A SIMPLE PORE-WATER SAMPLER FOR LONG-TERM GROUND-WATER MONITORING AT DISCHARGE POINTS BENEATH STREAMS

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Abstract. The U.S. Geological Survey, in cooperation with the Naval Facilities Engineering Command Southeast, used innovative sampling methods to investigate ground-water contamination by chlorobenzenes beneath a drainage ditch on the southwestern side of Installation Restoration Site 4, Naval Air Station Corpus Christi, Corpus Christi, Texas, during 2005-06. The drainage ditch, which is a potential receptor for ground-water contaminants from Installation Restoration Site 4, intermittently discharges water to Corpus Christi Bay. This report evaluates a new type of pore-water sampler developed for this investigation to examine the subsurface contamination beneath the drainage ditch. The new type of pore-water sampler consists of an inner perforated pipe enclosed in a larger perforated pipe. The annular space between the two pipes is filled with granular sand as a filter pack, and the sand is prevented from moving through the perforated pipe by two sheets of polyethylene mesh. The device is sampled by attaching a peristaltic pump to the tubing connecting the sampler to the shoreline. The sampler appears to be an effective approach for long-term monitoring of ground water in the sand and organic-rich mud beneath the drainage ditch.

Introduction

Ground-water contamination by chlorobenzene and dichlorobenzene is present at Installation Restoration (IR) Site 4, Naval Air Station Corpus Christi, on the Gulf of Mexico near the city of Corpus Christi, Texas (Terraine Inc., 2006). A drainage ditch on the southwestern side of the site is a potential receptor for the ground-water contamination. The present investigation was conducted by the U.S. Geological Survey, in cooperation with the Naval Facilities Engineering Command Southeast, to evaluate a new type of pore-water sampler capable of obtaining repeated water samples from the sand and organic-rich mud beneath the drainage ditch on multiple sampling events.

Background

A variety of methods are available for examining pore-water concentrations beneath the ditch, however, existing technologies have shortcomings for long-term monitoring. Existing technology for sampling contaminants in pore water beneath surface water includes using diffusion samplers, pumping samples from wells, and sediment-core squeezing. Diffusion samplers have been widely used in wells and other environments to passively collect samples for volatile organic compound (VOC) analysis (Karp, 1993; Vroblesky and Hyde, 1997; Imbrigiotta and others, 2002). Examples of passive diffusion samplers include passive diffusion bag (PDB) samplers and passive vapor diffusion samplers (Church and others, 2002; Vroblesky, 2001a; 2001b; 2002a; 2002b). A variety of diffusion samplers have been used to collect water for analysis of inorganic constituents, including peepers and nylon-screen samplers (Hesslein, 1976; Paludan and Morris, 1999; Vroblesky and others, 2002a, 2002b). A broad variety of other diffusion-type samplers are available and are reviewed in Namieśnik and others (2005). These methods provide useful snapshot concentrations but are not reliable for long-term monitoring because of the uncertainty associated with resampling the same location. Wells sometimes are installed in surface-water bodies to monitor pore-water concentrations, but wells are limited in their application. They require a surface expression, such as a standpipe, that may be subject to disturbance by floating objects or currents. Moreover, bottom sediment is often fine-grained, necessitating the need for a sand pack or other sediment-filtering material surrounding the screen. The samplers tested during this investigation have the potential to overcome these shortcomings.

Approach and Methods

For this investigation, two different variations of six newly developed pore-water samplers, as well as three standard water-filled PDB samplers were installed at a drainage ditch on the southwest side of IR Site 4. The samplers were installed at five sites within approximately 20 feet (ft) of each other near a monitoring well (R5).

One tested variation of the new pore-water sampler consists of an inner perforated polyethylene pipe, approximately 1.4 inches (in.) in diameter, enclosed in a larger perforated pipe, approximately 2.5 inches in diameter and about 0.7 ft long. The annular space between the two pipes is filled with granular sand as a filter pack, and the sand is prevented from moving through the perforated pipe by two sheets of polyethylene mesh. One sheet is wrapped tightly around the outer face of the inner pipe, and the other is held against the inner face of the outer pipe. The raised, beveled perforations on the outer pipe allow water to move into the sampler and prevent the sampler from becoming clogged by organic detritus, such as leaf matter. The sand pack between the inner and outer pipes provides further filtration. The tubing connected to the inner pipe provides a means of recovering water from the sampler by use of a peristaltic pump. A second variation is similar to the one just described except that the dimensions of the outer pipe are smaller (about 1.4 in. diameter), and the inner pipe consists of a perforated section of 3/16-in.-diameter nylon tubing. Four of the new samplers (two of each diameter variation) were installed by burying them approximately 1.5 ft below the bottom of the ditch bed by means of a hand auger and temporary casing that was advanced with the auger hole to prevent hole collapse. Upon removal of the temporary casing, the hole was backfilled with native sediment. Tubing (1/4-in. outer-diameter nylon) attached to the inner pipe of the pore-water sampler extended up to the ditch-bed surface, then horizontally along the ditch-bed surface to a protective valve box on the shore. The tubing provided a means of collecting the pore-water samples by using a peristaltic pump. In addition, four samplers were buried less than one foot deep beneath the ditch bed. These included one new sampler (1.4-in diameter) and three standard PDB samplers . The PDB samplers in this investigation were polyethylene bags filled with deionized water (Vroblesky, 2001a; 2001b). The PDB samplers were installed to collect water samples for chlorobenzene analysis from directly beneath the sediment/surface-water interface in the drainage ditch. One new sampler (1.4-in. diameter) was installed in surface water at the ditch. The samplers remained in place approximately 5 months prior to the collection of water samples. The water samples were collected by connecting a peristaltic pump to the nylon tubing attached to the inner pipe of the sampler. Approximately three sampler volumes of water were pumped to purge the sampler prior to sample collection. In the case of the larger diameter samplers (2.5 in.), approximately 1 liter of water was purged prior to sample collection. In the case of the smaller diameter samplers (1.4 in.), approximately 300 milliliters of water was purged prior to sample collection. Samples were then sent to a laboratory for VOC analysis. Selected samples were analyzed for turbidity, pH, specific conductance, sulfide, carbon dioxide, alkalinity, and dissolved iron (Fe^{2+}). Well R5 was sampled by using low-flow technology.

Discussion

All of the newly developed pore-water samplers were capable of collecting water from the sand and organic-rich mud beneath the ditch and in surface water in September 2005. During August 2006, four of the six samplers remained operational. Sampler WDS3 did not obtain water, however, and the inner screen failed in sampler WDS4, allowing the sampler to pump highly turbid water mixed with sand from the internal sand pack. A likely explanation for the failure of WDS3 is that the tubing extending to the shoreline was inadvertently crushed underfoot while related activities were conducted in the drainage ditch in 2006 or following sampling in 2005. Improvements that would make the samplers more reliable include the use of a sand pack that closely approximates the grain size in the target horizon, replacement of the nylon screen with a polyethylene screen material, and use of polyvinyl chloride pipe as a protective casing for the sample tubing in places where it may be crushed by surface activity.

Water from the pore-water samplers contained concentrations of chlorobenzene, 1,2-dichlorobenzene, and 1,2-dichlorobenzene consistent with concentrations measured in nearby well R5. The constituent concentration data collected during this study show that the samplers can function as adequate long-term sampling devices for monitoring ground-water contaminant concentrations beneath drainage ditches. More information regarding this field test can be found in Vroblesky and Casey (2007).

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