Restoration Advisory Board Fact Sheet

Conceptual Site Models

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This fact sheet is one in a series prepared for RAB members about the Travis AFB Installation Restoration Program (IRP).

Much has been learned since investigators initiated remedial investigations and feasibility studies (RI/FS) at the first Superfund sites. Contamination caused by industrial and military operations can be broadly categorized now, based on collective knowledge gained by regulatory agencies and those responsible for cleanup. Relying on this base of experience, investigators preparing to do a remedial investigation (RI) can evaluate preliminary data and develop a conceptual site model.

A PREDICTION TOOL

The conceptual site model describes the site's chemical and physical characteristics, including potential sources of contamination, mechanisms of chemical release and transport, potential human and ecological receptors, potential pathways, and fate of contaminants. In other words, what are the potential contaminants, how did they get into the environment, who and what might be affected by the contaminants, and is exposure to these contaminants likely? The conceptual model attempts to answer these questions.

Basing assumptions on data gathered during previous investigations or at other sites in the area, investigators develop a concept for how to investigate a given site. The conceptual site model is based on knowledge of the physical characteristics of the site's geology and hydrogeology, and on knowledge of the chemical characteristics of the contaminants of concern (COC).

With this information, investigators can model what has taken place and predict where plumes of contamination are likely to occur. If a historical release of solvents is known, for example, knowledge of the subsurface and of solvents lets investigators estimate how far the solvent plume could travel. The conceptual model gives investigators a starting point on which to plan their investigation. It tells them where to put monitoring wells, what contaminants to look for, the magnitude of the problem (needed for budgeting, staffing, and scheduling), and what kind of remedial activities to consider.

UNDERSTANDING COCs

Recognizing general characteristics of the suspected contaminants helps investigators to predict what might have happened to them over time. Solvents and other volatile organic compounds (VOC) tend to volatilize (mix with air and dissipate). Chemists know the rate of volatilization for each kind of VOC and typical degradation products to look for. Some petroleum products are lighter than others, such as gasoline or BTEX (benzene, toluene, ethylbenzene, and xylene), which move quickly through some media or volatilize. Heavier petroleums, like oil and grease, don't move much at all. Metals tend to cling to fine soil particles and migrate little.

TRAVIS AIR FORCE BASE

Areas under investigation at Travis Air Force Base (AFB) include the buildings used to house a variety of radiological and industrial operations, waste burial and storage sites, grazing management units (GMUs), stormwater distribution facilities, and land adjacent to railroad lines. Each operation or facility may have produced specific types of waste depending on its use. For example, buildings used for the maintenance of aircraft could be contaminated with cleaning solvents; underground storage tanks could be contaminated with petroleum hydrocarbons and other volatile organic compounds; areas used for mixing and preparing pesticides for on-base use could be contaminated with organochloride and organophosphate pesticides and herbicides. Each type of material contaminates in its own way depending on its physical properties.

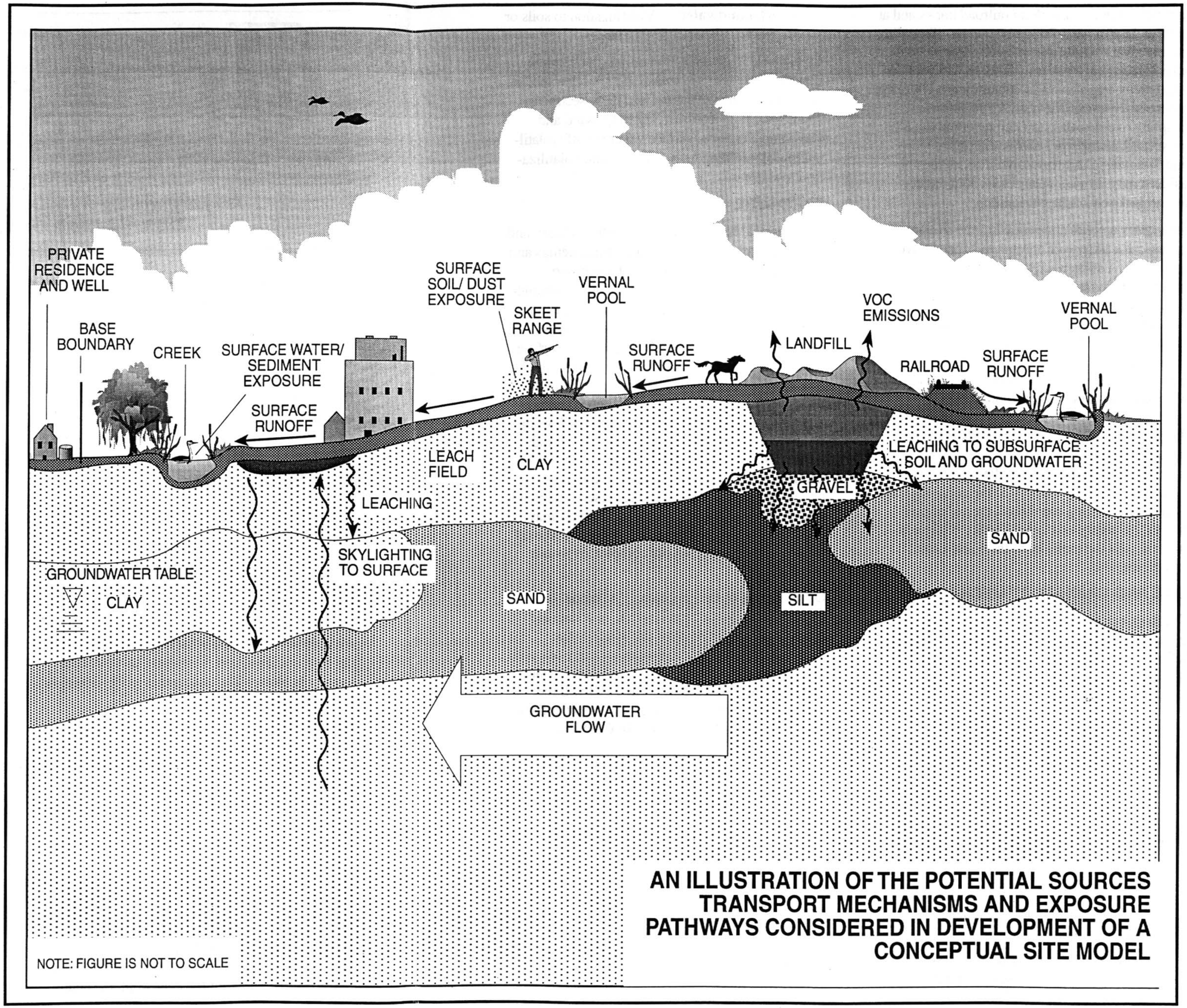
The way in which a hazardous material migrates is determined by the physical characteristics of a site. Determining the nature of the contemination, the transport mechanisms, and exposure pathways at a site involves a complex series of sampling, testing, and analysis. Typically, investigators sample several media: surface water, groundwater, surface soil, subsurface soil, and soil vapor.

DETERMINING POTENTIAL CONTAMINATION

Groundwater is the water present in the saturated soil zone, in which the pore space between the soil grains (or rock fractures) is filled with water. Groundwater is sampled to determine (1) whether contamination has traveled from the soil to the groundwater, (2) how far the contamination has traveled, and (3) where the source of contamination is. When groundwater is found to be contaminated, monitoring wells are placed both upgradient and downgradient of the site to determine if the groundwater was contaminated by another source and how far contamination has moved . The presence of high levels of contaminants may indicate the need for source control, containment, or groundwater treatment. Groundwater is usually sampled through either a temporarily or permanently installed well. It can also be sampled anywhere it is present, such as in a pit or hole dug to below the water table.

Surface water (rivers, streams, creeks; lakes and ponds; impoundments and lagoons; and estuaries) and ***sediments*** (often sampled in conjunction with surface water) are sampled to find evidence of contamination in either the water body itself or from another source. At Travis AFB, surface waters of concern include creeks, ponds, storm drains, and a reservoir. Samples are collected immediately downstream of a turbulent area or downstream of any marked physical change in a stream channel. Sediment samples are collected along a cross-section of a river or stream bed.

Surface soil is generally considered to be soil that can be sampled using hand tools (less than 3-feet deep). Surface soils at Travis AFB that require



AN ILLUSTRATION OF THE POTENTIAL SOURCES TRANSPORT MECHANISMS AND EXPOSURE PATHWAYS CONSIDERED IN DEVELOPMENT OF A CONCEPTUAL SITE MODEL

sampling include soils along railroad tracks and at grazing, landfill, and firing range areas. Sampling locations vary with surface features such as rock outcrops, drainage patterns, fill areas, and depositional areas. High levels of contamination found in surface soil indicate the need for subsurface sampling to determine how far the contamination has seeped. ***Subsurface soil*** is soil that is more than 3-feet deep. As with surface soil, stains or residues may provide visual clues about underground leaks or leachate migration.

Soil vapors are gases contained in the soil pore spaces in the vadose or unsaturated zone above the water table of subsurface soils. Nitrogen, oxygen, carbon dioxide, water vapor, and smaller amounts of other chemical vapors naturally occur in the soil. Soil vapors may arise from chemicals spilled on the surface of the ground; from chemicals in leaking impoundments or other basins; from chemicals in leaking underground tanks and associated plumbing or pipes; or from volatilization of chemicals in contaminated groundwater. The concentration of these chemicals in the soil vapor depends upon parameters such as the quantity and concentration of the source of contamination, the proximity of the contamination to the location being monitored, the vapor pressure, the solubility and vapor density of the contaminant, and the mobility of the contaminant through the soil.

FATE AND TRANSPORT MECHANISMS

What happens to a chemical in the environment depends on the characteristics of the chemical and the soil, water, air or other media into which it is released. Some mechanisms that may affect a chemical's fate include:

- **Surface soil** — Volatilization into air, channeling through wind and erosion, surface water runoff, leaching to subsurface, or transformation (biotic or abiotic)
- **Subsurface soil** — Volatilization to soil gas, leaching to groundwater, excavation (or other physical disturbance), or transformation
- **Surface water** — Runoff to soil, sediment or other water bodies, volatilization or transformation
- **Sediment** — Volatilization into surface water or air, erosion, surface water runoff, or transformation
- **Groundwater** — Volatilization to soils or surface water or sediments.

In response to changing conditions, a chemical may be rereleased and transported to other media. Contamination is released from these secondary sources through diffusion, tracking, wind and mechanical erosion, surface water runoff, volatilization, skylighting to the surface, and volatilization to soil gas.

EXPOSURE

If a chemical has traveled through the primary and secondary release mechanisms, human beings and ecological populations can then be exposed through air, soil, surface water, sediment, groundwater, and subsurface soil by inhaling, ingesting, or touching the chemical or by ingesting food affected by contaminated groundwater or surface water. The conceptual site model examines the possibility of contaminants finding their way to receptors through these routes. For each location where there may be COCs, investigators develop site models — at Travis that means one for radiological sites; one for building sites; one for GMUs, landfills; and firing ranges; one for railroad sites; one for storage tank sites; one for reservoirs; ponds and creeks; and so forth. Additional routes may exist for ecological pathways — plant and animal intake — generating a more complex exposure calculation.

Development of the conceptual site model is considered a dynamic process. As new data are revealed, for example, they are added to the model. During the RI, investigators will work with the basewide conceptual model and develop site-specific conceptual models. The RAB will receive investigation results; it is helpful to consider these results in terms of these conceptual models.