Appendix A14

Technical Memorandum:

Electrical

TECHNICAL MEMORANDUM: ELECTRICAL

KENSINGTON EXPRESSWAY PROJECT, PIN 5512.52

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PREPARED FOR

New York State of Opportunity. Department of Transportation

PREPARED BY

HNTB

LaBella

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1. Introduction

1.1. Project Location and Description

The Kensington Expressway Project is seeking to reconnect communities surrounding a stretch of the currently depressed NYS Rte. 33, Kensington Expressway corridor, Figure 1. The project includes the reconstruction of the Kensington Expressway with a tunnel extending approximately 4,150 feet, with southern portal at Dodge Street and northern portal at Sidney Street, Figure 2.

Figure 1 Project Location Map

Figure 2 Proposed Plan of Tunnel – Project Limits

1.2. Objectives

This Technical Memorandum serves to compare potential electrical solutions for power supply to support the tunnel systems and provide recommendations for an electrical solution that is feasible with respect to constructability, costs, and impacts.

1.3. Background

The design of the tunnel systems is in accordance with the following design guides:

- National Electric Code (NFPA 70) – National Fire Protection Association (NFPA)
- Standard for Road Tunnels, Bridges, and Other Limited Access Highways (NFPA 502) – NFPA
- Design of Roadway Facility Lighting (ANSI/IES RP-8-21) – American National Standards Institute (ANSI) / Illuminating Engineering Society (IES)
- Recommended Practice: Lighting Roadway and Parking Facilities (ANSI/IES RP-8-22) – American National Standards Institute (ANSI) / Illuminating Engineering Society (IES)

LaBella and HNTB collaboratively worked towards an electrical scheme that:

- Addresses the electrical demand for the proposed tunnel,
- Minimizes impacts to the surrounding community,
- Meets National Grid (NG) and NYSDOT requirements and standards, and
- Addresses potential electrical failures.

1.4. Configurations and Considerations

Given the length of the tunnel, three electrical rooms are recommended along the length of the tunnel to limit wire runs to support tunnel systems, such as lighting and fire alarm systems, to a maximum of 1000 feet. These electrical rooms would be strategically located near the jet fans, given their large power draw.

Based on coordination with National Grid (NG), lower voltage options were explored so that NYSDOT would not have to maintain a substation for the project. However, NG is not able to provide lower power without potentially affecting other customers. Therefore, Main and Emergency Power supply options were evaluated, and an alternative was selected based on appropriate justifications.

An evaluation of full and emergency power demands was conducted as well as the systems required to be on uninterrupted power supply (UPS) in the event of an emergency (i.e., power outage).

Essential loads were evaluated for comparison against peak demand loads to attempt to reduce the design size of the backup power supply system. However, the difference was found to be negligeable ~2600 kW for peak load demand versus ~2400 kW for essential load demand. Therefore, recommendation is to design the backup power supply for the full peak load demand.

The combined electrical demand for the tunnel is anticipated to be on the order of 3MVA.

2. Power Supply Options

Several power supply configurations were discussed with National Grid and NYSDOT. Three electrical substation options were investigated and are presented below in order of preference, followed by additional options that were eliminated from further consideration.

2.1. Option 1: Two 23kV Feeders and Two Substations

This option consists of two (2) 23kV feeders from National Grid (NG) each terminating in a separate and independent, 23kV to 4.16kV, NYSDOT-owned substation. This option meets the intent of NFPA 70 for two separate services and allows for two (2) independent power supplies (separate trenches) to each of the three (3) electrical rooms along the length of the tunnel. The two separate circuits from NG originate from the same substation, which is setup in a closed bus-tie configuration, which is inherently reliable. Similarly, there would be redundancy in the NYSDOT substation equipment, which would be similarly configured in a closed bus-tie configuration. The separate feeders from NG would allow for NG to take one feeder out of service at a time, for maintenance purposes, while retaining full operations via the second feeder.

In the event the NG distribution substation fails, or the feeders between the NG and NYSDOT substations are severed, there would be no power to the tunnel and the tunnel would be closed with gates operated by uninterrupted power supply (UPS). Similarly, in the event of a regional power failure, the tunnel would be closed with gates operated by UPS. The size of each substation is approximately 22'x75' and comprises of a building partially below grade (top ~3' above grade for ventilation purposes). The two substations would be adjacent to one another but separated by a wall. The substations would be located in the triangular plot north of Best Street and between West Parade Avenue and the Kensington Expressway Eastbound access ramp.

2.2. Option 2: Two 23kV Feeders, Two Substations, and Backup Generator Plant

This option consists of two (2) 23kV feeders from NG each terminating in a separate and independent, 23kV to 4.16kV, NYSDOT-owned substations and one (1) NYSDOT owned backup generator plant. Operationally, this option is similar to Option 1 and additionally provides for generator backup in case of failure of the NG power supply.

Cons for this option are that there is increased space needs for generator plant, and, if diesel fuel generators are specified, storage of diesel fuel will need to be considered. The size of the substation is the same as in Option 1; additionally, the backup generator plant is estimated to be a 50'x75' above grade building. The location for the substation would be the same as in Option 1; however, the potential location for the generator plant is subject to further evaluation. There is a cost impact to this option as well that will require an additional upfront capital expense for backup generator plant, building, and systems for building as compared to Option 1. Also, there will be additional operating costs for generator testing, inspection, and maintenance as compared to Option 1. Based on NG feedback on the resiliency of their terminal substation, it is not anticipated that this backup generator system would be used frequently. NG cited one terminal substation outage over the past 20 years that would have led to the use of the backup generator in this configuration. Given such limited anticipated use. It is not recommended to proceed with the cost of this additional infrastructure.

2.3. Option 3: Two 23kV feeders and a Single Substation

This option consists of two (2) 23kV feeders from NG terminating into one (1) 23kV to 4.16kV NYSDOT owned substation, via an additional primary circuit breaker, and one (1) NYSDOT owned backup generator plant. Pros for this option include: allowing for two (2) independent power supplies (separate trenches) to each of three (3) electrical rooms, providing for separate backup generator in case of failure of NG power supply, and reduction in substation real estate. However, disadvantages include: loss in substation redundancy, meaning that the generator would function as backup for extended periods of time in the case of long lead-time for replacement (such as transformer failure). If diesel fuel generators are specified, storage of diesel fuel needs to be considered. The sizes and locations of the substations and backup generator are the same as in Options 1 and 2. As in Option 2, there will be additional operating costs for generator testing, inspection, and maintenance compared to Option 1.

2.4. Generator Considerations

In practice, electrical systems fail because of circuit brakers or overheating. Stringent requirements on reliability and testing of switchgear are essential. Generators can be diesel or natural gas. The benefits and drawbacks of each are outlined below:

1. Diesel – This generator type has the more economical upfront cost, but it is more costly to operate. This option would also require a load bank, which is only available for 600V, not 5kV, triggering the need for transformers to step down from 5kV to 600V for testing of generators. 5kV would still be delivered to the electrical rooms. Degradation (oxidation) of diesel fuel over time and the need for diesel fuel polishing (diesel fuel not used except during exercising of generators) would also need to be accounted for.

2. Natural gas – This generator type has an upfront cost that is twice as much as diesel generator, but it is less costly to operate. Natural gas generators have cleaner emissions than diesel generators, and they do not require a load bank.

If generator options are pursued, natural gas generators are recommended.

2.5. Other Options Removed from Further Consideration

The following options were eliminated from further consideration:

- Substation on grade and within a fenced enclosure: This option was eliminated from further consideration due to the visual impacts to the local community.

- Substation on grade and within a building: This option was eliminated from further consideration due to the visual impacts to the local community.

2.6. Additional Substation Considerations

It is recommended that the substations be configured to accommodate the following:

- Partially buried structure, with the upper 2 to 3 feet exposed above ground to facilitate substation ventilation needs.

- Crane access via removable rood panels or hatch (10 feet x 15 feet) to allow for equipment placement and future replacement. Roof hatch would be accessed via a 12′ equipment access lane and would have 14-foot clearance overhead for crane movement.
- NG feeders from separate NG terminal substations, as closed bus-tie configuration would not be possible and would therefor reduce the reliability of the feeders.
- Fire/smoke detectors connected to the fire alarm system
- Heating, ventilation, and air conditioning (HVAC) systems with air intake and exhaust at the local street level.
- Maintenance access via enclosed stairways with two means of egress. Access doors would be (2) 36″x80″ single-leaf doors. Maintenance staff would clear snow from the access point after winter storms, so the access door remains accessible and functional. It is anticipated that there would be monthly access via the access doors for inspection, testing, and maintenance purposes.
- Two (2) parking spaces for utility vans/trucks.

3. Power Supply Recommendations

3.1. Electrical Substation

Based on coordination and direction from National Grid, we recommend Option 1. This option requires no backup generator. The power demands required to support tunnel operations will be supplied to the project site via adjoining, and partially underground, electrical substations, each approximately 22 feet wide by 75 feet long. These substations will be located near the southern limits of the project, just north of Best Street and between West Parade Avenue and the NYS Route 33 Eastbound onramp. At these substations, the National Grid supplied dual 23kV utility services will be converted to 4.16kV voltage for distribution to the tunnel electrical rooms. Schematic sketches are shown in Figure 3.

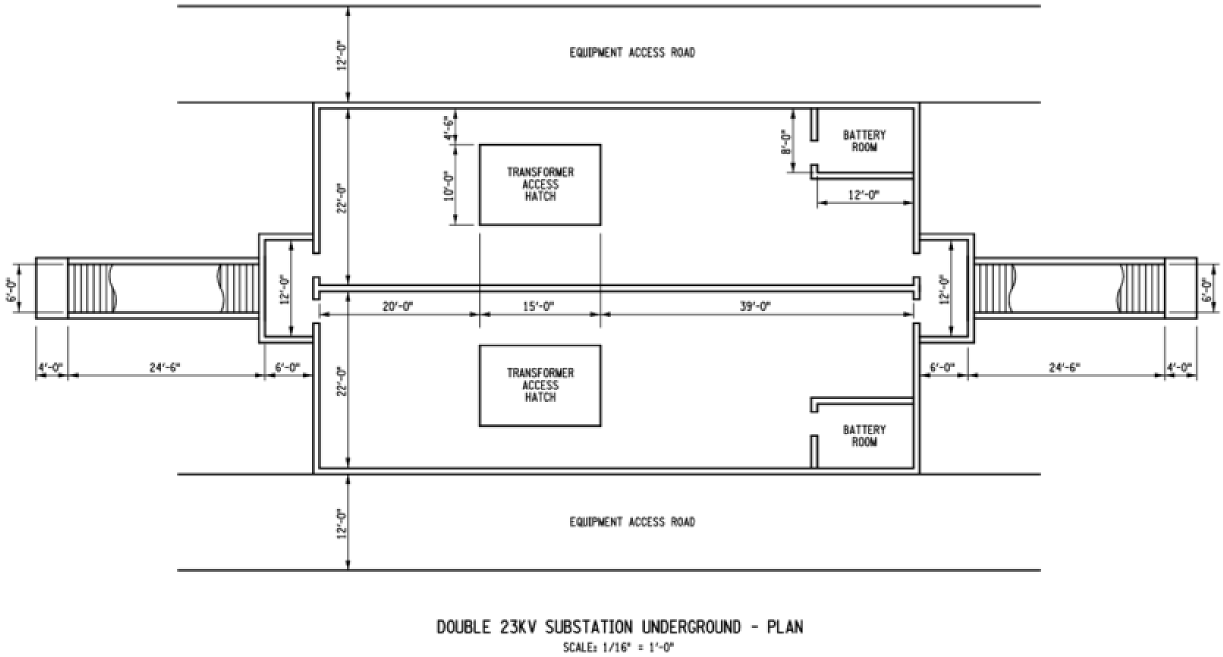

Figure 3: Two 23kV Underground Substations

3.2. Backup Power Supply

Like the electrical configuration at National Grid's terminal substation, NYSDOT's substations will operate in a closed bus-tie configuration which is inherently reliable. If one of the utility feeders is disrupted, such as for maintenance, electrical power will continue to be delivered via the other utility feeder. In the event of a regional power outage, such as may be caused by an outage of the National Grid terminal substation or simultaneous interruption of the two services from National Grid, UPS will be provided to ensure that all safety-related control systems, fire alarm system, emergency lighting and wayfinding lighting are never interrupted longer than 0.5 seconds, as required by NFPA 502. The UPS will be sized to provide 90 minutes of full operation for each of the below noted sub-systems and then will have adequate power to put these sub-systems in a safe state for full power loss. The UPS will also be sized with an additional 15% of overbuild to account for battery degradation over the life of UPS. 90 minutes not only meets NFPA requirements but also is judged to be sufficient time to clear and close the tunnel in a safe and orderly manner. After detection of a power outage, traffic approaching the tunnel would be alerted to take alternate routes and the tunnel would be closed via use of barrier gates. The following sub-systems would be connected to UPS:

- Floor guidance lighting and lighting of every 4th strip light to provide sufficient lighting to reach the tunnel portal;

- Communication systems;
- Fire detection systems;
- CCTV;
- Public address system; and
- VMS signs, lane control signals, and barrier gates to allow for diverting of approaching traffic and closure of the tunnel.

3.3. Maintenance and Inspection Considerations

The following maintenance and inspection frequencies are anticipated for the substations:

- Monthly inspection of substation equipment
- Yearly maintenance of substation equipment

3.4. Coordination with National Grid

Coordination with National Grid is ongoing via biweekly coordination meetings. Below is a summary of major discussion items resulting from ongoing discussions with National Grid:

- National Grid would supply the project with two circuits of 23kV service given the project's anticipated load of approximately 3MW.
- National Grid indicated that two circuits would stem from a common terminal substation (Seneca Station) with closed bus-tie configuration, which is inherently redundant and highly reliable. National Grid would not recommend providing feeds from separate utility terminal stations due to the possibility of circulating currents.
- National Grid has identified a bundle of four cables, two of which will be used to supply power to the project. The four cables that are being evaluated to supply power to the project have had a total of 14 service outages over the past five years, and some of these outages have been due to maintenance.
- National Grid has indicated that concurrent outages on two separate feeder cables are not anticipated to be a frequent occurrence and can be considered reliable as redundant power supply. Reliability data of the terminal substations is not available.
- National Grid supplied reliability data over the past five years (since 2018) for the two cables (16s and 17s) selected to feed the project. National Grid indicated that cable 16s has experienced a total of 4 outages, 3 of which were due to damage failure or

fault location on the cable itself, while the remaining outage was due to maintenance. Cable 17s has experienced a total of 3 outages, 2 of which were due to damage failure or fault location on the cable itself, while the remaining outage was due to maintenance. Furthermore, only one of the outages was concurrent for both cables. The duration of the concurrent fault outage was approximately 8 hours.

4. *Electrical Rooms*

There will be three electrical rooms along the length of the tunnel: one near the south portal, one near the middle of the tunnel, and one near the north portal. Each electrical room will be approximately 20 feet wide by 50 feet long and 8.5 feet high. The desired location for these rooms is near the communication rooms, which must be within approximately 150 feet of the jet fan locations, and below grade. Access door sizes are (2) 36″x80″ single-leaf doors and (2) 10′Lx12′H removable panels (to allow removal of transformers from the tunnel). Access frequency via the tunnel is monthly and will require at a minimum a shoulder closure (lane and shoulder for equipment delivery) for access. Air control and ventilation will require HVAC and fresh air ventilation from grade.

These electrical rooms would contain transformers and switchgear to operate the various tunnel systems, including:

- Longitudinal ventilation (jet fans)
- Fire alarm system
- Fixed firefighting system and its storage tank pumps
- Drainage pumps
- Tunnel and emergency wayfinding lighting
- CCTV
- Public address system
- VMS and lane use signs

The above noted technical rooms will be placed below ground, under the Humboldt Parkway, and alongside the tunnel. Electrical rooms will be equipped with fire/smoke detectors and will be connected to the fire alarm system. Adequate heating, ventilation, and air conditioning (HVAC) systems will be provided, with grates for air intake and exhaust at the local street level. Electrical rooms will also have lighting.

Maintenance access points to technical rooms will be from within the tunnel with use of exterior shoulder closures, both for routine maintenance needs as well as to accommodate equipment delivery.

5. Tunnel Lighting

Tunnel roadway lighting will consist of LED strip lighting in the upper corners of each tunnel direction. Near the entrance and exit portals, this lighting will be supplemented by additional LED strip lighting (threshold lighting) over the travel lanes to soften the transition from ambient lighting levels outside of the tunnel to those within the tunnel. To maximize efficiency, the tunnel control system will automatically regulate threshold lighting levels based on the levels of brightness outside the tunnel.

LED floor guidance lights will be in the outside (right) and inside (left) shoulders to assist drivers in staying within the travel lanes and serve as wayfinding lighting in case of a fire.

In the event of a regional power outage, tunnel roadway lighting and floor guidance lighting will remain under limited operation via Uninterruptible Power Supply (UPS) for a duration of 90 minutes to allow for adequate lighting levels for those motorists that might be within or approaching the tunnel at the time of the power outage to reach the tunnel portal prior to closure of the tunnel.