



Toxic Substances Hydrology Program

Cape Cod Toxics Field Research Site

Processes Controlling Transport of Solutes in a Sewage Plume in Ground Water at the Massachusetts Military Reservation, Cape Cod, Massachusetts



The USGS Toxic-Substances Hydrology Program

Ground-water contamination has many causes. Activities from fuel use to feedlots to landfills to sewage disposal all can introduce organic and inorganic contaminants into the subsurface. Once there, these contaminants move slowly with the flowing ground water and can eventually reach water supplies, streams, ponds, and the ocean. But many physical, chemical, and biological processes can change and disperse the contaminants along the way. The key to predicting the fate of contaminants and knowing how best to deal with them is to understand these processes.

The goal of the U.S. Geological Survey's Toxic Substances Hydrology Program is to develop this understanding by conducting in-depth, long-term studies of these processes where they're happening. This field-based knowledge is the critical leg of a three-part approach that also uses laboratory research and computer modeling to look at specific processes. By building knowledge at a particular site over many years, the processes can be understood so that the work transcends the local site and can be applied to aquifers worldwide. By working at a field site, hydrologists, chemists, microbiologists, computer modelers, and geophysicists have to "step outside the box" and work together to address these complex, multidisciplinary problems.

The USGS Cape Cod Toxics Field Research Site

The USGS Cape Cod Toxic-Substances Hydrology field site is one of the premier ground-water contamination research locations in the world. The site is a large outdoor field laboratory with the 4-kilometer-long sewage plume as the "lab bench." Sewage may sound ordinary, but it consists of a rich brew of toxic metals, phosphate, nitrate, detergents, organic chemicals, and microbes. The sewage plume that emanates from the Massachusetts Military Reservation provides an ideal field setting to address the many technical questions about how contaminants move in ground water.



Since 1983, USGS scientists from around the country and their university colleagues from four nations and more than a dozen institutions have been examining the sewage plume from a multitude of angles. More than a thousand wells have been drilled to sample the plume, and countless water samples have been collected and analyzed. The field evidence of various processes at work has led to investigation of topics ranging from the movement of bacteria and viruses in the plume to the dispersion that is caused by the geologic structure of the aquifer. But the hallmark of the Cape Cod

site is the use of controlled ground-water tracer experiments within the sewage plume. More than 50 tests have been done in which water containing tracers is injected into the plume and tracked as the tracers move and are altered in the subsurface. Several well arrays have been constructed for the experiments, including the "large-scale array," which has more than 10,000 sampling points and was shown in a National Geographic article a few years ago. Agencies that have co-funded work at the site to address problems that they face include the U.S. Environmental Protection Agency, the National Science Foundation, the U.S. Departments of Agriculture and Energy, and the Nuclear Regulatory Commission.



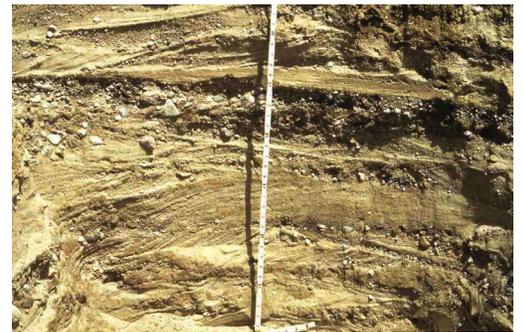
The Cape Cod Toxics Site Accomplishments

The product of the USGS Cape Cod site is scientific knowledge for use by resource managers, regulators, educators, and other scientists about the processes that affect contaminants. This new knowledge has been widely disseminated in more than 120 scientific articles, more than 130 federal reports, and 44 Masters and Ph.D. theses from MIT, Stanford, Princeton, and other universities. The

results are being put to practical use in solving ground-water problems worldwide. Scientists from the site have been featured participants at national meetings on the fate of arsenic in ground water and the discharge of plumes to lakes. The Massachusetts Dept. of Environmental Protection is basing its new phosphorus regulations on the findings at the site. The National Research Council recently used the knowledge gained from Cape Cod and other USGS Toxics sites to evaluate the potential for more reliance on natural processes to clean up ground water. Results from the site are featured in a growing number of textbooks, thus helping to educate the next generation of ground-water professionals. Groups ranging from the National Academy of Sciences to the Upper Cape Cod Technical High School have visited the site to learn about the latest in ground-water studies.

The USGS Toxics Program and the Cleanup of the Massachusetts Military Reservation

The ground-water cleanup at the Massachusetts Military Reservation is one of the most complex and expensive environmental restoration projects in the U.S. military. More than \$1 billion will probably be spent before the effort is completed. A senior USGS scientist presently is a member of the base's Technical Review and Evaluation Team. The USGS Cape Cod Toxics group has worked



For additional information

contact:

Wayne Sonntag, District Chief
Massachusetts-Rhode Island District
U.S. Geological Survey
10 Bearfoot Road
Northborough, MA 01532
508/490-5029
<http://toxics.usgs.gov>

shoulder with the military to help expedite this

Herculean task. The military has used the USGS work on the sewage plume to guide the study of the dozen or more other large plumes on the base. USGS scientists from the Toxics group have worked directly with the military to model ground-water flow, locate plumes discharging to ponds and the ocean, and develop less costly methods for sampling ground water.

