with chemicals through dermal absorption and direct exposure to gamma radiation from radioactively contaminated soil. There is a potential for human and ecological receptors to be exposed to contaminants at different soil depths (for example, humans may be exposed to only surface and subsurface soils, whereas plants and animals may encounter contaminants that are buried more deeply). This should be considered when contaminated soils are being evaluated.

6.5.5 *Biotic Pathway*—Bioconcentration and bioaccumulation in organisms and the resulting potential for transfer and biomagnification along food chains and environmental transport by animal movements should be considered. For example, many organic, lipophilic contaminants found in soils or sediments can bioaccumulate and bioconcentrate in organisms such as plankton, worms, or herbivores and biomagnify in organisms such as carnivorous fish and mammals or birds. The movement of contaminated biota can transport contaminants.

6.6 *Identifying Environmental Receptors*—Identify environmental receptors currently or potentially exposed to site contaminants. This includes humans and other organisms that are in direct contact with the source of contamination, potentially present along the migration pathways, or located in the vicinity of the site. It is advisable to compile a list of taxa representative of the major groups of species present at the site. It will rarely be possible or desirable to identify all species present at a site. It is recommended that the conceptual site model include species or guilds representative of major trophic levels. The complexity and iterative nature of the conceptual site model has already been mentioned in 4.2.

6.6.1 *Human Receptors*—The conceptual site model should include a map or maps indicating the physical boundaries of areas within which environmental receptors are potentially or currently exposed to the source(s) or migration pathways; separate maps may be prepared to illustrate specific contaminants or groups of contaminants. In addition, the human receptors should be represented in a figure similar to Fig. X1.4, which is based on *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*.Fig. X1.4 shows the potentially exposed populations, sources, and exposure routes. It represents a clear and concise method of displaying exposure information.

6.6.2 *Ecological Receptors*—The conceptual site model should include a map or maps identifying and locating terrestrial and aquatic habitats for plants and animals within and around the study area or associated with the source(s) or migration pathways. Consult local and state officials, U.S. Environmental Protection Agency regional specialists, and Natural Resource Trustees to determine whether any of the areas identified are critical habitats for federal- or state-listed threatened or endangered species or sensitive environments. Identify all dominant, important, declining, threatened, endangered, or rare species that either inhabit (permanently, seasonally, or temporarily) or migrate through the study area.

7. Keywords

7.1 conceptual site model; ecological; hazardous waste site; human health; risk assessment; site characterization

APPENDIX

(Nonmandatory Information)

X1. OUTLINE FOR A CONCEPTUAL SITE MODEL FOR CONTAMINATED SITES

X1.1 The conceptual site model should include a narrative and set of maps, figures, and tables to support the narrative. An outline of the narrative sections, along with an example for each section, is given below. The example is based on an hypothetical landfill site at which only preliminary sampling data are available. *The landfill site example is intentionally simplified and is for illustrative purposes only. Conceptual site models may contain considerably more detail than provided in this example.*

X1.1.1 *Brief Site Summary*—Summarize the information available for the site as this information relates to the site contaminants, source(s) of the contaminants, migration pathways, and potential environmental receptors. A brief description of the current conditions at the site (photographs optional) should be included. The inclusion of a standard 7.5-min United States Geological Survey topographic quadrangle map or geologic quadrangle map, or both, that shows the location of the site is recommended. All maps should contain directional information (for example, north arrow) and a scale.

Example—Geophysical surveys, aerial photographs, and subsurface exploration at Landfill No. 1 (LF-1) reveal the presence of at least one northeast-southwest trending waste trench. The trench is 300-ft (91-m) long and 100-ft (30-m) wide. Maximum depth of the trench indicated by the soil borings is 22 ft (7 m). As determined from the soil boring program, the waste material samples indicated that metal concentrations were at or below background concentrations, with the exception of cadmium and manganese in one sample. However, solvents (methylene chloride and trichloroethene (TCE) and pesticides (DDE, DDT, and DDD) were found at concentrations above background in soil boring samples. Soil samples taken from beneath the fill indicate that downward migration of contaminants has occurred. The surficial aquifer (ABC Formation) contains naturally high dissolved solids (>2000 mg/L) with yields of less than 4 gpm. Ground water flow in the surficial aquifer is toward the southeast at a rate of approximately 15 ft (5 m) per year. The terrain is flat with seeded and natural grasses and small (15-ft (5-m)), widely spaced loblolly pine tress covering the site. The site is fenced and unused currently.

X1.1.2 *Historical Information Concerning the Site:*

X1.1.2.1 *Site Description*—Describe the history of the site, paying particular attention to information affecting the present environmental condition of the site.

Example—LF-1, operated from 1960 to 1968. This trench-type landfill was reportedly used for the disposal of construction rubble and debris, packing material, paper, paints, thinners, unrinsed pesticide containers, oils, solvents, and contaminated fuels. Most of the trenches for waste disposal were reportedly oriented east-west and were 75-ft (23-m) wide, 350-ft (107-m) long, and an estimated 20-ft (6-m) deep. A few empty containers presumably buried in the landfill have worked their way to the surface and are partially exposed at the site. The site was partly covered by an unpaved industrial haulage road. The site was fenced in 1985 and has been unused since.

X1.1.2.2 *Source Characterization*—Present site-specific information to identify and define the location, size, and condition of the source(s) of contamination at the site.

Example—Four soil borings were used to characterize the waste disposal units at LF-1. Fig. X1.1 illustrates the soil boring locations. The depth of the soil borings were SB05 = 28 (9 m), SB06 = 30 ft (9 m), SB07 = 30 ft (9 m) and SB08 = 30 ft (9 m) below ground surface. Two of the borings, SB07 and SB08, encountered refuse/waste material. In SB08, the refuse was encountered from approximately 8 to 22 ft (2 to 7 m) below ground surface. The material was noted to be burnt debris, glass, and organic matter. A much dryer and thinner waste zone was encountered at SB07. The base of the excavation at this location was approximately 10 ft (3 m). Material that appeared to be burnt trash was noted in the backfill. The remaining two borings, SB05 and SB06, did not encounter waste. One sample was collected from each of these borings (SB05 and -06). These samples were used as background

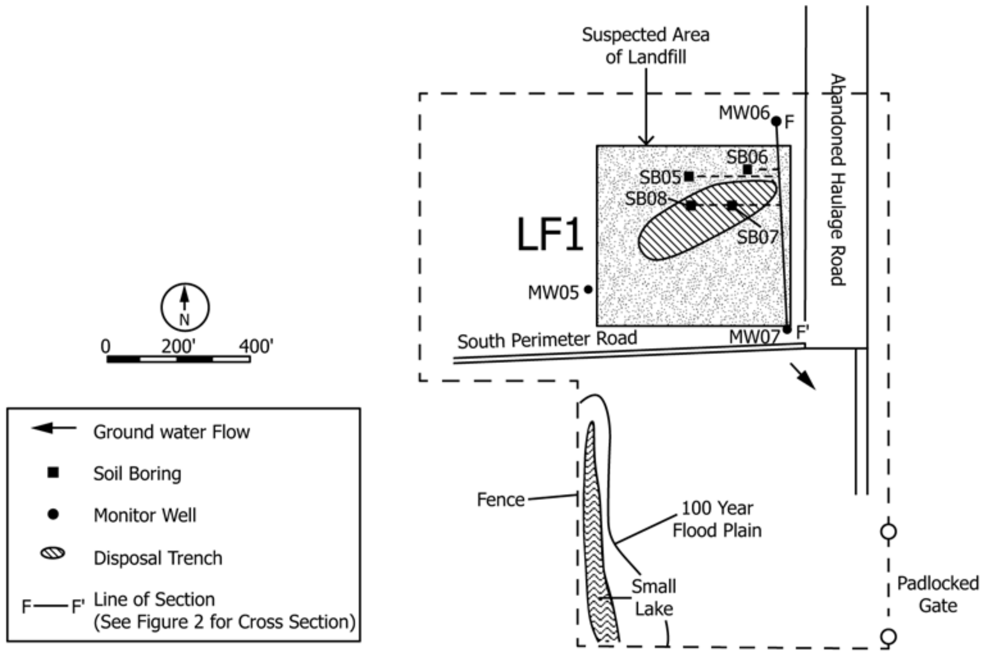


FIG. X1.1 Location Map for Landfill Number 1; Contours Showing the Potentiometric Surface from which Ground Water Flow Direction was Determined Could be Included in a Separate Figure to Avoid Clutter

samples. Additional samples were collected from SB07 and SB08, within the landfill, to characterize the source. Analytical results are summarized in Table X1.1.

Petroleum hydrocarbons, which were suspected of being contaminants based on the site history, were not detected in any of the samples.

Volatile organic compounds found in the samples included methylene chloride and TCE. Methylene chloride was found in all soil samples in trace amounts (0.005 to 0.008 mg/kg).

The field quality control information suggests that methylene chloride may be a field artifact. The chlorinated solvent, TCE, was found significantly above background only at SB08 at a concentration of 0.05 mg/kg.

Organochlorine pesticides (DDE, DDD, and DDT), which were suspected of being present based on the site history, were not present above the detection limit in any of the samples.

Comparing metal concentrations of soil samples from SB05 and SB06 (background samples) with the remaining soil samples (SB07 and SB08) reveals that SB08 metals data exceeded the background soils data substantially for one analyte. That analyte was manganese (4320 mg/kg).

X1.1.2.3 *Migration Pathway Descriptions*—Describe the route(s) potentially taken by contaminants from the site as they migrate away from the source through the environmental media (ground water, surface water, air, sediment, soils, and food chain).

TABLE X1.1 Summary of Analytical Results at LF-1[A]

Parameter (Method)	Field Identification Number					
	DL[B]	Units	SB05[C]	SB06	SB07	SB08
Moisture (Test Method D2216)	N/A[D]	%	20.6	19.1	12.7	21.1
Petroleum hydrocarbons (SW3550/E418.1)	25	mg/kg	ND_{25}[E]	ND_{25}	ND_{25}	ND_{25}
Volatile organics (SW8240)						
Methylene chloride[F]	0.005	mg/kg	0.008	$ND_{0.0050}$	$ND_{0.0050}$	$ND_{0.0050}$
Trichloroethene	0.005	mg/kg	0.006	$ND_{0.0050}$	$ND_{0.0050}$	0.05
Organochlorine pesticides (SW3550/8080)		mg/kg				
4,4-DDE	0.0033	mg/kg	$ND_{0.0033}$	$ND_{0.0033}$	$ND_{0.0033}$	$ND_{0.0033}$
4,4-DDD	0.0033	mg/kg	$ND_{0.0033}$	$ND_{0.0033}$	$ND_{0.0033}$	$ND_{0.0033}$
4,4-DDT	0.0033	mg/kg	$ND_{0.0033}$	$ND_{0.0033}$	$ND_{0.0033}$	$ND_{0.0033}$
Metals (SW3050/6010)						
Cadmium	0.5	$ND_{0.5}$	$ND_{0.5}$	$ND_{0.5}$	$ND_{0.5}$	$ND_{0.5}$
Manganese	2	mg/kg	284	178	228	4320

[A] All results are expressed on a dry weight basis.
[B] DL = detection limit.
[C] SB = soil boring.
[D] N/A = not applicable.
[E] ND_x = not detected at concentration *x*.
[F] Suspected laboratory contaminant.

Example: *Ground Water Migration*—Three monitor wells (MWs) were installed at LF-1. The bedrock formation is typically nonwater-bearing and consists of thick clay and clay-stone (Fig. X1.2). The unconsolidated materials above the bedrock include a layer of fluvial terrace deposits. The sand and gravels that lie above the bedrock contain water with flow velocities of approximately 13 to 18 ft/year (4 to 5 m/year). Flow velocities were estimated from permeability tests conducted at MW06. Recharge at the site is from runoff associated with the nearby area that pools and stagnates at and near the site. Table X1.2 contains the water quality analyses from samples of MW05, MW06 (upgradient), and MW07 (downgradient). The upgradient samples contained no contaminants at concentrations above the detection limits, while the downgradient sample contained organic contaminants (pesticides). A comparison of metals from the downgradient and upgradient samples indicates that the concentration of metals in the downgradient ground water does not exceed background (upgradient) concentrations.

Example: *Surface Water and Sediment Migration*—The site surface water drainage map is shown in Fig. X1.3. Three surface water runoff samples and three sediment samples were collected at locations shown on the map. Samples SW-02 and SD-02 were collected to determine background, while SW-03, SW-04, SD-03, and SD-04 were placed downstream of the site. The analytical results given in Table X1.2 indicate that no contaminants are present above background in any of the samples. There appears to be no contamination entering the surface water pathway from the site.

Example: *Air Migration*—No air samples were taken since there was no indication that vapor or dust can enter the air pathway. The contamination is buried and effectively prevented from reaching the air pathway, and the site is covered by a thick layer of vegetation, which effectively acts as a natural cap and prevents dust from becoming airborne. Qualitative air monitoring showed no evidence of any organic vapors being present at the site during the initial stages of the site investigation.

Example: *Soils*—This pathway is not complete for humans because the site is surrounded by a 6-ft (2-m) fence with a padlocked gate and posted with no trespassing signs. Soil and sediment samples taken for the surface water pathway did not indicate the presence of contamination above background concentrations. Also, there was no loose soil at the site since the site was covered by a thick layer of vegetation. Exposed, empty containers have been tested for the presence of contaminant residues, and none have been found. The site was inspected for evidence of burrowing mammals and other small mammals, reptiles, amphibians, or birds that might not be deterred by the fence. There was no evidence of any threat to ecological receptors from the soils or direct contact.

Example: *Food Chain Transfer* —Samples collected from surface water, sediment, and soils indicate that there are no contaminants present at concentrations above background. There is therefore no concern for food chain transfer (biomagnification) in and around the landfill.

X1.1.2.4 *Environmental Receptor Identification and Discussion*—Current and future human and ecological receptor groups should be identified and located on site maps. The migration pathways and source(s) that place or potentially place the environmental receptors at risk should be discussed.

Example: The only residential housing in the vicinity of the site is approximately 2100 ft northwest of the landfill. The surficial aquifer is not used as a source of drinking water by the

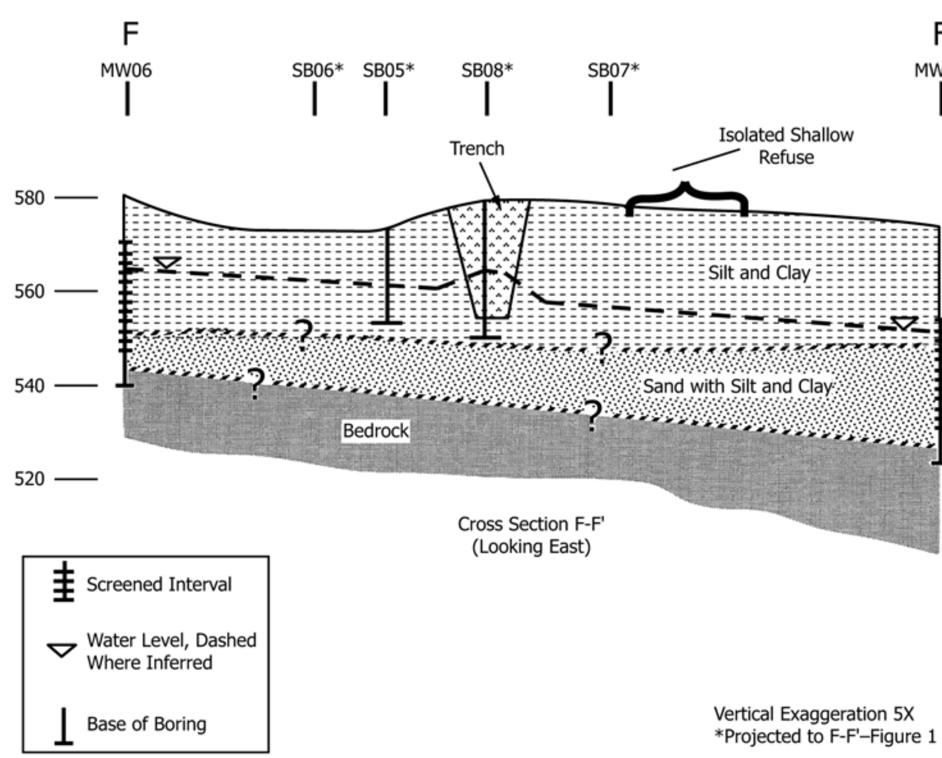


FIG. X1.2 Cross Section of Landfill Number 1

TABLE X1.2 Ground and Surface Water Quality Analysis at LF-1

Parameter	Field Identification Number						
	DL[A]	MW-05 μg/L	MW-06μ g/L	MW-07 μg/L			
Volatile organics							
Trichloroethene	5	ND_5[B]	ND_5	ND_5			
Methylene chloride	5	ND_5	ND_5	ND_5			
Organochlorine pesticides							
4,4-DDE	0.1	$ND_{0.1}$	$ND_{0.1}$	1			
4,4-DDD	0.1	$ND_{0.1}$	$ND_{0.1}$	3			
4,4-DDT	0.1	$ND_{0.1}$	$ND_{0.1}$	4			
Metals							
Cadmium	5	ND_5	ND_5	ND_5			
Manganese	15	ND_{15}	ND_{15}	ND_{15}			
	DL Water	μg/L SW-02	μg/L SW-03	μg/L SW-04	mg/kg SD-02	mg/kg SD-03	mg/kg SD-04
Petroleum hydrocarbons	1000	ND_{1000}	ND_{1000}	ND_{1000}	ND_{1000}	ND_{1000}	ND_{1000}
Volatile organics							
Trichloroethene	1	ND_1	ND_1	ND_1	ND_1	ND_1	ND_1
Methylene chloride	2	ND_2	ND_2	ND_2	ND_2	ND_2	ND_2
Organochlorine pesticides							
4,4-DDE	0.04	$ND_{0.04}$	$ND_{0.04}$	$ND_{0.04}$	$ND_{0.04}$	$ND_{0.04}$	$ND_{0.04}$
4,4-DDD	0.1	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$
4,4-DDT	0.1	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$	$ND_{0.1}$
Metals							
Cadmium	5	ND_5	ND_5	ND_5	$ND_{0.5}$	$ND_{0.5}$	$ND_{0.5}$
Manganese	20	ND_{20}	ND_{20}	ND_{20}	ND_2	ND_2	ND_2

[A] DL = detection limit.
[B] ND_x = not detected at concentration x.

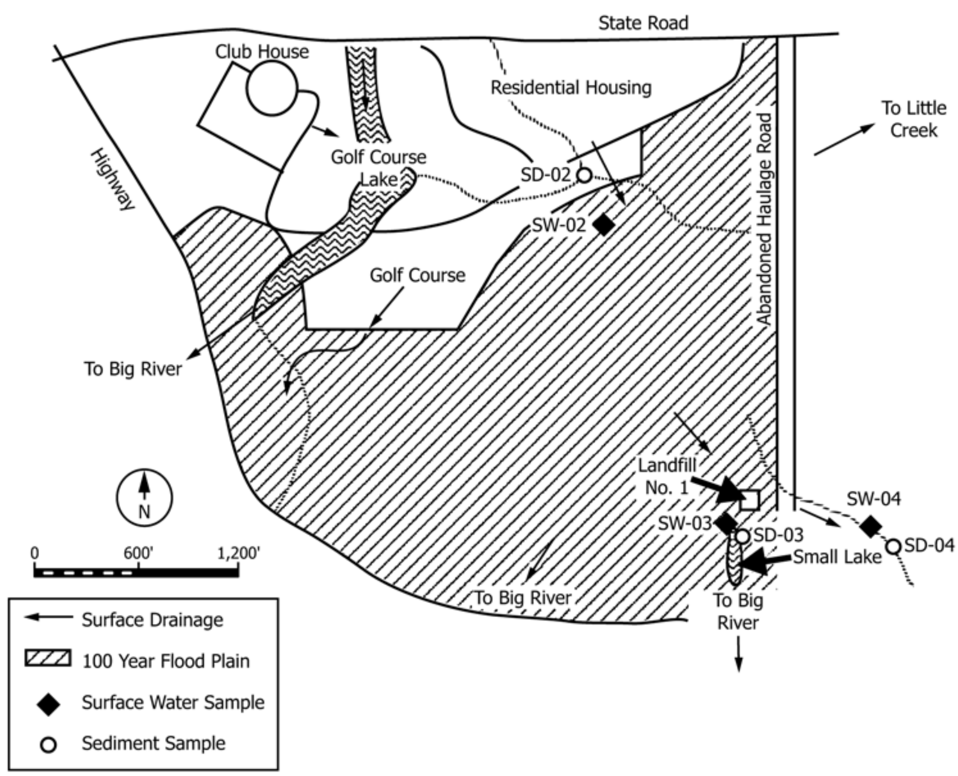


FIG. X1.3 Surface Drainage Pattern around Landfill Number 1

residents, and the ground water flow is toward the southeast and away from the residential housing. There is an active golf course just to the west of the residential housing. Golf Course Lake is recharged from north of the lake and is not influenced by LF-1. The golf course does not use the surficial aquifer for a drinking water source or for irrigating the golf course. There are no other human receptors in the vicinity of the site. There are no local, state, or federally designated declining, endangered, or rare species that inhabit or migrate through the vicinity of the study area. Other wildlife species that were observed on-site show no evidence of harm from the site. Plants on-site include seeded, cool-season grasses, and volunteer native grasses; herbian vegetation; upland shrubs; and coniferous trees. None of the vegetation shows signs of stress.

The most likely potentially threatened aquatic habitats are Small Lake and Big River, south of the landfill. However, environmental sampling of surface water and sediments (Table X1.2) has not shown any evidence of contaminant migration from the landfill to the lake or river. Fig. X1.4 illustrates the relationships among the elements of the conceptual site model, including the sources, release mechanisms, pathways, and environmental receptors.

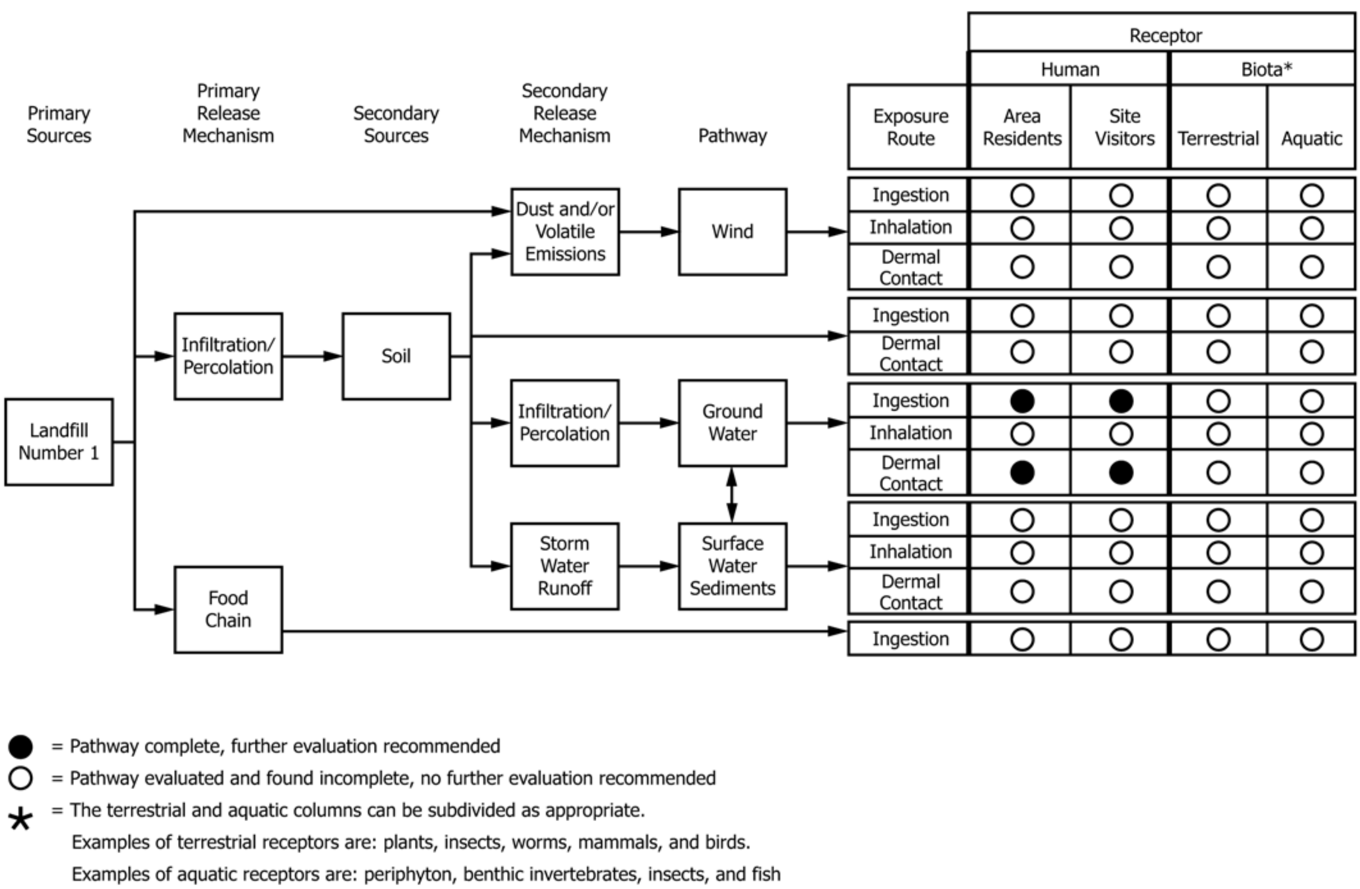
X1.2 *Examples of Maps, Tables, and Figures:*

X1.2.1 *Maps*—The use of maps in a conceptual site model is important. The maps may include United States Geological Survey topographic and geologic maps, site sketch maps, and maps drawn to scale. The maps should identify and locate key elements of the conceptual site model including source(s); ground water, surface water, sediment, soil and air pathway routes (direction of flow); and areas covered by environmental receptor populations and migration pathways. Morphological and geological features relevant to the environmental assessment of the site should be included on a map.

Example: Figs. X1.1-X1.3 are examples of sketch maps that contain a scale, a north arrow, and a legend.

X1.2.2 *Tables and Figures*—Tables and figures should be simple and easy to read, with explanations of qualified data and abbreviations. All tables and figures should be referred to in the narrative.

Examples: Tables X1.1 and X1.2 and Figs. X1.1-X1.3 are examples of simple summary tables and site maps. Fig. X1.4 is an example of a diagram illustrating the relationships between primary and secondary sources, release mechanisms, exposure routes, and environmental receptors.



NOTE 1—This example is based on Figure 2-2 of *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.*

FIG. X1.4 Example Diagram for a Conceptual Model at Landfill Number 1