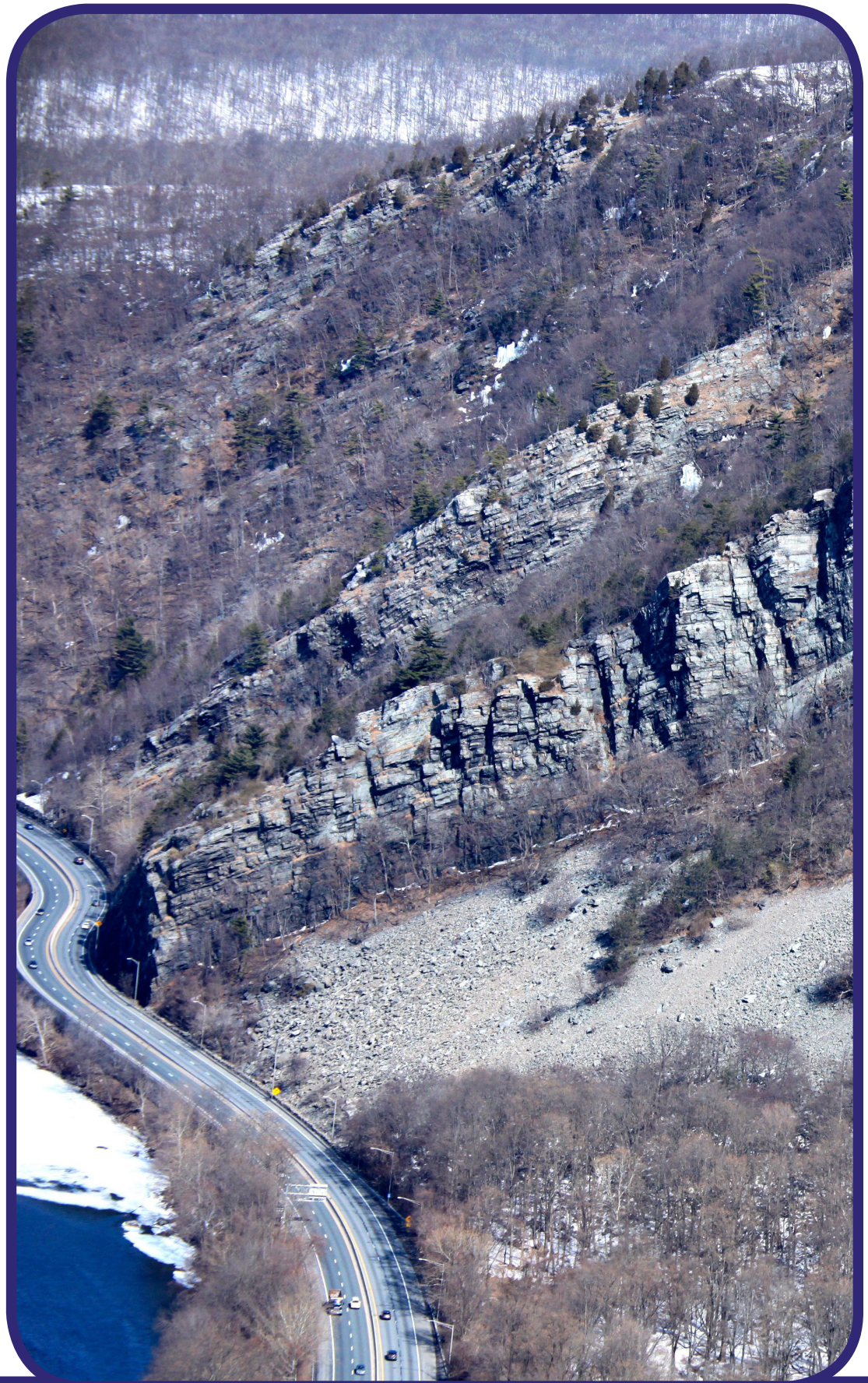
NEW JERSEY DEPARTMENT OF TRANSPORTATION

I-80 ROCKFALL MITIGATION

TRAFFIC STUDY



NEW JERSEY DEPARTMENT OF TRANSPORTATION

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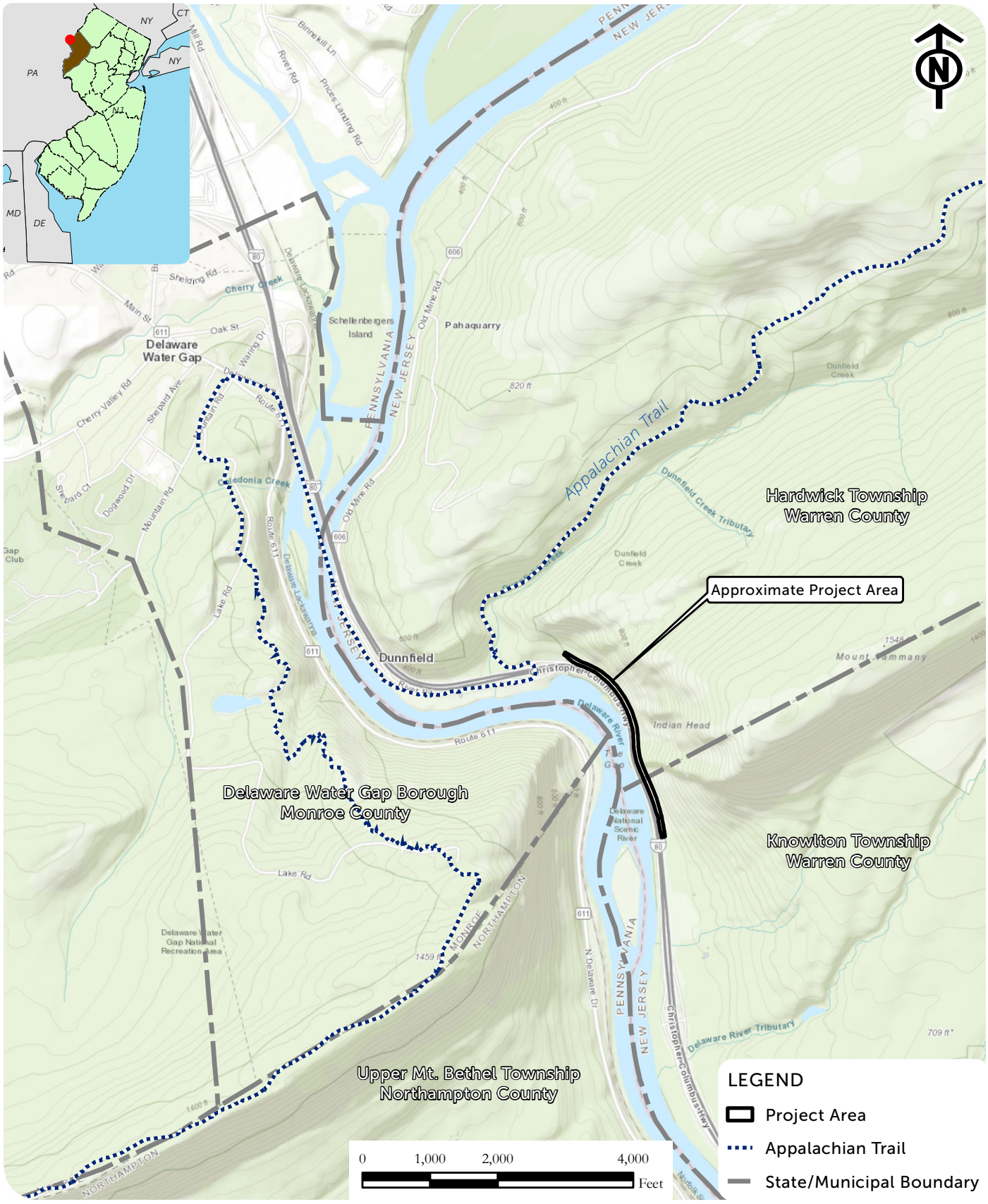
1.0 Introduction

This Traffic Study has been prepared by Dewberry Engineers Inc. (Dewberry) on behalf of the New Jersey Department of Transportation (NJDOT) for the I-80 Rockfall Mitigation Project (the Project) located in the Townships of Hardwick and Knowlton in Warren County, New Jersey (**Figure 1**).

The objective of this study is to assess the potential for impacts on traffic during construction activities. These activities involve temporary lane closures and roadway stoppages in both the westbound and eastbound directions along an approximately half-mile stretch within the project work zone. The majority of temporary lane closures are anticipated to be in the westbound direction. Roadway stoppages are limited during blasting activities and are expected to occur for no more than 15-minute durations.

The proposed project is receiving funding from the Federal Highway Administration (FHWA) and will require the preparation of an Environmental Assessment (EA), which will be prepared in accordance with the National Environmental Policy Act (NEPA). This document will serve as the basis for the findings and conclusions regarding the traffic analysis that will be presented in the EA.

Figure 1: Project Location Map



Date: 11/18/2020

Source: World Topographic Map, ESRI

2.0 Project Description

Under the Preliminary Preferred Alternative, construction would be performed only within the NJDOT right-of-way (see **Figure 2**). No access onto National Park Service (NPS) property would be required. Each of the four project segments (Area A, Area B, Area C, and Area D) include common mitigation elements to be built along the I-80 westbound travel lane, as follows:

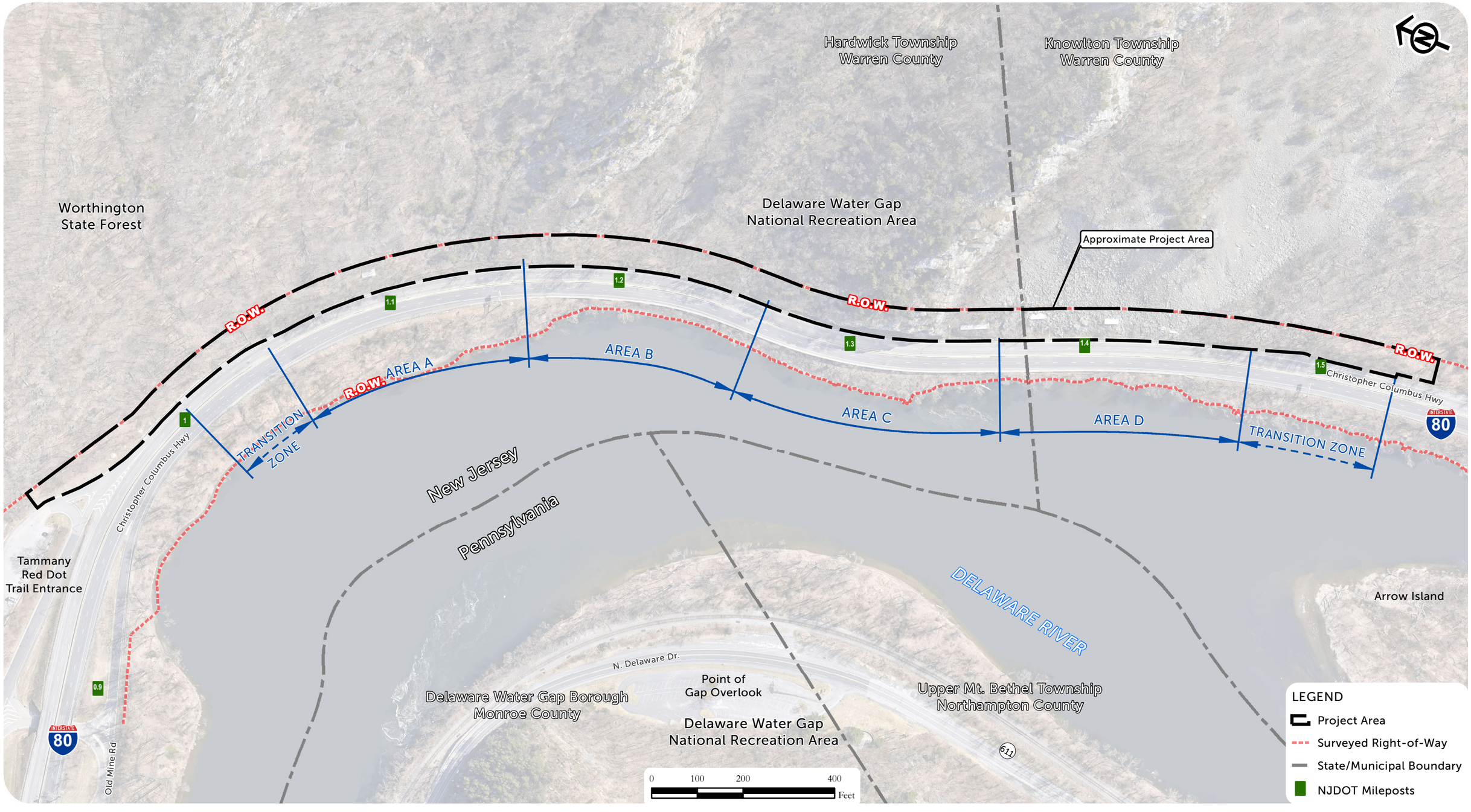
1. The existing concrete barrier curb and rock rubble wall would be removed. A new concrete barrier (approximately three feet high) would be constructed in front of the proposed 10-foot-tall roadside barrier wall. The visible portion of the barrier wall, approximately seven feet high, would be faced with an aesthetic treatment and would be constructed along the entire project length.
2. The proposed five-foot-high safety fence in Areas A, C, and D would include a gated entrance every 400 feet to allow emergency access to upland areas as well as providing access for NJDOT maintenance crews.
3. Drainage would be improved behind the barrier wall in order to control stormwater runoff, soil erosion, and snowmelt from overtopping the barrier and impacting the roadway.
4. New features would be designed to create a visually uniform appearance.
5. All work would be contained within property owned by the State of New Jersey in order to eliminate any physical impacts on federally owned lands.

Construction of the Preliminary Preferred Alternative is anticipated to take four years and would not require any I-80 traffic detours. The first year would involve paving operations and relocating the existing median barrier to shift the traffic lanes on I-80 towards the river; years two and three would involve construction of the rockfall mitigation improvements; and year four of the Project would involve paving operations and relocating the median barrier to shift the traffic lanes back to their original configuration. Four lanes of traffic on I-80 (two lanes in each direction) would be maintained during peak hours of construction. "Peak" hours represent typical hours of the day with the greatest volumes of traffic. Peak hours typically represent commuter and/or recreational travel; these time periods typically vary from weekday to weekend periods.

Temporary lane closures would occur during off-peak hours to allow for construction activities and deliveries of materials and/or equipment during the four years. "Off-peak" hours represent typical hours of the day when traffic volumes are normally low as fewer vehicles are traveling on the roadway. Traffic stoppages (limited to 15-minute intervals) would occur during off-peak hours for rock blasting activities and would be controlled by New Jersey State Police. These stoppages would be short in duration, and unrestricted travel would be restored once the blast zone is safe and clean up of any debris is complete. Blasting is anticipated to occur once per week (Monday through Thursday) between May 15 and September 15 (except holidays) during one construction season.

Figure 2: Aerial Map

Date: 11/18/2020



Source: NJDOT, 2019; NJOIT-OGIS, 2018; PennDOT, 2019

Note:Right-of-way limits are based upon boundary survey performed by GEOD Corporation, February 2014. Municipal boundaries are based upon publicly available data.

2.1 West Transition Zone

In order to provide construction access to the project site and allow future access to upslope areas for emergency services, a gated 10- to 20-foot-wide access drive would be constructed from the Dunnfield Creek parking area as part of the West Transition Zone adjacent to Area A. Within the transition zone, the Preliminary Preferred Alternative would consist of general excavation and grading for the beginning of the 10-foot-high roadside barrier wall behind which the access drive would connect with the gravel catchment area and allow NJDOT maintenance crews to perform routine inspections, mobilize equipment, and remove any rockfall material or debris. The access drive would be designed in a manner consistent with aesthetic and environmental considerations.

2.2 Area A

Within Area A, the Preliminary Preferred Alternative would consist of an excavated reinforced slope combined with a 10-foot-high roadside barrier wall and a rockfall catchment ditch that varies in width up to 20 feet. Excavation and stabilization of the existing soil slopes would be performed to create the engineered catchment ditch. A fence may be incorporated behind the highway barrier wall. A high-capacity rockfall barrier fence would "step up" in five-foot-high intervals to a maximum of 20 feet high and would continue into Area B. The rockfall barrier fence would prevent rockfall originating from high elevation source zones from entering the roadway. The fence would be constructed approximately four feet lower than the top of the roadside barrier wall; as a result, from a visual perspective, the fence would extend approximately one to 16 feet in height above the roadside barrier wall.

2.3 Area B

Within Area B, the Preliminary Preferred Alternative would consist of a new cut rock slope to address rockfall from rock toppling or sliding from the existing face, a 10-foot-high roadside barrier wall, and an approximately 20-foot-wide engineered rockfall catchment ditch. A high capacity rockfall barrier fence would also be incorporated behind the highway barrier wall to prevent large rock blocks originating from the high rockfall source zones beyond the right-of-way from entering the roadway. The total length of the 20-foot-high barrier fence (including the portion in Area A) would be approximately 325 feet. The rockfall barrier fence would "step down" in five-foot increments to a height of five feet. As explained above, from a visual perspective, the fence would extend approximately one to 16 feet in height above the roadside barrier wall. The rockfall barrier fence would extend along the remainder of Area B and into Area C.

2.4 Area C

Work within Area C would primarily consist of the installation of a pinned-mesh system on the high vertical rock cut face and construction of a rockfall berm in a portion of the talus field that would extend from the toe of the escarpment and into Area D. Proposed improvements in this area also include construction of an upslope rockfall barrier fence installed within the right-of-way and removal

or stabilization of the multiple loose, unrestrained large blocks within the right-of-way. The 10-foot-high roadside barrier wall, with a five-foot-tall fence installed on top of the barrier wall, would also extend through Area C.

The proposed pinned mesh system differs from a typical rockfall drape system as the mesh would be pinned to the rock face with short rock bolts in many locations to conform to the natural crenulations, irregularities, and overhangs in the rock. Unlike a loosely draped or "passive" system, a pinned mesh system would not allow rockfall to pass through to the catchment ditch below but would retain and hold a rock in place against the slope, preventing it from moving and falling on I-80. The proposed pinned mesh, when installed, would be offset from the rockface by three to four inches and would be less visible than a loosely draped system and would also be colorized to match the natural rock surfaces.

At the top of the vertical rock face in Area C, a rockfall barrier fence would be constructed to arrest rockfall and/or debris originating from upslope source zones beyond the right-of-way and would prevent rockfall from overshooting the pinned mesh and entering the highway from approximately 170 feet above the pavement. This eight to 10-foot-high rockfall barrier fence would be erected within the right-of-way close to the slope crest above the main rock face and would contain rockfall from upslope source zones. The final fence alignment would be visually consistent with the natural rock line such that it follows the geologic ridgelines along the slope to effectively mitigate rockfall and minimize potential impacts to forested areas and vegetation.

The proposed rockfall berm would extend as a ridgeline parallel to the I-80 roadway for approximately 150 to 200 feet before stepping down to the existing talus surface in Area D. The rockfall berm would range in height from 10 feet at the eastern limit to a maximum height of 60 feet above the highway. The toe of the berm would be located approximately 10 feet behind the front face of the barrier, and the front face of the berm would be angled backward at approximately 70 degrees. As proposed, the crest or top of the berm at its highest point would be located approximately 35 feet behind the face of the barrier. The crest width of the berm would vary from eight to 12 feet. A berm such as this is a fully engineered structure and would be built using horizontal reinforcement layers. The internal reinforcement layers would consist of engineered steel reinforcements, which would be placed in between controlled compacted layers of crushed stone from the base of the berm to the crest. The bottom of the rockfall berm would be constructed of a steel-reinforced structural concrete foundation supported on drilled micropiles. The installation of drilled micropiles would cause minimal disturbance and would require the least amount of excavation for foundation construction on the existing talus material. This small-diameter drilling method would also reduce the potential impacts to subsurface geology and groundwater conditions. The face of the berm that could be viewed from the highway and river would include natural rock type aesthetic treatments (e.g., boulderscaping) or using native rock inserts and natural vegetation to integrate the rockfall berm with the natural landscape.

2.5 Area D

The majority of work within Area D would consist of the construction of a 10-foot-high roadside barrier wall with a five-foot-tall fence installed on top of the barrier wall. A stabilization cap beam

would be located approximately five feet behind the roadside barrier wall to stabilize the "toe" of the talus field. The stabilization cap beam would extend from the end of the berm to the East Transition Zone and would not be visible from the highway or the Delaware River.

2.6 East Transition Zone

The East Transition Zone would be established immediately adjacent to Area D in order to provide construction access to the project site and allow future access to upslope areas for emergency services. Within the transition zone, the Preliminary Preferred Alternative would consist of excavation and grading for a 10-foot-high roadside barrier wall, a five-foot-high safety fence, a slope-side retaining wall, and a gated access drive. The stabilization cap beam supported by drilled micropiles would continue from Area D to stabilize the toe of slope through the end of the talus field. An approximately 10-foot-high slope-side retaining wall would be constructed approximately 25 feet behind the proposed face of the concrete barrier curb in front of which the access drive would allow NJDOT maintenance crews to mobilize equipment safely off the highway and perform routine inspections. The slope-side retaining wall would be constructed with an aesthetic treatment similar to the roadside barrier wall. The access drive would be designed in a manner consistent with aesthetic and environmental considerations.

3.0 Methodology

The following sections discuss the methodology followed while conducting this traffic analysis. Data sources used to support the basis of this study included:

- toll data provided by the Delaware River Joint Toll Bridge Commission (DRJTBC);
- field observations;
- StreetLight© probe data; and
- observed travel time and travel time information obtained from StreetLight©.

The analysis utilized volume data provided by the DRJTBC. StreetLight© information containing sample traffic data in both eastbound and westbound directions was used to support and validate traffic operations analysis. In addition, field observations were conducted from September to December of 2017 during temporary off-peak hour single westbound lane closures at the approximate location of the Project. These observations were considered in order to better understand traffic operations under these constrained conditions.

Temporary lane and roadway closure scenarios were assessed within standard allowable off-peak hour lane closure hours provided by NJDOT Traffic Operations. **Table 1** below identifies time periods for anticipated westbound lane closures. The closure hours are based on the traffic volume profiles and overall operation of the study corridor. These restrictions also accounted for seasonal volume trends to minimize impacts on traffic operations. See the Conclusions and Recommendations section of this report for other recommended mitigation measures.

Note that scheduled eastbound temporary single-lane closures may be needed. The temporary closures would be limited to what is required for the construction of lane shifts. These would likely occur during overnight hours during the period of lowest traffic.

Table 1: Temporary Single-Lane Westbound Closure Hours

All Lanes Maintained		
	From	To
Monday to Friday*	12:00 PM	9:00 PM
Saturday	7:00 AM	8:00 PM
Sunday	8:00 AM	8:00 PM
One Lane Closed - One Lane Maintained		
Monday to Thursday*	9:00 PM	12:00 PM (Next Day)
Friday	9:00 PM	7:00 AM (Saturday)
Saturday	8:00 PM	8:00 AM (Sunday)
Sunday	8:00 PM	12:00 PM (Monday)

*No temporary closures Friday mid-May to early September.

In addition to single-lane closures, rock blasting activities may require full roadway stoppages in both eastbound and westbound directions. The temporary lane closure hours stated above, combined with New Jersey state regulations, restrict blasting from 8:00 AM to 12:00 PM Monday to Thursday. (See **Table 2** below.) Blasting on Friday, Saturday, and Sunday will be prohibited for the Project. According to the New Jersey Department of Labor and Workforce Development's Explosives and Fireworks Act, Section 12:190-7.6, blasting can be conducted only during daylight hours, but not before 8:00 AM or after 6:00 PM. Blasting is prohibited on Sundays. Preparations may occur during any daylight hours, including before 8:00 AM.

With the proposed project, blasting is anticipated to occur once per week (Monday through Thursday) between May 15 and September 15 (except holidays) during one construction season. Traffic stoppages (limited to 15-minute intervals) would occur during off-peak hours for rock blasting activities and would be controlled by the New Jersey State Police. These stoppages would be short in duration, and unrestricted travel would be restored once the blast zone is safe and clean up of any debris is complete.

Table 2: Allowable 15-Minute Full Roadway Stoppage Hours

15 Minute Blasting Permitted		
	From	To
Monday to Thursday	8:00 AM	12:00 PM

3.1 Traffic Study Area

Traffic was analyzed both upstream and downstream of the project work area. The model was calibrated to account for existing conditions operations, including the study area's existing geometric conditions and access points. Metrics, including roadway capacity, traffic volumes, vehicle speeds, and queue dissipation, were studied from the Delaware Water Gap Toll Plaza to MP 4.58, shown in **Figure 3** below, where I-80 meets the interchange with Route 94 and Route 46.

Figure 3: Traffic Study Area

3.2 Analysis Tools

The Aimsun Next version 8.3[1] microsimulation software was utilized to model and assess traffic conditions. The model was calibrated for existing base conditions during summer weekdays supported by data collected via field observations, as well as speed and travel time information obtained from StreetLight© and Google Maps travel time.

3.3 Data Sources

3.3.1 Delaware Water Gap Toll Bridge Data

Traffic volume inputs primarily relied on DRJTBC data provided for all months of 2018. Traffic volumes were provided for both directions of travel. The westbound traffic volumes based on plaza toll transactions were provided by vehicle type. DRJTBC also provided traffic data in the eastbound non-toll direction. The data was then used to identify and select appropriate study periods considered for lane closures and roadway stoppages.

[1] Aimsun Next is owned by Aimsun, a registered trademark.

3.3.2 StreetLight© Speed Data

StreetLight© is a data source that utilizes location-based service information to provide sample travel information including speed, origin-destination, travel time, and volume information. This information was used to calibrate and validate traffic model operations as well as to confirm hourly and seasonal traffic operational trends.

3.4 2017 Field Observations

Field observations were conducted in 2017 to observe single-lane closure operations. Lane closure activities were at the approximate location of the Project. The team documented traffic conditions that were used to validate traffic model runs involving lane closures.

3.5 Calibration and Validation

The Highway Capacity Manual, 6th Edition, was used to estimate the capacity of existing condition operations and the construction base condition in the work zone. Speed data from StreetLight© was used to validate the existing capacity and vehicle travel statistics.

3.5.1 FHWA Microsimulation Calibration Guidelines

The traffic model was calibrated and adjusted in accordance with FHWA guidelines for microsimulation modeling. FHWA guidelines specify the utilization of the Geoffrey E. Havers (GEH) statistic that assesses the accuracy of traffic volumes generated in the model based on collected field counts. FHWA establishes a minimum threshold requiring 85 percent of link flows to meet the GEH criteria.

FHWA also requires the modeled travel time to be within a 15 percent differential compared to the travel time collected in the field. In addition, if the model exceeds this criterion, FHWA guidance mandates that modeled travel time must be within 60 seconds of the travel time collected in the field. The model generates a differential that is below these guidelines.

3.6 Analysis Scenarios

Four scenarios were assessed as part of this study. The scenarios include:

- Existing Conditions Scenario;
- Construction Base Condition;
- Temporary Single-Lane Westbound Closure; and
- Blasting Event, Full Stoppage.

3.6.1 Existing Conditions Scenario

The existing conditions scenario represents traffic operations with two full travel lanes in each direction with shoulders, as seen below in **Figure 4**. Under this condition, traffic is free-flowing without congestion during all typical hours of all seasons with a posted speed limit of 50 miles per hour (mph). Roadway capacity is estimated at approximately 2,300 passenger cars per hour (pc/h) per lane or 4,600 pc/h in each direction based on the Highway Capacity Manual, 6th Edition.

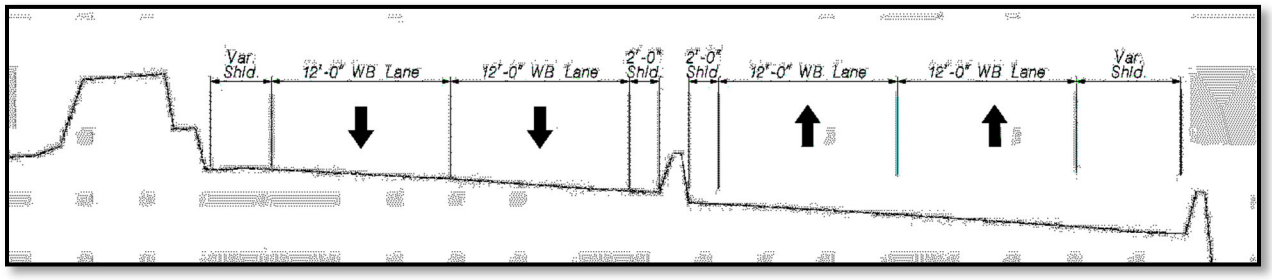


Figure 4: Existing Condition Lane Configuration

3.6.2 Construction Base Condition

Under this scenario, the roadway configuration would be shifted to the west slightly, with traffic operational speeds generally reduced from 50 mph to 40 mph. All existing four lanes would be open to traffic during peak hours. There would be minimal to no shoulders available, and the existing 12-foot lanes would be reduced to 11-foot lanes within the construction zone, as shown below in **Figure 5**, with speeds reduced to 40 mph. Roadway capacity is estimated to be 2,100 passenger car equivalents per hour (pce/h) per lane or 4,200 pce/h in each direction. This condition would remain for the length of construction, approximately four years.

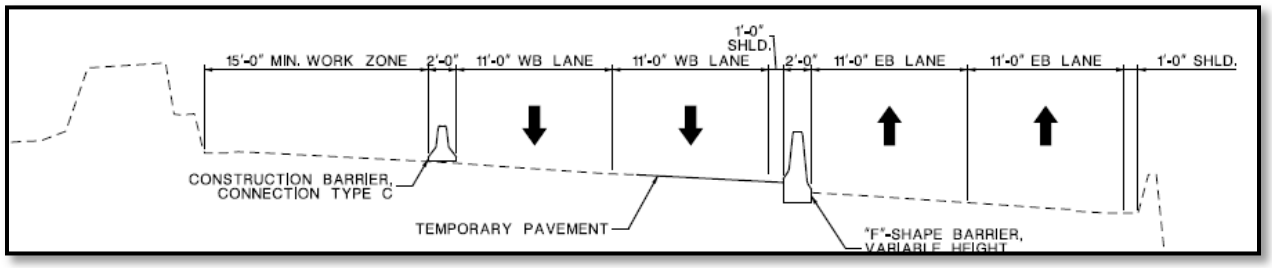


Figure 5: Construction Condition Lane Configuration

3.6.3 Temporary Single-Lane Westbound Closure

During allowable closure hours (refer to **Table 1**), a single lane would be closed temporarily during off-peak hours to traffic in the westbound direction within the Project Area; see **Figure 6** below. This temporary lane closure would allow for material deliveries and the performance of specific construction activities during construction.

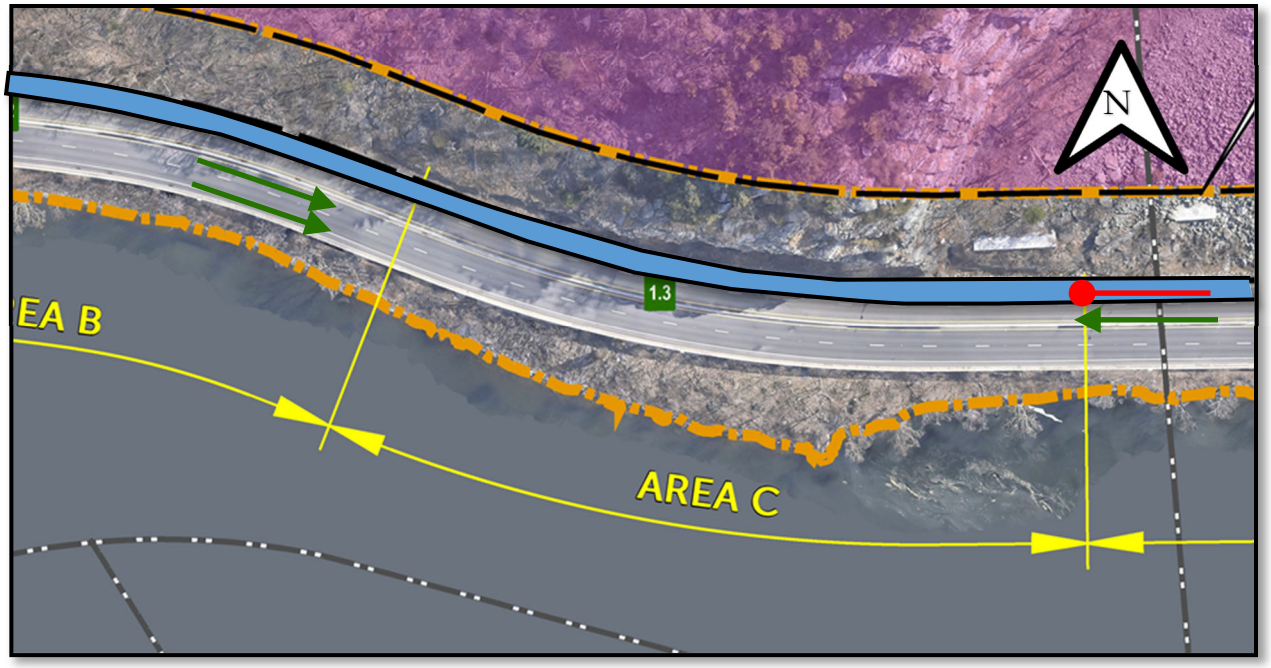


Figure 6: Temporary Single-Lane Westbound Closure

3.6.4 Blasting Event, Full Stoppage

During allowable blasting hours on weekday off-peak hours between 8:00 AM and 12:00 PM, occasional full stoppages may occur for 15-minute periods in both the eastbound and westbound directions. These would occur to facilitate rock blasting. During the 15-minute stoppage, all traffic would be stopped in both directions at the blasting site.

4.0 Existing Conditions

Based on data provided by the DRJTBC, traffic demand is generally highest during the summer season, with the typical average Friday experiencing the greatest volumes in the westbound direction and Sunday experiencing the highest volumes in the eastbound direction. I-80 generally provides two travel lanes in each direction with a capacity of 4,600 pce/h. Traffic flow under prevailing conditions is generally under capacity with negligible congestion Monday through Thursday during allowable closure hours in either direction. It should be noted that prevailing conditions consider a typical day but do not include delays caused by accidents, incidents, or construction scenarios.

4.1 I-80 Westbound

Historical traffic data indicate that summer months generally show the highest traffic volumes compared to other seasons throughout the year. Within the summer season, the month of August registered the greatest traffic demand, particularly on Fridays. Traffic during other typical weekdays (i.e., Monday through Thursday) experiences much lower volumes. During certain hours, volumes are up to 25 percent less than on a summer Friday. Truck activity during a typical August midweek day ranges from six to 22 percent of vehicle volumes during the day and from 11 to 46 percent overnight (10 PM to 6 AM).

It should be noted that during allowable blasting times, heavy vehicle volumes do not exceed 14 percent. The trucks were accounted for and converted to equivalent passenger cars using HCM methodology for level terrain. **Figures 7 and 8** below show traffic volume profiles during the average weekday compared to a Friday during the summer season. Lane closures and roadway stoppages are prohibited during periods of high travel demand, as identified in **Table 1**.

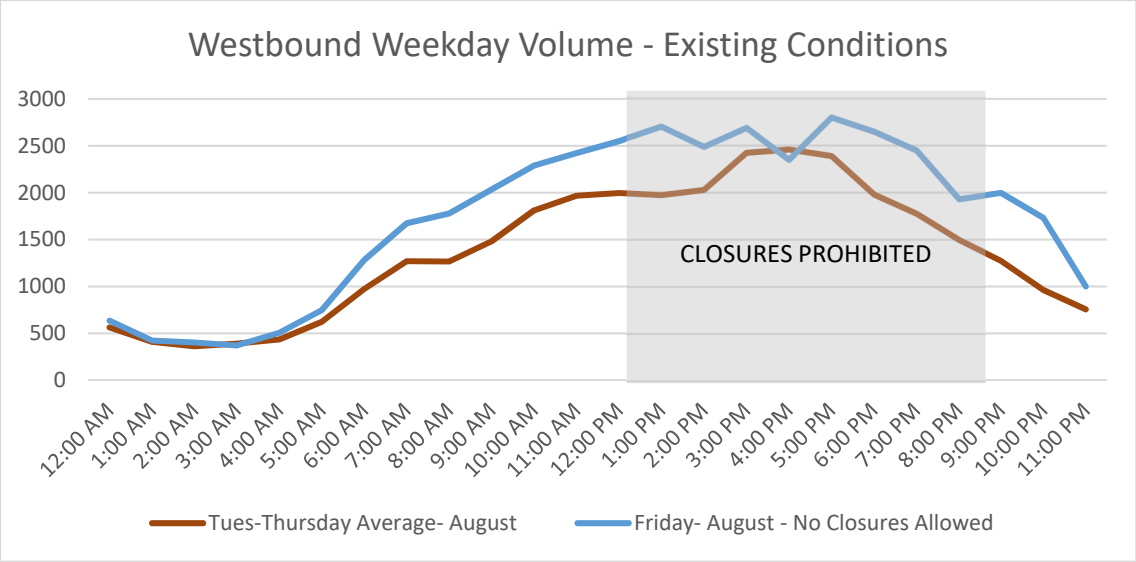


Figure 7: Existing Westbound Travel Demand during Single-Lane Closure

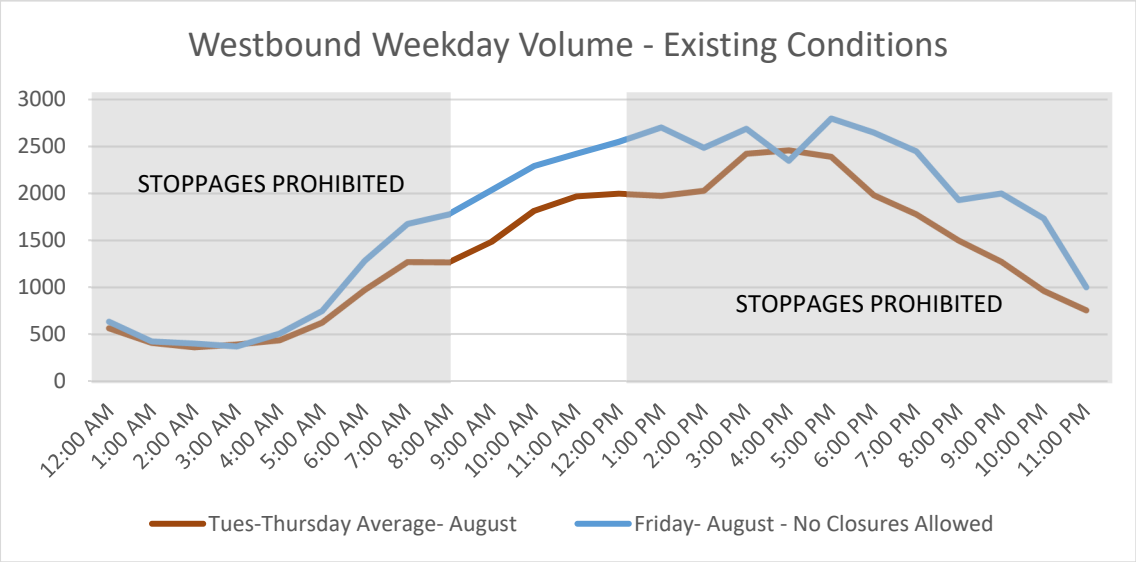


Figure 8: Existing Westbound Travel Demand during Full Roadway Stoppage

4.2 I-80 Eastbound

Similar to the westbound direction, a review of eastbound traffic volume data indicates that the summer season's highest traffic demand is during August. The eastbound direction operates under similar capacity constraints when compared to the westbound direction. I-80 eastbound provides two travel lanes, and the capacity is not exceeded under normal traffic operating conditions. As vehicles at the toll plaza are only classified in the westbound direction, truck percentages from the westbound approach were also applied to the eastbound approach to provide conservative values. The eastbound direction would experience delays associated with stoppages during blasting events shown in **Figure**

9 below. Blasting stoppage hour constraints, mentioned in the Methodology section of this report, can be seen on the volume figure below.

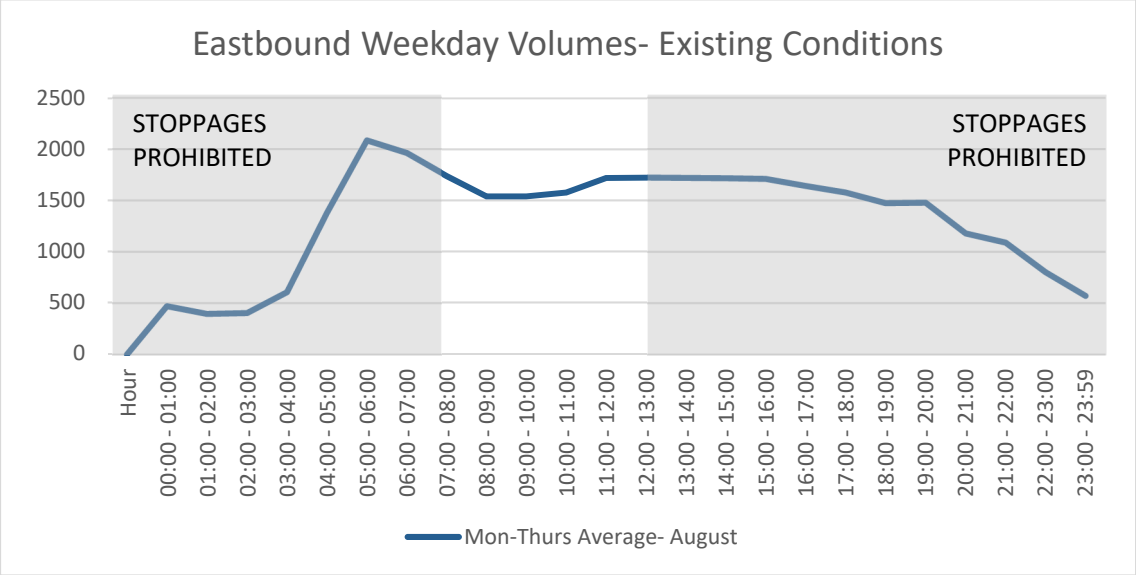


Figure 9: Existing Eastbound Travel Demand with Full Roadway Stoppages

5.0 Potential Impacts and Mitigation Measures

5.1 Construction Period Scenarios

Construction of the Project is anticipated to require temporary roadway stoppages and lane closures along I-80 during off-peak hours in order to provide a work zone for various construction activities, including rock blasting and staging. The majority of temporary lane closures would potentially occur in the westbound direction and would follow NJDOT's Lane Closure Guidelines identified in **Table 1.** In the first and last years of construction, lane closures may occur in either the eastbound or westbound directions to allow lane shifts on I-80 during the construction period. These closures would occur during periods of lowest traffic volumes of construction, primarily during the overnight hours.

Temporary roadway stoppages would potentially occur in both directions and would follow the restricted hours. It should be noted that full roadway stoppages only occur during blasting events.

Scenarios considered in this analysis include:

- Construction Base Condition;
- Temporary Single-Lane Westbound Closure; and
- Blasting Event, Full Stoppage.

5.2 Construction Base Condition

As compared to existing conditions, eliminating shoulders and narrowing lane widths to 11 feet reduced roadway capacity from 4,600 to 4,200 vehicles per hour (vph) in the capacity analysis of the study segment. Since traffic volumes do not exceed the 4,200 vph threshold, minimal increases in travel time and delay were projected (see **Figures 10 and 11**).

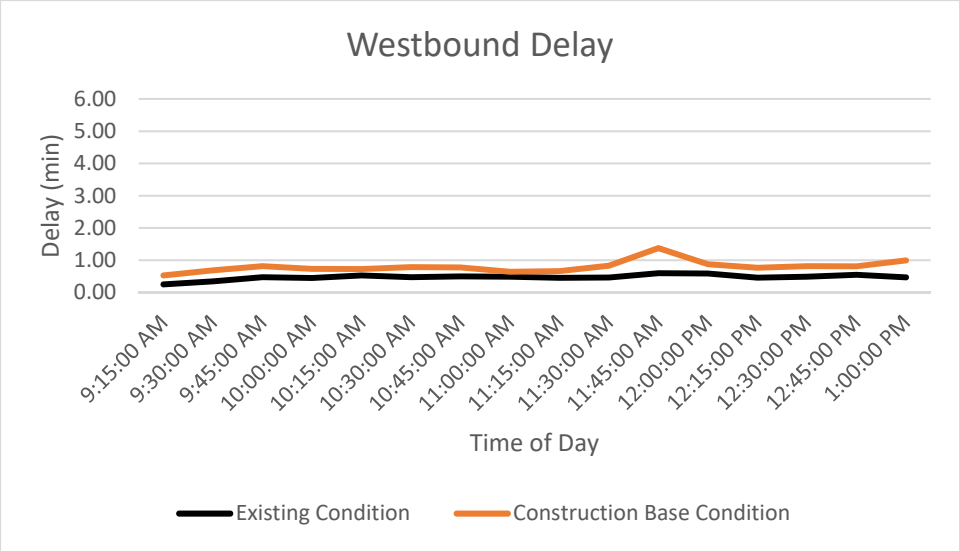


Figure 10: Westbound Delay Comparison – Existing/Construction Base (Two Lanes Maintained)

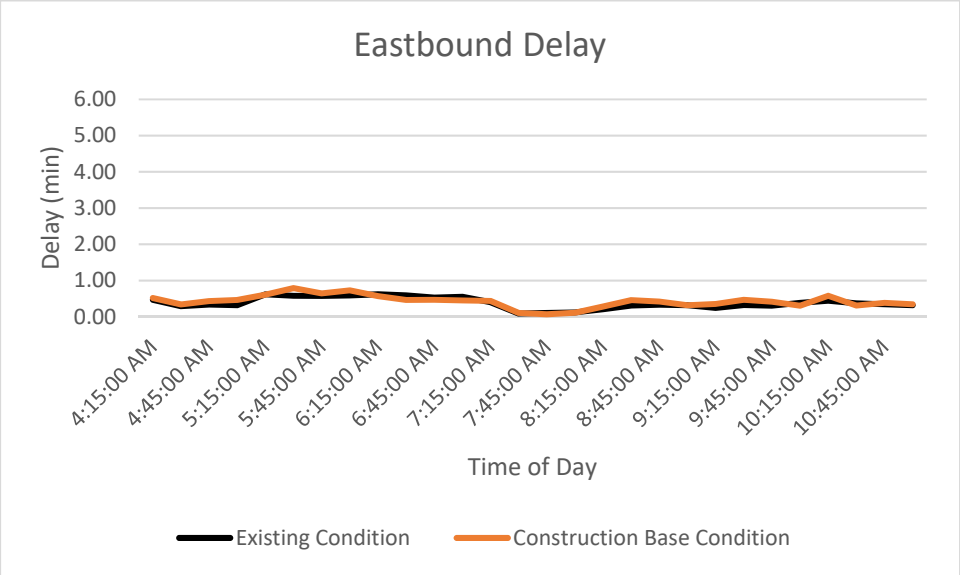


Figure 11: Eastbound Delay Comparison – Existing/Construction Base (Two Lanes Maintained)

5.3 Temporary Single-Lane Westbound Closure

Traffic conditions were analyzed for a temporary single-lane closure scenario. This type of closure only occurs in the westbound direction. This closure scenario followed the allowable closure hour guidelines identified in **Table 1** and is a representative summer peak weekday (Monday through Thursday). Based on the analysis and available traffic data, only relatively minor delays and queues are anticipated between 9:00 AM and 12:00 PM. Sufficient capacity is available during all other hours within the allowable lane closure window. Between 9:00 AM and 12:00 PM, projected incremental

delays resulting from this type of closure were less than six minutes, as indicated in **Figure 12**. During this time period, vehicle queues were projected to extend approximately one mile from the lane closure, as shown in **Figure 13**.

Based on the analysis of single-lane closures during typical Friday summer months, long delays and queues are expected. As a result, it was decided to prohibit single-lane closure during this time period. It is also noted that during Spring, Fall, and Winter seasons, delays and queues on Friday nights from the toll plaza may reach to or past the project site. Should this occur, closure placement would be delayed until queuing is cleared from the site. In addition, allowable lane closure hours would be reevaluated as the Project approaches the beginning of construction.

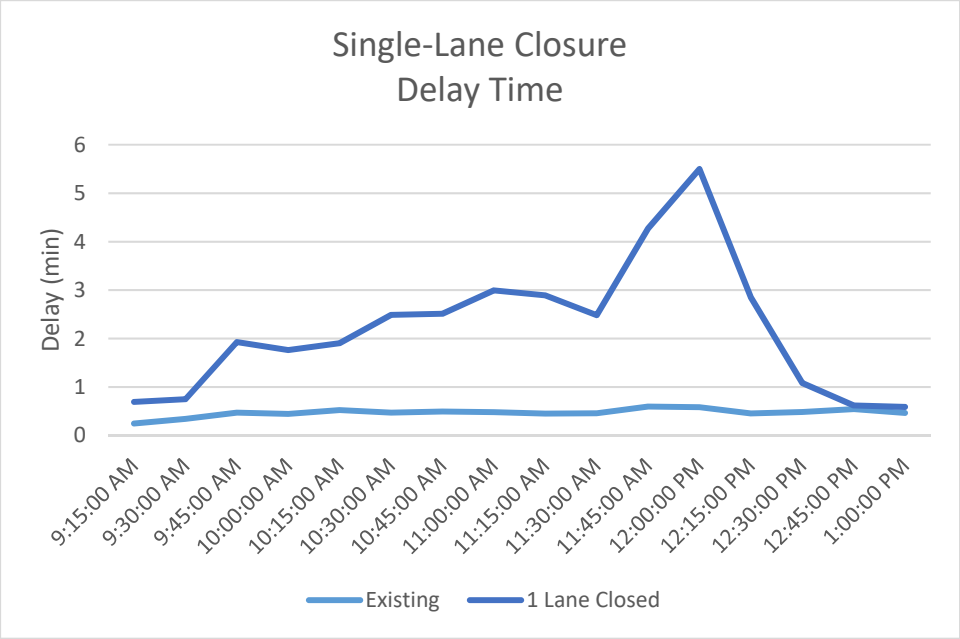


Figure 12: Single-Lane Westbound Closure Delays

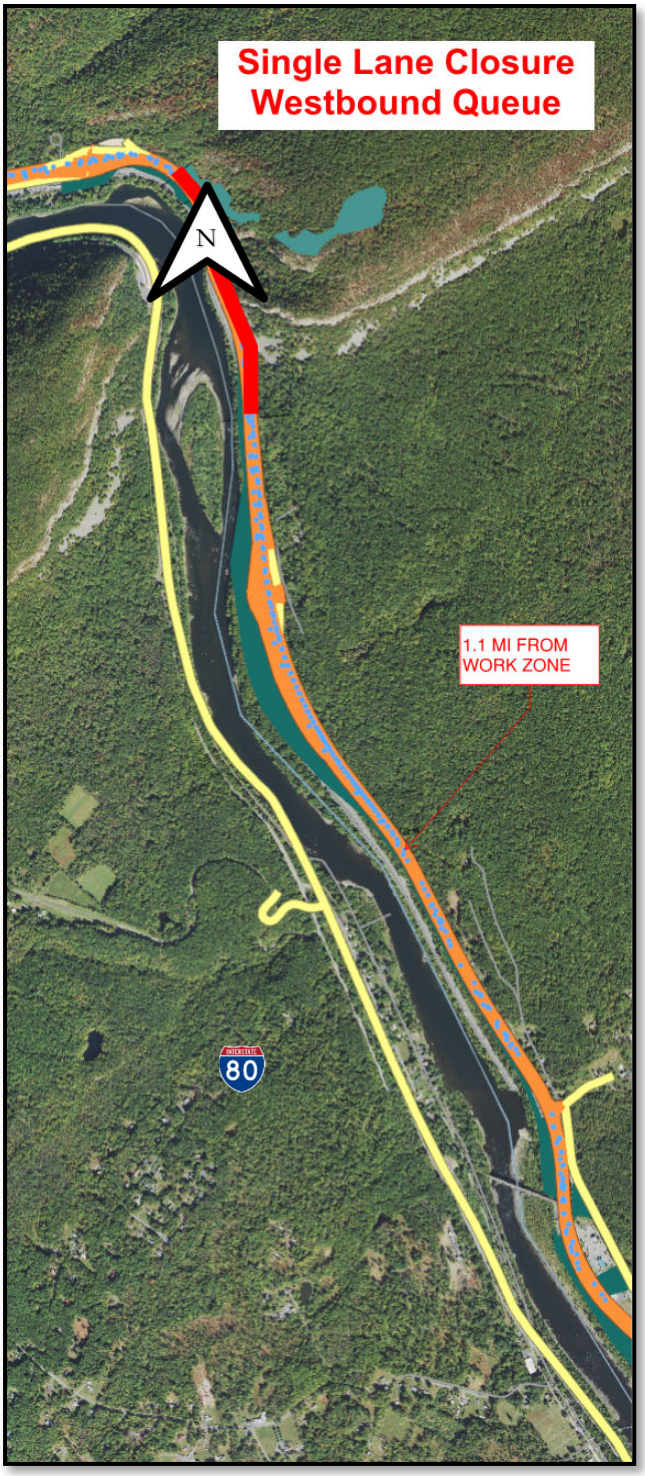


Figure 13: Single Westbound Lane Closure Queueing

5.4 Blasting Event, Full Stoppage

Blasting activities would require full roadway stoppages on I-80 in the eastbound and westbound direction for approximately 15 minutes during allowable closure hours. For the purposes of this analysis, blasting was conservatively assumed to occur during 15-minute periods at 8:00 AM and 11:00 AM on a typical weekday (Monday through Thursday) in the eastbound and westbound directions, respectively.

5.4.1 8:00 AM Blasting

As described earlier, traffic volumes in the eastbound direction are highest during the 8:00 AM hour during the allowable rock blasting time period. During this time period, average vehicular delays were projected to reach 25 minutes, including the time of roadway stoppage, in the eastbound direction (see **Figure 14**) and 20 minutes in the westbound direction (see **Figure 15**). Eastbound queues were projected to extend approximately 1.2 miles from the work zone in the eastbound direction (see **Figure 16**) and 0.9 miles in the westbound direction (see **Figure 17**).

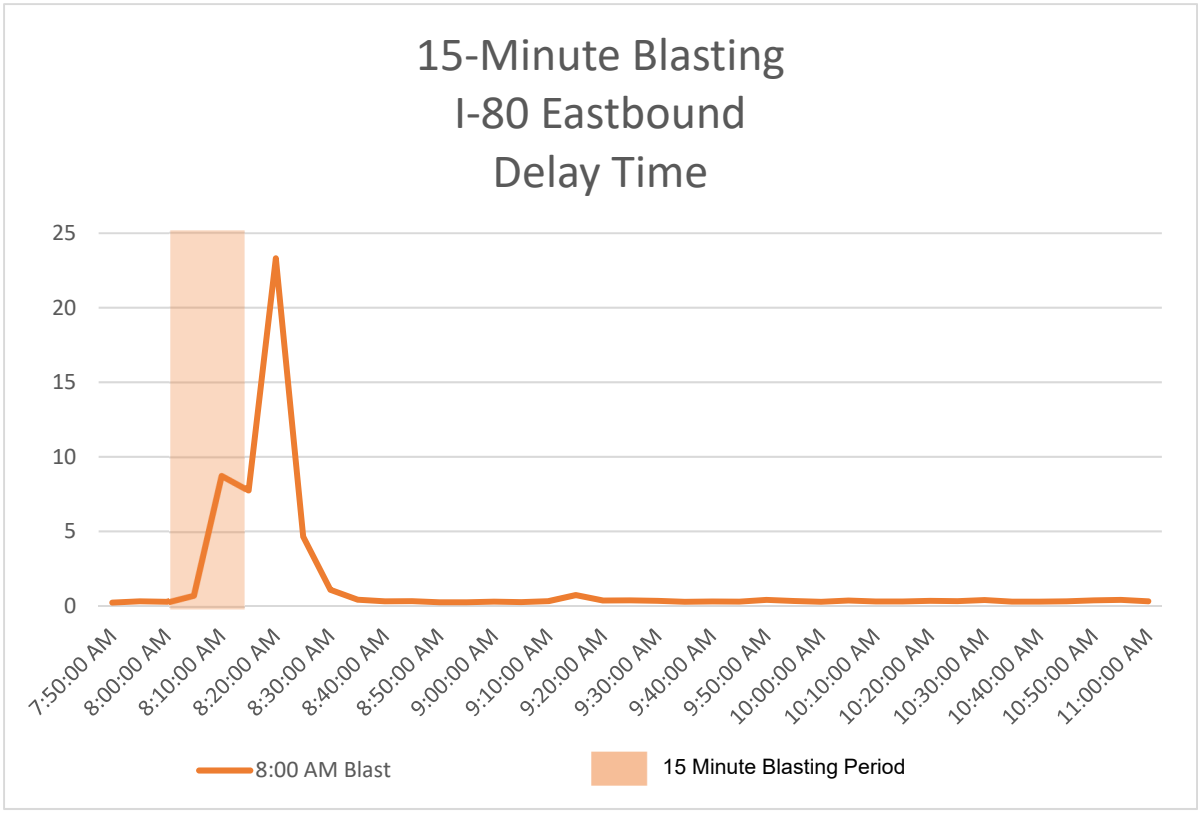


Figure 14: Eastbound Delays – 8:00 AM Blasting

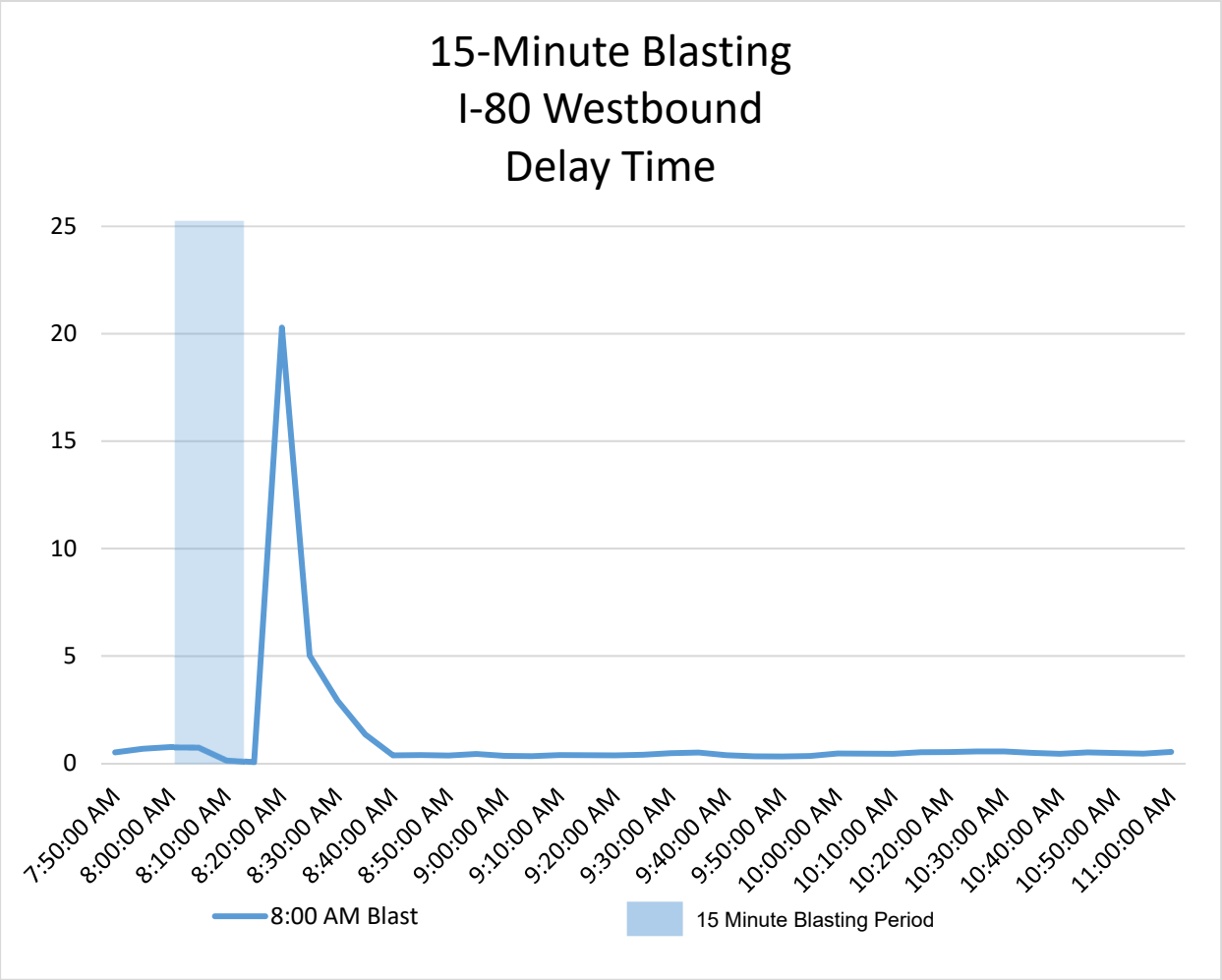


Figure 15: Westbound Delays – 8:00 AM Blasting

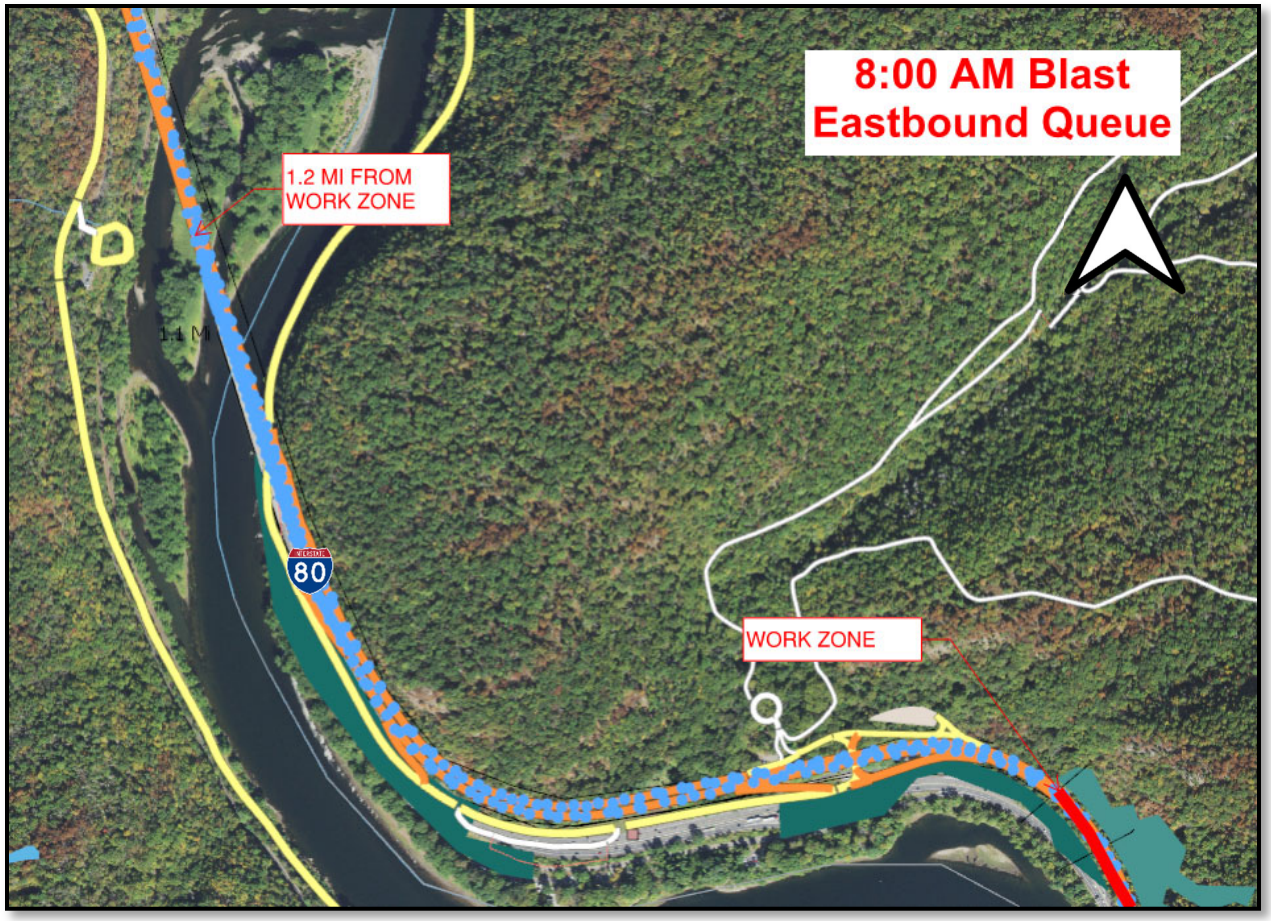


Figure 16: Eastbound Blasting Queuing – 8:00 AM Blasting

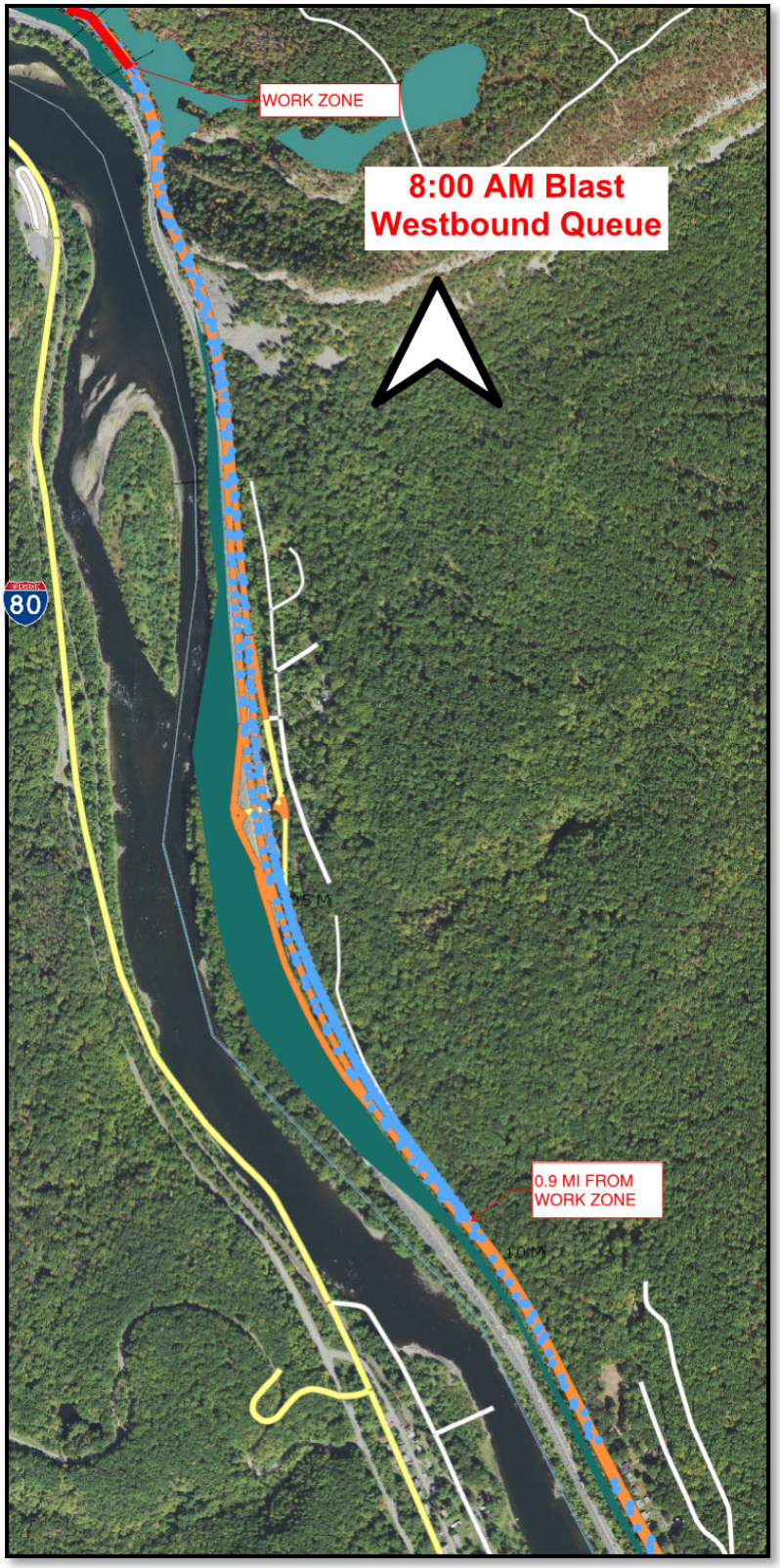


Figure 17: Westbound Queuing – 8:00 AM Blasting

5.4.2 11:00 AM Blasting

Blasting during mid-day would most likely occur mid to late morning. For analysis purposes, blasting activities were assumed to begin at 11:00 AM. The modeled results show longer queues in the westbound direction when compared to the eastbound direction. The analysis projects that vehicular delays could reach as high as 25 minutes in either direction (see **Figures 18 and 19**.) Queueing is projected to extend as far as 1.75 miles from the work zone area, as indicated in **Figure 20**. In the eastbound direction, queueing reaches approximately 1.1 miles from the work zone area, as seen in **Figure 21.**

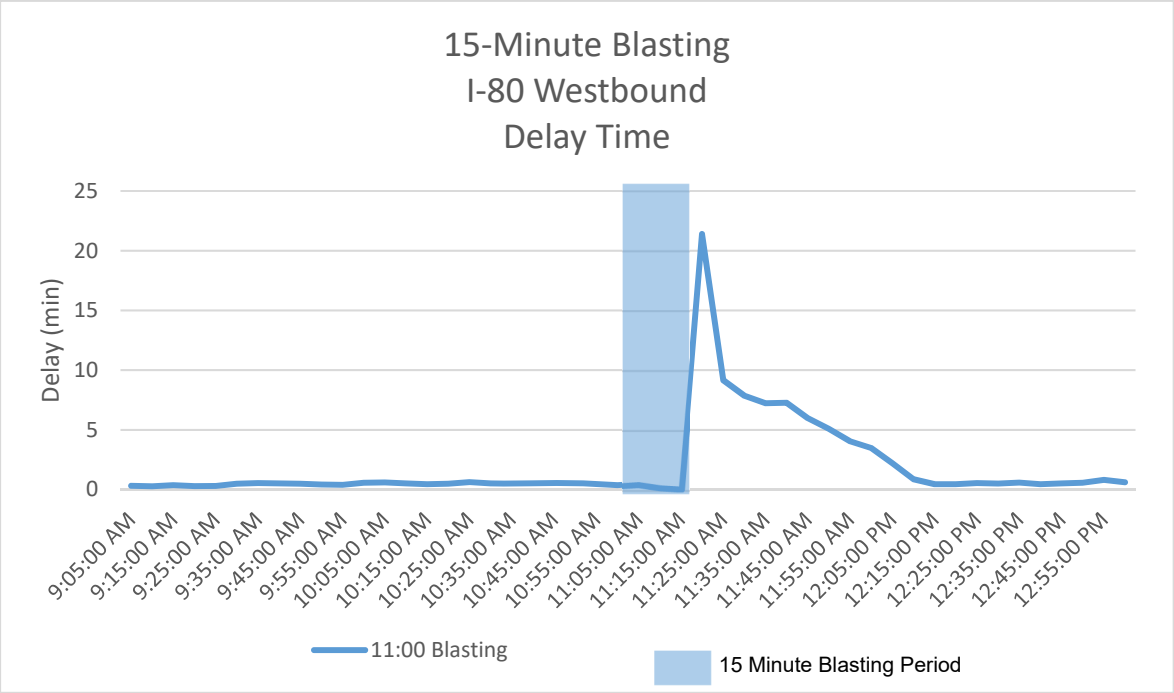


Figure 18: Mid-Day Westbound Delays – 11:00 Blasting

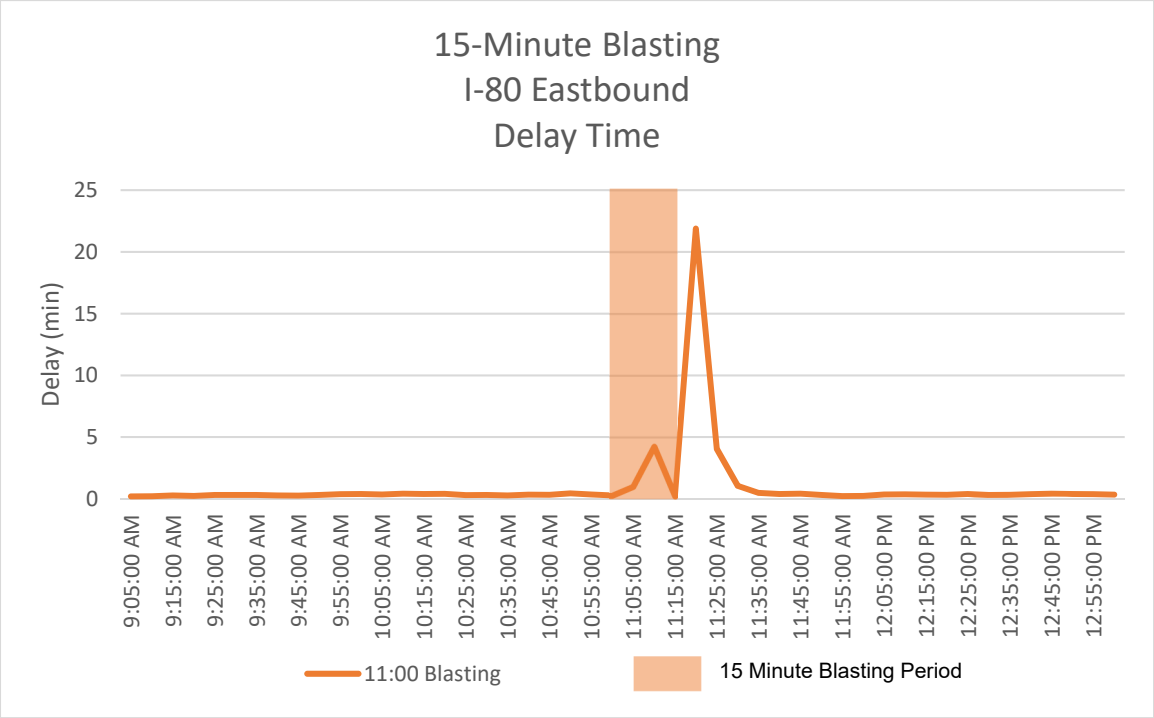


Figure 19: Mid-Day Eastbound Delays – 11:00 Blasting

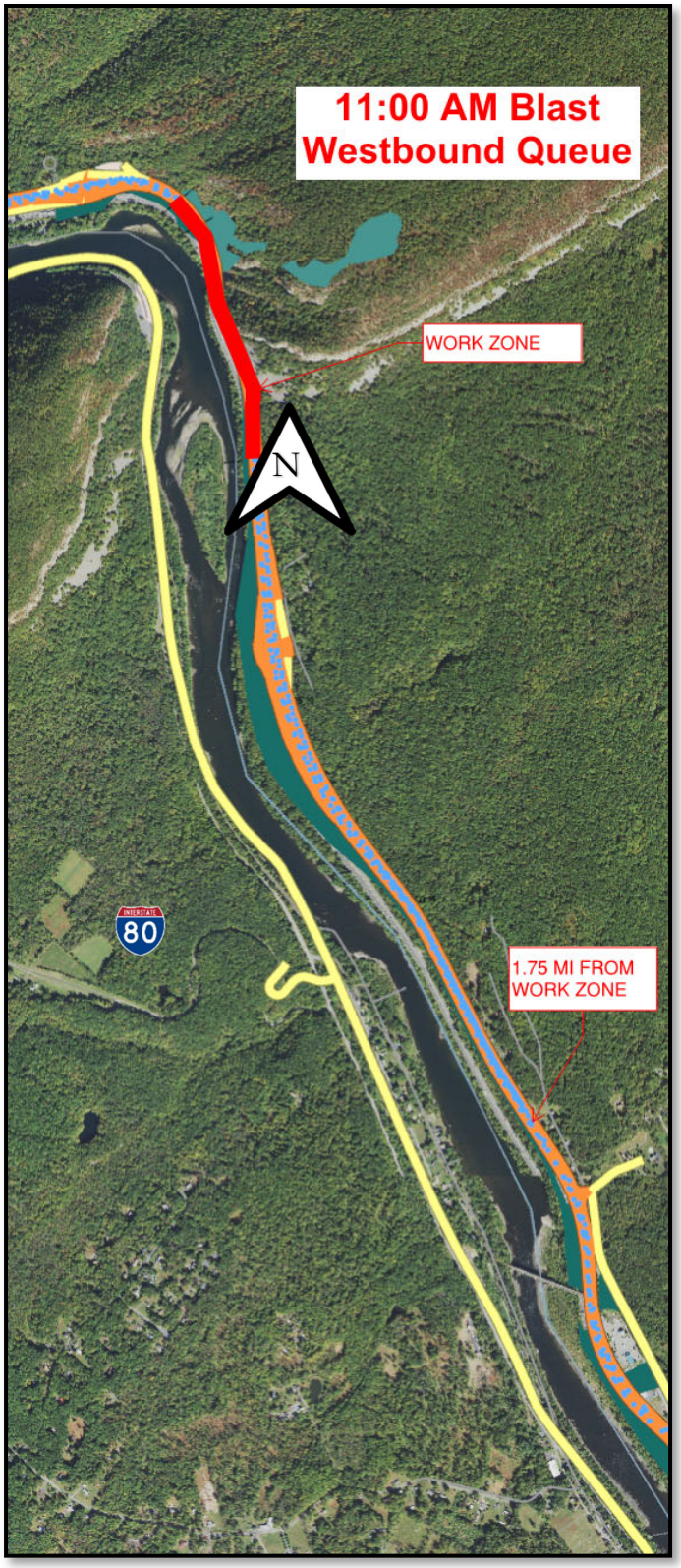


Figure 20: Mid-Day Westbound Queues – 11:00 AM Blasting

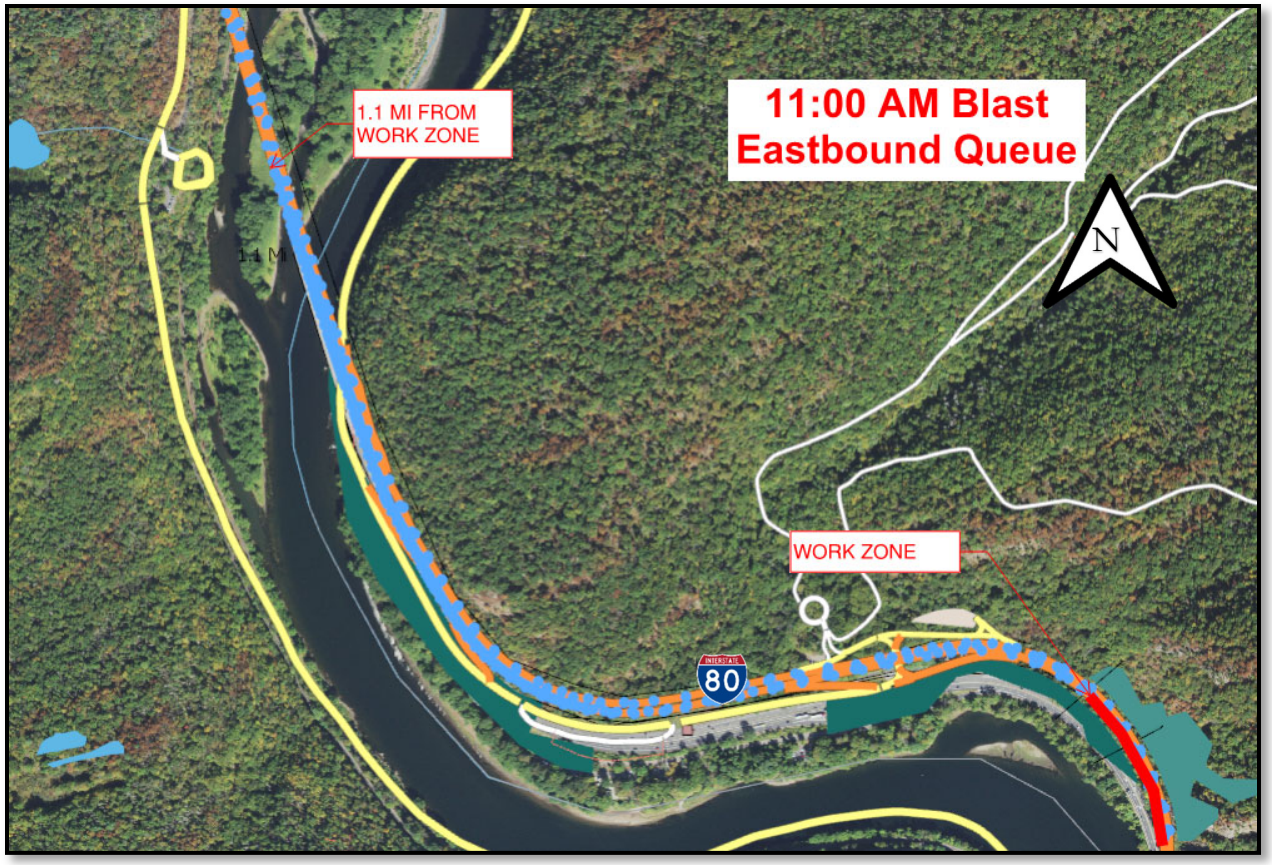


Figure 21: Mid-Day Westbound Queues – 11:00 AM Blasting

5.5 Alternate Route Choice

5.5.1 Travel Time

5.5.1.1 Local Alternative Routes

Under prevailing conditions, it takes approximately seven minutes to travel the I-80 westbound corridor through the traffic study area between the Columbia-Portland Interchange (Exit 4A/4B) and the I-80 on-ramp in the vicinity of the Delaware Water Gap. If a vehicle were to instead utilize Route 611 in Pennsylvania heading westbound as an alternate route, travel time between the same points would theoretically increase to 14 to 16 minutes or an additional seven minutes. (Refer to the travel time comparisons in **Figures 22** and **23**.) Some motorists may be inclined to utilize Route 611 when incremental delays exceed seven minutes. While this alternate route appears to be a potential option to bypass the project work zone, it may not be desirable to motorists given capacity constraints at the Portland-Columbia Toll Bridge and on approach roadways (Main Street and Broad Street) to the I-80 Delaware Water Gap Interchange. Please refer to section 5.5.2, 2017/2018 Historic Traffic Data for additional discussion relating to traffic diversions to Route 611.

The Project would utilize several measures to address the local concern of diversion. These measures include minimizing the duration of lane closure activity associated with blasting activity, limiting construction activities requiring lane closures to periods of low traffic demand when possible, community outreach programs, and the use of dynamic messaging signs to advise drivers of upcoming closures. Should queueing approach the upstream Columbia-Portland Interchange for any reason, the closure would be lifted to avoid delays on adjacent highways.

Should an unplanned event occur, Warren County's existing incident management program would be utilized. The Warren County Traffic Incident Management Diversion Route Plan is the combined effort of the NJDOT, the New Jersey State Police – Incident Management Unit, the Warren County Office of Emergency Management, and the municipal police departments in Warren County. It has been developed to provide guidance when responding to traffic incidents on state highways. During events, NJDOT would make its equipment and resources available to the investigating police agency. Specific to the Project, a smart work zone with the use of cameras and detection would help supply the responding team with real time information. These measures are intended to minimize response time and expedite the clearing of obstructions.

For a comprehensive list of mitigation measures, please see the Conclusions and Recommendations section of this report.

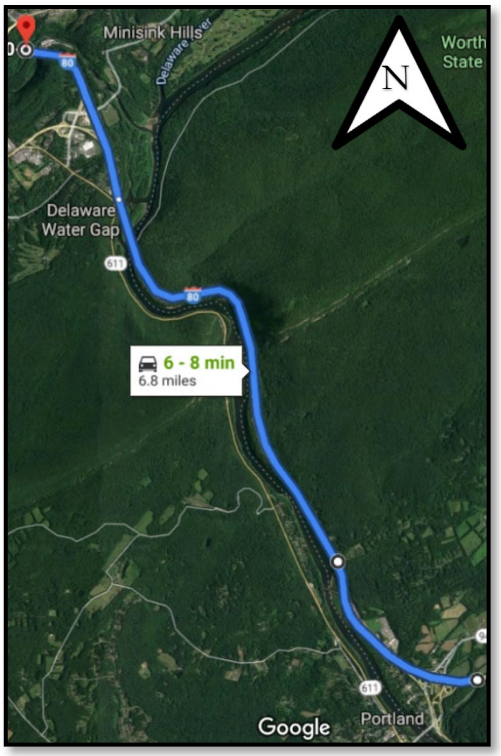


Figure 22: Travel Time – No Diversion

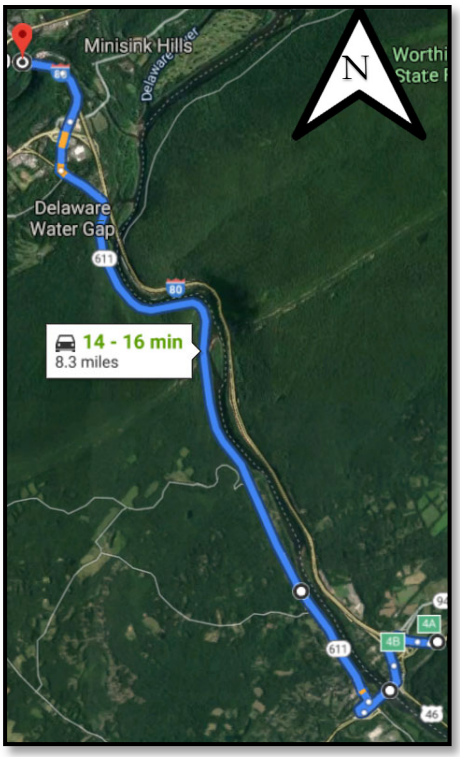


Figure 23: Travel Time – Route 611 Diversion

5.5.2 2017/2018 Historic Traffic Data

Toll traffic data was provided by DRJTBC, who owns and operates the Portland-Columbia Bridge that leads to Route 611 (see **Figure 24**). This bridge would likely be utilized by drivers looking to divert to Route 611. As such, an increase in traffic crossing the bridge would be an indicator of a diversion to Route 611 due to reduced capacity in this section of I-80. The data was for September 2017 to February 2018, the time period during which temporary single-lane westbound closures occurred on I-80 in the Project Area. The data includes the numbers of vehicles utilizing the bridge before, during, and after work activities. The analysis of the data did not reveal a trend for vehicles consistently diverting to use Route 611 as a detour. Approximately 10 percent of the 43 days studied showed a measured increase in volumes crossing the bridge that coincide with lane closures. The slight increase can be seen in the figure below during the approximate hours of 9:00 AM and 12:00 PM.

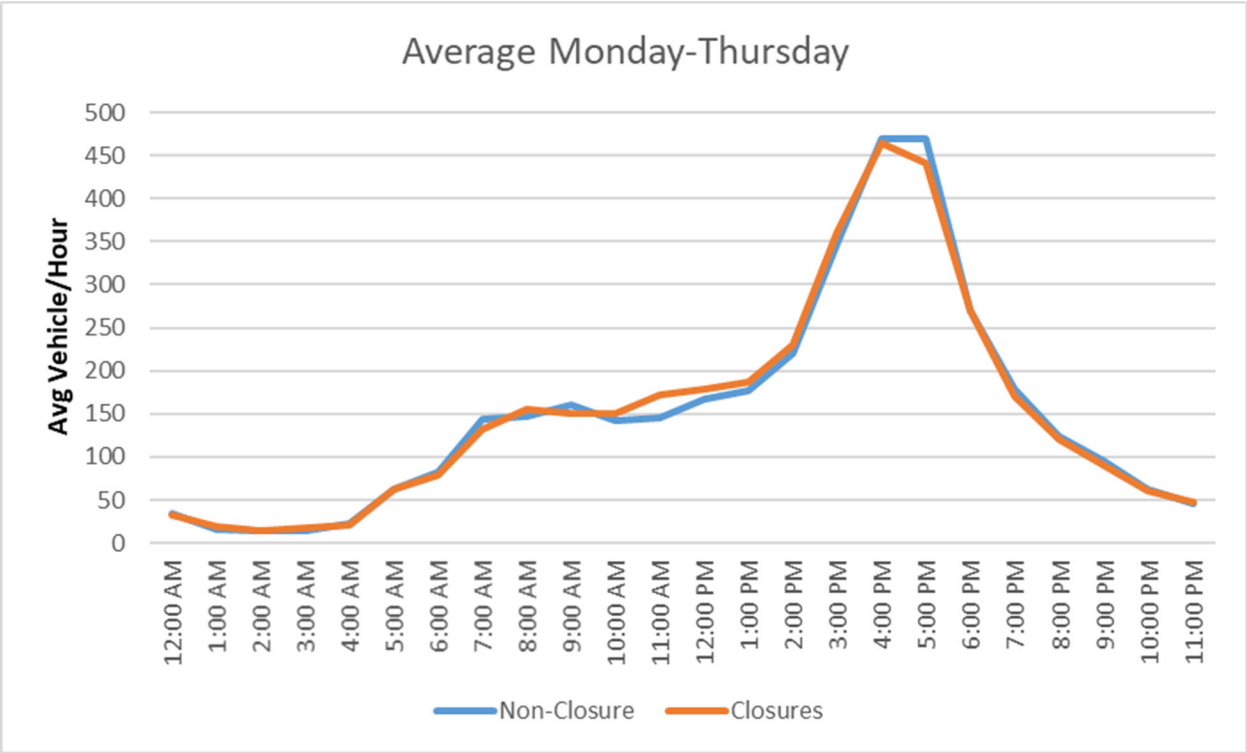


Figure 24: Portland-Columbia Bridge Volume Data

5.5.2.1 Regional Alternative Routes

Motorists would be notified of scheduled temporary lane closures and roadway stoppages so that drivers could make informed decisions regarding the use of alternative regional routes. A potential regional route has been identified as an alternative route to destinations west of I-80. For destinations west of the project site, motorists would be advised to utilize I-287, I-78, and State Road 33 (SR33), as shown in **Figure 25**.

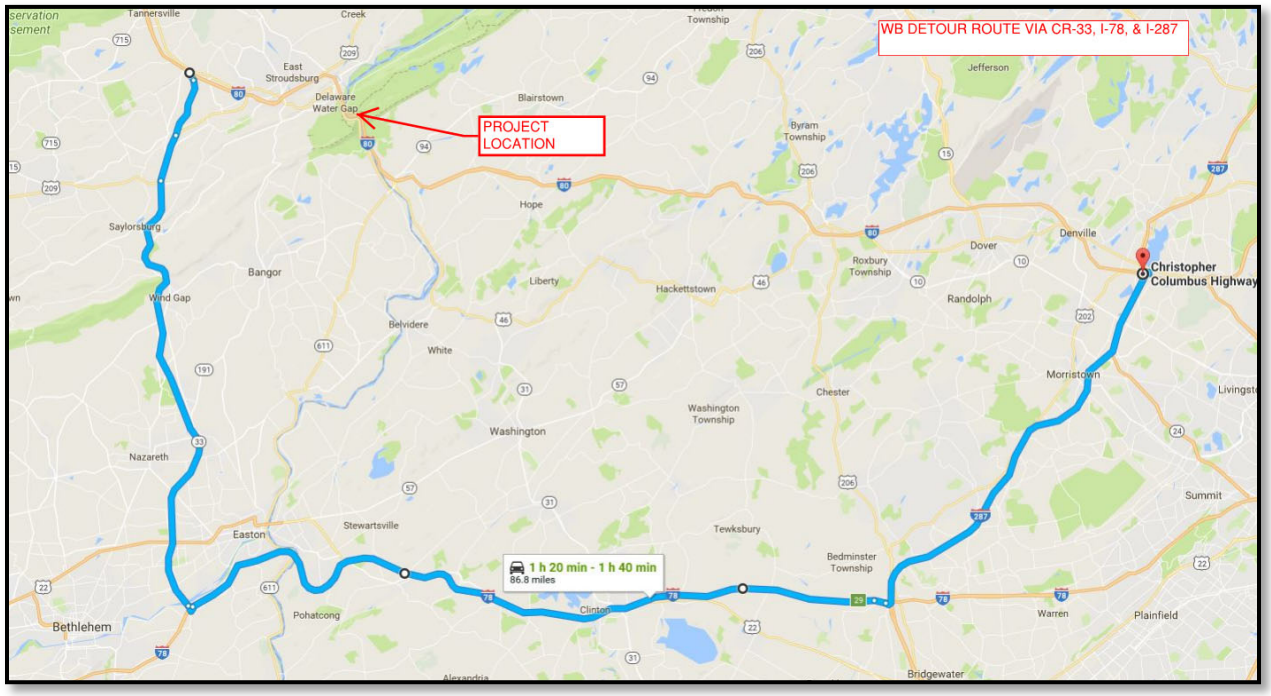


Figure 25: Alternate Regional Route

6.0 Conclusions and Recommendations

Overall, the traffic analysis indicated delays not exceeding 30 minutes from various off-peak hour temporary lane closure and roadway stoppage scenarios required by construction of the Project (see **Table 3**). Blasting during the 11:00 AM peak hour on a typical Monday through Thursday weekday accounts for the highest delays of 25 minutes, with queues extending up to 1.75 miles long in the westbound direction. Blasting is anticipated to occur once per week (Monday through Thursday) between May 15 and September 15 (except holidays) during one construction season. Delays not exceeding 10 minutes and queuing approximately one mile would be expected during construction activities requiring single-lane closures when following NJDOT Standard Lane Closure Hour guidelines. It should be noted that the scenarios conservatively assumed that no traffic diversions occur and all vehicles continue to travel on I-80.

It is noted that during past events, such as disabled vehicles, collisions, and other unplanned incidents causing lane closures, there has been queueing and drivers seeking alternative local routes. The allowable closure hours described in this report are designed to minimize impacts to the roadway and drivers that utilize this corridor. The temporary lane closures and roadway stoppages are planned events, and ample notice would be provided to drivers and law enforcement. It should be noted that delays during unplanned events could be significantly higher due to factors including significantly narrowed lane widths, improper tapering, severity and type of incident, presence of medical emergency vehicles, and "rubbernecking" by drivers distracted by the incident. Such delays could be exacerbated by closures during peak hours, which would not be permitted during project construction.

The following are recommendations provided to further minimize potential impacts to traffic operations during construction:

- Minimize the duration of lane closure activity leading up to and after blasting activity.
- Limit construction activities requiring lane closures to periods of low traffic demand when possible.
- Initiate a community outreach program in advance of construction activities to inform users of the I-80 corridor of anticipated delays.
- Evaluate any improvements that can be made to the existing Emergency Management Plan for Warren County.
- Continue consultation with local communities (and emergency services in particular) in order to develop a Traffic Management Plan. It is expected that the NJDOT Office of Emergency Management would coordinate these efforts. In addition, a project task force would be established to work with multiple levels of bi-state regional and local emergency services representatives.
- Evaluate the establishment of a dedicated emergency services patrol during construction.

- Implement extensive advanced warning of blasting events/construction at a local, regional and statewide level. NJDOT Traffic Operations and Statewide Traffic Management Center (STMC) would be integral in this effort including coordination with Pennsylvania representatives. Upstream dynamic messaging signs on I-80 and other major roadway connectors would aid in alerting drivers. Advanced notice would be implemented to advise thru travelers to divert to other regional interstates such as I-78 to the south.
- Explore using "Smart Work Zone" technology, using variable-message signage, detectors, and cameras to actively monitor traffic in the construction zone.
- Continue news releases on construction operations with interstate commerce and transportation groups, both private and public, throughout the duration of the Project.
- Implement full-time Traffic Control Coordinator(s) during construction to continually assess traffic conditions and monitor emergency radio to make safe and timely adjustments to the traffic flow to meet arising situations.
- Implement prudent and feasible efforts to restrict traffic from diverting to local roads.
- Incorporate lane usage restrictions (for trucks), using signs and markings that can be included in the traffic control plan.
- Coordinate temporary lane closures/roadway stoppages with traffic navigation applications such as Waze, Google Maps, and INRIX.
- State police will be present during all construction activities. Should for any reason, queueing approach the upstream Columbia-Portland Interchange, the closure would be lifted in order to avoid delays on adjacent highways.
- Investigations will be conducted at existing park facilities in the vicinity of the project site, including parking and pedestrian traffic. Safe practices such as advanced warning signs would be considered at approaches to parking facilities due to parking lot overflows.

Table 3: Temporary Lane Closure and Roadway Stoppage Impact Summary

Scenario	Delay	Queue Length
Single-Lane Westbound Mid-Day	6 minutes	1.1 miles
11:00 AM Blasting (Westbound)	25 minutes	1.75 miles
8:00 AM Blasting (Eastbound)	25 minutes	1.2 miles

7.0 List of Preparers

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