Parallel Thimble Shoal Tunnel Project

Managing Construction Materials on the Parallel Thimble Shoal Tunnel Project

When building a large infrastructure project, there are almost always construction waste products that require disposal. The Parallel Thimble Shoal Tunnel project is no different, as it generates process water, excavated soils (dirt) and other construction materials. This paper will briefly describe the major activities that generate soil, and the proper management and disposal of solid materials resulting from the construction of the tunnel. Once the volume of waste has been reduced as much as possible through efficient design and reuse, end products such as dredged material and bored soil are disposed. The Chesapeake Tunnel Joint Venture (CTJV) is managing the containment, transportation, and disposal of dirt and other solid construction materials in compliance with all regulatory requirements.

Slurry walls

One of the first construction activities is to build the launch portal for the Tunnel Boring Machine (TBM). This is a deep pit that allows the TBM to begin boring. Slurry walls are used to form the concrete portals at the entrance and exit of the tunnel. First, a small area is excavated and concrete walls are poured to form a guide for the slurry wall excavator. The guide walls (see number 1 in the figure) are four feet apart and are embedded about six feet into the earth.

What is a polymer slurry? Think of how cornstarch thickens gravy. The thick, viscous slurry keeps the deep excavation stable while the concrete is added.

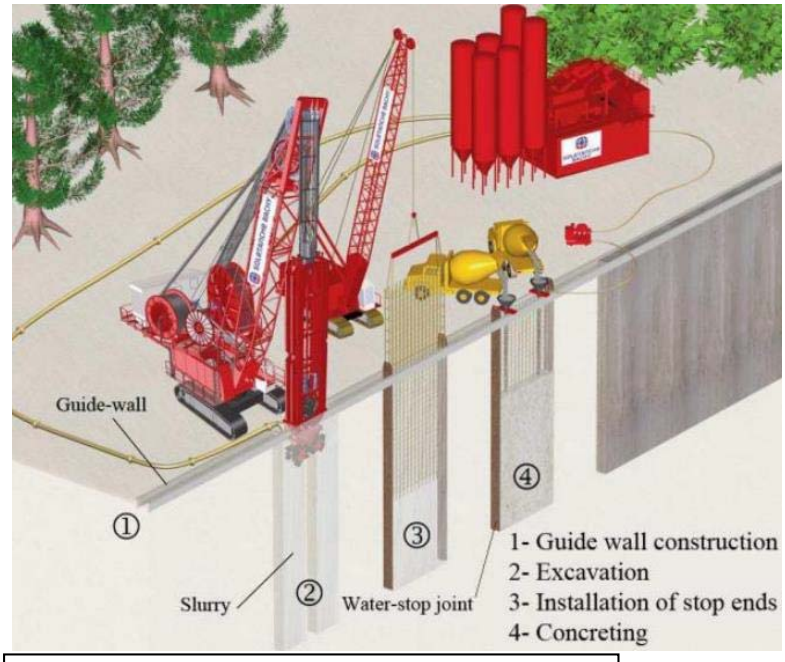

Figure 1. Schematic of slurry wall construction

The soil between the guide walls is then excavated to a depth of up to 120 feet. To maintain the stability of this deep excavation, slurry polymer (see number 2 in the figure) is used to replace the soil that is removed. After excavation reaches the proper depth, a steel reinforcing cage is placed in the excavation, and concrete is then placed from the bottom up using a tremie pipe. The polymer slurry is gradually extracted as the concrete fills the space between the guide walls (see number 4 in the figure).

The excavated soils are in contact with the polymer slurry during the

operation, therefore the material is tested and disposed of in a Virginia Department of Environmental Quality (DEQ)- approved location.

After each slurry wall panel is complete, the polymer slurry is recycled for use on the next panel. At the end of the slurry wall operations, the remaining slurry will be disposed of in DEQ-approved locations. The slurry is comprised of approximately 86% water, 13.5% stone dust and 0.5% biodegradable polymer, and does not contain constituents which would render it environmentally concerning.

Jet grouting

Jet grouting is a method of using Portland cement and water to solidify subsurface soils. On the Parallel Thimble Shoal Tunnel Project, it is used to strengthen and waterproof certain areas, and to stabilize weak foundation soils to allow safe tunneling. High-pressure jets of air and water (see Figure 2) are used to loosen subsurface foundation soils so that they can be mixed with a jet of grout (Portland cement). The resulting mixture cures into a low-strength concrete with specific design properties. During jet grouting, a slurry of excess water, soil, and cement (called jet grout residual) is brought to the surface for treatment before disposal.

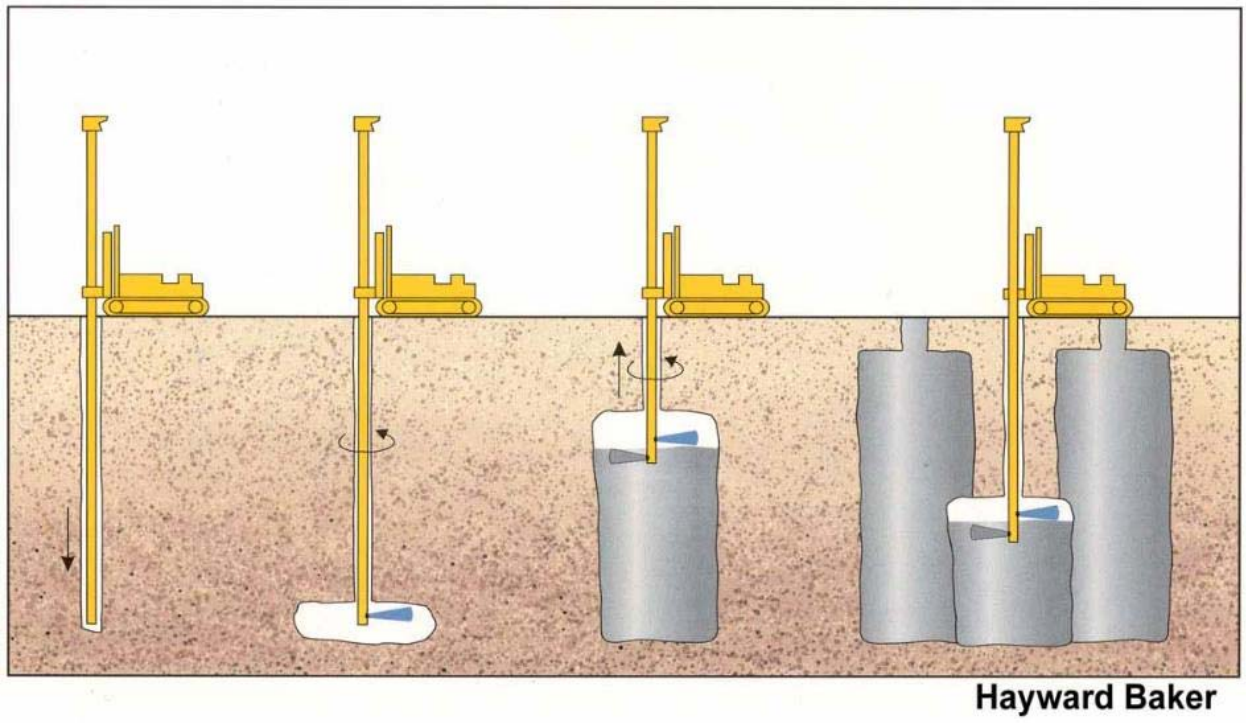

Figure 2. Jet grouting schematic.

Jet grouting creates low strength-concrete pillars, each about five feet in diameter, below the surface of the soil. These pillars overlap to form a solid mass of material. The jet grout residual is pumped into decanting bins, which separate the water from the solids. The water is adjusted for pH prior to discharge, and the solids are allowed to settle before being disposed by truck to a DEQ-approved location.

Tunnel portal excavations

Once the slurry walls and jet-grout are in place, the areas they enclose are excavated to create the tunnel portals. In the case of the Parallel Thimble Shoal Tunnel, the material to be excavated is clean marine sand that was used to construct the original portal islands in the 1960s. Once the portals are excavated, the base of each portal is completed by constructing a concrete slab at the bottom. Now the entrance portal is ready for the tunnel boring machine (TBM).

Tunnel boring

The 43-foot-diameter tunnel boring machine (TBM) is lowered into the tunnel entrance portal at Island One and will bore approximately 1 mile to the exit portal at Island Two. As the TBM bores through the soil, precast concrete segments are installed at the rear of the machine to form the tunnel lining. Excavation and lining occur concurrently with the TBM advancing in increments of six and a half feet, consistent with the width of the precast concrete segments.

The TBM will excavate through Chesapeake Bay sediments beneath the Thimble Shoal Channel at depths of up to 150 feet. There are two important reasons that soil conditioners are added to the cutting head of the TBM. The first is that in order to maintain stability of the ground ahead of the TBM, the pressure in the soil (due to water and weight of soil) at the cutterhead (see number 1 in figure 3) must be balanced with the air pressure in the tunnel. The second reason is to ensure the proper consistency of the soil to allow removal by the screw conveyor (see number 2 in figure 3) from the cutterhead in a controlled manner. Once excavated material exits the screw conveyor, it is transported through the tunnel on a conveyor belt (see number 3 in figure 3). To maintain excavated material in a consistency suitable for removal by conveyor, very small amounts (on the order of 6/10ths of 1 percent by volume) of conditioning additives are added in the excavation chamber/cutterhead of the TBM.

Conditioning additives are matched to the types of sediment encountered, and may include drying agents, foaming agents, and surfactants (like dishwashing soap or laundry detergent) that help convey bored material out of the cutterhead and onto a conveyor belt. Once the excavated material reaches the entrance portal, it is placed either on barges or in a temporary decanting storage location on the island, where it can settle before disposal at a proper facility.

As with the other construction materials, baseline environmental testing is conducted on the excavated material prior to disposal. Testing is also conducted during construction to ensure proper environmental stewardship.

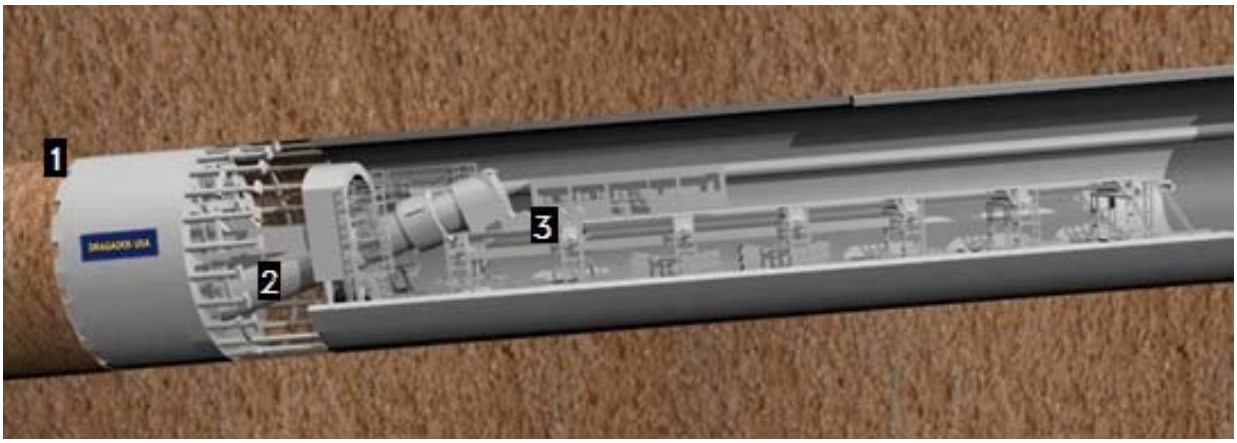

Figure 3. Tunnel Boring Machine.

Five brand-name conditioning additives were tested for use in the tunnel boring operations including two that indicated small amounts of diesel range organics, also known as total petroleum hydrocarbons (TPH). Virginia DEQ regulations require that soils containing more than 50 parts per million of TPH must be disposed in lined landfills. Permitting has proceeded based on the most conservative approach, assuming that all TBM excavated material will be disposed in a lined landfill. However, the Chesapeake Tunnel Joint Venture is working with the additive manufacturers to review and reformulate their products. Preliminary test results are very encouraging, and the CTJV expects that the final products will be found to be classified as clean fill.

Conclusion

At each step along the way, from the initial concepts to the final design and construction, the Chesapeake Tunnel Joint Venture and Chesapeake Bay Bridge and Tunnel District have sought to reduce environmental impact. This includes minimizing impact to the Chesapeake Bay by minimizing the amount of dredging and reducing the amount of water used for construction processes. Plans are in place to properly dispose of soil and construction materials in accordance with all DEQ (permit) requirements.