SCMAGLEV – Innovative Mass Transportation in the Northeast Corridor (NEC)

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ABSTRACT

The Northeast Corridor Superconducting Maglev Project (SCMAGLEV) entails construction of a high-speed train system between Washington, D.C. and New York City, with the first leg between Washington and Baltimore, MD. This innovative project will shorten travel times between Washington D.C. and Baltimore to approximately 15 minutes, and connect Washington, DC to New York City in under an hour. In 2021 the draft EIS is expected to be issued for comment with a Final EIS/ROD anticipated by early 2022. This paper provides an update on the project as presented in Gall et al. (2020) and discusses the economic and environmental benefits, preferred alignment alternative, preliminary staging and launching of the TBMs for construction, and preliminary station design.

INTRODUCTION

The Superconducting Maglev (SCMAGLEV) Project is a proposed high-speed train system that used state-of-the-art magnetic levitation technology between Washington, D.C. and the City of Baltimore, approximately 55.4 km (34.4 mi) in length (Figure 1). The Washington, D.C. to Baltimore segment is the first leg of a route that eventually would be between Washington, D.C and New York City. Additionally, the envisioned route would include stations at Wilmington, DE and Philadelphia, PA, as well as Philadelphia International Airport and Newark Liberty International Airport.

The SCMAGLEV system operates using a combination of electromagnetic levitation, propulsion and guidance rather than flanged wheels, axles and bearings as in conventional high-speed rail systems. The train system will cross several transportation corridors including interstate highways (I-95, I-195, MD295 Baltimore Washington Parkway, I-495, I-695, I-895), several state, city and local routes, and railroad lines, as well as BWI Airport, with all crossings grade separated. The project developer is Baltimore Washington Rapid Rail (BWRR), which is supported by WSP (formerly Louis Berger) as the prime consultant and Gall Zeidler Consultants as the tunneling sub-consultant.

An Environmental Impact Statement (EIS) was initiated in the fall of 2016 in accordance with the National Environmental Policy Act (NEPA) with the Draft Environmental Impact Statement (DEIS) expected to be published in early 2021 and the Final Environmental Impact Statement (FEIS) and Record of Decision (ROD) anticipated by early 2022.

NORTHEAST CORRIDOR (NEC)

The Northeast Corridor (NEC) main line, from Washington, D.C. to Boston, MA represents one of the most heavily traversed regions in the United States with more than 2,000 trains per day carrying approximately 750,00 daily riders across eight states and Washington, D.C. (NEC, 2014). With the regional population expansion expected to continue growing from approximately 51 million as of 2010 to over 64 million by 2040, the aging rail and transit infrastructure will require significant overhaul and additions to satisfy the needs of this economically critical region (Amtrak, 2019). The NEC is a massive economic engine for the

US contributing an annual economic output of approximately $3 Trillion USD, with the NEC rail network alone moving a workforce that contributes more than $50 billion annually to the national economy (NEC, 2014). The NEC Commission projects the unexpected loss of the NEC for even one day would cost the nation nearly $100 million in productivity losses and transportation-related impacts. This serves as a point of emphasis of the need to further expand the mass transportation capabilities of the region; the goal of major projects like the proposed SCMAGLEV and the Gateway Program in New Jersey – New York, which includes rehabilitation of the North and East River tunnels and new Hudson River tunnels (Gall and Nasim, 2019).

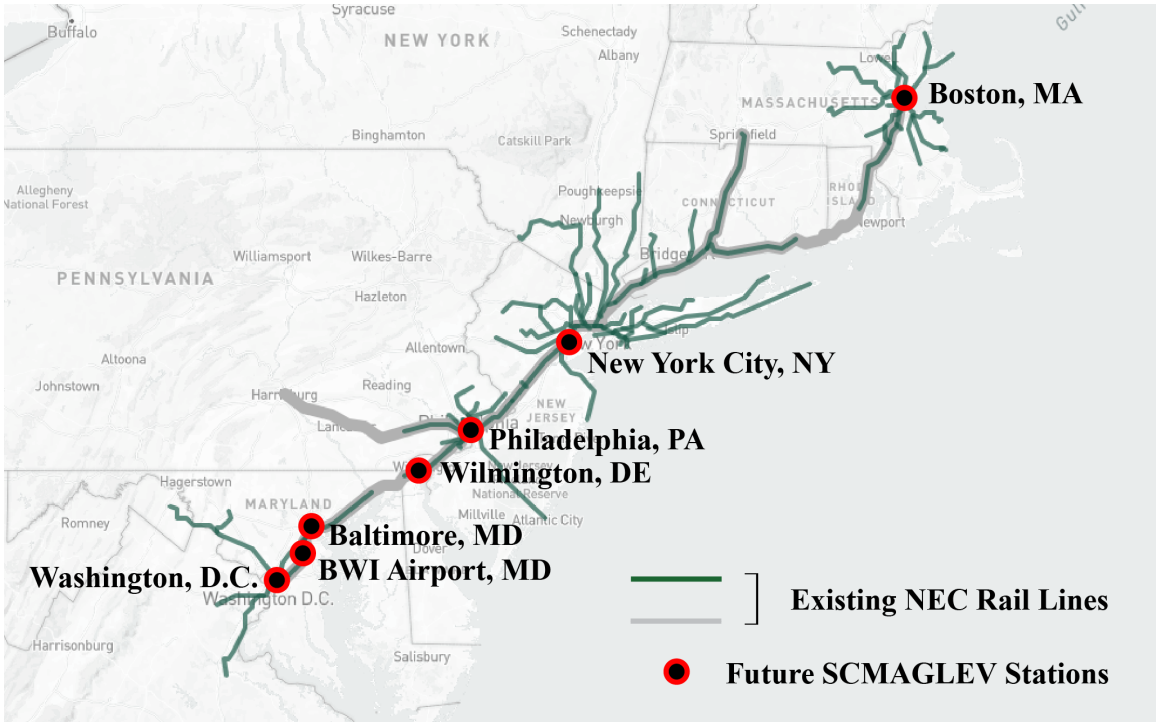

Figure 1. NEC Rail Corridor and proposed future major SCMAGLEV stations.

SCMAGLEV PROJECT BENEFITS

Economic Benefits

With the demand already in place and only anticipated to increase as the NEC population continues to expand, the SCMAGLEV presents an opportunity to contribute to and boost the economic output of the region. It is estimated the SCMAGLEV will create as many as 205,000 jobs over the construction period, with long-term career opportunities for skilled labor and trades to maintain and operate the train. Construction of the SCMAGLEV could result in an increase in the national Gross Domestic Product (GDP) by as much as $22.5 billion and an addition of nearly $600 million annually once revenue service starts. Locally, construction will produce 74,000 jobs in Maryland and a GDP increase of $6.5 billion, with a contribution of $268 million annually after revenue service begins. (The Northeast Maglev, 2019).

On a personal level, according to a study performed by INRIX Research, a private transportation and analytics firm, traffic congestion costs the average commuter in the Washington, D.C. area $1,835 per year, with 124 hours spent in traffic (INRIX, 2020). The same analysis of the congestion and mobility trends in the US found five (5) of the ten (10) most congested cities in the US to be within the NEC: Boston, MA (#1), Philadelphia, PA (#3), New York, NY (#4), Washington, D.C. (#5), and Baltimore, MD (#9). The yearly cost to commuters for the five cities ranged from $2,205 for Boston, MA commuters to $1,243 for Baltimore, MD commuters.

Community Benefits

In addition to the positive regional impact, the SCMAGLEV will provide substantial benefits to the local communities. Such a regional project that facilitates the flow of people readily over long distances essentially enlarges the accessible commuting zone for individuals to work. The SCMAGLEV will make it possible to live and work in areas that were once too distant to consider, changing the dynamics of the region. The implementation of such state-of-the-art mass transportation infrastructure will also serve to promote continued growth and investment into the region, benefiting local businesses, schools and communities. The project would also further establish the NEC as a center of technical innovation in the US, while leading the way on high-speed rail.

Environmental Benefits

Vehicular and air traffic along the NEC is substantial, with one of the main arteries, I-95, registering over 72,000 vehicular trips per day, with peaks of 300,000 on some days (Ignacio, 2019). This amount of vehicular traffic represents a substantial production of greenhouse gases and noise pollution in the NEC region. The key to long-term reduction of vehicular traffic, and a corresponding reduction in air emissions, is investment in new high-speed transportation to meet the current and future needs of the region. According to BWRR's estimates, the expected emissions reduction associated with the decreased vehicle miles traveled (VMT) are on the order of 2,000,000 tons of greenhouse gases, 76,000 tons of carbon monoxide, 15,000 tons of nitrogen oxides, and 4,000 tons of volatile organic compounds (VOCs). Air pollution has a serious toxicological impact on human health and the environment, with pollutants acting as major factors in disease in humans. Air pollution is most impactful to those living in urban areas, where excessive vehicular emissions result in a degradation of air quality that can result in short-term health impacts such as COPD (Chronic Obstructive Pulmonary Disease), cough, asthma, respiratory disease, etc., and long-term effects such as chronic asthma, cardiovascular disease, and increased risk of morbidity and mortality (Manisalidis et al., 2020). Furthermore, the impacts of increasing greenhouse gas emissions on the climate are well documented (IPCC, 2014), requiring more urgent and large-scale measures to effectively reduce emissions.

In addition to vehicular traffic, airports within the NEC are among the most congested in the US, with over 244 million annual passenger trips, constituting 30% of all US air travelers, and a 20% increase in air traffic from 2000 to 2010 (NEC, 2014). The SCMAGLEV technology provides a more energy efficient mode of high-speed transportation, consuming far less energy than a commercial airliner per seat, thereby providing a more environmentally beneficial alternative to air travel. The combined reduction in vehicular and air traffic will also result in noise pollution reduction, pavement maintenance savings, and safety benefits.

ALIGNMENT ALTERNATIVES

The first phase of the project is located in Washington, D.C. and Maryland, traversing a distance of approximately 55.4 km (34.4 mi) with three stations: Washington D.C., BWI Airport and in Baltimore, MD. The Washington, DC and BWI Airport stations are underground. There are above and below ground options for the Baltimore station. The SCMAGLEV system requires an independent and grade-separated right-of-way. Further, the SCMAGLEV requires limited horizontal and vertical curvature for ultra-high-speed travel. To accommodate the range of topographical and surface features, existing dense urban areas, utility mains, and existing structures, the proposed construction is expected to consist of below-ground (deep tunnel) for at approximately 75% of the route, and elevated structures (viaduct) for the remainder. The train system incorporates two main guideways, three stations, trainset maintenance facility, electrical substations, and fresh air and emergency egress facilities.

The environmental review process narrowed two alignment alternatives which generally follow the Baltimore Washington Parkway (MD 295) (Figure 2). The preferred alternative will be identified in the EIS process. A preferred station location in Baltimore is still being assessed and will be identified in the EIS process as well. Stations will have a platform length of approximately 400 m (1312 ft.), enabling accommodation of 16-car trains.

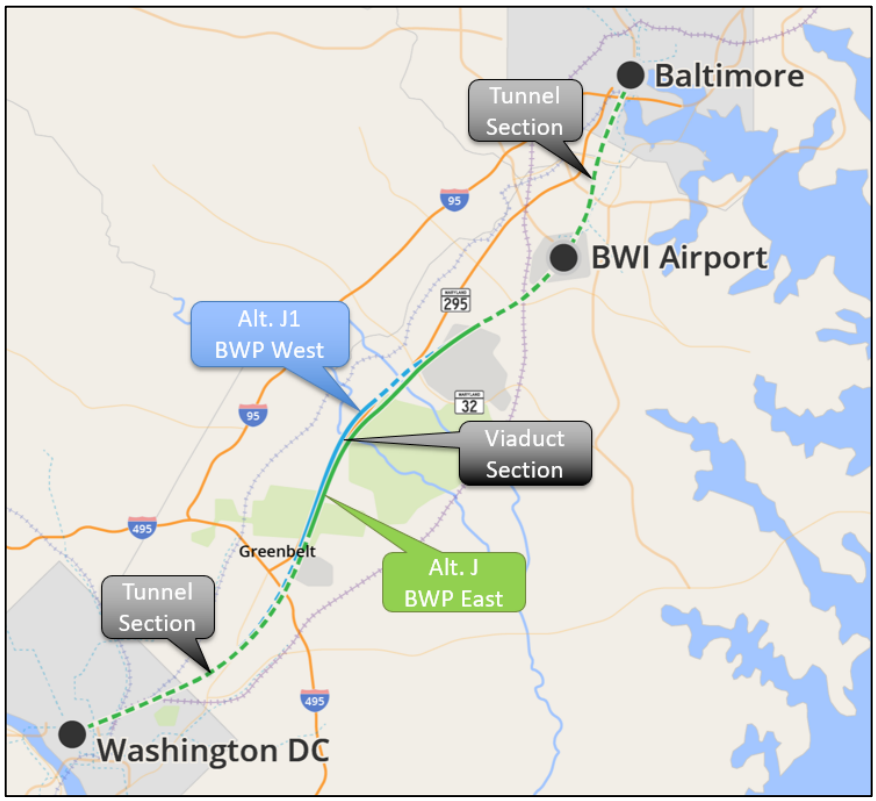

Figure 2. Proposed alignment alternatives under consideration

GROUND CONDITIONS

Top of bedrock which varies considerably along the alignment as a result of the proximity of the alignment alternatives to the Fall Line. Tunneling is anticipated to occur primarily through fluvial sediments of the Patapsco, Arundel, and Patuxent formations of the Potomac Group, which consist of laterally discontinuous layers of sands, silts, and clays, with gravels. Bedrock is anticipated at portions of the alignment closest to the Fall Line, which includes the Washington, D.C. and Baltimore stations, as well as the central portion of the alignment alternatives approximate to the viaduct segment. Locally higher sections of the bedrock cannot be excluded, and would be a target of future geotechnical investigations.

Groundwater conditions are expected to vary widely across the alignments, from dry conditions to groundwater levels ranging from relatively shallow depths of less than 10 ft. (3 m), to depths in excess of 40 ft. (12 m). Fluctuations in groundwater levels across the alignment will occur seasonally due to variations in rainfall, evaporation, construction activity, surface runoff and proximity to adjacent streams and the Chesapeake Bay shoreline. Localized perched groundwater and isolated water-saturated sediment lenses can also be expected.

TUNNELING CHALLENGES

The proposed alignment alternatives include deep tunnel sections. Considering the length of the tunnel sections and the required uniform geometry, it is anticipated that mechanized tunneling will be implemented for the majority of the alignment that will need to address the following challenges:

- Tunneling in soft ground, consisting of sands, silts, clays and gravels.
- High groundwater level
- Tunneling across urban areas and therefore under major infrastructure

Considering the soil types and groundwater conditions expected along the deep tunnel sections, which require an active face support, the use of a closed face Tunnel Boring Machines (TBMs) will be required. Based on the available preliminary information on the geological and hydrogeological conditions and the critical impact of groundwater to the tunneling activities, implementation of Earth Pressure Balance Machines (EPBM) is considered, at this stage, most appropriate for the anticipated subsurface conditions. Alternatively, Slurry and/or Mix Shield TBMs could be considered, as the alignment could encounter sections of mixed geology with hard rock potentially shallower at the two ends of the alignment, pending the next phase of ground investigations. The information acquired from the additional ground investigation program will clarify the appropriate TBM-type(s) for the alignment segments.

The soft ground TBM tunnels will be supported by pre-cast segments, which are erected at the tail end of the TBM producing a continuous lining over the tunnel length with a circular, uniform geometry. Segmental linings will be equipped with gaskets in the joints between the segments to inhibit groundwater inflow into the tunnel. The inside diameter of the SCMAGLEV tunnel will be approximately 13 meters. A single bore TBM tunnel with an outside diameter of approximately 15 m (50 ft.) is expected to be required.

TBM LAUNCH AND RETRIEVAL

Subdivision of the TBM tunnel alignment into sections with a length of 5 to 6 km (3 to 4 mi) is currently considered for enabling concurrent boring along various sections. This division means, depending upon the final alignment, as many as 8 to 9 TBMs could be boring concurrently. To minimize project footprint, emergency exit locations will be used as TBM launch/retrieval shafts, also serving to minimize cost and streamline construction. As the launch sites will be also used for stockpiling of the spoils, implementation of additional launch sites along the alignment will allow more efficient storage and transport of the spoils to the areas designated for disposition.

CONCEPTUAL STATION DESIGN

Due to the dense urban environment in Washington D.C. and Baltimore and the relatively deep alignment, construction of the stations with minimal surface impact and disruption to the city activities will be challenging and will require a well-thought design. Similarly, construction of the station under the BWI airport without disrupting airport operations will pose a significant undertaking. Both structures will be within soft unconsolidated sediments and below the groundwater table. Additionally, the close proximity of the stations to existing structures sensitive to settlements precludes dewatering during construction. This necessitates the use of slurry-type SOE with reinforcement and bracing sufficient to compensate for the large loads likely to be encountered by the deep station structures. Preliminary excavation sequencing aims to limit road closure, maintaining traffic flow throughout construction.

BWI station presents additional challenges as a result of the need to effectively have no impact on airport traffic and services during construction. Conceptual designs for the BWI station segment include three parallel TBM tunnels, permitting two of the tunnels to be used for local station traffic, and the third central tunnel for eventual express trains between Washington, D.C. and New York.

OUTLOOK & PROJECT TIMELINE

With the successful completion of the preliminary ground investigation program, the EIS process is underway with ROD anticipated in 2022. A positive ROD would mean forward movement on the next phase of ground investigation and preliminary engineering. The project timeline and outlook are currently as follows:

- Early 2021: Official notice of availability of a Draft EIS published in the Federal Register (FR)
- Early 2022: Official notice of availability of a Final EIS published in the Federal Register (FR)
- Early 2022: Issuance of a ROD

The proposed SCMAGLEV is a technically challenging but innovative project that will shorten commuting time between Washington D.C. and Baltimore, and later to New York City. The project will enhance mobility along the northeast corridor and could spur development and economic growth in the region.

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