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The MBTA Station Modernization Program

Executive Summary

The MBTA has over 250 stations in the MBTA transit system. The MBTA has embarked on a \$376.9 million capital investment program dedicated to station renovations. The majority of this money is devoted to the renovation of subway stations and system wide replacement of escalators and elevators. Extensive renovation work is being completed on the Red and Blue lines at stations serving the communities of East Boston, Dorchester, Mattapan and Downtown Boston. The total investment in stations represents 10.2% of the MBTA's current Capital Investment Program. Most of the funding is focused particularly on work to modernize the Blue line stations (Maverick, State Street, and Airport stations and allow for six car trains), as well as to complete the renovations of Savin Hill, Fields Corner, Shawmut Ave. and Ashmont stations along the Dorchester branch of the Red Line. Other station modernization investments were for ADA accessibility and elements of the Key Station plan.

The MBTA's Design and Construction Department has developed a Lessons Learned document that is the outcome of past experiences with the construction of station modernization projects. The Project Management of the department has identified elements of the design and construction of station projects that can be improved to allow for more efficient and effective design and construction practices. The department has solicited ideas on how to improve the design and construction process from the Engineering and Construction fields, as well as other MBTA departments. The MBTA identified that all the parties in station development must work closely to effectively design, manage and construct station modernization projects.

The Design and Construction department has instituted a Lessons Learned Document identifying fifteen (15) items that have become an important management and planning tool to overcome the constructability hurdles that the MBTA often faces in Station Modernization.

Currently, the MBTA's Design and Construction Department has a Web based library of Standard Specification Guidelines that are the Basis of all Design and Construction projects. These Specification Guidelines are utilized via a password based application that insures that all projects are designed with the most recent MBTA and Industry Standards and Regulations.

The Lessons Learned Document will also become part of this web based library which designers will be required to utilize and incorporate so as to allow for the MBTA to realize the benefits in and meeting its goal of providing the best service possible for our customers. This document will make recommendations that should be considered in all future design and construction projects. The MBTA will update this document on an as needed basis.

1. Lesson –More Department Coordination

The MBTA Project Managers and their design engineers must have participation in MBTA's Project Development Group (PDG) at the onset of the design/planning process. This will allow for communication and coordination of all pertinent MBTA department needs and to provide project development updates. This Project Development Group was established to bring all the MBTA departments that are affected by a particular project to the table to discuss aspects of a project. The PDG meets at 15, 30, 60 and 90 % design levels. Each department can offer input and comments on the development of the project to the MBTA project staff and design engineers. All projects should have full cooperation and coordination with all MBTA departments to ensure reviews of design plans and proposals for station projects, and all parties are satisfied with the design plans prior to construction advertisement. This early involvement will allow MBTA operations and other departments to have their needs and requirements incorporated in each project. Participation in the PDG prevents costly change orders that have been historically required to accommodate operational needs or other department requirements after construction of a station has begun. Any and all issues raised during the PDG process can be addressed during the design phase rather than through costly change orders. This PDG group has allowed project teams to plan accordingly when it comes to station development.

Background

In the past, lack of close coordination with other MBTA departments has caused significant delays and costly change orders. The Design and Construction Project staff and Design Engineers need to have interface with other departments such as Operations, Safety and Environmental, to identify an inventory of each department's requirements to ensure efficient and optimal operations. The issues or concerns were often not picked up in time and had to be addressed with change orders during the construction phase rather than the more suitably in the design phase. The Senior Management of the MBTA identified this as a problem that must be addressed, which resulted in the creation of the Project Development Group (PDG). This topic has been viewed as a key Lessons Learned and has already proven to be and will continue play a vital role in improving the Station Modernization program for the MBTA.

Below is an overview of the MBTA's PDG process for each station modernization project that the MBTA will undertake:

Project Development Group (PDG)

When developing the design for construction projects, there are a number of MBTA departments involved in the projects' implementation. The Design and Construction Department's Project Management Manual identifies the steps and requirements for the development of each project. In the manual, a prominent role is given to the Capital Management Group (CMG) to approve project scope, budgets and schedules. Since the CMG has been inactive over the past few years, the role previously played by the CMG will be replaced by the creation of a Project Development Group (PDG). This will provide a smooth transition to a project team approach since the responsibilities of the CMG are clearly articulated in the manual and Design and Construction managers are already familiar with the process. Conversion from the CMG to a PDG will facilitate the effort to engage active participation of all applicable MBTA departments in the design process.

A PDG will be created for each design project. The membership of each PDG will be tailored to encompass all appropriate departments. The Committee will be formed from individuals from the following list of departments, as applicable. Depending on the scope and the nature of a given project, specific departments may or may not be included on the Committee for a given project.

To ensure that all departments' interests and concerns are coordinated and incorporated into a given project, a Steering Committee (SC) will also be created. The SC will meet on a monthly basis to discuss the progress and the issues confronting the various PDGs. The SC will include Jon Davis, Joe Cosgrove, Joe Kelley, John Lewis and Frank DePaola.

The master list of Departments that will participate on the case-by-case basis is as follows:

- Design and Construction
QA/QC Department
Real Estate Acquisition
- Systemwide Maintenance and Improvements (SMI)
Signal Department
Communications Department

Maintenance of Way

- Operations Support
 - Power Division
 - Building Division
- Environmental Affairs
- Bus Operations
- Safety Department
- Subway Operations
 - Blue Line
 - Green Line
 - Orange Line
 - Red Line
 - Silver Line
- Railroad Operations
- Water Transportation
- Budget Department
- Marketing Department
- Intergovernmental and Public Affairs
- Legal Department
- Police Department
- AFC Department
- Systemwide Accessibility

Although the quantity and timing of PDG meetings will vary from project to project, the PDG will meet a minimum of five (5) times during the design phase. The five scheduled reviews shall occur at the beginning of the project (kick-off

meeting) and at the 15%, 30%, 60% and 90% design milestones. During the conceptual design process (15% design), the project manager will have a minimum of three design alternatives (as applicable) prepared that will be presented to the PDG for their consideration. The PDG will provide written feedback to the project manager for his/her consideration in the preparation of 30% design plans. The process of design preparation, project presentation to the PDG, and written feedback to the project manager will repeat itself at the 30%, 60% and 90% design stages.

In addition to focusing on the technical aspects of design, the PDG should also consider and comment on topics such as affordability (capital costs and operational costs), benefits to the MBTA and its customers, safety, ease of maintenance, durability of proposed building materials, functionality and conformity/uniformity with other similar facilities.

The PDG meetings will be facilitated by the Development Department up to and including the 30% design submission. After the 30% design stage, the Design and Construction Department will facilitate the meetings.

Project Definition (up to 30% design)

Elements included in the Project Definition stage (up to 30% design) include:

1. Project Identification
 - Conduct feasibility analyses, major investment studies and alternative analysis studies to identify the project purpose and need, and conceptual plans.
2. Financial Planning
 - Ensure the project has been evaluated and included in the Program for Mass Transportation (PMT), Regional Transportation (RTP), Capital Investment Program (CIP), and Transportation Improvement Program (TIP), if warranted.
3. Project Definition
 - Conduct preliminary design to the 30% design stage.
 - File Environmental Notification Form (ENF) and prepare Draft Environmental Impact Reports/Statements (DEIR/DEIS), as applicable.
4. Finance Strategies

- Explore federal funding through congressional earmarks and FTA New Start funding.
- Seek Commonwealth funding in transportation bond bills or outside sections.
- Consider public/private partnerships through real estate transactions, Transit Oriented Development (TOD), and land swaps

5. Community Support

- Resolve community/state issues.
- Build consensus for preferred project alternatives.

Project Design (30% to 100% Design)

During this stage of the project, the PDG will be responsible for ensuring that the design is consistent with the planning effort and that the project meets the needs and expectation of the Operations Department and MBTA customers.

The Design and Construction and Construction Department project managers will also prepare a quarterly Project Status Report (PSR) for each project during this phase. The PSR will include a budget summary, schedule summary and a management discussion. The management discussion should include:

- Progress and achievement in project design and/or specifications development;
- Status of consultant contracts;
- Proposed Scope Changes;
- Potential budget and/or schedule issues; and
- Action Plan to address proposed scope, budget and schedule changes and identification of decisions required by PDG.

The PDG will review and discuss the previous quarter's PSR before the end of the first month of the quarter and provide feedback as necessary.

Applicability

The MBTA values this Lessons Learned process as a way to insure that all elements or concerns from each department are incorporated in the development of project

specifications and shall be applicable in all Station Modernization projects. The PDG Lessons Learned has already proven to be beneficial to several MBTA modernization projects such Fairmount Corridor Improvements-Four Corners, Brookline Village/ Longwood Ave. stations and other projects currently in varying design phases. This Lesson will continue to be a crucial coordination aspect that will consistently the MBTA to save construction dollars.

Contact

Francis A. DePaola, Assistant General Manager for Design and Construction
Ed Hunter, Director of Construction

2. Lessons – Providing only minimum Safety and Accessibility Improvements

(Any and all accessibility issues should be brought to the attention of the MBTA’s Department of System wide Accessibility (SWA) for review and comments. A full site analysis regarding accessibility issues and safety concerns should be performed by the MBTA during the design phase of projects regardless of financial constraints.)

Background

Accessibility issues became apparent with the Brookline Village/Longwood Avenue Station Renovation project on the D-Branch of the Green Line. The station upgrades included elevating the existing platforms to accommodate low floor vehicles for direct boarding and to provide wooden mini – high platforms for non-direct boarding for persons with disabilities. The access to the inbound platform was provided from the outbound side only; persons would have to cross the tracks at the designated crosswalks in order to access the inbound side. Prior to construction award, it was presumed that the level of accessibility was sufficient to meet MAAB requirements. However, after the construction contract was awarded, it became evident that the design did not incorporated all aspects of accessibility to provide a safe and designated path of travel both to and from the inbound for the disabled community.

Applicability:

In the future, if there is an accessibility issues, the MBTA should notify and involve the Department of System wide Accessibility (SWA) for review and comments to

incorporate the necessary design elements prior to construction. This will eliminate the need of a costly change order regarding accessibility issues. The MBTA has made a commitment to be the most accessible transportation agency in the nation by maximizing accessibility for the disabled community.

Contact

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3. Lesson-The MBTA should not adopt structures that are architecturally significant instead of ensuring functionality, maintenance durability, reliability and construability.

Background

The MBTA has a history with some station projects that stood out architecturally at a larger cost than was necessary for a transportation entity. Stations were designed with special features or material that are seen on a higher scale aesthetically and may not have been proven to be the most cost effective to maintain. The basic functional needs of station construction need to be conformity of materials. The stations should be designed using similar construction materials for true tested materials with like features for all common elements such as, mechanical, electrical, communications, lighting, platforms, lobbies and generators ect. Providing for this conformity and standardization in the design process allows for cost savings on construction and maintenance.

Applicability

The MBTA should focus utilizing true tested standard construction materials. Elements of construction and materials that can be maintained and can have conformity and standardization. Construction of stations must provide standard station elements that can allow for effective and efficient MBTA operations and maintainability.

Contact

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4. Lesson - Acknowledgement of Historical and Social Significance

Background

For existing stations located near buildings or facilities that are socially, historically or commercially significant such as the Boston Public Library, Government Center or Trinity Church, special care must be given to the protection of these structures. At Copley Station the location of the new outbound elevator is placed about 12 feet from the east wall of the Old South Church and the inbound elevator structure is only inches away from the McKim Building of the Boston Public Library. Both Old South Church and Boston Library McKim Building are both listed on National Register of historic places as well as being listed as National Landmark. In order to maintain ground water level for the purpose of protecting the timber piles underneath these two buildings and to accommodate the existing utilities as well as the unforeseen subsurface conditions, the engineer specified the jet grout as a preferred construction method for the support of excavation. The jet grout application was successfully used previously near other historic landmarks but has inherent potential risk for grout migration and ground heave. Despite the additional protective underground cut off wall that was installed prior to the jet grout installation to protect the Old South Church from the potential grout migration and ground heave, the building is adversely impacted during the jet grout installation. The work is immediately stopped and appropriate protective measures have been taken to stabilize and monitor the building. The contractor is developing an alternative construction method to finish the work.

At State Street Station, the tunnel extension requires the relocation of a deep sanitary sewer and a 115 KV power line together with other utilities. The tunnel extension is sandwiched between two high-rise buildings in Boston's downtown commercial district with little space to spare. The design is developed based on limited existing surface condition available that is not uncommon for this type of urban underground construction. However the design provides little flexibility to accommodate the unknown existing subsurface conditions of the building and utilities to such a degree that if the existing building foundation or utilities is few inches away from assumed location the entire utility relocation and tunnel structure design would have to be revised. The engineering design that leaves little or no tolerance to the assumed underground existing conditions has resulted significant construction delay and cost increase.

Applicability

In the urban underground construction near the historic buildings and significant commercial facilities the protection of the resources adjacent to the construction should be a prime objective of the design and construction. The lack of certainty of some construction techniques and their associated risk for potential adverse impact

to the adjacent buildings must be assessed. No less attention should be paid to the protection of the adjacent historic building and facilities than the structure itself that the MBTA is constructing.

Given the fact that it is not possible in the most urban underground construction to have completely accurate information on the existing conditions, the design must be developed in such a way as to offer flexibilities to accommodate the actual site condition that may be different from the design assumption. The engineer should seek the consultation of the experienced construction expert to identify and avoid such constructability problems.

Contact

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5. Lesson: Station Walkways

Background

The MBTA's Quality Control & Quality Assurance Testing Lab performed a film thickness testing on the zinc galvanizing of the Grafton Station overhead steel walkway structure on April 22, 2009, in order to determine the cause of widespread corrosion on both the steel walkway and two stairways at the station. This steel structure was shop galvanized at Gregory Galvanizing & Metal Processing in Canton, Ohio in September, 1999. The General Contractor was The Middlesex Corporation. A minimum contract thickness of 3.4 Mils was used as an acceptable thickness. All zinc thickness exceeded the 3.4 mils minimum. Based upon the testing, it does not appear that there was a material deficiency on the zinc galvanizing for this structure.

It was the Lab's assessment that rain water collected in the overhead walkway. Water seeped and was trapped between the concrete walkway and the steel sheeting below the concrete slab. The steel sheeting corroded. Eventually rain water spilled onto both stairways from the overhead walkway leading to the corrosion of the walkways and railings. In addition, the concrete walkway had to be removed and replaced last winter because the salt used for ice melting disintegrated the concrete slab.

Applicability: Based upon this investigation, the MBTA has identified the following Lessons Learned to address with station amenities.

- 1.) On overhead walkways, collect and properly dispose of rainwater collected in overhead walkways to minimize corrosion potential of adjacent structural elements.
- 2.) On concrete walkways that will receive salt, add a coating that will protect the concrete.

Contact:

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6. Lesson: Lack of Coordination with City of Boston

Background

Lack of Public Improvement Commission (PIC) approval can significantly impact project schedule and costs. The MBTA must present all station modernizations plans to City of Boston's Public Improvement Commission (PIC). The PIC must approve design plans prior to the awarding of any construction activities. This process has caused significant delays and costs associated with station improvements in the city of Boston. The delays associated with the PIC process were evident during the State Street Station. The PIC process delayed the start of construction for the station for over one year resulting in a costly delay claim from the MBTA's contractor. This issue was also evident with Arlington/Copley and Maverick Stations.

Applicability

Make sure the City of Boston (COB) is in agreement with station plans and provide documentation to allow for PIC approval prior to the construction contract being advertised. The MBTA cannot grant a Notice to Proceed (NTP) until PIC approval. The MBTA has initiated discussions and station designs to the COB PIC sooner in the design process and began including the PIC in project development schedules. The Design and Construction directorate has identified this function as a priority and has placed an emphasis on this cooperation with the city. The MBTA has established close coordination with the COB to ensure smooth communications and planning of construction activities. There will always be issues that need to be addressed with all MBTA construction in the city, but being more proactive with city issues will only help the MBTA in saving on construction costs and schedule.

Contact

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7. Lessons: Not Having MOU's with all parties finalized prior to Construction

Background

Not having a Memorandum of Understanding (MOU) with all participating parties in place prior to the need to perform work causes schedule delays and added costs. This Lessons Learned has historically been problematic with the MBTA. Not having clearly defined agreements between the MBTA and other participating parties have caused the MBTA to assume ownership and costs that may not otherwise have been necessary if agreements were in place prior construction.

Applicability

Make sure the scope of work is properly defined and included in MOU's to cover all work activities and the appropriate costs. The MBTA must include all Real Estate items as well as Interagency Service Agreements (ISA's) and force account plans in place prior to construction advertisements.

Contact

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8. Lesson: Lack of accurate engineer's estimates can result in bids exceeding the estimate, delays to the award of contract, and not meeting cash spending projections.

Background

Over the past few years, several of the MBTA's Construction projects engineer's estimates were not representative of the construction bids that the Authority received from the General Contractors. Bids were coming in over the budgeted funds for the construction projects, resulting in redesign and budget revisions or cancellation of projects. What the MBTA was realizing was that the construction estimates that the design firms were generating were not reflective of the current construction market and the design teams did not possess the expertise on construction estimating.

Applicability: The MBTA will work to provide estimate reviews by peer groups or independent consultants at various stages in the design process to ensure accurate estimates, and to provide added assurance of obtaining a bid within 5 to 10 % of the Engineer's estimate. The MBTA can also direct consultants that a member of their team requires an estimating specialist on their professional services contracts. For engineer's estimates that are over the accepted range of the construction bid, incorporate penalties to the designer's fees. If a situation occurs where redesign is required, have the designer redesign at no cost to the Authority. The MBTA can also utilize bid alternates if the budget allows.

Contact

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9. Lesson: Provide greater oversight of Design Consultant contracts to track burn rates and to assure that potential over runs are caught early, and to allow amendments to be processed prior to running out of budget.

Background

Often, Design contracts were proceeding with tasks that were not necessarily part of the original scope and production rates were not monitored effectively until monies were exhausted requiring additional design amendment to be processed.

Applicability

The MBTA has now moved to require that design consultants establish matrices to monitor progress that equates to work performed against budgets expended to identify discrepancies. The MBTA has asked that Designers provide an earned value estimate and schedule that the MBTA Project Managers can use to evaluate the tasks and budgets that are required to meet project schedules. This approach can track the schedule and costs and identify any variances to provide for more oversight and controls of design scopes, schedules and costs.

This approach is more proactive by way of tracking the schedule and costs for the designer. This method allows the MBTA to identify problems while also providing information to handle the issues in a more proactive manner. From now on schedules will be provided to all parties and to assist in planning for the entire project.

This approach has been incorporated with the design of the Silver Line Phase III project, which has proven to be beneficial for the MBTA. This Lesson is good for all levels of design scopes, but even more rewarding for larger scale efforts.

Contact:

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Senior Project Manager for Project Controls

10. Lessons: Do not overlook potential structural or similar type issues during the design process due to reasons of budget or scope (i.e. platforms at Ashmont, mezzanine slab at Arlington) as this work will be required to be done with the contract work at a higher cost with schedule impacts.

Background

As part of the Ashmont Station project, a full investigation of the existing platforms was not performed due to budgetary issues. Once the construction began it became evident that the structural integrity of the platforms was in question. This element of the station was later incorporated in the scope of work which resulted in increased costs.

Applicability

The MBTA needs to address all issues when performing stations rehabilitations, even if the scope is limited, to avoid having to add in scope at a later date at a higher cost. “Don’t skip over the needs of the station just for meeting the budget”. Develop a common sense phasing for any budgetary issues. When evaluating station modifications, the MBTA has begun to focus on station functions and operating functionality as a priority.

Contact

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11. Lesson: Dividing the scope of project into separate contracts

(I.e. station rehabilitation and finishes such as Ashmont due to lack of budget will only mean paying higher costs in the future and delays to the overall completion of total budget.)

Background

This lesson became apparent with the construction of the South Boston Transitway South Station Project, as well as recently with the Ashmont Station project. Each station contract was separated from the finishes contract due to budgetary concerns.

The MBTA has identified the notion of avoiding at all costs, piece –mailing contracts. The value of procuring one contract from start to completion proves to be more cost effective rather than splitting up the finishes end of station contracts. This also works for bundling station bridges and other major work into one contract. This approach saves monies resulting from impacts on schedule associated with coordination with multiple contracts/contractors as well as with MBTA operations. This was proven beneficial with the Red Line Stations contract. It was actually cheaper to build three stations (Savin Hill, Shawmut & Fields Corner) from start to finish, then it will be to construct Ashmont Station, which was one construction contract. The MBTA will be advertising the Finishes part of the Ashmont Station in August 2009.

Applicability

Address all issues when performing station rehabilitations, as well as obtaining the necessary funding, to allow the projects to be completed in less time and for less money.

Contact

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12. Lessons: Monthly monitoring of contractor progress schedules with the contractor and the MBTA schedule consultant is necessary to assure projects are completed for less money.

Background

In the past, as part of MBTA construction projects, construction schedules may not have been provided or updated. The Contractor often times did not provide a baseline schedule which would allow the MBTA's Project Managers to effectively monitor the construction schedule and to identify how changes may affect the critical path for projects.

Applicability

The MBTA has become more proactive with regards to this matter. The Authority is requiring mandatory monthly schedule updates to be provided to the MBTA by the contractors as part of the payment requisition, and will require reviews with schedule consultants. The MBTA's project managers will work with the newly created position of Senior Project Manager for Construction Cost Controls to oversee cost and scheduling and bring consistency to this area of Construction Management. This new position will be a valuable resource that will provide assistance, and oversight to ensure consistent scheduling submittals from contractors and design engineers.

This new schedule approach will allow for the MBTA and its' contractors to know at all times the status of the project. The Contractor will be required to provide a cost loaded schedule of values that will identify what resources and staffing requirements are required to perform the work. The contractor will also need to provide updated schedules that will identify areas of concern or time sensitive elements that will allow the projects to use this as a tool to mitigate construction issues in a more proactive manner. These schedules will allow for more information to be provided which will assist the MBTA's Project Managers in effectively managing their projects.

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13. Lesson: More Public Involvement

Background

The MBTA needs to get input from all neighborhood and community groups, abutters as well as local and elected officials when designing Station modernization projects. All parties that are affected by the proposed project want to have input in the process.

As a quasi -public agency the MBTA needs to allow for design plans to be reviewed and approved by all stakeholders prior to a station being advertised for construction.

Applicability

The MBTA Project Staff has made a concerted effort to provide station designs earlier to the public and more often, and offering more public meetings. The Design and Construction department has established the Communications Section to work with the communities to coordinate the communication of all construction activities associated with station projects. This has proven beneficial to the MBTA's station modernization program. The Design and Construction department has developed a process of alerting abutters and the public about all the constructability issues required for station construction. The communication to all stakeholders is key to keeping the public aware and serving as a good neighbor. Given that the MBTA operates in neighborhoods throughout Boston and Eastern Massachusetts, it is imperative that the Authority communicate and work effectively with all the stakeholders.

Contact

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14. Lessons – Lack of field reconnaissance and site evaluations.

Background

During the design phase of the Charles/MGH project, a full reconnaissance of the lead and asbestos was not performed. Allowances were put into the contract for both items. Once in construction, it was clear that the allowances were severely underfunded and the line items were significantly overrun. The lead and asbestos analysis was not fully comprehensive enough to provide a true idea of the amount of lead and asbestos that needed to be removed.

Another example of lack of field reconnaissance site analysis was at the Fields Corner Station on the Red Line. The line item for rock excavation was significantly overrun and additional borings were necessary to allow for a better evaluation of the amount of rock that needed to be excavated. More upfront site analysis would have prevented these items from being overrun and requiring change orders.

Applicability

This lesson was applied immediately to the Ashmont Station Modernization Project. Ashmont Station was experiencing similar issues with design and limited reconnaissance and field data. Funding was made available and a full reconnaissance

was performed and included in the bidding documents advertised for construction. The MBTA needs to ensure that all field surveying and site evaluations are performed upfront to provide all necessary data to include in contract specifications and plans to alleviate questions on site conditions which can help to ensure more effective bids and prevent potential costly change orders. The MBTA needs to place value on providing the resources up front to ensure a proper return on investment.

Contact:

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15. Lesson: Unforeseen site Conditions related to undocumented and/or poorly documented utilities has increased project costs and delays.

Background

Several construction projects within the city of Boston have proven problematic to the MBTA with regards to utility identification and utility coordination. Often times, the utility elements on construction projects have not been properly identified or realized until the construction commences, with the projects having to cover the utility issues with change orders. These surprise issues could have been alleviated if a more thorough evaluation of the site conditions was performed.

Applicability

The MBTA will require additional condition assessments including test pits, utility survey and sub surface examinations. The MBTA must allow for coordination with Utility Specialists to identify conditions that may not be easily identified on As-built drawings that may have been seen using other advanced technological methods (i.e. 3-Dimensional Imaging) Also, regularly scheduled meetings with utility companies is crucial in coordinating utility issues that can be properly and effectively addressed. As stated in previous lesson, the MBTA will place a value on providing more resources up front in design to ensure proper return on investment.

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