Exhibit I

Alpha Corporation Subject Matter Expert Report

ALPHA CORPORATION
1800 Washington Boulevard, Suite 415 Baltimore, MD 21230 410) 646-3044 Fax: (410) 646-3730

March 14, 2014

Montgomery County OIG
51 Monroe Street, Ste 802
Rockville, MD 20850

Attn: Edward L. Blansitt, Inspector General

Reference: Analysis of Project Control

Dear Mr. Blansitt,

As requested and in conformance with our contract, Alpha Corporation has attached our Analysis of Project Controls for the Silver Spring Transit Center.

We appreciate the opportunity to assist the County in this matter and if you have any questions or concerns, please contact us.

Sincerely,
ALPHA CORPORATION

Michael Damron, P.E. LEED AP
Vice President

Enclosure: Analysis of Project Controls

SILVER SPRING TRANSIT CENTER

ANALYSIS OF PROJECT CONTROLS

Prepared for:

Montgomery County, Maryland
Office of the Inspector General
Rockville, Maryland

Prepared by:

ALPHA CORPORATION

March 14, 2014

TABLE OF CONTENTS

I. Terms and Acronyms Used in This Analysis

A/E	Architect/Engineer. The design team also includes professionals from disciplines such as electrical, mechanical, and plumbing. Parsons Brinckerhoff (PB) was the prime/leader of the team on the SSTC Project.
ACI	American Concrete Institute. A non-profit technical society that has developed many of the concrete industry's design standards and recommendations.
AOR	Architect of Record. The registered, licensed professional on this project was Zimmer Gunsul Frasca Architects LLP (ZGF).
ASI	Architect's Supplemental Instruction. ASIs are used when the designer would like to modify the Construction Documents.
ASTM	American Society for Testing and Materials. An international organization that develops and publishes voluntary consensus technical standards.
Concrete Cover	The least distance between the surface of embedded reinforcement and the surface of the concrete. Concrete cover is required to prevent corrosion and damage to the reinforcement.
Construction Contract	Contract between Montgomery County and Foulger-Pratt Contracting, LLC to construct the SSTC facility.
Construction Documents	Final drawings and Specifications prepared by the Design Team and approved by DPS in 2008.
CM	Construction Manager is responsible for management of project planning, design, and construction from inception to completion to controlling time, cost, and quality.
Construction Manager Contract	Contract between Montgomery County and Parsons Brinckerhoff to provide Construction Project Management Services. The contract is reproduced in KCE Exhibit M1 beginning on page 296.
Construction Team	Foulger-Pratt Contracting, LLC and subcontractors (See Figure 1).
Contractor	Foulger-Pratt Contracting, LLC. The company selected via competition to implement the construction of the SSTC.
CQC	Contractor Quality Control. Quality Control (see description under QC in this list) implemented by the Contractor on construction efforts. Compare to DQC.
Definable Features of Work	A task that has limits which can be separate from other tasks and has control requirements and crew unique to that task. Installation of the fire alarm system for the second level is a Definable Features of Work.
Design Contract	Contract between Montgomery County and Parsons Brinckerhoff, Inc. to design the SSTC facility.
Design Team	Parsons Brinckerhoff, Inc.
DGS	Montgomery County Department of General Services, the branch of government that acts as the Owner of the SSTC until the completion of construction.
DOR	Designer of Record. For this project the DOR is Parsons Brinckerhoff, Inc.
DPS	Montgomery County Department of Permitting Services. The branch of government that issues building permits.
DQC	Design Quality Control. Quality Control (see description under QC in this list) implemented by the Design Team on design efforts. Compare to CQC.

EOR	Engineer of Record. The registered, licensed professional responsible for a design, on this project Doug Lang of PB served as EOR.
Facchina	Facchina Construction Company, Inc. The company selected by FP to provide all concrete for the SSTC.
FP	Foulger-Pratt Contracting, LLC. The company selected to implement construction of the SSTC.
GPR	Ground Penetrating Radar. Used to scan the existing concrete to detect reinforcing.
IBC	International Building Code. A model document that becomes the building code when adopted by a government.
Inspection Contract	Contract between Montgomery County and Robert B. Balter Company to perform third-party inspections including field testing during the construction efforts for the SSTC.
KCE	KCE Structural Engineers. The company selected by the County to perform a structural evaluation of the SSTC.
KCE Report	Report prepared by KCE of their findings dated March 15, 2013.
MOU	Memorandum of Understanding. On this project, it refers to a document called the Silver Spring Technical Plan dated January 26, 2008 found in KCE Exhibit M1 beginning on page 555.
OLO	Montgomery County Office of Legislative Oversight. The report: *Managing the Design and Construction of Public Facilities: A Comparative Review* was developed by the OLO.
O&M	Operations and Maintenance
PB	Parsons Brinckerhoff. The company who designed the SSTC. See also DOR and SEOR.
PT	Post-Tensioned. A technology where cables called tendons are pulled in tension to provide strength for a concrete assembly.
QC	Quality Control. A system of efforts directed at maintaining standards and procedures
RBB	Robert B. Balter Company. The company selected as inspector of the SSTC.
RFF	Rockville Fuel and Feed Co., Inc. A company who provided ready-mixed concrete in the floors of the SSTC. (Some of the concrete in other elements such as walls, columns and foundations were provided by Lafarge Concrete).
RFI	Request for Information. Contractors generate RFIs in order to ask the Design Team a question and obtain written information regarding the project.
R&R	R&R Reinforcing, Inc. The company selected by Facchina to install reinforcing for the SSTC.
SEOR	Structural Engineer of Record. On this project the SEOR was Parsons Brinckerhoff, Inc. See also DOR and EOR.
SI	Special Inspections
SSI	Statement of Special Inspections
Specification	Detailed requirements written in paragraph form that must be satisfied for materials, design, products, or services. In this analysis refers to a specific document as developed by Parsons Brinckerhoff and included in Construction Documents.

SSTC	Silver Spring Transit Center, the subject of this analysis. See the introduction for a description of the facility.
Variance	Alternatives submitted to the original Design Team during the submittal process.
VSL	VSTRUCTURAL LLC. The company selected by Facchina to provide all post-tensioning for the SSTC.
w/*c*	Ratio of water to cement in concrete. The *w*/c ratio has a significant influence on the strength and durability of concrete.
WMATA	Washington Metropolitan Area Transit Authority. The agency that owns the building site and will provide maintenance and operations for the SSTC.

II. Executive Summary

The Silver Spring Transit Center (SSTC) is a new ground transportation hub in Silver Spring, Maryland. It accommodates bus and taxi movements while loading and unloading passengers, and is located immediately beside an existing station for rail passengers. Bus loops are located on both the ground and second floors, while private vehicles and taxis use the third, smaller level. The second and third levels are made of concrete reinforced with both mild steel reinforcing bars and post-tensioned tendons embedded in the floors to provide strength.

The land upon which the Silver Spring Transit Center is situated has two owners: Montgomery County Maryland and Washington Metropolitan Area Transit Authority (WMATA). Under a formal Memorandum of Understanding (MOU) between Montgomery County and WMATA, Montgomery County is the project owner authorized to take any actions necessary for the successful construction of the SSTC. Under the MOU, upon completion of construction, WMATA is to become the owner and will be responsible for future maintenance and operations. Construction participants also include the Design Team (lead by Parsons Brinckerhoff), the Construction Team (lead by Foulger-Pratt), and the third-party inspector (Robert B. Balter Company).

During construction, small pieces of concrete above a few tendons broke away making the tendons visible and demonstrating that the amount of concrete over the tendons was not sufficient. The series of investigations that followed produced a report by KCE Structural Engineers (KCE) in March of 2013 which identified multiple deficiencies with the Silver Spring Transit Center. Some of the deficiencies result from construction activities that deviate from the design. To correct the deficiencies, a working group was formed to design and implement a remediation plan. At the writing of this analysis, design and implementation of the remediation plan for one of the deficiencies (the pour strips discussed below) had been completed while plans to address other deficiencies are in progress.

This analysis focuses on project controls, those actions intended to prevent problems that result in such deficiencies. The Silver Spring Transit Center project implemented many project controls that if properly designed and implemented should have identified deviations from project plans early enough to allow corrective action during initial construction. In spite of the many controls, some of the deficiencies identified by KCE in the mostly-completed structure were not identified and/or not corrected during construction. This analysis examines available documents to understand the design, implementation and effectiveness of controls implemented during the construction of the SSTC and provides information relating to the activities made by construction participants in conjunction with the deficiencies.

During the course of this analysis we reviewed the Construction Documents, Requests for Information (RFIs) and their responses, Architectural Supplemental Instructions (ASIs), and numerous sketches and field changes. As is typical for construction projects, an Owner's needs are communicated in written form via Specifications and drawings depicting an intended design which directs the creation of document submittals by a Contractor. Typical submittals include concrete mix designs, trade-specific shop drawings, and quality control programs. Submittals are reviewed by the Owner's representative to confirm that needs and design has been correctly interpreted. Coordination between all parties is promoted by requiring meetings before specified events and at specified time intervals.

The three construction deficiencies discussed within this analysis are: the pour strips (narrow sections of concrete floor cast later than adjacent portions of the floors) in which some of the required reinforcing was omitted; the concrete composition, which has lower compressive strength than is required by the Construction Documents; and, concrete placement issues that resulted in slabs of insufficient thickness and with insufficient concrete cover over reinforcing steel and post-tensioned tendons. Controls on post-tensioning were also analyzed. This analysis mentions deficiencies in design cited in the KCE report, such as design stresses related to post-tensioning, but does not specifically examine the design deficiencies cited in the KCE report or the controls intended to identify and correct design deficiencies.

Pour Strips

The SSTC structure includes three pour strips, one on the top level and two on the second level. Both pour strips at the second floor are 10' by 80' rectangles which were purposely installed at least 60 days later than the rest of the floor. KCE found that concrete in one of the second level pour strips has less reinforcing steel than is required by Construction Documents, and neither of the second level pour strips have post-tensioned tendons. This structural deficiency resulted from failure of the reviewers to detect the absence of specified reinforcing steel in shop drawings for one of the pour strips, and failure to question the absence of any drawings for the two pour strips in the post-tensioning shop drawing set.

Construction drawings appear to require post-tensioned tendons in all the pour strips. The absence of post-tensioned tendons in the pour strips is consistent with the absence of post-tensioning shop drawings for the pour strips. The mild steel reinforcing that was detected by KCE coincides with the reinforcing shop drawings. Both sets of shop drawings were created by the Construction Team and reviewed by the Design Team. As a control measure, the manager of the construction quality control plan was required to review each submittal, including shop drawings, and note any variances from the construction drawings, but no differences were noted. Further, the RFI process existed to address any apparent inconsistencies or ambiguities, but that process was not used regarding the pour strips. These controls, as designed, should have been effective, but implementation of these controls failed in regards to the construction of the pour strips.

The shop drawings are among the items that were discussed in a pre-installation conference for post-tensioning. At the time this meeting was held, not all post-tensioned shop drawings were available because on this project the shop drawings were submitted in phases. Having these shop drawings available during the pre-installation conference might have facilitated the work of the reviewers in identifying the differences between the construction drawings and the shop drawings. Phased submissions are not prohibited, but steps were not taken to enable reviewers to clearly understand and track which submittals were outstanding or when delivery of submittals should have been expected.

Concrete Composition

Concrete strength measured by KCE in cores taken from the mostly-completed structure was in many cases considerably less than that of test cylinders collected during construction activities. Concrete properties can be affected by many variables, so many controls were evaluated. Some were found to have functioned largely as intended, such as selection of the concrete's components and vibration of the fresh concrete to remove entrapped air. Other controls suffered from poor implementation, such as not inspecting two of the batch plants or failing to correct a trend of low quantities of entrained air. Slump limits and curing practices met typical industry practice but not the higher standard requested by WMATA. Confusion about where to take samples and about cold weather limits existed that could have been avoided by clearer language in the Specifications. Although the proper records were kept and submitted regarding the amount of water in the concrete mix, KCE testing indicates that in many cases water was added without permission or documentation.

Concrete Placement

The Design Team, Contractor, and Owner moved quickly to resolve the problem of surfacing post-tensioned tendons upon its discovery during construction, so controls on tendon location as implemented at the end of the project are considered to have been effective. However, the issue of slab thickness continued until the project's end even though it was identified about halfway through construction of the floors. Minutes from a meeting which included all parties in November of 2010 note that, "Area around popped tendons was surveyed for slab thickness. Slab came in thin in some areas." Thickness maps of the entire slab surface at both floors that were later created by KCE show how widespread the problem was, even in work completed after the aforementioned meeting. Since controls are supposed to allow corrective action on identified deviations from project plans, the controls on slab thickness were not effective.

Construction records do not document direct measurements of the thickness of the concrete floor slabs. The top surface was given the desired shape based on measurements taken by survey equipment operated while concrete was being placed. Thickness was realized as the difference between formwork position and concrete top surface, and inspectors could not independently check thickness except at the perimeter. This construction method, selected by the Contractor, depended upon his own implementation being correct. No redundant measurements were taken, despite repeated reminders from the engineer of record. Future construction efforts should either utilize a construction method that allows direct measurement of floor thickness so that inspectors can help the Contractor by identifying problems before the concrete is placed, or the inspectors should perform a second, independent survey during construction.

This analysis reviewed records kept during construction to evaluate the controls associated with the three slab deficiencies described above. KCE identified other deficiencies, such as reinforcing bar cover in columns and cracks in beams and girders. Although these deficiencies were not reviewed as part of this analysis, some of the conclusions and recommendations relating to controls for the slab deficiencies will apply to the column, beam and girder deficiencies. "Lessons learned" from the experience of the SSTC construction will improve effectiveness of remedial actions and will benefit both future projects and the ongoing remediation efforts. Table 1 on page 10 summarizes results of the control analysis with regard to the control's design, implementation, and effectiveness.

Table 1

Control	Design	Implementation	Effectiveness
Pour Strips			
RFIs and meetings	no deficiency	no deficiency	not utilized to clarify PT
submittal review	no deficiency	deficient	deficient
pre-installation conference	phased submittals not anticipated	no deficiency	PT shop drawings expected at pour strips but not produced
daily reports	no deficiency	no deficiency	inconsistent follow-up
Concrete Composition			
pumped concrete samples	ambiguous	no deficiency	weakened
batch plant inspections	vague	inconsistent	weakened
concrete mix design	no deficiency	no deficiency	no deficiency
water added at site	no deficiency	no deficiency	KCE petrographic data suggests water additions
slump measurements	inconsistent with WMATA	no deficiency	no deficiency
cold weather curing	inconsistent with WMATA	confusion regarding referenced standard	weakened
surface curing	inconsistent with WMATA	few records	no deficiency
entrapped air	no deficiency	no deficiency	no deficiency
entrained air	no deficiency	QC missing	pump effect unknown
Concrete Placement			
PT tendon placement	no deficiency	deficiency fixed	some popped tendons
steel rebar placement	no deficiency	few records	unknown
floor thickness	no redundant measurements	ineffective, even after deficiencies identified	ineffective
Post Tensioning			
stressing records	no deficiency	no deficiency	no deficiency
concrete stresses	questionable	none documented	ineffective
grout strength	no deficiency	records unavailable	unknown
time to grouting	not specified	inconsistent	unknown except for limited destructive evaluation by KCE
strength at stressing	drawings stricter than Specification	followed the Specification	no impact
age at stressing	no deficiency	late once	no impact

[balance of page intentionally left blank]

III. Introduction and Purpose

The Silver Spring Transit Center is located in downtown Silver Spring, Maryland, adjacent to the existing Washington Metropolitan Area Transit Auhorty (WMATA) pasenger rail station. The SSTC's primary purpose is to serve as a bus terminal, but the SSTC also provides accommodations for passenger drop-off and pick-up for private vehicles and taxis. Under a formal Memorandum of Understanding (MOU) between the two owners of the land being used for this project, Montgomery County Maryland and Washington Metropolitan Area Transit Authority (WMATA), Montgomery County is authorized to manage the development and construction of the SSTC. Upon completion of the project and WMATA's acceptance, WMATA will control, operate and maintain the facility.[1]

A contract to construct the SSTC was signed in 2008. During the construction efforts in October 2010, tendons became visible in a completed floor when small pieces of concrete above a few tendons broke away. Concerns about the visible tendons coupled with visible evidence of extensive cracking of concrete prompted immediate review by the entire construction team, as well as an investigation by both present and future owners. Montgomery County ultimately retained the services of KCE Structural Engineers, PC (KCE) to perform a structural evaluation of the SSTC structure and to conduct an extensive document review. KCE prepared a report of their findings dated March 15, 2013 which is herein referred to as 'KCE Report'.

The SSTC is comprised of three floors which are referred to as Levels 305 (sometimes referred to in the KCE report as Level 300), 330, and 350. Level 305 is constructed at ground level while both Levels 330 and 350 are elevated. The SSTC is primarily constructed from reinforced cast-in-place concrete. The elevated floors are constructed from concrete and reinforced with mild steel and post-tensioned (PT) tendons. Post-tensioning is a method of strengthening concrete or other materials with high-strength steel strands or bars, typically referred to as tendons.[2] Concrete posts, beams and girders support the above grade floors. At the East and West ends of the facility on Level 330 there are ten foot wide strips of slab (pour strips) which encompass the full width of the slab and join the adjacent sections to create a continuous surface. The concrete in the pour strips was required to be placed a minimum of sixty days after both adjacent sections of concrete. See Appendix C for drawings showing how the floors were sequenced by the Contractor.

Objectives, Methodology, and Scope

Management actions intended to prevent problems are called project controls. Management of construction requires flexibility since each project is different, but construction managers have found success when they implement systems to control time, cost, scope and quality. Effective controls identify deviations from project plans early enough to allow corrective action. This project implemented many controls, but some of the deficiencies identified by KCE in the mostly-completed structure were not

[1] Amended and Restated Memorandum of Understanding between Washington Metropolitan Area Transit Authority and Montgomery County Maryland dated September 25, 2008, page 9. (KCE Report, Exhibit M1 pdf page 496).

[2] "What Is Post-Tensioning?" Post-Tensioning Institute, December, 2000.

identified and/or not corrected during construction. Therefore, identification of controls that were omitted, deficient or failed is necessary to avoid repeating mistakes due to misplaced confidence in deficient controls.

This analysis has three objectives:

- to review the construction project controls which were established particular to this project;
- to evaluate control implementation with regards to selected deficiencies; and,
- to identify any controls that were either omitted or ineffective and the causes of such deficiencies.

The methodology used in this analysis is to evaluate records kept during construction beginning with the KCE report including its exhibits and attachments. As specific records are found to be lacking in this primary resource, such records are requested individually. Our knowledge of the construction industry and of structural design is then applied to interpret records and make appropriate recommendations.

This analysis discusses project controls related to three components for which deficiencies are identified in the KCE report. The first component in the scope of this analysis was the pour strips. The investigation performed by KCE identified that the as-built West pour strip on Level 330 does not have temperature and shrinkage reinforcing steel required by Construction Documents and that both as-built pour strips on Level 330 do not have post-tensioning tendons. The second component discussed is the concrete composition. Based on in-situ testing performed by KCE, the cast-in-place concrete in areas of the structure does not meet compressive strength requirements set in the Construction Documents. The third component discussed is concrete placement. The KCE report identified that concrete cover over reinforcing is less than required, and the thickness of the concrete floors does not comply with Construction Documents. Project controls relating to reinforcing cover and thickness of the concrete in the floors are similar, thus, the two deficiencies are addressed in one section.

During the course of this analysis we reviewed the Contract Documents, Requests for Information (RFIs) and their responses, Architectural Supplemental Instructions (ASIs), and numerous sketches and field changes. However, this analysis does not specifically examine the design deficiencies cited in the KCE report or controls intended to identify design deficiencies. The design issues noted by KCE include:

- a lack of coordination during design between elements, such as electrical and other embedded items interfering with reinforcing and post-tensioning, slab geometry and sloping to drains relative to specified slab thickness;
- failure to take into account various required limitations on stress induced during initial post-tensioning;
- induced forces that overbalanced the structure due to post-tensioning forces that exceeded the actual weight of the slabs, beams, and girders, inducing cracks in the structure;
- failure to accommodate the stress caused by restraint forces due to the as-designed integral concrete walls, columns, and girders, which induced cracking in the slabs and in those elements themselves;

- failure to incorporate into the Contract Documents all of the required WMATA Manual of Design Criteria and the WMATA Standards; and,
- under-design of certain elements of the structure to resist shear forces and torsion forces.

IV. SSTC Background and Project Controls

SSTC Background

Within DGS, the Division of Building Design and Construction is responsible for planning, designing, and constructing Montgomery County's public buildings. DGS serves as the Owner during construction of the Project.[3] Preliminary planning for the SSTC began in the 1990's and required the relocation of the neighboring WMATA station before plans could be formalized for the SSTC. Under the terms of the MOU between Montgomery County and WMATA, DGS would lead the construction effort and WMATA would maintain the structure upon construction completion. The MOU required that WMATA design standards be incorporated into the design of the SSTC.

Montgomery County entered into contract with Parsons Brinckerhoff, Inc (formerly known as Parsons Brinkerhoff Quade and Douglas, Inc. and PB Americas, Inc.) in 2004 to design the facility. Herein, this contract is referred to as "Design Contract." Parsons Brinckerhoff, Inc (PB) was/is the Designer of Record (DOR) as well as the Structural Engineer of Record (SEOR) for the project and hired sub-consultants to perform design work associated with other disciplines such as architectural design services.[4] For the SSTC project, the term Architect/Engineer (A/E) refers to PB since they hold the prime design contract with Montgomery County. Per the Montgomery County Contract with PB, the Design Team was required to prepare progress documents for three phases: Schematic, Design Development, and Construction Documents. At each phase, PB was required to submit progress drawings, Specifications, and cost estimates for DGS review, comment, and approval.[5]

Specifications are detailed requirements written in paragraph form that must be satisfied for materials, design, products, or services. For example, specifications include explicit material, composition, and performance requirements for concrete mixes as well as other materials utilized in construction. Specifications also provide direction, expectations, and minimum requirements for all parties involved in the construction process. Specifications are divided into sections with each section focused on one topic or material.[6] Herein, the use of the word "Specification" refers to the specific document developed by PB and incorporated into the Construction Documents.

---

[3] In the Construction Contract between Montgomery County and Foulger-Pratt, signatures representing the Owner are those of the director of DGS and of the chief of the Division of Building Design and Construction. (KCE Report, Exhibit M1 pdf page 17).

[4] The Architect of Record, Zimmer Gunsul Frasca Architects LLP (ZGF), performed sub-consulting architectural services for Parsons Brinckerhoff, Inc.

[5] Design Contract, sections 3.3.1.1 and 6.2. (KCE Report, Exhibit M1 pdf pages 146 and 157).

[6] The Specifications are organized into sections that are numbered according to the industry standard called MasterFormat, as set forth by the Construction Specifications Institute. In this system, the prefix number 01 gives general construction direction such as submittal procedures or testing requirements while sections with prefix numbers of 02 through 16 provide information for specific material types.

All construction projects must be designed to the minimum requirements dictated in building codes. Montgomery County has adopted the use of the International Building Code (IBC), which requires compliance with several other standards prepared by independent committees or industry agencies. For example, the American Concrete Institute (ACI) develops the standards for concrete and IBC requires all concrete design to be in conformance with ACI requirements. Another example is the American Society for Testing and Materials (ASTM) which provides standards for test methods, material performance requirements, as well as other recommended guides and best practices. The IBC and those standards referenced by it were utilized by PB in the preparation of the SSTC's design documents. Since specific standards are typically revised and updated over time, the standards referenced during the design were those that were in effect at the time the structure was designed.

The final drawings and Specifications prepared by PB are dated 2008 and are herein called "Construction Documents." These were approved by Montgomery County Department of Permitting Services (DPS) with the issue of a building permit in 2009. DPS enforces standards that control what goes on before, during and after construction through a mandatory permitting process. The Building Construction Division of DPS is responsible for ensuring public safety through the enforcement of construction codes and zoning standards. This is accomplished through engineering plan review and construction inspection related to the administration and enforcement of building, structural, electrical, mechanical, fire-safety, energy conservation, and accessibility codes. DPS is independent from DGS, the county branch that handled construction of the SSTC.[7]

Montgomery County contracted with Foulger-Pratt Contracting, LLC (FP) in 2008 to construct the facility. Herein, this contract is referred to as "Construction Contract" and FP is referred to as "Contractor." The Construction Contract incorporated the Construction Documents developed by PB. As is typical construction procedure, the Specifications required FP to interpret the Construction Documents and prepare trade-specific drawings called shop drawings and to submit product information that communicates FP's intended construction methodology and understanding of the proposed construction.

Specifications require the designer of record (PB) to review and approve the shop drawings and submittals to confirm that FP's intended construction is in conformance with the design intent. Examples of required submittals include FP's intended concrete mix designs as well as their intended quality control (QC) program.

FP subcontracted all concrete-related aspects of the project work to Facchina Construction Company, Inc. (Facchina). Facchina in turn entered into a contract with VSTRUCTURAL LLC (VSL) to provide design, shop drawings, hardware, and on-site consultation for post-tensioned aspects of the concrete work. At the same time, Gerdau Ameristeel provided shop drawings and materials for the mild steel reinforcing aspect of the concrete work. R&R Reinforcing, Inc. (R&R) provided installation for Facchina of both the mild steel reinforcement and the post-tensioning elements. Lafarge Concrete and Rockville Fuel and Feed Co., Inc. (RFF) are the companies that supplied ready mix concrete for the SSTC project.

[7] Row 11 (Cont'd) of undated, tabulated responses by DGS to WMATA comments on the CQC plan submitted by FP says, "It is important to realize that the County is not a monolithic organization. The County team managing this project ... [is] DGS, and they submitted their permit application ... [to] DPS. DGS must satisfy DPS requirements" in order to obtain permission for occupancy.

Montgomery County Special Inspections Program

The building code requires certain inspections for all construction projects. Montgomery County's Special Inspection Program procedures applicable to the SSTC are those required by Montgomery County Building Code, and in accordance with the International Building Code (IBC).

Owners of buildings and structures whose elements are subject to special inspections must submit, as part of the permit application, a Statement of Special Inspections (SSI) prepared by the Structural Engineer of record (SEOR) as a condition for permit issuance and pre-construction meeting. This statement must include a complete list of materials requiring special inspections, the inspections to be performed and a list of the individuals, approved agencies and firms intended to be retained for conducting such inspections.

The Special Inspector (SI) is the registered design professional retained by an owner to provide special inspections and material testing services as specified by appropriate design professionals of record and approved by the DPS. The SI must provide construction observation and testing services of required scope and frequency to offer a professional opinion that the constructed project was built in accordance with the DPS-approved construction documents, and that construction has been tested and inspected in accordance with the SSI and applicable codes and standards. The SI may be an agent of, or independent of the Inspection and Testing agency or the project's SEOR.

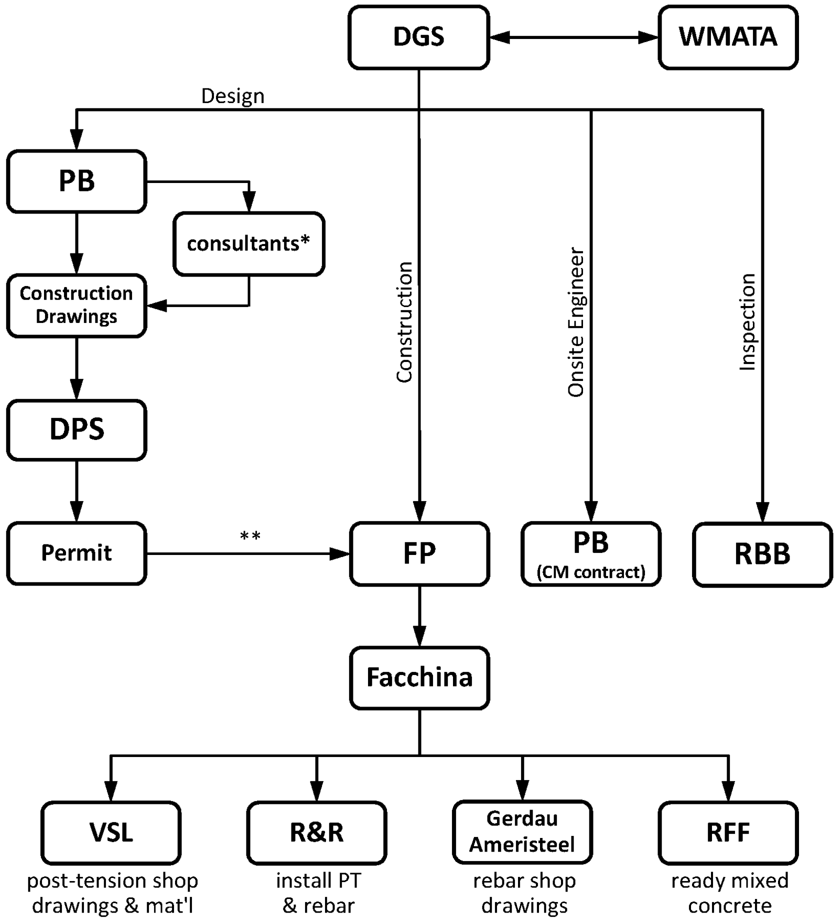
The Special Inspector is required to keep records of specified inspections and testing and is required to furnish specified inspection and test reports to the DPS building official, and to the registered design professionals of record. All discrepancies are required to be brought to the attention of the contractor for correction or, if not corrected, to the attention of the code official and to the registered design professionals of record, as appropriate. Interim reports shall be submitted as required by the special inspection program manual. A Final Report of Special Inspections documenting completion of all required special inspections and correction of documented discrepancies shall be submitted prior to the issuance of an occupancy permit.

Montgomery County contracted with Robert B. Balter Company (RBB) to perform all of the third-party inspections and field testing under the SSI during the construction efforts.[8] Herein, the contract with RBB is referred to as "Inspection Contract."

PB was contracted by Montgomery County in 2009 to provide Construction Project Management Services. Herein, this contract is referred to as "Construction Manager Contract." The Scope of Services for PB indicates that they provide a full-time on-site project engineer to work under the direction of the County's Contract Administrator or his designee, which in this case is DGS.

[8] Contract for Inspection and Materials Testing Services between Montgomery County, Maryland and The Robert B. Balter Company, County Contract No. 6504510207-AA, signed 10/24/2006. (KCE Report, Exhibit M1 pdf page 333-405).

Figure 1 depicts the sequence of some of selected relationships between parties involved in the construction of the SSTC.



*Consultants to PB include Zimmer Gunsul Frasca Architects LLP (ZGF), A B Consultants, Inc., Coastal Resources, Inc., Gallop Corporation, Remline Corporation, Rosborough Communications, Inc., and Staiano Engineering, Inc.

**The Permit was officially granted to DGS. For practical purposes, however, it authorized FP to proceed.

Figure 1 – Sequence of SSTC Relationships

Many project controls are associated with the design and construction of the SSTC. Controls are identified and established via the Design Contract, Construction Contract, Inspection Contract, and the Construction Manager Contract. As is typical for all design and construction efforts, additional project controls are established for the project during permit review.

Quality control programs are required for both PB and FP as established in their respective contracts. Project conferences and the design submittal process are also established in the Design Contract. The Construction Documents generated by PB include Specifications and drawings, both of which are incorporated into the Construction Contract. The Specifications establish minimum project controls that FP is required to execute including document control, daily quality control reports, shop drawing generations and review criteria, inspections, and conferences. The various controls established for the

SSTC relating to the three deficiencies reviewed in the analysis are described more specifically in the following paragraphs.

Design Project Controls

The Design Contract included language requiring PB to execute a Design Quality Control (DQC) program and to initiate early and continuous reviews and coordination with the appropriate government entities for permits and approvals.[9] The Design Contract also required project conferences throughout all phases of the Project including work sessions as required during the submittal review meetings.[10] Phases included Concept, Schematic, Design Development, and Construction Documents. Exhibit A of the Design Contract indicates the required scope of services including requirements per discipline for documents submitted in each phase. Exhibit L of the Design Contract indicates requirements for the DQC, which are summarized in the next paragraph.

PB was required to submit a DQC plan within 30 calendar days after receipt of a Notice to Proceed. The Plan was required to include staff names and qualifications for each person assigned a DQC function including the Design Quality Control Manager who must report directly to a Principal of the firm and have minimum 10 years of experience in architectural or engineering design with 5 of those years involving DQC functions. The plan was also required to include a submittal tracking plan, coordination plan, design review plan, design schedule, and a cost estimate and analysis form. An orientation meeting was required and opportunities were provided throughout the Design Contract duration to reconfirm mutual understanding of the Plan. During the Design Development, Construction Document, and the Construction Bid phases of design, the DQC Manager must maintain the Plan and submit checklists for submittal tracking, coordination, design review, and design schedule. During the Construction Administration Phase, the DQC Manager was required to submit the submittal tracking checklist, a RFI/Issue tracking checklist, and a review of the Critical Path Method schedule and any related General Contractor's claims for delay.[11]

The copy of the DQC program submitted by PB that was provided to this analysis did not show evidence of having been maintained after submission. The DQC plan has staff names, but does not provide qualifications. It includes procedures for tracking documents supplied by third parties, but does not specifically address submittals. The DQC plan describes coordination and design review without identifying design elements. Therefore, the DQC program does not meet many of the requirements given in the Design Contract as explained in the preceding paragraph.

During the course of this analysis we reviewed the Construction Documents, Requests for Information (RFIs) and their responses, Architectural Supplemental Instructions (ASIs), and numerous sketches and field changes. However, this analysis does not specifically examine the design deficiencies cited in the KCE report or controls intended to identify design deficiencies. This analysis reviewed design documents only to determine whether specific requirements were presented for Contractor implementation,

---

[9] Contract for Architectural/Engineering Services between Montgomery County, Maryland and Parsons Brinckerhoff Quade & Douglas, Inc. for Design of Silver Spring Transit Center, County Contract #4504510121-AA, page 13-14. (KCE Report, Exhibit M1, pdf page 141-142).

[10] ibid, page 21. (KCE Report, Exhibit M1, pdf page 149).

[11] ibid, pages L-1 – L-3

because the deficiencies reviewed stemmed from activities which occurred during construction. Therefore, the controls surrounding design were not directly relevant to the deficiencies. Accordingly, evaluation of the implementation or effectiveness of design controls is not considered within this analysis. Where appropriate, this analysis does include a few recommendations to the designers specifically related to the slab deficiencies.

Construction Project Controls

Designer Controls

Per the Design Contract, PB was obliged to perform one Pre-Construction Conference and attend construction progress meetings on a bi-weekly basis. Emergency field meetings were also required and were to be held at DGS request to resolve urgent problems. Also, the Design Contract required PB to attend any meetings necessary to properly coordinate the design and construction administration effort including without limitation, meetings with government agencies, code officials, and applicable utilities. PB was required to review field coordination and provide written field reports within three working days of each site review.[12]

Montgomery County Personnel

DGS personnel performed many of the tasks typically assigned to a Construction Manager, and had primary responsibility for document control activities and to perform Quality Assurance functions.[13] Quality assurance can be described very briefly as continuously reviewing all operations and auditing all test reports. Quality control, on the other hand, consists of inspecting, testing and checking the products of construction activity. Quality control responsibilities on this project were shared by FP and RBB according to the Test Matrix included in Appendix A.

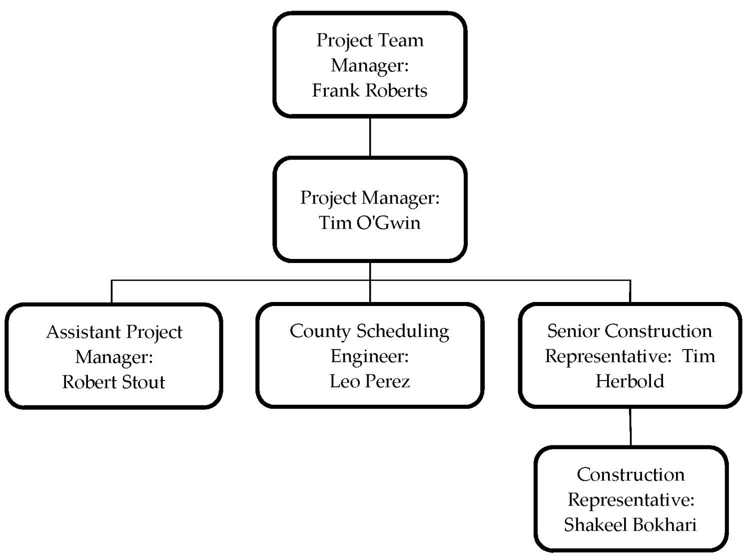


Figure 2 – Organizational Chart of DGS Personnel

[12] ibid, page 21-22. (KCE Report, Exhibit M1, pdf page 149-150)
[13] Foulger Pratt Quality Control Plan Revised Submission 4/17/09; DGS response to question 11

Several DGS personnel were involved in the construction administration of the SSTC. A full description of the duties and functions of each person as provided by DGS can be found in Appendix B. The organization of personnel is summarized in Figure 2 on page 18 and was developed based on duty and function descriptions from Appendix B. The organizational relationships were and continue to be in effect throughout the duration of the construction activities.

Construction Manager

The Construction Management Contract was initiated after construction began to provide on-site construction project management services. The Background section of the Construction Management Contract indicates that during the first part of the construction effort substantial redesign was necessitated by large scale underground utility relocation and several unforeseen conditions. Due to the significant delay relating to the redesign, Montgomery County determined it necessary to have a full-time project engineer from PB's staff on-site to coordinate the redesigns and review process activities.

John Anderson serves the role of onsite project engineer. The scope of services in the Construction Management Contract indicate that Mr. Anderson's responsibilities include coordination of project design activities and issues with various outside agencies, production of required progress reports to outside agencies, coordination of document reviews, documentation and assistance to DGS staff in negotiating Construction Contract changes, identification and resolution of project design issues, participation in progress meetings, and assistance to DGS's Capital Projects Manager and other County personnel with other duties that may be necessary to expedite and assure satisfactory coordination with WMATA and other agencies involved in project.[14]

While the contract with PB was called a Construction Management Contract, responsibilities of Mr. Anderson do not correlate to typical industry Construction Manager roles. Without an independent Construction Manager engaged for the project, DGS was expected to function in the typical CM role, which is described in an industry publication as "conducting periodic progress meetings, document control, cost tracking and management, evaluation of payment requests, change order management, quality management, schedule control, monitoring of Contractor's safety efforts, commissioning and generation of the punchlist."[15] Mr. Anderson was in a support staff position to DGS as they provided construction management. Additional discussion relating to the role of Construction Manager can be found in the *Considerations* section of this analysis.

Contractor Quality Control Plan

Provisions in the Design Contract require PB to include certain quality control provisions in the Construction Documents. These provisions would require the Contractor to submit a Contractor Quality Control (CQC) Plan.[16] Review of the Plan FP submitted indicates that it identifies requirements for personnel organization, document control, RFI procedures, submittal control, testing, phased inspections,

[14] Agreement for On-Site Project Engineering Services between Montgomery County, Maryland and P.B. Americas, Inc. for On-Site Construction Project Management Services for the Silver Spring Transit Center Contract No. 0363200005-AA, page 2-3. (KCE Report, Exhibit M1, pdf page 298-299)
[15] An Owner's Guide to Project Delivery Methods by the Construction Management Association of America, August 2012, page 15
[16] Contract for Architectural/Engineering Services between Montgomery County, Maryland and Parsons Brinckerhoff Quade & Douglas, Inc. for Design of Silver Spring Transit Center, County Contract #4504510121-AA, page L3 – L-15.

deficiency correction, commissioning, and material handling. Also included in the Plan is the inspection processes including concealed elements of work, special inspections per the Montgomery County Statement of Special Inspections, substantial completion inspections and final inspections. The CQC Plan applies to aspects of the work both on-site and off-site. The primary focus is on the early identification and resolution of potential problems before they impact the project. A more detailed description of the CQC Plan is found in Appendix A.

Shop Drawing & Submittal Review

Per the Specifications in Section 01330.1.4.H, a standard submittal review cycle requires four copies of the shop drawing be submitted from the Contractor to PB. PB keeps one reviewed copy and transmits one copy to the Owner and two copies to the Contractor. During the October 29, 2008 Progress Meeting, a modification to the review cycle was presented, "FPC will distribute submittals to each party, (1 to MC, 3 to WMATA, and 6 to PB). PB will distribute as required for internal review. PB will return submittals to each party (1 to MC, 1 to WMATA, 1 to ZGF, 1 to FPC). FPC's copies will be fedexed unless they are reviewed 2 days prior to a progress meeting which case they will be delivered to the meeting."

A flow chart of the review process is depicted in Figure 3 below.

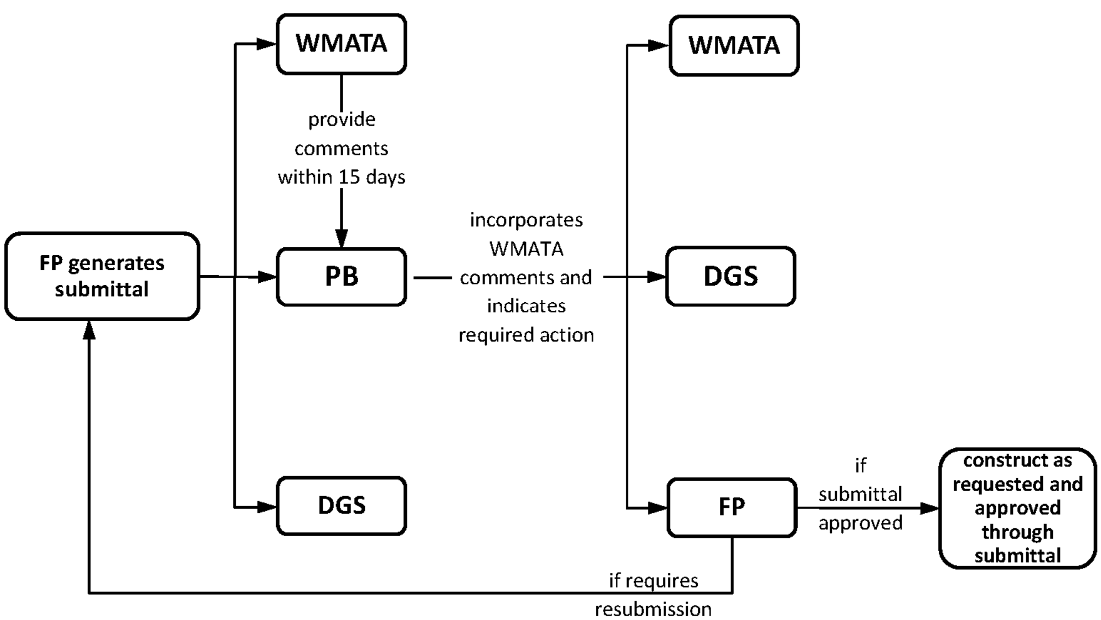


Figure 3 – SSTC Submittal Review Process

Per Specification Section 01330.1.4.G, FP is required to review and approve all submittals for compliance with Construction Documents and field dimensions prior to submission to A/E. FP's approval should be noted on the label or title block. The A/E is required to return any un-reviewed submittal not bearing notation of the Contractor's approval. DORs indicate results of their review of the shop drawings, product data, and samples by use of a rubber stamp, as shown in Figure 4, which usually has some exculpatory language in fine print plus some options which can be exercised by use of check marks. The stamp used by PB provided the options of Approved; Approved as Noted; Return No Action Taken; Revise and Resubmit; and Rejected, See Comments.

PB

PARSONS BRINCKERHOFF

100 South Charles Street
Tower 1, 10th Floor
Baltimore, Maryland 21201-2727

PROJECT.	Silver Spring Transit Center
DIVISION NO.	3
SPECIFICATION NO.	03381
SUBMITTAL NO.	03381 – 011 - 01
DESCRIPTION	Level 330 Partial Pour 1A & 1B Elongation and Effective Force Calculations

APPROVED	☐
APPROVED AS NOTED *(Revise, but no resubmittal required if noted items are modified as indicated.)*	☒
RETURN NO ACTION TAKEN	☐
REVISE AND RESUBMIT *(Noted items only. Resubmittal review will be limited to noted items only.)*	☐
REJECTED, SEE COMMENTS	☐

Review is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for conformation with all requirements of the plans and specifications, including, but not limited to, dimensions which shall be confirmed and correlated at the job site, for information that pertains solely to the fabrication process or to the means, methods, techniques, sequences and procedures of construction, and for coordination of the work of all trades.

BY: Douglas Lang
DATE: 04/12/10

Figure 4 – Representative Submittal Stamp used by PB on the SSTC project

Meetings and Conferences

PB conducted bi-weekly meetings at the Project site as required by Specification 01310.1.7. Copies of minutes from these meetings are included in KCE Exhibit P. Additional meetings were held as required before or after various Definable Features of Work. For instance, a pre-installation conference for post-tensioning is required by Specification 03381.6.E.1-8. This analysis reviewed minutes of the meeting, which was held July 13, 2010. As required, discussion included schedule, onsite storage, structural load limitations, coordination of PT installation drawings, mild reinforcing steel drawings, tolerances, marking and measuring of elongations, submittal of stressing records, and removal of formwork. A pre-installation conference for concrete is required by Specification 03300.1.5J. This analysis reviewed minutes of two such meetings, held April 28, 2010 and August 25, 2010. As required, discussion included mix design and procedures for field quality control, cold and hot weather, finishing and curing.

Testing

Department of Permitting Services

As previously described, the Special Inspections Program for Montgomery County requires Special Inspections (SI) to be performed on projects for verification of compliance of specific items listed on the Statement of Special Inspections (SSI) which is a condition of the building permit. In the SSI, the SEOR identifies those components that require special inspections, and names the inspection and testing agency retained by the owner to perform the inspections. The Inspection Contract required RBB to perform the third-party testing.[17] RBB was required to furnish copies of their inspection reports to the building official at DPS within ten business days of each inspection.

Contractor

Administrative and procedural requirements for quality control and quality assurance are established in the Specifications in Section 01400. The Section requires that FP engage an Independent Testing and Laboratory Agency (different than the one utilized by the Owner) to provide inspection services not specified as Owner's responsibility. The section also references Section 01440, *Contractor's Quality Control (CQC)*, which requires FP to submit a plan for execution of a CQC Program. As contained in Section 01440.3.7, *Tests*, FP is to perform tests to verify control measures are adequate to provide a product conforming to Construction Documents. Contractor required testing is shown herein in the Testing Matrix included in Appendix A.

The Special Inspections Program requires the Contractor to secure and deliver to A/E or its testing agency samples of proposed material which are required to be tested, submit through the testing agency to the A/E the proposed concrete mix design for approval, furnish labor as necessary to obtain and handle samples, advise testing agency in advance of operations for completion of quality tests, and furnish copies of mill test reports of all shipments of cement and reinforcing steel to Architect and testing agency. Based on the documents reviewed, it appears the Contractor provided the appropriate submittals.

Testing Agency

Per the Specifications in Section 03300, *Cast-in-Place Concrete*, Paragraph 3.17 indicates field quality control requirements for concrete work associated with the project. Subparagraph 3.17(A) indicates that the Owner will engage a qualified testing and inspecting agency to perform test and inspections and prepare test reports. Montgomery County entered into the Inspection Contract with RBB in accordance with the Specification requirements. Section C of the Specification Section provides requirements for the concrete testing including how the samples are to be obtained, frequency, which tests to perform on the samples, how the tests are to be performed, how the testing results are to be communicated, what is considered to be acceptable results, and what is required if testing indicates deficiencies. Slump, air content, concrete temperature, and compressive-strength tests are all required to be measured. Direction relating to slump indicates that one test must be performed at point of placement for each composite sample. Direction on location where samples must be obtained is not included for other tests.

[17] Contract for Inspection and Materials Testing Services between Montgomery County, Maryland and The Robert B. Balter Company, County Contract No. 6504510207-AA, page 2. (KCE Report, Exhibit M1 pdf page 336).

For the compressive-strength test, Section 03300 Subparagraph 3.17 (C)(6)(a) requires a test of one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days. Additionally, one set of two field-cured specimens are to be tested at 2 days for evaluation of the concrete for acceptability to begin post-tensioning, one set of field specimens to confirm concrete placed in post-tensioned members has reached strength required for completion of stressing, and two cylinders for evaluation at 28 days to compare to laboratory cured cylinders. The tests are to be performed in accordance with ASTM C 39. The number of sets was expanded by mutual agreement during construction to include a set at 56 days.[18]

The Special Inspection Program documentation included in the Inspection Contract includes requirements for testing of cast-in-place concrete as well as other components of a construction project. RBB was required to perform slump tests; fabricating, sorting, transporting, curing, and testing of compression test cylinders; test of fine and coarse aggregate; preparation and distribution of test and other pertinent reports; review of mill test certificates for specification conformance; and report findings to Architect and Contractor. The Program does not require RBB to test reinforcing steel, wire fabric, or mill tests on cement and steel.[19]

Inspections

The Special Inspection Program requires inspectors to hold current certifications by the Maryland Chapter of the American Concrete Institute or the Ready Mix Concrete Producers Technical Committee.[20] Also, the inspectors must have a minimum of five years of experience in test inspection for construction projects of similar scope and size.[21] Per the Specifications in Section 03300, *Cast-in-Place Concrete*, Section 3.17 indicates field quality control requirements for concrete work associated with the project. Section A indicates that the Owner will engage a qualified testing and inspecting agency to perform test and inspections and prepare test reports. Montgomery County initiated the Inspection Contract in accordance with the Specification requirements.

The Special Inspection Program documentation included in Exhibit E of the Inspection Contract includes requirements for inspection of cast-in-place concrete as well as other components of a construction project. Concrete structures require:

- inspection of formwork and reinforcing prior to placement of concrete,
- authorization in writing for the stripping of formwork and reshoring only after the criteria approved by the Structural Engineer of Record (SEOR) is met,
- inspection of the batching tickets and delivery operations for compliance with project Specifications, and
- performance of compression tests.

[18] Item 4.2 in FP Preinstallation Conference minutes dated 4/28/2010

[19] Contract for Inspection and Materials Testing Services between Montgomery County, Maryland and The Robert B. Balter Company, County Contract No. 6504510207-AA, Exhibit D, page 32. (KCE Report, Exhibit M1 pdf page 366).

[20] ibid, Exhibit D, page 33. (KCE Report, Exhibit M1 pdf page 367).

[21] ibid, Exhibit D, page 28. (KCE Report, Exhibit M1 pdf page 362).

Post-tension concrete structures require:

- inspections of formwork, tendons, and reinforcing prior to placement of concrete,
- inspection of all concrete placement,
- inspection of all tensioning,
- retention of elongation records, and
- provision of permission to Contractor to burn, cut, or cap pre-stressing anchorage only after the criteria approved by SEOR has been met.[22]

The Special Inspection Program documentation included in Exhibit D of the Inspection Contract indicates that inspection of the plant (including batching) of all concrete and field inspection of concrete before, during, and after placement is required. However, the design or inspection of formwork and the supervision of the placing of reinforcing steel are excluded.[23] SSTC Specifications delegate design and implementation of formwork to the Contractor. The third-party inspector RBB was required to inspect the final placement of reinforcing steel, but not the day-to-day operations relating to placement.

Administrative and procedural requirements for quality control and quality assurance are established in the Specifications in Section 01400. The section references Section 01440, *Contractor's Quality Control (CQC)*, which requires FP to submit a plan for execution of a CQC Program. As contained in Section 01440.3.8, *Substantial and Final Completion Inspections*, when work or a designated portion thereof is determined to be substantially complete by FP, then the CQC System Manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved plans and Specifications. An additional inspection and list is also required at final completion. The Special Inspection Program requires that the Contractor schedule and coordinate the required inspections such that they are conducted and approved prior to proceeding with work.

Considerations

The report *Managing the Design and Construction of Public Facilities: A Comparative Review* (OLO Report) prepared by the Office of Legislative Oversight (OLO) reviewed the management practices used within Montgomery County Government and found that the practices largely align with the models and practices used by other jurisdictions and with "best practice" literature.[24] Elaboration on controls discussed within the OLO Report and the presentation of additional future considerations for project controls are discussed herein.

Construction Manager

The role of a Construction Manager (CM) can vary widely between construction projects so the scope of CM services must be agreed by contract based on the owner's needs. For the SSTC project, DGS had a dedicated staff that performed many duties and functions (see Appendix B). Review of the Construction Manager Contract for SSTC and the project description for the project engineer indicates that PB had a limited role as CM and was engaged after problems arose in order for the Design Team to have addi-

---

[22] ibid, Exhibit E, page 46-47. (KCE Report, Exhibit M1 pdf page 380-381).
[23] ibid, Exhibit D, page 32. (KCE Report, Exhibit M1 pdf page 366).
[24] Managing the Design and Construction of Public Facilities: A Comparative Review, Office of Legislative Oversight, OLO Report 2013-8, July 30, 2013, page i.

tional field presence during construction. It appears the additional field presence was intended to foster more cohesive lines of communication between the Design Team and DGS field personnel, Contractor, and other agencies involved/impacted by the project such as WMATA or utility providers.

As a clarification, the CM services provided by PB were handled separately from the same company's other roles in this project as DOR and SEOR. A single staff member, John Anderson, was assigned by PB to fulfill their CM contract on the SSTC project. For the duration of CM activities, Mr. Anderson was under the direct supervision of DGS project manager and had no decision making authority.[25] A different PB engineer, Douglas A. Lang, sealed the Construction Documents, reviewed shop drawings and provided site observations as designer's representative.

Examples of duties that, in general, can be handled by the CM are listed by the Construction Management Association of America in its publication Quality Management Guidelines.[26] Of these items, DGS took responsibility for: bid packaging and contracting strategy, permitting, public relations, and project commissioning. Items that were delegated to FP include: master schedule, resource planning, and safety considerations.

Of particular interest are items in which responsibility seems to have been shared between DGS and FP, such as document control, because these items have the potential for contributing to confusion. At the beginning of the project, DGS anticipated having "primary responsibility for document control activities. These activities include tracking and obtaining responses to RFIs, submittals and proposals for extra work from FPC, and maintaining an up-to-date set of Construction Documents."[27] The submittal logs and RFI logs that are included in the record,[28] however, were all contributed by FP. It was also FP who maintained the up-to-date set of Construction Documents.[29]

The lack of clarity in project roles caused comment during review of the CQC submittal. "QA and QC roles and responsibilities are split between [DGS], [RBB], [FP], and [FP]'s subcontractors, and the division seems unclear to WMATA. WMATA doesn't fully understand who is responsible for what. Any confusion regarding roles and responsibilities can lead to lapses and mistakes, so this lack of clarity is troubling."[30] Future projects would benefit from well-defined allocation of responsibility between project participants. Performance of project participants in each area of responsibility could be confirmed by an independent agency carrying out the function of quality assurance. For example, if CM services are obtained by contract from an independent organization, DGS can supervise the CM.

[25] Memorandum dated June 16, 2009 attached to Construction Manager Contract (KCE Report, Exhibit M1, pdf page 309).
[26] Page 6, 2000 edition, section contributor: Darryl Dunn of Construction Dynamics Group, Inc., Allentown, Pennsylvania.
[27] Row 11 (Cont'd) of undated, tabulated responses by DGS to WMATA comments on the CQC plan submitted by FP.
[28] Minutes from numerous PB Construction Progress Meetings (KCE Report, Exhibit series P).
[29] June 14, 2010, email regarding Contract Drawings attached to RBB letter dated August 29, 2012 (for letter see KCE Report, Exhibit Q1, pdf page 3)
[30] Row number 1 of undated comments attached to the CQC plan submitted by FP.

Document Control

FP utilized *Prolog Manager*[31] for RFI tracking and submittal tracking, with such logs usually included in weekly progress meeting minutes.[32] Minutes also include lists of action items, deficiencies, non-conformances, and drawing changes. Revisions were tracked using spreadsheets maintained by FP. Due to the complexity of the project, a drawing log is a necessity to enable the entire project team to use the same version of the Construction Documents. While it is beneficial to the team to have a Contractor who is utilizing the latest edition of construction software, it is equally important for the Owner to have access for use of the same documents.

Web-based software programs such as *Prolog Converge* or *Primavera Contract Management* allow a records custodian to maintain the document database on a real time basis and allow real time access by stake-holders across the project to these documents. In most cases an Owner can set restrictions to access to these documents appropriate. An Owner has the option to request access into the Contractor web-based software (access could be granted as read only) or to maintain their own database which the Contractor utilizes. For future projects, additional control can be obtained through the use of an Owner established web-based construction contract management database which is maintained by the Contractor or CM in order to effectively manage the project's administration, analysis, and reporting.

Shop Drawing Review

The PB approval stamp on shop drawings, such as in Figure 4 on page 21, were typically only applied to the first (top) drawing of each set/batch of submitted shop drawings. Therefore, shop drawings that were not the first drawing in a set/batch do not specifically bear evidence of PB approval, although the PB stamp on the first page does list the other pages that were reviewed. While the application of the stamp on the first drawing does not contradict Specification requirements, confusion may occur as to which version of the drawing is the final, approved drawing. To avoid possible confusion, the requirement of stamping each drawing could be incorporated into either future project specifications or into DGS Special Inspection program. Stamping every drawing in a set is currently being implemented by many engineers in the industry. Additionally with the advent of full size scanners, the loss of manpower due to the repetition of stamping every sheet can be avoided by scanning and printing the shop drawings.

Additional project control can be obtained through the clear communication amongst all parties during the submittal review process. Figure 5 on page 27 depicts a flow chart generally based on the submittal review process implemented by a government agency to clearly define roles and responsibilities within the submittal review process. Generation of a similar flow chart to identify and foster lines of communication may be beneficial to DGS.

[31] Prolog Manager is a construction project management computer application sold by Meridian Systems, a Trimble Company.

[32] For an example, see PB Construction Progress Meeting #55, February 27, 2011 minutes. (KCE Report, Exhibit P4, pdf pages 10 through 17).

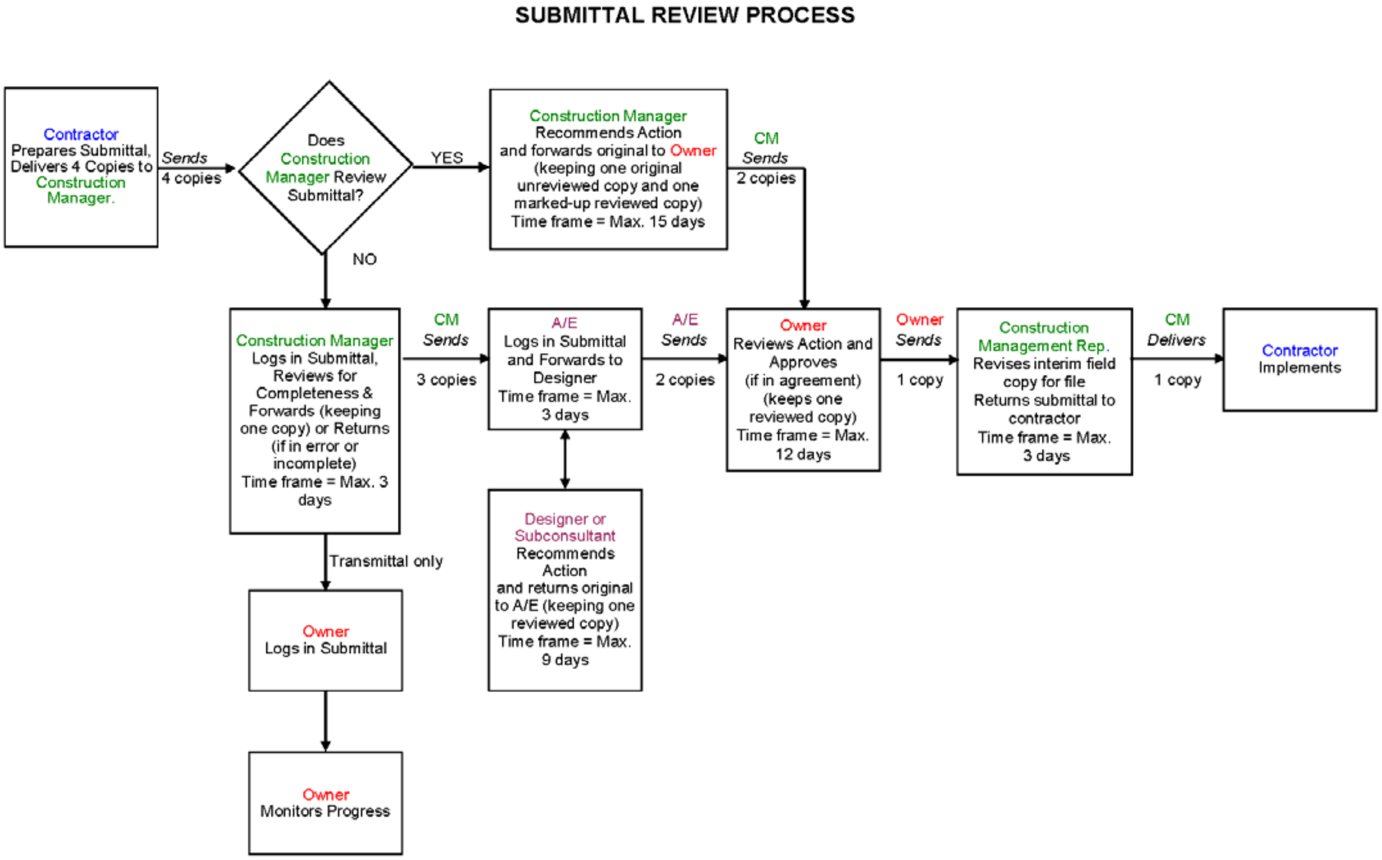


Figure 5 – Representative Federal Agency Submittal Review Process

V. Pour Strips

Deficiency Identified in KCE Report

KCE utilized ground penetrating radar (GPR) to scan the constructed pour strips in order to detect the presence of reinforcing. Two pour strips were required on the 330 level, one at each the east and the west end. One pour strip was required on the shorter 350 level at the east end. The results indicated that neither the east nor the west pour strip on Level 330 was constructed with post-tensioning tendons. Additionally, the west pour strip on Level 330 did not have mild steel reinforcing in the North-South direction.[33] The pour strip constructed on the east end of Level 350 was constructed with both the mild steel reinforcing and post-tensioning tendons.

KCE opined that drawings in the Construction Documents required mild steel and post-tensioning tendons within the pour strips on the 330 level. No explanation has been offered for the missing mild steel, but a response from Facchina to the KCE report stated that VSL disagreed that drawings require

[33] KCE Report, page 46.

post-tensioning tendons in the Level 330 pour strips,[34] and asserts that their shop drawings were intentionally prepared without such tendons. All of the shop drawings submitted by VSL were approved by PB, although no VSL shop drawings were submitted for Level 330 pour strips.[35] A VSL shop drawing, approved by PB, does exist for the pour strip on the 350 level which indicates post-tensioning cables in conformance with Construction Documents.

Shop drawings from VSL were submitted in phases, and each phase had a key plan such as the one in Figure 6, below, to indicate the scope of the shop drawing. It is possible that the shop drawing reviewer expected that shop drawings of the pour strips would be submitted after other shop drawings since these areas would have been poured last; however, none of the key plans in shop drawings submitted by VSL include the pour strip. Facchina asserts that VSL shop drawings identify pour strips containing no post tensioning because of a blank area that is depicted in shop drawing PT-02.[36] The area surrounding the East pour strip is shown in Figure 7 on page 29, which is taken from the same shop drawing page as the sample key plan in Figure 6.

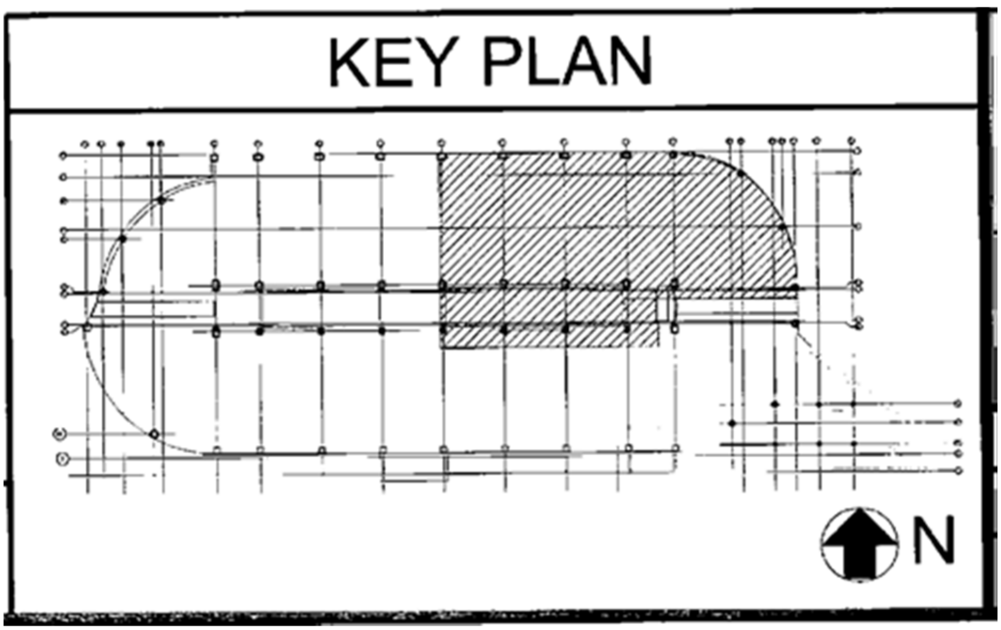


Figure 6 – Representative Key Plan used by VSL on the SSTC project

[34] Facchina letter dated August 30, 2012, item 4, page 2, (KCE Report, Exhibit J3, pdf pages 259).
[35] "Based on a review of our shop drawing files, no post-tensioning shop drawing submittals were provided for the Level 330 delayed pour strip areas." PB letter dated August 24, 2012, page 3 (KCE Report, Exhibit K1, pdf page 70).
[36] Facchina letter dated August 30, 2012, item 6, page 3, (KCE Report, Exhibit J3, pdf pages 260).

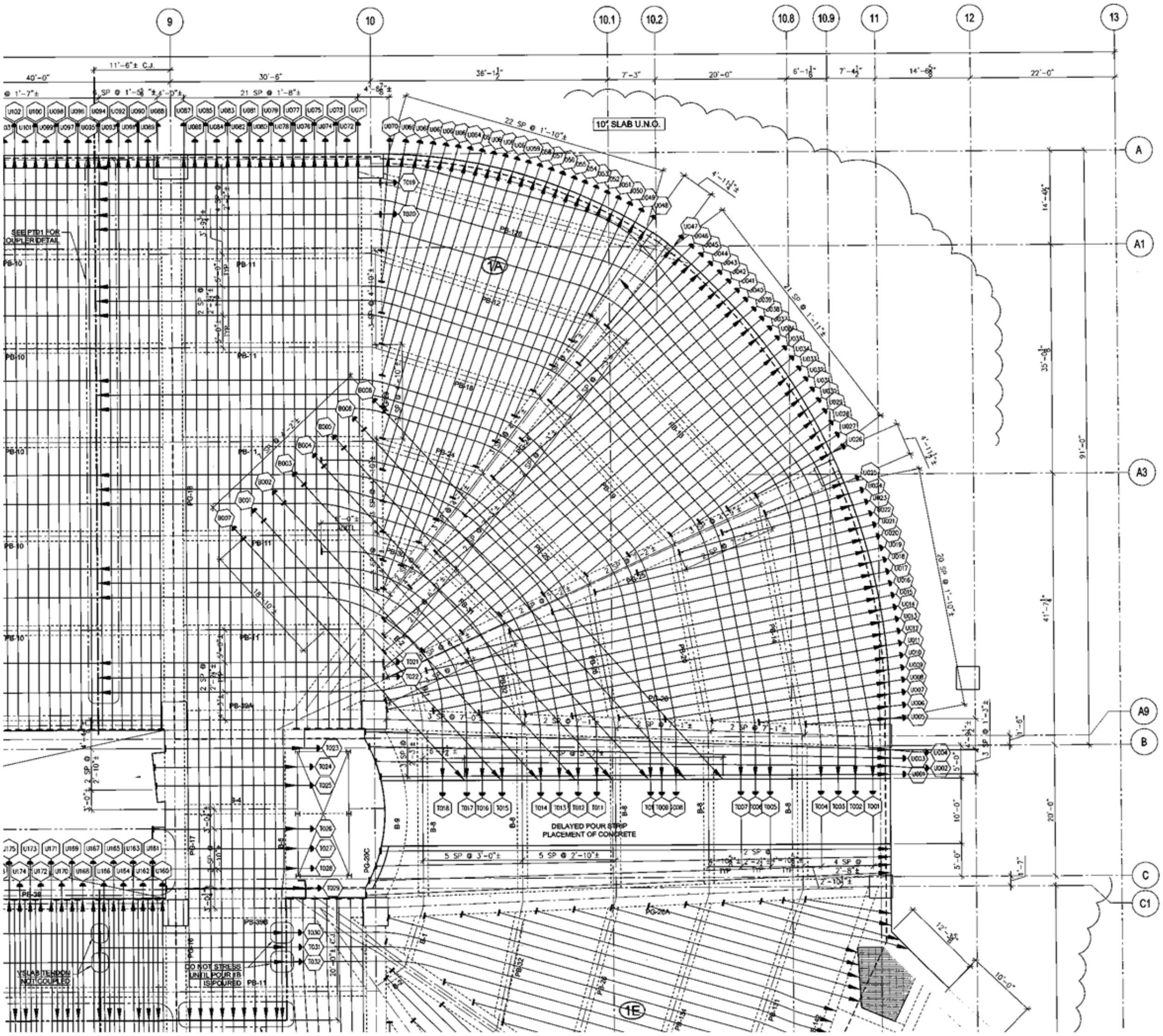


Figure 7 – Portion of VSL shop drawing PT-02

The required extent of post-tensioning is indicated in the Construction Documents using callout notations on drawing S2.01 which reference a schedule. Of the callouts located near pour strips, three are inside the pour strips while nine are located to one side or the other. VSL and FP claimed the variability in callout locations were reasonably interpreted to mean that "drawings did not require the inclusion of PT in the pour strips on level 330."[37] The RFI process, available to address and clarify any interpretation issues, was not utilized.

[37] Letter from Facchina Construction Company to Foulger-Pratt Contracting dated August 30, 2012, Item 4 on pages 2-3 (KCE Report, Exhibit J3, pdf pages 259-260).

Project Control Deficiencies contributing to this defect:

RFIs and Meetings

Questions regarding interpretation of the Construction Documents may be discussed at meetings or answered via the RFI process.[38] If the callout notation for locations of post-tensioning tendons near pour strips was confusing, then FP and their subcontractors had multiple opportunities to ask for clarification. This project utilized regularly scheduled meetings to encourage communication, but the issue of post-tensioning in pour strips at Level 330 was not raised until the KCE Report findings were presented. The methodology surrounding the RFI and meeting process was in conformance with Specification requirements and is typical industry protocol. No deficiencies are noted in design or implementation of project controls for RFIs and meetings. Adequate channels of communication were available to the Contractor, although they were not utilized in regard to pour strip reinforcing.

Submittal Review

The CQC Plan directs that "the QC System Manager will certify contract compliance [of all submittals] or note any variances."[39] The QC System Manager is another name for the CQC Manager that is discussed in Appendix A of this document. In general, submittals are used to coordinate those details of a project that are outside the scope of Construction Documents as well as present the Contractor's understanding of required construction. Design professionals review all submittals in order to check for conformance with the design concept.

In addition to the review by the A/E, this project required FP to "review and approve all submittals for compliance with Construction Documents and field dimensions."[40] The approval stamp from FP states, "This submittal has been reviewed for general compliance with the plans and specifications. This review and the response indicated below do not relieve the subcontractor or supplier of any contract responsibilities including the furnishing of all items required by the documents and the confirmation of all quantities and dimensions." The stamp from Facchina certifies "that the specification requirements have been met and all dimensions, conditions and quantities have been verified as shown and/or as corrected in these drawings."

The PB shop drawing review stamp says, "Review is only for general conformance with the design concept of the project and general compliance with the information given in the construction documents. The Contractor is responsible for conformation with all requirements of the plans and specifications, including, but not limited to, dimensions which shall be confirmed and correlated at the project site, for information that pertains solely to the fabrication process or to the means, methods, techniques, sequences and procedures of construction, and for coordination of the work of all trades." As communicated by these review stamps, shop drawings are considered to integrate all relevant requirements of Construction Documents and are intentionally used to direct construction efforts.

---

[38] Item 1.8.A of Specification 01310 reads, "Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified."
[39] FP Quality Control Plan Revised submitted 4/17/09, item 3.D "Submittal Control," page 11.
[40] Item 1.4.G of Specification 01330

We noted that both mild steel shop drawings and post-tensioning shop drawings were submitted in multiple packages consisting of several drawings each, versus being submitted as one complete package. There is no Construction Contract language or language in the Specifications which prevents FP from submitting the shop drawings for a Definable Feature of Work in multiple submissions. It is possible that phased submission of shop drawings contributed to the reviewers' failure to notice the missing reinforcing and tendons in the pour strips. For future projects, changes to submittal procedures should be implemented to make it less likely that reviewers will fail to notice and correct omissions. For example, requiring a log of anticipated submittals would improve detection of missing items. A requirement that submittals associated with each Definable Feature of Work be delivered in one shipment should also reduce this vulnerability but may not be practical in all cases.

In the case of the pour strips, mild steel reinforcing shop drawings show reinforcing for level 330 in the East/West direction[41] but not in the North/South direction[42] at the west pour strip. At the east pour strip, shop drawings show reinforcing in both the East/West[43] and North/South[44] directions. Mild steel reinforcement in both directions is depicted in pour strip detail 10 of drawing S4.02 in the Construction Documents. All shop drawings by Gerdau Ameristeel bear approval stamps from Facchina and from FP. The shop drawings were approved as noted by PB. Approved shop drawings by Gerdau Ameristeel were used to direct placement of mild steel reinforcing and were also the standard referenced by RBB inspectors.

If the Contractor who prepared the post-tensioning shop drawings believed that post-tensioning should not be included in the pour strips for level 330, the independent review by the QC manager should have highlighted this difference from the Construction Documents and should have flagged it as a variance. Since no variances were noted on the post-tensioning submittal, the CQC manager's initial review was ineffective. The review of post-tensioning shop drawings by PB also failed to detect this difference from the Construction Documents.

The submittal review process was performed in accordance with the Contractor Quality Control Plan, the Specifications and industry practice. Although further control, such as an additional review by another individual, could be implemented to help guard against human error, that is not standard for the industry. Design of the control for submittal review should have been adequate because it required two independent reviews, and both reviews required by the control were implemented, but the control was ineffective in the case of the pour strips because both reviewers failed to notice reinforcing omissions in pour strips and PB failed to request clarification about whether a shop drawing for the pour strips was forthcoming.

It should be noted that one page in the KCE copy of shop drawings still bears the mark "Revise and Resubmit." The page with this notation is Gerdau Ameristeel drawing R30-1A-2,[45] which shows part of

[41] Gerdau Ameristeel drawing R30-1D-1 (KCE Report, Exhibit Y5, pdf page 16).
[42] Gerdau Ameristeel drawing R30-1D-2 (KCE Report, Exhibit Y5, pdf page 17).
[43] Gerdau Ameristeel drawing R30-1E-1 (KCE Report, Exhibit Y5, pdf page 18).
[44] Gerdau Ameristeel drawing R30-1A-2 and R30-1E-2 (KCE Report, Exhibit Y5, pdf pages 13 and 19).
[45] KCE Report, Exhibit Y5, pdf page 13. Revise and Resubmit comment is dated October 7, 2009. A newer version of this drawing with Approved as Noted comment dated March 29, 2010 was provided upon request.

the steel reinforcing in Pour 1A, adjacent to the east pour strip. Normally records should only include approved versions, but this copy was included by KCE because their exhibits were intended to record what was available to inspectors.

Inspections of work in progress based on unapproved drawings can lead to errors in the field. The EOR's comments on this particular drawing did not directly contribute to any of the deficiencies observed by KCE, however an indirect connection could be construed with reinforcing missing from the west pour strip. Only approved drawings should be utilized. FP was responsible for distribution of shop drawings as described in Appendix A. Implementation of document control was deficient in the case of shop drawing R30-1A-2.

Pre-Installation Conference

A pre-installation conference for post-tensioning was held on July 13, 2010 to fulfill the Specification requirements discussed in Section IV of this analysis. The methods and procedures discussed included post-tensioning mobilization (schedule, shop drawings, delivery and storage of materials), placement of reinforcement and tendons in the slab (layout of formwork, rebar sequence, horizontal and vertical tolerances and spacing) , stressing of tendons- inspections and testing (calibration, inspection and installation coordination, stressing sequence and timing, elongation measuring, stressing procedures), grouting of tendon duct (installation methods, testing, grout type), removal of formwork (timing, sequence), and general safety.[46] At the time of the pre-installation meeting, not all shop drawings had been submitted and approved.[47] The shop drawings were submitted prior to each pour rather than submitted as a single package. As a result, the pre-installation conference for the post-tensioning in its entirety was held prior to approval of all shop drawings in their entirety. It is preferable that when practicable, all submittals associated with a Definable Feature of Work be submitted in one shipment prior to pre-installation meetings. If the Definable Feature of Work is extensive, then at a minimum a log of anticipated submittals should be generated and reviewed at the pre-installation conference.

Daily Reports

Daily reports do not mention any anomalies prior to placement of concrete in the pour strips. The Level 330 east pour strip was poured on January 12, 2011. The FP daily report from this date mentions "pour strip between pours 1A & 1E" as work performed by Facchina.[48] In advance of the concrete pour, the FP daily report on January 11 has no mention of any preparatory meetings or discussions between FP and Facchina. The RBB daily report for January 12 noted that "Facchina placed approx. 50 cy of 8000 psi concrete for pour strip between concrete deck pour 1A and 1E."[49]

The Level 330 west pour strip was poured on April 19, 2011, and available evidence makes clear that the Contractor and sub-contractors were not aware of the deficiencies. Neither the FP daily report nor the RBB daily report mention any concerns or deficiencies on the day of this concrete pour, while the April 18 report notes that "Facchina worked on cleaning and finishing up installing reinforcing steel for

46 SSTC Preparatory Meeting and Preinstallation Conference Meeting Minutes, 7/13/10. (KCE Report, Exhibit Q1, pdf page 7)
47 SSTC Preparatory Meeting and Preinstallation Conference Meeting Minutes, 7/13/10, Item 4.2. (KCE Report, Exhibit Q1, page 10.)
48 FP Daily CQC Report dated January 11, 2011 (KCE Report, Exhibit A4, pdf page 231).
49 RBB Daily Report by John Welk, 1/12/11. (KCE Report, Exhibit B5, pdf page 83).

concrete pour strip area 330 between concrete deck pours 1H and 1D. A final inspection was done for the pour strip area and it was approved for concrete placement tomorrow 4-19-11 (Tues)."[50]

The quality control plan for this project includes the following list of instructions for deficiencies:[51]

> Upon determination during any course of the work, or during any part of the three phased CQC Inspection Process of the existence of a deficiency the following procedures will be followed:
>
> - Identification and documentation of the noted deficiency in the Contract Compliance Notice Log.
> - Review of deficiency with Subcontractor or Supplier party to the deficiency.
> - Investigation of the cause of the nonconforming work. Documentation of any significant findings.
> - Determination and documentation of corrective action.
> - Coordination and/or approval of corrective action as needed with Architect, Engineer, and/or Owner.
> - Develop, implement and document procedures and/or controls to prevent recurrence by having a new Initial Phase Inspection, re-inspection to confirm and document adequacy of corrective measures.

The above project control was not activated with regard to the pour strips because available evidence indicates that the team believed that the mild steel layout indicated in the shop drawings was correct. Workers and inspectors also had no reason to believe that there was post-tensioning required to be installed in the pour strip since post tensioning shop drawings did not exist. A comparison might be made with the Level 350 pour strip, for which post tensioning was provided. Although the three pour strips, two on Level 330 and one on Level 350, serve the same function and were built and inspected by some of the same people, the width of the upper pour strip and the configuration of supporting girders are different. SSTC is a complicated and unique project, so workers and inspectors would not have been guided by intuition or experience. VSL, who has experience in similar structures,[52] had to resubmit many of their shop drawings after review by PB due to the complexity of the project. Therefore, no deficiencies are noted in controls on daily reporting with regard to pour strips. However, some issues noted in RBB daily reports are not documented to have received follow up. See the section of this analysis that discusses unhydrated cement for more details.

[balance of page intentionally left blank]

[50] RBB Daily Report by John Welk, 4/18/11. (KCE Report, Exhibit B6, pdf page 66).
[51] FP Quality Control Plan Revised submitted 4/17/09, item 3.F "Phased Inspection and Deficiency Control," pages 14-15.
[52] Facchina letter dated August 30, 2012, item 2, page 2, (KCE Report, Exhibit J3, pdf pages 259).

VI. Concrete Composition

Deficiencies Identified in KCE Report

Based on in-situ sampling and testing performed by KCE, the concrete within the SSTC structure has several deficiencies:

- First, the concrete in some areas of the floors has lower compressive strength than required by Construction Documents. The compressive strength is also lower than that reported by construction period testing and sampling.
- Second, petrographic analysis of coring samples taken by KCE indicates between 5-12% of the Portland cement and 16-18% of the slag was unhydrated.
- Third, petrographic analysis of coring samples taken by KCE indicates the presence of entrapped air.

Lower compressive strength than is required by Construction Documents contributes to an inability of the structure to support the intended loading. The deficiencies noted in the concrete composition also provide evidence of concrete that had not gained sufficient strength at the time stressing of post-tensioning tendons occurred, which contributed to the excessive cracking visible in the slabs, beams and girders.

Compressive Strength

KCE documentation includes results of laboratory testing of concrete sample cylinders obtained by RBB during concrete pouring operations,[53] which show that concrete compressive strength was tested per the Specification requirements during construction. The documents reflecting RBB laboratory test results indicate that the strength of the laboratory specimens exceeds the minimum value required in Construction Documents.

However, results of the tests performed by KCE on the samples taken from the in-situ concrete forming the floors are less than required in the Construction Documents.[54] The concrete compressive strength test results on the samples obtained by KCE also show considerable variance, indicating to KCE that quality control was insufficient.[55] Discussion of the project controls relating to several aspects of concrete quality follows.

Project Control Deficiencies

Pumped Concrete Samples

The purpose of a concrete pump is to move fresh concrete via hose from the truck chute (near the pump hopper, at a fixed location) to the hose end, which may be easily moved as needed and is typically a great distance away from the delivery truck. Through the use of a pump, all delivery trucks can unload at one location and the concrete is efficiently distributed throughout the project. In order for the concrete to

[53] KCE Exhibits R1 through R4.
[54] KCE report, Table 4, page 40.
[55] ibid, page 26.

move easily through the pump, lower viscosity helps as long as the concrete remains cohesive. Therefore, it is not uncommon for workers to add water or chemical admixtures which improve these properties. Excessive water in the mix has performance ramifications and should, therefore, be monitored closely.

Review of project documentation relating to the location where sample cylinders were to be created when concrete is pumped indicated contradiction and ambiguity. The Inspection Contract[56] and the Statement of Special Inspection indicate that the sampling location should be the point of placement, which, during pumping operations, is the discharge end of the hose. This does not agree with industry guidance from ASTM. Specification section 03300.1.5.B references ASTM C 94 and that standard states that slump samples should be taken from the point of delivery, which is the truck chute.

Meeting minutes from July 2010 indicate that the question was discussed during the pre-installation conference[57] and at some point soon after RBB was directed to make a limited number of comparison cylinders at the end of the concrete pump hose while conducting the majority of testing at the truck chute.[58] The minutes do not indicate who directed that course of action or why that direction was given.

Taking most of the samples at the truck chute increased the risk that the concrete samples taken would not be representative of the in-situ concrete. Since the contradiction between standards and Specifications was raised in the appropriate forum, and since RBB documents indicate that testing followed the protocol established therein, the control was implemented as directed. However, the control was weakened and failed to fully achieve its purpose. The design of this control should be clarified so that future projects require testing at the point of placement, because air content and other properties can change during pumping.

Inspection of Batch Plants

RFF provided the concrete for the floors from two of their batch plants.[59] Batch plants are the location where the components of concrete are dispensed into a ready mixed concrete truck. Batch plant inspections are required as indicated in Section IV of this analysis. There are no specifics given as to what items at the batch plant should be inspected. Inspections do not attempt to confirm the accuracy or calibration of measurement devices used at the plant. Rather they are intended to confirm setup and maintenance in accordance with industry standards and project specifications. An industry publication says, "While the professional inspection does add to cost, the continuing education of the suppliers and concrete subcontractors in the areas of quality control should ultimately create better concretes of all strengths and result in better and more economical use of materials."[60]

---

[56] Contract for Inspection and Materials Testing Services between Montgomery County, Maryland and The Robert B. Balter Company, County Contract No. 6504510207-AA, Exhibit D, page 34. (KCE Report, Exhibit M1, pdf page 368).
[57] SSTC Preparatory Meeting and Preinstallation Conference Meeting Minutes, 7/13/10. (KCE Report, Exhibit Q1, pdf page 9).
[58] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 7. "As directed by Montgomery County and as agreed to by WMATA and PB at the pre-pour meeting, [RBB] cast sets of 6 'comparison' cylinders on the deck at the end of the concrete pump hose."
[59] Item 1.8 in FP minutes reads "concrete will be shipped from both Rockville plant and the College Park plant," Preparatory Meeting 8/25/2010 regarding 03300 Concrete Placement Methods, Logistics, and Testing
[60] ACI publication number 363-R92 section 7.6, page 43.

RBB inspected the batch plant at Lafarge concrete in May of 2010,[61] but batch plants belonging to RFF were never inspected.[62] PB meeting minutes from July of 2010 note that "concrete plant inspection can occur anytime, [DGS] and [RBB] to coordinate a time."[63] Based on available documentation, the inspection was not performed. The project control to inspect concrete batch plants was vague and was not consistently implemented.

Batch plants owned by RFF are certified by the National Ready Mix Concrete Association.[64] Certification indicates that the batch plant maintains a documented quality management system and has been audited by a third party independent of the batch plant. Aggregate moisture content is measured at least once per each day of production and water addition to batches is adjusted accordingly. Measuring devices on truck water tanks may be either sight gages accurate to ±1 gallon or water meters accurate to ±2%. Procedures for verifying accuracy of measuring devices are described in the company's quality manual. Certification of RFF batch plants does not replace the inspection required by Specifications, but shows that the concrete producer is in accordance with industry standard quality control measures.

Concrete Mix Design

Concrete is a mixture of Portland cement, water, aggregates, and admixtures. Combining water with cement initiates a chemical reaction called hydration where the cement turns to paste and, in effect, glues the aggregate together. The quantity of each component affects performance, so mixture formulations must be customized to each application. Construction Documents give the required performance and mandate that FP submit proposed mixes for PB review approval. The mix designs for each application were submitted early in the project and discussed often at progress meetings.[65]

The concrete mix design used for the floors was identified on submittals and batch tickets as 8K2DC2NL. The mix submittal was revised to address comments made by both PB and WMATA, after which it was approved by PB. A modification of admixture quantities submitted by FP was approved separately by PB. Since the mix was reviewed and approved by all parties required by Construction Documents and according to industry practice, no deficiency is evident in implementation or design of the control for approval of the concrete mix design.

Water to Cement Ratio

The ratio of water to cement (*w*/*c*) in concrete has a great influences on concrete's behavior. A low water to cement ratio yields a stronger, more durable mixture while a greater value allows for easier flow and placement. KCE tested the *w*/*c* ratio in hardened samples taken from the in-situ concrete and tabulated the results in the KCE Report.[66] Values for *w*/*c* ratio are expressed as a range or with a tolerance because

---

[61] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, pages 168-169.

[62] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 8. "[RBB] requested inspection of Rockville Fuel and Feed's plant several times, but authorization was never granted."

[63] PB Construction Progress Meeting #43, July 15, 2010 minutes. (KCE Report, Exhibit P3, pdf page 196). Item 3.1 of FP Preinstallation Conference minutes dated April 28, 2010 is similar and reads, "Mike Bailey indicated there is a requirement for [RBB] to inspect the concrete plant. John Hershey indicated any of us could call and come by anytime."

[64] Certificates from NRMCA were submitted with Concrete Mix Design Submittal. (KCE Report, Exhibit V1, pdf pages 73-74).

[65] Minutes from various PB Construction Progress Meetings. (KCE Report, Exhibit P2, pdf pages 29, 105, item 18.2 on pdf pages 154, 190 and 234),

[66] KCE Report, Table 3, page 40.

they are estimates which are made based on evaluation of polished samples under microscopes.[67] An article in the ASTM Journal found that petrography estimates are routinely accepted by the concrete industry.[68] That same article gave four different methods upon which such estimates can be based, and said there are few studies that can attest to the accuracy of the *w/c* ratio estimates. In all cases the *w/c* ratio reported by KCE exceeds the value approved in the mix design. The petrographic test results together with compressive strength test results suggest that water was added to the mixture without documentation.

Motives for adding water to the mixture include pump protection and workability during placement. The *w/c* ratio of fresh concrete cannot be directly tested, so the quantity of water added is controlled via records from both the batch plant and the project site. These records are intended to control the three locations where water can typically be added to concrete mixtures: at the batch plant, in the delivery truck, or at the pump hopper.

Batch plants measure how much of each ingredient is used in every load, and a computer records these quantities on the delivery ticket. The amount of water already present in wet sand or gravel is subtracted from the amount of plain water provided. Often, batch plants purposefully provide less than the full amount of water so that this "withheld" or "holdback" water can be added later to fine-tune consistency. The lower right-hand corner of RFF delivery tickets indicates the amount of withheld water, which is the maximum amount that is supposed to be added to the mixture at the project site. An example concrete batch ticket is included in Appendix E – Sample Reports.

Ready mixed concrete trucks have a water reservoir used for cleanup which also provides water for adjusting mixture consistency. The truck driver can dispense water into the mixer drum at the touch of a button, which the driver is only supposed to do when authorized by the appropriate person. Available documents do not clearly identify who was responsible for providing such authorization. KCE says "it is generally the concrete superintendent" who determines if water is to be added (KCE Report, page 20). RBB asserts that "the QC manager from [Facchina] directed the water to be added."[69] We were unable to determine from documents reviewed whether or not all parties at the time of construction were aware who had the authority to direct additive amounts.

Water meters on delivery trucks can range in simplicity from a clear tube mounted beside the water tank to a digital meter mounted on the pipe leading to the mixer drum. This project used the clear tube type of water level indicators. Field reports from RBB indicate how much water they observed being added to the concrete mixture at the project site. A comparison of this number with the amount of withheld water indicates that documented water additions at the project site were not in excess of allowed amounts on

---

[67] "The water/cement ratio of the concrete was estimated by viewing a thin section of the concrete under an Olympus BH-2 polarizing microscope at magnification up to 1000x. Thin section analysis was performed in accordance with APS Standard Operating Procedure 00 LAB 013, 'Determining the Water/Cement of Portland Cement Concrete, APS method.' The samples are first highly polished, then epoxied to a glass slide. The excess sample is cut from the glass and the slide is polished until the concrete reaches 25 microns or less in thickness." American Petrographic Services, Inc. report dated October 29, 2012, page 4 (KCE Report, Attachment 47, pdf page 127).

[68] Erlin, Bernard (2006). "Catching the Elusive Water-Cement Ratio Using Petrographic Methods—and Their Evaluation." *Journal of ASTM International*, Volume 5, Issue 7.

[69] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 7.

loads for which records exist. However records exist for only one in five trucks. It is assumed that batch tickets for other trucks were discarded after review by RBB. It is helpful to retain all batch tickets through completion of the project so that project records are complete. This is not standard practice, but easily implemented for future projects.

RBB asserts that they also monitored "loads which were not sampled, to observe that the amount added did not exceed the holdback amount."[70] The inspector recorded the amount of water he observed to be added, so control of water additions to concrete mixes was implemented according to Specifications. However, water additions by truck drivers can occur unnoticed by the inspector. Therefore, the design of this control could be improved in future projects by specifying the use of meters on the water lines that lead to mixer drums, not just level indicators on the water tank (which can also be used for cleaning purposes). This is practical, and sometimes happens, although it is not yet standard.

Water additions at the pump hopper are not mentioned in the project documents, either to confirm or refute this practice. Any water additions at the pump hopper would likely have been observed by the RBB inspectors stationed nearby. Since these inspectors were confirming that water additions did not exceed holdback amounts (as asserted above), it is expected they would have objected to such a practice. The water additions implied by KCE's petrographic evaluation are approximately 10 gallons per cubic yard of concrete.[71] It is highly unlikely that such a quantity could have been added at the pump hopper without notice, or that such a quantity could be thoroughly mixed into the fresh concrete by the pump.

Water is sometimes added to the concrete surface during finishing. A soft surface layer[72] was noted by KCE petrographers in some cores,[73] so water additions at the concrete surface may be one explanation for the occurrence of a soft surface layer. However, it is possible for water to "bleed" to the surface of fresh concrete, and such bleed water may explain the soft surface layer. Adding water during concrete finishing is never recommended because it decreases the durability of the surface layer. The addition of water at the surface during finishing was discussed and declared unacceptable during the preconstruction meeting.[74] Concrete finishing includes the processes called screeding (which removes concrete from high areas and fills in low areas), floating (which embeds large aggregate and moves a small amount of cement paste upward) and either troweling or brooming (which provide a smooth or textured surface, respectively). Finishing operations do not deeply stir the concrete, so water additions at the surface would not explain the *w/c* ratio found by KCE inside the concrete slabs.

---

[70] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 6.

[71] As shown on the RFF delivery ticket in Appendix D, the design W/(C+P) ratio was 0.26 and the design quantity of water at this ratio was 31.0 gallons per cubic yard. To reach a ratio of 0.35 (the low end of the range reported by KCE), water content would have to be: (31 gallons) x (0.35) / (0.26) = (41 gallons), a 10 gallon per cubic yard increase.

[72] "The immediate top surface of the core samples is soft and easily removed rendering the surface lacking sufficient wear resistant. The inferior paste properties observed surficially can be attributed to an elevated water-cementitious materials ratio, possibly [due to] applied water." Universal Construction Testing, Ltd. report dated February 19, 2013, page 3 of 65 (KCE Report, Attachment 51, pdf page 214).

[73] "The water/binder ratio was approximately 0.35, but the 0.40 to 0.45 near the top surface which indicated more water at the surface which could be a sign of re-tempering." RJ Lee Group report dated December 4, 2012, page 6 of 19 (KCE Report, Attachment 51, pdf page 393).

[74] Item 2.3 in FP minutes reads "No water used to aid in finishing. Eucobar finishing aid is approved," Preparatory Meeting 8/25/2010 regarding 03300 Concrete Placement Methods, Logistics, and Testing.

Water additions without documentation are implied by KCE, who writes:[75]

> We also believe the .24-.26 range [of *w/c* ratio] is not consistent with the slumps as RBB reported, presumably after a high range water reducer was added per the approved mix design. In fact if the water/cement ratio was .24-.26, it is our opinion the concrete would have been very difficult to pump and even harder to finish and would not have permitted complete hydration to occur.

Slump Measurements

The slump test is used on fresh concrete mixtures to measure workability. Slump measurements are influenced by mixture proportions, water content, and admixtures. Water-reducing admixture WRDA 35 and superplasticizer EXP 950 were approved on this job,[76] and the quantity of each admixture added at the batching plant was recorded under rows labeled WRDA and SUPER, respectively, in the RFF delivery tickets (see Appendix E – Sample Reports). A low slump value indicates a stiff mixture while higher values correspond to thinner mixtures. Slump measurement values were recorded by RBB once for every 50 cubic yards, in accordance with Construction Document requirements. The approved submittal limits slump to 8 inches, and slumps were consistently within the range of 7 and 8 inches at slab pours. Since documents indicate that slump limits are in accordance with the approved submittal, no deficiency in control implementation relating to slump is noted. However, WMATA Specifications limit slump to 2 – 4 inches[77] so the design of this control was inconsistent with WMATA requirements.

Unhydrated Cement

If concrete does cure not properly, cement in the mixture can remain unhydrated (uncombined with water). Portland cement must combine with water in order to bind the other components together. Ground blast-furnace slag (an industrial byproduct that improves the strength and quality of concrete) was combined with Portland cement on this job, so the term "cementitious materials" is used to refer to all active ingredients. The presence of unhydrated cementitious material is attributed by KCE to delayed placement and/or early removal of thermal protection during cold weather.[78] The paragraphs that follow discuss these ideas and present another possible source of unhydrated cementitious material.

Ambient temperature affects the chemical reaction between cement and water; therefore newly placed concrete needs protection during cold weather. Cold weather is defined as a period when the average of expected daily high and low temperatures falls below 40°F for three successive days. Specifications provide limits on the temperature of delivered concrete and on surface temperatures for the next several days. Documents indicate that these limits were not clear to project participants[79] since the Specifications reference ACI 306.1 for such limits. Photocopies attached to the cold weather meeting minutes are taken from ACI 306R, the Guide to Cold Weather Concreting rather than the Specification for Cold Weather Concreting. Tables in ACI 306R repeat some of the limits given in ACI 306.1, but other requirements are

---

[75] KCE Report, page 22.
[76] Concrete Mix Design Submittal, (KCE Report, Exhibit V1 pages 25 and 27).
[77] WMATA specification 03300 section 3.02 C.1.c (KCE Report, Exhibit E1, pdf page 1115).
[78] KCE Report, pages 23-25.
[79] Item 4.1 of FP preparatory meeting 03300 Cold Weather Concrete minutes dated 11/4/2010 reads, "Facchina believed the cold weather protection requirement to be 3 days. Subsequent research of ACI leads the group to believe that 3 days cold weather cure time is proper."

not duplicated. Some details of cold weather protection were affected by this confusion in document retrieval, resulting in incorrect implementation of the cold weather project control as discussed below.

Cold weather specification ACI 306.1 sets minimum surface temperature at 55°F while concrete is protected, and also notes that temperature of fresh concrete is not to exceed the minimum by more than 20°F. WMATA Specifications provide for a minimum surface temperature of 55°F, with no upper limit. Cold weather protection measures required by the Specifications were implemented by the Contractor for eight of the floor pours. Plastic sheeting and blankets were placed on top surfaces just after the concrete was poured, and the area below the pour was enclosed and heated. RBB monitored concrete surface high and low temperatures at several locations. Based on RBB temperature readings,[80] lower limits were frequently exceeded in the days following placement of concrete for the floors. It may be that none of the parties who reviewed RBB's daily reports to DGS noticed that temperatures were outside of the range allowed by the referenced standard.

Prevention of sudden temperature changes is also the reason for another limit in both ACI and WMATA Specifications. ACI 306.1 Table 3.2.1 requires a gradual decrease in surface temperature limited to 50 degrees per day, while WMATA Specifications limit temperature drop to 20°F per day. A gradual decrease in surface temperature cannot be confirmed on this project since RBB did not monitor concrete temperatures after area heat was discontinued,[81] which typically occurred after 3 days. Three days is the minimum thermal protection period required by ACI 306.1 Section 3.4.4, while WMATA Specifications require that curing protection should last 7 days.[82]

Controls for cold weather concrete as designed were less restrictive than WMATA Specifications. This project should have clearly conveyed temperature limits during cold weather curing, and the duration of these limits should have been coordinated with those set by WMATA. The Contractor should have procedures for correcting any temperatures that were outside of these limits. The Construction Manager should have taken action when temperatures measured by their Inspector exceeded project limits.

Another potential source of unhydrated cementitious material is drying. To limit water loss during concrete finishing operations, Specification 03300 3.13.B indicates that evaporation retarding chemicals be applied when "hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot per hour." RBB asserts that evaporation retarding chemicals were used as specified,[83] although RBB daily reports do not discuss this topic. Eucobar, an evaporation retardant, was discussed before concrete placement,[84] and a representative from Eucobar visited the project.[85] After concrete finishing, Specification 03300 3.13.E requires one of three methods to prevent moisture loss: wet curing, moisture retaining covers, or curing compounds. The use of moisture retaining covers was observed during cold

---

[80] Various RBB Daily Reports, (KCE Report, Exhibit B4 pdf pages 391, 397, 405, 411 and 415 are related to pour 2B).
[81] RBB Daily Report, 12/14/10. (KCE Report, Exhibit B4, pdf page 415). "Heat turned off under deck, stopped monitoring temps."
[82] WMATA specification 03300 section 3.06 B.1.c (KCE Report, Exhibit E1, pdf page 1123, KCE Report, Exhibit N2, pdf page 80).
[83] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 5.
[84] Item 2.3 in FP minutes reads, "No water used to aid in finishing. Eucobar finishing aid is approved." Preparatory meeting held August 25, 2010 regarding 03300 Concrete Placement Methods, Logistics and Testing.
[85] "EUCOBAR rep onsite," FP Daily CQC Report dated December 10, 2010 (KCE Report, Exhibit A4, pdf page 151).

weather,[86] but RBB reports do not otherwise document the curing method used by Facchina. Implementation of controls to prevent drying is poorly documented based on reviewed information. Design of these controls is less restrictive than WMATA Specifications, which require wet curing except where application of moisture would be impractical.[87]

A third potential source of unhydrated cementitious material is a type of drying called self-desiccation. Self-desiccation can arise with mixtures having *w/c* ratios around 0.40 or less[88] when the water initially incorporated into the concrete is insufficient to completely hydrate all the cementitious materials. Self-desiccation can be prevented by using saturated, porous aggregate to provide internal curing. Since internal curing was not specified on this project, the unhydrated cementitious material found by KCE may be explained by self-desiccation rather than by any construction deficiency. Indeed, low *w/c* ratio is linked to unhydrated particles in one of KCE's petrographic reports.[89] The presence of self-desiccation is not detrimental to concrete as long as performance objectives such as strength, stiffness and durability are met. For future projects, if the A/E believes that self-desiccation will affect the structure's performance, project requirements should be modified to include internal curing.

Entrapped Air

Entrapped air was noted in some of the concrete samples taken from the in-situ concrete by KCE.[90] The only project control on entrapped air given in the Construction Documents is a requirement for the vibration of fresh concrete. One of the four RBB inspectors that were present during concrete pours monitored concrete placement in the slab. In his report regarding pour 1B, an RBB inspector writes, "Concrete was properly vibrated, 2 vibrators were used."[91] Based on this comment made early in the slab pours, inspectors did verify that the vibration control was implemented.

The presence of entrapped air in the core samples is not surprising because an industry guide states, "complete removal of entrapped air is rarely feasible."[92] Lack of additional project controls for entrapped air does not indicate a deficiency in control design because monitoring and testing for entrapped air is not possible. The same industry guide says, "Presently, there is no quick and fully reliable indicator for determining the adequacy of consolidation of the freshly placed concrete. Adequacy of internal vibration is judged mainly by the surface appearance of each layer."[93] Therefore, no deficiencies are noted in controls relating to entrapped air.

---

[86] "Slab was covered with poly sheets followed by insulated blankets." RBB Daily Report by Tony Lord, 12/7/10, (KCE Report, Exhibit B4, pdf page 384).
[87] Item 3.05 of section 03300 (KCE Report, Exhibit E1, pdf page 1121).
[88] American Concrete Institute, ACI 308R-01, Section 1.3.2 (KCE Report, Exhibit Z1, pdf page 12).
[89] "[Samples] show a superabundance of residual portland cement and slag particles evidencing restricted hydration as would be anticipated due to the low *w/cms*." Figure 13 in Petrographic Examinations of Cores from the SSTC dated February 14, 2013 by The Erlin Company (KCE Report, Attachment 50, pdf page 204).
[90] KCE Report, Table 16, page 70.
[91] RBB Daily Report by Tony Lord, 10/02/10, (KCE Report, Exhibit B3, pdf page 847).
[92] American Concrete Institute, ACI 309R-96, Section 7.2.
[93] American Concrete Institute, ACI 309R-96, Section 7.6.2.

Entrained Air

Entrained air refers to microscopic cells of air distributed throughout the concrete paste. Entrained air voids are much smaller than entrapped air, and are beneficial because they improve concrete's resistance to damage caused by freezing. The approved mix design required between 4 and 7 percent of entrained air. The entrained air content in hardened cores taken from the in-situ concrete on this project was identified by KCE[94] and in some cases was outside the approved range. Differences may be due to the presence of a concrete pump, which can alter the air-void system. However, apparent differences may not be statistically significant due to the limited number of hardened samples which were evaluated and the variability inherent in test methods. Also, the comparison of the post-hardened values directly to Construction Document requirements is disputed by another engineer.[95]

The entrained air content of fresh concrete was sampled by RBB once for every 50 cubic yards, in accordance with Construction Documents. Batches with low air content were treated with Fritz-Pak (an approved[96] admixture), and RBB asserts that the subsequent load or two were also tested.[97] Pour 1Ea "showed a pattern of low entrained air content spanning the majority of concrete sampled. For the concrete trucks sampled this condition was rectified by the addition of air packs."[98] The pattern of low entrained air content was not recorded as an issue in the FP quality control log.[99] The inspector implemented testing for entrained air at the frequency given in Specifications, but the pattern of low values thus detected was not dealt with as a deficiency according to the CQC plan. Design of controls on entrained air is in accordance with industry standards, but implementation was deficient because it lacked quality control.

The amount of entrained air at the point of concrete placement was only measured three times per floor slab pour. Entrained air can be lost as concrete is conveyed through a pump,[100] an effect that was not quantified on this project. Air entrainment solutions used on future projects should take into account the presence of a concrete pump.

VII. Concrete Placement

Deficiency Identified in KCE Report

The two deficiencies relating to concrete placement are concrete cover and thickness of the structural floors. Based on GPR testing and coring samples by KCE, the required amount of concrete over reinforcing (concrete cover) is not provided in some areas. In these areas, placement of reinforcing is not

[94] KCE Report, Table 15, page 69.

[95] "Technical specifications did not include performance requirements for air-void characteristics of the hardened concrete, and the technical specifications permitted concrete finishing techniques attributed by CTL [Group, Inc.] for the reduction of air in the near surface." by Simpson Gumpertz & Heger dated June 21, 2012, page 3, (KCE Report, Exhibit L1, pdf page 50).

[96] Concrete Mix Design Submittal, (KCE Report, Exhibit V1 page 23).

[97] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 10.

[98] RBB Daily Report by Brian Flickinger, 11/12/10, (KCE Report, Exhibit B4, pdf page 264).

[99] PB Construction Progress Meeting #52, December 9, 2010 minutes (KCE Report, Exhibit P3, pdf page 342).

[100] "It is normal to find a loss of about 0.5 to 1.0 percent air as concrete is conveyed through a pump. … Certainly, air loss through a pump doesn't occur every time. However, it does occur often enough to be considered seriously until better solutions are developed." Publication CIP 21, 2005, by the National Ready Mixed Concrete Association.

in accordance with Construction Documents or industry standards. The significance of this defect is explained by KCE, who states, "The durability of a concrete structure is reduced as the depth of concrete cover over reinforcement is decreased. This relationship is a result of the fact that there is a smaller distance through which chlorides must penetrate to reach the depth of the reinforcing steel to initiate corrosion."[101]

Further, there are many locations where the thickness of the concrete floors does not meet the minimum requirements as indicated in the Construction Document. The significance of this defect is explained by KCE, who states, "Our analysis of the as-built post-tensioned slabs indicates slab areas with thicknesses below approximately 9 inches and with compressive strengths at or below 6,970 psi do not have adequate shear capacity in certain locations to support the design loads (the areas less than 9 inches thickness are limited in extent and therefore do not limit overall load-carrying capacity). In addition, the as-designed analysis indicates the initial and service level stresses were exceeded."[102]

The insufficiency of concrete cover on tendons was identified as an issue on October 28, 2010 when three ducts became exposed to view through the surface of Pour 1A shortly after being grouted.[103] The Design Team was immediately notified, and "new procedures for tendon placement have been installed to prevent them from surfacing after grouting/stressing."[104] The new procedure[105] helped, but not all tendon cover values measured by KCE in slabs cast after this date met Construction Document provisions.[106]

Project Control Deficiencies

Post-Tensioned Tendon Placement

Discussions during the post-tensioned pre-installation conference included vertical tolerance on tendon placement.[107] Checklists used by RBB before each pour included an item for "duct high and low points (profiles) at the correct elevation with sufficient cover."[108] The engineer of record observed general alignment of tendons a few days before at least nine of the pours.[109] The efforts by various parties to control tendon alignment did not prevent some cover deficiencies, but it is quite possible that insufficient cover at tendons was caused by insufficient concrete thickness rather than by incorrect tendon placement. Controls on location of post-tension tendons, including pre-installation meetings and pre-pour checklists, were implemented correctly, but did not prevent some popped tendons. No deficiency is noted in the design of these controls since solutions were quickly created when problems arose.

---

[101] KCE Report, page 97.

[102] KCE Report, page 6.

[103] RBB Daily Report by Tony Lord, 10/28/10. (KCE Report, Exhibit B4, pdf page 151).

[104] PB Construction Progress Meeting #51, November 16, 2010, minutes (KCE Report, Exhibit P3, pdf page 317).

[105] PB Field Observation Comments, 10/30/10. (KCE Report, Exhibit C1, pdf page 10). "the top of the duct should not be closer than 1 3/8 inch below the top of the slab. FP has made a template to check that this dimension is held."

[106] KCE Report, Attachment 33.

[107] FP Preinstallation Conference Minutes, 7/13/2010. (KCE Report, Exhibit Q1, pdf page 8).

[108] RBB Daily Report by Tony Lord, 12/3/10. (KCE Report, Exhibit B4, pdf page 369).

[109] PB Field Observation Comments, various dates. (KCE Report, Exhibit C1).

Mild Steel Reinforcing Placement

RBB asserts that concrete clear cover was verified on mild steel reinforcing bars,[110] although results of such measurements were not documented in their reports. The concrete cover found by KCE at slab bottom bars and at beams and girders meets requirements for fire ratings.[111] (Wide variations found in the cover of mild steel reinforcing at columns[112] was not reviewed as part of this analysis.) Per Specification 03381.3.6D, reinforcing was to be secured against displacement, and an inspector verified that it was not disturbed during concrete placement.[113] Inspection of reinforcement placement which is required by Specification 03300 3.17.B.1 was provided,[114] although some inspections were possibly hurried based on statements made in RBB daily reports.[115] No deficiencies are noted in either implementation or design of project controls on mild steel reinforcing bar locations.

Thickness of Concrete Floors

Thickness of concrete floors was not directly measured during concrete pours. The method selected by the Contractor to establish floor thickness was to give the top surface the desired shape based on measurements taken by survey equipment operated while concrete was being placed.[116] The bottom surface was established by formwork positions. Thickness was realized as the difference between formwork and top surface, with no redundant system to prevent floor thickness problems.

Slab thickness deficiencies were identified in portions of the incomplete project as early as November 2010,[117] when less than half of the slab concrete had been placed. Thickness deficiencies were discovered during the investigation into popped tendons, and WMATA immediately requested a survey to identify other thin areas. WMATA's survey was followed by other surveys,[118] which show that thin areas also

---

[110] RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 5.

[111] KCE Report, page 89.

[112] KCE Report, page 48.

[113] RBB Daily Report by Tony Lord, 10/18/10. (KCE Report, Exhibit B4, pdf page 7). "I monitored concrete placement on deck. Tendons and reinforcing steel were maintained in their proper positions."

[114] Inspector Tony Lord (typical of multiple inspectors and occasions) writes, "I continued to inspect the placement w/ VSL and structural drawings. I logged all items requiring correction that were found in my inspections. Placement is ongoing and will continue tomorrow." RBB Daily Report, 12/2/10. (KCE Report, Exhibit B4, pdf page 361).

[115] RBB Daily Report by John Welk, 10/16/10. (KCE Report, Exhibit B3, pdf page 2). "Work & corrections were still not completed today. Therefore sign-off for concrete pour [1C] card was not done today. I will arrive @ 2:00 AM Monday morning 10-18-10 to do final inspection of completed work, at which time, if all work is completed as per specifications, I will sign-off on completed work (concrete pour card)." Records for pour 2A are missing after KCE Report, Exhibit B4, pdf page 201. RBB Daily Report by Tony Lord, 11/11/10. (KCE Report, Exhibit B4, pdf page 256). "At day's end, placement was approx 90% complete. Placement [for pour 1Ea] is scheduled for tomorrow at 4 am. Concrete placement will begin in the areas where reinforcement has been approved. Incomplete areas will be done ahead of concrete placement." RBB Daily Report by John Welk, 12/6/10. (KCE Report, Exhibit B4, pdf page 376). "Work is still not completed. I will come in tonight @ 11:00 [PM] and do a final walk through inspection. When work is completed I will sign-off on pour card." Pour 2B was begun at 1:00 AM on 12/7/10. RBB Daily Report by John Welk, 12/9/10. (KCE Report, Exhibit B4, pdf page 393). "Work is still not completed. I will come in tomorrow morning @ 5:00 AM & do a final walk through inspection. When work is completed I will sign-off on pour card."

[116] Entry 1.13 of FP minutes from meeting held 8/25/2010 regarding 03300 Concrete Placement Methods, Logistics and Testing: "How will grades and elevations be established on finished concrete surface? Facchina's surveyor/ layout man will shoot all elevations of top of concrete as placed during the pour for use by W concrete to rake out and screed to established top of concrete elevations."

[117] PB Construction Progress Meeting #51, November 16, 2010, minutes. (KCE Report, Exhibit P3, pdf page 317-318.) "Area around popped tendons was surveyed for slab thickness. Slab came in thin in some areas."

[118] Project Management Team Meeting #13, September 15, 2011 minutes item 6.1. "Slab Thickness Survey. WMATA's survey was confirmed by both MC's surveyor and Faccina's surveyor."

exist in concrete placed following this discovery. The results of the Greenhorne thickness survey are reproduced in Appendix C, which shows measured thickness by color code. The method selected by the Contractor to establish thickness depended upon his own correct implementation. The inspector did not (according to the response from RBB to the KCE report, the inspector could not) independently check thickness except at the perimeter.[119] However, wet depth checks using a simple rod inserted vertically into the fresh concrete would have been practical. The engineer of record repeatedly included reminders to "all parties" in comments noted in October and November 2010 field reports[120] to maintain thickness, but no independent method to check thickness was developed.

Construction Documents indicate several controls related to floor thickness:

- Tolerance on finished floor elevation was required to be discussed in the concrete pre-installation conference as indicated in Specification section 03300.1.5J, but the topic is not found in this meeting's minutes.[121]
- Specification section 03300.3.1B references ACI 117 for formwork tolerances, which sets a limit of ¾ inch on form surface elevations. The RBB checklist includes formwork shape, location, and dimensions and RBB is listed among those testing correct installation of formwork in the FP Test/ Inspection Matrix[122] (included as Appendix A of this analysis). However, the Inspection Contract specifically excludes inspection of formwork,[123] so it is unclear whether this tolerance was actually verified.

Thus two project controls related to concrete thickness were not implemented, and concrete thickness was not directly measured due to the construction method utilized. Future projects would benefit from selecting a construction method that allows direct measurement of floor thickness, or at least from having redundant verification of formwork and surface elevations.

VIII. Post Tensioning

Concrete is very strong in compression but easily cracks when loaded in tension, so reinforcing is typically cast into it. Steel, which is strong in tension, is positioned where tensile forces are expected to occur. The reinforcing can be conventional or an alternative is to reinforce concrete with high strength steel strand, to which tension has been externally applied. When this tension is applied after the surrounding concrete has hardened, the system is known as post-tensioned concrete.

---

[119] "Thickness of the slab at points away from the perimeter could not be measured without survey equipment." RBB Letter regarding Response to KCE Report Dated March 15, 2013, April 22, 2013, page 5.

[120] PB Field Observation Comments, 10/15/10, 10/30/10, 11/11/10. (KCE Report, Exhibit C1, pdf pages 5, 8, 22) "Elevations of formwork, system for maintaining required design elevations at the top of the concrete, and system for maintaining typical concrete thickness at 10 inches should be verified by all parties."

[121] Item 6.1 in FP Preinstallation Conference minutes dated 4/28/2010 reads, "How will top of slab / thickness be determined? This will be discussed at a future meeting." The meeting held 8/25/2010 regarding 03300 Concrete Placement Methods, Logistics and Testing did not discuss tolerances or thickness; surface profile in item 1.13 is the most similar item of discussion.

[122] Foulger-Pratt QC Plan-Appendix E.

[123] Contract for Inspection and Materials Testing Services between Montgomery County, Maryland and The Robert B. Balter Company, County Contract No. 6504510207-AA, Exhibit D, page 32. (KCE Report, Exhibit M1, pdf page 366).

Steel used for post-tensioning commonly takes the form of high strength wires braided into a flexible strand. This strand goes inside corrugated plastic tubes called ducts, as shown in Figure 8, below. Ducts are held in place above formwork on rows of disposable supports called chairs. Chair sizes are selected so that the center of gravity of steel ("CGS" in the figure) matches the height specified by the engineer. Components called anchors are located at each end of the duct to transfer forces from the strand into the concrete. The assembly of strand, anchors and duct is referred to as a tendon.

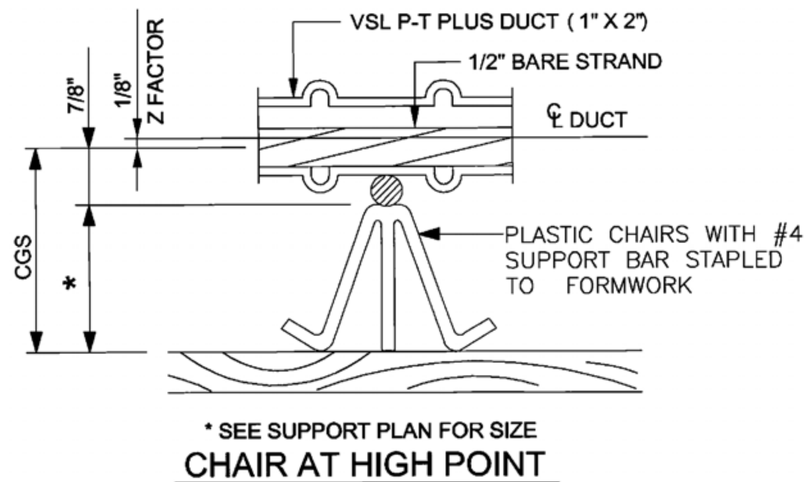


Figure 8 – Post-Tensioning Elements[124]

A hydraulic machine called a jack is used to apply tension to one or both ends of each strand. The action of applying tension using a jack is called stressing. Stressing cannot commence until the concrete is strong enough to support the jacking forces. Jacking forces are measured with calibrated gauges, and the actual force is compared to the required force as given in the approved shop drawings. Strand elongations are also measured and are compared to predicted elongations as a method of quality control. Once everything checks out, then strands are permanently fixed in place by pumping a liquid into the void surrounding them. This liquid is called grout, and it later becomes a solid by the chemical reaction of the water and cement from which it was made.

Controls in Construction Documents

The SSTC was designed utilizing post-tensioning tendons, and several controls on this activity were established in the Specifications. Structural drawings give the required forces and profiles of post-tensioning tendons, but do not identify controls specific to post-tensioning. The CQC plan also does not include controls specific to post-tensioning. The primary applicable Specification Section is 03381, Bonded Post-Tensioned Concrete, which includes requirements for the design, supply, and construction of post-tensioning tendons and all associated items. The design, implementation and effectiveness of some of these controls are analyzed below.

Specification 03381.3.3.B gives requirements for support of post-tensioning ducts. VSL submitted shop drawings and detailed supports for tendons that were selected to achieve these profiles. Actual tendon profiles were verified by RBB, and any tendons that did not meet construction criteria were added to a

[124] Typical tendon support detail, VSL shop drawing number PT03.

pre-pour checklist. Each item on the checklist was initialed after being corrected, prior to placement of concrete. In spite of these efforts, a few popped tendons did occur (that is, the post-tensioning ducts became visible when the concrete cover cracked off and fell away). Popped tendons and controls on post-tensioned tendon placement are discussed in the Concrete Placement section of this analysis. Please see that section for an evaluation of the control's effectiveness.

Stressing Records

Specification 03381.1.4.A indicates that the Contractor is to "provide effective forces and profiles shown on the drawings." VSL submitted shop drawings that detailed tendons selected to achieve the required effective forces. The effective force is distinct from the force applied by the stressing ram to the tendon because some of the applied force dissipates. Loss of stressing force occurs both immediately (due to elastic shortening, friction, and anchorage slip) and over the life of the structure (due to creep, shrinkage, and relaxation). Effective forces were calculated by VSL engineers taking into account the expected sum of all these losses. The results of these calculations were provided to field crews before post-tensioning operations in the form of expected elongations for each tendon.

Specification 03381.1.5.J indicates the elements to be included in stressing records. Stressing records having the requested elements are included in KCE Exhibits C, D and H. Specification 03381.3.7.H indicates that the stressing records are to be submitted and that elongations that deviate from the expected value by more than 5 percent should be resolved to satisfaction of the EOR. This tolerance was modified by PB during construction to plus or minus 7 percent,[125] which is the tolerance given for post-tensioned construction in section 18.20.1 of the ACI 318 concrete building code.

Sometimes the actual elongations were outside allowable tolerances.[126] Each such instance was evaluated by the responsible engineer at VSL, and associated calculations were submitted to PB and are included in Exhibit H of the KCE report. Out-of-tolerance elongations were reviewed by PB, and records of approval are also included in Exhibit H. For example, one such evaluation is found in Exhibit H4 page 100, where regarding pour 1A girders PG-26 and PB-39A, PB writes, "Final effective post-tensioning force of 1363 kips has been calculated by VSL. This effective force is lower than the 1450 kip effective force identified for these members in the Construction Documents (ASI #11), however, the members noted will still have a capacity that is more than adequate for the design loading. Based on the final effective forces determined by VSL, and PB's review of the design, I recommend that the post-tensioning of these members be accepted." No deficiency is noted in the design, implementation, or effectiveness of the control on stressing records.

Concrete Stresses

Stress in concrete is typically calculated rather than measured. The calculation starts with the forces acting on a structural element, and then divides by the area of that element. A large force on a large element may thus cause the same stress as a small force on a small element. The greatest stress is caused by large forces acting on small elements.

---

[125] RFI number 657 dated November 10, 2010 (KCE Report, Exhibit U3, pdf page 699).

[126] KCE summarized elongation results in attachment 55 to the KCE Report, beginning in Volume 3 on pdf page 473.

Structural elements can experience different forces on opposite sides, for example compression on the top and tension on the bottom. In these cases, somewhere between the two sides there is always a dividing line at which there is neither compression nor tension. This line is called the neutral axis. The part of the element that is farthest away from the neutral axis is called the extreme fiber. Building codes limit the stress at the extreme fiber because that is the place on the element where cracks begin to form, thus decreasing the strength and durability of the element.

Specification 03381.1.4.C indicates, "Comply with ACI 318 limits on stresses at transfer of prestress and under service load." Stress limits at the time of post-tensioning are found in section 18.4.1 of ACI 318, which says that the extreme fiber stress is not to exceed $0.60f_{ci}'$ in compression or $3\sqrt{f_{ci}'}$ in tension. Under service loads, ACI 318 section 18.4.2 limits compression stress to $0.45f_c'$ while section 18.3.3 creates a serviceability group for concrete with tensile stress of less than $7.5\sqrt{f_c'}$. WMATA is more restrictive than ACI at service loads, limiting tension stress to $6\sqrt{f_c'}$.[127]

To check whether these limits are met, one must calculate the concrete extreme fiber stress. This calculation is complex in post-tensioned members and is usually done only by the engineer who designs the post-tensioned building elements. For the SSTC, PB provided the member sized and specified reinforcing geometry. Engineers from VSL selected the tendons needed to achieve the effective forces specified by PB and evaluated stressing operations.

Since decisions by PB controlled the extreme fiber stress, it seems misplaced for them to place a control on concrete stress in the SSTC Specification. Sample specifications for post-tensioned concrete structures as produced by MasterSpec® contain a provision worded very similar to Specification 03381.1.4.C, but the context of these sample specifications is for buildings in which the design services have been delegated to a specialty engineer. Since design services were not delegated to the Contractor, inclusion of a Specification provision providing limits on concrete stresses may have been inadvertent. The design of this control is questionable because it delegates a check that PB should have performed.

KCE observes that, "Review of the Contract Documents and the PB calculations presented show that PB attempted to comply with WMATA's 6√f'c extreme fiber tension stress limit for service loads. However, no initial stress review appears to have been performed."[128] The success of these attempts was challenged in the structural investigation by outside engineer Simpson Gumpertz & Heger.[129] No documentation is found that any member of the Construction Team performed the calculations necessary to implement the control on concrete stresses given in Specification 03381.1.4.C. The ineffectiveness of this control may be responsible for some of the cracking observed in the SSTC. KCE notes that exceeding the initial extreme fiber stress limit "could lead to concrete cracking during initial stressing. The initial cracking would affect the distribution of service level stresses, but does not impact the ultimate strength of the structure."[130]

---

[127] Section 5.09.C.3.a.3 of the WMATA Manual of Design Criteria. (KCE Report, Exhibit E1, pdf page 331).
[128] KCE Report, page 33.
[129] "We analyzed PB's original structural design using ADAPT-PT 2010 (Build 2010.2) with PB's input load files. We found service level stresses exceeded PB's stated 6√f'c criteria with the specified compressive strength of 8,000 psi." by Simpson Gumpertz & Heger dated March 14, 2012, page 6, (KCE Report, Exhibit L1, pdf page 14).
[130] Ibid.

Grout Strength

Specification 03381 sections 2.5 and 2.10 give requirements for the grout inside of ducts, and provide restrictions in addition to those in ACI 318 section 18.18. Strength is supposed to be 8,000 psi at 7 days, which apparently was not always obtained based on meeting minutes from the post tensioning summit held in November 2010.[131] KCE Exhibits do not include sufficient documentation of grout strength break results to evaluate the control's effectiveness. Specification 03381 Sections 3.9 and 3.10 give grouting requirements, with the frequency of sampling modified by RFI 624.[132] Records indicating that grout strength specimens were created are included in the KCE Exhibits, and it is apparent that PB reviewed results of these tests because they authored a letter recommending acceptance of grout strengths.[133] Independent evaluation of control effectiveness is limited by access to records.

Time to Grouting

During the post-tensioning preparatory meeting, "it was discussed that the expected maximum time limit to grout tendons after placement is 30 days. If tendons are left ungrouted after 60 days VSL can apply a corrosion inhibitor product into the duct."[134] The Specifications do not provide any limit on time before grouting. An industry guide suggests 20 days as the permissible interval between tendon installation and grouting unless corrosion protection is used.[135] Grouting operations were initiated 39 days after the first pour, and grouting equipment broke immediately[136] and repeatedly.[137] By 46 days after the first pour, all but a "small section of pour 1A not under pour 2A"[138] had been grouted, with six blocked tendons grouted after 88 days.[139] Both the grout and the slab required external heat sources for pours 1C and 1D.[140] No explanation was noted for the delay of grouting tendons at other pours, which have elapsed times as shown in Table 2, below. No records were found documenting the use by VSL of the corrosion

---

[131] Item 1.13 in PB minutes reads, "Monitor closely next grouting operation to ensure proper mixing and sampling is taking place – concern about low 28-day breaks,"and item 1.16 reads, "Facchina to evaluate why grout numbers are coming in low," post tensioning summit held November 30, 2010 (KCE Report, Exhibit C1 page 29).

[132] RFI number 624 dated October 18, 2010 (KCE Report, Exhibit U3, pdf page 538). "One test is to be taken at the beginning of the mixing of grout each day, every 2 hours during the operation, and at the conclusion of grouting each day."

[133] "The purpose of this letter is to confirm that Parsons Brinkerhoff has reviewed the grout strength comparison test results performed on three batches of post-tensioning duct grout." Letter dated February 4, 2011 from Douglas A. Lang to Timothy O'Gwin. (KCE Report, Exhibit B5, pdf page 289).

[134] Item 4.2 in FP minutes, Preparatory Meeting 7/13/2010 regarding 03381 Bonded Post Tensioned Concrete (KCE Report, Exhibit Q page 10).

[135] Post-Tensioning Manual, sixth edition by the Post-Tensioning Institute (2006), Table 4.7 (page 86).

[136] RBB Daily Report by Brian Flickinger, 10/22/10. (KCE Report, Exhibit B4, pdf page 93). "The 1st mixer/pump used ceased to operate after 1 hour. Inspector informed of a clog in mixer at pump inlet. 2nd mixer attempted to be placed in service and inspector informed that this mixer is in a non-functional state."

[137] RBB Daily Report by Brian Flickinger, 10/26/10. (KCE Report, Exhibit B4, pdf page 112). "Grout placement for post tensioned elements of concrete pour 1A resumes today… mixing equipment again clogged then broken in afternoon about 4pm." RBB Daily Report by Brian Flickinger, 10/29/10. (KCE Report, Exhibit B4, pdf page 186). "Grout operations started early in the afternoon, the delay caused by the contractors primary grout mixer/pump having ceased functionality, and the contractors back up mixer/pump being long term inoperative."

[138] RBB Daily Report by Brian Flickinger, 10/29/10. (KCE Report, Exhibit B4, pdf page 186).

[139] RBB Daily Report by John Welk, 12/10/10. (KCE Report, Exhibit B4, pdf page 399). "Contractor also resumes grouting operation for (6) blocked PT tendons for pour 1A, level 330'."

[140] RBB Daily Report by Brian Flickinger, 1/11/11. (KCE Report, Exhibit B5, pdf page 75). "Today's grouting is started in morning due to overnight heating of deck sections 1C and 1D, and the heating of materials to bring temperature of liquid grout and surrounding concrete up to spec's required for job. Without these heating efforts grout placement could not have been able to be accomplished within job specs today."

inhibitors mentioned above. KCE exposed a limited number of tendons during their destructive testing program,[141] and did not remark about their condition.

Table 2 – Time Elapsed to Grouting of Post Tensioning Ducts

		Grouting Date		Days Elapsed	
Pour Name	Pour Date	Begin	End	Begin	End
1A	9/13/2010	10/22/2010	12/10/2010	39	88
1B	10/2/2010	11/3/2010	12/3/2010	32	62
1C	10/18/2010	1/5/2011	1/11/2011	79	85
2A	11/2/2010	1/20/2011	2/4/2011	79	94
1Ea	11/12/2010	2/14/2011	3/7/2011	94	115
2B	12/7/2010	2/2/2011	2/4/2011	57	59
1D	12/20/2010	1/11/2011	1/28/2011	22	39
1F	12/30/2010	2/17/2011	3/4/2011	49	64
2C	1/14/2011	3/7/2011	3/15/2011	52	60
2D	1/31/2011	3/9/2011	3/15/2011	37	43
1G	2/8/2011	3/16/2011	3/22/2011	36	42
1H	2/18/2011	3/16/2011	3/23/2011	26	33
2Ia	3/29/2011	4/20/2011	4/20/2011	22	22
350' Pour Strip	6/1/2011	7/28/2011	7/28/2011	57	57

Strength and Age of Concrete at Time of Stressing

Specification 03381.3.7.C indicates that concrete strength at time of stressing was supposed to exceed 4000 psi or 6000 psi, depending on specifics given in that section. KCE notes a discrepancy[142] between this provision and drawing S1.00, which has a single value for minimum concrete strength at time of stressing corresponding to 6000 psi. As discussed in the section of this analysis related to Pour Strips, discrepancies in Construction Documents are to be discussed at meetings or answered via the RFI process. The Specification requirements were repeated during the post-tensioning pre-installation conference,[143] but minutes have no mention of the requirement from the drawing. An RFI was issued regarding PT stressing order,[144] but no clarification of concrete strength at time of stressing was requested or given through the RFI process. The design of the control on concrete strength at time of stressing exhibits inconsistency between drawings and specifications which was not explicitly clarified during construction; therefore, the control is found to be deficient in design.

When a discrepancy is noted between drawings and specifications, the more stringent requirement was to have been followed.[145] Based on comments in RBB daily records,[146] the Construction Team followed

[141] "We exposed post-tensioning tendons in 36 of the 49 inspection openings. … After we collected grout samples from inside the duct and documented general conditions (including concrete cover dimension and grout and strand condition), we replaced the grout and repaired both the duct and opening." KCE Report, page 51. Results of inspection openings are included as attachment 42 to the KCE Report, beginning in Volume 3 on pdf page 103.
[142] KCE Report, page 16.
[143] Items 3.7 and 3.8 in FP minutes, Preparatory Meeting 7/13/2010 regarding 03381 Bonded Post Tensioned Concrete (KCE Report, Exhibit Q page 9).
[144] RFI number 594 dated September 24, 2010 (KCE Report, Exhibit U3, pdf page 394).
[145] Item H.3 in the Construction Contract between Montgomery County and Foulger-Pratt. (KCE Report, Exhibit M1 pdf page 5).

the Specification, which is less restrictive. Actual strength at time of stressing is shown in Table 3, below. In 9 of 14 pours, the strength at time of stressing would not have met the more restrictive requirements given in the drawings, but the strength did meet the Specification requirements. An example specification from the Post Tensioning Institute requires 3000 psi concrete strength at time of stressing.[147] Since the Specification and the drawings were more restrictive than industry recommendations, implementation of the Specification instead of the drawing requirements had no noticeable impact on the control's effectiveness.

Table 3 – Strength and Age of Concrete at Time of Stressing

		Initial Stressing			Days Elapsed	
Pour Name	Pour Date	4000 psi Concrete	6000 psi Concrete	Date	Begin	End
1A	9/13/2010	RBB, KCE		10/22/2010	3	18
1B	10/2/2010	RBB		11/3/2010	4	11
1C	10/18/2010	RBB		1/5/2011	3	9
2A	11/2/2010	RBB, KCE		1/20/2011	3	13
1Ea	11/12/2010	RBB, KCE		2/14/2011	4	11
2B	12/7/2010	RBB, KCE		2/2/2011	3	9
1D	12/20/2010	RBB, KCE	KCE	1/11/2011	3	8
1F	12/30/2010	RBB, KCE	KCE	2/17/2011	4	11
2C	1/14/2011	KCE		3/7/2011	4	10
2D	1/31/2011	KCE		3/9/2011	4	8
1G	2/8/2011	RBB, KCE	RBB, KCE	3/16/2011	3	8
1H	2/18/2011	RBB, KCE	RBB, KCE	3/16/2011	4	8
2Ia	3/29/2011	RBB, KCE		4/20/2011	3	8
350' Pour Strip	6/1/2011	KCE	KCE	7/28/2011	3	5

"RBB" in this table indicates that an RBB inspector made a comment confirming concrete strength in the corresponding daily report. "KCE" in this table indicates that strength was verified based on data from the KCE exhibits. KCE exhibits do not include data necessary for verification of pours 1B and 1C.

Specification 03381.3.7.D indicates that concrete age at time of initial stressing was supposed to be less than 96 hours. An example specification from the Post Tensioning Institute says stressing should be completed "within 72 hours after the concrete is placed to minimize early age concrete shrinkage cracking."[148] Considering the high concrete strength specified at time of stressing as discussed above, a slightly longer period of time is reasonable in order to allow the material to gain strength. Some increase in shrinkage cracking can be expected in association with this longer delay in applying initial post-tensioning stress. Early age shrinkage cracking did in fact occur, although project participants attributed it to other causes.[149] Therefore, no deficiency is noted in the control's design.

[146] See for example RBB Daily Report by Tony Lord, 4/1/11. (KCE Report, Exhibit B6, pdf page 3). "Concrete test cylinder results representing pour 2I-A exceeded 4000 psi, stressing of U-slab tendons is permitted."
[147] Post-Tensioning Manual, sixth edition by the Post-Tensioning Institute (2006), section 6.4.1 (page 120).
[148] ibid
[149] Follow up Meeting for Concrete Finishing Pour 2B, 12/16/10, minutes item 2.2. "The group agrees the windy conditions contribute to shrinkage cracking and Facchina indicated it is suspected that the minimal use of Eucobar may contribute to shrinkage cracking."

Concrete age at the time of initial stressing is discussed in the KCE Report on page 16. A review of Table 3 for the elapsed time in days to the beginning of initial stressing confirms that all pours received initial stressing at either three or four days after the pour. In one instance, RBB commented that more than 96 hours had passed,[150] apparently because the pour was cast early in the morning and stressing was implemented on the fourth day, but not as early in the morning. Such an occurrence is considered to have no significant influence on the performance of a post-tensioning system, so the effectiveness of the control is not impacted.

IX. Conclusions

Project control deficiencies identified in this analysis stem from either evidence that project controls for the SSTC were not implemented properly or evidence that additional controls were required, as discussed in the four preceding sections. The intent is, in part, to consider the "lessons learned" from evaluating controls related to the deficiencies identified by KCE in the SSTC structure.

East and West Pour Strips on Level 330

As required in the CQC Plan for the SSTC, the CQC Manager is required to highlight any proposed variances from the Construction Documents in the submitted shop drawings. The variances should be noted on the shop drawings and discussed in the progress meetings. A log maintained by FP of requested variances is also recommended. The log should include a description of the variance, the submittal number which demonstrates the proposed variance, the date requested by FP, the date of PB approval, and the date of DGS approval.

Due to phased shop drawing submittal process used, the pre-installation conference occurred before all shop drawings were reviewed. While this process was not prohibited in the Specifications, it allowed for ambiguity regarding outstanding submittals. Several changes to this procedure could occur. First, if possible and practical, all shop drawings could be required to be submitted before the pre-installation conference occurs. Second, a pre-installation conference could occur with each new area covered by a recently approved shop drawing. At a minimum the Submittal Registry should include the number of proposed shop drawings anticipated for the phases. For example, if only one pre-installation conference occurs at the beginning of the Definable Feature of Work, part of the conference should cover how many submittals will be generated for DOR review for the phased construction. Then as construction proceeds discussion should occur whether each of those proposed submittals have been approved during the progress meetings.

In the case of the mild reinforcement steel, PB approved shop drawings which omitted some of the reinforcing shown in Construction Documents. Since the A/E is responsible that shop drawings correctly convey the design intent, PB should carefully consider Contractor interpretations. FP should also be

---

[150] RBB Daily Report by Tony Lord, 2/22/11. (KCE Report, Exhibit B5, pdf page 379). "NON-COMPLIANT ISSUES: Pour 1H: 96 hours elapsed after concrete placement before tendons were stressed."

diligent in the future when reviewing submittals from its subcontractors. Pre-installation meetings should confirm that all construction personnel are using approved versions of shop drawings.

Concrete Composition

Specifications should be reworded to require that testing of concrete occur at the point of placement. Where referenced standards require testing at the point of delivery, clarify in the specification that such testing is in addition to typical testing. Concrete batch plants are required to be inspected by the Specifications, and the Construction Manager should verify that this has occurred. Results of the in-situ concrete testing indicate water may have been added to the fresh concrete mixture without documentation, so additive water requires close monitoring in the future. One possibility is to require meters on water lines leading to mixer drums, in order to better monitor and document the amount of water added to concrete by the delivery truck driver.

Agreements with WMATA required the SSTC project to meet WMATA design requirements. All WMATA Specification requirements should have been reviewed and implemented unless a variance was mutually discussed and agreed upon. The specific items where differences were noted from WMATA standards (and their suggested resolution) are: slump limits during concrete pouring operations (a variance should be requested for use with pumped concrete), temperature limits during curing (should be coordinated and clearly conveyed rather than included by reference), and wet curing (Specifications for moisture retaining covers should be revised). Specifications should require the Contractor to develop procedures for active monitoring and correction of temperatures during cold weather. The Construction Manager should be notified when independent temperature measurements made by the inspector are outside of project limits for corrective action.

As Designer of Record, PB should review performance of the concrete mixture and specify internal curing if self-desiccation is found to be the reason that in-situ compression strength is less than that of laboratory cured cylinders. Due to the presence of entrapped air found by KCE in the completed structure, a review of vibration and finishing methodologies is also needed. The DOR should also consider if any changes are required in Construction Documents to improve air-void performance when concrete is pumped.

Construction documentation such as daily logs indicates the addition of entrained air to the concrete mixture was not administered consistently. It is recommended, therefore, that monitoring and documenting the quantity of entrained air be implemented. The effect of pumping operations on entrained air content should be taken into account.

Concrete Placement

Placement of reinforcement and tendons were addressed during the pre-installation conference, and were discussed again when it was discovered that adequate cover was not being maintained, but the issue of insufficient top cover continued to occur and corrective action by FP was not effective. Reinforcing and tendon locations were established relative to the bottom, formed surface because the concrete top surface did not yet exist while reinforcing was being placed. Inspectors also measured reinforcing and tendon locations relative to the bottom of slab, calculating top cover by assuming that the minimum slab thickness would be provided. It is assumed that concrete cover issues would be resolved when adequate slab thickness is obtained as discussed below.

Construction Documents and approved shop drawings require a minimum concrete thickness for the floors was not achieved in all installed locations. RBB asserts that concrete thickness could not be checked without survey equipment. Direct measurement was not possible except at the perimeter due to FP's use of survey equipment for establishing the slab's top surface. It is recommended that construction methods should be any of several methods that are available which allow direct measurement of floor thickness, or alternatively, that redundant survey equipment should be utilized to monitor concrete thickness, with a report of survey results submitted for Owner and PB approval.

X. Qualifications

Alpha Corporation

Alpha Corporation (Alpha) is a full-service consulting firm offering a wide array of engineering and program/construction management and construction consulting services. Since 1979, we have provided these services to a broad spectrum of clients, including government agencies, municipalities, institutions, private enterprises, developers and contractors.

Alpha Corporation's diverse staff of more than 182 includes professional engineers, project and construction managers, inspectors, cost estimators, schedulers, and risk managers. Each brings a solid background of technical knowledge and experience to every project, earning Alpha Corporation an outstanding reputation in a very competitive industry. Alpha's personnel are registered as Professional Engineers (P.E.); LEED Specialists through U.S. Green Building Council; Certified Construction Managers (CCM) through CMAA; Certified Professional Estimators (CPE); Planning and Scheduling Professionals (PSP) through the Association for the Advancement of Cost Engineers; and Project Management Professionals (PMP) through PMI.

J. Michael Damron, P.E., LEED AP

Mr. Damron is an experienced professional engineer and manager with more than 20 years of experience in the building construction industry. He has performed audits, evaluations, and analysis for various building systems and clients. He has expertise in review of procedures and processes, building evaluations and load analysis, structural design and analysis, team coordination, construction and contract documentation, and construction administration for government, educational, institutional, office, medical and residential buildings. Mr. Damron has provided services for government, institutional, and commercial clients. Mr. Damron is also a LEED accredited professional.

State Registrations:	MD, VA, PA, NY, ME, NJ
Education:	Bachelor of Science in Building Construction Virginia Polytechnic Institute and State University
Professional Affiliations:	ACI, SAME, ACEC

Mary Billings, P.E., LEED AP BD+C

Ms. Billings is an experienced senior engineer with more than 13 years of experience in the performance of peer and constructability reviews of construction documents as well as preparation of construction documents for new or repair construction projects. She has expertise in building evaluations and load analysis, design construction and construction documents for government, industrial, and heavy infrastructure projects. Ms. Billings is a LEED accredited professional.

State Registrations:	MD, VA, WV, DC
Education:	Master of Science, Civil Engineering
	Virginia Polytechnic Institute and State University
	Bachelor of Civil Engineering
	Georgia Institute of Technology
Professional Affiliations:	SAME

XI. Appendices

Appendix A – Contractor Quality Control Plan

Appendix B – Duties and Functions of DGS Project Management Team

Appendix C – Plans of SSTC Floors

Appendix D – Cited Standards

Appendix E – Sample Reports

[balance of page intentionally left blank]

Appendix A – Contractor Quality Control Plan

Note: All the information in this appendix is paraphrased from the CQC plan submitted by FP. Descriptions represent what was supposed to happen according to that plan and have not been confirmed unless specifically noted. This summary was produced as part of the analysis to show the type and extent of controls that were utilized on the SSTC project.

This appendix describes the document control, submittal control, and quality control aspects that are implemented by the SSTC project CQC Plan. Doug Goetz is responsible as CQC Manager for overall implementation of the CQC Plan in conjunction with trade focused QC Project Engineers. The Manager is also responsible for monitoring of off-site QC activities to the extent necessary to meet the specific Construction Contract requirements and those of the CQC Plan. The Manager is an onsite, fulltime employee who has day-to-day responsibility for onsite administration of the Plan including submittal review, phased inspections, and overall CQC coordination. The CQC Manager also has authority over Construction Contract compliance, stop/reject work, order correction of defective work, and direct and coordinate activities of all QC personnel.

Document Control

The CQC Plan addresses document control as a critical function of the Contractor and indicates use of proprietary software, Prolog Manager, as the primary means of document control. The types of documents included within the Document Control Plan are Construction Documents and constructability review, Request for Information (RFI) generation and tracking, Construction Drawings revision logs, and Construction Drawings distribution logs. As questions arise on a project or if the Contractor would like to construct something differently than as shown in Construction Documents, contractors generate RFIs in order to ask the DOR the question. Response to questions or clarifications may alter the Construction Documents. Also, if the DOR would like to modify the Construction Documents, they may issue an Architect's Supplemental Instruction (ASI) in the form of a supplemental drawing. As a result, the Construction Document revision log is maintained to reflect the current revision level of each drawing and the current set of Construction Documents with all changes initiated by RFIs or ASIs are called "field set of Construction Documents." Detailed changes for Drawing and Specification are tracked in Microsoft Excel and are accessible to the project team at all times.

All Construction Documents distributed to subcontractors and vendors are sent with a transmittal showing the drawing numbers and current revision dates. Upon receipt, the CQC System Manager, posts all revisions on the field set of Construction Documents to allow dissemination of the most current information. The CQC System Manager conducts periodic inspections of the field set of Construction Documents to verify they are being kept up to date by all trades. The field set of Construction Documents are maintained throughout the duration of the project and are the basis for the Record Set of documents provided at project completion. A Plan Distribution Log is maintained in the project database management system, Prolog, to enable subcontractors and vendors to verify they have received current Construction Documents. Subcontractors Field Drawings are inspected by the CQC Manager on a weekly basis and verified against the Plan Revision Log.[151]

Upon discovery or notification by Subcontractor/Supplier of a question or conflict in the Construction Documents, existing conditions, and/or conflicts with the work to be installed; FP is required to generate an RFI using the Request for Information form. The CQC Manager reviews all RFI's to confirm accuracy of the clarification being requested, that an appropriate plan or other reference data is included, and in

---

[151] Foulger-Pratt Quality Control Plan Revised 4/17/09 section B.4 page 5

order to coordinate with Project Staff to determine a possible solution if necessary. After review, the RFI is distributed to the A/E and DGS. Upon receipt of an RFI response, the CQC Manager and the Superintendent along with subcontractor field staff reviews the response to check for completeness and accuracy. If the response is complete and accurate, the CQC Manager posts the RFI to the Record Documents, logged into the tracking system, and distributed to the affected trades. If the RFI response does not completely or accurately answer the question, a subsequent RFI numbered with the Original RFI number supplemented by a Revision number is issued and the RFI tracking process begins again. The CQC Manager assures that the Subcontractors work with the current set of RFI responses.

Submittal Control

The CQC System Manager is responsible for managing and controlling the submittal review process.[152] Submittals are required to be reviewed in a sequence that does not cause delay in the work, the work of the Owner, or third-party contractors. In addition to compliance with Construction Contract requirements, all submittals are required to be checked for accurate dimensions and coordination with other trades prior to submission for review. Any variations from the Construction Documents are clearly indicated in the submittal. The processing of submittals is initiated and controlled by FP, in coordination with the QC System Manager. All submittals are numbered by FP upon receipt. Submittals are forwarded by FP's Project Manager, Brett Harton, to the QC System Manager. Foulger-Pratt's Project Manager certifies to the QC System Manager that the submittal has been reviewed by the Foulger-Pratt project staff with respect to drawing and trade coordination, that it can be constructed or installed in the space allocated, and that it meets the technical requirements of the Construction Contract. Upon completion of QC review, the QC System Manager certifies Construction Contract compliance or notes any variances, and the submittal is returned to FP's Project Manager who forwards it to the A/E and others per the agreed upon distribution.[153]

Upon receipt of the returned submittal, it is reviewed by the QC Manager and Foulger Pratt Project Manager for action noted by reviewer and any comments made on the submittal. The submittal is forwarded to the appropriate Subcontractor and/or Supplier and is also forwarded to appropriate trades whose work must be coordinated with the work indicated in the submittal. All original and reviewed/returned submittals are kept on file with Foulger Pratt for future reference by the QC Manager and Foulger Pratt project staff. In the event that the action by the reviewer results in a rejection or requirement to revise and resubmit, the appropriate logs are updated, the submittal returned to the Subcontractor, and resubmission is tracked. The Submittal Register is the primary tool used in managing the submittal control process. The register lists the submittals as identified in the Specifications by section and type (shop drawing, product data, certificates, test data, close out requirements, warranties, instructions, O&M data, and spare parts).

---

[152] Foulger-Pratt Quality Control Submittal Section 3.D page 11

[153] Per direction from PB in Progress Meeting dated Oct 29, 2008 "FPC will distribute submittals to each party, (1 to MC, 3 to WMATA, and 6 to PB. PB will distribute as required for internal review. PB will return submittals to each party (1 to MC, 1 to WMATA, 1 to ZGF, 1 to FPC). Exhibit P1 pages 39/59 section 1.1 Submittal Schedule and Logs

Ongoing periodic review of the register occurs in conjunction with the schedule to maintain timely submissions. As subcontracts and purchase contracts are awarded, the individual subcontractor/supplier sends a letter outlining specific submittal requirements including a list of items to be submitted, number of copies, any other administrative requirements set forth in the Specifications, and a timetable for submission. Submittal dates are scheduled in accordance with Foulger-Pratt's project schedule. The CQC System Manager and Project Manager monitor the status of submittals to confirm satisfactory progress. If a submittal becomes delinquent, it is to be addressed by verbal contact with the responsible party followed by written correspondence and other actions necessary to avoid impact to the project.[154]

The Submittal Log is a continuous and ongoing update of the submittal packages that have been submitted. The submittal packages are comprised of submittals as listed in the Submittal Register. The Submittal Log is maintained in Prolog which allows the CQC System Manager to effectively manage the process by using the various reporting functions of the database management system. The status of submittals is updated in the database as they are received and processed and presented in the regularly scheduled progress meetings with the Project Team or at other intervals as may be required by the Project Owner. The Submittal Log is kept current throughout the project and a final record copy is provided to the Owner at project completion.

Quality Control

The CQC Plan requires all testing and inspection during construction to be conducted in accordance with the Specifications and in compliance with the Construction Contract. As part of the Plan, a Test Matrix was created and is reproduced at the end of this appendix. The Test Matrix identifies each test and inspection required by type and the Specification paragraph as related to each Definable Feature of Work. The matrix also indicates the frequency of each test/inspection and the person or the certified independent testing agency responsible for performing each test/inspection. The Test Matrix is reviewed by the CQC Manager and coordinated with the Construction Schedule and planned work in the field. Additionally, the Test Matrix is coordinated with the Owner's Independent Testing Agent, RBB, as well as with the testing requirements of the Special Inspections Program.

The Test Matrix is maintained by the QC System Manager. Upon receipt of the written certified test report from the testing agency, the QC System Manager records the results in the Test Matrix. DGS is notified of any non-conforming test results within 24 hours of receipt of the information. Any non-conforming results are addressed prior to further work progressing relative to the non-conformance. After corrective actions are taken, re-testing is performed to confirm satisfactory results/acceptance have been achieved. The Quality Control Manager verifies that testing procedures comply with the requirements of the Construction Documents, verifies that facilities and testing equipment are available when needed and comply with applicable testing standards, checks test instrument calibration against certified standards, and verifies that recording forms and test identification control number system have been prepared. Results of all tests taken are recorded on the Quality Control Daily Report. The QC Manager's implementation of the Contractor's required Testing and Inspection process is integrated with

[154] Foulger Pratt Quality Control Plan Submittal Revised 4/17/09

the Independent Testing & Inspection provided by the Owner and as required by the Special Inspections Program. Daily communication, both written and verbal, with the Owner's Independent Testing agent(s) occurs so that the Independent Testing results are tracked, monitored, and have satisfactory results. In the event a test does not produce satisfactory results, the QC Manager verifies the re-inspection and/or re-test has been performed and satisfactory results have been achieved.

The CQC Plan utilizes a three-phased QC inspection process, incorporating Preparatory, Initial and Follow-Up control phases. These three phases are required to be scheduled, conducted, and documented by the QC System Manager in conjunction with the assigned QC Project Engineer and Trade Foreman. Each distinct trade activity/task that requires separate control procedures is assigned as a Definable Feature of Work.

The preparatory phase is to be performed prior to beginning work on each Definable Feature of Work and includes a check that the portion of the CQC System for the work to be performed has been accepted by the Owner, a review of the Construction Documents by the CQC System Manager with the construction personnel responsible for carrying out the construction, a check to assure that all materials and/or equipment have been tested, submitted, and approved, a check to assure that provisions have been made to provide required control inspection and testing, an examination of the work area, and a physical examination of required materials, equipment, and sample work to assure that they conform to approved shop drawings or submitted data and are properly stored. For each Definable Feature of Work, the QC System Manager is required to conduct a Preparatory Phase Meeting and Inspection at least 24 hours prior to the start of work. Where multiple Definable Features of Work are provided by the same subcontractor and are commencing at the same time, a preparatory meeting is required to be held with the Subcontractor to cover the multiple definable features. A minimum of 72-hour notice is required to allow attendance by all appropriate parties including respective trade supervisory personnel.

The CQC Plan requires the QC System Manager to conduct an Initial Phase Inspection with the respective trade crew and foremen as a specific Feature of Work starts for the first time. The purpose of this inspection is to confirm that the initial segment of work complies with all Construction Contract requirements. The QC System Manager documents the results of this inspection in the daily QC Report. Any issues encountered are documented and tracked. Included in the Initial Inspection Phase is a check of preliminary work for compliance with Construction Documents, a review of the minutes of the preparatory meeting, verification of full Construction Contract compliance, verification of required control inspection and testing, establishment of a level of workmanship and verification that it meets minimum acceptable workmanship standards, comparison with sample panels or mock-ups as appropriate, a check of conditions to include compliance with applicable safety regulations, and a review of safety issues with each construction personnel.

Minutes of the Initial Phase Inspection are prepared by the CQC System Manager and attached to the daily CQC report submitted to the Owner's Construction Representative. Exact location of the Initial Phase must be indicated for future reference and comparison with follow-up phases. The Initial Phase is required to be repeated for each new crew to work on-site, or whenever quality standards are not being met. The Follow-up Phase Inspection is performed by the QC System Manager on a periodic basis to verify continued Construction Contract compliance for a specific Feature of Work until the work is complete. The quality of the workmanship is compared to that which was established in the Preparatory and Initial Inspections. Testing is monitored and reviewed for proper performance and satisfactory results. Any re-work items are verified as being corrected. As with the previous inspections, the QC System Manager documents the results in the QC Daily Report. Any issues encountered are documented and tracked for timely resolution. Follow-up Inspections are documented in the Quality Control Managers Daily Report.

Test Matrix

The test matrix that follows is copied from the CQC plan submitted by FP.

FOULGER-PRATT

#10
#11

QC PLAN-APPENDIX E

SILVER SPRING
TRANSIT CENTER

51-0037

TEST/INSPECTION MATRIX

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
		Division 2				
02205	Planting Soil	1.3	ASTM - USDA AASHTO	Soil Tests	Once for each three types	Balter / QC Manager
02270	Tieback Anchors	1.2, D	ASTM C 109	Standard test method for compressive strength of hydraulic cement mortars	As required	Sub / QC Manager
02270	Tieback Anchors	1.5		Alignment Tolerances. 1.5 degrees of required inclination. Within 2" of required loc	Each anchor	Berkel / ECS / QC Manager
02270	Tieback Anchors	3.5, A, K,L,M	PTI	Anchor Testing	Each Anchor	Berkel / ECS / QC Manager
02271	Tie-Down Anchors	1.4,	ASTM C 109	Standard test method for compressive strength of hydraulic cement mortars	As required	Sub / QC Manager
02271	Tie-Down Anchors	1.7	ASTM D 1586	Standard penetration testing for borings	As required	Sub / QC Manager
02271	Tie-Down Anchors	3.5	PTI	Anchor Testing	Each anchor	Sub / QC Manager
02271	Tie-Down Anchors	3.5, K	PTI	Performance Testing	10 % of anchors for foundation tie-down	Sub / QC Manager
02300	Earthwork	3.19	ASTM D - 1556	Subgrades, fills, backfills - compactions	Per 3.19, D -1, 2, 3	Balter / QC Manager
02300	Earthwork	3.8		Proof - roll	As required	Balter / QC Manager
02310	Controlled Blasting	1.9, D	BATF - COMAR - CFR - WMATA	Pre-Blast Inspection Survey	Prior to blasting	Balter / QC Manager
02310	Controlled Blasting	1.9, A, 4	BATF - COMAR - CFR - WMATA	Test Blasts / Production Blasts	Daily	Balter / QC Manager
02310	Controlled Blasting	1.9, E	BATF - COMAR - CFR - WMATA	Vibration Overpressure Monitoring	During blasting	Balter / QC Manager
02466	Drilled Piers	3.2	ACI-336.1	Test Borings	Prior to pier excavation	Balter / QC Manager
02466	Drilled Piers	3.9, A	ACI-336.1	Inspection of Excavations	Each Excavation	Balter / QC Manager
02466	Drilled Piers	3.9, C	ACI-336.1	Pier Inspection	Each Pier	Balter / QC Manager
02466	Drilled Piers	3.15, A	ACI-336.1	Crosshole Sonic Logging	All piers	Balter / QC Manager
02466	Drilled Piers	3.05, B	ACI-336.1	O-Cell Load Test	Demonstration Piers	LOADTEST
02466	Drilled Piers	3.16	ACI-336.1	Pier report, soil/rock testing, concrete testing	As required	Balter / QC Manager

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
02510	Water Distribution System	3.15, C		Hydrostatic Test - pressure - leak test for water pipes	After backfill	WSSC / Ross / QC Manager
02510	Water Distribution System	3.15, D		Hydrostatic test of thrust restraint system	After valve installation and testing of water main	WSSC / Ross / QC Manager
02510	Water Distribution System	3.15.F		PVC Pipe Continuity Test	Once after installation of pipe	WSSC / Ross / QC Manager
02510	Water Distribution System	3.7		Chlorination	Per WSSC 02511	WSSC / Ross / QC Manager
02530	Sanitary Sewer	3.8, B		Gravity Sewer - except for 42" and larger RCP	After completion of backfill	WSSC / Ross / QC Manager
02530	Sanitary Sewer	3.8, C		Gravity Sewer - 42" and larger diameter RCP	Once after installation of pipe	WSSC / Ross / QC Manager
02530	Sanitary Sewer	3.8, C, 2		Final Sewer Testing	Once	WSSC / Ross / QC Manager
02530	Sanitary Sewer	3.8, D		Mandrel Test	Once after installation of pipe	WSSC / Ross / QC Manager
02530	Sanitary Sewer	3.8, E		Force Mains - pressure / leak test	Once after installation of pipe	WSSC / Ross / QC Manager
02530	Sanitary Sewer	3.8, F		CCTV Sewer House Connection	Once after installation of pipe	WSSC / Ross / QC Manager
02530	Sanitary Sewer	3.8, G		Manholes	As required	WSSC / Ross / QC Manager
02630	Storm Drainage	3.18, B		Pressure Test Piping	Once after installation of pipe	WSSC / Ross / QC Manager
02630	Storm Drainage	3.11	ASTM C 172	Concrete Testing	One sample of each mixture exceeding 5 cu. Yd.	Balter / QC Manager
02741	Hot-Mix Asphalt	3.11	SHA	Asphalt Testing / Thickness, Smoothness, Density	After placement	Balter / QC Manager
02742	Stamped Asphalt	1.9, C	SHA	Asphalt Testing / Thickness, Smoothness, Density - Stamping Depth	After placement	Balter / QC Manager
02780	Unit Pavers	3.2, C		Proof Roll	As required	Balter / QC Manager
02780	Unit Pavers	3.3, F		Tolerances: lippage - 1.6-mm unit to unit nor 3mm in 3m from level	As required	Balter / QC Manager
02812	Irrigation	2.2		Coverage Test	After installation	Engineer / QC Manager
02920	Lawns & Grasses	2.3	ASTM D 5268	Topsoil Soil Testing	Each 50 cubic yards	Sub / QC Manager
02920	Lawns & Grasses	1.02, E		Inspect Plant Material	Prior to digging and at arrival on site	Engineer / QC M

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 39 C - 39 M	Compressive Strength Test: One set of two field cured specimens at 2 days for evaluation of the concrete for acceptability to begin post-tensioning, test one set of field specimens to confirm concrete in post-tensioned members has reached required strength	For each pour	Balter
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 231	Air Content: One test for each sample	At Placement	Balter / QC Manager
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 1064 C 1064 M	One test hourly when air temp. is 40 deg.F or lower and when 80 deg. and higher. One test for each composite sample	At Placement	Balter / QC Manager
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 31 C / 31M	Compression Test Specimens: Five sets of two standard cylinders for each composite sample. Laboratory cure two sets of cylinders and field cure three sets of cylinders	For each pour	Balter
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 39 C - 39 M	Compressive Strength Tests: One set of two laboratory cured specimens at 7 days and one set of two specimens at 28 days	For each pour	Balter
03381	Bonded Post-Tensioned Concrete	2.9	ACI 304 R	Testing for Concrete and Grout Mixes: Comply with requirements of Division 03300	As required	Balter / QC Manager
03381	Bonded Post-Tensioned Concrete	3.10, A, 1		Inspection of Duct after installation	After installation	Sub / Balter / QC Manager
03381	Bonded Post-Tensioned Concrete	3.6	ACI 5.3.2	Inspection of Concrete Placement	During placement	Sub / Balter / QC Manager
03381	Bonded Post-Tensioned Concrete	3.7		Tendon Stressing	After concrete strength reaches 4000 psi	Sub / Balter / QC Manager
03381	Bonded Post-Tensioned Concrete	3.10, A		Field Quality Control: Refer to Specification Requirements	As required	Sub / Balter / QC Manager
03381	Bonded Post-Tensioned Concrete	3.4		Inspect duct for damage, ensure ducts are watertight with no voids	After installation	Sub / Balter / QC Manager
03381	Bonded Post-Tensioned Concrete	3.10, A, 2		Contractor Inspections and Records: See Field Quality Control Test Reports	As required	Sub / Balter / QC Manager
03408	Segmented Retaining Wall	2.7	ASTM D 422 - 4318-698	Reinforced Soil Inspection	After Backfill	Balter / QC Manager
03408	Segmented Retaining Wall	3.3	Per 3.8	Compaction Testing: Infill soils	After wall installation	Balter / QC Manager
03408	Segmented Retaining Wall	3.4		[illegible]		

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
02930	Trees & Shrubs	3.08		Acceptance Inspection	Once	Engineer / QC Manager
		Division 3				
03300	Cast -In-Place Concrete	3.9	ACI 301-10	Verify correct installation of formwork, reinforcement, embeds	Each Pour	Sub / Balter / QC Manager
03300	Cast -In-Place Concrete	3.9	ACI 5.3.2	Inspection of Concrete Placement	As required	Sub / Balter / QC Manager
03300	Cast -In-Place Concrete	3.17	ACI 304 R	Concrete Tests and Inspections	As required	Sub / Balter / QC Manager
03300	Cast -In-Place Concrete	3.17, C, 1	ASTM C 172	Concrete Samples: one composite sample for each days pour of each mixture exceeding 5 cu. Yd. plus one set for each additional 50 cu. Yd	At Placement	Balter / QC Manage
03300	Cast -In-Place Concrete	3.17, C, 2	ASTM C 134/C 143 M	Slump: one for each sample	At Placement	Balter / QC Manage
03300	Cast -In-Place Concrete	3.17, C, 3	ASTM C 231	Air Content: One test for each sample	At Placement	Balter / QC Manage
03300	Cast -In-Place Concrete	3.17, C, 4	ASTM C 1064 C 1064 M	One test hourly when air temp. is 40 deg.F or lower and when 80 deg. and higher. One test for each composite sample	At Placement	Balter / QC Manage
03300	Cast -In-Place Concrete	3.17, C, 5	ASTM C 31 C / 31M	composite sample. Laboratory cure two sets of cylinders and field cure three sets of cylinders	For each pour	Balter
03300	Cast -In-Place Concrete	3.17, C, 6	ASTM C 39 C - 39 M	Compressive Strength Tests: One set of two laboratory cured specimens at 7 days and one set of two specimens at 28 days	For each pour	Balter
03300	Cast -In-Place Concrete	3.17, C, 6, a	ASTM C 39 C - 39 M	Compressive Strength Test: One set of two field cured specimens at 2 days for evaluation of the concrete for acceptability to begin post-tensioning, test one set of field specimens to confirm concrete in post-tensioned members has reached required strength	For each pour	Balter
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 231	Air Content: One test for each sample	At Placement	Balter / QC Manager
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 1064 C 1064 M	One test hourly when air temp. is 40 deg.F or lower and when 80 deg. and higher. One test for each composite sample	At Placement	Balter / QC Manager
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 31 C / 31M	Compression Test Specimens: Five sets of two standard cylinders for each composite sample. Laboratory cure two sets of cylinders and field cure three sets of cylinders	For each pour	Balter
03331	Cast-In-Place Architectural Concrete	3.5	ASTM C 39 C - 39 M	Compressive Strength Tests: One set of two laboratory cured specimens at 7 days and one set of two specimens at 28 days	For each pour	Balter

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
08912	Structural-Sealant-Glazed Curtain Walls	3.4, B, 4	AAMA 501.2	Water Spray Test: A minimum area of 50 ft. by one story	Before installation of interior finishes. As directed by architect	Independent Agency QC Manager
08960	Sloped Glazing Assemblies	3.4, B, 1	ASTM C 1401	Structural Sealant Adhesion Test	As installation proceeds	Independent Agency QC Manager
08960	Sloped Glazing Assemblies	3.4, B, 2	ASTM E 783	Air Infiltration Test: 1.5 times rate specified, but not more than 0.50 cfm/sq. ft. at min. static pressure differential of 12 lbf/sq. ft. Test area: one bay wide, not less than 30 ft by one story	As installation proceeds	Independent Agency QC Manager
08960	Sloped Glazing Assemblies	3.4, B, 3	ASTM E 1105	Water Penetration Test: 0.67 times the static-air-pressure differential, not less than 6.24 lbf/sq. ft. Test area: one bay wide, not less than 30 ft by 30 feet of sloped glazing assembly	As installation proceeds	Independent Agency QC Manager
08960	Sloped Glazing Assemblies	3.4, B, 4	AAMA 501.2	Water Spray Test: A minimum area of 30 by 30 ft.	Before installation of interior finishes. As directed by architect	Independent Agency / QC Manager
		Division 13				
13110	Cathodic Protection	3.8, C, D		Bond resistance testing, Theoretical joint and bond resistance, Insulation continuity	As Required	Sub / QC Manager
13110	Cathodic Protection	3.8, D		Test each insulating joint for continuity of insulation	Prior to Backfill	Sub / QC Manager
13110	Cathodic Protection	3.8, E		Test continuity, pipe to soils potential	After Backfill	Sub / QC Manager
13760	CCTV	3.4, C, E		Pre - Testing and Operational Testing	Operational: After system has been in normal function for 14 days	Mfg. Rep. / Sub / QC Manager
13760	CCTV	3.6, D		Pre - Testing and Final Testing	Final Testing after acceptance of pre-testing	Mfg. Rep. / Sub / QC Manager / WMATA
13852	Fire Alarm And Intrusion Detection System	3.4,B, D		Pre - Testing and Final Testing	Final Testing after acceptance of pre-testing	DPS / Sub / QC Manager
13930	Wet Pipe Fire Suppression System	3.11		Leak Test, Controls and Safeties, Flush, pumps, Fire Alarm Coordination	As required	Fire Marshall / DPS / Sub / QC Manager
13935	Dry Pipe Fire Suppression System	1.6, G		Fire Hydrant Flow Test	Once	Fire Marshall / DPS / Sub / QC Manager
13935	Dry Pipe Fire Suppression System	3.11		Leak Test, Controls and Safeties, Flush, pumps, Fire Alarm Coordination	Upon Completion of Installation	Fire Marshall / DPS / Sub / QC Manager
	Clean Agent Extinguishing	3.7, A B, C,				

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
03410	Plant-Precast Structural Concrete	3.3	ASTM E 165-709	Inspection of Field Welds	Each weld	Balter / QC Manager
		Division 4				
04200	Masonry	1.5, A, 1		Placement: Do not place when temp. falls below 40 degrees or when temperatures below 40 degrees are likely after mortar is placed.	During placement	Sub / QC Manager
04200	Masonry	1.5, A,2		Placement: Heat and maintain temp. of mtrls. At not less than 40 degrees - not more than 160 degrees	During placement	Sub / QC Manager
04200	Masonry	1.5, B		Placement during hot weather: cover work for 3 days, when ambient temp. is over 95 degrees protect work for 72 hrs.	During placement	Sub / QC Manager
04200	Masonry	3.3		Placing Tolerances: Average thickness of any three consecutive joints 3/8" to 1/2"	During placement	Sub / QC Manager
04810	Unit Masonry	3.9, A, 1		Spacing, Grades, Sizes, Reinforcement	Prior to Grout	Balter / QC Manager
04810	Unit Masonry	3.9		CMU Test, Mortar Test, Grout Test, Prism Test	Each 5000 sq. ft. of wall	Balter / QC Manager
04815	Glass Unit Masonry	1.6		Weather Limitations: Install when temps. Are 40 deg. Or higher	As required	Sub / QC Manager
04815	Glass Unit Masonry	2.3	ASTM C 270	Mortar Mixes: Type S mortar	As required	Sub / QC Manager
04815	Glass Unit Masonry	3.2, E,		Place pointing mortar in 3/8" layers	During placement	Sub / QC Manager
04860	Stone Masonry	1.6, B, C	ACI 530.1	Cold Weather Requirements: Comply with ACI 530.1 / ASCE 6 / TMS 602	As required	Sub / QC Manager
04860	Stone Masonry	3.4		Tolerances: variation from level: 1/8" in 5 ft. Slope: 1/8" from back of tread to nose of tread	During placement	Sub / QC Manager
		Division 5				
05120	Structural Steel	2.8		Shop Tests and Inspections	Fabrication	Balter
05120	Structural Steel	3.5, B	ASTM A 325 - A 490	Shop-bolted connections	As required	Balter
05120	Structural Steel	3.5, C	AWS D1.1	Field Welded Connections	As required	Balter / QC Manager
05310	Steel Deck	3.4, B	AWS D1.3	Inspection of Field Welds	After installation	Balter / QC Manager
		Division 7				
07131	Sheet Waterproofing	3.1	ASTM D 4263	Capillary Moisture Test	Prior to installation	Sub / QC Manager

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
15181	Hydronic Piping	3.9, C		Performance Test	Prior to operating system	DPS / Sub / QC Manager
15410	Plumbing Fixtures	3.4		Verify installation for compliance with Contract requirements and operation	After Installation	DPS / Sub / QC Manager
15415	Drinking Fountains and Water Coolers	3.5		Performance Tests	After powering	DPS / Sub / QC Manager
15446	Sump Pumps	3.4		Check Mechanical Operation	Start up	DPS / Sub / QC Manager
15485	Electric Water Heaters	3.3, A, B, C		Leak Test, Operational Test, Controls and Safeties	After Installation	DPS / Factory Rep / Sub / QC Manager
15629	Scroll Water Chillers	3.3		Operation Testing	Start up	Factory Rep / Sub / QC Manager
15725	MIC - AHU's	3.4, A, B, C		Leak Test, Refrigerant Leak Test, Fan Operation Test	Start up	Factory Rep / Sub / QC Manager
15731	Packaged Terminal AC	3.3, A		Compliance with Requirements, Operational Test, Controls and Safeties	Start up	DPS / Sub / QC Manager
15732	Rooftop AC Units	3.4, A, B, C		Compliance with Requirements, Operational Test, Controls and Safeties	Start up	DPS / Sub / QC Manager
15778	Heat Tracing	3.3		Continuity, Insulation Integrity, Cable Rating and Power	Before application of coverings	DPS / Sub / QC Manager
15815	Metal Ducts	3.6	SMACNA	Air Duct Leak Test	After Installation	DPS / Sub / QC Manager
15820	Duct Accessories	3.2		Operate Dampers, Access Door Location, Inspect Turning Vanes	After Installation	DPS / Sub / QC Manager
15836	Axial Fans	3.3		Fan Operation, Damper Linkage and Operation, Motor Rotation	After Installation	DPS / Sub / QC Manager
15840	Air Terminal Units	3.3	ARI 880	Compliance with Requirements, Operational Test, Controls and Safeties	After Installation	DPS / Sub / QC Manager
15950	TAB			See Commissioning Plan		
		Division 16				
16055	Overcurrent Protection	3.5		Voltage Drop Study: Not to exceed 2% at rated capacity, Max. voltage drop 3%	As required	Sub / QC Manager
16060	Grounding and Bonding	3.5		Ground Resistance Test	After Installation	Sub / Independent Agency / QC Manager
16124	Medium Voltage Cables	3.2		Visual, Mechanical, Electrical per NETA ATS	As required	DPS / Sub / Independent Agency / QC Manager
	Lighting Control					

Silver Spring Transit Center

Testing Inspection Matrix
FPC Job #51-0037

FOULGER-PRATT

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
13974	Fire Suppression Standpipes	1.3, B, 1		Fire Hydrant Flow Test	Upon Completion of Installation	Fire Marshall / DPS Sub / QC Manager
13974	Fire Suppression Standpipes	3.1	NFPA 14	Leak Test, Controls and Safeties, Flush, pumps, Fire Alarm Coordination	Upon Completion of Installation	Fire Marshall / DPS Sub / QC Manager
		Division 14				
14200	Hydraulic Elevators	3.02		Acceptance and Elevator Tests (Full Load Run Test - Speed Test)	As required: One hour continuous run	DPS / Sub / QC Manager / Engr.
14300	Heavy duty Escalator	3.04		Load Test, Overspeed Test, Handrail Tension, Broken Chain Protection	After Installation	DPS / Sub / QC Manager / Engr.
		Division 15				
15073	Vibration and Seismic Controls for Plumbing	3.5		Performance Tests: Four of each type to 90% of rated load	After Installation	DPS / Sub / QC Manager
15074	Vibration and Seismic Controls for HVAC	3.5		Performance Tests: Four of each type to 90% of rated load	After Installation	DPS / Sub / QC Manager
15082	Plumbing Insulation	3.1		Insulation	Once - random locations	DPS / Sub / QC Manager
15083	HVAC Insulation	3.5,B,1		Ductwork Inspection	One location for each duct system	DPS / Sub / QC Manager
15083	HVAC Insulation	3.5, B, 2		Pipe, fittings, strainers and valves	Three locations of straight pipe	DPS / Sub / QC Manager
15140	Domestic Water Piping	3.9, A		Rough-in Inspection, Final Inspection	Rough-in and Final	DPS / Sub / QC Manager
15140	Domestic Water Piping	3.9, B		Domestic Water Piping	Prior to concealment / 50 psgi for 4 hrs.	DPS / Sub / QC Manager
15140	Domestic Water Piping	3.11	AWWA C651 / AWWA C652	Disinfection of Domestic Water Piping	50 ppm chlorine for 24 hrs	DPS / Sub / QC Manager
15145	Domestic Water Piping Specialties	3.3		Vacuum Breaker and Backflow Preventer	After Installation	DPS / Sub / QC Manager
15150	Sanitary Waste and Vent Piping	3.8, A, C		Rough-in and Final: Leaks and defects	After Installation	DPS / Sub / QC Manager
15150	Sanitary Waste and Vent Piping	3.8, D		Force Main: Static water pressure of 50 psig for four hours	Prior to concealment	DPS / Sub / QC Manager
15160	Storm Drainage Piping	3.7, A, D		Rough-in and Final: Leaks and defects	Prior to concealment	DPS / Sub / QC Manager

SPEC. SECTION	FEATURE of WORK	PARAGRAPH	STANDARD	REQUIREMENTS	FREQUENCY	TEST BY
16211	Electricity Metering	3.2	NECA 1	Meter Load Test	Once for eight hours	Sub / QC Manager
16231	Packaged Engine Generator	3.4		NETA Acceptance Testing, NFPA 110 Acceptance Tests	Coordinate with tests for transfer switches	Factory Rep / Sub / QC Manager
16269	Frequency Controllers	3.8		Insulation resistance, continuity, visual	Prior to acceptance	Sub / Independent Agency / QC Manager
16289	Transient Voltage Suppression	3.3	NETA ATS	Compliance, Start up Checks, Visual - Mechanical	Once - After surge protection, before energizing circuitry	Sub / Independent Agency / QC Manager
16341	Medium Voltage Switchgear	3.5	NETA ATS	Electrical - Mechanical Acceptance Tests per NETA ATS	Prior to acceptance	Factory Rep / Sub / QC Manager / Independent Agency
16410	and Circuit Breakers	3.5	NETA ATS	Connections, Switch-Relay Type, Fuse Rating, Visual - Mechanical	As required	DPS / Factory Rep / Sub /QC Manager
16415	Transfer Switches	3.3	NEMA ICS 1	Compliance, Visual - Mechanical per NETA ATS, Insulation Resistance	As required	DPS / Factory Rep / Sub /QC Manager
16420	Enclosed Controllers	3.8	NETA ATS	Insulation Resistance, Continuity, Controllers, Components, Equipment	As required	DPS / Factory Rep / Sub /QC Manager
16441	Switchboards	3.5	NETA ATS	Insulation Resistance, Continuity, Electrical - Mechanical per NETA ATS	As required	Sub / Independent Agency / QC Manager
16442	Panelboards	3.4	NETA ATS	Electrical - Mechanical Acceptance Tests per NETA ATS, Load Balancing	As required	Sub / Independent Agency / QC Manager
16443	Motor Control Centers	3.7	NETA ATS	Insulation Resistance, Continuity,	After Installation	Sub / Independent Agency / QC Manager
16461	Low Voltage Transformers	3.4	NETA ATS	NETA Acceptance Testing	After Installation	Sub / Independent Agency / QC Manager
16511	Interior Lighting	3.2		Test Emergency Lighting	After Installation	DPS / Sub / QC Manager
16521	Exterior Lighting	3.7	IESNA LM	Measure Light Intensity	After Installation	Sub / QC Manager
16601	AEMS	3.03		System Start Up, Verify Operation	After Installation	Sub / QC Manager
16670	Lightning Protection	1.1, B		Ground Resistance Test	After Installation	Sub / Independent Agency / QC Manager
16724	Emergency Speakerphone	3.2		Components - Equipment, Operational Test	After Installation	DPS / Sub / QC Manager
16740	Structured Cabling System	3.4	ANSI/TIA/EIA	Test for product capability, OTS, continuity, polarization and shorts, OTDR	After Installation	Sub / QC Manager

Appendix B – Duties and Functions of DGS Project Management Team

Note: The information provided in this appendix was provided by DGS. It has been reformatted slightly to fit this document but is otherwise not a product of this analysis. The descriptions provided have not been verified and are provided for information purposes only.

Several County personnel are involved in the construction administration of the SSTC. The Montgomery County Special Inspections Program outlines the duties and functions required by the owner or owner's representatives.[155] The following outlines each individual's duties and functions, which fulfill the requirements.

The description of Mr. Anderson's duties and functions as supplied by DGS include:

- Works under the lead of the Project Manager Tim O'Gwin primarily to supports County with interface with WMATA for All submittals – review and acceptance issues, coordination with PB in the resolution of All submittal issues
- As time evolved on the project this support grew to include coordination of the Safety & Security Certification process (WMATA close out/checklist program), Commissioning and Closeout; which are now his major activities since submittals are down to a minimum
- Spends time in the site office and in the field to support the daily construction activities
- Coordination with MTA with all QA/QC inspections and issues on the project
- Support County activities in major settlement with the Contractor and their caisson sub-contractor to optimize DGS's payment for extra caisson work on the project
- Support DGS in other cost related (no time-related) PCOs
- Attends progress meetings, construction prep meetings, Commissioning meetings, Closeout meetings, Safety & Security meetings, some MTA coordination meetings

Frank Roberts serves as Project Team Leader and his duties and functions include:

- Performing all the functions of a Team Leader of the on-site SSTC County personnel to manage their day to day activities as well as reporting to the Division management on a day to day basis
- Coordination with WMATA, MTA, FTA management of all project issues
- Performing all the lead functions associated with managing the Prime Contract for both Contractor and A/E, together with coordination and adherence to WMATA requirements as defined in the MOU for the project. Additionally coordinates with MTA, FTA and DGS management team to ensure that the work is proceeding according to agreements.
- Coordinating with FP on-site and home-office management team including monthly MC/FP management team meetings in which major problems are jointly flushed out ; works very closely with PM on Field Orders and Change Orders with FP/PM to manage the fairness and accuracy of that process
- Spending time in the site office and in the field to support the daily construction activities
- Coordinating with the PM on RFIs, ASIs and All project issues and problems to the level of detail needed to get resolution and eliminate project delays
- Assisting the PM with work associated with Review, negotiation and resolution of PCO by Field Order or Change Order instrument
- Attending all progress meetings, some construction prep meetings, project SWAT 3-person team meeting (FP/PB/County) PMP meetings (Chairs this meeting), FTA/MTA meetings, SSTC briefing meetings, weekly team meetings, and prepares input to the respective meetings, and quarterly MTA meeting as-required

[155] Montgomery County Special Inspections Program, Section 1.7.1 Owner (Owner's Representatives), Page 4 of 26, Revised 10/26/2012

- Keeping DGS Division management personnel well informed of all issues critical and pending that will affect the success of the project, on a daily basis
- Coordinating with Tim Herbold on daily urgent construction issues that need PM resolution
- Monitoring the project website content and updates accordingly
- Attending Safety & Security, Commissioning , Closeout meetings
- Attending monthly schedule review meetings and reviews the schedules and Notices of Delay proposed by the Contractor for input to County response and evaluation of those delay claims.

Tim O'Gwin serves as Project Manager and his duties and functions include:

- Performing all the lead functions associated with managing the Prime Contract for both Contractor and A/E, together with coordination and adherence to WMATA requirements as defined in the MOU for the project. Additionally coordinating with MTA, FTA and DGS management team to ensure that the work is proceeding according to agreements.
- Spending time in the site office and in the field to support the daily construction activities
- Reviewing, negotiating the Contractor's PCOs for settlement (together with DGS's cost estimating contractor) and prepares all the documentation – Field Orders or Change Orders, for settlement inclusive of meetings with the CRC (for Change Orders)
- Reviewing all the contract RFIs & A/E responses for clarification for accuracy and agreement ; has the final word in direction for closure of RFIs
- Reviewing all the contract ASIs & A/E responses for clarification for accuracy and agreement ; has the final word in direction for closure of RFIs
- Attending all progress meetings, some construction prep meetings, PMP meetings, FTA/MTA meetings, SSTC briefing meetings, weekly team meetings, and prepares input to the respective meetings
- Coordinating with Bob Stout in the running of the weekly A/E Design Team meetings
- Coordinating monthly meetings with WMATA's site construction personnel
- Supporting the Project Team Leader in the resolution of All issues related to the execution of both the A/E Contract and the Construction Contract
- Acting as lead in the supervision of work done by PB's on-site construction management engineer (John Anderson)
- Coordinating with Tim Herbold on daily urgent construction issues that need PM resolution

Robert Stout serves as Assistant Project Manager and his duties and functions include:

- Assisting the Project Manager -Tim O'Gwin and the Project Team Leader – Frank Roberts as-needed in the execution of all functions to support the management of the SSTC project; but within those functions has some fixed roles such as All project Financial and Invoicing, and Reports
- Spending time in the site office and in the field to support the daily construction activities
- Preparing All project Reports including monthly reports to MTA and FTA, and EOB Briefings
- Coordinating the monthly PMP meetings that include the presence of FTA/MTA/WMATA/PB/County and prepares minutes and agenda
- Updating DGS input to the MTA Quarterly meetings on the project
- Processing All the Invoices on the project – verification through payment, keeps an update on the project financial balances
- Administering PB Contract including assignment of task orders and ASIs
- Assisting the PM in the review and execution of RFIs on the project so that DGS stays current and in-control of clarifications and potential changes

- Coordinating and runs weekly meetings with the Design Team (PB/ZGF) and biweekly meetings with MTA
- Performing other duties as assigned by the PM and the Team Leader to assist with coordination documentation with WMATA, FTA and MTA.

Leo Perez serves as County Scheduling Engineer and his duties and functions include:

- Performing all the functions of an on-site scheduling engineer including and not limited to daily photos of All ongoing construction on the site in order to maintain records and to help to validate the monthly schedule updates from the Contractor
- Spending time in the site office and in the field to support the daily construction activities
- Coordinating the monthly schedule reviews of the project which are attended by MTA and their scheduling consultant, County and the Contractor
- Assisting in preparation of letter responses to the contractor of schedule updates as well as Notices of Delay
- Assisting in review and preparation of DGS settlement with the Contractor for time lost in the early phases of construction on the project – Change Order #8.
- Attending all progress meetings, PMP meetings, some site prep meetings, schedule review meetings and County biweekly management team meetings.
- Supporting the activities of A/E in their review of project Notices of Delay from the Contractor; TC26 schedule through the current TC42 schedule
- Supporting the PM and Team Leader in numerous and miscellaneous activities involved with a better understanding of construction slippage in time and issues that may be driving the Contractor's PCO submittal
- Supporting the cost estimating efforts of the team as-required

Tim Herbold serves as Senior Construction Representative and his duties and functions include:

- overseeing the daily functions of Shakeel Bokhari
- Spending majority of time on the site
- Reporting daily construction activities, issues, problems, and look-ahead conditions of the construction activities to the Team Leader and Project Manager
- Inspecting all site construction installations by General Contractor and Subcontractors including but not limited to the major items of Earthwork, Sediment & Erosion Control, Caisson drilling & concrete, Concrete, Steel, Post-tensioning, Formwork, Finishes, Electrical & Mechanical installations, Glazing , Escalator & Elevator installations, Paving, Underground & Above ground Utility installations, Miscellaneous Metals installations
- Coordinating and documents daily inspection performed by RBB in the execution of all the work categories listed above; prepares daily Construction Representative reports for County use and records
- Reviewing RFIs, ASIs and other change instruments on the project and follows through inspection with the Contractor on implementation of those Construction Documents
- Attending construction preparatory meetings, biweekly progress meetings, superintendents' meetings, subcontractor meetings, safety meetings, weekly SSTC project meetings, Commissioning meetings, Closeout meetings, safety & Security meetings
- Attending biweekly project Briefing meetings in the EOB and presents work status activities to the SSTC management team
- Reviewing RBB daily and monthly inspection reports
- Reviewing and okays RBB's monthly Invoices with corrections as-needed

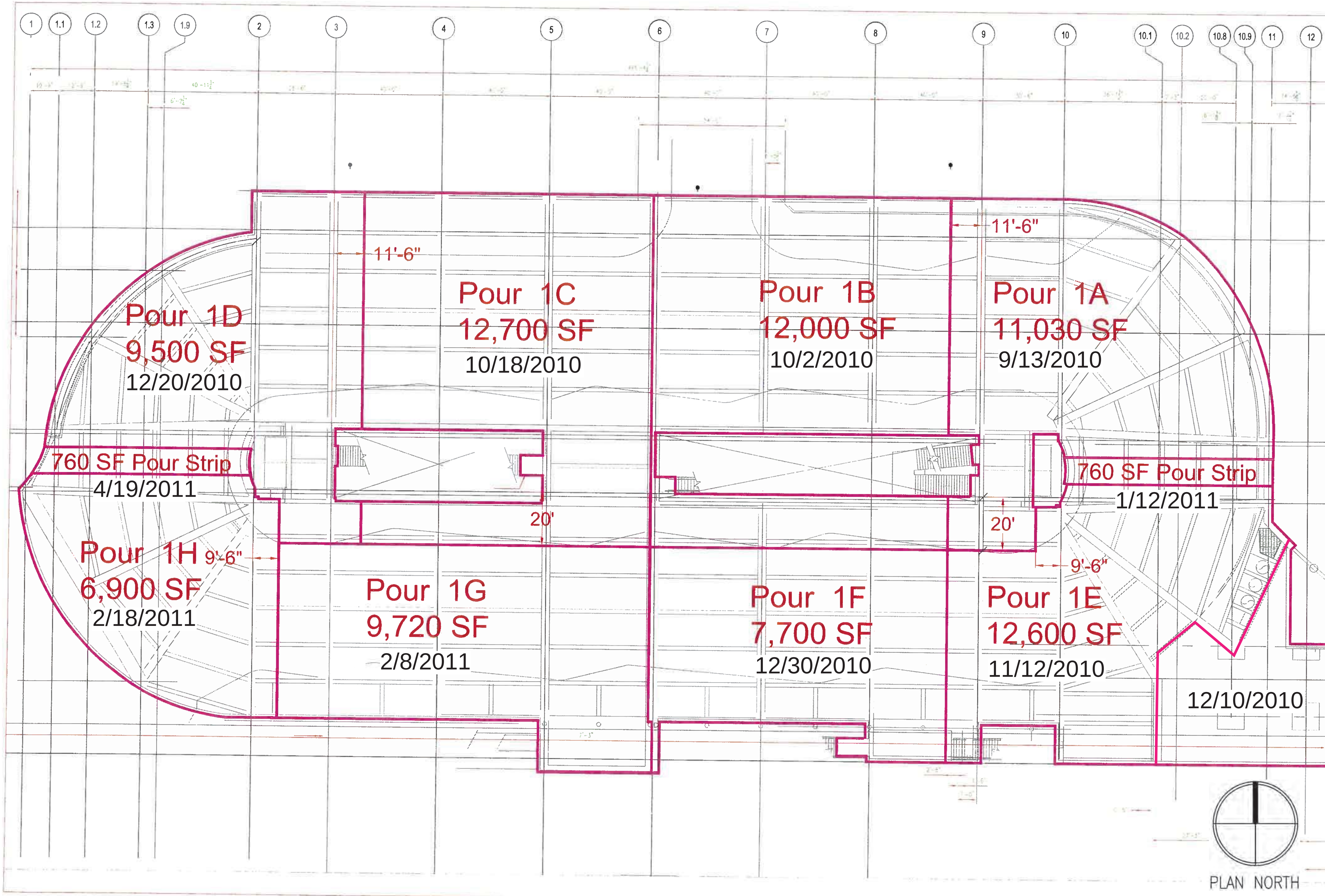
- Reviewing the Contractor's monthly Payment Applications, line by line, for accuracy and inspects materials being billed for in the monthly Payment Applications
- Maintaining a presence on the site during after –hours or weekend construction presence by the General Contractor or their subs

Shakeel Bokhari serves as Construction Representative and his duties and functions include:

- Reporting to the Senior Construction Representative, Tim Herbold for definition of daily functions
- Spending majority of time on the site
- Inspecting all site construction installations by General Contractor and Subcontractors including but not limited to the major items of Earthwork, Sediment & Erosion Control, Caisson drilling & concrete, Concrete, Steel, Post-tensioning, Formwork, Finishes, Electrical & Mechanical installations, Glazing , Escalator & Elevator installations, Paving, Underground & Above ground Utility installations, Miscellaneous Metals installations
- Coordinating and documents daily inspection performed by RBB in the execution of all the work categories listed above; prepares daily Construction Representative reports for County use and records
- Reviewing RFIs, ASIs and other change instruments on the project and follows through inspection with the Contractor on implementation of those Construction Documents
- Attending construction preparatory meetings, biweekly progress meetings, superintendents' meetings, subcontractor meetings, safety meetings, weekly SSTC project meetings, Commissioning meetings, Closeout meetings, safety & Security meetings
- Reviewing RBB daily and monthly inspection reports
- Reviewing the Contractor's monthly Payment Applications, line by line, for accuracy and inspects materials being billed for in the monthly Payment Applications
- Maintaining a presence on the site during after –hours or weekend construction presence by the General Contractor or their subs

Appendix C – Plans of SSTC Floors

Note: The information provided in this appendix is taken from KCE Attachments 11 and 26. It has been reformatted slightly to fit this document but is not otherwise a product of this analysis. The content has not been verified and is provided for information purposes only.



PROJECT NO : 490

DATE: July 17, 2009

SCALE: N.T.S.

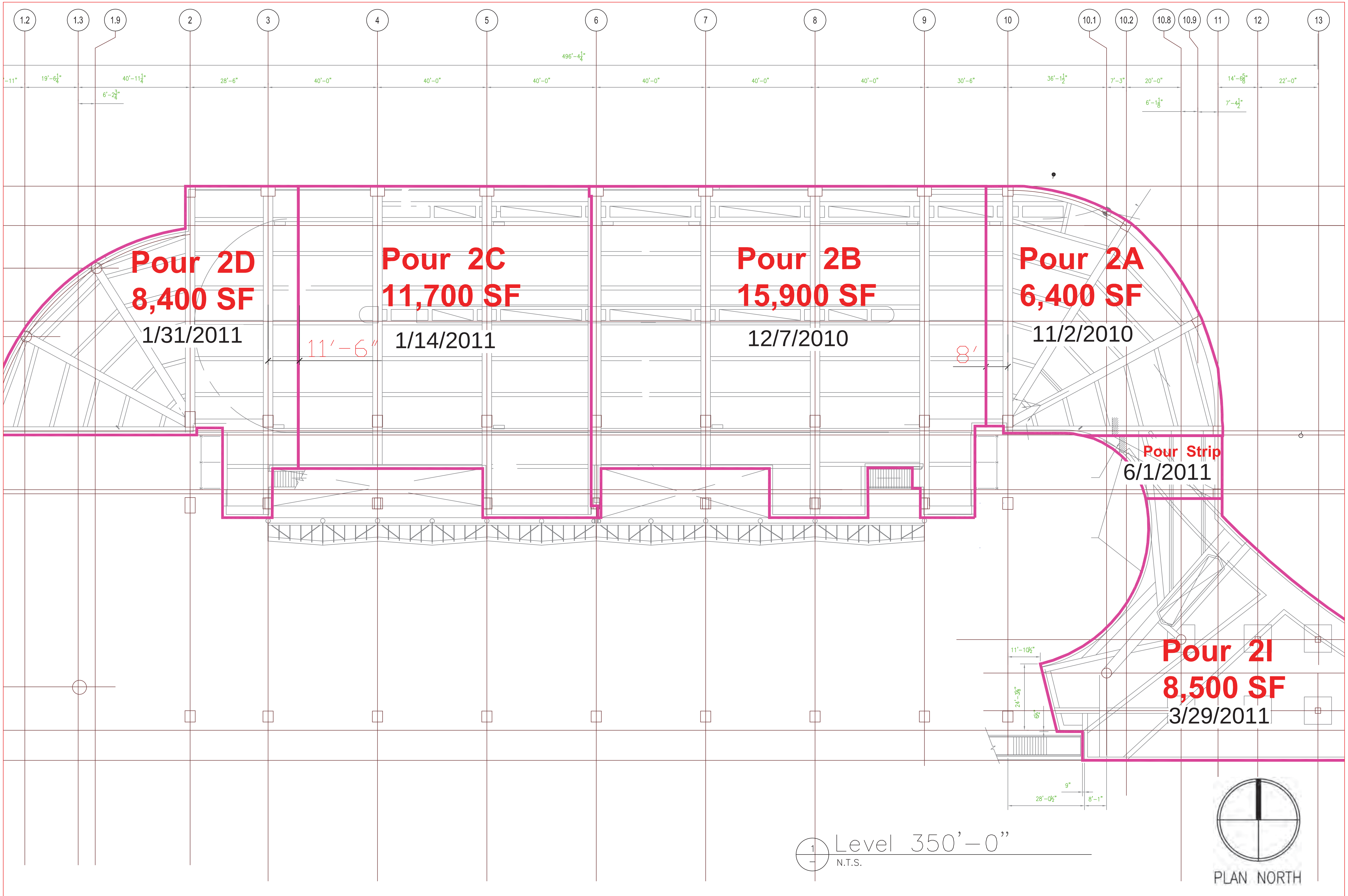
Silver Spring Transit Center

Ramsey Avenue & Bonifant Street
Silver Spring, Maryland

Construction Joints 330 Level

Facchina CONSTRUCTION COMPANY, INC.

DWG NO: CJ - 100



PROJECT NO : 490

DATE: 04/15/2010

SCALE: N.T.S.

Silver Spring Transit Center

Ramsey Avenue & Bonifant Street
Silver Spring, Maryland

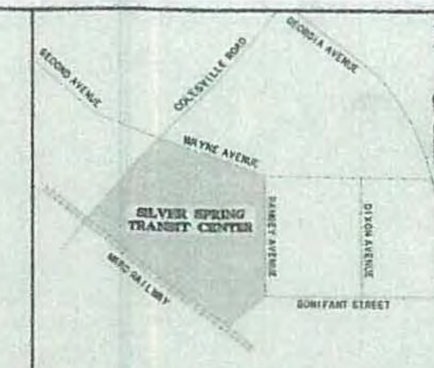
Construction Joints 350 Level

Facchina
CONSTRUCTION COMPANY, INC.

DWG NO:
CJ - 200

LEGEND:

&	AND
LB	LICENSE BUSINESS
NO.	NUMBER
SQ.FT.	SQUARE FEET



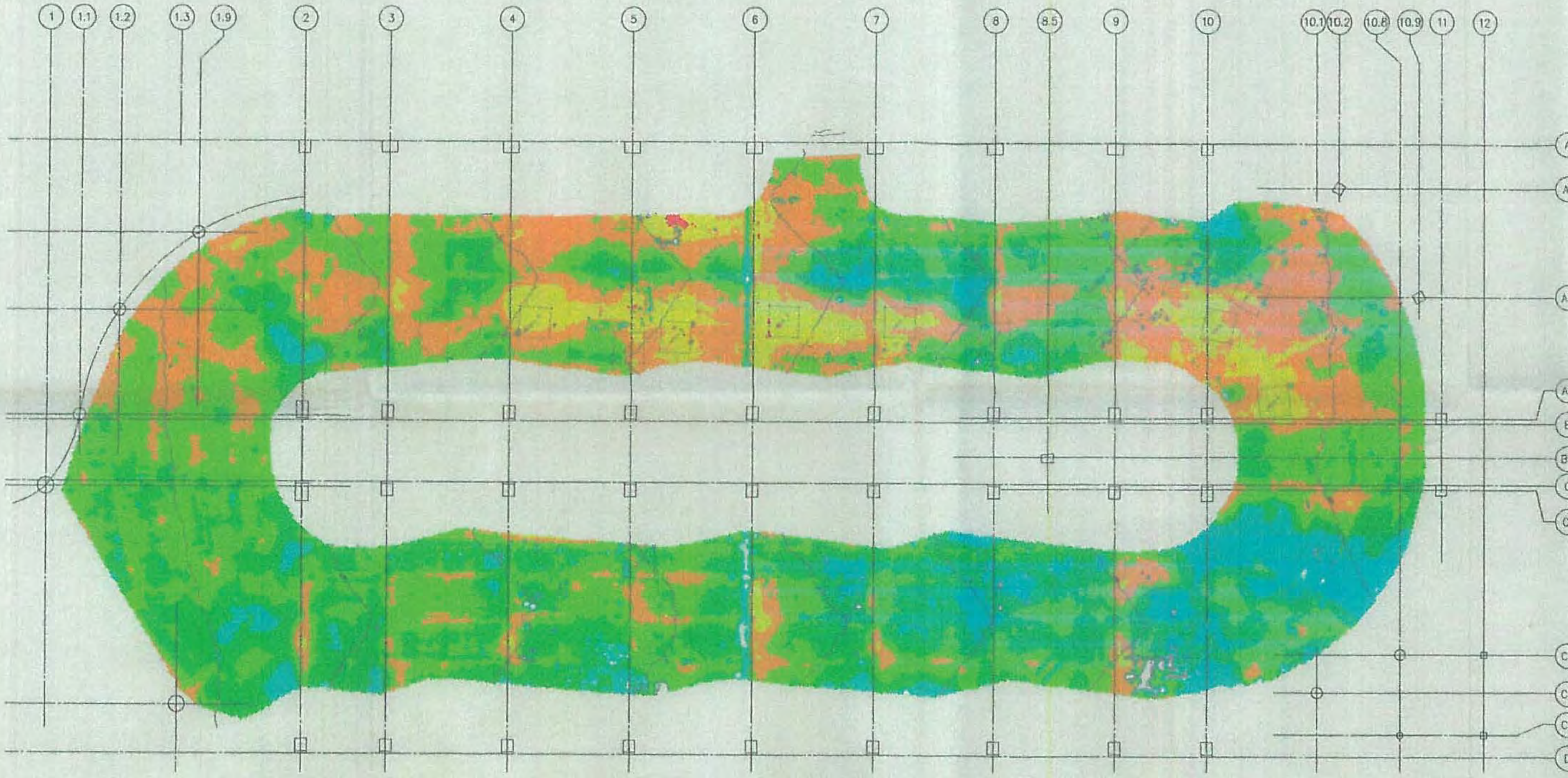
LOCATION MAP

NOT TO SCALE

Concrete Slab Thickness (inches)

Number	Minimum Elevation	Maximum Elevation	Color	Surface Area (sq.ft.)
1	7.00	8.00		30.6
2	8.00	9.00		2938.9
3	9.00	9.76		9737.2
4	9.76	10.38		17870.3
5	10.38	11.00		12317.6
6	11.00	13.00		4486.7

GRAPHIC SCALE
FEET



CONCRETE SLAB BETWEEN LEVEL 305 AND 330

SCALE: 1"=20'

NOTE: 1 FOOT CONTOURS ARE BASED ON TOP OF CONCRETE SLAB ONLY.

REPORT OF ASBUILT SURVEY:
THE SURVEY SHOWN HEREON IS A FORENSIC SURVEY OF THE SILVER SPRING TRANSIT CENTER'S LOWER AND UPPER CONCRETE SLABS BEING BETWEEN FLOORS 305 AND 330 AND FLOORS 330 AND 350, LOCATED IN SILVER SPRING IN MONTGOMERY COUNTY, MARYLAND. THE FIELD SURVEY WAS COMPLETED NOVEMBER 1 THROUGH 8, 2011, UNDER THE DIRECTION OF JOHN H. ADLER III, PROFESSIONAL SURVEYOR AND MAPPER (PSM). THIS SURVEY IS VALID ONLY WHEN THE SIGNATURE AND RAISED EMBOSSED SEAL ARE FOUND AT THE END OF THIS REPORT.

ACCURACY:
HORIZONTAL, VERTICAL CONTROL, AND BUILDING GRID LINES WERE PROVIDED BY WMATA VIA A SURVEY CONTROL PLAN SET. ALL EQUIPMENT UTILIZED FOR THIS SURVEY HAS BEEN CALIBRATED WITHIN ONE YEAR OF THE DATE OF THE FIELD SURVEY AS RECOMMENDED BY THE MANUFACTORERS.

DATA SOURCE:
SILVER SPRING TRANSIT CENTER, WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY SURVEY CONTROL SET, DRAWING NO.B6-8713-SP001, DATED 8/2011

A STAR*NET DATA FILES PROVIDED: 8713-CONTROL.DAT, 8713-TRAV-FINAL.DAT, AND 8713-TRAV-VIKA_PNTS-FINAL.DAT.

MEASUREMENT METHODS:
ADDITIONAL HORIZONTAL CONTROL WAS SET UTILIZING A TOTAL STATION. ALL HORIZONTAL ANGLES WERE TAKEN EIGHT (8) TIMES AND AVERAGED. ADDITIONAL VERTICAL CONTROL WAS ESTABLISHED FOR FLOOR SST305 UTILITZING A DIGITAL LEVEL RUNNING A CLOSED BENCH LOOP FROM "BM1" TO A SCRIBE ON A SOUTHEAST CONCRETE RETAINING WALL. ADDITIONAL VERTICAL CONTROL WAS ESTABLISHED FOR FLOOR SST330 UTILIZING A DIGITAL LEVEL RUNNING A CLOSED BENCH LOOP FROM "BM2" BACK TO "BM2". ADDITIONAL VERTICAL CONTROL WAS ESTABLISHED FOR FLOOR SST350 UTILIZING A DIGITAL LEVEL RUNNING A CLOSED BENCH LOOP FROM "BM3" BACK TO "BM3". SURVEY DATA WAS COLLECTED UTILIZING A LEICA HDS3000 HIGH DEFINITION LASER SCANNER. THE CEILING OF THE SST305 FLOOR WAS SCANNED FROM EIGHTEEN (18) LOCATIONS. THE CEILING AND FLOOR OF THE SST330 FLOOR WERE SCANNED FROM FIFTEEN (15) LOCATIONS. THE FLOOR OF THE SST350 FLOOR WAS SCANNED FROM SIX (6) LOCATIONS. ALL SCANS WERE REGISTERED USING LEICA CYCLONE v7.1.1. REGISTRATION FOR ALL SCANS ACHIEVED A MAXIMUM MEAN ABSOLUTE ERROR OF 0.018 FEET FOR ALL TARGET CONTROL POINTS. LEVEL SST305 CEILING IS BASED ON A POINT CLOUD OF 7,017,762 POINTS. LEVEL SST350 FLOOR IS BASED ON A POINT CLOUD OF 13,930,867 POINTS. LEVEL SST350 CEILING IS BASED ON A POINT CLOUD OF 13,930,867 POINTS. LEVEL SST350 IS BASED ON A POINT CLOUD OF 2,689,734 POINTS. A MESH WAS CREATED FROM EACH UNIFIED FLOOR OR CEILING AND A SAMPLE SIX (6) INCH BY SIX (6) INCH GRID WAS EXPORTED INTO AUTOCADD CIVIL 3D. ELEVATION BANDINGS ARE BASED ON THIS SAMPLE GRID. ONE FOOT CONTOURS ARE BASED ON FLOOR SURFACE MODEL ONLY.

LIMITATION:
SCANS WERE LIMITED TO THE ROADWAY AREAS ONLY. AREAS OUTSIDE OF THE CURB LINE WERE NOT EVALUATED.

NOVEMBER 25, 2011
Date of Signature

John H. Adler III
Professional Surveyor and Mapper
Florida License Number 4693

SURVEYOR'S NOTES

1. ATTENTION IS DIRECTED TO THE FACT THAT THIS MAP MAY HAVE BEEN REDUCED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.
2. GREENHORNE & O'MARA, INC. AND THE CERTIFYING SURVEYOR ACCEPT NO RESPONSIBILITY FOR RIGHT-OF-WAYS, EASEMENTS, RESTRICTIONS OR OTHER MATTERS AFFECTING TITLE TO THE LANDS SURVEYED.

REVISIONS: | DATE:

ENGINEERS • ARCHITECTS • PLANNERS • SCIENTISTS • SURVEYORS • PHOTOGRAMMETRISTS

GREENHORNE & O'MARA, INC.
3223 COMMERCE PLACE, SUITE 100
WEST PALM BEACH, FL 33407
(561) 686-7707

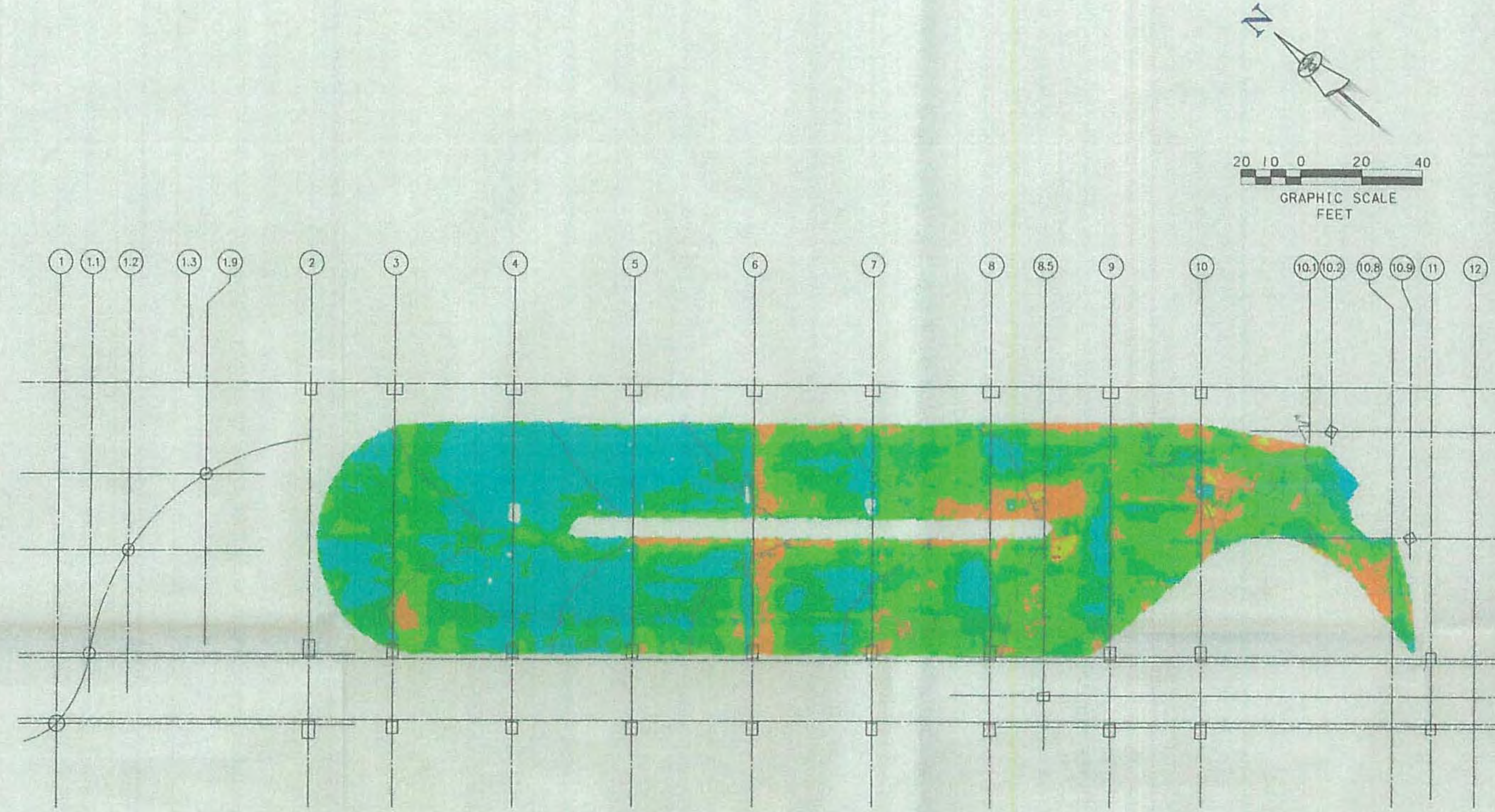
ANNAPOLIS, MD • FAIRFAX, VA • FREDERICKSBURG, VA • LAUREL, MD
MECHANICSBURG, PA • RALEIGH, NC • ROCKVILLE, MD • ST. PETERSBURG, FL • WALDORF, MD

FORENSIC SURVEY FOR:

SILVER SPRING TRANSIT CENTER
CONCRETE FLOOR SLABS

SILVER SPRING, MARYLAND

DESIGN	1" = 20' SCALE
RITZEL DRAWN	1 OF 2
ADLER CHECKED	
11/25/2011 DATE	030931.053.ADLE.459 DRAWING NO.



CONCRETE SLAB BETWEEN LEVEL 330 AND 350

SCALE: 1"=20'

WMATA HORIZONTAL SURVEY CONTROL IS BASED ON AN ADJUSTMENT USING BUILDING GRID CONTROL POINTS PROVIDED BY VIKA AND SHOWN ON REFERENCE DRAWING ENTITLED "GRID CONTROL WORKSHEET"

WMATA VERTICAL SURVEY CONTROL IS BASED ON AN ADJUSTMENT HOLDING VERTICAL BENCHMARK "B" PROVIDED BY VIKA AND SHOWN ON DRAWING ENTITLED "BENCHMARK1 EXHIBIT".

WMATA HORIZONTAL SURVEY CONTROL

POINT ID	NORTHING	EASTING	DESCRIPTION
100	483411.1848	1303853.7307	25MM MINI PRISM
101	483330.3931	1303925.5100	25MM MINI PRISM
102	483187.4617	1304015.2959	25MM MINI PRISM
103	483103.7294	1303923.4118	25MM MINI PRISM

WMATA VERTICAL SURVEY CONTROL

POINT ID	ELEVATION	DESCRIPTION
BM1	306.9714	BERNTSEN RS30 PLASTIC SMART TARGET
BM1A	301.0633	PK NAIL
BM1B	300.8369	BERNTSEN RS30 PLASTIC SMART TARGET

WMATA HORIZONTAL SURVEY CONTROL

POINT ID	NORTHING	EASTING	DESCRIPTION
200	483438.0481	1303837.1604	25MM MINI PRISM
201	483463.6393	1303814.2208	25MM MINI PRISM
202	483481.2826	1303765.9228	25MM MINI PRISM
203	483256.9601	1303850.5444	25MM MINI PRISM
204	483143.9050	1303836.6066	25MM MINI PRISM

WMATA VERTICAL SURVEY CONTROL

POINT ID	ELEVATION	DESCRIPTION
BM2	327.8824	BERNTSEN RS30 PLASTIC SMART TARGET

WMATA HORIZONTAL SURVEY CONTROL

POINT ID	NORTHING	EASTING	DESCRIPTION
301	483257.3121	1304007.6350	25MM MINI PRISM
302	483362.0978	1303904.7943	25MM MINI PRISM
303	483473.1899	1303782.5505	25MM MINI PRISM
304	483471.2749	1303687.3312	25MM MINI PRISM
305	483383.8157	1303726.6814	25MM MINI PRISM
306	483183.2417	1303904.1828	25MM MINI PRISM

WMATA VERTICAL SURVEY CONTROL

POINT ID	ELEVATION	DESCRIPTION
BM3	348.7744	BERNTSEN RS30 PLASTIC SMART

Concrete Slab Thickness (inches)

Number	Minimum Elevation	Maximum Elevation	Color	Surface Area (sq.ft.)
1	7.00	8.00		6.5
2	8.00	9.00		84.9
3	9.00	9.76		1675.8
4	9.76	10.38		6751.9
5	10.38	11.00		7040.1
6	11.00	13.00		6678.0

NOTE: 1 FOOT CONTOURS ARE BASED ON TOP OF CONCRETE SLAB ONLY.

© LATEST DATE HEREON

SURVEYOR'S NOTES

1. ATTENTION IS DIRECTED TO THE FACT THAT THIS MAP MAY HAVE BEEN REDUCED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.
2. GREENHORNE & O'MARA, INC. AND THE CERTIFYING SURVEYOR ACCEPT NO RESPONSIBILITY FOR RIGHT-OF-WAYS, EASEMENTS, RESTRICTIONS OR OTHER MATTERS AFFECTING TITLE TO THE LANDS SURVEYED.

REVISIONS: DATE:

ENGINEERS • ARCHITECTS • PLANNERS • SCIENTISTS • SURVEYORS • PHOTOGRAMMETRISTS
GREENHORNE & O'MARA, INC.
3223 COMMERCE PLACE, SUITE 100
WEST PALM BEACH, FL 33407
(561) 686-7707
ANNAPOLIS, MD • FAIRFAX, VA • FREDERICKSBURG, VA • LAUREL, MD
MECHANICSBURG, PA. • RALEIGH, NC • ROCKVILLE, MD • ST. PETERSBURG, FL • WALDORF, MD

FORENSIC SURVEY FOR:

SILVER SPRING TRANSIT CENTER
CONCRETE FLOOR SLABS

SILVER SPRING, MARYLAND

DESIGN	SCALE 1" = 20'
RITZEL DRAWN	2 OF 2
ADLER CHECKED	
11/25/2011 DATE	030931.053.ADLE.459 DRAWING NO.

Appendix D – Cited Standards

ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 318	Building Code Requirements for Structural Concrete
ACI 306R	Guide to Cold Weather Concreting
ACI 306.1	Specification for Cold Weather Concreting
ACI 308R-01	Guide to Curing Concrete
ACI 309R-96	Guide for Consolidation of Concrete
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	Standard Specification for Ready-Mixed Concrete

Appendix E – Sample Reports

This appendix contains examples of some of the records that were reviewed during the analysis. It is not intended to be complete, because several thousand pages of construction records were created for the SSTC project. These sample pages are included for the benefit of the reader who does not have access to the full KCE Exhibits. The samples selected for inclusion in this appendix are associated with concrete pour 1Eb which was cast on December 10, 2010. This pour was chosen arbitrarily and illustrates cold weather provisions.

Page	Description	KCE Exhibit Source
80	FP daily CQC report	A4 pages 150, 151
82	RBB inspector's daily report	B4 pages 401, 403
84	concrete slab temperature report	B4 page 405
86	concrete cylinder test specimen ticket	S1 *
87	concrete cylinder test log	S1 page 588
88	concrete cylinder break report	R3 page 150

* The KCE Exhibit contains pages similar to the sample, but this particular page was missing from the KCE Exhibit and was provided by RBB as page 187 of their April 22, 2013 letter.

Note: The information provided in this appendix is taken from the noted KCE Exhibits. It has been reformatted slightly to fit this document but is not otherwise a product of this analysis. The content has not been verified and is provided for information purposes only.

Foulger Pratt Construction

Daily CQC Report

Project	Day: 743
Silver Spring Transit Center	**Fri, 10-Dec-10**
51-0037	Weather; Temp. (AM/PM):
	clear 27-445

NO.	FOULGER PRATT PERSONNEL	NO.	FOULGER PRATT PERSONNEL	NO.	OWNER / ARCHITECT
1	Project Executive	2	Assistant Superintendent	1	Architect
1	Project Manager	1	CQC Assistant Manager	1	Owner Representative
1	CQC Manager		Field Engineers / Surveyors		Developer Representative
1	Superintendent	1	Safety officer		Consultants
2	Assistant Project Manager	4	Laborers	1	Project Admin. Asst.

NO.	SUBCONTRACTOR / TRADE	CPM Activity	WORK PERFORMED
5	Ross	02230	excavate grade beam for pedestrian bridge, test pit for duct bank, backfill at A-line and radius wall
5	Ross Colesville Road	02530	excavate towards SS1, load contaminated soil
1	CHS		traffic control
2	W&R	Div 15	layout, install drain pour 1D
5	Freestate	Div 15	layout, install conduit pour 1D
1	American Automatic	13935	install sleeve pour 1Eb
3	Berkel	02260	drill piles 10, 11, place concrete piles 1, 8, 9
	Consolidated	07170	
	Facchina	03300 03381	place concrete pour 1Eb
			grout blocked tendons in pour 1A & 2A
			install non corrosive material in pour 1Ea tendon ducts

NO.	INSPECTION / TESTING AGENCY	TEST / INSPECTION PERFORMED	SPEC SECTION	Para / Dwg	COMMENTS	LOCATION
4	Balter	visual / PT / grout	03300 03381		see report	various
	Balter	visual	02260		see report	Box culvert
2	FPC	visual	03300 03381		inspected material and installation	various
	FPC	visual	02260		inspected material and installation	Box culvert

Poulger Pratt Construction

Daily CQC Report

Project **Silver Spring Transit Center** **51-0037**	

MATERIAL RECEIVED (see attached)	Approved (Y/N)	SUB RESPONSIBI	COMMENTS

No.	DEFICIENCIES IDENTIFIED	SPEC SECTION	SUB RESPONSIB	CORRECTIVE ACTION	LOCAT
	DEFICIENCIES CORRECTED				

SUBMITTALS REVIEWED	SUBMITTAL #	SPEC SECTION	REVIEWED BY	ACTIC

GENERAL NOTES / OBSERVATIONS /SAFETY

no safety violations

Monitoring of soldier piles / lagging: visual

7:45 QC mtg. discussion items: 1.) PT stressing procedures. 2.) use of EUCOBAR. 3.) use of air entraned concrete at trowled 4.) FCC indicated that no salts are to be used on slabs for one year after placement.

FPC held meeting for revised multi strand stressing procedures

EUCOBAR rep onsite

DIRECTION PROVIDED BY THE OWNER / ARCHITECT

Contractor's Verification Statement: Workmanship and all equipment and materials incorporated into the SSTC project comply with the Contract Documents

CQC Representative: [signature]

Brook Foster (NAME)

10-Dec-10 (DATE)

THE ROBERT B. BALTER COMPANY

DAILY REPORT

Page 1 of 1

Project: Silver Spring Transit Center — Contract No.: 16027-0

Client: Montgomery County — Date: 12/10/2010

Contractors: Foulger-Pratt — Weather: Mostly cloudy — Temps: 28-35

Type of Inspections: Inspection of post-tensioning system installation

Tests Performed:

Samples Sent for Testing:

Contacts: Shak B., Brook Foster, Scott Hamilton, Doug Goetz

Summary of today's work: Facchina: 1. Attended meeting regarding revised multistrand and monostrand stressing procedures. Procedures were devised by Facchina and VSL, and have been approved by Doug Lang/PB. See procedure documents for details.

2. Stressed tendons of pour 2B. Uniform tendons were stressed (50% of total); temperature tendons were stressed (all). Willie Lewis of VSL supervised operations.

3. Concrete test cylinder strength of pour 2B exceeded 4000 psi @ 3 days.

4. Continued placing tendons and associated reinforcement for pour 1D. Placement is ongoing and will continue next working day.

NON-COMPLIANT ISSUES:

PARTIES NOTIFIED:

RESOLUTION:

Verification: — Hours: Reg 8 OT 4 — Inspector: Tony Lord

INFORMATION IS SUBJECT TO FINAL REVIEW: Supervisor: — PE:

THE ROBERT B. BALTER COMPANY

DAILY REPORT

Project: Silver Spring transit ctr.

Contract No.: 16027-G

Client: Montgomery county

Date: 12-10-10

Contractors: Facchina

Weather: Cloudy/Snow Temps: 28°-35°

Type of Inspections: concrete quality assurance

Tests Performed:

Samples Sent for Testing:

Contacts:

Summary of today's work: Facchina: placed approx 150 cubic yards of 8,000 psI concrete for deck pour. IER elevation 330' Level. I assisted tom w. with sampling and testing of concrete. Concrete placement was monitored. Concrete test cylenders were made, slump test, aE-contents, and concrete temps were taken. All per spec.

NON-COMPLIANT ISSUES:

PARTIES NOTIFIED:

RESOLUTION:

Verification: Hours: Reg 8 OT Inspector: [signature]

INFORMATION IS SUBJECT TO FINAL REVIEW: Supervisor: PE:

THE ROBERT B. BALTER COMPANY
Geotechnical Engineers

410-363-1555
18 Music Fair Road, Owings Mills, MD 21117

CONCRETE SLAB TEMPERATURE REPORT

Project: Silver Spring Transit

Contract No. 16027-0

Date: 12-10-10

Placement ID:

Time	Location in placement	Concrete Temperature	Weather/Ambient Temperature
7:03AM	DECK POUR 2B 350' 1ST LOCATION	No thermometer	CLEAR, 19°
7:06AM	DECK POUR 2B 350' 2ND LOCATION	94° / 76°	CLEAR, 19°
7:11AM	UNDER 2B 350' FORMWORK TEMP	76°	CLEAR, 19°
7:19AM	UNDER STEPS (FIELD CURE AREA)	78° / 46°	CLEAR, 19°
7:08AM	CURING BOX ON DECK 350'	56° / 42°	CLEAR, 19°
7:20AM	CURING SHED	88° / 82°	CLEAR, 19°
4:00PM	Deck pour 2B level 350', 1st loc.	93°/74°	Clear 35°
4:02PM	Deck pour 2B level 350', 2nd loc.	90°/72°	" "
4:08PM	Underside 2B level 350' formwork	75°	" "
4:05PM	Curing box on deck 350' FC	55°/43°	" "
4:10	Curing Shed	75°/72°	" "

(4)

THE ROBERT B. BALTER COMPANY
Geotechnical Engineers

18 Music Fair Road
Owings Mills, Maryland 21117

COMPRESSIVE STRENGTH TEST SPECIMEN DATA

Project: SST Ctr Proj. No.: 16027-0-MD
Client: Montgomery Co.
Contractor: Facchina
Sample Location: DECK POUR 1EB 330' LEVEL BETWEEN COLUMN LINE 10.2 & 10.8 and C9 & E
Method of Placement: Concrete Pump
Slump: 7.5" inches
Water added at site? ☐ Yes, ______ gallons ☒ No
Specimen made by: TOM W & JOSH M
Concrete Temperature: 60° °F
Air Content: 4.6% ☐ N/A
Specimen Set No.: 463

Supplier: Rockville Fuel & Feed Co
Ticket No.: 91444 Truck No.: 26
Water-Cement Ratio: 0.26
Mix Number: 8K2DC2NL
Mix Design: 8000psi
Time Batched: 10:45AM
Batch Size: 10 cu yds
Date Molded: 12-10-10 Time: 12:19pm
Date Delivered to Lab: ______
Unit Weight: ______ PCF ☒ N/A
Weather: CLOUDY
Air Temperature: 27° °F

Test Req'd: ____ At ____ Days; 2 At 7 days; ____ At 14 Days; 3 At 28 Days; ____ Reserved

Remarks: Revolutions = 89, 2 = 56-day Breaks (Lab Cured), 2 = 3-day Breaks (Field Cured), 2 = 5-day Breaks (Field Cured), 3 = 28-day Breaks (Field Cured)

ROCKVILLE FUEL AND FEED
PLANT #1 & #2

10Dec10
10:45AM

Flop Gate:.. DRY
Batch:. 2 of 2

Volume:10.00 yd3   Mix ID: 8K2DC2NL   Mix Desc:.8000 PSI #8 ST AIR/2DCI
Truck #:... 26   MAXWELL AKOTO   Ticket # 91444
FACCHINA CONSTRUCTION CO., INC.
SILVER SPRING TRANSIT CENTER-750

W/(C+P) Ratio: 0.26

Material		Design	Moist		Target	Actual	Free H2O	Status
CON_SAND		1000 Lb	5.5%	0.0%	5291 Lb	5260 Lb	291 Lb	Done
STONE8		1850 Lb	0.5%	0.0%	9296 Lb	9260 Lb	46 Lb	Done
CEMENT		550 Lb	0.0%		2750 Lb	2740 Lb	0 Lb	Done
SLAG		360 Lb	0.0%		1800 Lb	1790 Lb	0 Lb	Done
AEA	*1	9.0 oz	100.0%		23 oz	24 oz	2 Lb	Done
WRDA		41.0 oz	0.0%		205 oz	204 oz	0 Lb	Done
SUPER		54.6 oz	100.0%		273 oz	272 oz	18 Lb	Done
DCI		256.0 oz	100.0%		1280 oz	1312 oz	85 Lb	Done
WATER	*1	31.0 Gal	100.0%		88 Gal	88 Gal	733 Lb	Done

Ice/Batch 0 Lb   Water allowed by mix design:. 310   Total Water 280
Moisture compensation water:. 104   Water allowed at jobsite: 30 Gal

14th Truck 8:00 p.m.

ROCKVILLE FUEL & FEED COMPANY, INC.

Set # 4 (6x12)

READY MIXED CONCRETE

Revs: 87
Air Temp: 27
Conc Temp: 60
Slump: 7.5
Air: 5.4%
Time: 12:11 pm

CAUTION: FRESHLY MIXED CONCRETE ... KEEP OUT OF REACH OF CHILDREN

P.O. Box 1707 12-10-10
Rockville, MD 20849-1707

(4)

PLANT LOCATIONS:
Rockville, MD
College Park, MD
Columbia, MD

301-762-3988
1-877-847-RMIX

DATE		TICKET #
10-DEC-10	4 CYL MADE	[illegible]

CUSTOMER #	CUSTOMER NAME	PROJECT #	PROJECT NAME
7572	FORTUNA CONSTRUCTION CO., INC.	[illegible]	SILVER SPRING ... CENTER [illegible]

DELIVERY ADDRESS	MAP	LOT/BLOCK	P.O. #	CUSTOMER JOB NUMBER
8444 COLESVILLE ROAD, SILVER SPR				

INSTRUCTIONS
RVL - E/MONTROSE, R/GEORGIA AVE., ... L/COLESVILLE RD TO JOB ON RIGHT.
**** DRUM ROTATION COUNTER MUST BE WORKING ****

USE: SLAB

PLANT	TRUCK #	DRIVER	ORDER #	
1	35	MCDOWELL, [illegible]	34	[illegible]

LOAD TIME: 10:43PM
START POUR:
ARRIVE JOB SITE:
FINISH POUR:

ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH.
ANY WATER ADDED IS AT CUSTOMER'S RISK.
WATER ADDED ON JOB AT CUSTOMER'S REQUEST ______ GAL.
WATER ADDED TO THIS LOAD BY AUTHORITY OF X ______

LOAD QUANTITY	CUMULATIVE QUANTITY	ORDERED QUANTITY	PRODUCT CODE	PRODUCT DESCRIPTION	UNIT OF MEASURE	UNIT PRICE	AMOUNT
10.00	140.00	170.00	[illegible]	3000 PSI ...	[illegible]		

NOTE: CUMULATIVE QUANTITY VALUES MAY NOT REFLECT ACTUAL YARDS DELIVERED ON JOB.

CON_SAND	1800 Lb	WRA	#1	9.0 oz	SUB TOTAL	
STONE	1620 Lb	WRDA		41.0 oz	TAX	
CEMENT	330 Lb	RUPPER		24.6 oz	TOTAL	
WATER #1	31.0 Ga	DCI		234.0 oz		
SLAG	300 Lb					

I HEREBY AUTHORIZE THE TRUCK (OR TRUCKS) DELIVERY MATERIAL TO THIS JOB TO LEAVE THE ROAD AND DRIVE ONTO PRIVATE PROPERTY AS DIRECT. IN GRANTING THIS AUTHORIZATION I ASSUME RESPONSIBILITY FOR ANY AND ALL DAMAGE THAT MAY BE DONE TO SAID PRIVATE PROPERTY AND TO ANY OTHER PROPERTY ADJACENT TO SAID PROPERTY THAT MAY BE TRESPASSED ON FOLLOWING MY DIRECTIONS. I FURTHER INDEMNIFY ROCKVILLE FUEL & FEED COMPANY, INC. AND THE DRIVER OF THIS TRUCK (THESE TRUCKS) FROM ANY LIABILITY RESULTING FROM THIS AUTHORIZATION.

Deck pour [illegible] 337' Level ... Column lines ... 2 & 10.8 and C9 & E

CUSTOMER ACKNOWLEDGES AND UNDERSTANDS ALL OF TERMS AND CONDITIONS CONTAINED ON BOTH SIDES OF THIS DOCUMENT.

RECEIVED BY: X

CUSTOMER ... SIGNATURE

THE ROBERT B. BALTER COMPANY

Silver Spring Transit Center Project

CONCRETE TESTING INFORMATION

Specimen set #	Date	Truck #	Ticket #	Slump	Air %	Concrete Temp.	Air Temp
460	12-10-10	27	91399	8"	6.2%	60°	24°
461	12-10-10	30	91403	8"	5.1%	60°	24°
462	12-10-10	83	91423	8"	4.5%	60°	27°
463	12-10-10	26	91444	7.5"	4.6%	60°	27°
464	12-9-10	43	91329	7.5"	6.1%	65°	28°
465	12-9-10	410	91340	4"	6.4%	67°	32°
466	12-16-10	3600216	65349618	8"	6.5%	60°	20°
467	12-17-10	3600046	65349644	8"	4.9%	65°	30°
468	12-20-10	67	91818	6.5"	5.1%	55°	19°
469	12-20-10	67	91818	7.5"	5.3%	57°	19°
470	12-20-10	74	91821	7.5"	6.2%	55°	19°
471	12-20-10	79	91826	7.5"	6.5%	58°	18°
472	12-20-10	84	91832	7.5"	4.1%	55°	19°
473	12-20-10	77	91837	7"	6.2%	55°	20°
474	12-20-10	77	91837	8"	5.7%	58°	19°
475	12-20-10	83	91843	8"	5.5%	55°	21°
476	12-20-10	79	91849	7"	5.6%	61°	21°
477	12-20-10	32	91855	7.5"	5.9%	61°	21°
478	12-20-10	37	91862	8"	6.9%	61°	22°
479	12-20-10	56	91881	6"	4.0%	62°	22°
480	12-20-10	79	91883	7"	5.7%	60°	22°
481	12-20-10	79	91883	7.5"	5.9%	61°	22°
482	12-20-10	43	91889	7.5"	5.5%	61°	23°

REPORT OF CONCRETE CYLINDER TEST
THE ROBERT B. BALTER COMPANY
Silver Spring Transit Center

Report Date: 1/7/11

Project Number: 16027-0

Report Number: 515

Project: Silver Spring Transit Center

Client: Montgomery County DPW&T/DCD/CS

Address: 1110 Bonifant Street,
Silver Spring, Maryland 20910

Attn: Mr. Timothy O'Gwin

FIELD TEST CONDITIONS AND RESULTS (AASHTO T 23))

Contractor: Facchina

Date Placed: 12/10/2010

Number of Specimens: 14

Time Sampled: 12:19 PM

Reserves: 0

Location of Sample: Deck Pour 1EB, 330' Level, Between Column Lines 10.2 & 10.8 and C9 & E.

Supplier: Rockville Fuel & Feed Co.

Truck Number: 26

Method of Placement: Concrete Pump Truck

Mix Number: 8K2DC2NL

Method of Curing: Field Cured & Moist Cured

Design Strength: 8000

Ticket Number: 91444

Time Batched: 10:45 AM

Time Placed: 12:19 PM

Batch Size: 10.0

Unit Weight: N/A (ASTM C 138)

Slump: 7.5" (AASHTO T 119)

Air Content: 4.6% (AASHTO T 152)

Concrete Temp: 60 (ASTM C 1064)

Ambient Temp: 27

Water Added: NO

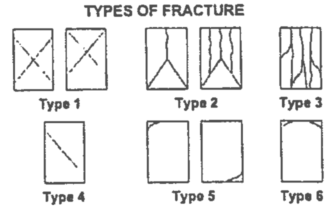
Technician: Tom W & Josh M

LABORATORY TEST RESULTS (AASHTO T 22)

Specimen	Test Date	Age	Load	Diameter	Area	Strength	Percent of Design	Type of Fracture
FC 5488	12/13/2010	3	127800	4.00	12.57	10170	127%	3
FC 5488	12/13/2010	3	125960	4.00	12.57	10020	125%	3
FC 5488	12/15/2010	5	127780	4.00	12.57	10170	127%	5
FC 5488	12/15/2010	5	127960	4.00	12.57	10180	127%	5
5488	12/17/2010	7	146060	4.00	12.57	11620	145%	5
5488	12/17/2010	7	147120	4.00	12.57	11710	146%	5
5488	1/7/2011	28	156250	4.00	12.57	12430	155%	2
5488	1/7/2011	28	155040	4.00	12.57	12340	154%	2
5488	1/7/2011	28	152270	4.00	12.57	12120	152%	2
FC 5488	1/7/2011	28	154880	4.00	12.57	12330	154%	2

Remarks: W/C Ratio: 0.26
Revolutions = 89; 2 = 56 Day Breaks (Lab Cured);
2 FC = 3 Day Breaks; 2 FC = 5 Day Breaks;
3 FC = 28 Day Breaks *** FC = Field Cured ***

TYPES OF FRACTURE



Copies to:

Reported by: ____________________

Vincent Gerard V. Pineda
Engineering Technician

This Page Intentionally Blank

Alpha Corporation
1800 Washington Boulevard, Suite 425
Baltimore, MD 21230
Tel: (410) 646-3044 Fax: (410) 646-3730

www.alphacorporation.com