

QUALITY CONTROL AND PERFORMANCE OF A CUTOFF WALL FOR CONTAINMENT OF DNAPL PLUME

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This paper describes the quality control and performance of a soil-bentonite cutoff wall at the Taylor Lumber Superfund Site in Sheridan, Oregon. The cutoff wall was constructed under an EPA Emergency and Rapid Response contract. The site is used for the wood treatment of telephone poles, pilings, and railroad ties. The cutoff wall was constructed to contain a dense nonaqueous phase liquid (DNAPL) plume, which threatened to contaminate the nearby Yahmill River. The cutoff wall with a length of 2,030 feet and a maximum depth of 26 feet completely surrounds the wood treatment facility. The wood treatment facility remained active, and care was taken to limit the impacts of construction on the facility's operations. Challenges included achieving a maximum permeability of 1×10^{-7} cm/sec with materials containing minimal fines, excavating around utilities including gas and sewer lines, and meeting the fast tracked mobilization and construction schedule. The project included construction of a cap over the cutoff wall, which consisted of geosynthetic clay liner (GCL), geotextile, and aggregate base. This project represents the first full closure slurry cutoff wall constructed for EPA Region 10.

1.0 Introduction

The United States Environmental Protection Agency (US EPA) required the construction of a soil-bentonite cutoff wall. The cutoff wall provides isolation of a DNAPL plume at an existing wood processing facility, and prevents migration of the same plume into a local river. The cutoff wall was constructed in September 2000. Subsequent groundwater monitoring indicates that the cutoff wall is performing well.

2.0 Background and Existing Conditions

The site is located at the Taylor Lumber Wood Treatment Facility in Sheridan, Oregon, approximately 50 miles southwest of Portland. This facility is used for the chemical treatment of wood for use as telephone poles, pilings, and railroad ties. This site was listed as a superfund site after a spill released chemicals into the underlying aquifer. This spill released a dense nonaqueous phase liquid (DNALP) plume, which required mitigation prior to reaching the adjacent Yahmill River. Several alternatives were evaluated for the mitigation of this site, including remediation by steam injection. However, the method chosen for this site was the construction of a soil-bentonite cutoff wall, which created a subsurface barrier to contain the plume. The United States Environmental Protection Agency (USEPA), Region 10, enacted an Emergency and Rapid Response contract to construct a soil-bentonite cutoff wall at the site.

The construction schedule required mobilization and pre-construction submittals within one week of award of the contract. Also, the completion date was governed by the requirement of the Oregon Department of Transportation, for the placement of asphalt concrete before September 30. Since the asphalt concrete paving was the last phase of the site restoration, it was essential that the cutoff wall be completed in time to allow the paving prior to September 30. The greatest economy can be realized where the excavated soils can be reused in the soil-bentonite backfill. However, on this site the excavated soils were not suitable for preparation of soil-bentonite backfill, and were wasted at a

site location. The excavated soils contained a low fines content (materials passing a 200 sieve). Imported fine-grained soils were selected for preparation of the soil-bentonite backfill.

3.0 Project Description

The soil-bentonite cutoff wall was constructed using the slurry trench method. This method allows excavation without the use of other lateral support such as shoring. Slurry walls are constructed by excavating a narrow trench which is three feet wide for this project, while pumping slurry into the trench and maintaining its level at or near the top of the trench during the excavation process. Usually, the trench is keyed into an underlying aquiclude which for this project is a two feet key into a siltstone layer. The aquiclude forms the bottom and the slurry wall forms the sides of the containment. The trench is filled with a bentonite slurry, which hydraulically shores the sides of the trench. The slurry is a mixture of water and bentonite which is heavier and thicker than water. The trench is backfilled with a soil-bentonite mixture which is impervious (10^{-7} cm/sec) to form a permanent cutoff.

The cutoff wall at the Taylor Lumber site completely surrounds the wood treatment facility. The length of the cutoff wall is 2030 linear feet with a maximum depth of 26 feet, and average depth of 22 feet, and a width of three feet. The wood treatment facility remained active at all times, and accommodations were made to minimize disturbance to the facility's operation. This included continuous coordination with the facility managers, a daily updated schedule, and construction of ramps over the cutoff wall at key access points.

3.1 Mix Design

A mix design was developed for this project to determine the necessary proportions to achieve the maximum specified permeability of 1.0×10^{-7} cm/sec. To achieve this, soils were imported from an offsite borrow area, and mixed with dry bentonite at a rate of 8% by dry unit weight of soil. The permeability was later verified by testing of both batch samples taken during the construction activities, and through core samples taken after cutoff wall completion. Mix design was accelerated to meet the schedule necessitating a conservative dry bentonite additive to insure the permeability requirements were met.

3.2 Bentonite Slurry Mixing for Cutoff Wall Construction

Bentonite slurry was mixed at a central location in a high speed colloidal mixer. Slurry was mixed at a ratio of 6% bentonite by weight of water. After slurry was mixed, it was stored in a storage pond with a capacity of approximately 30,000 gallons. In this pond the slurry was recirculated and allowed to hydrate until it was pumped into the open trench through a six-inch High Density Polyethylene (HDPE) pipe.

3.3 Cutoff Wall Excavation

The cutoff wall was excavated three (3) feet wide from the existing surface to a maximum depth of twenty-six (26) feet using a 150,000 pound hydraulic excavator (See Figure 1). Bentonite slurry was maintained in the trench to within two (2) feet of the surface. Excavated soils were loaded directly into trucks for transportation and disposal at an onsite cell. Excavation was completed two (2) feet into the siltstone layer.



3.4 Soil-bentonite Preparation Backfill

The soil-bentonite backfill (backfill) was mixed at a prepared earthen working pad using a hydraulic excavator and a dozer until a thoroughly consistent mixture was achieved. Imported soils were staged alongside trench alignment. Dry bentonite powder and bentonite slurry were added to the imported soil in accordance with the mix design proportions. The dry bentonite was added from 3,000-lb bags, and bentonite slurry was added from the trench as it was displaced by backfill, and from the slurry mixer.

These materials were mixed together until they formed a homogeneous mixture that was roughly the consistency of concrete. As the backfill was placed in the trench it formed an approximate slope of 7:1. This slope was maintained by placing the backfill at the top of the slope and letting it slide down the slope face. In this way the backfill material was installed without causing any voids or trapped pockets of slurry.

3.5 Utilities Accommodation

Challenges of constructing the cutoff wall included accommodation of the numerous utilities on the site. These utilities included gas, sewer, electric, telephone, water, and storm drains (See Figure 2). Utilities were accommodated by potholing and excavating around them, and in the case of the gas line, protecting in place with concrete prior to excavation. Multiple utilities in a small area required excess caution while excavating.



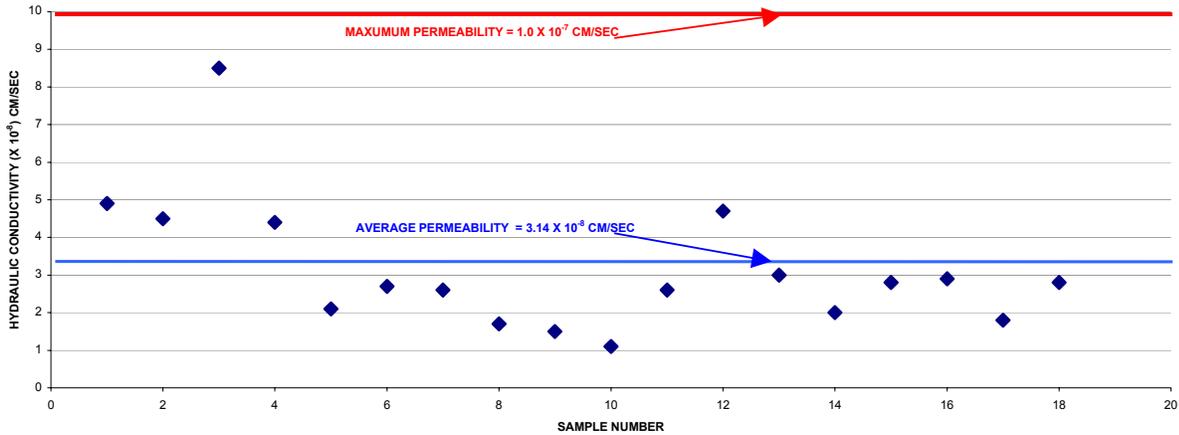
4.0 Trench Cap

Following completion of the cutoff wall, a cap was constructed over the entire length of the wall. The cap consisted of geotextile fabric, geosynthetic clay liner (GCL), and aggregate base rock. The purpose of this cap is to seal and protect the cutoff wall, while still providing a structural base to support the operations of the wood treatment facility. Special care had to be taken when constructing the GCL due to inclement weather conditions. Aggregate base was constructed in lifts and compacted to 95% in order to provide a sufficient foundation for the paved surface to go over the cap.

5.0 Quality Control

Strict adherence was maintained for all quality control procedures on this project. Properties of the slurry and backfill were tested daily by the contractor. These properties include unit weight, viscosity and slump. The depth of the cutoff wall including the siltstone layer was measured at twenty foot intervals. This depth was verified by both the contractor and EPA's representative. An independent testing laboratory conducted nineteen flexible wall permeability tests of the soil-bentonite samples collected during construction at a frequency of one test every shift. The test results listed below were consistent with the mix design result and exceeded the criteria of 1×10^{-7} cm/sec.

HYDRAULIC CONDUCTIVITY OF SOIL-BENTONITE BACKFILL
TAYLOR LUMBER WOOD TREATMENT FACILITY
SHERIDAN, OREGON



6.0 Site Safety

Due to potential exposure to contaminants and the congestion of the work area, site safety was extremely important on this project. A full time site safety officer was employed by the contractor to perform real-time air monitoring for the personnel in the work zone. In addition to this, perimeter air monitoring was performed on the outer boundaries of the project site. Site safety meetings were held daily, and included representatives from the EPA and the contractor.

7.0 Conclusion

The project was completed by constructing a soil-bentonite cutoff wall into an existing siltstone aquiclude. The project was successful due to the cooperation among the facility's owner, the design engineer, and the contractors. To facilitate future projects, we recommend the following:

1. Characterize completely and accurately the subsurface soils and the required depth of excavation; and
2. Conduct a laboratory mix design utilizing proposed construction materials. The mix design simulates field conditions and provides quality control parameters.