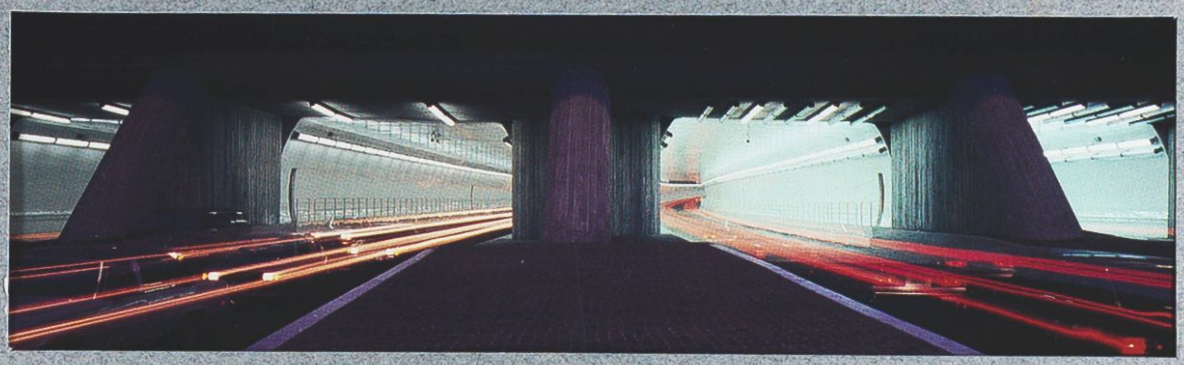
THE FORT McHENRY TUNNEL



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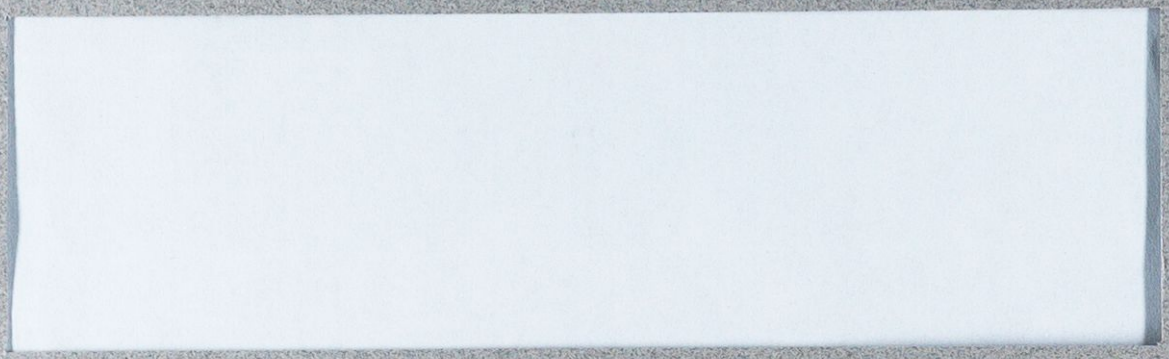


Dedicated to General Sam Smith. (1752–1839)

This distinguished American patriot commanded the land and sea defenses of Baltimore during the War of 1812. General Smith was responsible for the American victory in the Battle of Baltimore on September 12–14, 1814. This battle and the bombardment of Ft. McHenry inspired Francis Scott Key to write "The Star Spangled Banner."

Since The Fort McHenry Tunnel is located at the site of his greatest triumph, it is dedicated to the memory of General Sam Smith. It not only honors his heroism in battle, but also his love of country and a lifetime of selfless public service to the people of Baltimore and the State of Maryland.

INTRODUCTION

The opening of The Fort McHenry Tunnel is a milestone in many ways. It is the final link in the East Coast's most important interstate route, I-95. It is the world's largest submerged tube tunnel designed specifically for vehicular traffic. And the $425 million contract for tube fabrication and placement was the largest single construction project ever undertaken in the National Interstate and Defense Highway System.

In spite of enormous challenges, The Fort McHenry Tunnel has been completed on time and under the proposed $825 million budget. This fact alone is a tribute to the patience, skill and resourcefulness of the planners, designers, engineers, contractors, laborers and city, state and federal officials who put in thousands of hours to make this vitally important project a reality.

This dedication brochure provides a brief overview of the design, construction, funding, and environmental engineering required by this complex project.

DESIGN

Original plans called for an eight-lane bridge across Baltimore's harbor to close the final gap in I-95. However, the consensus was that a bridge would have a negative environmental impact on the National Monument and Historic Site at Fort McHenry and the Community of Locust Point. A 1.7-mile tunnel was proposed as an alternative.

The Fort McHenry Tunnel was designed by SPB, a joint venture of Sverdrup & Parcel and Associates, Inc. and Parsons Brinckerhoff Quade & Douglas, Inc., under the direction of the Interstate Division for Baltimore City and the Federal Highway Administration. The tunnel design team included several subconsultant firms: Delon Hampton & Associates, Chartered; Whitman, Requardt & Associates; Rummel, Klepper & Kahl; RTKL Associates Inc.; Purdum & Jeschke; The Leon Bridges Company; and EA Engineering, Science, and Technology, Inc. The toll plaza was designed by the joint venture of The Beavin Company and Lyon Associates, Inc. assisted by Ecosystems International, Inc.

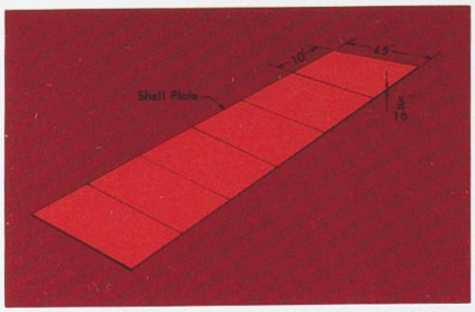
The tunnel extends from Andre Street on the Locust Point peninsula, passes south of Fort McHenry, under the harbor navigation channel slightly south of Fort McHenry, and below Clinton Street in the Canton Industrial Area, then rises to grade and widens to accommodate the toll plaza.

The challenges of building an eight-lane tunnel nearly two miles long were immense. Painstaking scheduling of contracts had to be maintained to prevent costly delays and to avoid disrupting road, rail and shipping access to the second largest port on the East Coast.

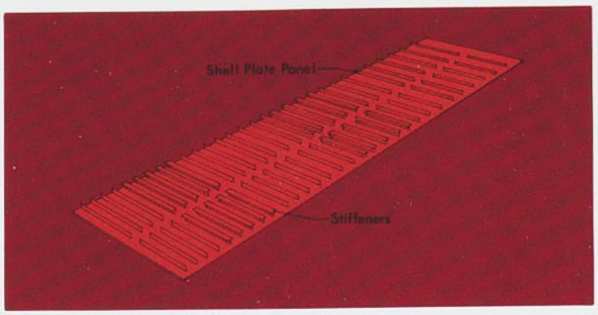
The alignment around Fort McHenry and below the shipping channel required the design of the world's first tunnel sections with both vertical and horizontal curvature. Rigorous planning—including 25 separate exhaustive design reports—resolved many of the anticipated problems and resulted in enormous savings of time and money. The relocation of a water main four feet in diameter under the harbor without disrupting service and numerous other logistical and environmental concerns had to be addressed.

Acquisition of property for the tunnel was the responsibility of the Interstate Division for Baltimore City. Over a three year period, more than 108 acres in the Locust Point and Canton areas were acquired at a cost of $17 million through the combined efforts of the State Highway Administration Office of Real Estate, Bureau of Appraisal Review, and Baltimore City's Office of Business Relocation. While the land acquired by the project included some of the largest railroad, port, petroleum and chemical facilities in the City of Baltimore, no residential property was affected.

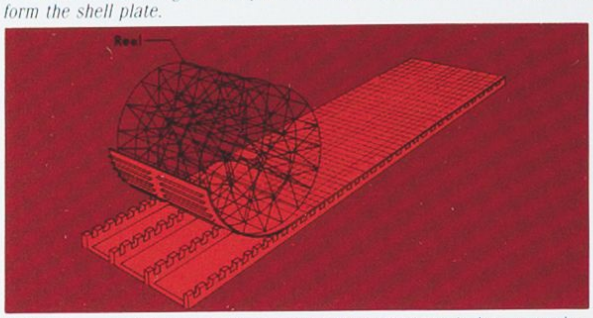
Photo (left): Emergency personnel communicate with surface units through tunnel antenna system which also provides motorists with AM and FM radio reception. Antenna system interrupts radio reception to broadcast bulletins.



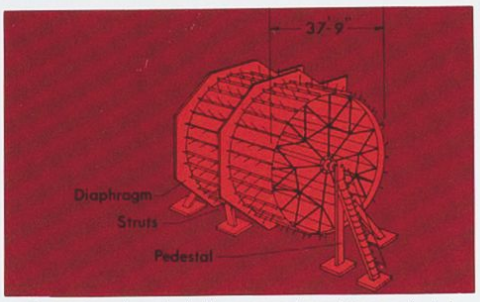
1. Tube fabrication begins with panels welded together to form the shell plate.



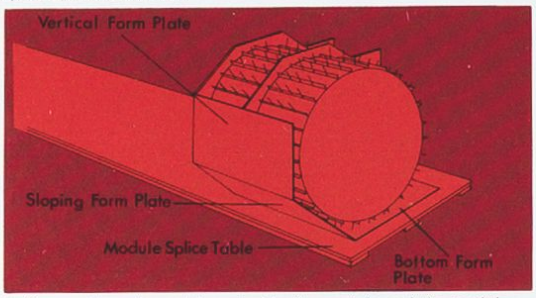
2. Longitudinal stiffeners are added for strength.



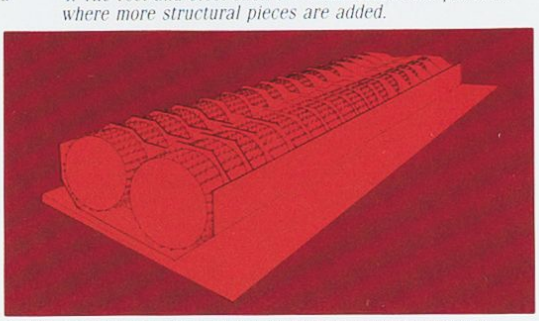
3. Shaping a module begins by wrapping the welded steel plate around a specially designed reel.



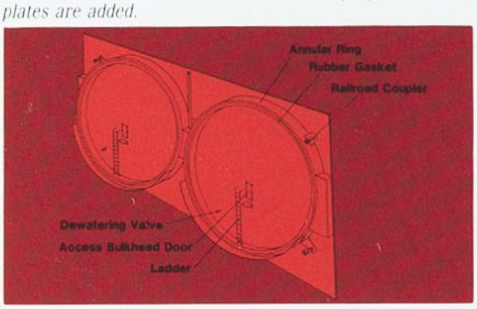
4. The reel and steel shell are transferred to a pedestal where more structural pieces are added.



5. The reel is collapsed from inside the module and the module is transferred to a table where bottom, sloping, and vertical form plates are added.

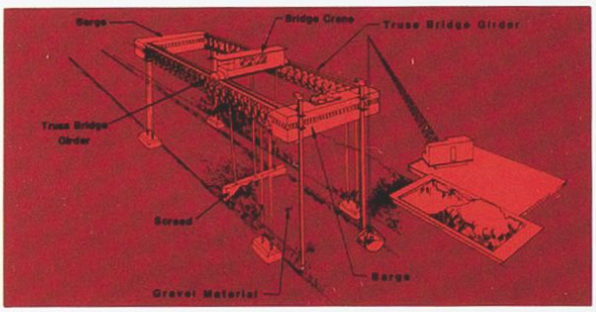


6. Sixteen of the modules (8 for each tube) are joined on the shipway to form a section of the double barreled tube.

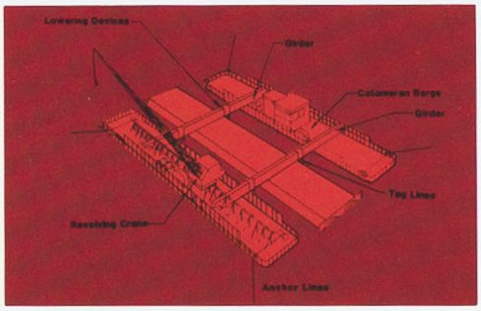


7. Dam plates are fabricated and attached to seal each end of the tube.

8. Keel concrete is placed to add strength and rigidity and the double barreled tubes are side launched for the 12-hour tow to the outfitting pier near Fort McHenry.



The screed barge. Suspended from the bridge crane is the actual screed, a heavy plow-like beam which spreads and levels the gravel material.



The lay barge. The tube is positioned for lowering between the catamaran barges of the lay barge. Additional concreting adds the proper weight for lowering the tube.

CONSTRUCTION

The construction of The Fort McHenry Tunnel required the precise coordination of 11 prime contracts. The initial contract of $425 million for the trench/tunnel was awarded to a joint venture of Kiewit-Raymond-Tidewater. They began work in May of 1980 to construct a dredge disposal site at Canton/Seagirt, 1½ miles southeast of the tunnel crossing. The designated area was first enclosed by 5,600 linear feet of cellular cofferdams, each 62 feet in diameter. A pipeline was then laid from the dredging site. During excavation of the trench, 146 acres of water were displaced by three and one-half million cubic yards of dredged material. The disposal site was designed so as not to preclude ultimate development by The Maryland Transportation Authority as a marine terminal. It is now under construction at a projected cost of $160 million.

Concurrent with the construction of the disposal site, fabrication of the 32 massive tube sections began at Wiley Manufacturing in Port Deposit, Maryland, on the Susquehanna River. As each football field-size section was completed, it was towed 56 miles from Port Deposit to a pier near Fort McHenry for concrete outfitting. While these giant modules were being fabricated, the dredging of the 180-foot-wide tunnel trench was underway.

The excavation was accomplished by a 27-inch hydraulic dredge which operated like a vacuum cleaner to cut a trench 50 to 70 feet deep into the harbor floor. Next, gravel was placed in the trench and carefully spread by a screed barge. This gravel bed served as the leveling course and foundation for the tubes.

The tube sections were then towed to a special lay barge near the trench where additional concrete was added to achieve negative buoyancy. A complex system of tag lines permitted precise adjustments of the tubes as they were lowered onto the gravel bed. The lowering process for each section took from six to twelve hours. As each tube section was completed, lowered and secured, another was placed within a few feet of it. Divers connected the tubes using coupling devices similar to those on railroad cars. Hydraulic jacks pulled the tubes together, sealing the rubber gaskets around the dam plates. Water trapped between the two tubes was pumped out.

Once the interior could be entered, a plate was welded across the joint seam and the area behind it filled with concrete for final water tightness. The dam plates were then removed and concrete placed to match up the insides of the tubes.

After a section was in place and joined to the next, backfill was placed around and on top of the tubes to keep each one protected and in position.

Eight tunnel modules were placed and backfilled on the Locust Point side of the harbor before work shifted to the Canton shore. While the western tubes were located at the harbor's edge, a unique system of land dredging extended an excavated trench 1,200 feet inland on the eastern side. Special pumps and water treatment facilities had to be implemented

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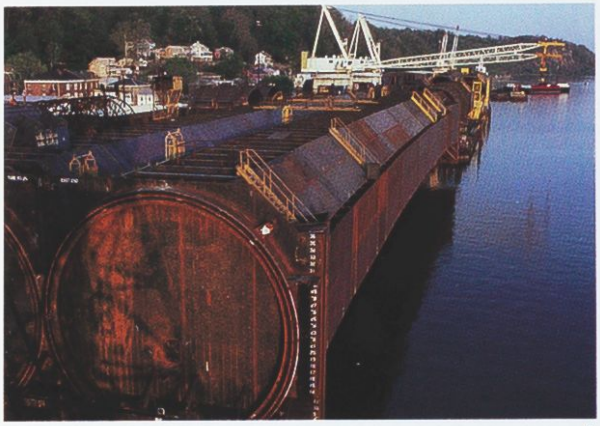

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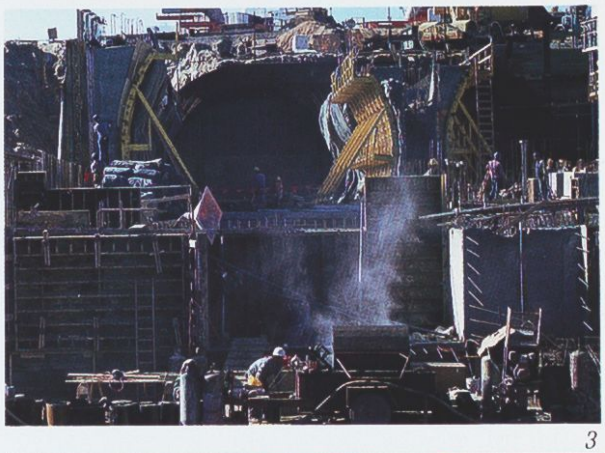

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to neutralize the highly acidic water found at the site. Sections of sheet piling were driven to limit the width of the trench and minimize interference with the operation of the industries in the area. After excavation reached the ground water table, the dredging, gravel foundation, tube placement and backfilling techniques were repeated.

After placement of tubes at the shorelines, work began on both approaches. The western approach was constructed by The Lane Construction Corporation, while the eastern approach was built by S.J. Groves & Sons Company. Each approach included a section of open roadway, cut-and-cover tunnel and the underground portions of the ventilation buildings. Massive concrete "gravity slabs" were constructed to counteract the buoyant effect of ground water.

The ventilation buildings were completed at each end of the tunnel by The Whiting-Turner Contracting Company. The eastern building is a steel structure with precast panels; the western one includes a brick facing and appropriate landscaping to make it visually compatible with the historic fort area. Inside the buildings, 48 nine-foot-diameter electric fans and damper controls, installed by TLT-Babcock, Inc., exchange the air in the tunnel once every minute.

When the tunnel was ready for the installation of mechanical, electrical and other finishing components by The Howard P. Foley Company, pump installations, fire fighting equipment, lighting, traffic sensors, signals and closed-circuit television cameras to monitor traffic flow were added. The tunnel walls were completed by lining them with over eight million ceramic tiles. White concrete-filled panels form the roadway ceiling. The space above the ceiling becomes the duct through which fumes are exhausted. Fresh air is provided through space beneath the roadway.

The administration building and toll booths were constructed by S.J. Groves & Sons Company. A computerized toll and data collection system was installed by Automatic Toll Systems, Inc.

Garages for emergency vehicles were built near both ends of the tunnel by Orfanos Contractors, Inc. Paving of the roadway surface was completed by P. Flanigan & Sons, Inc. Under the direction of the Interstate Division for Baltmore City, construction management services were provided by Sverdrup/Parsons Brinckerhoff and their subconsultants: Rummel, Klepper & Kahl; Whitman Requardt & Associates; District Engineering Services, Inc.; and EA Engineering, Science, and Technology, Inc.

The Fort McHenry Tunnel is one of the largest and most complex construction projects ever undertaken. In addition to increasing jobs, payrolls, tax revenues and the need for related services and supplies, it completes an essential link in the National Interstate and Defense Highway System; removes heavy commercial traffic from the central business district and neighborhood streets of East and South Baltimore; enhances the capabilities of the Port by providing important new access to the terminals at Locust Point, Canton and Dundalk; and relieves congestion at the Baltimore Harbor Tunnel.

Photos: (1) Tube end readied for installation of dam plate by Wiley employees. (2) Football field length tube elements were towed from Port Deposit launch site 56 miles to outfitting pier near Fort McHenry. (3) Construction cross section of east portal. (4) Tube in outfitting pier receives additional interior and exterior concrete. (5) Additional concrete is placed until negative bouyancy is attained while tube element rests in lay barge. Tube is lowered into trench and joined to in-place elements.


MARYLAND
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FUNDING

The construction of The Fort McHenry Tunnel required five and one half years at a cost of about $750 million. Ninety percent of the funding was provided by the Federal Highway Administration and, through a special Act of Congress, the remaining ten percent advanced by the Federal Highway Administration to the City of Baltimore during construction. This unique funding arrangement was secured by members of the Maryland Congressional Delegation, who were instrumental in the passage of this special Act of Congress. The Maryland Transportation Authority will repay the ten percent advance within the next three years by issuing revenue bonds. These bonds will be repaid through the collection of tolls.

The tunnel was constructed by the City of Baltimore through the Interstate Division for Baltimore City and will be operated by the Maryland Transportation Authority.

A special wage stabilization agreement between the Interstate Division for Baltimore City and the affiliated Local Unions of the Baltimore Building and Construction Trades Council was instrumental in keeping the project on schedule, while unique value engineering and escalation clauses helped keep the project under budget.

The dedication of everyone involved at each level—city, state, federal—is a monumental example of intergovernmental communication and cooperation.

Photo (left): Tolls are used to repay bonds and meet operating expenses.

ENVIRONMENT

Environmental considerations dictated not only resourceful design but also the preservation of the scenic integrity of Fort McHenry and the careful disposal of the three and a half million cubic yards of material dredged from the harbor bottom.

Approval was obtained from the United States Environmental Protection Agency; the Maryland Water Resources Administration; and the United States Army Corps of Engineers.

The dredge disposal requirements were resolved by creation of the Canton/Seagirt site. The slurry from the hydraulic dredging operation was treated before release from the site to prevent contamination of the Patapsco River and its contiguous wetlands. The resulting 136 usable acres will provide the Port of Baltimore with the basic infrastructure for a major new three berth marine terminal and much-needed storage facilities capable of handling 2.5 million tons of cargo annually. This should create a projected 14,000 jobs statewide.

To replace wetlands lost by developing the containment site, new tidal marshes will be created elsewhere in the harbor area. One such wetland has already been created with eight acres of marsh grasses located at the water's edge directly above the western end of the tunnel.

The aesthetic preservation of the Locust Point peninsula was achieved by a curved tunnel alignment; by design of a low-profile ventilation building; and by creative landscaping at the west ventilation building by Kim Landscaping, Inc. A landscaped embankment adjoins the building and enhances the area. In summer, visitors to Fort McHenry will see only trees along the shoreline. In winter, the ventilation building appears to be a brick wall behind a cluster of evergreen trees.

Photo (left): Container ship passes over tunnel near Fort McHenry—south of toll plaza.

STATISTICS

Time of construction	Five and One-Half Years (1980–1985)
Estimated construction cost	$825 million
Actual construction cost	$750 million
Tunnel Length:	
Length:	
Grade point to grade point	8800 feet
Portal to portal	7200 feet
Tube Section	5400 feet
Dredged trench depth (at deepest point)	115 feet
Number of tubes	32
Weight of steel in each tube	1,688 tons
Concrete required for each tube	21,200 cubic yards
Tube weight with concrete	44,620 tons
Total fan capacity (24 supply and 24 exhaust)	11,900,000 cubic feet per minute
Total capacity of pumps (28 total)	44,000 gallons per minute
Quantities of major construction items used:	
Structural steel	101,659,700 lbs.
Reinforcement (all types)	42,504,730 lbs.
Concrete	1,032,000 cubic yards
Piling (disposal site) restoration	35,000,000 lbs.
Dredged material	3,524,820 cubic yards
Ceramic tiling	1,800,000 square feet
Backfill	2,488,400 cubic yards
Electrical and Communications Wiring	3,000,000 L.F. (570 miles)
Paving	32,260 square yards
Prime Consultants-joint ventures	2
Subconsultants	8
Approach Consultants	22
Contractors	10
Subcontractors and Suppliers	558
Jobs associated with project	16,000
Dedication Ceremony	November 23, 1985