CONF-9609162--1
ANL/ES/CP--91223
RECEIVED
NOV 12 1996
OSTI

AN INNOVATIVE FUNNEL AND GATE APPROACH TO GROUNDWATER REMEDIATION

D.O. Johnson, M.L. Wilkey, J.M. Willis: Argonne National Laboratory*,
Energy Systems Division, Argonne, IL 60439
Tel: (630) 252-3392
Louis Breaux and Tim McKinsey:
Barrier Member Containment Corporation, Belle Chasse, LA 70037
Tel: (504) 398-0501

Abstract

The U.S. Department of Energy, Office of Science and Technology (EM-50) sponsored a demonstration project of the Barrier Member Containment Corporation's patented EnviroWall™ system at the Savannah River site. With this system, contaminated groundwater can be funneled into a treatment system without pumping the contaminated water to the surface. The EnviroWall™ barrier and pass-through system, an innovative product of six years of research and development, provides a means to enhance groundwater flow on the upgradient side of an impermeable wall and direct it to an insitu treatment system.

The EnviroWall™ system is adaptable to most site conditions. Remedial applications range from plume containment to more robust designs that incorporate groundwater manipulation coupled with insitu treatment. Several key innovations of the EnviroWall™ system include the following:

- A method for guide box installation,
- A means for using interlocking seals at vertical seams,
- A down-hole video camera for inspecting seams and panels,
- Installation of horizontal- and vertical- collection systems,
- Installation of vertical monitoring wells and instrumentation on each side of the barrier,
- Site-specific backfill design, and
- A pass-through system for funneling groundwater into a treatment system.

Background

The U.S. Department of Energy (DOE) has a need to remediate contaminated groundwater at numerous sites where nuclear materials were handled or where weapons production activities took place. Because of the geologic setting and/or because of existing regulations, in many situations it is desirable to handle groundwater remediation in an insitu mode. Often, the contaminated groundwater is moving as a plume, thus it is necessary to intercept and contain the plume with some type of wall or barrier in order to facilitate various remediation strategies. This approach has become known as funnel and gate, where the contaminated plume is collected and funneled to a pass-through or gate where treatment commences.

DOE's Office of Science and Technology (EM-50), under the direction of Dr. Clyde Frank, has supported a research program to identify, evaluate, and field demonstrate promising barrier or containment technologies. Recently, DOE sponsored a demonstration to evaluate the ability of Barrier Member Containment (BMC) Corporation's patented EnviroWall™ funnel and gate system for remediating metals-

* Work supported by the U.S. Department of Energy, Office of Science and Technology (EM-50) under contract W-31-109-Eng-38.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER

contaminated groundwater at the 400 D-Area coal pile runoff basin on DOE's Savannah River site in South Carolina. BMC installed the barrier under contract to Argonne National Laboratory (ANL); ANL provided engineering and technical oversight. Westinghouse Savannah River Company (WSRC) provided site coordination including permitting, characterization, and technical support.

The EnviroWall™ barrier system

EnviroWall™ is a patented groundwater barrier and pass-through system (funnel and gate) with applications that range from plume containment to more robust designs of groundwater manipulation coupled with insitu treatment. This system (Fig. 1) can function as:

- Permeable or impermeable reaction walls;
- Cut-off walls;
- Interceptor trenches;
- Barriers with collection systems and pass-throughs.

This versatility is accomplished because of the patented guide box installation method that allows for the placement of piping and backfill into the clean void on both sides of the geomembrane. High density polyethylene (HDPE) is normally used as the barrier membrane, however, a choice of any type of material including geomembrane, polymer slurry, cementing agent, or porous reactive material can be placed inside the void created by the guide box. Fig. 2 shows a cross-section of the system.

The guide box is constructed of various components that, when assembled, provide trench stability while maintaining a sediment/debris free open area in which to place barrier or treatment media. Guide boxes are eight ft long and interconnected to one another along the length of the trench. Five to seven guide boxes are used in a "leap frog" type procedure. Removal of the guide box from the excavation is accomplished by disassembling the components and lifting them from the trench. The width of the guide box determines the width of the open area that can be used for the installation of piping and filter/reaction material. The width of the guide box can easily be changed by widening the spreader bars and the end gates. Standard designed trench width is 36 to 42 in., however, EnviroWall™ can be installed inside a 24-in. trench or can be expanded to any width greater than the standard. Maximum depth limitation is dependent on the site conditions and restrictions, however, depths of 40 to 50 ft can be achieved using standard construction practices.

An HDPE geomembrane is generally installed as the barrier material. Spools of HDPE are inserted into the guide box and unrolled along the length of the barrier wall in continuous lengths up to 240 ft. The geomembrane is held in a vertical position by insert beams that are placed inside of the guide box. Multiple geomembranes and filter fabrics can be installed in parallel fashion to attain the following:

- Separation between filter pack and natural formation materials;
- Double wall barrier protection;
- Increased flow path and retention time with treatment media.

The vertical seams between geomembrane sheets are sealed using one of several patented interlock designs. The interlock consists of two ends that are heat fused to the panels prior to installation. When the interlock (with elastomeric gasket) is engaged, it provides a tight seal instantly. This provides an advantage over some types of interlocks which require hours of hydration time for sealant material to swell, risking the possibility of foreign debris bridging inside the interlock assembly and causing the seal to leak. Visual verification of the barrier and interlock integrity is provided with a downhole video camera. The camera is lowered into the guide box where the inspection of the geomembrane is observed and recorded from the attached monitor at ground surface. This inspection is recorded on a VHS video format and provides positive assurance that can become part of an administrative record.

Multi-level monitoring wells, pressure transducers, and insitu monitoring instruments (pH sensors, flow meters, vadose zone lysimeters) can be easily installed on both sides of the barrier membrane in order to monitor barrier effectiveness and provide data for meeting regulatory requirements. Monitoring networks can be installed just inches from the barrier membrane. The clean opening on each side of the barrier allows for the easy installation of both vertical and horizontal piping that can be used for either monitoring or collection. Multi-level monitoring wells and vertical extraction wells up to 8 in. in diameter (greater with modified guide box) can be installed. Horizontal extraction or injection wells can be placed at any depth and on either side of the barrier membrane.

Backfill material consistent with the function of the system can be specified in the design and can be used to enhance or reduce the groundwater flow, or to provide a passive treatment/pretreatment process by selecting a chemically reactive material. Because the guide box functions as a structural support to keep the trench open, the backfilling can be performed slowly in order to achieve an even and homogeneous distribution of material. Since a slurry is not required in order to maintain trench stability, there are no suspended sediments that will disrupt the effectiveness of the backfill.

The pass-through provides a means of conveyance for groundwater to enter a treatment cell or reactor. This mechanism, combining insitu treatment with a barrier wall, permits more robust remedial designs which incorporates groundwater manipulation along with insitu treatment. The pass-through can be designed to any configuration in order to match the requirements of the selected treatment system. The possibilities range from a pipe discharge conduit to a completely open cross section area with width determined by the treatment capacity. This variation in design can accommodate both retrievable and non-retrievable treatment media.

An example of retrievable treatment media is a system where the media is contained in cassettes that are held in place by vertical tracks and are raised or lowered to change out the spent media. This design can include multiple types of media placed in series in order to provide a staged treatment system. Additional control can be provided using a "sluice gate" type of mechanism to stop the flow of groundwater into the treatment area while cassettes are being changed out.

An insitu bioreactor is an example of non-retrievable treatment media. The reactor is constructed in-place at the pass-through and required treatment elements, such as nutrients, are introduced from the surface into reactor piping.

System installation

The conceptual design for the demonstration project incorporated a semi-permeable groundwater barrier and interceptor well system to create the capture zone and groundwater delivery capability for the MAG*SEP℠ treatment system. BMC was selected to install the patented EnviroWall™ groundwater barrier and pass-through system used to manipulate the flow direction of the contaminated groundwater. The system installation included a central pass-through module where groundwater was directed to an opening in the high density polyethylene (HDPE) geomembrane wall. The well connected to the upgradient side of the pass-through is constructed using four 6-in. diameter stainless steel screens each 15 ft long and with 0.030 in. openings. The screens are attached on top of a stainless steel sump box which also collects water from the four horizontal wells that extend in front of the barrier. The pass-through Module extends from the top of the sump box and is sealed through the HDPE geomembrane as a 4-in. diameter pipe. On each side of the pass-through module, a HDPE wing wall was constructed to a length of 120 ft making the total capture zone approximately 250 ft in length. During the installation, both sides of the geomembrane were backfilled with a very coarse sand (Foster Dixiana FX-99) to provide a zone of enhanced groundwater flow potential along the upgradient side of the barrier and in the direction of the pass-through. Horizontal wells were installed on the front side of the barrier at a depth of 15 ft below the water table and used to increase groundwater flow. The total depth of the barrier system is 30 ft below ground surface with a saturated vertical thickness of approximately 20 ft. Several monitoring well clusters were installed in the barrier backfill during installation of the wing walls.

Installation of the EnviroWall™ system followed a prescribed and patented method using trench and guide box construction. Five 8-ft long guide boxes were interconnected to one another along the length of the trench in a "leap frog" type procedure. After completion of piping and backfill installation, the guide boxes were disassembled and removed from the trench. An unstable sand was encountered at a depth of approximately 27 ft below ground surface which necessitated placement of temporary sheet piling to maintain an open trench until the guide boxes could be set. Site accessibility was limited and created difficulty in designing the method of tie-backs for the sheet piling. Once this problem was overcome, the placement of sheet piling did not greatly impact the installation rate of the barrier system. With the guide boxes in place, the geomembrane was installed by lowering a dispenser box into the 22-in. wide opening that was created. The dispenser box contained a roll of HDPE which was moved through the guide boxes for the length of the barrier. Insert beams were placed on both sides of the geomembrane in order to hold it upright and a downhole video camera was used to inspect the geomembrane wall to confirm the integrity of the barrier. The entire barrier was completed with one continuous sheet of HDPE, eliminating the need for a vertical or horizontal seam.

The horizontal wells in front of the geomembrane were installed after partially backfilling with filter material inside the guide box to the designed depth of the wells. Three-inch diameter perforated HDPE flexible piping was then placed at the desired level and the backfilling completed. Two horizontal wells were installed on the upgradient side of each wing wall with approximate perforated zones extending from 40 to 80 ft and from 70 to 110 ft. A horizontal well, perforated from 0 to 100 ft was installed on the downgradient side of the south wing wall, in the same manner, to provide for re-distribution of groundwater into the aquifer. Vertical monitoring clusters were installed approximately every 50 ft on the upgradient and downgradient side of the geomembrane. Each cluster was constructed to monitor across the water table, 5 ft below the water table and 27 to 29 ft below ground surface. The end of each wing was sealed with a bentonite and silty sand mixture in order to prohibit flow around the ends of the barrier.

Future use of this system will include the experimentation and demonstration of innovative insitu treatment technologies (such as Selentec's MAG*SEP℠ system) coupled to the EnvironWall™ groundwater barrier and pass-through module both at the SRS D-Area and possibly at other sites.

Status

The system is completely installed and is operating as an impermeable barrier. During the 1997 fiscal year, system performance data will be collected, including leak-test studies. Also, the system will be used to provide metals-contaminated groundwater for a demonstration of the DOE-funded MAG*SEP℠ treatment technology. Additional demonstrations using other types of treatment technologies are being considered.

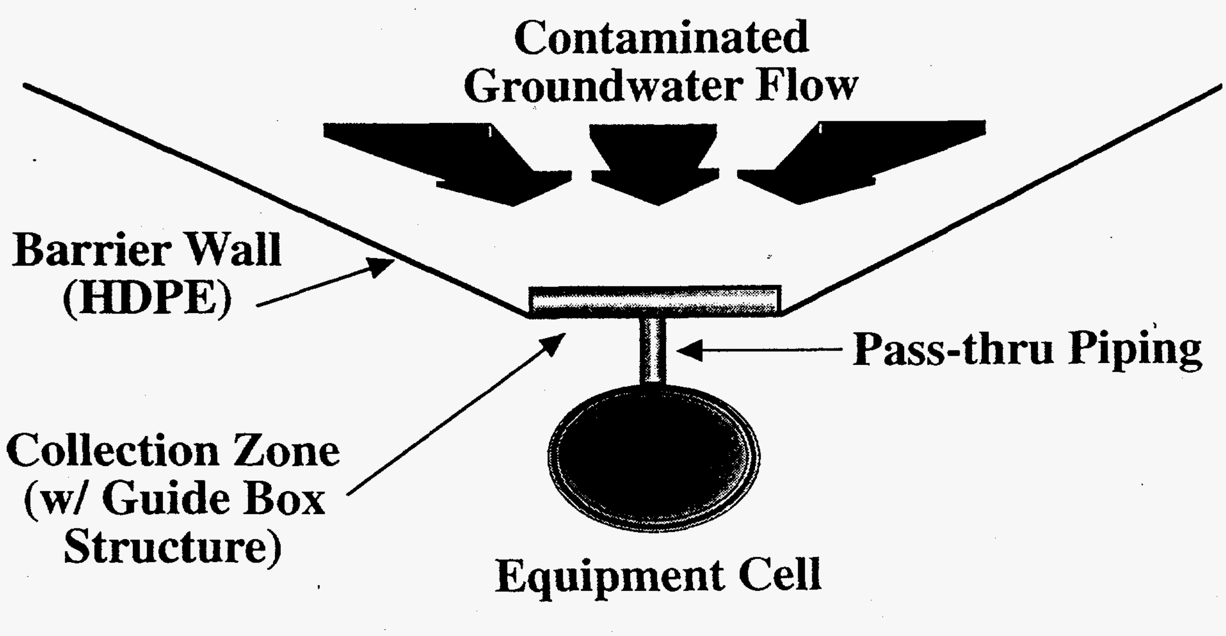

Fig. 1 EnviroWall™ Funnel and Gate System Configuration

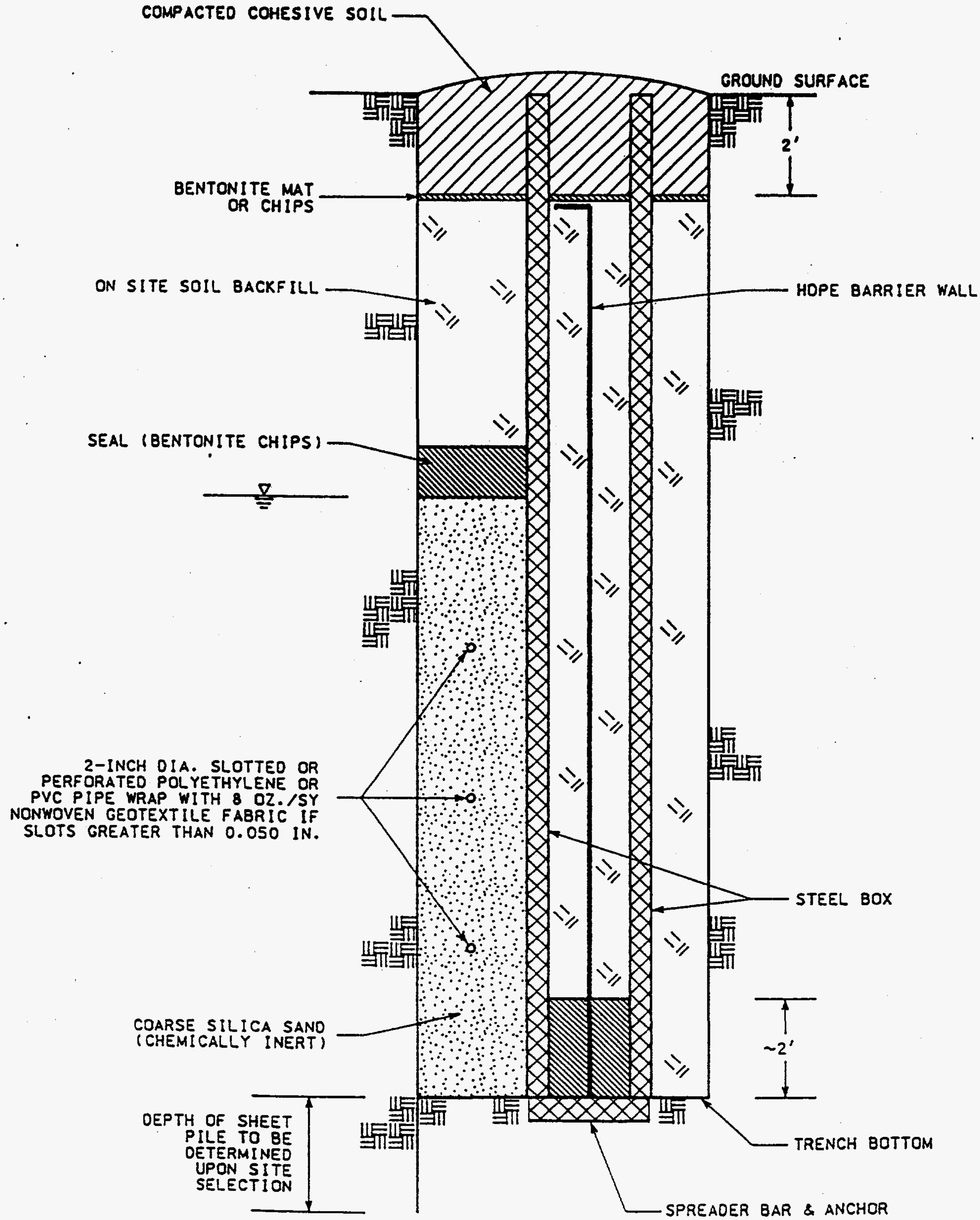

Fig. 2 Typical Cross Section of the EnviroWall™ System