

# TECHNICAL SPECIFICATIONS CEMENT-BENTONITE SLURRY TRENCH CUTOFF WALL

## SCOPE

This section of the specifications includes requirements for the Slurry Trench Cutoff Wall and related work as indicated on the drawings and as hereinafter specified. The work consists of furnishing all plant, labor, equipment, materials and of performing all operations as required to construct the slurry trench cutoff wall.

Slurry trench cutoff walls shall be plastic, cement-bentonite slurry, providing a continuous homogeneous, relatively impermeable barrier to groundwater seepage and approximating the strength of the insitu soil.

## REFERENCE STANDARDS

The following publications of the current issue form a part of this specification to the extent indicated by the references hereto:

American Society for Testing and Materials (ASTM)

C150	Portland Cement
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American Petroleum Institute (API)

13 A	Bentonite
13 B	Testing

## SLURRY TRENCH CUTOFF

A relatively impervious slurry trench cutoff wall shall be constructed to the lines, grades and cross sections as indicated on the drawings. The trench shall have essentially vertical walls, a minimum width of \_\_\_\_\_ ft, and shall extend through the overburden and key a minimum depth (as specified) into the aquiclude. A generalized description of the overburden through which the slurry trench cutoff is to be excavated is indicated by boring logs included in the drawings.

## **SUBMITTALS**

### Qualifications of Contractor

The Contractor shall submit evidence that he is experienced and competent to construct a cement-bentonite (C-B) slurry trench. He shall have completed at least three projects of similar scope and magnitude. This evidence will insure that the Contractor will have sufficient, competent, and experienced personnel to carry out the operations specified. In particular, a slurry trench specialist (as approved by the Engineer) shall supervise the construction, slurry preparation, and quality control.

### Design Mix

The design mix for the slurry trench cutoff walls, including proposed additives, shall be submitted to the Engineer for review. At the same time, test results verifying this mix achieves the performance requirements shall be submitted.

### Installation Procedure

The Contractor shall submit a complete description of the procedure(s) to be used in excavating for and installing the slurry trench cutoff walls to the Engineer for review.

### Equipment Description

The Contractor shall submit for review complete descriptions of all equipment to be used in the trench excavation, and in the mixing, storing, circulating, pumping and placing the cutoff wall.

## **MATERIALS**

### Bentonite

Bentonite shall be pulverized natural Wyoming sodium montmorillonite clay complying with American Petroleum Institute Specifications 13 A.

### Cement

Cement shall be Portland Cement Type 1 meeting the requirements of ASTM Specification C 150. Based upon performance requirements, alternative cements may be utilized as approved by the Engineer.

### Water

Water shall be clean, fresh, and free from excessive oil, acid, organic matter or other deleterious substances. Admixtures such as softening agents may be used to improve the characteristics of the water to permit proper bentonite and cement hydration.

## Additives

Admixtures of softening agents, dispersants, retarders or plugging or bridging agents may be added to the water or the slurry to permit efficient use of bentonite and proper workability of the C-B slurry. However, no additives shall be used except as approved by the Engineer.

## **INSTALLATION**

### Excavating

Trenches shall be excavated by backhoe, clamshell, or other suitable trenching equipment. The excavating tool shall have a minimum width equal to the specified trench width.

The Contractor shall maintain the stability of the excavated trench at all times for the full depth. Slurry shall be introduced into the trench at the beginning of excavation. Slurry shall always be 2 ft above groundwater level and not more than 3 ft below the top of trench during excavation.

If slurry in the trench begins to set or becomes unworkable before excavation is completed, then freshly made slurry or admixtures shall be added to correct the situation. Addition of water to the slurry in the trench will not be permitted.

Any suspended sand, gravel or other sediment that may settle out of the slurry or fall to the bottom of the trench shall be removed with the excavating tool or other suitable equipment.

### Mixing

The slurry batching plant shall include the necessary equipment including a mixer capable of producing a stable suspension of cement in a bentonite and water slurry, pumps, valves, hoses, supply lines and all other equipment as required to adequately supply slurry to the trench. All slurry for use in the trench shall be prepared using a suitable high shear mixer, such as a colloidal or paddle mixer. No slurry is to be made in the trench.

Bentonite slurry shall be prepared by mixing water and bentonite until the bentonite particles are fully hydrated and the resulting slurry appears homogeneous. Storage ponds may be used to hydrate the bentonite slurry.

Cement shall be added to the bentonite slurry just before introduction in the trench. The cement shall be thoroughly blended into the slurry until the mix is homogeneous and the cement particles are fully dispersed in the bentonite slurry. The C-B slurry shall be constantly circulated until introduced in the trench.

## Backfill Placing

Slurry shall be introduced into the trench at the same time trenching is begun and shall be maintained in the trench during excavation.

For slurry placement, the slurry shall be the self-hardening cement-bentonite slurry. Once the cement-bentonite slurry is introduced into the trench, excavation shall be continuous. If excavation is delayed more than 1 hour, the panel shall be agitated by other means to impede the set of the mix. If the panel is not agitated, the panel shall not be disturbed or joined with a new panel for at least 8 hours or until the hardened cement-bentonite is self-supporting.

## **EXECUTION OF THE WORK**

### Slurry Trenching

Excavation shall be carried to final depth at the point where excavation is started and then the final depth of cut shall be carried along the line of the trench.

Excavation shall proceed continuously from the starting point to the finishing point. Slurry shall be introduced into the trench at the same time trenching is begun and shall be maintained in the trench during excavation. The Contractor shall maintain the stability of the excavated trench at all times for its full depth. The level of the slurry shall not be permitted to drop more than 3 ft below the surface of the slurry trench working platform except as approved by the Engineer. The Contractor shall have personnel, equipment, and materials ready to raise the slurry level at any time. To this end, the Contractor shall have personnel on call to raise the slurry level, weekends and/or holidays included.

### Key

Unless otherwise directed, the bottom of the slurry trench will be keyed (as specified) into the underlying aquiclude beneath the site as indicated by soil borings, except that if the backhoe or clamshell is unable to achieve the minimum specified penetration into weathered rock without the assistance of ripping teeth, blocks or percussion chisels, the minimum penetration requirements will be modified and the trench will extend to the depth where refusal of the excavating equipment is encountered. The final depth and penetration of the trench shall be measured and checked by the Contractor and approved by the Engineer immediately following excavation.

### Continuity Between Trench Segments

Anytime that a trench segment is extended where the slurry in the previously excavated trench has taken a set, the excavation tools will be arranged to re-excavate a minimum 3 ft overlap into the end of the previously excavated trench.

### Slurry in Trench

If at anytime the slurry in the trench begins to set or gel before excavation is completed to the full depth at the point of excavation, or otherwise becomes unworkable, then sufficient freshly made slurry with admixtures, if necessary, shall be added to correct the situation. Addition of water to the slurry in the trench shall not be permitted.

### Trench Top Treatment

After initial slurry hardening, the top of the completed trench shall be checked for free water or surface depressions. Any free water shall be removed and the trench shall be filled with slurry to the specified elevation. Following initial set of this additional slurry, the top of the trench shall be covered with material to prevent drying of the slurry. The Contractor may elect to forego this second filling of the top of the trench and replace it with clay material to the surface. The clay material shall be placed in 1 ft maximum loose lifts and compacted to a minimum density of 90% ASTM D698. No cover material shall be placed until the trench has been inspected by the Engineer.

### Clean-up

Material excavated from the trench shall be stockpiled or disposed of in areas designated on the drawings. After completion of the slurry trench, the surface shall be cleaned of all excess slurry. No slurry shall be left in ponds, and all ponds shall be pumped dry and backfilled.

## **QUALITY CONTROL**

The Contractor shall maintain his own Quality Control for the cutoff wall construction under the direction of the Engineer. Testing requirements are summarized in Table 1 and specified herein.

### Design Mix Requirement

Permeability - Hydraulic conductivity to be less than \_\_\_\_\_ cm/sec.

Density - Density of fluid samples and cured samples to exceed \_\_\_\_\_ pcf.

Strength - Unconfined strength to exceed \_\_\_\_\_ psi when fully cured.

## Trench Continuity and Key

The Contractor shall be responsible for demonstrating to the satisfaction of the Engineer that the trench is continuous and keyed the minimum specified depth into the underlying aquiclude. Trench continuity shall be assured by the action of movement of the trench excavation equipment such that the digging tools can be passed vertically from top to bottom of the trench as well as moved horizontally along the axis of the trench without encountering unexcavated material. Penetration of the bottom of the trench into the aquiclude shall be demonstrated by observation of the cuttings removed from the trench and by direct measurement of trench depth to the satisfaction of the Engineer.

## Slurry

Testing requirements for slurry are as follows:

### (A) Materials

Bentonite: Certification of Compliance with the Specification shall be obtained from the material manufacturer.

Cement: Certification of Compliance with the Specification shall be obtained from the material manufacturer.

### (B) Bentonite Slurry

The viscosity of the bentonite slurry shall be measured at least once per shift or each time a pond is prepared.

At the time of introduction of cement in the bentonite-water slurry, the bentonite slurry shall have a minimum \_\_\_\_\_ seconds reading through a Marsh Funnel Viscometer.

### (C) Cement-Bentonite Slurry

Cement shall be weighed or metered and added to the bentonite slurry to produce a minimum cement-water ratio of \_\_\_\_\_ by weight.

Slurry prepared for introduction into the trench shall have a minimum density of \_\_\_\_\_ pcf.

## Hardened Slurry

Samples of the cement-bentonite slurry shall be obtained from the trench while still fluid and properly stored and cured for testing.

- The average permeability of these samples when fully cured, consolidated to insitu conditions, and permeated shall be  $k \leq$  \_\_\_\_\_ cm/sec.

- The minimum unconfined compressive strength of the hardened slurry at 28 days after mixing shall be greater than \_\_\_\_\_ psi and consistent with the design mix.
- The density and water content of the fully cured samples shall be consistent with the design mix.

### Method of Reporting

All quality control data will be available for inspection by the Engineer. Daily field tests may be observed by the Engineer. The results of daily field tests will be compiled on an appropriate form. These forms shall be verified daily by the Engineer's on-site representative. A copy of these reports will be given to the Engineer at the end of each working day.

Laboratory results shall be made available as soon as possible after the tests are complete. A comprehensive summary report on the laboratory and field tests will be provided at the completion of the work by the slurry trench contractor.