

APPENDIX A

ENGINEERING REPORT

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APPENDIX A.3

Engineering Design Process

PROJECT: Sunnyside Yard Master Plan
LEAD: HNTB
DATE: 11/22/19
SUBJECT: Engineering Design Input Process

I. Overview

This memorandum summarizes the design input process for the development of the Sunnyside Yard Master Plan (SSY-MP) to facilitate the construction of an overbuild deck and associated preliminary design scenarios above Amtrak's Sunnyside Yard (SSY).

Over the course of the SSY-MP development, the design team submitted various interim documents to Amtrak and coordinated with Amtrak to review future Amtrak SSY improvements (based on Amtrak's 2014 SSY Master Plan), design standards, operational needs, and safety approaches. Following those discussions, the design inputs were modified as necessary to reflect Amtrak's feedback. This memo provides a summary of the inputs that led to the final Comprehensive Overbuild Master Plan and Preliminary Design for Near Term Public Realm Improvements.

The following materials were used in the production of this memo:

Existing Conditions Data

- A. 2014 Amtrak Master Plan for Sunnyside Yard
- B. Below Deck Infrastructure Matrix
- C. Deck Coverage Evaluation – Operational Assessment

Design Standards and Assumptions

- A. Amtrak Overbuild Assumptions List
- B. Amtrak and Railroad Design Standards – Horizontal Clearances
- C. Amtrak and Railroad Design Standards – Vertical Clearances
- D. DOT Bridge Clearances
- E. Ventilation and Safety Inputs

II. Establishment of Existing Conditions

As the first step in considering how an overbuild deck would best integrate with the existing rail yard and operations, the SSY-MP team undertook a review of the existing physical and operational conditions at SSY. The following elements were key to this assessment:

- A. **2014 Amtrak Master Plan for Sunnyside Yard**: The team reviewed the 2014 Amtrak Master Plan for SSY (2014 Amtrak-MP), which was developed by Amtrak as a guide for the coordination of long-term future projects and development within the Yard.

While it is understood that this plan is currently under review by Amtrak and may change, the 2014 Amtrak-MP was utilized as the baseline existing condition for the SSY-MP with the understanding that further evaluations will be necessary should any changes occur.

Some of the major planned Amtrak improvements to the Yard, as shown in Figure 1, include:

- The existing HSR facility will be expanded from two to six tracks
- Expansion of the bowl tracks to provide additional storage and the ability to perform light servicing of the equipment
- Construction of a new Maintenance of Way (MOW) yard
- Construction of a new Conventional Repair Shop, Wheel True/Drop Table Building, and Commissary and Materials Management Building

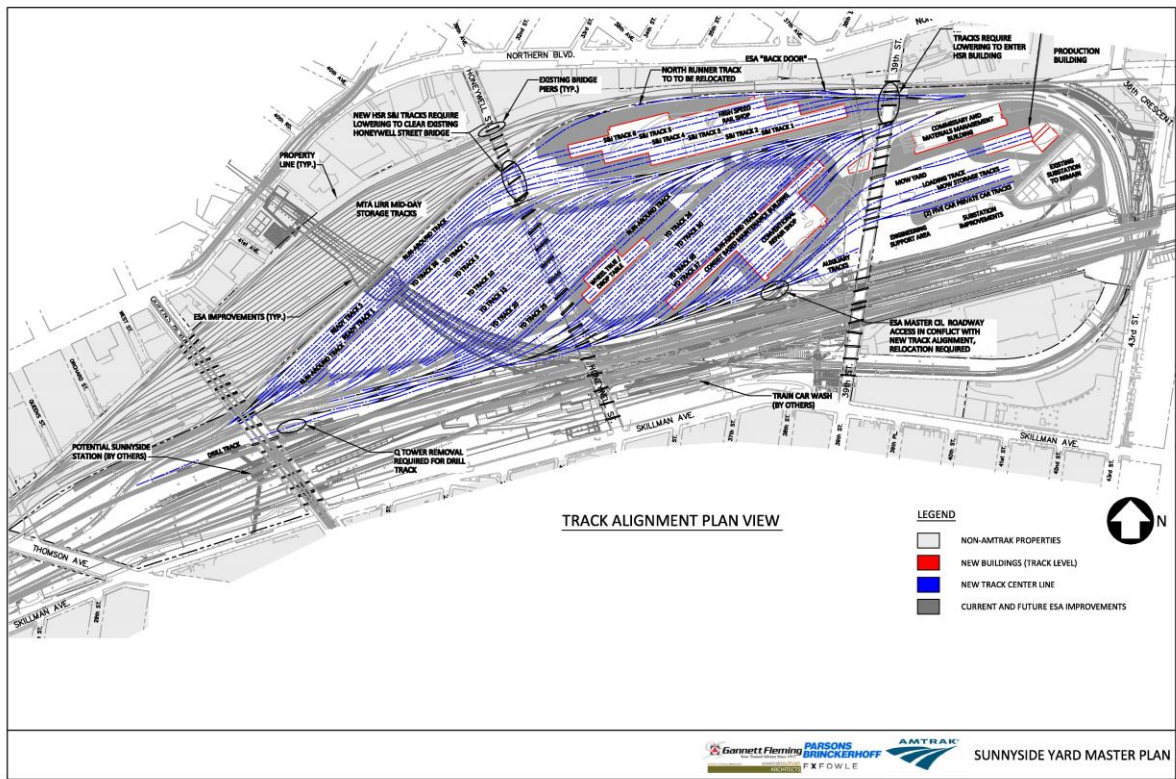


Figure 1: 2014 Amtrak Master Plan

B. Below Deck Infrastructure Matrix

The SSY-MP team separated the Yard and potential project limits into nine zones for rail analysis, as shown in Figure 2, and then developed a matrix of all existing and proposed infrastructure in the Yard, as shown in Figure 3. The matrix identified limitations, constraints, opportunities, and parameters, setting the stage for an integrated preliminary design process between the below-deck and overbuild design needs, and a baseline understanding between rail stakeholders and the SSY-MP design team. The matrix documented current conditions and future baseline conditions as a result of the 2014 Amtrak-MP and the LIRR Mid-Day Storage Yard (MDSY).

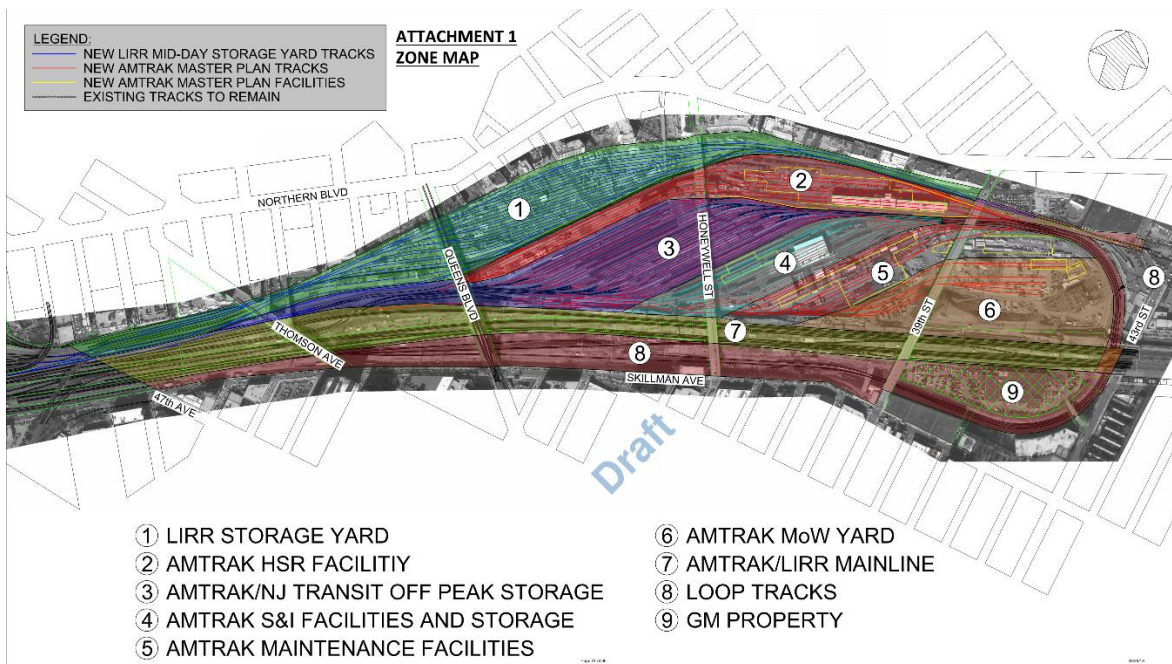


Figure 2: SSY-MP Zones of Analysis

Below is a summary of key findings for each zone:

- **Zone 1 LIRR Mid-Day Storage Yard (MTA Owned):** The new MDSY will be completed prior to any potential Yard overbuild construction activities. Most infrastructure will not be able to be modified except for lighting structures which can be relocated to avoid overbuild foundations. Although it was not identified at the time of the matrix development, later SSY-MP memos noted that MDSY will also include a foot bridge for maintenance workers that will need to be rebuilt and integrated into a future overbuild.
- **Zone 2 Amtrak HSR Facility:** Until the expanded HSR Facility is built, the area will provide laydown space for deck construction; most utilities will be flexible except storm and sewer lines. Subsurface tunnels and building and track infrastructure occupying most of the zone will provide the greatest limitations in determining locations for overbuild supports.
- **Zone 3 Amtrak/NJ Transit Off-Peak Storage:** Overbuild and track reconfiguration should happen in tandem to prevent constructability concerns. Area will be fully occupied by track infrastructure; however, Q Tower, OCS structures and other railroad facilities will be relocated/modified providing some opportunity. New ESA Tunnels also run beneath this zone and will need to be worked around.
- **Zone 4 Amtrak S&I Facilities and Storage:** Tracks, signals, and tunnels provide the greatest limitations; however, these facilities can incorporate overbuild structural elements.
- **Zone 5 Amtrak Maintenance Facilities:** The maintenance facility is fixed as it occupies the full width of Zone 5; the other facilities may have flexibility regarding their locations if the functionality is maintained. OCS infrastructure can be incorporated onto the deck to provide flexibility, while signal and track infrastructure have limited flexibility.
- **Zone 6 Amtrak MOW Yard:** Future use may be less fully utilized by track, providing some flexibility for the relocation of the rail. OCS infrastructure can be incorporated onto the deck to provide flexibility. The loop tracks are not able to be relocated.

- **Zone 7 Amtrak/LIRR Mainline:** The Mainline is one of the busiest railroad segments and interlockings in North America. The proposed overbuild will need to accommodate the Mainline track and interlocking configuration. After additional analysis through later stages in the SSY-MP process, an overbuild above the Mainline was eliminated from the project design as a result of constructability limitations and the resulting impact on the project cost.
- **Zone 8 Loop Tracks:** The Loop tracks are in constant use and will have limited flexibility for outages and/or relocation; other tracks in the zone will have some flexibility. Tunnel, power, and signal components will have limited flexibility.
- **Zone 9 GM Facility:** At the time the matrix was initially developed, it was noted that if this property was acquired it could provide additional contractor laydown area from which to stage the deck construction and to provide structural support for the overhead deck. However, this area is no longer included with the overbuild project limits.

NYCDOT Sunnyside Yard Master Plan
Below Deck Infrastructure Matrix DRAFT

Zone	Zone Elements		Constructability/Staging Considerations	Operational Considerations	Force Account Considerations	Environmental Considerations	Unknowns	Change to Amtrak Master Plan (Yes/No)	Assessed Feasibility Ranking	Notes
	Type	Existing								
Zone 5: Amtrak Maintenance Facilities	Track Infrastructure	4 full weekend repair tracks	12 tracks serving the maintenance facility. Full weekend repair tracks.	The area contains certain facilities critical to operations such as the power-to-lighting substations, vehicle repair area, and equipment storage. The functionality of these elements would need to be relocated and maintained to support normal yard operations.	There are no operational considerations above and beyond what is described in the constructability/staging column.	Amtrak force account would be required for all track installation and surfacing. Contractor would be able to perform bulk of the trackwork best work.	Zone 5 overlaps with O&A, O&A, and O&A. O&A has ongoing remedial measures and there is no currently required further action, although there is an environmental assessment associated with O&A. O&A and O&A-5 have ongoing remedial action. O&A-5 cover system beneath the site occupying the area under and across the MDP.	Confirmation that the current layout for the tracks and maintenance facility conforms to the latest Amtrak master plan.	This cannot be determined until the design of the overbuild structure has been advanced and problems with the proposed track layout are identified.	Reconfiguration of the tracks is dependent on the maintenance facility layout, which occupies the full width of the zone. Some light modifications are assumed to be possible within these areas, which may be helpful in terms of shifting the footprint around to accommodate the overhead structure but a further detailed design is required.
	Canopy	No Existing OCS wires over the zone	New future tracks will be installed.	N/A	OCS transfers or relocations must be designed to maintain service critical to operations.	Amtrak would need a special agreement with their utility to allow the contractor to install OCS structures and conduct all final wiring installations and connections will be made by Amtrak force account.	Amtrak would need a special agreement with their utility to allow the contractor to install OCS structures and conduct all final wiring installations and connections will be made by Amtrak force account.	Level for the OCS and type of structures proposed in the master plan.	To be determined during design development in coordination with TI.	No identified tracks in this zone. New design should incorporate the OCS wires to be installed on the deck.
	Power	OCS cross canopy structure needed to carry Amtrak signal power	New traction power duct banks for new disconnects, switch houses.	N/A	Signal power cable relocations must be designed to maintain service critical to operations. More detailed analysis and design required.	Amtrak force account will be required to perform all the traction power work without special agreement with their utility.	Level of Amtrak protection/conservation areas available to perform the work.	To be determined during design development in coordination with TI.	Minority Feasible	See duct banks for new disconnects, switch houses, OCS and MDP house can be designed to work with the location of the future proposed plans. Existing signal power ducts currently parallel to 10th St. Bridge will need to be relocated underground. These ducts are running from existing 10th St to the north and east of Sunnyside Yard limits. The signal power separation between Amtrak and LIRR signal power occurs under the 10th St bridge. Relocating these cables underground in new duct bank or micro tunnel would need to be carefully planned and staged in order to ease the existing underground disconnection between A, B, C, D, approach structures, LDM duct bank.
	Signal	Existing dwarfment signals, no signal bridges.	The new signal system will maintain the use of dwarfment signals, no signal bridges.	Signal work would be performed in tandem with the track reconfiguration with no significant constructability concerns above and beyond what is required for the track reconfiguration.	There are no operational considerations above and beyond what is required for maintaining operations due to the track reconfiguration.	The contractor would be able to install signal foundations and run individual track signals as required. All final signal installations and connections will be made by Amtrak force account.	N/A	To be determined during design development in coordination with TI.	Not Feasible	The location of actual signals will be tied into the track alignment which is not considered to be feasible, as functions within the signal location. It should be noted that the location of the signal foundations are not anticipated to be in conflict with overhead elements as low dwarf signals are anticipated to be used which are at least 8 ft horizontal clearance. Locating the signal cables and conductors is assumed to be flexible enough to not be in conflict with the overhead structural elements. The location of signal cabinets/fundamentals will be moderately flexible in terms of avoiding conflicts with overhead structural elements if nearby real estate is available, or possibly above deck.
	Facilities	Commissary, restrooms, mobile maintenance shed	Conventional repair shed, new commissary building, house building	The new commissary building would have to be constructed prior to demolition of the existing facilities. All other elements critical to yard operations would have to be relocated to ensure critical yard operations are maintained.	There are no operational considerations above and beyond what is described in the constructability/staging column.	Force account is not required for new facility construction.	Track configuration and building outline do not match, need confirmation that we are using the latest track alignment and building outline.	To be determined during design development in coordination with TI.	Minority Feasible	It is assumed that the design and construction of the maintenance facility will be integrated into the overhead structural elements and will be constructed in tandem. The location of the maintenance facility is fixed and occupies the full width of Zone 5, but the other new facilities do seem to have more flexibility regarding their location, as long as the functionality that is provided in the master plan is maintained.
	Utilities	Sanitary, storm, water, electrical, as well as various utilities connected to the commissary.	Utilities required to service Amtrak Master Plan.	Utility relocations and protections would happen in tandem with the reconfiguration of the yard tracks and the construction of the overhead structural elements.	Utilities critical to yard operations need to be maintained at all times.	Force account is not required for non-overhead system utilities.	Confirmation that the utilities shown in the O&A are thorough/complete and accurate. Need to know the interconnections of the tie.	No	Minority Feasible	Most utilities should be fairly flexible in terms of being able to be relocated. Larger utilities that are gravity driven, such as larger sanitary and storm sewer lines, will be difficult to relocate and will likely require some sort of protection or steel structure member to support overhead structural elements.

Figure 3: A page from the SSY-MP Below Deck Infrastructure matrix

This matrix, along with a cover memo that provided a summary of findings and next steps, was initially submitted to Amtrak on June 29, 2018 as the Below Deck Infrastructure Matrix. Following discussions with Amtrak and a comment review period, the final version was submitted on November 2, 2018.

C. Deck Coverage Evaluation- Operational Assessment

As part of the SSY-MP team Deck Coverage Evaluation task, the team undertook an investigation and documentation of the Yard's role in regional rail operations. This was key to understanding flexibility of different components of the yard to be relocated within or outside of the yard. This task was also a key input to developing future cost estimating and force account estimates. Key findings of this operational assessment are as follows:

- Sunnyside Yard was built to support Penn Station. All trains operating to Sunnyside Yard from Penn Station are looped. This precludes the need to move locomotives to the other end of trains and change the direction of the coach seats.

- The Loop Tracks pass under the NEC at HAROLD Interlocking before routing trains to the Loop Tracks that continue around the Yard towards Q Interlocking, the High-Speed Rail Maintenance Facility, or to the main yard. Once in the Yard, there are multiple storage tracks used by either Amtrak or NJ Transit trains, some of which provide dual capacity (NJ Transit for day-time storage and Amtrak for overnight storage).
- The Yard provides the operational support for Amtrak’s Empire, Keystone and Northeast Corridor trains, as well as Intercity and Acela trains such as looping trains for return trips, allowing for layover of trains, providing overnight storage, cleaning and inspecting of trains, maintenance of Acela trains and stocking of café cars.
- NJ Transit uses the Yard for looping and layover of the Northeast Corridor, North Jersey Coast, Raritan, Morristown and Montclair – Boonton Lines. NJ Transit also utilizes SSY for servicing, inspection and cleaning.
- LIRR will use the Loop Tracks to reach their MDSY with trains from Penn Station. Access to the MDSY will allow LIRR to shift the layover of some trains from West Side Yard and create assignments for crews and equipment between their two Manhattan terminals.
- The control of trains at SSY is managed by a network of interlocking towers located within SSY.
- The overhead catenary power and third rail power is derived from multiple AC conversion, distribution and DC substations through the yard complex.
- On average, SSY will accommodate several hundred train movements per day for both Amtrak and NJ Transit.

The operational analysis continued to evolve throughout the life of the SSY-MP. The first version was provided in the “Deck Coverage Evaluation” memo dated January 31, 2019. The latest versions can be found in the “Conceptual Design for Comprehensive Master Plan” report and the “Preliminary Deck Design” Report dated November 22, 2019.

III. Design Standards and Assumptions

Following the existing conditions establishment, the SSY-MP team defined their understanding of railroad design standards and assumptions to be used as a basis for the Master Plan development. These design standards and assumptions were reviewed by MTA-LIRR and Amtrak at coordination meetings during the SSY-MP process. It is understood that these preliminary standards and assumptions are likely to evolve throughout the design life. The following is a summary of the key standards and assumptions used as baseline inputs for the Master Plan development.

A. Amtrak Assumptions List

The SSY-MP team documented assumptions to be used as a basis for the Master Plan development in the “Amtrak Assumptions List.” The list of general assumptions and supporting sketches were intended to provide further clarity and feedback for the design team to consider during the Deck Coverage Evaluation, the Comprehensive Master Plan Development and future phases of design. The following is a listing of topics included on the Assumptions List:

- Maximum span lengths
- Track centerline spacing
- Personnel Access Way
- OCS Minimum Vertical Clearances
- Crash Protection

- Fire and Life Safety
- SSY Rail Zone specific assumptions

The List was first submitted on September 4, 2018 and after Amtrak’s review and Comment, the final version was submitted on February 20, 2019.

B. Railroad Design Standards - Horizontal Clearances

Requirements and Standards

Minimum horizontal track clearances within Amtrak’s Sunnyside Yard, as it pertains to column locations, are defined at two levels:

- 16’-0” from center-line of track for any permanent obstruction (Amtrak standards)
- 8’-6” from center-line of track (as per New York State law), shown in Figure 4.

Any violation of the 16’-0” requirement can be approved by Amtrak while any variance of the 8’-6” requirement must be approved by the New York State Department of Transportation. Additionally, these clearances must be increased through track curvature to account for excesses the vehicle generates as it navigates curved track.

The latest and most expansive narrative, diagrams and appendices on clearances and curvature calculations can be found in the “Conceptual Design for Comprehensive Master Plan” Report and the “Near Term Public Realm Improvement Phase” Report.

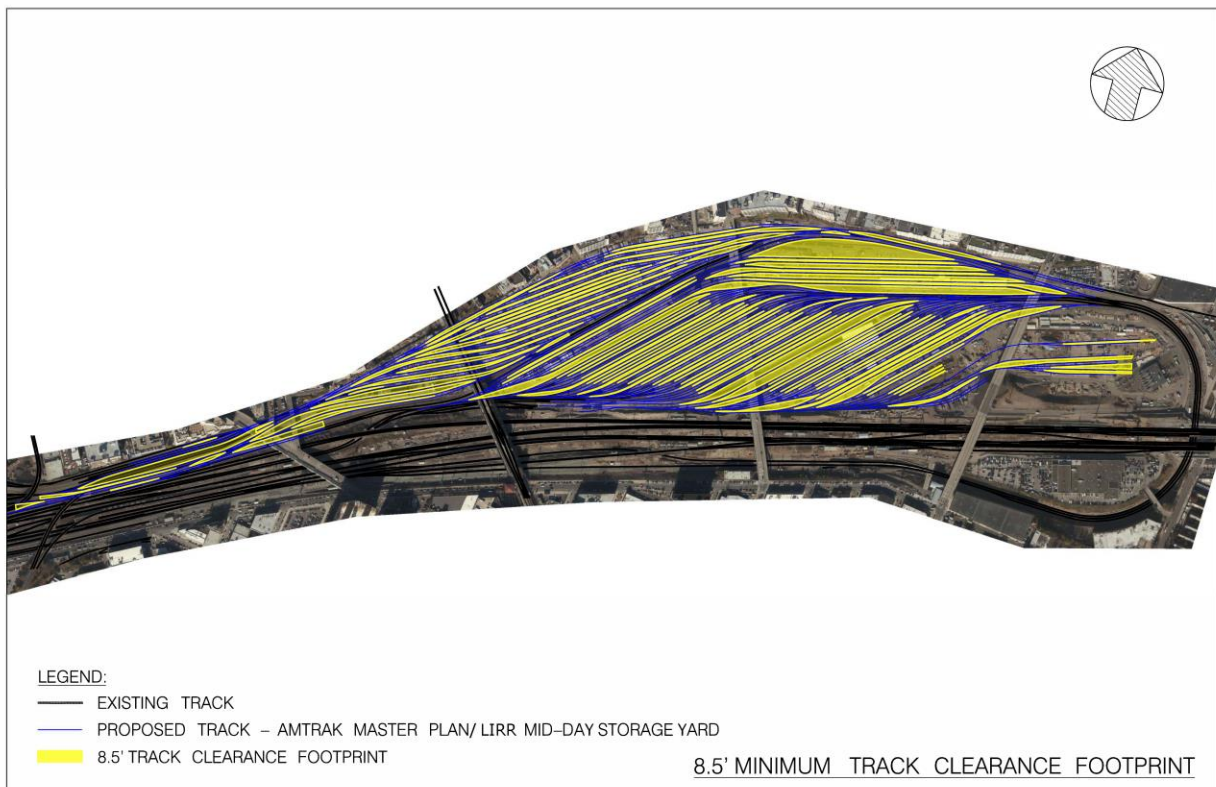


Figure 4: Minimum Track Clearance Footprint

C. Railroad Design Standards - Vertical Clearances

Requirements and Standards

All track not electrified by OCS must meet a minimum vertical clearance, as prescribed by NYSDOT, of 22'-0" from top of rail to the underside of structural deck or other permanent obstruction. For OCS electrified track, vertical clearances from top of rail to underside of structural deck or fixtures are as follows:

- Amtrak ET200 – Minimum Roadway Clearances, minimum 26'-9" from top of rail to any overhead bridge and other structures in electrified territory for 24'-6" trolley wire height.

These values are only valid for OCS systems where along- and cross-track feeders are not present. Many structures in SSY support these feeders which can increase the minimum to 40'-0" to account for the minimum electric clearances for 12kV and 34kV systems and design requirements.

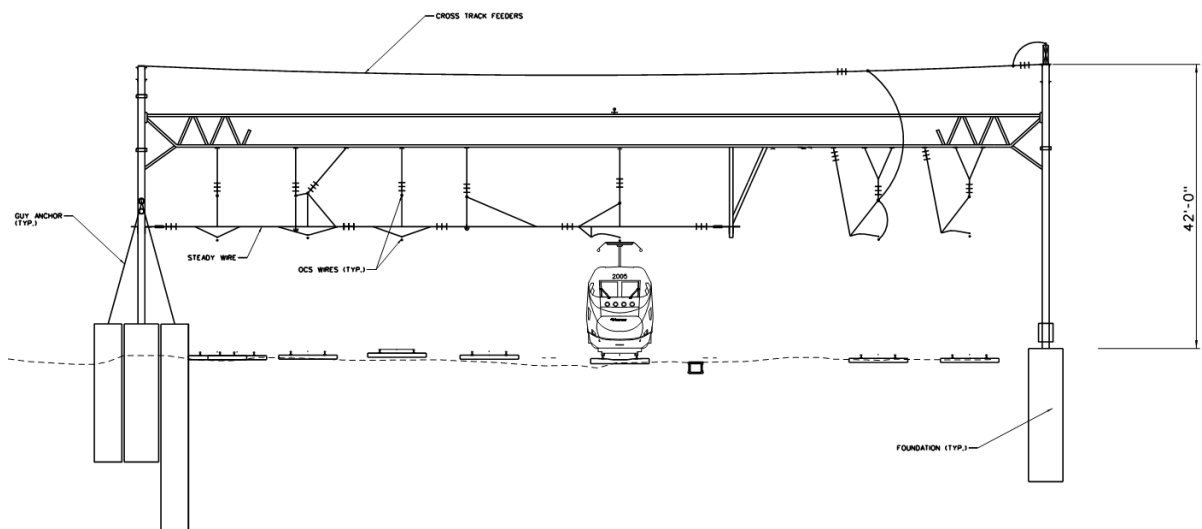


Figure 5: Typical Truss Structure with cross track feeders (Refer to the SSY Conceptual Deck Design Memo for more detail)

The latest and most expansive narrative, diagrams and appendixes on vertical clearances can be found in the "Conceptual Design for Comprehensive Master Plan" Report and the "Near Term Public Realm Improvement Phase" Report.

D. DOT Bridge Clearances

As discussed above, the SSY-MP team identified the minimum vertical clearances to be maintained. However, during the identification of existing conditions, the team found instances where variances and modifications would be needed due to the existing NYCDOT Bridges crossing SSY. To achieve access from the existing bridges onto the deck, a vertical clearance variance would be needed to allow for this transition zone between the deck area and the existing bridges.

The lowest vertical clearances below the bridges within MDSY are as listed in Table 1:

Bridge	Approximate Lowest Clearance
Thomson Avenue	19'-2"
Queens Blvd	15'-6"
Honeywell Street	16'-7"
39 th Street	17'-10"

This full assessment and approach to setting the deck evaluations can be found in the “Deck Coverage Evaluation” Memo.

E. Ventilation and Safety Inputs

An overbuild at SSY will be designed to maintain health and safety for occupants of the yard. This section provides a summary of some of the key inputs for crash protection, fire & life safety and ventilation development.

Crash Protection

As a slow speed area, SSY will contain columns designed to withstand direct impact from a derailed train. Additionally, along track segments running adjacent to columns, guard rails will be installed to minimize the distance that a derailed train could diverge from the track.

To calculate the forces a column would have to absorb without failing, a NJ Transit twelve car multi-level trainset was used for modeling given that this is the heaviest train set in the Yard. The analysis assumes empty equipment, no passengers, and results in a total weight of 1,877,180 lbs. for the full trainset. The speeds used to calculate the force to be absorbed by the columns will be the restricted speeds as given in the operating agencies timetable. For all tracks through the yard the restricted speed is 5 MPH.

The full discussion of Crash Protection inputs can be found in the “Deck Coverage Evaluation” Memo. The resultant outputs and impact on the structural design continued to evolve throughout the life of the SSY-MP. While the first version was provided in the “Deck Coverage Evaluation” Memo, the latest versions can be found in the “Conceptual Design for Comprehensive Master Plan” Report and the “Preliminary Deck Design” Report.

Fire & Life Safety

Fire & Life Safety (F&LS) for an overbuild at SSY is not fully covered by any existing Fire and Life Safety guidelines and standards. This project is of an unprecedented scale and complexity. Existing guidelines were used for orientation and as a guide for future design considerations. It will be imperative that as the project continues into the next phase of design, a working group (including MTA/LIRR, Amtrak, FDNY, NYPD, consultant team) is formed to define the safety approach, develop safety standards and to develop, review, and reach consensus on the final design and construction approach. Existing codes and guidelines used as a basis for the Master Plan are as follows:

- Overbuild of AMTRAK RIGHT-OF-WAY DESIGN POLICY, Revision 6, 09/11/2015
- NFPA 502 – 2020, Standard for Road Tunnels, Bridges, and Other Limited Access Highways

- NFPA 130 - 2017, Standard for Fixed Guideway Transit and Passenger Rail Systems
- EN 1991-1-2: Eurocode 1: Actions on Structures – Part 1-2: General Actions – Actions on Structures Exposed to Fire, 2000
- EN 1993-1-2: Eurocode 2: Design of Concrete Structures – Part 1-2: General Rules – Structural Fire Design
- EN 1993-1-2: Eurocode 3: Design of Steel Structures – Part 1-2: General Rules – Structural Fire Design

The F&LS inputs continued to evolve throughout the life of the SSY-MP. The first version was provided in the “Deck Coverage Evaluation” Memo. The latest and most expansive narrative, diagrams and appendixes on F&LS can be found in the “Conceptual Design for Comprehensive Master Plan” Report and the “Preliminary Deck Design” Report.

Ventilation

Any ventilation plants installed on top of deck to ventilate the rail yard beneath the overbuild will follow the 2014 New York Fire Code. NFPA 130 will also be applicable to any area that includes passenger terminals and transit ways used for public-occupied trains.

A series of Design Guidelines for the ventilation fan plants were determined related to:

- Amtrak and MTA preference for horizontal flow configuration of axial reversible fans to facilitate equipment removal and maintenance operations
- Tunnel Ventilation Fan Plant concepts
- Ventilation discharge stack design

Computational Fluid Dynamic (CFD) Simulations were conducted to evaluate how natural smoke extraction can take place through openings in the deck in the event of an incident during construction, to determine the appropriate number of ventilation fan plants and plenums for the full overbuild and to determine if the Near Term Public Realm Improvement Phase would need mechanical ventilation. Simplified crash walls were modeled to create a more realistic representation of the CFD study area. Fire design scenarios were proposed based upon the criteria supplied in the Overbuild of Amtrak Right-of-Way Design Policy.

Due to variance of ceiling clearance between ground and the concrete slab of the overbuild deck, two different configurations with the following assumptions were modeled:

1. Staggered deck configuration to represent the slope down towards Queens Blvd, with lowest ceiling clearance of 17'-5" and highest ceiling clearance of 27'-9".
2. Flat deck configuration- deck is assumed to be flat thus the overall study area has uniform 27'-9" ceiling clearance.

Note: Both ends of the two CFD models are open to the outside, and without any walls (natural ventilation).

The ventilation inputs and modeling evolved through the SSY-MP process. The first version was provided in the “Deck Coverage Evaluation” Memo. The latest and most expansive narrative, diagrams and appendixes on ventilation can be found in the “Conceptual Design for Comprehensive Master Plan” Report and the “Near Term Public Realm Improvement Phase” Report.

IV. Summary

This memo provides a high-level overview of the inputs, including existing conditions data, design standards, guidelines, codes and assumptions related to rail integration, that enabled the SSY-MP design team to develop a Master Plan for the Overbuild of Sunnyside Yard and the Preliminary Design of the Early Public Realm Improvements.

A full listing of documents that provide more expansive information on each of the topics in this memo and were shared with Amtrak for their review and feedback can be found below:

Timeline of Memos/Deliverables to Amtrak

1. June 29, 2018: Task 3A Below Deck Infrastructure Matrix (DRAFT)
2. September 4, 2018: Task 3B Amtrak Assumptions List (DRAFT)
3. September 14, 2018: Task 3B Memo 1 (FINAL)
4. November 2, 2018: Task 3A Below Deck Infrastructure Matrix Rev 1 (FINAL)
5. December 9, 2018: Potential Changes to Amtrak Facilities (DRAFT-Only)
6. January 31, 2019: Task 3D Memo – Deck Coverage Evaluation (DRAFT-Only)
7. February 20, 2019: Task 3B Amtrak Assumptions List (FINAL)
8. August 26, 2019: Primer Phase- Rail System Impacts at Skillman (Draft)
9. October 28, 2019: Task 3E Report Conceptual Design for Comprehensive Master Plan (DRAFT)
10. October 28, 2019: Task 3F Report (DRAFT)
11. November 22, 2019: Task 3E Report Conceptual Design for Comprehensive Master Plan (Rev 1)
12. November 22, 2019: Task 3F Report (Rev 1)