Abstract

CSX’s National Gateway Initiative II is a continuation of a public private partnership that extends CSX’s double-stack train route to the East Coast. The project includes clearance improvements at twenty-one sites, each with its own series of challenges. As the project approaches completion in 2016, this paper looks to summarize the conditions and challenges encountered. The 21 sites through West Virginia, Maryland, Washington DC and Virginia include overhead bridges, mountain tunnels, truss modifications of river bridges and the reconstruction of the Virginia Avenue Tunnel through Washington DC.

The challenges dealt primarily with obtaining clearance while maintaining rail operations and facilitating drainage through the corridor. Clearance improvements at the Harpers Ferry Tunnel included liner notching with a road header, liner removal reinforced with rock bolts, shotcrete and steel ribs as necessary performed during night and weekend outages. At the Point of Rocks and Catoctin Tunnels in Point of Rocks, Maryland, the trackbed was modified over a series of weekends where up to 12” of bedrock was removed and the track restored prior to the final weekend where the track was put into its final position. The track lowering through the L’Enfant corridor included lowering approximately 1800’ of track up to three feet below three highway overpasses and one 700’ long air rights structure while maintaining rail traffic through shared corridor between CSX, Amtrak and Virginia Railway Express. The Virginia Avenue Tunnel, located north of L’Enfant, is being expanded to accommodate two tracks.

INTRODUCTION

Increased volumes of domestic and international freight, and the need for improved service reliability, have prompted the North American railroads to accommodate double-stack, containerized intermodal service. Changes in the transportation marketplace are allowing the railroads to capture additional new business along routes, which only a few years ago were deemed too short to be efficient and economical. The highly anticipated completion of the Panama Canal expansion is expected to further increase container traffic flow through east coast ports and to inland consumer markets. Currently, 70% of intermodal shipments are made by containers suitable for double stack train transport. The ability to operate double-stack trains allows for twice as many containers for a given train length, reducing the
shipping costs per container. With the dramatic growth in intermodal traffic and in order to remain competitive, CSX recognized the need to double-stack clear its mainline route connecting Mid-Atlantic region ports with the large consumer markets in the Midwest and beyond.

NATIONAL GATEWAY INITIATIVE II PROGRAM SCOPE

National Gateway Initiative Phase II (NGI II) builds upon the successful completion of the 1st phase National Gateway Initiative program which was jointly undertaken with public agencies and CSX to clear a route for double-stacks between the east coast and Greenwich, Ohio. National Gateway Initiative Phase I was a $200M+ jointly funded public-private-partnership (PPP) between CSX and public agencies, in recognition of the substantial public and private benefits expected from clearing the route for double stacks.

CSX’s NGI II is a continuation of a public private partnership that extends CSX’s double-stack train route to the East Coast Ports and this part of the program was fully funded by CSX. The project includes clearance improvements at twenty one (21) locations, each with its own set of challenges. As the project approaches completion in 2016, this paper looks to summarize the conditions and challenges encountered. The 21 sites discussed are shown in the map below.
NGI II PROGRAM CHALLENGES

The entire NGI II rail corridor provides passenger rail service for VRE, MARC and Amtrak passenger trains and is also a primary freight connection between the Midwest and East coast. Track time on this corridor is limited especially during the week when commuter train service is in operation. On a typical day CSX operates 40 to 50 freight trains, 18 MARC commuter trains and 2 Amtrak passenger trains from Chambersburg, PA to Washington DC and 20-30 freight trains, 32 VRE commuter trains and 20 Amtrak passenger trains from Washington DC to the East Coast Ports. Through the selection of a Contractor Led Design/Build Team, the team was able to develop clearance solutions that maximized constructability while minimizing impacts on rail operations.

A major challenge was building consensus amongst the various stakeholders including West Virginia Department of Highways, City of Harpers Ferry, National Park Service, Utility companies, Norfolk Southern Railroad, Winchester and Western Railroad, City of Germantown, Maryland State Highway Administration, Montgomery County, and the list continues. The project team built support and consensus with early engagement of stakeholders and a transparent approach to design and permitting. The team worked towards win/win solutions and the projects frequently included betterments for the stakeholders.

One of CSX’s goals was to move quickly from their Phase 1 engineering reports to construction and gain double stack corridor clearance on an accelerated timeline. CSX made the decision to perform this work design/build which provides the benefits of an accelerated schedule with early contractor involvement. CSX selected the Clark/Parsons Joint Venture team to perform final design, permitting and construction.

VIRGINIA AVENUE TUNNEL

Tunnel & Project History

The Virginia Avenue Tunnel, located in southeast Washington, D.C., is just blocks from the Capitol Building and is a crucial part of the United States’ East Coast railroad network. The tunnel enables trains to move freight between key ports, manufacturing centers, and consumer markets through the District of Columbia. CSX is replacing the century-old tunnel with a twin cell shallow cut and cover tunnel. The project will help CSX serve customers better while reducing rail and highway congestion in the District of Columbia and the surrounding area, and improving the environment.

Since 2011, CSX, the District Department of Transportation and the U.S. Department of Transportation Federal Highway Administration have been working through the rigorous National Environmental Policy Act (NEPA) process to ensure that community impacts are understood, addressed and mitigated through the federal process, potential environmental impacts were identified and CSX committed to providing appropriate mitigations including:

- Limiting construction hours;
- Controlling dust at the construction site to maintain air quality;
- Reducing construction noise and vibration by creating physical barriers, choosing less noisy construction techniques, and monitoring noise and vibration levels throughout the community;
- Working with District Department of Transportation to monitor and maintain traffic flow around the construction site to reduce impact.

Project Benefits and Impacts

*Capacity Expansion Supports Regional Transportation Fluidity*
Expanding the tunnel to two tracks with enough vertical clearance for trains carrying double-stacked containers will:

- Improve the fluidity of freight and passenger rail services in and around the District and the Greater Washington region by double-tracking the rail network through the tunnel and removing a long-standing regional rail bottleneck.
- Reduce the impact of freight traffic on passenger service by allowing two-way traffic through the tunnel and doubling the capacity of each train transporting intermodal containers.
- Reduce highway congestion and reduce highway maintenance costs. One freight train can carry the load of more than 280 trucks.
- Reduce the risk of service disruptions and future damage to one of the region’s busiest rail lines due to flooding and weather-related issues.

**Environmental Benefits**

Rail is the most fuel-efficient and environmentally friendly form of surface transportation. Environmental groups such as the Chesapeake Bay Foundation, the Conservation Fund, Jones Fall Watershed, and the Natural Resources Defense Council have endorsed the benefit of shipping more freight by rail. A double-stack cleared Virginia Avenue Tunnel will:

- Allow twice as many intermodal containers to move on the same number of trains, resulting in decreased fuel usage and lower greenhouse gas emissions. Carbon dioxide emissions will decrease by more than 5.5 million tons in the District, Maryland and Virginia.
- Help CSX continue to improve the efficiency of its network. Currently, CSX can move a ton of freight more than 450 miles on a single gallon of fuel, which makes moving freight by rail three times more efficient than moving freight on the highway.

**Project Status**

The Virginia Avenue Tunnel Reconstruction is currently under construction. The replacement tunnel is a 4500 foot long twin track reinforced concrete box structure with improved vertical clearance to accommodate double-stack intermodal container trains. The project includes maintaining traffic along seven urban street crossings the tunnel corridor, coordination with existing water, sewer and other utility lines at or below the existing tunnel profile and staged tunnel construction to maintain rail traffic through the corridor while the new tunnel is being constructed in phases. The project is working towards obtaining double stack clearance by the conclusion of 2016.

**HARPERS FERRY TUNNEL**

**Tunnel History & Significance**

The Harpers Ferry Tunnel is located in Sandy Hook, Maryland, just across the Potomac River from the historic town of Harpers Ferry, West Virginia. The town is located at the confluence of the Shenandoah and Potomac rivers. Two bridges carry trains from it to the western end of the tunnel. Situated within both the Harpers Ferry National Historical Park and the Chesapeake and Ohio Canal National Historical Park, the tunnel is owned and operated CSX, and serves both freight and commuter rail. Amtrak and the Maryland Area Regional Commuter (MARC) service use the tunnel to provide regular commuter service to Harpers Ferry. Amtrak provides service to the town twice a day; MARC operates 10 trains per week between Martinsburg, West Virginia, and Union Station, in Washington, D.C., via Harpers Ferry. Adding to the traffic, some 40 to 50 CSX freight trains pass through the tunnel each day carrying everything from coal and grain to building supplies, military equipment, wind turbines, and automobiles.
Railroads have been operating in the Harpers Ferry area since the 1830s. The Baltimore and Ohio Railroad (B&O) completed its first bridge across the Potomac River near Harpers Ferry in 1837 and was able to link to the Winchester and Potomac railroad, which ran along the Shenandoah River from Winchester, Virginia, to Harpers Ferry (John F. Stover, *History of the Baltimore and Ohio Railroad* [West Lafayette, Indiana: Purdue University Press, 1987]). In 1892 construction began on a replacement for the bridge. It followed the same basic alignment as the 1837 bridge but eliminated the sharp curves. B&O began work on the Harpers Ferry Tunnel that same year; the tunnel eliminated the need for a sharp curve to meet the alignment of the new bridge. The tunnel was built by drilling and blasting. Steam-powered drills were employed, and construction proceeded from both ends of the tunnel using the top heading and bench method. With this technique, a small opening (called the heading, which is the top portion of the tunnel) is excavated first, and once mining has advanced some distance into the rock, the rest of the tunnel is excavated below the heading. Most of the tunnel, which was completed in 1894, was left unlined, the exceptions being 80 ft at the western end and 45 ft at the eastern end. These two stretches featured limestone masonry walls and a brick arch.

The tunnel portals were initially limestone, but they proved inadequate. In 1896 the tunnel was fully lined with brick, and the liner was extended for over 30 ft at each end. Brick portals were added as well (Andrew S. Lee, Harpers Ferry National Historical Park, *Historical Background Report: Baltimore and Ohio Railroad, Harpers Ferry Station* [2003], Historic American Engineering Record No. WV-86). The western 200 ft stretch of the tunnel was extended and widened in 1931, when a second rail bridge over the Potomac was built to carry the B&O mainline to Martinsburg. The new, double-track bridge was aligned with the tunnel for tangent track and required the western end of the tunnel to be widened into a bell mouth. The bell mouth allowed the track from the old bridge to join the tangent tracks from the new bridge just inside the tunnel. A switch is located inside the western end of the tunnel. Reinforced concrete was used in forming this bell mouth along with a new western portal structure. This concrete portal is still there and is visible from the town of Harpers Ferry; it is engraved with the year 1931 and is one of the most commonly photographed railroad tunnel portals in the United States. The tunnel is currently listed on the National Register of Historic Places (NRHP).
Design Considerations & Goals

Track Alignment and Drainage
The existing double track through Harpers Ferry Tunnel includes a turnout at the west end, located just inside the tunnel portal, connecting the Shenandoah Sub with CSX’s mainline. Additionally, the large open deck bridge over the Potomac River located just west of the west portal restricted the opportunities to optimize the track profile. The existing track alignment contained tight track centers of just under 12 feet within the 28-foot-wide portion of the tunnel. The design team was able to adjust the horizontal alignment to improve track centers to 12.5 feet through the narrowest portion of the tunnel. The track profile was optimized to the extent possible with the additional vertical clearance, including an improved profile through the special trackwork at the west end and blending it into the existing open deck bridge.

The design improved drainage with the addition of track drains along each tunnel wall, extending beyond the east portal and beyond the adjacent bridge abutment, and the installation of a new culvert under the track. The drainage improvements implemented eliminated standing water that would collect at the east portal.

**Clearance Methods**

The clearance improvement design consisted of several major elements. First, the sidewalls throughout the tunnel were grouted and 10-foot-long rock bolts were installed in the sidewalls on 5-foot centers at 2 feet below the tunnel springline. The clearance impediments were small enough in most of the concrete-lined tunnel section near the west portal that notching could be used to obtain the required clearance. In addition, because of the bell mouth at the west portal, most of the notching was over only one track (the north main line). However, since most of the notches were greater than 5 inches, the concrete liner in notching areas was pre-grouted. The notching included the west portal, which was modified per CSXT’s agreement with the National Park Service. The notch in the portal was smoothed into the surrounding liner to minimize the visual impact.

**Notched West Portal**

Total Arch Liner Replacement (TALR) was required in the remainder of the tunnel, including the entire brick-lined section. In areas of fair or better ground (as determined by the tunnel exploration program), the brick and concrete arch liner, any packing or debris on it, and bedrock (where required) were removed from springline to springline to obtain the required clearance. The bedrock was then scaled to remove any loose rock, loose bricks from the adjacent in-place liner, or other loose material. Where clearance was achieved, the initial support was installed prior to the end of the work window. The initial support consisted of arrays of eight double-corrosion protected rock bolts per cross section on 5-foot spacing both radially and longitudinally, and 2 inches of steel fiber-reinforced micro silica shotcrete (FRMS).
If clearance was not achieved during a work window, as a contingency measure temporary support could be installed prior to the end of the work window to secure the exposed ground. The temporary support consisted of 6-foot-long friction anchors and the application of either unreinforced dry mix shotcrete or FRMS as needed to the exposed ground. If temporary support was installed, the contractor had to remove the bedrock and temporary support to obtain clearance during a subsequent shift, and then install the standard initial support described above.

Near the east portal where there was not enough cover to anchor rock bolts, the arch was grouted and a portal cap was installed. First, the soil and loose and weathered rock above the portal were excavated to expose the back of the tunnel liner down to springline. The excavation was then backfilled with concrete to a minimum thickness of 24 inches at the tunnel centerline. Groutable bar spiles were then installed through the portal face on 18-inch centers at 18 inches above the masonry removal line (the limit of brick excavation in the portal face) to tie the portal headwall to the portal cap.

The brick arch liner, grouted void, and bedrock were then removed from springline to springline in 4-foot sections. W8x40 steel sets were installed on 4-foot centers and were blocked or cribbed to the exposed ground prior to the end of the work window. The steel sets were then lagged with C6x8.2 steel channels and backfilled with concrete. The lagging and backfill concrete could occur in subsequent shifts if the exposed ground was stable. The track side of the steel sets was then covered with 2 inches of FRMS, and drain holes were drilled on 20-foot centers at 3 feet above the design top of rail.

**Exposed rock surface and brick portal. Concrete backfill visible across the arch.**

**Construction Considerations**

Because of the amount of train traffic through the tunnel, rail service through the tunnel could not be discontinued for any extended period of time. Therefore, the project had to be completed under “live track” conditions. By the end of each work window, the tunnel had to be secured so that the railroad safely run trains through the construction zone.
The highly visible project location and nature of the work also required special considerations. These considerations included: work window availability to minimize disruption to train schedules, in particular Amtrak and MARC trains; minimizing any impact to the very popular national parks and their visitors; and minimizing any impacts to the Town of Harper's Ferry and the private residences located several hundred feet outside the east portal of the tunnel. These factors weighed heavily on the development of work schedules, location of the staging areas, and environmental control and mitigation measures.

As a result, construction activities were performed during the nighttime hours with the majority of the work being performed at night during the weekend when 12-hour work windows were available from 8:00 p.m. to 8:00 a.m. During the week, 6-hour work windows were available from 10:00 p.m. to 4:00 a.m. on one track only; trains were active on the other track. This limited some of the construction activities that could be performed during the week, and made TALR operations possible only during the weekend shifts.

The nighttime and weekend work schedule prevented the project construction from interrupting the commuter train schedules and allowed for construction to occur outside of the peak visiting times to the national parks. In addition, construction crews recognized that the nighttime work had the potential to adversely impact the nearby residents; therefore, efforts were made to minimize this impact, including directing work lights away from the town, using alternate communication methods, and employing tight housekeeping practices.

Further efforts were made to minimize disturbances to the local community by locating the contractor's staging area approximately 4 miles south of Harpers Ferry Tunnel on a private parcel of land and a private railroad track siding. Equipment and materials for the project were stored at the staging area during nonworking hours, and the majority of construction equipment was staged on rail cars so that it could easily be moved to the tunnel via rail on a daily basis.

The project is considered a significant success resulting from the close coordination between CSX, the design/build team including key subcontractors, and the local authorities. TALR was completed on August 15, and double-stack clearance (including notching) was achieved throughout the tunnel on August 29, 2014. The drainage and cleanup operations were finished on October 25, 2014. This was the first location in the NGI II program to achieve clearance. Construction was completed after 7.5 months, approximately 5 months ahead of schedule.

WASHINGTON DC TRACK LOWERING AT 10TH, I-395, AND 12TH STREETS

History of Project

CSX's Long Bridge over the Potomac River connects Arlington, Virginia with the District of Columbia. The bridge provides the connection for VRE trains from the south and west of DC to connect with Washington's Union Station via L'Enfant Plaza Station. VRE operates a total of 32 trains per day across Long Bridge and into Union Station while Amtrak operates 20 trains per day across the bridge and into Union Station. To add to the operating challenges all passenger trains that need to stop at L'Enfant Plaza station, which are most VRE and two Amtrak trains are required to operate on the northern most track only due to single passenger platform. Additionally CSX operates 20-30 freight trains per day, which continue north and go through the Virginia Avenue Tunnel to locations north and east of Washington, DC.

The project corridor for the Washington, DC track lowering consists of three bridge crossings and one air-rights structure over the CSX tracks. 10th Street (L'Enfant Plaza) marks the eastern limit where existing clearance is at 20'-5". The Interstate 395 (L'Enfant Plaza) marks the eastern limit where existing clearance is at 20'-5". The 12th Street crossing where only 18'-10" vertical clearance is available. Adjacent to 12th Street and extending west is "The Portals" Structure that carries the Maryland Avenue extension over the CSX.
corridor for 650 feet with clearances between 20’ and 21’ over the majority of the length. ConRail sold the air rights to the corridor back in 1989 at 18’-6” above the existing top of rail. The structure over was designed to accommodate a future clearance in excess of 23 feet through a track lowering. Given the extent of coverage and the fact that the three bridges carry a large volume of vehicular traffic, raising the bridges was quickly determined to be not feasible.

**Design Considerations & Goals**

The corridor in question is bounded by a ballasted deck bridge at the western limit of the work where the CSX tracks cross over Maine Avenue approximately 350 feet beyond the limit of the Portals structure and at the east where a second ballasted deck bridge crosses over 9th Street, approximately 450 feet beyond the limits of the L’Enfant Plaza bridge. This portion of the corridor has been operating since the 1830’s originally as part of the Baltimore and Ohio Railroad Company.

The tracks enter the corridor from the west with a pair of tracks crossing the Long Bridge. The tracks are descending at a grade of approximately 1.2% when they cross under the western limit of the Portal Structure. The Portals is arranged as a four-span cross section with the superstructure consisting of butted prestressed deck beams. The CSX right of way is located below the middle two spans with the track alignment located under the second span from the south, bounded by a pair of pier caps with crash walls. Just before crossing under the 12th Street overpass, a right-hand cross over accommodates a third track within the corridor. The three tracks enter into a vertical curve after emerging from under the 12th Street overpass and begin climbing at a grade of approximately 1.8%. After exiting from beyond 12th Street overpass, the corridor is bounded by a pair of stone masonry retaining walls to beyond the L’Enfant Plaza Bridge with a limiting width of approximately 60 feet.

Thus the design challenge was how to accommodate the additional clearance requirements necessary for double stack operations that are occurring near the low point of a vertical curve through a heavily traveled corridor within a restricted footprint while maintaining operations. The challenge was further complicated due to the long history of the corridor and its changing conditions over the years.

Site drainage challenges involved taking the low point of a bounded area that already had drainage issues and dropping the low point an additional two plus feet deep. The beginning and end of the project are both near high point elevations along the track profile, and the project limits drain to a single low point. From the low point, CSX records indicate the storm water drained to an existing storm drainage system that ultimately discharges towards 14th Street SW and Maine Avenue SW, the site of the original B&O 14th Street Storage Yard. This drainage pattern was modified in 1989 with the construction of air-rights structure, “The Portals”. The “Portals” project included drainage improvements in which the downstream portion of the existing storm drainage line was abandoned within the CSX right-of-way, and other portions of the existing system were left in place and tied into a new storm drain system. That new system consists of a parallel pipe just north of the rail corridor and drains storm water to the original discharge location along 14th Street SW and into a direct tidal outfall to the Washington Channel of the Potomac River.

Proposed project improvements include storm drain upgrades commensurate with the existing drainage pattern, so that the site can achieve positive drainage to the original storm drain along 14th Street SW. The proposed drainage includes 8-inch and 12-inch perforated underdrains within stone storm water management trenches and side ditches beginning west of the 9th Street SW paralleling the railroad corridor to the low point just east of 12th Street SW. Due to the grade lowering, the existing drainage system was removed for a short length west of the low point and a new concrete storm drain line was installed that runs parallel to the 1989 drainage system, until a point where the systems could tie together and discharge to its current discharge location. Further complicating the pipe routing, there were existing utility crossings of the rail corridor and the proposed track lowering reduced the available envelope between the bottom of rail and the top of the pipe crossings. New pipes are proposed within 4 inches of existing encasements.
The track lowering had to be staged to maintain a minimum of two tracks in operation at all times and to allow continuous access to L'Enfant Plaza Rail Station for Amtrak and VRE trains. The narrow existing corridor and the need to lower the track profile by two feet created challenges to adjacent train operations. We had to provide sufficient interim track centers to maintain a standard ballast section and allow for trains to operate at maximum authorized track speeds. A sample track chart is shown below depicting one of the 5 key phases of construction and design which demonstrates the complexity of track design at this location. A key component of the staging was to provide a run-around track along the northern side of the corridor that provided the operational flexibility required to allow the construction. The run around track was routed below the third span of the Portal Structure. Beyond the limits of the 12th Street Bridge, the added track ran parallel to the northern track with a 13 feet track center. With the added track in place, the sequence of construction was to remove the mainline tracks from south to north and to accommodate switch-overs through a series of track cut and throws over weekend outages when the lower train volumes allowed the two track operation.

Construction Considerations

It was determined early in the project planning stage that the project could not impact operations to VRE or Amtrak. This required a complex schedule with 5 phases of construction. To add to the challenge we were lowering the track profile nearly 2’ and had to maintain a standard ballast section on adjacent tracks that were operating at normal track speed. As a result of this requirement, construction crews had to work adjacent to or in between live tracks at all times. Safety is of the utmost importance, and constant communication was necessary to allow crews to maximize their productive work time while allowing CSX, VRE, and Amtrak to maintain daily passenger and freight traffic.
Excavation of track 2 between active tracks.

Additionally, the project location presented significant access issues. The north end of the corridor was accessible by gate, but the entrance was through a park owned by the National Park Service, which would impose permit requirements. The south end of the project had an access ramp through a private lot. An agreement with the current owner was reached to allow for use throughout the project. Modifications to the ramp were required to provide adequate space for truck and other equipment access. Furthermore, the access restricted truck traffic on site to a loop with only one way in and one way out, which impacted the project schedule as well.

During construction, not unexpectedly for a track lowering through a historic corridor, several unaccounted for obstructions were encountered. Unknown utilities, remnants of previously abandoned bridge piers and other ancillary structures, shoring or support of excavation were uncovered during the excavation and required removal. Additionally, local zones of unsuitable clay layers were encountered and required additional excavation and replacement activities. Other work activities include the stabilization of existing retaining walls, the relocation of overhead drainage and traffic signal conduits and the removal and replacement of an existing ramp to accommodate the installation of drainage structures and to improve site access.

The schedule for this project also presented a unique challenge. Again, as a result of maintaining traffic through the corridor and phasing the work on 1 track at a time, there was a lot of turnover between the contractor led crews and CSX maintenance of way crews. The contractor crews installed new drainage infrastructure, excavated the track to the new subgrade, and set the new track section subballast and ballast up to 4” below the tie. The CSX crews then came in to set the new track structure and line and tamp to final grade. Completing each track in sequence before moving to the next track. Currently, 2 of the 3 tracks are cleared for double stack clearance and the team is on pace for clearance of the entire corridor by the summer 2016.
WINCHESTER AND WESTERN RAILWAY

The CSX tracks run generally east-west in Martinsburg, West Virginia where the Winchester & Western Railroad operates a single railroad track that runs north-south on a raised embankment with two bridges that includes an overhead crossing of the CSX tracks with clearance of approximately 19’-7”. To achieve the minimum 21 ft clearance required above the CSX corridor as well as allowing additional clearance for CSX track profile improvements, the two bridges needed to be raised approximately 2’-6”, impacting approximately 1,725 ft of the W&W railroad track and embankment.

The W&W track operates in a 66 foot right of way through the adjacent low-lying terrain that includes the Tuscarora Creek. W&W crosses the Tuscarora Creek on an existing open deck multi girder bridge crossing of approximately 40 feet in length. The Tuscarora Creek crossing is located approximately 240 feet north of the CSX grade crossing. It was reported that the embankment between the two bridges had originally been part of a timber trestle and that the trestle was abandoned and the embankment built in its place, with its height approaching twenty five feet above the adjacent terrain. The geotechnical exploration described the embankment fill soils as consisting of a poorly graded mix of sands, silts, clays, gravel and ballast with slag, metal, wood, shells, and other debris. The existing side slopes are steep, exhibiting areas of sloughing soils and throughout the embankment, dumped timber ties were helping to retain the slopes. Further complicating the conditions is that site access was difficult and access along the east edge of the embankment between the bridges was considered non-existent without an easement from the adjacent property owner and the disruption of a heavily wooded area.

The team was challenged with how to accommodate the two bridge raises as well as how to accommodate the grade change through the embankment. To address the embankment, a pair of soldier pile and lagging retaining walls were constructed at 12’ off of the track centerline. The retaining walls had an exposed height of up to 8 feet tall. In total, approximately 775 linear feet and 6200 square feet of retaining wall was installed. A waler beam with a tie rod was provided along the outside face of the soldier pile between every other pile to resist the lateral force between two opposing soldier piles. Tierods are high strength threaded bars encased in unfilled PVC pipes along the length to protect them from settlement-induced stresses during and after construction. Precast concrete lagging was used between soldier piles.

The challenge with the retaining walls was their installation. The piles were installed from a crane placed along the track centerline. There were concerns about the pile, the hammer and the leads being too heavy and long to mobilize a crane. However, the installation by crane proved more workable than options of augering a shaft from the track centerline or installing a wall system along the base of the embankment.

From the geologic exploration, limestone bedrock was expected to be encountered between 4 feet and 12 feet below the existing ground surface in the borings drilled at the base of the railroad embankment. The bedrock was described as medium strong to very strong, slightly to highly weathered, moderately to highly fractured limestone. As the minimum embedment depth of the soldier pile is determined not only by the vertical pile capacity but also by lateral and global stability, a sufficient embedment depth below the extent of the embankment and beyond the ground surface was required. While the majority of the piles were driven to a sufficient embedment depth, the bedrock surface was fairly irregular that 14 piles encountered “refusal” prior to their “design tip elevation” and required additional remediation. The remediation was accomplished by drilling into the rock a minimum of five feet, and grouting a #9 reinforcing bar in place. The reinforcing bar was placed in a five inch diameter steel casing located at the flange to web interface of the pile. The casing ran full height of the pile to top of rock and was attached to the top portion of the pile with a field weld between the casing and the pile web and flange. This detail created a “pin” at the base of the pile to ensure the stability of the toe.
To raise the bridge over the CSX corridor, jacking brackets were anchored into the abutment stem below each of the main girders. After the bridge was cut loose of its bearings, jacking began under the four lifting points, simultaneously jacking the bridge to maintain the bridge level. During jacking, shims were placed below the girders to ensure the bridge remained plumb and stable. After reaching the proposed elevation, steel bolsters and new bearing plates were installed and the bridge lowered onto the bolster assembly and the bridge reconnected to the bearings. The bolsters were later encased into the raised concrete bridge seat and the backwalls were extended.

The Tuscarora Creek Bridge is an open tie deck girder consisting of four built up riveted plate girders spanning 42 feet over the creek. The bridge had more than sufficient capacity to support the design live load from the Cooper E80 train. While jacking of the bridge was initially considered, there were permit implications to working adjacent to and in the creek. Converting the open timber tie bridge to a ballasted deck bridge allowed the team to accommodate the required grade change without working within the creek and without changing the bridge seat elevations. 12 inch deep ties with a long tie at every four feet to support a walkway on one side of the bridge were installed across the deck girders. Timber ballast retainers were installed along each side of the bridge and the remaining change in grade was made up for with ballast. The bridge backwalls were extended by drilling and anchoring reinforcing steel into the existing back wall and casting the extension.

At each bridge, the design team needed to account for the additional load imposed on each abutment due to the grade increase. There was little historical data available for either of the bridges, especially related to abutment dimensions. It was apparent from the existing condition of the bridge seats that the bridges had been previously increased in height. The team’s strategy for dealing with the increased height of the abutments was to make adjustments to the backfill so as not to increase the lateral force acting against the abutments. The abutments in their current condition were deemed to be adequately supporting the imposed lateral forces due to the lateral earth pressure and the train surcharge. By replacing the existing backfill with a lightweight controlled low strength material (CLSM) backfill over a determined depth, the
height of the abutment could be increased without increasing the resultant forces along the backside of the abutment. Through available research, CLSM fill are noted to act as fluid during the initial placement with long term forces dropping off to values near zero after set. For each of the abutments in question, by replacing the existing backfill over a ten foot height with a layer of CLSM placed in lifts, the abutment could be increased in height without increasing the current calculated driving forces along the backside of the abutments. Approximately 120 cubic yards of CLSM was used behind each abutment over a length of approximately 20 feet beyond the abutment between the retaining walls. A geomembrane drainage layer was provided along the backside of the wall to ensure proper drainage. Additionally, a concrete jacket was installed along the front face of the abutments to help tie the existing stone masonry together and to alleviate distress and movement between the stones that occurred over time. The project was completed and clearance achieved in December 2014.

OTHER PROGRAM CLEARANCE LOCATIONS

Point of Rocks & Catoctin Tunnels, Frederick County, MD

The Point of Rocks Tunnel (799’) and the Catoctin Tunnel (494’) are located along the Chesapeake & Ohio Canal National Historic Park in Frederick County, Maryland. Clearance was achieved by lowering the tracks 2’2” and 1’8” respectively. The main factor that impacted the project schedules was the presence of rock beneath tracks. Ultimately, the track was panelized so the contractor was able to work in sections of the tunnel each weekend, excavating the rock with hoe rams, installing new drainage ditches, and lowering the track to the final elevation within 8 single track outage weekends for each tunnel. Clearance was achieved in August 2015.

Norfolk Southern Railroad Overhead Bridge, Shenandoah Junction, WV

This location obtained clearance by lowering and shifting both tracks. A similar method to the Point of Rocks and Catoctin Tunnels was used by performing the shift and lowering over single track weekend outages. Complicating factors on this project involved building an abutment support wall at the base of the northern Norfolk Southern Railroad Bridge abutment and modifying the adjacent public road profile due to impacts at the at-grade road crossing. Coordination was required between WVDOH, CSX Signals, CSX Maintenance of Way and the design-build team. Clearance was achieved in May 2016.
**East Deer Park Drive Bridge, Washington Grove, MD**

Clark Construction worked with Arcadis as the designer for this location. Extensive coordination with the local community was required due to the bridge being listed on the National Register of Historic Places and their concern that the clearance method maintain the historic integrity of the bridge. Clearance was achieved by replacing the existing three single span superstructure with a three span continuous cambered girders. This allowed for 1'-8" of clearance improvement with minimal impact to the roadway profile. Construction took place during the summer to minimize impacts to adjacent schools while the bridge was closed. Clearance was achieved in July 2014.

**Germantown Pedestrian Bridge, Germantown, MD**

Clark Construction worked with Arcadis as the designer for this location. Significant overhead utilities and the requirement to maintain pedestrian traffic across the bridge for the duration of the project complicated the means to achieve clearance. The design-build team came up with the concept of cutting the bridge longitudinally to be able to demolish the existing bridge in two separate sections while safely allowing pedestrians to cross at all times. The new bridge, which is a lightweight, single span, warren truss
structure, was installed in the same footprint to a clearance height of 23’0”. Clearance was achieved in May 2015.

Jessup Road (Rte 175) Bridge, Jessup, MD

This is the third Maryland bridge that Clark Construction is working on with Arcadis. The bridge needs to be raised 8” to achieve clearance, and the team expects to accomplish this by jacking the heavily trafficked bridge to its new height in a single weekend outage. The project is currently in permitting and clearance is projected to be achieved by the end of 2016.
Platinum Road Bridge, Richmond, VA

Clearance was achieved in October 2013 at Platinum Road Bridge by demolishing the old bridge in a single 4 hour track outage on both tracks. Extensive pre-planning was required to ensure revenue traffic could resume at the 4 hour mark.

Blue Shingles Road Bridge, Richmond, VA

Clearance was achieved in October 2013 at Blue Shingles Road Bridge by demolishing the bridge in a single 4 hour track outage on both tracks. Extensive pre-planning was required to ensure revenue traffic could resume at the 4 hour mark.

Stony Creek Bridge, Stony Creek, VA

Clearance was achieved at this location in 2012 by modifying the overhead truss structure.
Courthouse Road Bridge, Stafford, VA

The existing bridge was demolished and a new wider spanned bridge was built in its place. Clearance was achieved in July 2011.

Railroad Avenue Bridge, Woodbridge, VA

The bridge was demolished by CSX as part of a larger development project by VDOT to provide new access to a community off of Route 1 in Woodbridge, VA. The bridge was demolished by removing sawcut sections with a crane. The tracks remained in service throughout the project while a CSX Employee-In-Charge controlled traffic through the area. Clearance was achieved in August 2015.
Potomac River Swing Bridge, Washington DC

Clearance was achieved in April 2014 by modifying the overhead truss structure on the bridge and removing the existing catenary system.

I-295 Baltimore-Washington Parkway/Kenilworth Avenue, Washington DC

Clearance was achieved in April 2014 by lowering the tracks through this corridor.
Acknowledgements

Arcadis U.S., Inc.; Amec Foster Wheeler Environment & Infrastructure, Inc.; McMillen Jacobs Associates; AECOM; Schnabel Engineering

References


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National Gateway Clearance Improvement Project
Chambersburg, PA, to Wilmington, NC (Phase II)

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National Gateway Initiative

- Phase I – Completed
- Phase II – Under Construction
- CSXT Double-Stack Routes
- Other CSXT Routes

- Connects Mid-Atlantic region to the Midwest and beyond
- Supports long-term growth of Mid-Atlantic ports

Phase II Scope

- 21 locations to clear in three states and the District
  - 3 abandoned bridge removals
  - 2 railroad through-truss modifications
  - 3 remove/replace overhead highway bridges
  - 6 track lowerings beneath bridges
  - 2 bridge raises
  - 1 urban tunnel (Virginia Avenue Tunnel)
  - 3 mountain tunnels
- Work varied from minor modifications to complete reconstructions

Challenges

- Limited track time/maintaining rail service
  - Four to 12 hours per day, two to three days per week
  - 25 to 30 revenue freight trains through the projects daily
  - Amtrak trains
  - MARC trains
  - VRE trains
- Reaching a consensus among stakeholders
  - Communities
  - Highway agencies
  - National parks

Implementation

- Contractor-led design-build process
- A joint venture of Clark Construction and Parsons Engineering was selected

Today’s Discussion

- Virginia Avenue Tunnel
- Track lowerings under L’Enfant Plaza
- Harpers Ferry Tunnel

Virginia Avenue Tunnel

History

- Constructed in two phases between 1870 and 1904
- Originally contained two tracks – later reduced to one when electrified in the 1930s
- Approximately 3,788 feet long
- Single track through the tunnel with double track on either side
- Vertical clearance is insufficient for double-stack intermodal container freight trains (> 18’)
- Constructed by the Pennsylvania RR
Virginia Avenue Tunnel

Scope and Schedule
- Proposed two new double-stack clear tunnels
- Public meetings (300+) started – 2008
- Received NEPA record of decision – November 2014
- Major Construction started – May 2015
- Phase 1 (clearance achieved) to be complete – Late 2016
- Project to be complete – Late 2018

Virginia Avenue Tunnel

Construction Phasing

South Tunnel Portal

1904

2016

Virginia Avenue Tunnel

South Portal Retreat

Virginia Avenue Tunnel

Tiber Creek Bridge
Virginia Avenue Tunnel
Looking North

Virginia Avenue Tunnel
North End Tunnel Construction

Virginia Avenue Tunnel
North Portal

Virginia Avenue Tunnel

DC Track Lowering L’Enfant Plaza
Looking North

DC Track Lowering L’Enfant Plaza
Looking South
**DC Track Lowering L’Enfant Plaza**

**HISTORY OF AREA**
- Virginia connection to DC’s Union Station via CSX Long Bridge and L’Enfant Plaza.
- “The Portals” 650-foot structure carrying Maryland Avenue over CSX tracks built in the 1960s.
- Two to three mainline tracks and an abandoned support yard for the Bureau of Engraving & Printing.
- Portion of corridor in operation since 1830s by Pennsylvania Railroad Company.

**PROJECT GOALS**
- Achieve minimum vertical clearance of 21’0” from existing 18’10”
- Improve site and track drainage
- Maintain two operating tracks at all times

**DESIGN CHALLENGES**
- Trains per day (at 30 mph P/ 25 mph F)
  - 20-30 Freight
  - 20 Amtrak
  - 32 VRE
- Restricted vertical track geometry
- Interlocking
- Conflicting utilities

**Work between active main line tracks**
DC Track Lowering L’Enfant Plaza

PROJECT SCOPE

- Build temporary track
- Sequentially excavate tracks for lower/new profile
- Provide new positive drainage system
- Relocate fiber-optic cables through corridor
- Construct cast-in-place retaining walls to support new profiles
DC Track Lowering L’Enfant Plaza

PROJECT DATES

- Start Construction: December 2014
- Spring 2015: Drainage relocation and installation
- Temporary Track Complete: June 15, 2015
- Track 2 Complete: January 16, 2016
- Track 3 Complete: June 26, 2016
- Track 4 Complete: September 2016 (anticipated)
**Harpers Ferry Tunnel**

- Vital transportation link for CSX, MARC, and Amtrak trains
  - Up to 50 CSX trains per day
  - 20 MARC trains daily
  - 2 Amtrak trains
- National Park System (five parks)
- Historic site – *Most photographed railroad tunnel in the world*

**Harpers Ferry Tunnel**

- Construction of Harpers Ferry Tunnel began in 1892.
- Tunnel was built using drill and blast techniques with steam-powered drills.
- Tunnel was completed in 1896. Most of the tunnel was unlined, except for 80 feet on the west end and 45 feet on the east end.
- Initial limestone portals were inadequate and were replaced. In 1896, the tunnel was fully lined in brick.
- The western 200 feet of tunnel was widened in 1931 when a second bridge across the Potomac River was built to carry the B&O line to Martinsburg, WV.
- Bellmouth was widened to accommodate new turnout. A switch is located just inside the tunnel’s west portal.

**Harpers Ferry Tunnel**

- Increase existing clearance to a minimum of 21 feet to allow for double-stack train operation
  - We increased tunnel clearance for an improved and optimized track profile
- Improve drainage
- Optimize track geometry and increase track centers
Harpers Ferry Tunnel

Options Evaluated

- Track shifting and lowering
- Open cutting (daylighting)
- Total arch liner replacement (TALR)
- Notching

Looking west from inside portal

Clearance verified with LiDAR survey

Harpers Ferry Tunnel

- Initial condition assessment performed to verify:
  - Tunnel liner condition
  - Portal structural integrity and surrounding bedrock
  - Initial probe holes
- Structural, drainage, and track design 2013
- Construction began in January 2014:
  - Clearance achieved August 2014
  - Construction complete October 2014
  - Project completed five months ahead of schedule

Harpers Ferry Tunnel

- Design Solution
  - Total arch liner replacement through 745 feet of tunnel:
    - Mechanical excavator.
    - Liner fragments are captured by steel shields lying against the tunnel sidewalls deflecting fragments into railcar for disposal.
  - Notching used, as needed, from West Portal through the bell mouth area of tunnel.
  - Steel sets were used for the soft ground conditions adjacent to the eastern tunnel portal.
  - Track underdrains were installed, along with a new culvert, east of the east portal.
  - Track alignment and profile were optimized.

Harpers Ferry Tunnel

Brick liner removed
Preventing for shotcrete

Setting rock bolts
Arrays of rock bolts to be installed
Harpers Ferry Tunnel

Applying shotcrete

Final application

Harpers Ferry Tunnel

• East Tunnel Portal
  - Concrete backfill installation

Maintaining Historic Tunnel Portal

Project team worked with the National Park Service and the Town of Harpers Ferry.

Pre-notching

Post-notching

Harpers Ferry Tunnel

• Project completed without any incidents or injuries
• No unplanned impact to train operations
• Clearance achieved August 17, 2014
• Project complete October 2014, five months ahead of schedule

Program Update

18 of 21 locations have achieved clearance
And are tracking for program completion by the end of 2017

Thank you