Appendix D
Hydrogeologic Investigations of Groundwater Contamination

D.1 INFORMATION ON THE HYDROGEOLOGIC ENVIRONMENT USED IN INVESTIGATIONS: DEFINITION OF TERMS[a]

Term	Definition
TOPOGRAPHIC DATA	Data describing the relief and contour of the land surface.
VEGETATIVE DATA	Information about types and extent of vegetation covering the land surface at and adjacent to the site of interest.
CLIMATIC DATA	Data concerning precipitation, evapotranspiration, and temperature at the site of interest and surrounding region.
1. Precipitation	Precipitation history including spatial distribution, temporal variance, long-term *averages,* and records of short-term events of great magnitude *(e.g.,* record rainfalls).
2. Evapotranspiration	Movement of water to the atmosphere by evaporation from the soil surface, evaporation from open bodies of water, and transpiration by plants.
3. Site temperature	Temperature ranges for different periods of the year as well as long-term averages.
GEOLOGIC DATA	Data concerning the rock and soil makeup of the hydrologic system including information on the thickness of different units and fracture patterns.
1. Surficial deposits	Unconsolidated deposits resulting from fluvial (i.e., river), lacustrine (i.e. , lake), glacial, deltaic, and aeolian (i.e. , wind) processes.
2. Subsurface stratigraphy	Describes the gectnetrical configuration of and temporal relationships among various lenses, beds, and formations of sedimentary origin.
3. Lithology	Describes the sediments or rocks that ccmprise the hydrogeologic system including mineralogy, grain size, grain shape, and packing of sediments and rock grains.
4. Structural geology	Describes the features produced by rock movement after deposition (e.g., due to consolidation or plate tectonics) including tension cracks (i.e. , joints), faults, and folds.

Term	Definition
SURFACE HYDROLOGY DATA	Data concerning the properties, distribution, and movement of water on the land surface.
1. Overland flow	Downgradient flow of surface water to an established surface channel.
2. Stream discharge	Quantity of water flowing through a stream.
3. Stage	Height of the water surface in a stream above an arbitrary zero point.
4. Recurrence interval	Average time (e.g., number of years) that hydrologic events of a given or greater size will be equaled or exceeded.
5. Baseflow discharge	Groundwater discharge contribution to streamflow; also called dry weather flow.
UNSATURATED ZONE DATA	Data concerning the properties, distribution, and movement of water in the unsaturated zone.
1. Unsaturated zone (or Vadose zone)	Zone between the land surface and the water table. Generally, any water contained in the void spaces of this zone is under less than atmospheric pressure; some of the voids contain air (at atmospheric pressure).
2. Water table	Surface separating the saturated and unsaturated zones. At the water table, water pressure is equal to atmospheric pressure. (See Unconfined aquifer, GROUNDWATER HYDROLOGY DATA, below.)
3. Geometry of the unsaturated zone	Describes the location of the upper (land surface) and lower (water table) boundaries of the unsaturated zone, the lateral extent of the zone, and the upper, lower, and lateral bounds of differing heterogeneities within the zone.
4. Hydraulic properties	Properties that control the movement of water through the unsaturated zone.
a. Effective porosity	Ratio of the volume of void space in a volume of rock or soil to the total volume.
b. Permeability	Ease with which a porous medium can transmit a fluid when saturated with that fluid. (It should be noted that permeability is a property of the porous medium and is independent of the fluid characteristics.)

Term	Definition
c. Effective perrmeability	Ease with which a porous medium can transmit a fluid under pressure (i.e., a hydraulic gradient; see Hydraulic gradient, below) when the pore spaces are also filled with other fluids (e.g., oil or air).
d. Relative permeability	Ratio of the permeability of a porous medium with respect to the fluid phase when two or more phases are present (i.e. , solid, liquid, and/or gas) to the permeability.
e. Specific storage	Volume of water released from or taken into storage per unit volume of porous medium when the pressure head (or head) is changed by one unit (see Pressure head, below).
5. Flow parameters	Measurements used to define water movement in the unsaturated zone.
a. Pressure head (or Head)	Height of a column of water that can be supported by water pressure at the point of measurement. At the water table, the pressure head is zero; below the *water* table, the pressure head is positive; and above the water table, it is negative, reflecting the fact that water in the unsaturated zone is held in the pores by principally surface tension. Negative pressure head is sometimes referred to as tension head or suction head.
b. Hydraulic gradient	Rate of change of pressure head (or head) per unit distance of flow at a given point and in a given direction. In an unconfined aquifer, the hydraulic gradient is defined by the slope of the water table.
c. Fluid saturation	Ratio of the volume of water to the volume of voids in the unsaturated zone. In the saturated zone, the fluid saturation is always 1.0.
6. Recharge/discharge	Inflow and outflow of water to and from the unsaturated zone.
a. Surface water	See SURFACE HYDROLOGY DATA, above.
b. Precipitation/ evapotranspiration	See CLIMATIC DATA, above.

Term	Definition
GROUNDWATER HYDROLOGY DATA	Data concerning the properties, distribution, and movement of water in the saturated zone.
1. Saturated zone	A subsurface zone in which all the voids are filled with water under pressure equal to or greater than that of the atmosphere. Even if the zone contains some gas-filled voids or voids filled with fluids other than water, it is still considered saturated. This zone is separated from the unsaturated zone by the water table.
2. Aquifer characterization	Describes the flow system in terms of the number of aquifers and their extent, depth, thickness, and boundary type (i.e. , unconfined, confined, or leaky confined).
a. Aquifer	Geologic material containing sufficient saturated permeable material to transmit and yield significant quantities of water to wells or springs.
b. Unconfined aquifer	An aquifer that is not overlain by relatively impermeable or restricting material so that groundwater levels are free to rise and fall. The top of the aquifer is the water table (i.e., the level to which water will rise in a well penetrating the unconfined aquifer).
c. Confined aquifer	An aquifer that is bounded between relatively impermeable material. In the absence of a freely moving water table, the pressure condition of a confined aquifer is characterized by the piezometric surface (i.e. , the artesian equivalent of the water table -- the level to which water will rise in a well penetrating the confining layer). The word confined is synonymous with artesian.
d. Leaky confined aquifer	A confined aquifer that receives or transmits significant quantities of water from/to adjacent formations.
3. Hydraulic parameters of aquifers	Physical properties of aquifers that control groundwater movement.

Term	Definition
4. Relative saturations	Relative portions of the pore space filled by water, air, and/or immiscible fluid contaminants.
5. Cation exchange capacity	Describes the excess of cations in solution adjacent to a charged surface that replaces other cations already absorbed onto that surface.
6. Subsurface mineralogy	Chemical makeup of rocks and soils, which influences the reactivity of contaminant s.
7. Ambient water chemistry	Natural chemistry of water, which influences the reactivity between water and contaminants.
8. Microbiology	Characteristics and distribution of micro-organisms in an aquifer.
GROUNDWATER USE	Describes how groundwater at a site of investigation is used.
1. Current usage	Present uses of groundwater including where wells are located, how much water is pumped from each well, what aquifers are being tapped, and what quality of water is needed for each use (e.g., water quality needed for drinking water is higher than for cooling at power plants).
2. Projected Usage	Anticipated future uses of groundwater including well locations, future water needs from wells, what aquifers may be tapped, and what quality of water will be needed for each use.

[a] The terminology of hydrogeology has evolved and expanded with the development of the science. Further, the field of hydrogeology requires multidisciplinary skills, and terms tend to be used in slightly different ways by different disciplines (e.g. , hydrologists, geologists, soil scientists, and chemists). OTA notes that definitions and usage have not yet been fully standardized.

Source: GeoTrans, 1983; Office of Technology Assessment, 1983.