

A thick blue vertical bar is positioned on the left side of the page. A thin black horizontal line and a thin black vertical line intersect to form a crosshair, with the intersection point located to the right of the blue bar.

PROJECT SPECIFICATIONS

EXPAND EAST PARKING STRUCTURE

ANN ARBOR, MI

Prepared for:
DEPT. OF VETERANS AFFAIRS

Page intentionally left blank.

DEPARTMENT OF VETERANS AFFAIRS

TABLE OF CONTENTS
Section 000110

	DIVISION 00 - SPECIAL SECTIONS
000115	List of Drawing Sheets
000860	Subsurface Soils Report
	Preliminary Geotechnical Evaluation Report
	DIVISION 01 - GENERAL REQUIREMENTS
010000	General Requirements
013216.15	Project Schedules (Small Projects - Design/Bid/Build
013323	Shop Drawings, Product Data, and Samples
014529	Testing Laboratory Services
015719	Temporary Environmental Controls
017419	Construction Waste Management
	DIVISION 02 - EXISTING CONDITIONS
024100	Demolition
	DIVISION 03 - CONCRETE
033000	Cast-in-Place Concrete
034133	Precast Structural Pre-Tensioned Concrete
	DIVISION 04 - MASONRY
040523	Masonry Procedures and Accessories
042000	Unit Masonry
047200	Cast Stone Masonry
	DIVISION 05 - METALS
051200	Structural Steel Framing
053100	Steel Decking
055000	Metal Fabrications
	DIVISION 06 - WOOD, PLASTICS AND COMPOSITES
060700	Pressure-Treated Wood Products
061000	Rough Carpentry
	DIVISION 07 - THERMAL AND MOISTURE PROTECTION
071816	Vehicular Traffic Coatings
071916	Silane Water Repellents
076000	Flashing and Sheet Metal
076100	Metal Roofing Systems

079200	Joint Sealants
	DIVISION 08 - OPENINGS
081113	Hollow Metal Doors and Frames
087100	Door Hardware
	DIVISION 09 - FINISHES
099100	Painting
	DIVISION 10 - SPECIALTIES
101400	Signage
104413	Fire Extinguisher Cabinets
	DIVISION 21- FIRE SUPPRESSION
210511	Common Work Results for Fire Suppression
211200	Fire-Suppression Standpipes
	DIVISION 22 - PLUMBING
220511	Common Work Results for Plumbing
221100	Facility Water Distribution
221400	Facility Storm Drainage
	DIVISION 26 - ELECTRICAL
260511	Requirements for Electrical Installations
260521	Low-Voltage Electrical Power Conductors and Cables (600 Volts and Below)
260526	Grounding and Bonding for Electrical Systems
260533	Raceway and Boxes for Electrical Systems
260541	Underground Electrical Construction
260923	Lighting Controls
262726	Wiring Devices
264100	Facility Lightning Protection
265100	Interior Lighting
265600	Exterior Lighting
	DIVISION 28 - ELECTRONIC SAFETY AND SECURITY
282300	Video Surveillance
	DIVISION 31 - EARTHWORK
312000	Earth Moving
316316	Auger Cast Grout Piles
316326	Drilled Caissons
	DIVISION 32 - EXTERIOR IMPROVEMENTS

321216	Asphalt Paving
321723	Pavement Markings
323113	Chain Link Fences and Gates
	DIVISION 33 - UTILITIES
331000	Water Utilities
333000	Sanitary Sewerage Utilities
334000	Storm Drainage Utilities
334613	Foundation Drainage

Page intentionally left blank.

SECTION 000115 - LIST OF DRAWING SHEETS

The drawings listed below accompanying this specification form a part of the contract.

Drawing No.

Title

GENERAL

G-001	Cover Sheet, Drawing Index & Site Location Map
G-002	Legends, Code Analysis Summary & Abbreviations

CIVIL / LANDSCAPE

C-100	Existing Site Survey & Demolition Plan
C-101	Dimensional Site Plan
C-102	Grading & Site Utilities Plan
C-103	Soil Erosion & Sediment Control Plan
C-501	Site Details
L-101	Landscape Planting Plan
L-501	Landscape Details & Plant Schedule

STRUCTURAL / DEMOLITION

SD-201	Demolition Elevation & Details
--------	--------------------------------

STRUCTURAL

S-001	General Notes and Details
S-100	Foundation Plan
S-101	Level A Plan
S-102	Level B Plan
S-103	Level C Plan
S-104	Level D Plan
S-210	Shear Wall Elevations & Details
S-501	Foundation Schedule & Details
S-502	Foundation Details
S-503	Foundation Details
S-504	Foundation Details
S-510	Column & Beam Details
S-515	Tee Details
S-520	Structural Details
S-521	Structural Details
S-522	Structural Details
S-601	Lap Splice Schedule

ARCHITECTURAL

A-101	Level A Plan
A-102	Level B Plan
A-103	Level C Plan
A-104	Level D Plan
A-201	Building Elevations
A-202	Building Elevations
A-301	Exterior & Interior Wall Sections
A-302	Exterior & Interior Wall Sections
A-303	Exterior & Interior Wall Sections
A-401	Storage Room Plan & Miscellaneous Details
A-501	Architectural Details
A-502	Architectural Details
A-503	Architectural Details

GRAPHICS

AG-601	Sign Schedule, Sign & Mounting Details
--------	--

MECHANICAL / PLUMBING

M-001	General Notes & Details
M-101	Level A Plan
M-102	Level B Plan
M-103	Level C Plan
M-104	Level D Plan
M-601	Riser Diagrams

ELECTRICAL

E-001	Lighting Fixture Schedule, General Notes, Symbols & Abbreviations
E-101	Level A Plan
E-102	Level B Plan
E-103	Level C Plan
E-104	Level D Plan
E-401	Enlarged Room Plan
E-501	Electrical Details
E-601	Panel Schedules

END OF SECTION 000115

SECTION 000860 - SUBSURFACE SOILS REPORT

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The following report furnished by the Owner describes the results of the subsurface investigation made on the site. It and the tabulated results of the borings are included for the Contractor's information only. The Contractor shall determine soil conditions and shall accept conditions as they exist.
- B. The data on indicated subsurface conditions are not intended as representations of warranties of the continuity of such conditions between soil borings. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn there from by the Contractor. The data are made available for the convenience of the Contractor.

END OF SECTION 000860

This page left blank intentionally.

above ground storage tank
air quality
asbestos/lead-based paint
baseline environmental assessment
brownfield redevelopment
building/infrastructure restoration
caisson/piles
coatings
concrete
construction materials services
corrosion
dewatering
drilling
due care analysis
earth retention system
environmental compliance
environmental site assessment
facility asset management
failure analyses
forensic engineering
foundation engineering
geodynamic/vibration
geophysical survey
geosynthetic
greyfield redevelopment
ground modification
hydrogeologic evaluation
industrial hygiene
indoor air quality/mold
instrumentation
masonry/stone
metals
nondestructive testing
pavement evaluation/design
property condition assessment
regulatory compliance
remediation
risk assessment
roof system management
sealants/waterproofing
settlement analysis
slope stability
storm water management
structural steel/welding
underground storage tank

PRELIMINARY GEOTECHNICAL EVALUATION REPORT

ADDITION TO EAST PARKING STRUCTURE UNITED STATES DEPARTMENT OF VETERANS AFFAIRS ANN ARBOR HEALTH SYSTEM ANN ARBOR, MICHIGAN

**SME Project No. PG62404
November 9, 2010**



© 2010 soil and materials engineers, inc.

Soil and Materials Engineers, Inc.



Soil and Materials Engineers, Inc.

The Kramer Building
43980 Plymouth Oaks Blvd.
Plymouth, MI 48170-2584

tel (734) 454-9900
fax (734) 454-0629
www.sme-usa.com

Kenneth W. Kramer, PE
Founder

Mark K. Kramer, PE
Timothy H. Bedenis, PE
Gerald M. Belian, PE
Chuck A. Gemayel, PE
James M. Harless, PhD, CHMM
Larry P. Jedele, PE
Cheryl A. Kehres-Dietrich, CGWP
Edward S. Lindow, PE
Gerard P. Madej, PE
Timothy J. Mitchell, PE
Robert C. Rabeler, PE
Daniel O. Roeser, PG

Daniel R. Cassidy, CPG
Andrew J. Emmert, CPA
Sheryl K. Fountain, SPHR
Michael E. Gase, CWI, ASNT III
Davie J. Hurlburt, PE
Laurel M. Johnson, PE
Jeffery M. Krusinga, PE, GE
Michael S. Meddock, PE
Mark L. Michener, LEED GA, CDT
Louis J. Northouse, PE
Joel W. Rinkel, PE
Jason A. Schwartzenger, PE
Larry W. Shook, PE
Thomas H. Skotzke
Michael J. Thelen, PE
John C. Zarzecki, CET, CDT, NDE

November 9, 2010

Mr. Michael E. Johnson, PE
Walker Parking Consultants
525 Avis Drive, Suite 1
Ann Arbor, Michigan 48108

RE: Preliminary Geotechnical Evaluation
Addition to East Parking Structure
United States Department of Veterans Affairs
Ann Arbor Health System
Ann Arbor, Michigan
SME Project No. PG62404

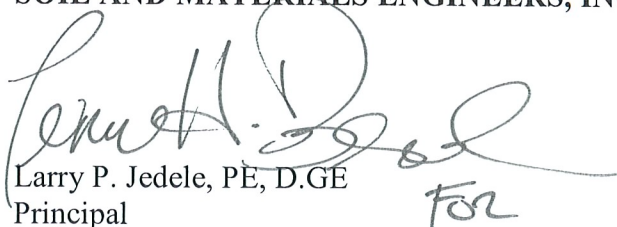
Dear Mr. Johnson:

We have completed our preliminary geotechnical evaluation for the proposed addition to the east parking structure at the United States Department of Veterans Affairs Ann Arbor Health System in Ann Arbor, Michigan. This report presents the results of our observations and analyses, our preliminary geotechnical recommendations for general site preparation, subgrade preparation for grade slabs, re-use of on-site soils as engineered fill, foundation design, below-grade walls and drainage, and general construction considerations based on the information disclosed by the borings.

We appreciate the opportunity to be of service. If you have questions or require additional information, please contact me.

Very truly yours,

SOIL AND MATERIALS ENGINEERS, INC.


Larry P. Jedele, PE, D.GE
Principal

Enclosed: Two originals

OFFICES
Indiana
Michigan
Ohio

T:\PROJ\62000\PG62404\PG62404-110910-RPT.DOC

© 2010 soil and materials engineers, inc.

consultants in the geosciences, materials, and the environment

TABLE OF CONTENTS

SUMMARY	i
1. INTRODUCTION.....	1
1.1 Previous Evaluation	1
1.2 Site Conditions.....	1
1.3 Project Description.....	2
2. EVALUATION PROCEDURES.....	2
2.1 Field Exploration	2
2.2 Laboratory Testing.....	3
3. SUBSURFACE CONDITIONS	3
3.1 Soil Conditions.....	3
3.2 Groundwater Conditions	5
4. PRELIMINARY ANALYSIS AND RECOMMENDATIONS.....	5
4.1 Site Preparation and Earthwork	5
4.1.1 Existing Fill Considerations	5
4.1.2 General Site Subgrade Preparation.....	6
4.1.3 Subgrade Preparation for Grade Slabs	8
4.1.4 Engineered Fill Requirements	9
4.2 Foundations.....	10
4.2.1 Augered Cast-In-Place (ACIP) Piles.....	10
4.2.2 Concrete Filled Steel Pipe Piles	13
4.3 Seismic Site Class	15
4.4 Below-Grade Walls and Drainage	15
4.5 Construction Considerations.....	17
APPENDIX A:	
Boring Location Diagram	
General Notes	
Unified Soil Classification System (USCS)	
Boring Logs (B1 through B3)	
APPENDIX B:	
Important Information about your Geotechnical Engineering Report	
General Comments	
Laboratory Testing Procedures	

SUMMARY

The report conclusions and preliminary recommendations are summarized as follows.

1. The soil conditions encountered at the boring locations generally consist of surface topsoil overlying sand fill underlain by interbedded layers of sands and clays to the explored depths of the borings. Groundwater was encountered during the drilling operations from about 19 to 52 feet below the existing ground surface.
2. There is an increased risk of cracking and settlement associated with constructing grade slabs on undocumented fill. In general, we believe the risk of poor performance of grade slabs constructed over the existing undocumented fill is relatively low. However, test pits should be performed prior to construction to evaluate the fill and its suitability for grade slab support.
3. The existing fill and natural sands and clays encountered at the site are generally considered suitable for the reuse as engineered fill. The clays will likely require moisture conditioning prior to reuse as engineered fill.
4. Deep foundations consisting of either augered cast-in-place (ACIP) piles or concrete filled pipe piles are recommended for support of the proposed parking structure addition. A working capacity of 100 tons is feasible for 16-inch diameter ACIP piles and 125 tons for 12-3/4-inch diameter pipe piles bearing in the dense to extremely dense natural sands and/or hardpan.
5. Groundwater seepage into utility excavations is generally not anticipated to be a significant factor during construction. Groundwater seepage on a localized basis can typically be controlled utilizing normal sump pit and pumping procedures. In areas where groundwater accumulates, a working surface of crushed aggregate or crushed concrete may be required to protect the exposed surface from disturbance.

The summary presented above includes selected elements of our findings and recommendations and is provided solely for purposes of overview. It does not present crucial details needed for the proper application of our findings and recommendations. It should, therefore, not be considered apart from the entire text of this report and appendices, with all of the qualifications and considerations mentioned therein which are best evaluated with the active participation of SME.

REPORT PREPARED BY:

Kevin L. Wilk, PE
Project Engineer

REPORT REVIEWED BY:

Timothy H. Bedenis, PE
Principal

1. INTRODUCTION

This report presents the results of the geotechnical evaluation performed by Soil and Materials Engineers, Inc. (SME) for the proposed addition to the east parking structure at the United States Department of Veterans Affairs Ann Arbor Health System in Ann Arbor, Michigan. This evaluation was conducted in general accordance with the scope of services outlined in SME Proposal No. P10-1111, dated October 15, 2010. This evaluation was authorized by Mr. Michael Johnson, PE of Walker Parking Consultants. This report is considered “Preliminary” until additional borings are performed by SME during the “Construction Phase” when the site is cleared of trees and brush.

1.1 Previous Evaluation

SME performed the original geotechnical evaluation for the East Parking Structure. The results of that evaluation are summarized in our Geotechnical Evaluation Report dated February 16, 1993. In that report, we provided recommendations for augered cast-in-place (ACIP) piles and concrete filled steel pipe piles for support of the parking structure. The option for the pipe piles was used for construction. Based on our letter to Mr. Jay Desai, PE, of then Jay Desai Consulting Engineers, Inc., the design diameter of the pipe piles was increased to 14 inches from 12-3/4 inches in our geotechnical report to develop the needed lateral support. The piles were designed for a working capacity of 125 tons bearing in dense to extremely dense sand at pile tip elevations of about 757 to 774 feet (about 5 feet shallower in tip elevation than the originally recommended 12-3/4 inch piles. Additionally, since about 2 to 20 feet of fill was to be placed adjacent to the west wall of the east parking structure, there was to be a reduction in the pile capacity of 25 tons per pile due to downdrag forces, resulting in a working capacity of 100 tons per pile. We provided several recommendations for measures that could be taken to reduce the downdrag effect. However, we are not aware if the recommendations were incorporated in final design.

1.2 Site Conditions

The United States Department of Veterans Affairs Ann Arbor Health System facility is located at 2215 Fuller Road, which is east of Bonisteel Boulevard and west of Huron Parkway, in Ann Arbor, Michigan. Based on our observations, the area for the proposed East Parking Structure addition consists of open grassy landscaped areas, wooded area, and a gravel surface parking area. Based on the Existing Conditions drawing dated November 1, 2010, prepared by Midwestern Consulting, the ground surface slopes downward from the northwest to southeast, ranging from about elevation 814 feet near the northwest corner of the existing parking structure

to about elevation 794 feet near the east portion of the site. An existing asphalt concrete drive traverses the proposed building addition area from the north at the existing hospital entrance to the south where it connects to the existing parking structure.

The existing parking structure contains three supported levels and consists of both cast-in-place and precast concrete sections.

1.3 Project Description

The project will consist of the design and construction of an addition extending northeast of the existing parking structure. The addition will contain three supported levels (with possible two additional supported levels of future construction) and will be similar in construction to the existing parking structure. Based on information obtained from Walker Parking Consultants in an email to SME on November 2, 2010, maximum interior column loads (for the full future five supported levels) will be 2,400 kips and maximum exterior loads will be 1,250 kips. Also, based on the referenced email we understand the design finish floor elevation (FFE) has been preliminary set at elevation 804 feet. Therefore, based on the existing site topography, we estimate cuts and fills of about 1 to 10 feet will be required to establish final site subgrade elevations within the building addition area.

2. EVALUATION PROCEDURES

2.1 Field Exploration

SME completed three borings (B1 through B3) at the site on October 18 and 19, 2010. The borings were located near the proposed addition footprint and extended between about 59.5 to 60 feet below the existing ground surface. In total, 179.4 lineal feet of drilling was performed. The approximate locations of the borings are depicted on the Boring Location Diagram included in Appendix A of this report.

The number, depths, and locations of the borings were determined by SME. SME staked the location of the borings in the field referenced from existing site features. The existing ground surface elevations at the boring locations were estimated to the nearest 1-foot based on site topographical information included on the referenced Existing Conditions plan.

The borings were drilled using a truck-mounted, rotary-type drill rig and were advanced using continuous-flight, hollow-stem augers in conjunction with bentonite slurry. The borings included soil sampling based upon the Split-Barrel Sampling procedure and augering. Recovered split-barrel and auger samples were sealed in glass jars by the driller.

Groundwater level measurements were recorded during and immediately after completion of each boring. The boreholes were backfilled with the cement-bentonite to about 4 to 5 feet below the existing ground surface and excess auger cuttings above that level after completion. Therefore, long-term groundwater levels were not obtained from the borings.

Soil samples recovered from the field exploration were returned to the SME laboratory for further observation and testing.

2.2 Laboratory Testing

The general laboratory testing program consisted of performing visual soil classification on recovered samples along with moisture content and hand penetrometer tests on portions of cohesive samples obtained. The Laboratory Testing Procedures in Appendix B provide general descriptions of the general laboratory tests given above.

Upon completion of the laboratory testing, computer-generated boring logs were prepared and include materials encountered, penetration resistances, pertinent field observations made during the drilling operations, and the results of certain laboratory tests. The boring logs are included in Appendix A. The soil descriptions included on the boring logs were developed from both visual classification and the results of laboratory tests, where applicable.

Soil samples, retained over a long time, even sealed in jars, are subject to moisture loss and are no longer representative of the conditions initially encountered in the field. Therefore, soil samples are normally retained in our laboratory for 60 days and then disposed, unless instructed otherwise.

3. SUBSURFACE CONDITIONS

3.1 Soil Conditions

The soil conditions encountered at the borings generally consisted of surface topsoil overlying sand fill underlain by natural interbedded layers of sands and clays to the explored depths of the borings. A generalized summary of the materials encountered at the boring locations, beginning at the existing ground surface and proceeding downward, is provided below.

Stratum 1: Topsoil. The driller reported about 3 to 6 inches of surface topsoil at the boring locations.

Stratum 2: Fill. Sand fill was encountered below the surface topsoil at the boring locations and extended about 4.5 to 12 feet below the existing ground surface. At boring B2, the sand fill contained trace amounts of wood fragments from about 7 to 8 feet below the ground surface. Also, occasional cobbles were encountered within the fill. Standard Penetration Test (SPT) resistances (N-values) within the sand fill ranged from 8 blows

per foot (bpf) to 50 blows for 4 inches of penetration indicating a loose to extremely dense condition. However, generally the sand fill was in a loose to medium dense condition.

A layer of crushed limestone was also encountered below the fill in boring B3 from about 6.5 to 7 feet below the existing ground surface.

Stratum 3: Interbedded Layers of Natural Sands and Clays. Natural sands were encountered below the sand fill in boring B1 and were encountered interbedded with natural clay in borings B2 and B3. The natural sands were penetrated about 16 to 27.5 feet to the explored depths of borings B3 and B1, respectively. Also, the drillers reported encountering cobbles within the natural sands. N-values within the natural sands ranged from about 14 bpf to 100 blows for 3 inches of penetration.

Natural silty clay was encountered above the natural sands in boring B1 and interbedded with the natural sands in boring B3. The natural clays extended about 32 to 44 feet below the existing ground surface in borings B1 and B3, respectively. Occasional cobbles were encountered in the natural clays. Undrained shear strength measurements in the clay ranged from 2.0 ksf to greater than 4.5 ksf, indicating a stiff to hard consistency. Measured moisture contents varied from about 13 to 25 percent.

Sandy clay till (commonly referred to as “hardpan”) was encountered below the natural sands in boring B2 about 47 feet below the existing ground surface. Undrained shear strengths of the hardpan were greater than 4.5 ksf, indicating a hard condition. Measured moisture contents ranged from about 8 to 10 percent.

The soil profile described above and included on the appended boring logs are generalized descriptions of the conditions encountered. The stratification depths described above and shown on the boring logs are intended to indicate a zone of transition from one soil type to another. They are not intended to show exact depths of change from one soil type to another. The soil descriptions are based on visual classification of the soils encountered. Soil conditions may vary between or away from the boring locations. Please refer to the boring logs for the soil conditions at the specific boring locations.

Thickness measurements of surficial materials reported on the boring logs (e.g., topsoil) should be considered approximate since mixing of these materials can occur in small diameter boreholes. Therefore, if accurate thickness measurements are required for inclusion in bid documents or purposes of design, additional evaluations such as shallow test pits should be performed.

It is sometimes difficult to distinguish between fill and natural soils based on samples and cuttings from small-diameter boreholes, especially when portions of the fill do not contain man-made materials, debris, topsoil or organic layers, and when the fill appears similar in

composition to the local natural soils. Therefore, the delineation of fill described above and on the appended boring logs should be considered approximate only. A more comprehensive evaluation of the extent and composition of the fill could be made by reviewing former site topography plans such as grading plans from the original construction, aerial photographs, and other historic site records and by observing test pit excavations.

3.2 Groundwater Conditions

Groundwater was observed by the SME driller during the drilling operations about 19 to 52 feet below the existing ground surface. Due to the use of bentonite slurry in the hollow-stem augers to advance the boreholes, accurate measurements of groundwater levels upon completion of the drilling operations could not be obtained. The groundwater encountered in the borings appears perched or trapped within the sands overlying or interbedded within the clays.

Hydrostatic groundwater levels, perched conditions, and the potential rate of infiltration into excavations should be expected to fluctuate throughout the year, based on variations in precipitation, evaporation, run-off, and other factors. The groundwater levels indicated by the borings represent conditions at the time the readings were taken. The actual groundwater levels at the time of construction may vary.

4. PRELIMINARY ANALYSIS AND RECOMMENDATIONS

The following sections provide our preliminary recommendations for design based on our understanding of the potential addition and the subsurface information collected during this evaluation. This report should not be used solely for the final design. Once the site has been cleared of trees and brush and other design criteria (i.e., grade levels, building loads, etc.) are finalized, the preliminary conclusions and recommendations contained in this report should be supplemented with additional field exploration (borings). If the project design criteria are changed, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions of this report are modified or approved in writing by our office.

4.1 Site Preparation and Earthwork

4.1.1 Existing Fill Considerations

Sand fill was encountered in the borings extending about 4.5 to 12 feet below the existing ground surface. The fill encountered at boring B2 is likely associated with the backfilling of the

existing parking structure retaining walls. Based on the preliminary design finish floor elevation of 804 feet, we estimate about 9 feet of the 12 feet of existing fill at boring B2 will be removed and most if not all of the existing fill will be removed near boring B3 (since about 7 feet of fill was encountered at the existing ground surface elevation is about 811 feet). About 7 feet of new fill is required to establish the FFE near boring B1. Therefore, newly placed engineered fill will likely overly the existing 4.5 feet of fill. The fill near borings B1 and B2 may have been placed as engineered fill during construction of the parking structure. However, we are unaware of records that document the fill placement and any compaction operations during placement. Therefore, the fill is considered uncontrolled unless documentation can be shown otherwise.

Grade-slabs which are constructed over undocumented fill are at a risk for premature distress consisting of cracking and settlement. However, based on the generally adequate strength and the lack of appreciable debris and significant organics at the borings, we believe this risk is relatively low. Therefore, we believe grade slabs can be supported on the undocumented fill provided the relatively low risk for poor slab performance is acceptable. Additional testing (e.g., hand auger probes, test pits, etc.) prior to site earthwork operations and finalizing earthwork budgets is recommended to further quantify the risk and proper subgrade preparation (e.g., soil compaction, proofrolling, etc.) is recommended to reduce, but not eliminate the risk.

Once any unsuitable fill has been removed, the resulting subgrade should be observed and tested for suitability prior to the placement of engineered fill. See Section 4.1.4 of this report for compaction requirements for engineered fill.

The recommendations provided in the following report sections are based on the assumption that the Owner is willing to accept a relatively low level of increased risk, as described above, and that the existing fill will remain in-place. We should be contacted to review and revise the recommendations of this report if it is determined the existing fill will be removed and replaced.

4.1.2 General Site Subgrade Preparation

Existing below-grade structures such as foundations, walls, slabs, and utilities from previous construction should be completely removed to expose suitable natural soils and replaced with properly prepared engineered fill below new foundation areas within the building addition footprint. Existing below-grade obstructions should be removed at least 2.5 feet below final subgrade level to avoid creating "hard spots" in the subgrade in slab-on-grade and pavement areas. These areas where obstructions are removed should be backfilled with engineered fill, which is placed in lifts and properly compacted.

Existing utilities within the building addition footprint should be rerouted. All abandoned utilities should be removed and backfilled with granular engineered fill to the design subgrade level. As an alternative, existing abandoned utilities below proposed grade slab and pavement areas may be left in-place and fully grouted, provided the abandoned utility is situated at least 2.5 feet below the final subgrade level to reduce the potential of developing “hard spots” in the subgrade. If utilities are to be abandoned in-place, the locations should be reviewed to verify the utilities do not conflict with the proposed construction. Abandoned utilities should be removed below proposed foundations. The condition of the backfill in existing utility trenches where the utility is abandoned in-place should be evaluated to confirm these soils are adequate for support of engineered fill and grade slabs. Unsuitable existing trench backfill should be undercut and replaced with granular engineered fill. Care should be exercised when excavating near existing utilities to protect them from damage.

The proposed building addition area and areas to receive engineered fill should be cleared of existing pavement, concrete, topsoil, trees, shrubs, unsuitable fill and other deleterious materials, etc. to expose the underlying inorganic subgrade soils.

After stripping and removal of deleterious materials and cuts are made to design subgrade levels, we recommend the exposed sand subgrade be compacted with a relatively large vibratory smooth drum roller. Several passes in each direction should be performed. The subgrade should then be subjected to a comprehensive proofrolling program. The purpose of proofrolling is to locate areas of unsuitably loose or soft subgrade. Proofrolling should be performed with a fully-loaded, tandem-axle truck or other similar pneumatic-tired construction equipment. Areas of unsuitable (i.e., wet, loose or soft) subgrade revealed during proofrolling should be mechanically improved (compacted) in-place. If it is not possible to compact the unsuitable subgrade, it may be necessary to remove the unsuitable soils and replace them with engineered fill.

Proofrolling should be performed with a fully-loaded tandem-axle truck or other similar piece of pneumatic-tire construction equipment. Unsuitable subgrade soils should be undercut and replaced with engineered fill. Areas of unsuitable (i.e., wet or loose) subgrade revealed during proofrolling should be mechanically improved (compacted) in-place. If it is not possible to compact the unsuitable subgrade, it may be necessary to remove the unsuitable soils and replace them with engineered fill.

Any clay subgrade that may be encountered is sensitive to disturbance when exposed to water. If the subgrade is exposed to water, it may be necessary to improve the disturbed subgrade or remove and replace the soils with engineered fill, crushed aggregate or crushed concrete. Placement of crushed aggregate or crushed concrete, possibly with a geotextile for separation, is a traditional treatment to protect soft or easily disturbed subgrades.

After cuts are made to design grades and after the exposed subgrade is proofrolled and improved as necessary, engineered fill may be placed on the exposed subgrade to establish final subgrade levels. Section 4.1.4 presents materials and compaction requirements for engineered fill.

4.1.3 Subgrade Preparation for Grade Slabs

We anticipate the final subgrade for the parking structure grade slab will consist of properly prepared existing undocumented fill and engineered fill overlying suitable natural sands and clays. These soils are generally considered suitable for support of grade slabs provided the subgrade is properly prepared and engineered fill is properly placed and compacted and the Owner is willing to accept the relatively low risk for cracking and settlement associated with constructing grade slabs on the undocumented fill.

Prior to concrete placement for grade slabs, the building pad subgrade should again be observed and tested for suitability of grade slab support. The purpose of the re-evaluation is to identify any areas of subgrade that were disturbed during construction activities and verify subgrade conditions are suitable for floor slab support. The re-evaluation of the subgrade should consist of a thorough proofroll and/or the use of appropriate hand-operated equipment such as hand augers and cone penetrometers. The criteria for the final proofroll should be a maximum of 1/4 inch of deflection or rutting. Unsuitable subgrade indicated by SME should be recompacted or removed and replaced with engineered fill.

We recommend the top 8 inches of the grade slab subbase consist of an approved aggregate such as MDOT 21AA crushed limestone. However, a thicker layer of aggregate may be needed to provide a stable construction platform, depending on the condition of subgrade soils during construction and the type of construction equipment to traffic the prepared subgrade. The aggregate should also be compacted per the "Engineered Fill Requirements" section of this report (Section 4.1.4).

A vertical modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be used for design of slabs bearing on the MDOT 21AA crushed limestone overlying the fill or natural soils. This recommended subgrade modulus is based on empirical relationships between soil type and plate load tests performed with a 30-inch-diameter bearing plate and is the ratio of load in pounds per square-inch (psi) to a 0.05-inch deflection.

In general, we recommend providing vapor retarders below floor slabs that will receive an impermeable floor finish/seal, or a floor covering which would act as a vapor retarder. Even if these floor coverings are not planned, the vapor retarder can reduce the transmission of moisture vapor from the ground into the building, which can occur due to thermal and humidity

variations and other conditions. Plastic sheeting that is continuously placed and overlapped at least 18 inches is generally considered suitable for the vapor retarder system. For durability purposes during construction, we recommend the thickness of the plastic sheets be no less than 10 mils. The vapor retarder should be protected from damage during construction and the use of plywood “runways” may be required to transport concrete across the prepared subgrade. However, the placement of a vapor retarder affects construction of the floor slab, concrete curing, and the rate of moisture loss as the concrete dries. We would be pleased to discuss considerations related to vapor retarders in more detail, if desired.

Slabs should be separated by isolation joints from structural walls and columns bearing on their own foundations to permit relative movement. A minimum of 8 inches of engineered fill should be provided between the bottom of the slab and the top of the pile cap below. Otherwise other arrangements should be made to allow for potential relative settlements, such as grade beams, thickened slabs with appropriate reinforcing steel or other appropriate details.

The slab-on-grade subgrade soils should be protected from frost during winter construction. Any frozen soils should be thawed and compacted or removed and replaced prior to slab-on-grade construction.

4.1.4 Engineered Fill Requirements

Any fill placed within the construction area, including utility trench backfill, should be an approved material, free of frozen soil, organics, or other deleterious materials. The fill should be spread in level layers not exceeding 9 inches in loose thickness and compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with the Modified Proctor test. Sand fill should be compacted with a smooth drum vibratory roller or vibratory plate compactors including either walk-behind types, or plate compactors mounted on a backhoe or excavator (hoe-pacs), while clay fill should be compacted with a sheepfoot roller.

Based on the information from the borings, the existing inorganic sand fill and natural sands and clays are considered suitable for the reuse as engineered fill provided they meet the general requirements listed in the previous paragraph. If the proposed fill contains more than 4 percent organics, we recommend such soils not be used for engineered fill.

The clays may require drying prior to use as engineered fill. Based on our experience, we believe the moisture content of most of the clays is likely to be near or above the optimum moisture content of the soil. Most of the clays may require disking, aeration, and drying to allow for proper compaction.

Clays are also difficult to compact in confined areas where compaction by hand-operated equipment is required and should not be used where drainage is required (e.g., behind below-grade walls). The clays can be reused in open areas where large compaction equipment can operate.

The successful reuse of the on-site soils for engineered fill will be dependent on the time of year and the care the earthwork contractor uses in selecting and separating the fine grained soils (i.e., clays) from the more granular soils. During cold and wet periods of the year, the subgrade soils become saturated and disturbed and clays are difficult to dry. If such conditions occur, the contractor will have to import sand to the site.

In confined areas, and other areas where compaction is accomplished primarily by hand-operated equipment and drainage is likely required, an approved granular material, such as MDOT Class II granular material, should be used as backfill. Thinner lifts may be required in confined spaces to achieve compaction of the backfill.

4.2 Foundations

Based on the relatively high foundation loads, we are providing two deep foundation alternatives including augered cast-in-place (ACIP) piles and concrete filled pipe piles (pipe piles). H-Pile foundation elements were also considered. However, to reach the desired capacity the piles would require development of a “soil plug”. Based on our experience with the granular soils in the Ann Arbor area, it may not be possible to develop the soil plug in the flanges of the H-piles. Therefore, it is difficult to actually estimate the required lengths for the H-pile bearing in the sand stratum. Additionally, the existing parking structure is constructed on pipe piles and ACIP have been used for other portions of the hospital complex. Therefore, although the H-piles are technically feasible, in our opinion the ACIP piles and pipe piles are likely a better and more predictable deep foundation option. Recommendations for each type of system are presented below.

4.2.1 Augered Cast-In-Place (ACIP) Piles

ACIP piles are installed by rotating a hollow-stem, continuous-flight auger into the ground until a specified depth of penetration has been achieved. Subsequently, a sand-cement grout with admixtures is pumped under pressure through the auger stem as the auger is slowly withdrawn from the hole. The capacity of the pile is based on both the end bearing and side friction along the pile.

ACIP piles are a relatively cost effective deep foundation system, and do not generate the noise and vibration associated with driven piles. As with driven piles, multiple piles and a pile cap will be required at column locations. However, unlike the driven piles, augercast piles are not easily extended through or around obstructions (i.e., cobbles or boulders).

The key to a successful installation is continuous coordination of the rate of auger withdrawal with an adequate grout head (pressure) to support the hole and ensure that all voids are filled completely with grout. Care should be taken when extracting the augers to maintain a relative constant head of grout.

The pile capacity will be developed by both side friction and end-bearing. A working pile capacity of 100 tons is considered feasible for a 16-inch diameter ACIP with end bearing about 3 to 5 feet into the dense to extremely dense sands, encountered between about elevations 761 to 780 feet. Since it may be difficult to determine when the dense sand is encountered during the drilling of the ACIP, we recommend the design (minimum) tip elevation be set at 760 feet (i.e., pile lengths of about 40 feet), unless auger refusal is encountered. Auger refusal is defined as less than 1 foot of penetration per minute of drilling under full drilling power. The recommended capacity is based on a static analysis using a design factor of safety (FS) of at least 2.0, which was applied to the ultimate pile capacity.

Uplift capacity for the ACIP piles is developed from side friction and weight of the pile. We recommend an allowable uplift capacity (with a FS= 2.0) of 30 tons based on the minimum tip elevation of 760 feet.

Tensile reinforcement may be needed along a certain portion of the ACIP pile depending if the design pile loads include lateral or tensile loads. Typically, a single large high strength steel bar is used for tensile loads since it is generally easier to install into the grouted pile than a multi-bar reinforcing steel cage. However, a reinforcing steel cage through the upper portion of the pile may be needed to resistance lateral loads, and can be successfully installed by an experienced contractor. If needed, a lateral load analysis of the ACIP piles can be completed once additional design input is provided. Design input will include bending moment and shear applied to the pile top, pile layout for each pile cap, and allowable lateral deflection.

We recommend a minimum of two pile load tests for this project. From 6 to 8 production piles should be installed throughout the project site. Two of these piles can be selected for load the load tests by the Engineer with the assistance of SME, based on the conditions encountered during the installation of the piles. We recommend performing pile load tests prior to installing the remaining production piles so that any necessary design modifications can be made. The load tests should be performed in general accordance with ASTM D-1143, using the Quick Load Test procedure.

The pile capacities for ACIP piles cannot be directly verified from a driving resistance as with driven piles. However, careful observation of the pile penetrations and comparisons with boring logs should provide a basis for judging the capacity of the production piles. All production piles should be installed with same procedures as the test piles, including the amount and pressure of grout used during the removal of the augers.

We estimate total static settlement of less than 1/2-inch for ACIP piles using the design working capacity, which are constructed according to the recommendations of this report.

We recommend using a minimum design spacing of at least three pile diameters between adjacent piles (center-to-center) within a group. The use of closer pile spacing would require additional evaluation of the group effect. Generally, we recommend using a minimum of three piles per pile group for stability. Groups of one or two piles can be used if grade beams, rigid mats or other suitable methods are used to provide the required lateral structural support.

During ACIP pile installation, the contractor should carefully sequence operations to avoid damage to an installed pile during installation of an adjacent pile. We recommend adjacent piles closer than approximately 5 feet (edge-to-edge) spacing not be installed until initial set of the grout in the first pile has occurred (about 12 to 24 hours). It may be necessary to increase this spacing if interconnection between recently grouted piles is observed during construction.

Based on the borings and our experience in the Ann Arbor area and at this site, the dense to extremely dense sands contains frequent cobbles and boulders. The cobbles and boulders should be expected to cause obstruction to auger penetration through bearing sand during ACIP installation. This could result in unpredictable pile capacity. If auger refusal is encountered well above the design tip bearing elevation, or if the pile is knocked out of vertical alignment, it will be necessary to grout the pile from that point and install a new pile. The obstructed pile may either be rejected, or evaluated and assigned a reduced capacity, depending on circumstances and installation records. These situations should be assessed by SME on a case-by-case basis during construction.

There are inherent risks associated with installation of ACIP piles in close proximity to existing buildings, roads and utilities. To prevent loss of ground, and a reduction in support, the contractor should consider the following recommendations to reduce the risk of oversized holes due to decompression, or loss of soil. We recommend the contractor utilize a drill rig with a minimum torque of 55,000 ft-lbs and the ability to utilize full torque at a slow rotational speed. The rate of auger penetration should not exceed two rotations per flight. The contractor should have grout on-site prior to beginning of auger withdrawal. If equipment failure or other unusual factors occur, which require the augers to be withdrawn from an ungrouted pile excavation, the

augers should be removed using a slow reverse rotation, and not "dead pulled." The contractor should maintain a minimum grout volume ratio of 1.15, which is the ratio of the actual grout volume to the theoretical pile volume, but should expect higher grout volume ratios for piles constructed at this site. During auger withdrawal, a minimum pressure head equivalent to 6 feet of grout should be maintained above the groundwater level.

The successful installation of ACIP piles is highly dependent upon the skill, experience, and procedures used by the contractor. Therefore, full-time observation and testing by SME is strongly recommended. SME would be pleased to assist in developing pile specifications, reviewing contractor submittals, and in providing quality control testing and monitoring during construction. The quality control testing should include observing the installation of each pile and preparing a record including:

- Date and time of installation;
- Location of pile;
- Pile diameter and length (design and actual);
- Approximate grout volume;
- Grout pressure;
- Obstructions encountered, depths, and delay time;
- Reinforcing; and
- Grout strength.

4.2.2 Concrete Filled Steel Pipe Piles

A foundation system consisting of driven piles and grade beams is also considered suitable for support of the proposed structure. Based on the soil conditions encountered, concrete filled pipe piles with reinforced steel tips are judged the best type of pile for this site.

A working capacity of 125 tons per pile is considered feasible for this site. For stability purposes, the minimum number of piles for groups is three, depending if lateral support is provided in the transverse direction. For this project, the working capacity given above will be developed both by side friction and end bearing. The piles are anticipated to extend about 50 to 70 feet below the existing ground surface. For bidding purposes, we recommend a design bearing elevation of about 740 feet.

Uplift capacity for the piles is developed from side friction and weight of the pile. We estimate the allowable uplift capacity (with a FS=2.0) will vary from about 50 to 60 tons based on pile lengths of about 50 to 70 feet.

Final pile embedments should be based on the observed final set of the pile during driving. Therefore, the final driving depths may deviate from preliminary estimated pile length given above. Provisions in the contract should be made to allow for variable pile lengths. Unit prices for splices and pile lengths should be included in the bids for possible adjustments to the base pile length.

Top driven piles require a minimum stiffness to achieve a given ultimate pile capacity. The specific minimum pile size required depends on the driving system (hammer, hammer cushion, etc), the pile length, and the soil conditions. Since it is difficult to predict the driving system the contractor will use, it is sometimes best to allow the contractor to choose the size of pile required for a given pile capacity and soil conditions. However, the contractor must demonstrate the pile will be able to achieve the required capacity with the proposed driving system.

For the pipe piles, we recommend a minimum pile size of 12.75-inch O.D. by 0.500-inch thick wall be used conforming to ASTM 252 (Grade 2). Other pile sections may be considered as contractor proposed alternatives. The pipe piles should be driven closed end with a reinforced driving tip (to reduce potential damage to the piles due to obstructions and hard driving), and then filled with concrete upon verification of the pile capacity and integrity.

The ultimate load capacity of piles should be verified in the field during pile driving by observing the driving resistance, or “set”. The final set or driving criteria for pile foundations should be determined based on a wave equation analysis. We recommend a wave equation analysis be performed to determine the initial pile driving criteria and to determine if the proposed pile driving system is capable of obtaining the design working loads without damaging the piles.

The wave equation analysis should be performed by a qualified registered geotechnical engineer. However, this analysis requires specific information on the type and size of hammer, cushion materials, and other information usually not available until a pile contractor is selected. We recommend the wave equation analysis be required as part of the contractor submittals for the pile foundations.

If the obstructions result in pile refusal well above the design pile cutoff elevation, the piles should be cut-off, abandoned and a new pile(s) installed at an alternate location. Depending on the offsets required due to obstructions, the pile cap may need to be enlarged. The obstructions may also knock the pile out of vertical or horizontal alignment during driving. SME should be allowed to review the pile driving records for such short piles to assist in evaluating the reduced pile capacity. The structural engineer should review the location and position of misaligned piles to determine if any modifications to the pile cap are required.

Estimated settlement of the piles under the anticipated maximum working loads are expected to be about 1/2-inch or less, including the elastic compression of the pile. Differential settlement is estimated to be about one half the total settlement. The settlement estimates provided are based on the available boring information, estimated structural loads, our experience with similar structures and soil conditions, and field verification of suitable bearing soils by SME.

4.3 Seismic Site Class

Based on the Existing Conditions drawing dated November 1, 2010, prepared by Midwestern Consulting, the existing ground surface at the site ranges from about elevation 794 feet to 814 feet. Based on Plate 13 (Topography of the Bedrock Surface) in the Hydrogeologic Atlas of Michigan, the estimated level of the top of rock is about elevation 640 to 660 feet based on linear interpolation of rock contours plotted at 50-foot intervals. From this information, the glacial drift at the site is roughly 135- to 175-feet thick.

The known N-values and shear strength values for drift at this site are limited to the maximum explored depths 60 feet below the existing ground surface at the borings performed within for this evaluation. According to the limited information obtained from the borings and based on our general knowledge of the local geology, the subgrade soils at this site can be designated as seismic site Class C in determining seismic design forces for this project in accordance with the 2006 MBC Code (Table 1613.5.2).

4.4 Below-Grade Walls and Drainage

Below-grade retaining walls will be constructed as part of the parking structure addition, particularly along the north and west sides of the addition where grades are high. Excavation through the sand fill and natural sands should be limited to a maximum slope of 1H:1V for moist sands and 2H:1V where groundwater is encountered in the sands. Although cuts through the clays are not anticipated, where clays are encountered in any cuts the maximum slope should be 0.75H:1V for stiff clays with undrained shear strengths greater than 2.5 ksf (based on field penetrometer tests).

Below-grade walls should be backfilled with MDOT Class II granular material. Positive surface drainage should also be established away from exterior below-grade walls and roof downspouts should not be discharged onto the ground surface above below-grade walls.

Below-grade wall backfill that will support floor slabs and other improvements should be compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test. As a minimum, backfill that will not be used for structural support of pavements, floor slabs or sidewalks should be compacted to the degree where it is stable under construction equipment. Care should be exercised during compaction of the wall backfill to avoid overstressing the walls. If required, walls should be designed to accommodate the additional stresses associated with operating compaction equipment adjacent to the wall.

For a drained granular backfill and a level finish surface behind the wall, we recommend an active equivalent fluid pressure of 40 pounds per cubic foot (pcf) for design. This earth pressure is based on the wall being flexible enough to permit the active earth pressure condition to be reached. An outward movement away from the backfill equal to approximately 0.001 times the height of the wall is generally required to achieve the active earth pressure condition for granular backfill. If the wall is restrained or is rigid enough so that it does not rotate sufficiently to reach the active earth condition, a higher lateral earth pressure (at-rest condition) should be used for design. For rigid walls backfilled with a free-draining granular material and a level finish surface behind the wall, we recommend an at-rest fluid pressure of 55 pcf for design. Also, any additional lateral pressures due to surcharge loading, such as adjacent floor or column loads, traffic loads, sloping ground, or parking loads, should be added to the above lateral earth pressures for design.

The earth pressures presented above are for a drained backfill. To reduce the potential for the build-up of hydrostatic pressure behind below-grade walls, we recommend permanent edge drains be installed along the base of the perimeter of the below-grade walls, if feasible. The perimeter edge drains should consist of a minimum 6-inch-diameter perforated plastic drain pipe, wrapped with a filter fabric and surrounded by 6 inches of a filter material, such as pea gravel (MDOT 34G). As indicated above, the walls should be backfilled with MDOT Class II granular material. Additionally, as a minimum, the retaining walls should be damproofed.

The following parameters for evaluating the stability of the retaining walls assume the base of the wall bears directly on either the natural sands or natural clay, and the wall is backfilled with a free-draining granular backfill. To evaluate the sliding of the wall, the sliding resistance at the base and the passive (resisting) and active (driving) earth forces must be computed. The sliding resistance may be determined by using a recommended ultimate sliding coefficient of 0.40 for the natural clays, limited to an ultimate adhesion of 2,000 psf, and 0.45 for the natural sands and sand fill. Passive, active and at-rest earth pressure coefficients of 3.0, 0.33 and 0.50, respectively, may be used for design in combination with a unit weight of backfill of 120 pcf. This assumes a granular backfill will be in contact with the wall on the backside and on

the front, at the toe of the wall. Typically, a safety factor between 1.5 and 2.0 is used for the lateral sliding resistance analysis, depending on the boundary conditions being evaluated. The movement required to achieve the full passive pressure should also be considered when using passive pressure for resistance.

In addition to checking sliding stability of the retaining walls, the safety factor from overturning, location of the resultant force at the base, mass stability, and contact pressure at the base should also be evaluated. If desired, SME would be available to assist the project team in the design of the walls incorporating these considerations. However, such analyses go beyond the current scope of this evaluation.

4.5 Construction Considerations

Groundwater seepage into utility excavations is generally not anticipated to be a significant factor during construction. However, some accumulation from precipitation events, surface run-off or seepage from perched groundwater sources could be encountered. We anticipate standard sump pit and pumping procedures should generally be adequate to control these accumulations, on a localized basis. A working surface of either crushed aggregate or crushed concrete may be required to protect the exposed subgrade where seepage is encountered.

The exposed subgrade soils may be easily disturbed due to weather and activity on-site. Therefore, the contractor should remove standing water from areas where water collects and prevent surface water from reaching the foundation excavations and areas of prepared subgrade. Also, to reduce the potential of subgrade disturbance across the site, construction traffic should be restricted to special construction roads, and not be allowed to randomly traffic the site. Disturbed soils may have to be moisture conditioned and recompact in-place, or undercut and replaced with engineered fill. Moisture conditioning may not be feasible during seasonally cold and wet times of the year, resulting in a potential need for additional imported fill if the work is performed between the late fall and early spring seasons. Areas of exposed subgrade at the site may be protected by placing crushed concrete or crushed aggregate on it. Under adverse weather conditions, the placement of a geotextile fabric for separation on the exposed subgrade may be beneficial. Performing site work during the drier summer months should reduce the potential for subgrade disturbance and the need for improvement of the subgrade. Conversely, construction during wetter periods of the year could result in the need for undercutting and subgrade stabilization techniques.

Based on the potentially variable depths of fill within the proposed building addition and pavement areas, we recommend the bid documents require prospective contractors to include unit prices for excavating existing fill and other unsuitable soils and replacing them with imported engineered fill. We recommend establishing a contingency in the construction budget for this work. Actual quantities can be verified during construction by measuring excavation volumes, counting truck loads, or a combination of methods. SME can assist with estimating quantities for establishing the contingency, if desired.

The contractor must provide a safely sloped excavation or an adequately constructed and braced shoring system in accordance with federal, state and local safety regulations for individuals working in an excavation that may expose them to the danger of moving ground. If material is stored or heavy equipment is operated near an excavation, stronger shoring must be used to resist the extra pressure due to the superimposed loads.

APPENDIX A

BORING LOCATION DIAGRAM

GENERAL NOTES

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

BORING LOGS (B1 THROUGH B3)



FULLER ROAD

GLAZIER WAY

BEAL AVE.

B3

B2


EAST PARKING
STRUCTURE

PROPOSED
ADDITION

B1

MARSH

LEGEND

 APPROXIMATE BORING LOCATION

NOTE:
DRAWING INFORMATION TAKEN FROM AERIAL PHOTO EMAILED
TO SME ON OCTOBER 13, 2010, FROM WALKER PARKING
CONSULTANTS.

Nov 09, 2010 - 4:38pm - MANDRILA S:\62000\PG62404\PG62404-01.dwg



Date	10-26-10
Drawn By	GM
Designed By	KLW
Scale	1" = 150'
Project	PG 62404

BORING LOCATION DIAGRAM ADDITION TO EAST PARKING STRUCTURE VETERANS ADMINISTRATION HOSPITAL ANN ARBOR, MICHIGAN

No.	Revision Date

Figure No. 1



Drilling and Sampling Symbols

SS	-	Split-Spoon 1-3/8" I.D., 2" O.D. except where noted	NR	-	No Recovery
LS	-	Liner Sample	RC	-	Rock Core with diamond bit. NQ size, except where noted
AS	-	Power Auger Sample	RB	-	Rock Bit
2ST	-	Shelby Tube – 2" O.D.	VS	-	Vane Shear
3ST	-	Shelby Tube – 3" O.D.	PM	-	Pressuremeter
PS	-	Piston Sample – 3" diameter	WOH	-	Weight of Hammer
WS	-	Wash Sample			
HA	-	Hand Auger Sample	SP	-	Soil Probe
BS	-	Bag or Bottle Sample	PID	-	Photo Ionization Device
CS	-	Continuous Sample	FID	-	Flame Ionization Device

Standard Penetration 'N' – Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch O.D. split spoon, except where noted.

Particle Sizes

Boulders	-	Greater than 12 inches (305 mm)
Cobbles	-	3 inches (76.2 mm) to 12 inches (305 mm)
Gravel-Coarse	-	3/4 inches (19.05 mm) to 3 inches (76.2 mm)
Fine	-	No. 4 (4.75 mm) to 3/4 inches (19.05 mm)
Sand-Coarse	-	No. 10 (2.00 mm) to No. 4 (4.75 mm)
Medium	-	No. 40 (0.425 mm) to No. 10 (2.00 mm)
Fine	-	No. 200 (0.074 mm) to No. 40 (0.425 mm)
Silt	-	0.005 mm to 0.074 mm
Clay	-	Less than (0.005 mm)

Depositional Features

Parting	-	as much as 1/16 inch (1.6 mm) thick
Seam	-	1/16 inch (1.6 mm) to 1/2 inch (12.7 mm) thick
Layer	-	1/2 inch (12.7 mm) to 12 (305 mm) inches thick
Stratum	-	greater than 12 inches (305 mm) thick
Pocket	-	small, erratic deposit of limited lateral extent
Lens	-	lenticular deposit
Varved	-	alternating seams or layers of silt and/or clay and sometimes fine sand
Occasional	-	one or less per foot (305 mm) of thickness
Frequent	-	more than one per foot (305 mm) of thickness
Interbedded	-	applied to strata of soil or beds of rock lying between or alternating with other strata of a different nature

Groundwater levels indicated on the boring log are the levels measured in the boring at the times indicated. The accurate determination of groundwater levels may not be possible with short term observations, especially in low permeability soils. The groundwater levels shown may fluctuate throughout the year with variation in precipitation, evaporation and runoff.

Classification

Cohesionless Soils (Blows per foot or 0.3 m)

Very Loose	:	0 to 4
Loose	:	5 to 9
Medium Dense	:	10 to 29
Dense	:	30 to 49
Very Dense	:	50 to 80
Extremely Dense	:	Over 80

Soil Constituents

Trace	:	Less than 5%
Trace to Some	:	5% to 12%
Some	:	12% to 25%
Use Descriptor	:	25% to 50%
(i.e., Silty, Clayey, etc.)		

Cohesive Soils

<u>Consistency</u>	<u>Shear Strength</u>
Very Soft	: 0.25 kips/ft ² (12.0 kPa) or less
Soft	: 0.25 to 0.49 kips/ft ² (12.0 to 23.8 kPa)
Medium	: 0.50 to 0.99 kips/ft ² (23.9 to 47.7 kPa)
Stiff	: 1.00 to 1.99 kips/ft ² (47.8 to 95.6 kPa)
Very Stiff	: 2.00 to 3.99 kips/ft ² (95.7 to 191.3 kPa)
Hard	: 4.00 kips/ft ² (191.4 kPa) or greater

Soil description

If clay content sufficiently dominates soil properties, then clay becomes the primary noun with the other major soil constituent as modifier: i.e. silty clay. Other minor soil constituents may be added according to estimates of soil constituents present, i.e., silty clay, trace to some sand, trace gravel.



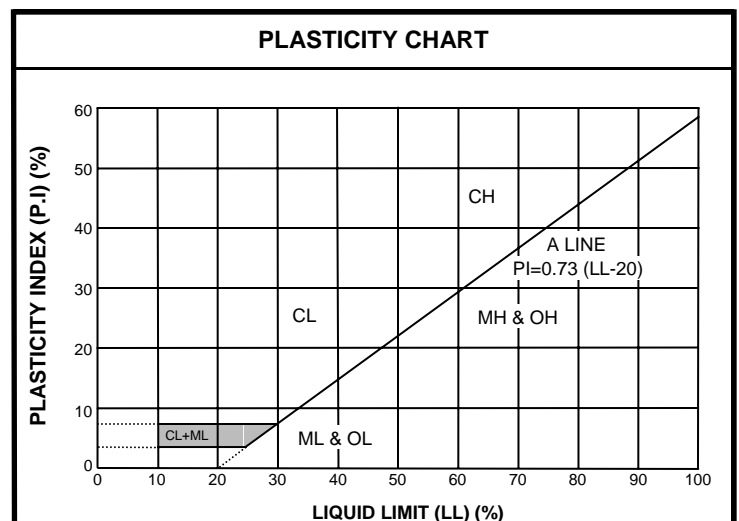
UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART		
COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	
		GW Well-graded gravels; sandy gravels, little or no fines
		GP Poorly-graded gravels; sandy gravels, little or no fines
	Gravels with fines (More than 12% fines)	
		GM Silty gravels, some sand or sandy gravels, some silt
		GC Clayey gravels, some sand or sandy gravels, some silt
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	
		SW Well-graded sands, gravelly sands, little or no fines
		SP Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
		SM Silty sands or sands, some silt
		SC Clayey sands or sands, some clay
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size)		
SILTS AND CLAYS Liquid limit less than 50%		ML Inorganic silty silts or clayey silts with slight plasticity
		CL Inorganic clays of low plasticity, sandy clays, silty clays
		OL Organic silts and organic clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater		MH Inorganic silts of high plasticity
		CH Inorganic clays of high plasticity
		OH Organic silts and organic clays of high plasticity
HIGHLY ORGANIC SOILS		PT Peat and other highly organic soils

LABORATORY CLASSIFICATION CRITERIA		
GW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent.....GW, GP, SW, SP
 More than 12 percent.....GM, GC, SM, SC
 5 to 12 percent.....Borderline cases requiring dual symbols





soil and materials engineers, inc.

PROJECT NAME: VA HOSPITAL EAST PARKING STRUCTURE ADDITION

A/E: WALKER PARKING CONSULTANTS

PROJECT LOCATION: ANN ARBOR, MICHIGAN

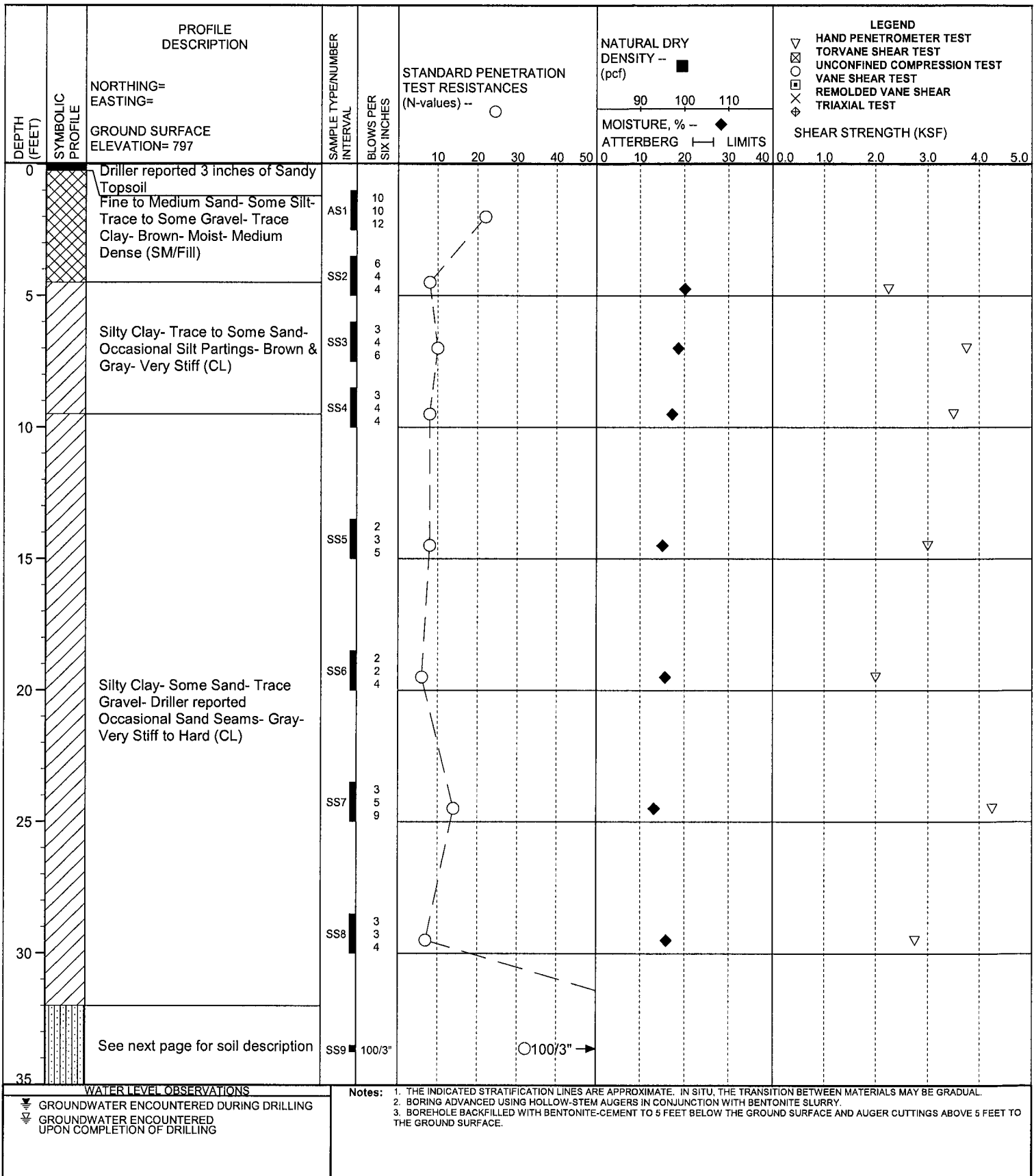
BY: SB/KLW DATE: 10/19/10

BORING B1

CLIENT: WALKER PARKING CONSULTANTS

PROJECT NUMBER: PG62404

SHEET: 1



DRILLER: JB

DRILL METHOD: Note 2

WATER LEVEL DURING DRILLING: 52

WATER LEVEL ONE DAY AFTER COMPLETION

RIG NO.: 253

BACKFILL METHOD: Note 3

WATER LEVEL UPON COMPLETION:

CAVE OF BOREHOLE AT



soil and materials engineers, inc.

PROJECT NAME: VA HOSPITAL EAST PARKING STRUCTURE ADDITION

A/E: WALKER PARKING CONSULTANTS

PROJECT LOCATION: ANN ARBOR, MICHIGAN

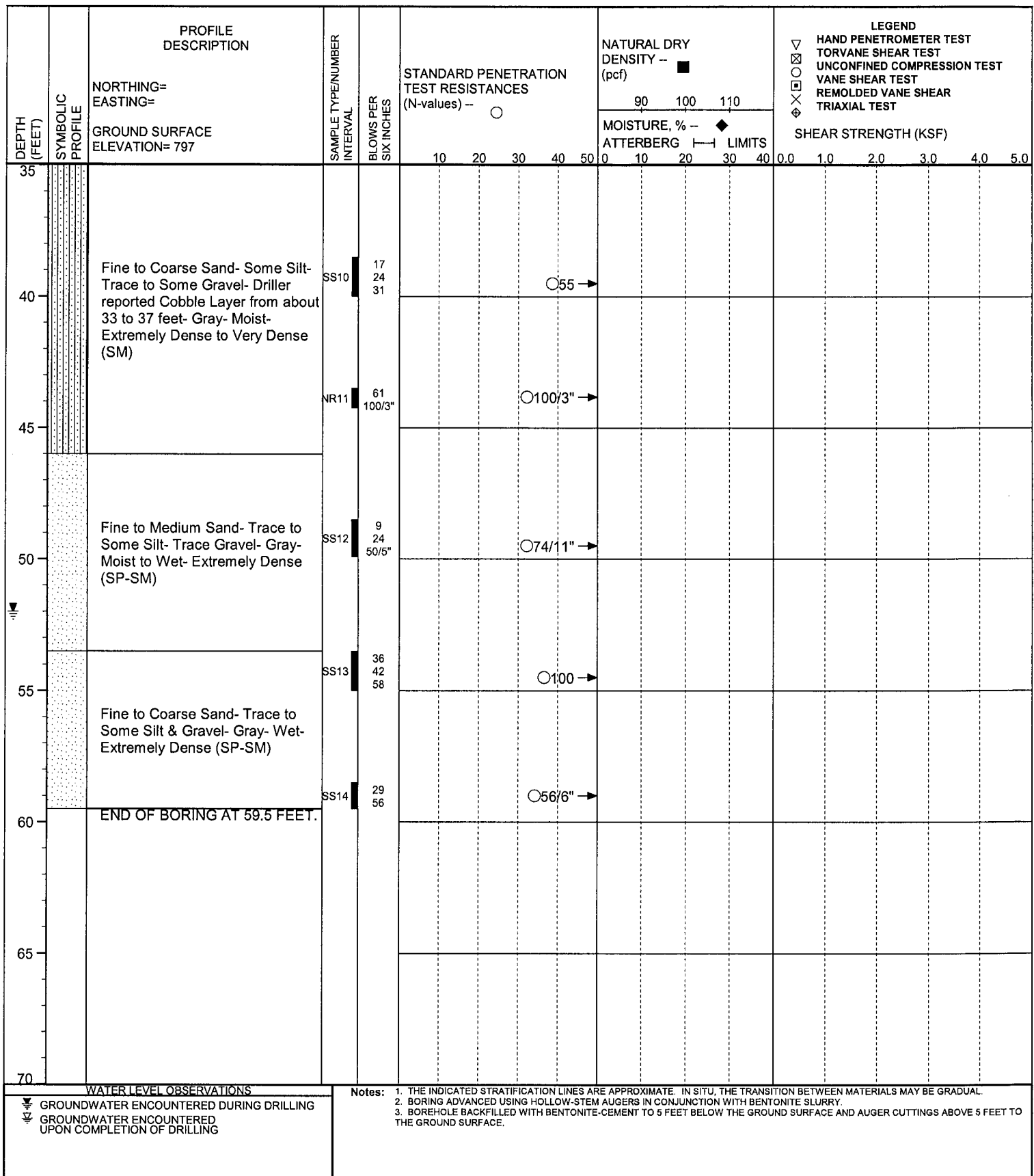
BY: SB/KLW DATE: 10/19/10

BORING B1

CLIENT: WALKER PARKING CONSULTANTS

PROJECT NUMBER: PG62404

SHEET: 2



DRILLER: JB

DRILL METHOD: Note 2

WATER LEVEL DURING DRILLING: 52

WATER LEVEL ONE DAY AFTER COMPLETION

RIG NO.: 253

BACKFILL METHOD: Note 3

WATER LEVEL UPON COMPLETION:

CAVE OF BOREHOLE AT



soil and materials engineers, inc.

PROJECT NAME: VA HOSPITAL EAST PARKING STRUCTURE ADDITION

A/E: WALKER PARKING CONSULTANTS

PROJECT LOCATION: ANN ARBOR, MICHIGAN

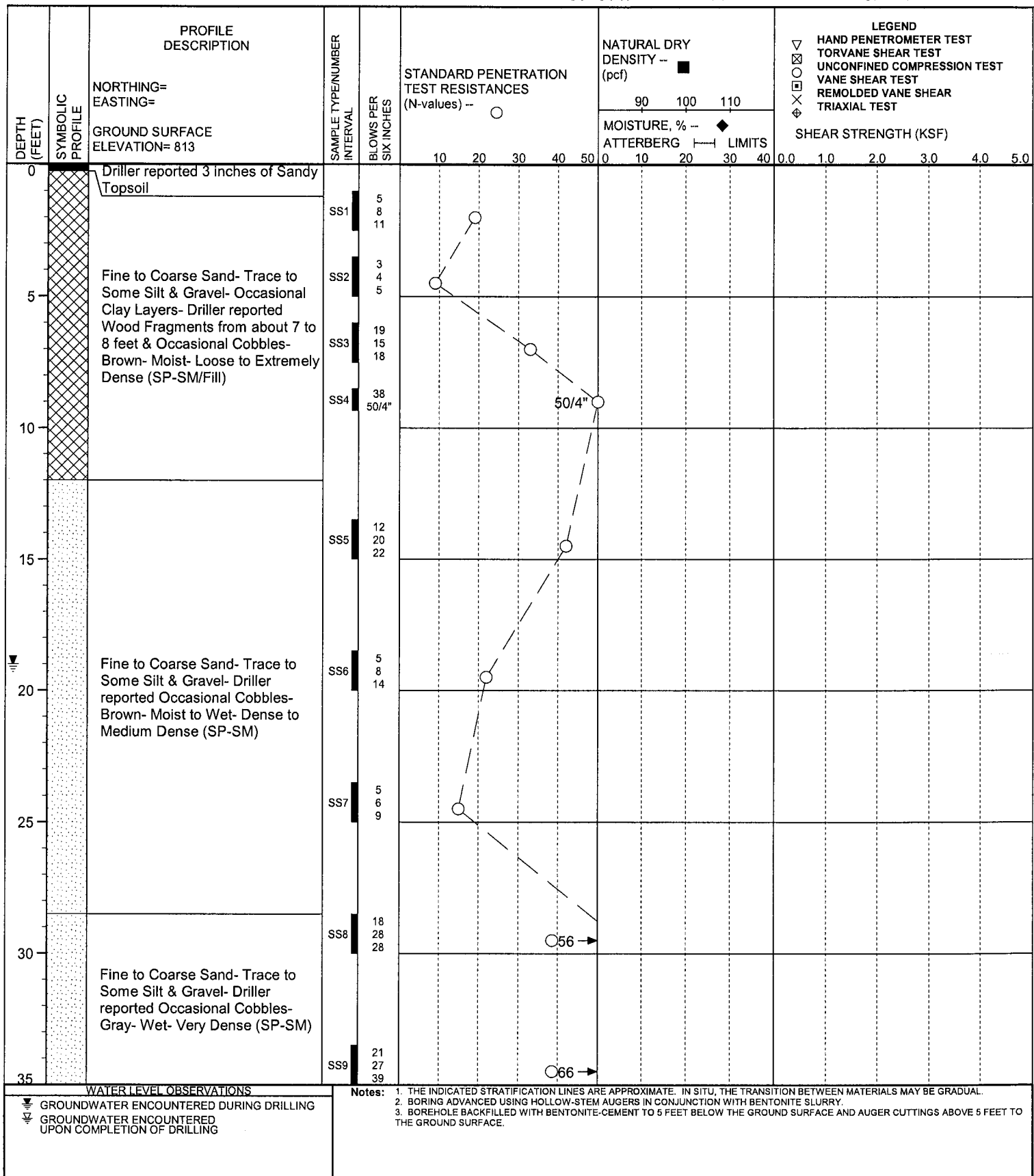
BY: SB/KLW DATE: 10/18/10

BORING B2

CLIENT: WALKER PARKING CONSULTANTS

PROJECT NUMBER: PG62404

SHEET: 1



DRILLER: JB

DRILL METHOD: Note 2

WATER LEVEL DURING DRILLING: 19

WATER LEVEL ONE DAY AFTER COMPLETION

RIG NO.: 253

BACKFILL METHOD: Note 3

WATER LEVEL UPON COMPLETION:

CAVE OF BOREHOLE AT 17 ft



soil and materials engineers, inc.

PROJECT NAME: VA HOSPITAL EAST PARKING STRUCTURE ADDITION

A/E: WALKER PARKING CONSULTANTS

PROJECT LOCATION: ANN ARBOR, MICHIGAN

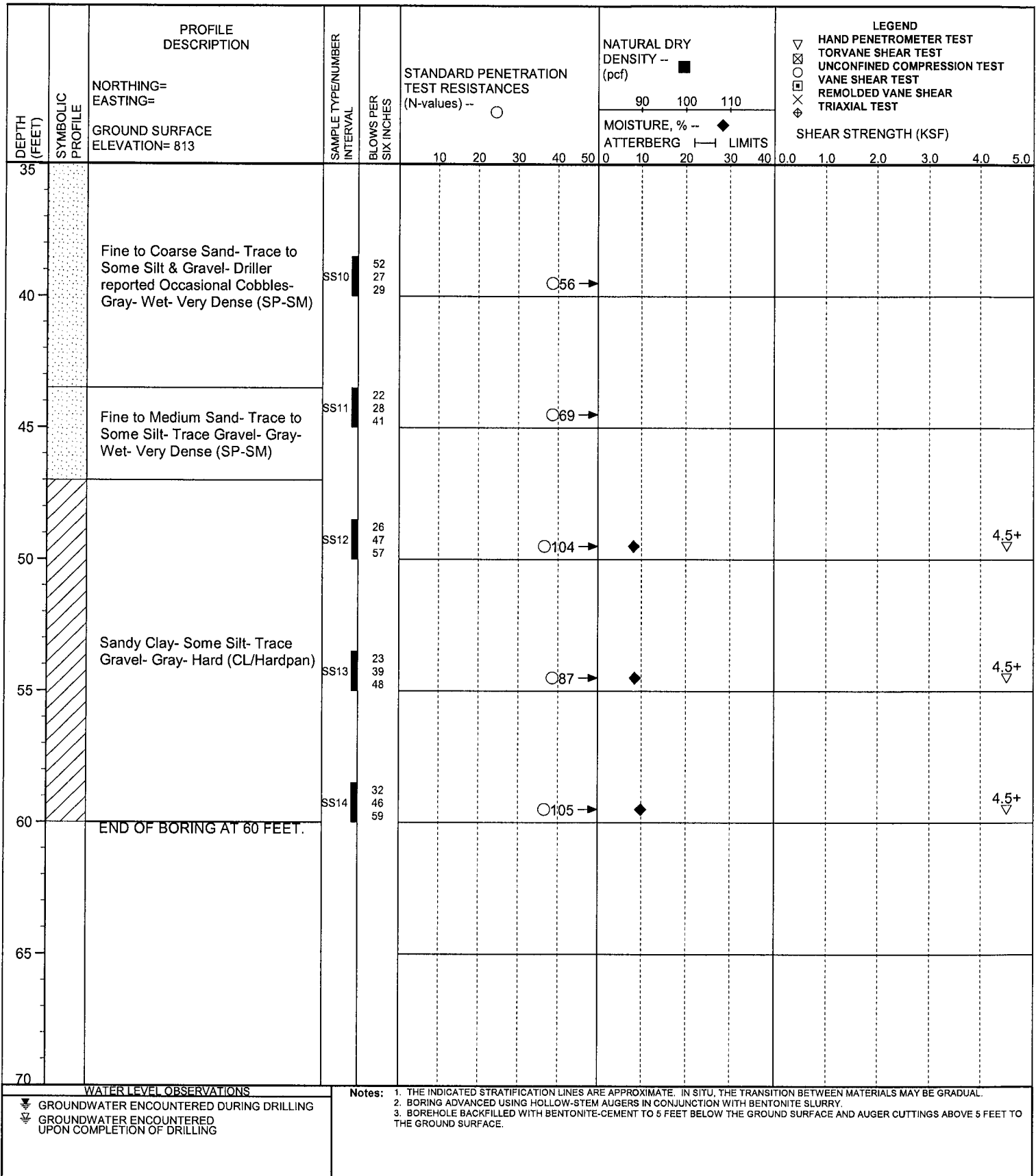
BY: SB/KLW DATE: 10/18/10

BORING B2

CLIENT: WALKER PARKING CONSULTANTS

PROJECT NUMBER: PG62404

SHEET: 2



DRILLER: JB

DRILL METHOD: Note 2

WATER LEVEL DURING DRILLING: 19

WATER LEVEL ONE DAY AFTER COMPLETION

RIG NO.: 253

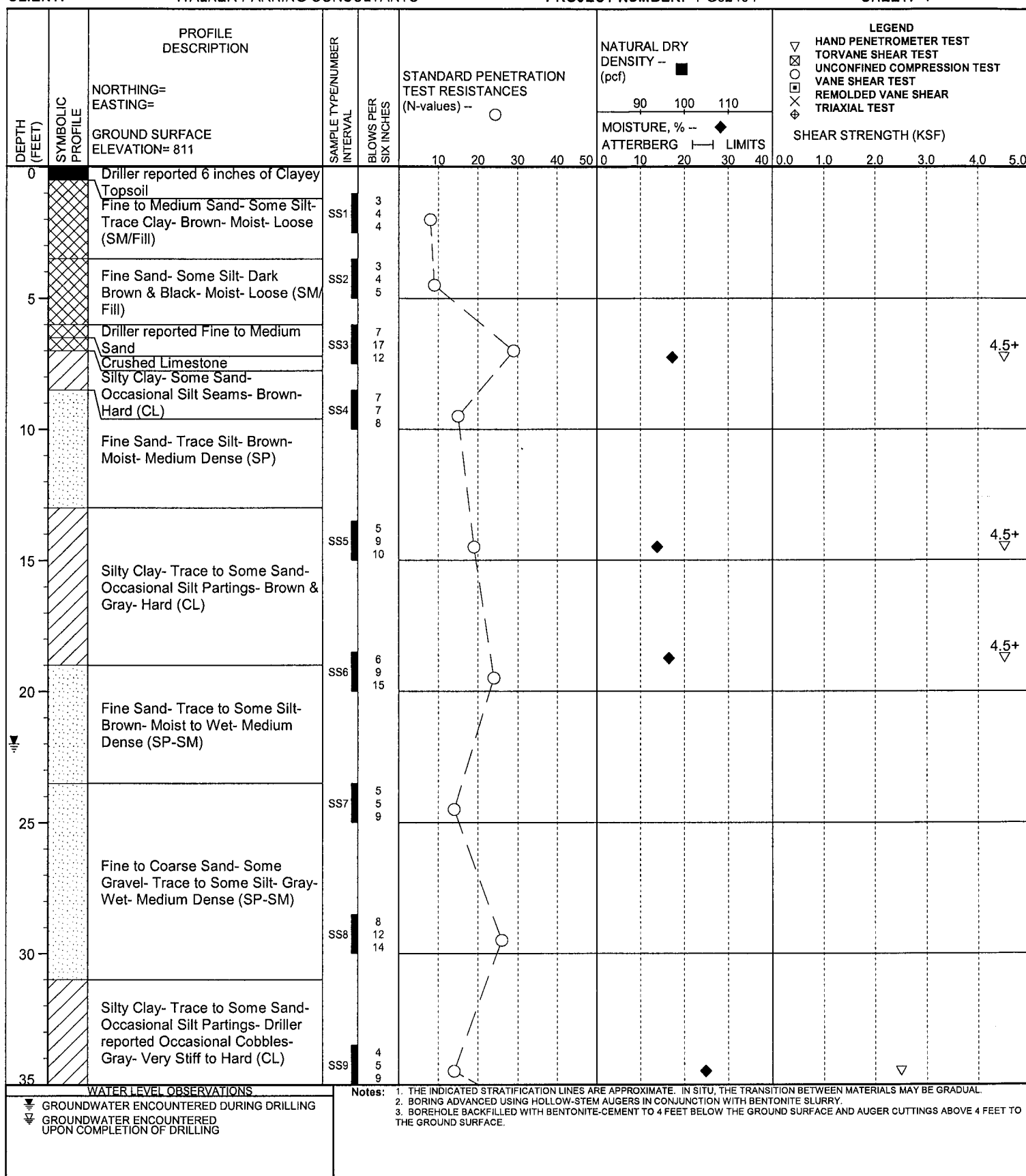
BACKFILL METHOD: Note 3

WATER LEVEL UPON COMPLETION:

CAVE OF BOREHOLE AT 17 ft



SHEET: 1



CAVE OF BOREHOLE AT



soil and materials engineers, inc.

PROJECT NAME: VA HOSPITAL EAST PARKING STRUCTURE ADDITION

A/E: WALKER PARKING CONSULTANTS

PROJECT LOCATION: ANN ARBOR, MICHIGAN

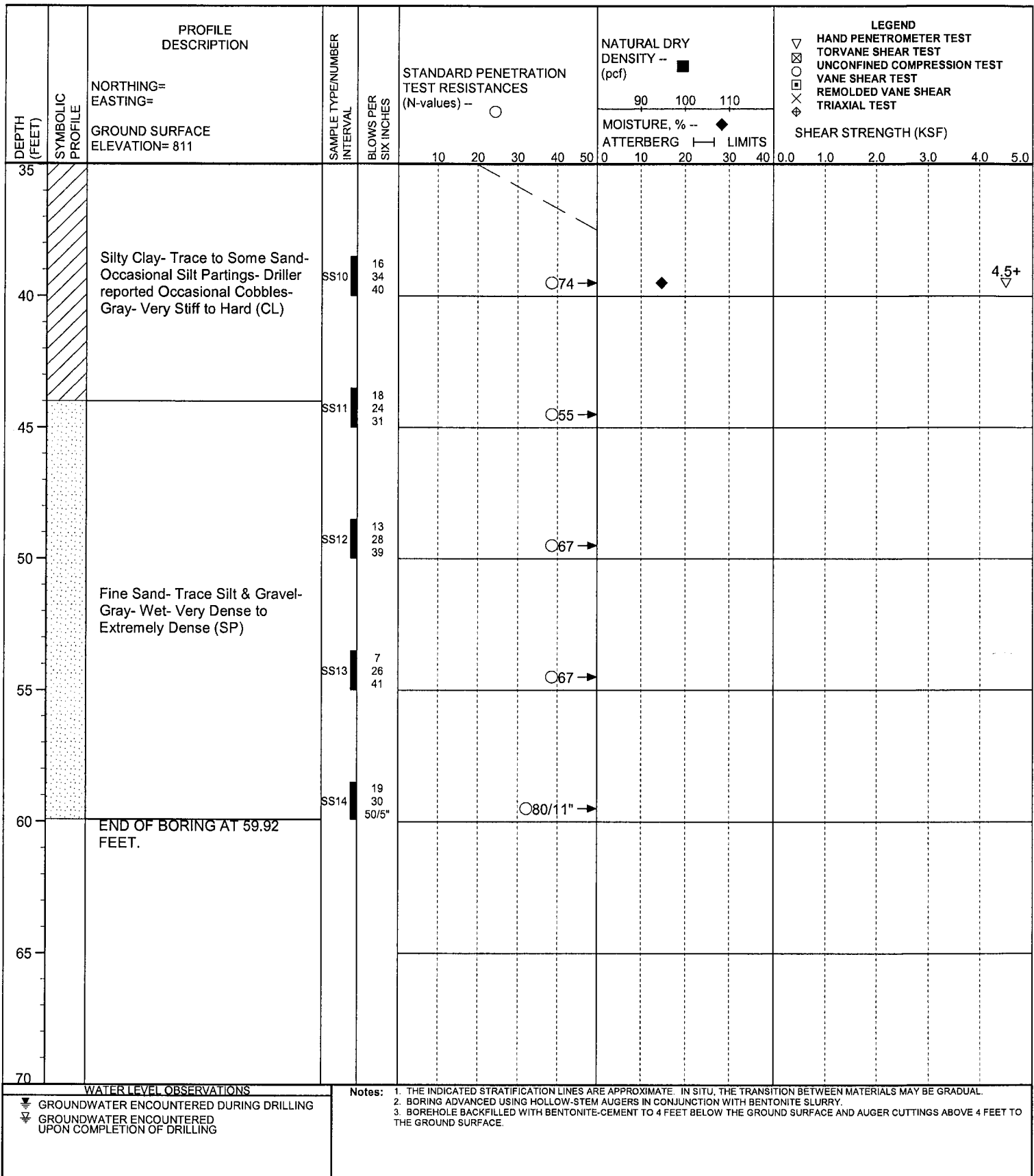
BY: SB/KLW DATE: 10/18/10

BORING B3

CLIENT: WALKER PARKING CONSULTANTS

PROJECT NUMBER: PG62404

SHEET: 2



DRILLER: JB

DRILL METHOD: Note 2

WATER LEVEL DURING DRILLING: 22

WATER LEVEL ONE DAY AFTER COMPLETION

RIG NO.: 253

BACKFILL METHOD: Note 3

WATER LEVEL UPON COMPLETION:

CAVE OF BOREHOLE AT

APPENDIX B

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

GENERAL COMMENTS

LABORATORY TESTING PROCEDURES

Important Information About Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply the report for any purpose or project except the one originally contemplated.*

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.



8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

Copyright 2004 by ASFE, Inc. Duplication, reproduction, or copying of this document, in whole or in part, by any means whatsoever, is strictly prohibited, except with ASFE's specific written permission. Excerpting, quoting, or otherwise extracting wording from this document is permitted only with the express written permission of ASFE, and only for purposes of scholarly research or book review. Only members of ASFE may use this document as a complement to or as an element of a geotechnical engineering report. Any other firm, individual, or other entity that so uses this document without being an ASFE member could be committing negligent or intentional (fraudulent) misrepresentation.

GENERAL COMMENTS

Basis of Geotechnical Report

This report has been prepared in accordance with generally accepted geotechnical engineering practices to assist in the design and/or evaluation of this project. If the project plans, design criteria, and other project information referenced in this report and utilized by SME to prepare our recommendations are changed, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions and recommendations of this report are modified or approved in writing by our office.

The discussions and recommendations submitted in this report are based on the available project information, described in this report, and the geotechnical data obtained from the field exploration at the locations indicated in the report. Variations in the soil and groundwater conditions commonly occur between or away from sampling locations. The nature and extent of the variations may not become evident until the time of construction. If significant variations are observed during construction, SME should be contacted to reevaluate the recommendations of this report. SME should be retained to continue our services through construction to observe and evaluate the actual subsurface conditions relative to the recommendations made in this report.

In the process of obtaining and testing samples and preparing this report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering. Specifically, field logs are prepared during the field exploration that describe field occurrences, sampling locations, and other information. Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory and differences may exist between the field logs and the report logs. The engineer preparing the report reviews the field logs, laboratory classifications, and test data and then prepares the report logs. Our recommendations are based on the contents of the report logs and the information contained therein.

Review of Design Details, Plans, and Specifications

SME should be retained to review the design details, project plans, and specifications to verify those documents are consistent with the recommendations contained in this report.

Review of Report Information With Project Team

Implementation of our recommendations may affect the design, construction, and performance of the proposed improvements, along with the potential inherent risks involved with the proposed construction. The client and key members of the design team, including SME, should discuss the issues covered in this report so that the issues are understood and applied in a manner consistent with the owner's budget, tolerance of risk, and expectations for performance and maintenance.

Field Verification of Geotechnical Conditions

SME should be retained to verify the recommendations of this report are properly implemented during construction. This may avoid misinterpretation of our recommendations by other parties and will allow us to review and modify our recommendations if variations in the site subsurface conditions are encountered.

Project Information for Contractor

This report and any future addenda or other reports regarding this site should be made available to prospective contractors prior to submitting their proposals for their information only and to supply them with facts relative to the subsurface evaluation and laboratory test results. If the selected contractor encounters subsurface conditions during construction, which differ from those presented in this report, the contractor should promptly describe the nature and extent of the differing conditions in writing and SME should be notified so that we can verify those conditions. The construction contract should include provisions for dealing with differing conditions and contingency funds should be reserved for potential problems during earthwork and foundation construction. We would be pleased to assist you in developing the contract provisions based on our experience.

The contractor should be prepared to handle environmental conditions encountered at this site, which may affect the excavation, removal, or disposal of soil; dewatering of excavations; and health and safety of workers. Any Environmental Assessment reports prepared for this site should be made available for review by bidders and the successful contractor.

Third Party Reliance/Reuse of This Report

This report has been prepared solely for the use of our Client for the project specifically described in this report. This report cannot be relied upon by other parties not involved in the project, unless specifically allowed by SME in writing. SME also is not responsible for the interpretation by other parties of the geotechnical data and the recommendations provided herein.

LABORATORY TESTING PROCEDURES

Visual Engineering Classification

Visual classification was performed on recovered samples. The appended General Notes and Unified Soil Classification System (USCS) sheets include a brief summary of the general method used visually classify the soil and assign an appropriate USCS group symbol. The estimated group symbol, according to the USCS, is shown in parentheses following the textural description of the various strata on the boring logs appended to this report. The soil descriptions developed from visual classifications are sometimes modified to reflect the results of laboratory testing.

Moisture Content

Moisture content tests were performed by weighing samples from the field at their in-situ moisture condition. These samples were then dried at a constant temperature (approximately 110° C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample and the weight of the water that was expelled during drying. The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

Hand Penetrometer Tests

In the hand penetrometer test, the unconfined compressive strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small calibrated, spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square-foot (tsf). Theoretically, the undrained shear strength of the cohesive sample is one-half the unconfined compressive strength. The undrained shear strength (based on the hand penetrometer test) presented on the boring logs is reported in units of kips per square-foot (ksf).

Torvane Shear Tests

In the Torvane test, the shear strength of a low strength, cohesive soil sample is estimated by measuring the resistance of the sample to a torque applied through vanes inserted into the sample. The undrained shear strength of the samples is measured from the maximum torque required to shear the sample and is reported in units of kips per square-foot (ksf).

Loss-on-Ignition (Organic Content) Tests

Loss-on-ignition (LOI) tests are conducted by first weighing the sample and then heating the sample to dry the moisture from the sample (in the same manner as determining the moisture content of the soil). The sample is then re-weighed to determine the dry weight and then heated for 4 hours in a muffle furnace at a high temperature (approximately 440° C). After cooling, the sample is re-weighed to calculate the amount of ash remaining, which in turn is used to determine the amount of organic matter burned from the original dry sample. The organic matter content of the specimen is expressed as a percent compared to the dry weight of the sample.

Atterberg Limits Tests

Atterberg limits tests consist of two components. The plastic limit of a cohesive sample is determined by rolling the sample into a thread and the plastic limit is the moisture content where a 1/8-inch thread begins to crumble. The liquid limit is determined by placing a 1/2-inch thick soil pat into the liquid limits cup and using a grooving tool to divide the soil pat in half. The cup is then tapped on the base of the liquid limits device using a crank handle. The number of drops of the cup to close the gap formed by the grooving tool 1/2 inch is recorded along with the corresponding moisture content of the sample. This procedure is repeated several times at different moisture contents and a graph of moisture content and the corresponding number of blows is plotted. The liquid limit is the moisture content at a nominal 25 drops of the cup. From this test, the plasticity index can be determined by subtracting the plastic limit from the liquid limit.

Page intentionally left blank.

SECTION 010000 - GENERAL REQUIREMENTS

TABLE OF CONTENTS

1.1	GENERAL INTENTION.....	1
1.2	STATEMENT OF BID ITEM(S).....	2
1.3	SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR	2
1.4	CONSTRUCTION SECURITY REQUIREMENTS	2
1.5	FIRE SAFETY.....	4
1.6	OPERATIONS AND STORAGE AREAS	6
1.7	DISPOSAL AND RETENTION.....	10
1.8	PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS.....	10
1.9	RESTORATION.....	11
1.10	PHYSICAL DATA.....	12
1.11	PROFESSIONAL SURVEYING SERVICES	12
1.12	LAYOUT OF WORK.....	12
1.13	As-Built Drawings	14
1.14	USE OF ROADWAYS.....	14
1.15	TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT	14
1.16	TEMPORARY USE OF EXISTING ELEVATORS	15
1.17	TEMPORARY TOILETS	15
1.18	AVAILABILITY AND USE OF UTILITY SERVICES	16
1.19	TESTS.....	17
1.20	INSTRUCTIONS	17
1.21	CONSTRUCTION SIGN	18
1.22	CONSTRUCTION DIGITAL IMAGES.....	18
1.23	FINAL ELEVATION Digital Images	19
1.24	HISTORIC PRESERVATION.....	20

Page intentionally left blank.

SECTION 010000 - GENERAL REQUIREMENTS

1.1 GENERAL INTENTION

- A. Contractor shall completely prepare site for building operations, including earthwork, selective demolition, and furnish labor and materials and perform work for construction of a 4-level horizontal expansion to the north end of the existing East Parking structure as required by drawings and specifications.
- B. Visits to the site by Bidders will take place during the designated time established by the Department of Veterans Affairs.
- C. Offices of Walker Parking Consultants, as Architect-Engineers, will render certain technical services during construction. Such services shall be considered as advisory to the Government and shall not be construed as expressing or implying a contractual act of the Government without affirmations by Contracting Officer or his duly authorized representative.
- D. Before placement and installation of work subject to tests by testing laboratory retained by Department of Veterans Affairs, the Contractor shall notify the COTR in sufficient time to enable testing laboratory personnel to be present at the site in time for proper taking and testing of specimens and field inspection. Such prior notice shall be not less than three work days unless otherwise designated by the COTR.
- E. All employees of general contractor and subcontractors shall comply with VA security management program and obtain permission of the VA police, be identified by project and employer, and restricted from unauthorized access.
- F. Prior to commencing work, general contractor shall provide proof that a OSHA certified "competent person" (CP) (29 CFR 1926.20(b)(2)) will maintain a presence at the work site whenever the general or subcontractors are present. This person shall be certified through OSHA training course in Construction Safety and Health (30-hour training course).
- G. Training:
 - 1. All employees of general contractor or subcontractors shall have the 10-hour OSHA certified Construction Safety course and /or other relevant competency training, as determined by VA CP with input from the ICRA team.
 - 2. Submit training records of all such employees for approval before the start of work.

1.2 STATEMENT OF BID ITEM(S)

Refer to Bid Schedule.

1.3 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

- A. Additional sets of drawings may be made by the Contractor, at Contractor's expense, from reproducible sepia prints furnished by Issuing Office. Such sepia prints shall be returned to the Issuing Office immediately after printing is completed.

1.4 CONSTRUCTION SECURITY REQUIREMENTS

A. Security Plan:

- 1. The security plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.
- 2. The General Contractor is responsible for assuring that all sub-contractors working on the project and their employees also comply with these regulations.

B. Security Procedures:

- 1. General Contractor's employees shall not enter the project site without appropriate badge. They may also be subject to inspection of their personal effects when entering or leaving the project site.
- 2. For working outside the "regular hours" as defined in the contract, The General Contractor shall give 3 days notice to the Contracting Officer so that security arrangements can be provided for the employees. This notice is separate from any notices required for utility shutdown described later in this section.
- 3. No photography of VA premises is allowed without written permission of the Contracting Officer.
- 4. VA reserves the right to close down or shut down the project site and order General Contractor's employees off the premises in the event of a national emergency. The General Contractor may return to the site only with the written approval of the Contracting Officer.

C. Key Control:

- 1. The General Contractor shall provide duplicate keys and lock combinations to the COTR for the purpose of security inspections of every area of project including tool boxes and parked machines and take any emergency action.
- 2. The General Contractor shall turn over all permanent lock cylinders to the VA locksmith for permanent installation. See Section 087100, DOOR HARDWARE and coordinate.

D. Document Control:

1. Before starting any work, the General Contractor/Sub Contractors shall submit an electronic security memorandum describing the approach to following goals and maintaining confidentiality of "sensitive information".
 - a. Sensitive Information is defined as: VA sensitive information is all Department data, on any storage media or in any form or format, which requires protection due to the risk of harm that could result from inadvertent or deliberate disclosure, alteration, or destruction of the information. The term includes information whose improper use or disclosure could adversely affect the ability of an agency to accomplish its mission, proprietary information, records about individuals requiring protection under various confidentiality provisions such as the Privacy Act and the HIPAA Privacy rule, and information that can be withheld under the Freedom of Information Act. Examples of VA sensitive information include the following: individually-identifiable medical, benefits, and personnel information; financial, budgetary, research, quality assurance; confidential commercial, critical infrastructure, investigatory, and law enforcement information; information that is confidential and privileged in litigation such as information protected by the deliberative process privilege, attorney work-product privilege, and the attorney client privilege; and other information which, if released, could result in violation of law or harm or unfairness to any individual or group, or could adversely affect the national interest or the conduct of federal programs.
2. The General Contractor is responsible for safekeeping of all drawings, project manual and other project information. This information shall be shared only with those with a specific need to accomplish the project.
4. Certain documents, sketches, videos or photographs and drawings may be marked "Law Enforcement Sensitive" or "Sensitive Unclassified". Secure such information in separate containers and limit the access to only those who will need it for the project. Return the information to the Contracting Officer upon request.
5. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer.
6. All paper waste or electronic media such as CD's and diskettes shall be shredded and destroyed in a manner acceptable to the VA. Coordinate with COTR.
7. Notify Contracting Officer and Site Security Officer immediately when there is a loss or compromise of "sensitive information".
8. All electronic information shall be stored in specified location following VA standards and procedures using an Engineering Document Management Software (EDMS).

- a. Security, access and maintenance of all project drawings, both scanned and electronic shall be performed and tracked through the EDMS system.

E. Motor Vehicle Restrictions

1. Vehicle authorization request shall be required for any vehicle entering the site and such request shall be submitted 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies.
2. Separate permits shall be issued for General Contractor and its employees for parking in designated areas only.

1.5 FIRE SAFETY

- A. Applicable Publications: Publications listed below form part of this Article to extent referenced. Publications are referenced in text by basic designations only.
1. American Society for Testing and Materials (ASTM):
E84-2009Surface Burning Characteristics of Building Materials
 2. National Fire Protection Association (NFPA):
10-2010.....Standard for Portable Fire Extinguishers
30-2008.....Flammable and Combustible Liquids Code
51B-2009Standard for Fire Prevention During Welding, Cutting
and Other Hot Work
70-2011.....National Electrical Code
241-2009.....Standard for Safeguarding Construction, Alteration,
and Demolition Operations
 3. Occupational Safety and Health Administration (OSHA):
29 CFR 1926.....Safety and Health Regulations for Construction
- B. Fire Safety Plan: Establish and maintain a fire protection program in accordance with 29 CFR 1926. Prior to start of work, prepare a plan detailing project-specific fire safety measures, including periodic status reports, and submit to Facility Safety Officer for review for compliance with contract requirements in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES Prior to any worker for the contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the general contractor's competent person per OSHA requirements. This briefing shall include information on the construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms,

use of VAMC equipment. Documentation shall be provided to the COTR that individuals have undergone contractor's safety briefing.

- C. Site and Building Access: Maintain free and unobstructed access to facility emergency services and for fire, police and other emergency response forces in accordance with NFPA 241.
- D. Separate temporary facilities, such as trailers, storage sheds, and dumpsters, from existing buildings and new construction by distances in accordance with NFPA 241. For small facilities with less than 6 m (20 feet) exposing overall length, separate by 3m (10 feet).
- E. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 241 and NFPA 70.
- F. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with facility Safety Officer.
- G. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to facility Safety Officer.
- H. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10.
- I. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.
- J. Standpipes: Install and extend standpipes up with each floor in accordance with 29 CFR 1926 and NFPA 241.
- K. Existing Fire Protection: Do not impair automatic sprinklers, smoke and heat detection, and fire alarm systems, except for portions immediately under construction, and temporarily for connections. Provide fire watch for impairments more than 4 hours in a 24-hour period. Request interruptions in accordance with Article, OPERATIONS AND STORAGE AREAS, and coordinate with and facility Safety Officer. All existing or temporary fire protection systems (fire alarms, sprinklers) located in construction areas shall be tested as coordinated with the medical center. Parameters for the testing and results of any tests performed shall be recorded by the medical center and copies provided to the COTR.
- L. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with facility Safety Officer.

- M. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with Project Engineer. Obtain permits from facility Safety Officer at least 24 hours in advance. Designate contractor's responsible project-site fire prevention program manager to permit hot work.
- N. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to Project Engineer and facility Safety Officer.
- O. Smoking: Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction. In separate and detached buildings under construction, smoking is prohibited except in designated smoking rest areas.
- P. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.
- Q. Perform other construction, alteration and demolition operations in accordance with 29 CFR 1926.
- R. If required, submit documentation to the COTR that personnel have been trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.

1.6 OPERATIONS AND STORAGE AREAS

- A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.
- B. Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.
- C. The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When

- materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.
- D. Working space and space available for storing materials shall be as shown on the drawings.
- E. **Workmen are subject to rules of Medical Center applicable to their conduct. Execute work in such a manner as to interfere as little as possible with work being done by others. Keep roads clear of construction materials, debris, standing construction equipment and vehicles at all times.**
- F. Execute work so as to interfere as little as possible with normal functioning of Medical Center as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others. Use of equipment and tools that transmit vibrations and noises through the building structure, are not permitted in buildings that are occupied, during construction, jointly by patients or medical personnel, and Contractor's personnel, except as permitted by COTR where required by limited working space.
1. Do not store materials and equipment in other than assigned areas.
 2. Schedule delivery of materials and equipment to immediate construction working areas within buildings in use by Department of Veterans Affairs in quantities sufficient for not more than two work days. Provide unobstructed access to Medical Center areas required to remain in operation.
 3. Where access by Medical Center personnel to vacated portions of buildings is not required, storage of Contractor's materials and equipment will be permitted subject to fire and safety requirements.
- G. Utilities Services: Where necessary to cut existing pipes, electrical wires, conduits, cables of utility services, or of fire protection systems or communications systems (except telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by COTR. All such actions shall be coordinated with the Utility Company involved:
1. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.

- H. Phasing: To insure such executions, Contractor shall furnish the COTR with a schedule of approximate dates on which the Contractor intends to accomplish work in each specific area of site, building or portion thereof. In addition, Contractor shall notify the COTR two weeks in advance of the proposed date of starting work in each specific area of site, building or portion thereof. Arrange such dates to insure accomplishment of this work in successive phases mutually agreeable to Medical Center Director, COTR and Contractor, as follows:
- I. The existing East Parking structure will be occupied during performance of work; but immediate areas near the north end will be vacated as shown on drawings. Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in the Medical Centers operations will not be hindered. Contractor shall permit access to Department of Veterans Affairs personnel and patients through other construction areas which serve as routes of access to such affected areas and equipment. Coordinate alteration work in areas occupied by Department of Veterans Affairs so that Medical Center operations will continue during the construction period.
- J. Construction Fence: Before construction operations begin, Contractor shall provide a chain link construction fence, 2.1m (seven feet) minimum height, around the construction area indicated on the drawings. Provide gates as required for access with necessary hardware, including hasps and padlocks. Fasten fence fabric to terminal posts with tension bands and to line posts and top and bottom rails with tie wires spaced at maximum 375mm (15 inches). Bottom of fences shall extend to 25mm (one inch) above grade. Remove the fence when directed by COTR.
- K. When a building is turned over to Contractor, Contractor shall accept entire responsibility therefore.
 - 1. Contractor shall maintain in operating condition existing fire protection and alarm equipment. In connection with fire alarm equipment, Contractor shall make arrangements for pre-inspection of site with Fire Department or Company (Department of Veterans Affairs or municipal) whichever will be required to respond to an alarm from Contractor's employee or watchman.
- L. Utilities Services: Maintain existing utility services for Medical Center at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables of utility services or of fire protection systems and communications systems (including

telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by COTR.

1. No utility service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without prior approval of COTR. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished, work on any energized circuits or equipment shall not commence without the Medical Center Director's prior knowledge and written approval. Refer to specification Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS,
 2. Contractor shall submit a request to interrupt any such services to COTR, in writing, 48 hours in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.
 3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Medical Center. Interruption time approved by Medical Center may occur at other than Contractor's normal working hours.
 4. Major interruptions of any system must be requested, in writing, at least 15 calendar days prior to the desired time and shall be performed as directed by the COTR.
 5. In case of a contract construction emergency, service will be interrupted on approval of COTR. Such approval will be confirmed in writing as soon as practical.
 6. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.
- M. Abandoned Lines: All service lines such as wires, cables, conduits, ducts, pipes and the like, and their hangers or supports, which are to be abandoned but are not required to be entirely removed, shall be sealed, capped or plugged. The lines shall not be capped in finished areas, but shall be removed and sealed, capped or plugged in ceilings, within furred spaces, in unfinished areas, or within walls or partitions; so that they are completely behind the finished surfaces.
- N. To minimize interference of construction activities with flow of Medical Center traffic, comply with the following:
1. Keep roads, walks and entrances to grounds, to parking and to occupied areas of buildings clear of construction materials, debris and standing construction equipment and vehicles. Wherever excavation for new utility lines cross existing roads, at least one lane must be open to traffic at all times.

2. Method and scheduling of required cutting, altering and removal of existing roads, walks and entrances must be approved by the COTR.
- O. Coordinate the work for this contract with other construction operations as directed by COTR. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

1.7 DISPOSAL AND RETENTION

- A. Materials and equipment accruing from work removed and from demolition of buildings or structures, or parts thereof, shall be disposed of as follows:
 1. Items not reserved shall become property of the Contractor and be removed by Contractor from Medical Center
 2. Items of portable equipment and furnishings located in rooms and spaces in which work is to be done under this contract shall remain the property of the Government. When rooms and spaces are vacated by the Department of Veterans Affairs during the alteration period, such items which are NOT required by drawings and specifications to be either relocated or reused will be removed by the Government in advance of work to avoid interfering with Contractor's operation.

1.8 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS

- A. The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.
- B. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

- C. Refer to Section 015719, TEMPORARY ENVIRONMENTAL CONTROLS, for additional requirements on protecting vegetation, soils and the environment. Refer to Articles, "Alterations", "Restoration", and "Operations and Storage Areas" for additional instructions concerning repair of damage to structures and site improvements.
- D. Refer to FAR clause 52.236-7, "Permits and Responsibilities," which is included in General Conditions. A National Pollutant Discharge Elimination System (NPDES) permit is required for this project. The Contractor is considered an "operator" under the permit and has extensive responsibility for compliance with permit requirements. VA will make the permit application available at the (appropriate medical center) office. The contractor and affected subcontractors shall furnish all information and certifications that are required to comply with the permit process and permit requirements. Many of the permit requirements will be satisfied by completing construction as shown and specified. Some requirements involve the Contractor's method of operations and operations planning and the Contractor is responsible for employing best management practices. The affected activities often include, the following:
- Designating areas for equipment maintenance and repair;
 - Providing waste receptacles at convenient locations and provide regular collection of wastes;
 - Locating equipment wash down areas on site, and provide appropriate control of wash-waters;
 - Providing protected storage areas for chemicals, paints, solvents, fertilizers, and other potentially toxic materials; and
 - Providing adequately maintained sanitary facilities.

1.9 RESTORATION

- A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of the COTR. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the COTR before it is disturbed. Materials and workmanship used in restoring work, shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.
- B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.

- C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables of utility services or of fire protection systems and communications systems (including telephone) which are indicated on drawings and which are not scheduled for discontinuance or abandonment.
- D. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown will be covered by adjustment to contract time and price in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88) or "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

1.10 PHYSICAL DATA

- A. Data and information furnished or referred to below is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.
 - 1. The indications of physical conditions on the drawings and in the specifications are the result of site investigations by SME, Inc. Plymouth, MI.
- B. Subsurface conditions have been developed by core borings and test pits. Logs of subsurface exploration are shown diagrammatically in the soil report by SME, Inc.
- C. A copy of the soil report is attached.
- D. Government does not guarantee that other materials will not be encountered nor that proportions, conditions or character of several materials will not vary from those indicated by explorations. Bidders are expected to examine site of work and logs of borings; and, after investigation, decide for themselves character of materials and make their bids accordingly. Upon proper application to Department of Veterans Affairs, bidders will be permitted to make subsurface explorations of their own at site.

1.11 PROFESSIONAL SURVEYING SERVICES

A registered professional land surveyor or registered civil engineer whose services are retained and paid for by the Contractor shall perform services specified herein and in other specification sections. The Contractor shall certify that the land surveyor or civil engineer is not one who is a regular employee of the Contractor, and that the land surveyor or civil engineer has no financial interest in this contract.

1.12 LAYOUT OF WORK

- A. The Contractor shall lay out the work from Government established base lines and bench marks, indicated on the drawings, and shall be responsible

- for all measurements in connection with the layout. The Contractor shall furnish, at Contractor's own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through Contractor's negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor.
- B. Establish and plainly mark building, lines and such other lines and grades that are reasonably necessary to properly assure that location, orientation, and elevations established for each such structure and/or addition, are in accordance with lines and elevations shown on contract drawings.
- C. Following completion of general mass excavation and before any other permanent work is performed, establish and plainly mark (through use of appropriate batter boards or other means) sufficient additional survey control points or system of points as may be necessary to assure proper alignment, orientation, and grade of all major features of work. Survey shall include location of lines and grades of footings, exterior walls, center lines of columns in both directions, major utilities and elevations of floor slabs:
1. Such additional survey control points or system of points thus established shall be checked and certified by a registered land surveyor or registered civil engineer. Furnish such certification to the COTR before any work (such as footings, floor slabs, columns, walls, utilities and other major controlling features) is placed.
- D. During progress of work, and particularly as work progresses from floor to floor, Contractor shall have line grades and plumbness of all major form work checked and certified by a registered land surveyor or registered civil engineer as meeting requirements of contract drawings. Furnish such certification to the COTR before any major items of concrete work are placed. In addition, Contractor shall also furnish to the COTR certificates from a registered land surveyor or registered civil engineer that the following work is complete in every respect as required by contract drawings.
1. Lines of each building and/or addition.
 2. Elevations of bottoms of footings and tops of floors of each building and/or addition.
 3. Lines and elevations of sewers and of all outside distribution systems.
 4. Lines and elevations of all swales and interment areas.

- E. Whenever changes from contract drawings are made in line or grading requiring certificates, record such changes on a reproducible drawing bearing the registered land surveyor or registered civil engineer seal, and forward these drawings upon completion of work to COTR.
- F. The Contractor shall perform the surveying and layout work of this and other articles and specifications in accordance with the provisions of Article "Professional Surveying Services".

1.13 AS-BUILT DRAWINGS

- A. The contractor shall maintain two full size sets of as-built drawings which will be kept current during construction of the project, to include all contract changes, modifications and clarifications.
- B. All variations shall be shown in the same general detail as used in the contract drawings. To insure compliance, as-built drawings shall be made available for the COTR's review, as often as requested.
- C. Contractor shall deliver two approved completed sets of as-built drawings to the COTR within 15 calendar days after each completed phase and after the acceptance of the project by the COTR.
- D. Paragraphs A, B, & C shall also apply to all shop drawings.

1.14 USE OF ROADWAYS

- A. For hauling, use only established public roads and roads on Medical Center property and, when authorized by the COTR, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.
- B. When new permanent roads are to be a part of this contract, Contractor may construct them immediately for use to facilitate building operations. These roads may be used by all who have business thereon within zone of building operations.
- C. When certain buildings (or parts of certain buildings) are required to be completed in advance of general date of completion, all roads leading thereto must be completed and available for use at time set for completion of such buildings or parts thereof.

1.15 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Use of new installed mechanical and electrical equipment to provide heat, ventilation, plumbing, light and power will be permitted subject to compliance with the following provisions:

1. Permission to use each unit or system must be given by COTR. If the equipment is not installed and maintained in accordance with the following provisions, the COTR will withdraw permission for use of the equipment.
 2. Electrical installations used by the equipment shall be completed in accordance with the drawings and specifications to prevent damage to the equipment and the electrical systems, i.e. transformers, relays, circuit breakers, fuses, conductors, motor controllers and their overload elements shall be properly sized, coordinated and adjusted. Voltage supplied to each item of equipment shall be verified to be correct and it shall be determined that motors are not overloaded. The electrical equipment shall be thoroughly cleaned before using it and again immediately before final inspection including vacuum cleaning and wiping clean interior and exterior surfaces.
 3. Units shall be properly lubricated, balanced, and aligned. Vibrations must be eliminated.
 4. Automatic temperature control systems for preheat coils shall function properly and all safety controls shall function to prevent coil freeze-up damage.
 5. The air filtering system utilized shall be that which is designed for the system when complete, and all filter elements shall be replaced at completion of construction and prior to testing and balancing of system.
- B. Prior to final inspection, the equipment or parts used which show wear and tear beyond normal, shall be replaced with identical replacements, at no additional cost to the Government.
- C. This paragraph shall not reduce the requirements of the mechanical and electrical specifications sections.

1.16 TEMPORARY USE OF EXISTING ELEVATORS

- A. Contractor will not be allowed the use of existing elevators.

1.17 TEMPORARY TOILETS

- A. Provide (for use of all Contractor's workmen) ample temporary sanitary toilet accommodations with suitable sewer and water connections; or, when approved by COTR, provide suitable dry closets where directed. Keep such places clean and free from flies, and all connections and appliances connected therewith are to be removed prior to completion of contract, and premises left perfectly clean.

1.18 AVAILABILITY AND USE OF UTILITY SERVICES

- A. The Government shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The amount to be paid by the Contractor for chargeable electrical services shall be the prevailing rates charged to the Government. The Contractor shall carefully conserve any utilities furnished without charge.
- B. The Contractor, at Contractor's expense and in a workmanlike manner satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of electricity used for the purpose of determining charges. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia.
- C. Contractor shall install meters at Contractor's expense and furnish the Medical Center a monthly record of the Contractor's usage of electricity as hereinafter specified.
- D. Heat: Furnish temporary heat necessary to prevent injury to work and materials through dampness and cold. Use of open salamanders or any temporary heating devices which may be fire hazards or may smoke and damage finished work, will not be permitted. Maintain minimum temperatures as specified for various materials:
- E. Electricity (for Construction and Testing): Furnish all temporary electric services.
 - 1. Obtain electricity by connecting to the Medical Center electrical distribution system. The Contractor shall meter and pay for electricity required for electric cranes and hoisting devices, electrical welding devices and any electrical heating devices providing temporary heat. Electricity for all other uses is available at no cost to the Contractor.
- F. Water (for Construction and Testing): Furnish temporary water service.
 - 1. Obtain water by connecting to the Medical Center water distribution system. Provide reduced pressure backflow preventer at each connection. Water is available at no cost to the Contractor.
 - 2. Maintain connections, pipe, fittings and fixtures and conserve water-use so none is wasted. Failure to stop leakage or other wastes will be cause for revocation (at COTR's discretion) of use of water from Medical Center's system.

1.19 TESTS

- A. Pre-test mechanical and electrical equipment and systems and make corrections required for proper operation of such systems before requesting final tests. Final test will not be conducted unless pre-tested.
- B. Conduct final tests required in various sections of specifications in presence of an authorized representative of the Contracting Officer. Contractor shall furnish all labor, materials, equipment, instruments, and forms, to conduct and record such tests.
- C. Mechanical and electrical systems shall be balanced, controlled and coordinated. A system is defined as the entire complex which must be coordinated to work together during normal operation to produce results for which the system is designed. D. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonably short period of time during which operating and environmental conditions remain reasonably constant.
- D. Individual test result of any component, where required, will only be accepted when submitted with the test results of related components and of the entire system.

1.20 INSTRUCTIONS

- A. Contractor shall furnish Maintenance and Operating manuals and verbal instructions when required by the various sections of the specifications and as hereinafter specified.
- B. Manuals: Maintenance and operating manuals (four copies each) for each separate piece of equipment shall be delivered to the COTR coincidental with the delivery of the equipment to the job site. Manuals shall be complete, detailed guides for the maintenance and operation of equipment. They shall include complete information necessary for starting, adjusting, maintaining in continuous operation for long periods of time and dismantling and reassembling of the complete units and sub-assembly components. Manuals shall include an index covering all component parts clearly cross-referenced to diagrams and illustrations. Illustrations shall include "exploded" views showing and identifying each separate item. Emphasis shall be placed on the use of special tools and instruments. The function of each piece of equipment, component, accessory and control shall be clearly and thoroughly explained. All necessary precautions for the operation of the equipment and the reason for each precaution shall be clearly set forth. Manuals must reference the exact model, style and size of the piece of equipment and system being furnished. Manuals referencing equipment similar to but of a different model, style, and size than that furnished will not be accepted.

- C. Instructions: Contractor shall provide qualified, factory-trained manufacturers' representatives to give detailed instructions to assigned Department of Veterans Affairs personnel in the operation and complete maintenance for each piece of equipment. All such training will be at the job site. These requirements are more specifically detailed in the various technical sections. Instructions for different items of equipment that are component parts of a complete system, shall be given in an integrated, progressive manner. All instructors for every piece of component equipment in a system shall be available until instructions for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. All instruction periods shall be at such times as scheduled by the COTR and shall be considered concluded only when the COTR is satisfied in regard to complete and thorough coverage. The Department of Veterans Affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the COTR, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.

1.21 CONSTRUCTION SIGN

- A. Provide a Construction Sign where directed by the COTR. All wood members shall be of framing lumber. Cover sign frame with 0.7 mm (24 gage) galvanized sheet steel nailed securely around edges and on all bearings. Provide three 100 by 100 mm (4 inch by 4 inch) posts (or equivalent round posts) set 1200 mm (four feet) into ground. Set bottom of sign level at 900 mm (three feet) above ground and secure to posts with through bolts. Make posts full height of sign. Brace posts with 50 x 100 mm (two by four inch) material as directed.
- B. Paint all surfaces of sign and posts two coats of white gloss paint. Border and letters shall be of black gloss paint, except project title which shall be blue gloss paint.
- C. Maintain sign and remove it when directed by the COTR.
- D. Detail Drawing of construction sign showing required legend and other characteristics of sign is shown on the drawings.

1.22 CONSTRUCTION DIGITAL IMAGES

- A. During the construction period through completion, furnish Department of Veterans Affairs with 300 views of digital images, including one color print of each view and one Compact Disc (CD) per visit containing those views taken on that visit. Digital views shall be taken of exterior and/or interior as selected and directed by COTR (RE). Each view shall be taken with a professional grade camera with minimum size of 6 megapixels (MP) and the images will

be a minimum of 2272 x 1704 pixels for the 200x250mm (8x 10 inch) prints, as per these specifications:

1. Normally such images will be taken at monthly intervals. However, the COTR may also direct the taking of special digital images at any time prior to completion and acceptance of contract. If the number of trips to the site exceeds an average of one per month of the contract performance period then an adjustment in contract price will be made in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).
 2. In event a greater or lesser number of images than specified above are required by the COTR, adjustment in contract price will be made in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).
- B. Images must show distinctly, at as large a scale as possible, all parts of work embraced in the picture.
- C. Prints shall be made on 200 x 250 mm (8 by 10 inch) regular-weight matte archival grade photographic paper and produced by a process with a minimum of 300 pixels per inch (PPI). Prints must be printed using the commercial RA4 process (inkjet prints will not be acceptable). Photographs shall have 200 x 200 mm (8 by 8 inch) full picture print with no margin on three sides and a 50 mm (2 inches) margin on the bottom for pre-typed self-adhesive identity label to be added by COTR.
- D. Images on CD-ROM shall be recorded in JPEG format with a minimum of 24 bit color and no reduction in actual picture size. Compressed size of the file shall be no less than 80% of the original with no loss of information. File names shall contain the date the image was taken, the Project number and a unique sequential identifier. The CD-ROM shall also contain an index of all the images contained therein in either a TXT or Microsoft Word format.
- E. In case any set of prints are not submitted within five days of date established by COTR for taking thereof, the COTR may have such images/photographs taken and cost of same will be deducted from any money due to the Contractor.

1.23 FINAL ELEVATION DIGITAL IMAGES

- A. A minimum of four (4) images of each elevation shall be taken with a minimum 6 MP camera, with different settings to allow the COTR to select the image to be printed. All images are provided to the RE on a CD.
- B. Photographs shall be taken upon completion, including landscaping. They shall be taken on a clear sunny day to obtain sufficient detail to show depth and to provide clear, sharp pictures. Pictures shall be 400 mm x 500 mm (16

- by 20 inches), printed on regular weight paper, matte finish archival grade photographic paper and produced by a RA4 process from the digital image with a minimum 300 PPI. Identifying data shall be carried on label affixed to back of photograph without damage to photograph and shall be similar to that provided for final construction photographs.
- C. Furnish six (6) 400 mm x 500 mm (16 by 20 inch) color prints of the following buildings constructed under this project (elevations as selected by the RE from the images taken above). Photographs shall be artistically composed showing full front elevations. All images shall become property of the Government. Each of the selected six prints shall be place in a frame with a minimum of 2 inches of appropriate matting as a border. Provide a selection of a minimum of 3 different frames from which the SRE will select one style to frame all six prints. Photographs with frames shall be delivered to the COTR in boxes suitable for shipping.

1.24 HISTORIC PRESERVATION

Where the Contractor or any of the Contractor's employees, prior to, or during the construction work, are advised of or discover any possible archeological, historical and/or cultural resources, the Contractor shall immediately notify the COTR verbally, and then with a written follow up.

END OF SECTION 010000

SECTION 013216.15 - PROJECT SCHEDULES

PART 1- GENERAL

1.1 DESCRIPTION

- A. The Contractor shall develop a Critical Path Method (CPM) plan and schedule demonstrating fulfillment of the contract requirements (Project Schedule), and shall keep the Project Schedule up-to-date in accordance with the requirements of this section and shall utilize the plan for scheduling, coordinating and monitoring work under this contract (including all activities of subcontractors, equipment vendors and suppliers). Conventional Critical Path Method (CPM) technique shall be utilized to satisfy both time and cost applications.

1.2 CONTRACTOR'S REPRESENTATIVE

- A. The Contractor shall designate an authorized representative responsible for the Project Schedule including preparation, review and progress reporting with and to the Contracting Officer's Representative (COTR).
- B. The Contractor's representative shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the requirements of this specification section.
- C. The Contractor's representative shall have the option of developing the project schedule within their organization or to engage the services of an outside consultant. If an outside scheduling consultant is utilized, Section 1.3 of this specification will apply.

1.3 CONTRACTOR'S CONSULTANT

- A. The Contractor shall submit a qualification proposal to the COTR, within 10 days of the contractor's notification of contract award. The qualification proposal shall include:
 - 1. The name and address of the proposed consultant.
 - 2. Information to show that the proposed consultant has the qualifications to meet the requirements specified in the preceding paragraph.
 - 3. A representative sample of prior construction projects, which the proposed consultant has performed complete project scheduling services. These representative samples shall be of similar size and scope.

- B. The Contracting Officer has the right to approve or disapprove the proposed consultant, and will notify the Contractor of the VA decision within seven calendar days from receipt of the qualification proposal. In case of disapproval, the Contractor shall resubmit another consultant within 10 calendar days for renewed consideration. The Contractor shall have their scheduling consultant approved prior to submitting any schedule for approval.

1.4 COMPUTER PRODUCED SCHEDULES

- A. The contractor shall provide monthly, to the Department of Veterans Affairs (VA), all computer-produced time/cost schedules and reports generated from monthly project updates. This monthly computer service will include: three copies of up to five different reports (inclusive of all pages) available within the user defined reports of the scheduling software approved by the Contracting Officer; a hard copy listing of all project schedule changes, and associated data, made at the update and an electronic file of this data; and the resulting monthly updated schedule in PDM format. These must be submitted with and substantively support the contractor's monthly payment request and the signed look ahead report. The COTR shall identify the five different report formats that the contractor shall provide.
- B. The contractor shall be responsible for the correctness and timeliness of the computer-produced reports. The Contractor shall also responsible for the accurate and timely submittal of the updated project schedule and all CPM data necessary to produce the computer reports and payment request that is specified.
- C. The VA will report errors in computer-produced reports to the Contractor's representative within ten calendar days from receipt of reports. The Contractor shall reprocess the computer-produced reports and associated diskette(s), when requested by the Contracting Officer's representative, to correct errors which affect the payment and schedule for the project.

1.5 THE COMPLETE PROJECT SCHEDULE SUBMITTAL

- A. Within 45 calendar days after receipt of Notice to Proceed, the Contractor shall submit for the Contracting Officer's review; three blue line copies of the interim schedule on sheets of paper 765 x 1070 mm (30 x 42 inches) and an electronic file in the previously approved CPM schedule program. The submittal shall also include three copies of a computer-produced activity/event ID schedule showing project duration; phase completion dates; and other data, including event cost. Each activity/event on the computer-produced schedule shall contain as a minimum, activity/event ID, activity/event description, duration, budget amount, early start date, early finish date, late start date, late finish date and total float. Work activity/event relationships shall be restricted to finish-to-start or start-to-start without lead

or lag constraints. Activity/event date constraints, not required by the contract, will not be accepted unless submitted to and approved by the Contracting Officer. The contractor shall make a separate written detailed request to the Contracting Officer identifying these date constraints and secure the Contracting Officer's written approval before incorporating them into the network diagram. The Contracting Officer's separate approval of the Project Schedule shall not excuse the contractor of this requirement. Logic events (non-work) will be permitted where necessary to reflect proper logic among work events, but must have zero duration. The complete working schedule shall reflect the Contractor's approach to scheduling the complete project. **The final Project Schedule in its original form shall contain no contract changes or delays which may have been incurred during the final network diagram development period and shall reflect the entire contract duration as defined in the bid documents.** These changes/delays shall be entered at the first update after the final Project Schedule has been approved. The Contractor should provide their requests for time and supporting time extension analysis for contract time as a result of contract changes/delays, after this update, and in accordance with Article, ADJUSTMENT OF CONTRACT COMPLETION.

- B. Within 30 calendar days after receipt of the complete project interim Project Schedule and the complete final Project Schedule, the Contracting Officer or his representative, will do one or both of the following:
 - 1. Notify the Contractor concerning his actions, opinions, and objections.
 - 2. A meeting with the Contractor at or near the job site for joint review, correction or adjustment of the proposed plan will be scheduled if required. Within 14 calendar days after the joint review, the Contractor shall revise and shall submit three blue line copies of the revised Project Schedule, three copies of the revised computer-produced activity/event ID schedule and a revised electronic file as specified by the Contracting Officer. The revised submission will be reviewed by the Contracting Officer and, if found to be as previously agreed upon, will be approved.
- C. The approved baseline schedule and the computer-produced schedule(s) generated there from shall constitute the approved baseline schedule until subsequently revised in accordance with the requirements of this section.
- D. The Complete Project Schedule shall contain approximately 20 work activities/events.

1.6 WORK ACTIVITY/EVENT COST DATA

- A. The Contractor shall cost load all work activities/events except procurement activities. The cumulative amount of all cost loaded work activities/events (including alternates) shall equal the total contract price. Prorate overhead,

- profit and general conditions on all work activities/events for the entire project length. The contractor shall generate from this information cash flow curves indicating graphically the total percentage of work activity/event dollar value scheduled to be in place on early finish, late finish. These cash flow curves will be used by the Contracting Officer to assist him in determining approval or disapproval of the cost loading. Negative work activity/event cost data will not be acceptable, except on VA issued contract changes.
- B. In accordance with FAR 52.236 – 1 (PERFORMANCE OF WORK BY THE CONTRACTOR) and VAAR 852.236 – 72 (PERFORMANCE OF WORK BY THE CONTRACTOR), the Contractor shall submit, simultaneously with the cost per work activity/event of the construction schedule required by this Section, a responsibility code for all activities/events of the project for which the Contractor's forces will perform the work.
- C. The Contractor shall cost load work activities/events for all BID ITEMS including ASBESTOS ABATEMENT. The sum of each BID ITEM work shall equal the value of the bid item in the Contractors' bid.

1.7 PROJECT SCHEDULE REQUIREMENTS

- A. Show on the project schedule the sequence of work activities/events required for complete performance of all items of work. The Contractor Shall:
1. Show activities/events as:
 - a. Contractor's time required for submittal of shop drawings, templates, fabrication, delivery and similar pre-construction work.
 - b. Contracting Officer's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.
 - c. Interruption of VA Facilities utilities, and rough-in drawings, project phasing and any other specification requirements.
 - d. Test, balance and adjust various systems and pieces of equipment, maintenance and operation manuals, instructions and preventive maintenance tasks.
 - e. VA inspection and acceptance activity/event with a minimum duration of five work days at the end of each phase and immediately preceding any VA move activity/event required by the contract phasing for that phase.
 2. Show not only the activities/events for actual construction work for each trade category of the project, but also trade relationships to indicate the movement of trades from one area, floor, or building, to another area, floor, or building.

3. Break up the work into activities/events of a duration no longer than 10 work days each or one reporting period, except as to non-construction activities/events (i.e., procurement of materials, delivery of equipment, concrete and asphalt curing) and any other activities/events for which the COTR may approve the showing of a longer duration. The duration for VA approval of any required submittal, shop drawing, or other submittals will not be less than 10 work days.
 4. Describe work activities/events clearly, so the work is readily identifiable for assessment of completion. Activities/events labeled "start," "continue," or "completion," are not specific and will not be allowed. Lead and lag time activities will not be acceptable.
 5. The schedule shall be generally numbered in such a way to reflect either discipline, phase or location of the work.
- B. The Contractor shall submit the following supporting data in addition to the project schedule:
1. The appropriate project calendar including working days and holidays. Failure of the Contractor to include this data shall delay the review of the submittal until the Contracting Officer is in receipt of the missing data.
- C. To the extent that the Project Schedule or any revised Project Schedule shows anything not jointly agreed upon, it shall not be deemed to have been approved by the COTR. Failure to include any element of work required for the performance of this contract shall not excuse the Contractor from completing all work required within any applicable completion date of each phase regardless of the COTR's approval of the Project Schedule.
- D. Compact Disk Requirements and CPM Activity/Event Record Specifications: Submit to the VA an electronic file(s) containing one file of the data required to produce a schedule, reflecting all the activities/events of the complete project schedule being submitted.

1.8 PAYMENT TO THE CONTRACTOR

- A. Monthly, the contractor shall submit the AIA application and certificate for payment documents G702 & G703 reflecting updated schedule activities and cost data in accordance with the provisions of the following Article, PAYMENT AND PROGRESS REPORTING, as the basis upon which progress payments will be made pursuant to Article, FAR 52.232 – 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.236 – 82 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS). The Contractor shall be entitled to a monthly progress payment upon approval of estimates as determined from the currently approved updated project schedule. Monthly payment requests shall include:

a listing of all agreed upon project schedule changes and associated data;
and an electronic file (s) of the resulting monthly updated schedule.

- B. Approval of the Contractor's monthly Application for Payment shall be contingent, among other factors, on the submittal of a satisfactory monthly update of the project schedule.

1.9 PAYMENT AND PROGRESS REPORTING

- A. Monthly schedule update meetings will be held on dates mutually agreed to by the COTR and the Contractor. Contractor and their CPM consultant (if applicable) shall attend all monthly schedule update meetings. The Contractor shall accurately update the Project Schedule and all other data required and provide this information to the COTR three work days in advance of the schedule update meeting. Job progress will be reviewed to verify:
1. Actual start and/or finish dates for updated/completed activities/events.
 2. Remaining duration for each activity/event started, or scheduled to start, but not completed.
 3. Logic, time and cost data for change orders, and supplemental agreements that are to be incorporated into the Project Schedule.
 4. Changes in activity/event sequence and/or duration which have been made, pursuant to the provisions of following Article, ADJUSTMENT OF CONTRACT COMPLETION.
 5. Completion percentage for all completed and partially completed activities/events.
 6. Logic and duration revisions required by this section of the specifications.
 7. Activity/event duration and percent complete shall be updated independently.
- B. After completion of the joint review, the contractor shall generate an updated computer-produced calendar-dated schedule and supply the Contracting Officer's representative with reports in accordance with the Article, COMPUTER PRODUCED SCHEDULES, specified.
- C. After completing the monthly schedule update, the contractor's representative or scheduling consultant shall rerun all current period contract change(s) against the prior approved monthly project schedule. The analysis shall only include original workday durations and schedule logic agreed upon by the contractor and COTR for the contract change(s). When there is a disagreement on logic and/or durations, the Contractor shall use the schedule logic and/or durations provided and approved by the COTR. After each rerun update, the resulting electronic project schedule data file shall be appropriately identified and submitted to the VA in accordance to the

requirements listed in articles 1.4 and 1.7. This electronic submission is separate from the regular monthly project schedule update requirements and shall be submitted to the COTR within fourteen (14) calendar days of completing the regular schedule update. **Before inserting the contract changes durations, care must be taken to ensure that only the original durations will be used for the analysis, not the reported durations after progress. In addition, once the final network diagram is approved, the contractor must recreate all manual progress payment updates on this approved network diagram and associated reruns for contract changes in each of these update periods as outlined above for regular update periods. This will require detailed record keeping for each of the manual progress payment updates.**

- D. Following approval of the CPM schedule, the VA, the General Contractor, its approved CPM Consultant, RE office representatives, and all subcontractors needed, as determined by the SRE, shall meet to discuss the monthly updated schedule. The main emphasis shall be to address work activities to avoid slippage of project schedule and to identify any necessary actions required to maintain project schedule during the reporting period. The Government representatives and the Contractor should conclude the meeting with a clear understanding of those work and administrative actions necessary to maintain project schedule status during the reporting period. This schedule coordination meeting will occur after each monthly project schedule update meeting utilizing the resulting schedule reports from that schedule update. If the project is behind schedule, discussions should include ways to prevent further slippage as well as ways to improve the project schedule status, when appropriate.

1.10 RESPONSIBILITY FOR COMPLETION

- A. If it becomes apparent from the current revised monthly progress schedule that phasing or contract completion dates will not be met, the Contractor shall execute some or all of the following remedial actions:
1. Increase construction manpower in such quantities and crafts as necessary to eliminate the backlog of work.
 2. Increase the number of working hours per shift, shifts per working day, working days per week, the amount of construction equipment, or any combination of the foregoing to eliminate the backlog of work.
 3. Reschedule the work in conformance with the specification requirements.
- B. Prior to proceeding with any of the above actions, the Contractor shall notify and obtain approval from the COTR for the proposed schedule changes. If such actions are approved, the representative schedule revisions shall be

incorporated by the Contractor into the Project Schedule before the next update, at no additional cost to the Government.

1.11 CHANGES TO THE SCHEDULE

- A. Within 30 calendar days after VA acceptance and approval of any updated project schedule, the Contractor shall submit a revised electronic file (s) and a list of any activity/event changes including predecessors and successors for any of the following reasons:
 - 1. Delay in completion of any activity/event or group of activities/events, which may be involved with contract changes, strikes, unusual weather, and other delays will not relieve the Contractor from the requirements specified unless the conditions are shown on the CPM as the direct cause for delaying the project beyond the acceptable limits.
 - 2. Delays in submittals, or deliveries, or work stoppage are encountered which make rescheduling of the work necessary.
 - 3. The schedule does not represent the actual prosecution and progress of the project.
 - 4. When there is, or has been, a substantial revision to the activity/event costs regardless of the cause for these revisions.
- B. CPM revisions made under this paragraph which affect the previously approved computer-produced schedules for Government furnished equipment, vacating of areas by the VA Facility, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or any other previously contracted item, shall be furnished in writing to the Contracting Officer for approval.
- C. Contracting Officer's approval for the revised project schedule and all relevant data is contingent upon compliance with all other paragraphs of this section and any other previous agreements by the Contracting Officer or the VA representative.
- D. The cost of revisions to the project schedule resulting from contract changes will be included in the proposal for changes in work as specified in FAR 52.243 – 4 (Changes) and VAAR 852.236 – 88 (Changes – Supplemental), and will be based on the complexity of the revision or contract change, man hours expended in analyzing the change, and the total cost of the change.
- E. The cost of revisions to the Project Schedule not resulting from contract changes is the responsibility of the Contractor.

1.12 ADJUSTMENT OF CONTRACT COMPLETION

- A. The contract completion time will be adjusted only for causes specified in this contract. Request for an extension of the contract completion date by the Contractor shall be supported with a justification, CPM data and supporting evidence as the COTR may deem necessary for determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof based on revised activity/event logic, durations (in work days) and costs is obligatory to any approvals. The schedule must clearly display that the Contractor has used, in full, all the float time available for the work involved in this request. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced calendar-dated schedule for the time period in question and all other relevant information.
- B. Actual delays in activities/events which, according to the computer- produced calendar-dated schedule, do not affect the extended and predicted contract completion dates shown by the critical path in the network, will not be the basis for a change to the contract completion date. The Contracting Officer will within a reasonable time after receipt of such justification and supporting evidence, review the facts and advise the Contractor in writing of the Contracting Officer's decision.
- C. The Contractor shall submit each request for a change in the contract completion date to the Contracting Officer in accordance with the provisions specified under FAR 52.243 – 4 (Changes) and VAAR 852.236 – 88 (Changes – Supplemental). The Contractor shall include, as a part of each change order proposal, a sketch showing all CPM logic revisions, duration (in work days) changes, and cost changes, for work in question and its relationship to other activities on the approved network diagram.
- D. All delays due to non-work activities/events such as RFI's, WEATHER, STRIKES, and similar non-work activities/events shall be analyzed on a month by month basis.

END OF SECTION 013216.15

Page intentionally left blank.

SECTION 013323 - SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- 1-1. Refer to Articles titled SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FAR 52.236-21) and, SPECIAL NOTES (VAAR 852.236-91), in GENERAL CONDITIONS.
- 1-2. For the purposes of this contract, samples, test reports, certificates, and manufacturers' literature and data shall also be subject to the previously referenced requirements. The following text refers to all items collectively as SUBMITTALS.
- 1-3. Submit for approval, all of the items specifically mentioned under the separate sections of the specification, with information sufficient to evidence full compliance with contract requirements. Materials, fabricated articles and the like to be installed in permanent work shall equal those of approved submittals. After an item has been approved, no change in brand or make will be permitted unless:
 - A. Satisfactory written evidence is presented to, and approved by Contracting Officer, that manufacturer cannot make scheduled delivery of approved item or;
 - B. Item delivered has been rejected and substitution of a suitable item is an urgent necessity or;
 - C. Other conditions become apparent which indicates approval of such substitute item to be in best interest of the Government.
- 1-4. Forward submittals in sufficient time to permit proper consideration and approval action by Government. Time submission to assure adequate lead time for procurement of contract - required items. Delays attributable to untimely and rejected submittals will not serve as a basis for extending contract time for completion.
- 1-5. Submittals will be reviewed for compliance with contract requirements by Architect-Engineer, and action thereon will be taken by COTR on behalf of the Contracting Officer.
- 1-6. Upon receipt of submittals, Architect-Engineer will assign a file number thereto. Contractor, in any subsequent correspondence, shall refer to this file and identification number to expedite replies relative to previously approved or disapproved submittals.
- 1-7. The Government reserves the right to require additional submittals, whether or not particularly mentioned in this contract. If additional submittals beyond those

required by the contract are furnished pursuant to request therefor by Contracting Officer, adjustment in contract price and time will be made in accordance with Articles titled CHANGES (FAR 52.243-4) and CHANGES - SUPPLEMENT (VAAR 852.236-88) of the GENERAL CONDITIONS.

- 1-8. Schedules called for in specifications and shown on shop drawings shall be submitted for use and information of Department of Veterans Affairs and Architect-Engineer. However, the Contractor shall assume responsibility for coordinating and verifying schedules. The Contracting Officer and Architect-Engineer assumes no responsibility for checking schedules or layout drawings for exact sizes, exact numbers and detailed positioning of items.
- 1-9. Submittals must be submitted by Contractor only and shipped prepaid. Contracting Officer assumes no responsibility for checking quantities or exact numbers included in such submittals.
 - A. Submit samples in quadruplicate. Submit shop drawings, schedules, manufacturers' literature and data, and certificates in quadruplicate, except where a greater number is specified.
 - B. Submittals will receive consideration only when covered by a transmittal letter signed by Contractor. Letter shall be sent via first class mail or hand delivery and shall contain the list of items, name of Medical Center, name of Contractor, contract number, applicable specification paragraph numbers, applicable drawing numbers (and other information required for exact identification of location for each item), manufacturer and brand, ASTM or Federal Specification Number (if any) and such additional information as may be required by specifications for particular item being furnished. In addition, catalogs shall be marked to indicate specific items submitted for approval.
Note: May use electronic submission of submittals except for shop drawings.
 1. A copy of letter must be enclosed with items, and any items received without identification letter will be considered "unclaimed goods" and held for a limited time only.
 2. Each sample, certificate, manufacturers' literature and data shall be labeled to indicate the name and location of the Medical Center, name of Contractor, manufacturer, brand, contract number and ASTM or Federal Specification Number as applicable and location(s) on project.
 3. Required certificates shall be signed by an authorized representative of manufacturer or supplier of material, and by Contractor.
 - C. In addition to complying with the applicable requirements specified in preceding Article 1.9, samples which are required to have Laboratory Tests (those preceded by symbol "LT" under the separate sections of the specification shall be tested, at the expense of Contractor, in a commercial laboratory approved by Contracting Officer.

1. Laboratory shall furnish Contracting Officer with a certificate stating that it is fully equipped and qualified to perform intended work, is fully acquainted with specification requirements and intended use of materials and is an independent establishment in no way connected with organization of Contractor or with manufacturer or supplier of materials to be tested.
 2. Certificates shall also set forth a list of comparable projects upon which laboratory has performed similar functions during past three years.
 3. Samples and laboratory tests shall be sent directly to approved commercial testing laboratory.
 4. Contractor shall send a copy of transmittal letter to both COTR and to Architect-Engineer simultaneously with submission of material to a commercial testing laboratory.
 5. Laboratory test reports shall be sent directly to COTR for appropriate action.
 6. Laboratory reports shall list contract specification test requirements and a comparative list of the laboratory test results. When tests show that the material meets specification requirements, the laboratory shall so certify on test report.
 7. Laboratory test reports shall also include a recommendation for approval or disapproval of tested item.
- D. If submittal samples have been disapproved, resubmit new samples as soon as possible after notification of disapproval. Such new samples shall be marked "Resubmitted Sample" in addition to containing other previously specified information required on label and in transmittal letter.
- E. Approved samples will be kept on file by the COTR at the site until completion of contract, at which time such samples will be delivered to Contractor as Contractor's property. Where noted in technical sections of specifications, approved samples in good condition may be used in their proper locations in contract work. At completion of contract, samples that are not approved will be returned to Contractor only upon request and at Contractor's expense. Such request should be made prior to completion of the contract. Disapproved samples that are not requested for return by Contractor will be discarded after completion of contract.
- F. Submittal drawings (shop, erection or setting drawings) and schedules, required for work of various trades, shall be checked before submission by technically qualified employees of Contractor for accuracy, completeness and compliance with contract requirements. These drawings and schedules shall be stamped and signed by Contractor certifying to such check.
1. For each drawing required, submit one legible photographic paper or vellum reproducible.
 2. Reproducible shall be full size.

3. Each drawing shall have marked thereon, proper descriptive title, including Medical Center location, project number, manufacturer's number, reference to contract drawing number, detail Section Number, and Specification Section Number.
 4. A space 120 mm by 125 mm (4-3/4 by 5 inches) shall be reserved on each drawing to accommodate approval or disapproval stamp.
 5. Submit drawings, ROLLED WITHIN A MAILING TUBE, fully protected for shipment.
 6. One reproducible print of approved or disapproved shop drawings will be forwarded to Contractor.
 7. When work is directly related and involves more than one trade, shop drawings shall be submitted to Architect-Engineer under one cover.
- 1-10. Samples, shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to:

Walker Parking Consultants, Inc.
(Architect-Engineer)
525 Avis Drive, Suite 1
(A/E P.O. Address)
Ann Arbor, MI 48108
(City, State and Zip Code)

- 1-11. At the time of transmittal to the Architect-Engineer, the Contractor shall also send a copy of the complete submittal directly to the COTR.
- 1-12. Samples (except laboratory samples) for approval shall be sent in care of COTR, VA Medical Center,

2215 Fuller Road, Bldg. 3
(P.O. Address)
Ann Arbor, MI 48105
(City, State and Zip Code)

END OF SECTION 013323

SECTION 014529 - TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained by Department of Veterans Affairs.

1.2 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- B. American Association of State Highway and Transportation Officials (AASHTO):

T27-06.....	Sieve Analysis of Fine and Coarse Aggregates
T96-02 (R2006).....	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
T99-01 (R2004).....	The Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop
T104-99 (R2003).....	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
T180-01 (R2004).....	Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
T191-02(R2006).....	Density of Soil In-Place by the Sand-Cone Method

- C. American Society for Testing and Materials (ASTM):

A325-06	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A370-07	Definitions for Mechanical Testing of Steel Products
A416/A416M-06	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A490-06	Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
C31/C31M-06.....	Making and Curing Concrete Test Specimens in the Field
C33-03	Concrete Aggregates
C39/C39M-05.....	Compressive Strength of Cylindrical Concrete Specimens
C109/C109M-05.....	Compressive Strength of Hydraulic Cement Mortars

C138-07	Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
C140-07	Sampling and Testing Concrete Masonry Units and Related Units
C143/C143M-05.....	Slump of Hydraulic Cement Concrete
C172-07	Sampling Freshly Mixed Concrete
C173-07	Air Content of freshly Mixed Concrete by the Volumetric Method
C330-05	Lightweight Aggregates for Structural Concrete
C567-05	Density Structural Lightweight Concrete
C780-07	Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C1019-08	Sampling and Testing Grout
C1064/C1064M-05.....	Freshly Mixed Portland Cement Concrete
C1077-06	Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
C1314-07	Compressive Strength of Masonry Prisms
D698-07	Laboratory Compaction Characteristics of Soil Using Standard Effort
D1143-07	Piles Under Static Axial Compressive Load
D1188-07	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
D1556-07	Density and Unit Weight of Soil in Place by the Sand-Cone Method
D1557-07	Laboratory Compaction Characteristics of Soil Using Modified Effort
D2166-06	Unconfined Compressive Strength of Cohesive Soil
D2167-94(R2001)	Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2216-05	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2922-05	Density of soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D2974-07	Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
D3666-(2002).....	Minimum Requirements for Agencies Testing and Inspection Bituminous Paving Materials
D3740-07	Minimum Requirements for Agencies Engaged in the Testing and Inspecting Road and Paving Material
E94-04	Radiographic Testing
E164-03	Ultrasonic Contact Examination of Weldments
E329-07	Agencies Engaged in Construction Inspection and/or Testing
E543-06	Agencies Performing Non-Destructive Testing

E605-93(R2006).....	Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
E709-(2001)	Guide for Magnetic Particle Examination
E1155-96(R2008).....	Determining FF Floor Flatness and FL Floor Levelness Numbers

D. American Welding Society (AWS):

D1.1-07	Structural Welding Code-Steel
---------------	-------------------------------

1.3 REQUIREMENTS

- A. Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (i.e.; E 329, C 1077, D 3666, D3740, A 880, E 543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the "Corporate Office."
- B. Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by COTR. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of COTR to such failure.
- C. Written Reports: Testing laboratory shall submit test reports to COTR, Contractor, unless other arrangements are agreed to in writing by the COTR. Submit reports of tests that fail to meet construction contract requirements on colored paper.
- D. Verbal Reports: Give verbal notification to COTR immediately of any irregularity.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EARTHWORK

- A. General: The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required herein, within the agreed to schedule and/or time frame. The work to be performed shall be as identified herein and shall include the following:

1. Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the COTR regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to COTR extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
2. Provide part time observation of fill placement and compaction and field density testing in building areas and provide part time observation of fill placement and compaction and field density testing in pavement areas to verify that earthwork compaction obtained is in accordance with contract documents.
3. Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.

B. Testing Compaction:

1. Determine maximum density and optimum moisture content for each type of fill, backfill and subgrade material used, in compliance with ASTM D1557.
2. Make field density tests in accordance with the primary testing method following ASTM D2922 wherever possible. Field density tests utilizing ASTM D1556 or ASTM D2167 shall be utilized on a case by case basis only if there are problems with the validity of the results from the primary method due to specific site field conditions. Should the testing laboratory propose these alternative methods, they should provide satisfactory explanation to the COTR before the tests are conducted.
 - a. Building Slab Subgrade: At least one test of subgrade for every 185 m² (2000 square feet) of building slab, but in no case fewer than three tests. In each compacted fill layer, perform one test for every 185 m² (2000 square feet) of overlaying building slab, but in no case fewer than three tests.
 - b. Foundation Wall Backfill: One test per 30 m (100 feet) of each layer of compacted fill but in no case fewer than two tests.
 - c. Pavement Subgrade: One test for each 335 m² (400 square yards), but in no case fewer than two tests.
 - d. Curb, Gutter, and Sidewalk: One test for each 90 m (300 feet), but in no case fewer than two tests.
 - e. Trenches: One test at maximum 30 m (100 foot) intervals per 1200 mm (4 foot) of vertical lift and at changes in required density, but in no case fewer than two tests.
 - f. Footing Subgrade: At least one test for each layer of soil on which footings will be placed. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each

subgrade with related tested subgrade when acceptable to COTR. In each compacted fill layer below wall footings, perform one field density test for every 30 m (100 feet) of wall. Verify subgrade is level, all loose or disturbed soils have been removed, and correlate actual soil conditions observed with those indicated by test borings.

- C. Testing for Footing Bearing Capacity: Evaluate if suitable bearing capacity material is encountered in footing subgrade.
- D. Testing Materials: Test suitability of on-site and off-site borrow as directed by COTR.

3.2 FOUNDATION AUGER CAST GROUT PILES

- A. Concrete Testing: Test concrete including materials for concrete as required in Article, CONCRETE of this section.
- B. Maintain a record of concrete used in each caisson. Compare records with calculated volumes.
- C. See Section 316316 for further requirements.

3.3 LANDSCAPING

- A. Test topsoil for organic materials, pH, phosphate, potash content, and gradation of particles.
 - 1. Test for organic material by using ASTM D2974.
 - 2. Determine percent of silt, sand, clay, and foreign materials such as rock, roots, and vegetation.
- B. Submit laboratory test report of topsoil to COTR.

3.4 ASPHALT CONCRETE PAVING

- A. Aggregate Base Course:
 - 1. Determine maximum density and optimum moisture content for aggregate base material in accordance with ASTM D1557, Method D.
 - 2. Make a minimum of three field density tests on each day's final compaction on each aggregate course in accordance with ASTM D1556.
 - 3. Sample and test aggregate as necessary to insure compliance with specification requirements for gradation, wear, and soundness as specified in the applicable state highway standards and specifications.
- B. Asphalt Concrete:

1. Aggregate: Sample and test aggregates in stock pile and hot-bins as necessary to insure compliance with specification requirements for gradation (AASHTO T27), wear (AASHTO T96), and soundness (AASHTO T104).
2. Temperature: Check temperature of each load of asphalt concrete at mixing plant and at site of paving operation.
3. Density: Make a minimum of two field density tests in accordance with ASTM D1188 of asphalt base and surface course for each day's paving operation.

3.5 SITE WORK CONCRETE

- A. Test site work concrete including materials for concrete as required in Article CONCRETE of this section.

3.6 CONCRETE

- A. Batch Plant Inspection and Materials Testing:
 1. Certify, in duplicate, ingredients and proportions and amounts of ingredients in concrete conform to approved trial mixes. When concrete is batched or mixed off immediate building site, certify (by signing, initialing or stamping thereon) on delivery slips (duplicate) that ingredients in truck-load mixes conform to proportions of aggregate weight, cement factor, and water-cement ratio of approved trial mixes.
- B. Field Inspection and Materials Testing:
 1. Provide a technician at site of placement at all times to perform concrete sampling and testing.
 2. Review the delivery tickets of the ready-mix concrete trucks arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads that do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal.
 3. Take concrete samples at point of placement in accordance with ASTM C172. Mold and cure compression test cylinders in accordance with ASTM C31. Make at least six cylinders for each 80 m³ (100 cubic yards) or less of each concrete type, and at least six cylinders for any one day's pour for each concrete type. Label each cylinder with an identification number. COTR may require additional cylinders to be molded and cured under job conditions.
 4. Perform slump tests in accordance with ASTM C143. Test every truck. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.

5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained and concrete not required to be air-entrained, test every truck. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.
6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete. Test the first truck and each time cylinders are made.
8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
9. Verify that specified mixing has been accomplished.
10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete:
 - a. When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
 - b. When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
 - a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
 - b. Inspect preparation of construction, expansion, and isolation joints.
16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
17. Observe concrete mixing:

- a. Monitor and record amount of water added at project site.
- b. Observe minimum and maximum mixing times.

18. Measure concrete flatwork for levelness and flatness as follows:

- a. Perform Floor Tolerance Measurements F_F and F_L in accordance with ASTM E1155. Calculate the actual overall F- numbers using the inferior/superior area method.
- b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
- c. Provide the Contractor and the COTR with the results of all profile tests, including a running tabulation of the overall F_F and F_L values for all slabs installed to date, within 72 hours after each slab installation.

19. Other inspections:

- a. Grouting under base plates.
- b. Grouting anchor bolts and reinforcing steel in hardened concrete.

C. Laboratory Tests of Field Samples:

- 1. Test compression test cylinders for strength in accordance with ASTM C39. For each test series, test two cylinders at 7 days and two cylinders at 28 days. Use remaining cylinders as spares tested as directed by COTR.
- 2. Furnish certified compression test reports (duplicate) to COTR. In test report, indicate the following information:
 - a. Cylinder identification number and date cast.
 - b. Specific location at which test samples were taken.
 - c. Type of concrete, slump, and percent air.
 - d. Compressive strength of concrete in MPa (psi).
 - e. Weather conditions during placing.
 - f. Temperature of concrete in each test cylinder when test cylinder was molded.
 - g. Maximum and minimum ambient temperature during placing.
 - h. Ambient temperature when concrete sample in test cylinder was taken.
 - i. Date delivered to laboratory and date tested.

3.7 REINFORCEMENT

- A. Review mill test reports furnished by Contractor.

3.8 PRESTRESSED CONCRETE

- A. Inspection at Plant: Forms, placement and concrete cover of reinforcing steel and tendons, placement and finishing of concrete, and tensioning of tendons.
- B. Concrete Testing: Test concrete including materials for concrete required in Article, CONCRETE of this section.
- C. Test tendons for conformance with ASTM A416 and furnish report to COTR.
- D. Inspect members to insure that specification requirements for curing and finishes have been met.

3.9 MASONRY

- A. Mortar Tests:
 - 1. Laboratory compressive strength test:
 - a. Comply with ASTM C780.
 - b. Obtain samples during or immediately after discharge from batch mixer.
 - c. Furnish molds with 50 mm (2 inch), 3 compartment gang cube.
 - d. Test one sample at 7 days and 2 samples at 28 days.
 - 2. Two tests during first week of operation; one test per week after initial test until masonry completion.
- B. Grout Tests:
 - 1. Laboratory compressive strength test:
 - a. Comply with ASTM C1019.
 - b. Test one sample at 7 days and 2 samples at 28 days.
 - c. Perform test for each 230 m² (2500 square feet) of masonry.
- C. Masonry Unit Tests:
 - 1. Laboratory Compressive Strength Test:
 - a. Comply with ASTM C140.
 - b. Test 3 samples for each 460 m² (5000 square feet) of wall area.
- D. Prism Tests: For each type of wall construction indicated, test masonry prisms per ASTM C1314 for each 460 m² (5000 square feet) of wall area.

Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.

3.10 STRUCTURAL STEEL

- A. General: Provide field inspection and testing services to certify structural steel work is done in accordance with contract documents. Welding shall conform to AWS D1.1 Structural Welding Code.
- B. Prefabrication Inspection:
 - 1. Review design and shop detail drawings for size, length, type and location of all welds to be made.
 - 2. Approve welder qualifications by certification or retesting.
 - 3. Approve procedures for welding in accordance with applicable sections of AWS D1.1.
- C. Fabrication and Erection:
 - 1. Weld Inspection:
 - a. Inspect welding equipment for capacity, maintenance and working condition.
 - b. Verify specified electrodes and handling and storage of electrodes in accordance with AWS D1.1.
 - c. Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.
 - d. Inspect preheating and interpass temperatures for conformance with AWS D1.1.
 - e. Measure 25 percent of fillet welds.
 - f. Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:
 - 1) 20 percent of all shear plate fillet welds at random, final pass only.
 - g. Welding Ultrasonic Testing: Test in accordance with ASTM E164 and AWS D1.1 for 100 percent of all full penetration welds, braced and moment frame column splices, and a minimum of 20 percent of all other partial penetration column splices, at random.
 - h. Verify that correction of rejected welds are made in accordance with AWS D1.1.
 - i. Testing and inspection do not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with the specified requirements.
 - 2. Bolt Inspection:

- a. Inspect high-strength bolted connections in accordance AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
 - b. Inspect field erected assemblies; verify locations of structural steel for plumbness, level, and alignment.
- D. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to COTR.

3.11 STEEL DECKING

- A. Provide field inspection of welds of metal deck to the supporting steel, and testing services to insure steel decking has been installed in accordance with contract documents and manufacturer's requirements.
- B. Qualification of Field Welding: Qualify welding processes and welding operators in accordance with "Welder Qualification" procedures of AWS D1.1. Refer to the "Plug Weld Qualification Procedure" in Part 3 "Field Quality Control."
- C. Submit inspection reports, certification, and instances of noncompliance to COTR.

END OF SECTION 014529

Page intentionally left blank.

SECTION 015719 - TEMPORARY ENVIRONMENTAL CONTROLS

EP-1. DESCRIPTION

- A. This section specifies the control of environmental pollution and damage that the Contractor must consider for air, water, and land resources. It includes management of visual aesthetics, noise, solid waste, radiant energy, as well as other pollutants and resources encountered or generated by the Contractor. The Contractor is obligated to consider specified control measures with the costs included within the various contract items of work.
- B. Environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which:
 - 1. Adversely effect human health or welfare,
 - 2. Unfavorably alter ecological balances of importance to human life,
 - 3. Effect other species of importance to humankind, or;
 - 4. Degrade the utility of the environment for aesthetic, cultural, and historical purposes.
- C. Definitions of Pollutants:
 - 1. Chemical Waste: Petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals, and inorganic wastes.
 - 2. Debris: Combustible and noncombustible wastes, such as leaves, tree trimmings, ashes, and waste materials resulting from construction or maintenance and repair work.
 - 3. Sediment: Soil and other debris that has been eroded and transported by runoff water.
 - 4. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, and agricultural operations and from community activities.
 - 5. Surface Discharge: The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "water of the United States" and would require a permit to discharge water from the governing agency.
 - 6. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass and crockery, metal and lumber scrap, tin cans, and bones.
 - 7. Sanitary Wastes:
 - a. Sewage: Domestic sanitary sewage and human and animal waste.
 - b. Garbage: Refuse and scraps resulting from consumption of food.

EP-2. QUALITY CONTROL

- A. Establish and maintain quality control for the environmental protection of all items set forth herein.
- B. Record on daily reports any problems in complying with laws, regulations, and ordinances. Note any corrective action taken.

EP-3. REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. U.S. National Archives and Records Administration (NARA):
33 CFR 328Definitions

EP-4. SUBMITTALS

- A. In accordance with Section, 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
 - 1. Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the COTR to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. Not more than 20 days after the meeting, the Contractor shall prepare and submit to the COTR for approval, a written and/or graphic Environmental Protection Plan including, as a minimum, the following:
 - a. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.
 - b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site.
 - c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.
 - d. Description of the Contractor's environmental protection personnel training program.
 - e. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control, noise control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.
 - f. Methods for protection of features to be preserved within authorized work areas including trees, shrubs, grasses, ground cover, landscape features, air and water quality, and soil.
 - g. Procedures to provide the environmental protection that comply with the applicable laws and regulations. Describe the procedures to correct

- pollution of the environment due to accident, natural causes, or failure to follow the procedures as described in the Environmental Protection Plan.
- h. Permits, licenses, and the location of the solid waste disposal area.
 - i. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials. Include as part of an Erosion Control Plan approved by the District Office of the U.S. Soil Conservation Service and the Department of Veterans Affairs.
 - j. Environmental Monitoring Plans for the job site including land, water, air, and noise.
 - k. Work Area Plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas. This plan may be incorporated within the Erosion Control Plan.
- B. Approval of the Contractor's Environmental Protection Plan will not relieve the Contractor of responsibility for adequate and continued control of pollutants and other environmental protection measures.

EP-5. PROTECTION OF ENVIRONMENTAL RESOURCES

- A. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this contract. Confine activities to areas defined by the specifications and drawings.
- B. Protection of Land Resources: Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, grasses, top soil, and land forms without permission from the COTR. Do not fasten or attach ropes, cables, or guys to trees for anchorage unless specifically authorized, or where special emergency use is permitted.
- 1. Work Area Limits: Prior to any construction, mark the areas that require work to be performed under this contract. Mark or fence isolated areas within the general work area that are to be saved and protected.
 - 2. Protection of Landscape: Protect trees, shrubs, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using any other approved techniques.
 - a. Box and protect from damage existing trees and shrubs to remain on the construction site.
 - b. Immediately repair all damage to existing trees and shrubs by trimming, cleaning, and painting with antiseptic tree paint.
 - c. Do not store building materials or perform construction activities closer to existing trees or shrubs than the farthest extension of their limbs.

3. Reduction of Exposure of Unprotected Erodible Soils: Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Clear areas in reasonably sized increments only as needed to use. Form earthwork to final grade as shown. Immediately protect side slopes and back slopes upon completion of rough grading.
 4. Temporary Protection of Disturbed Areas: Construct diversion ditches, benches, and berms to retard and divert runoff from the construction site to protected drainage areas approved under paragraph 208 of the Clean Water Act.
 - a. Sediment Basins: Trap sediment from construction areas in temporary or permanent sediment basins that accommodate the runoff of a local 10 (design year) storm. After each storm, pump the basins dry and remove the accumulated sediment. Control overflow/drainage with paved weirs or by vertical overflow pipes, draining from the surface.
 - b. Institute effluent quality monitoring programs as required by Federal, State, and local environmental agencies.
 5. Erosion and Sedimentation Control Devices: The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's activities. Construct or install all temporary and permanent erosion and sedimentation control features shown. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.
 6. Manage borrow areas on Government property to minimize erosion and to prevent sediment from entering nearby water courses or lakes.
 7. Manage and control spoil areas on Government property to limit spoil to areas shown on and prevent erosion of soil or sediment from entering nearby sewer system.
 8. Protect adjacent areas from despoilment by temporary excavations and embankments.
 9. Handle and dispose of solid wastes in such a manner that will prevent contamination of the environment. Place solid wastes (excluding clearing debris) in containers that are emptied on a regular schedule. Transport all solid waste off Government property and dispose of waste in compliance with Federal, State, and local requirements.
 10. Handle discarded materials other than those included in the solid waste category as directed by the COTR.
- C. Protection of Water Resources: Keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters and sewer systems. Implement management techniques to control water pollution by the listed construction activities that are included in this contract.

1. Washing and Curing Water: Do not allow wastewater directly derived from construction activities to enter sewer system. Collect and place wastewater in retention ponds allowing the suspended material to settle, the pollutants to separate, or the water to evaporate.
- D. Protection of Air Resources: Keep construction activities under surveillance, management, and control to minimize pollution of air resources. Burning is not permitted on the job site. Keep activities, equipment, processes, and work operated or performed, in strict accordance with the New York State Environmental Protection Agency and Federal emission and performance laws and standards. Maintain ambient air quality standards set by the Environmental Protection Agency, for those construction operations and activities specified.
1. Particulates: Control dust particles, aerosols, and gaseous by-products from all construction activities, processing, and preparation of materials (such as from asphaltic batch plants) at all times, including weekends, holidays, and hours when work is not in progress.
 2. Particulates Control: Maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause a hazard or a nuisance.
 3. Hydrocarbons and Carbon Monoxide: Control monoxide emissions from equipment to Federal and State allowable limits.
 4. Odors: Control odors of construction activities and prevent obnoxious odors from occurring.
- F. Reduction of Noise: Minimize noise using every action possible. Perform noise-producing work in less sensitive hours of the day or week as directed by the COTR.
1. Perform construction activities involving repetitive, high-level impact noise only between 8:00 a.m. and 6:00 p.m. unless otherwise permitted by local ordinance or the COTR. Repetitive impact noise on the property shall not exceed the following dB limitations:

Time Duration of Impact Noise	Sound Level in dB
More than 12 minutes in any hour	70
Less than 30 seconds of any hour	85
Less than three minutes of any hour	80
Less than 12 minutes of any hour	75
 2. Provide sound-deadening devices on equipment and take noise abatement measures that are necessary to comply with the requirements of this contract, consisting of the following:

- a. Maintain maximum permissible construction equipment noise levels at 15 m (50 feet) (dBA):

EARTHMOVING		MATERIALS HANDLING	
FRONT LOADERS	75	CONCRETE MIXERS	75
BACKHOES	75	CONCRETE PUMPS	75
DOZERS	75	CRANES	75
TRACTORS	75	DERRICKS IMPACT	75
SCAPERS	80	PILE DRIVERS	95
GRADERS	75	JACK HAMMERS	75
TRUCKS	75	ROCK DRILLS	80
PAVERS,	80	PNEUMATIC TOOLS	80
STATIONARY PUMPS	75		
GENERATORS	75	SAWS	75
COMPRESSORS	75	VIBRATORS	75

- b. Provide soundproof housings or enclosures for noise-producing machinery.
- c. Use efficient silencers on equipment air intakes.
- d. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.
- e. Line hoppers and storage bins with sound deadening material.
- f. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.
3. Measure sound level for noise exposure due to the construction at least once every five successive working days while work is being performed above 55 dB(A) noise level. Measure noise exposure at the property line or 15 m (50 feet) from the noise source, whichever is greater. Measure the sound levels on the A weighing network of a General Purpose sound level meter at slow response. To minimize the effect of reflective sound waves at buildings, take measurements at 900 to 1800 mm (three to six feet) in front of any building face. Submit the recorded information to the COTR noting any problems and the alternatives for mitigating actions.

G. Restoration of Damaged Property: If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the Contractor shall restore the damaged property to a condition equal to that existing before the damage at no additional cost to the Government. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.

H. Final Clean-up: On completion of project and after removal of all debris, rubbish, and temporary construction, Contractor shall leave the construction area in a

clean condition satisfactory to the COTR. Cleaning shall include off the station disposal of all items and materials not required to be salvaged, as well as all debris and rubbish resulting from demolition and new work operations.

END OF SECTION 015719

Page intentionally left blank.

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies the requirements for the management of non-hazardous building construction and demolition waste.
- B. Waste disposal in landfills shall be minimized to the greatest extent possible. Of the inevitable waste that is generated, at least 50% of non-hazardous waste material shall be salvaged, recycled or reused in order to comply with Executive Order 13514.
- C. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators, and facilitate their salvage and recycle to the following:
 - 1. Waste Management Plan development and implementation.
 - 2. Techniques to minimize waste generation.
 - 3. Sorting and separating of waste materials.
 - 4. Salvage of existing materials and items for reuse or resale.
 - 5. Recycling of materials that cannot be reused or sold.
- D. At a minimum the following waste categories shall be diverted from landfills:
 - 1. Soil.
 - 2. Inerts (eg, concrete, masonry and asphalt).
 - 3. Clean dimensional wood and palette wood.
 - 4. Green waste (biodegradable landscaping materials).
 - 5. Engineered wood products (plywood, particle board, etc).
 - 6. Metal products (eg, steel, wire, beverage containers, etc).
 - 7. Cardboard, paper and packaging.
 - 8. Bitumen roofing materials.
 - 9. Plastics (eg, ABS, PVC).
 - 10. Insulation.
 - 11. Paint.

1.2 RELATED WORK

- A. Section 024100, DEMOLITION.
- B. Section 010000, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

- A. Contractor shall practice efficient waste management when sizing, cutting and installing building products. Processes shall be employed to ensure the generation of as little waste as possible. Construction /Demolition waste includes products of the following:
1. Excess or unusable construction materials.
 2. Packaging used for construction products.
 3. Poor planning and/or layout.
 4. Construction error.
 5. Over ordering.
 6. Weather damage.
 7. Contamination.
 8. Mishandling.
 9. Breakage.
- B. Establish and maintain the management of non-hazardous building construction and demolition waste set forth herein. Conduct a site assessment to estimate the types of materials that will be generated by demolition and construction.
- C. Contractor shall develop and implement procedures to reuse and recycle new materials to a minimum of 50 percent.
- D. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling. Any revenues or savings obtained from salvage or recycling shall accrue to the contractor.
- E. Contractor shall provide all demolition, removal and legal disposal of materials. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by local, state, federal regulations. The Whole Building Design Guide website <http://www.wbdg.org> provides a Construction Waste Management Database that contains information on companies that haul, collect, and process recyclable debris from construction projects.
- F. Contractor shall assign a specific area to facilitate separation of materials for reuse, salvage, recycling, and return. Such areas are to be kept neat and clean and clearly marked in order to avoid contamination or mixing of materials.
- G. Contractor shall provide on-site instructions and supervision of separation, handling, salvaging, recycling, reuse and return methods to be used by all parties during waste generating stages.
- H. Record on daily reports any problems in complying with laws, regulations and ordinances with corrective action taken.

1.4 TERMINOLOGY

- A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial and industrial waste resulting from construction, remodeling, repair and demolition operations.
- B. Clean: Untreated and unpainted; uncontaminated with adhesives, oils, solvents, mastics and like products.
- C. Construction and Demolition Waste: Includes all non-hazardous resources resulting from construction, remodeling, alterations, repair and demolition operations.
- D. Dismantle: The process of parting out a building in such a way as to preserve the usefulness of its materials and components.
- E. Disposal: Acceptance of solid wastes at a legally operating facility for the purpose of land filling (includes Class III landfills and inert fills).
- F. Inert Backfill Site: A location, other than inert fill or other disposal facility, to which inert materials are taken for the purpose of filling an excavation, shoring or other soil engineering operation.
- G. Inert Fill: A facility that can legally accept inert waste, such as asphalt and concrete exclusively for the purpose of disposal.
- H. Inert Solids/Inert Waste: Non-liquid solid resources including, but not limited to, soil and concrete that does not contain hazardous waste or soluble pollutants at concentrations in excess of water-quality objectives established by a regional water board, and does not contain significant quantities of decomposable solid resources.
- I. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.
- J. Mixed Debris Recycling Facility: A solid resource processing facility that accepts loads of mixed construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing non-recyclable materials.
- K. Permitted Waste Hauler: A company that holds a valid permit to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal.
- L. Recycling: The process of sorting, cleansing, treating, and reconstituting materials for the purpose of using the altered form in the manufacture of a new

product. Recycling does not include burning, incinerating or thermally destroying solid waste.

1. On-site Recycling – Materials that are sorted and processed on site for use in an altered state in the work, i.e. concrete crushed for use as a sub-base in paving.
2. Off-site Recycling – Materials hauled to a location and used in an altered form in the manufacture of new products.

M. Recycling Facility: An operation that can legally accept materials for the purpose of processing the materials into an altered form for the manufacture of new products. Depending on the types of materials accepted and operating procedures, a recycling facility may or may not be required to have a solid waste facilities permit or be regulated by the local enforcement agency.

N. Reuse: Materials that are recovered for use in the same form, on-site or off-site.

O. Return: To give back reusable items or unused products to vendors for credit.

P. Salvage: To remove waste materials from the site for resale or re-use by a third party.

Q. Source-Separated Materials: Materials that are sorted by type at the site for the purpose of reuse and recycling.

R. Solid Waste: Materials that have been designated as non-recyclable and are discarded for the purposes of disposal.

S. Transfer Station: A facility that can legally accept solid waste for the purpose of temporarily storing the materials for re-loading onto other trucks and transporting them to a landfill for disposal, or recovering some materials for re-use or recycling.

1.5 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish the following:

B. Prepare and submit to the COTR a written demolition debris management plan. The plan shall include the following information:

1. Procedures to be used for debris management.
2. Techniques to be used to minimize waste generation.
3. Analysis of the estimated job site waste to be generated:
 - a. List of each material and quantity to be salvaged, reused, recycled.

- b. List of each material and quantity proposed to be taken to a landfill.
- 4. Detailed description of the Means/Methods to be used for material handling.
 - a. On site: Material separation, storage, protection where applicable.
 - b. Off site: Transportation means and destination. Include list of materials.
 - 1) Description of materials to be site-separated and self-hauled to designated facilities.
 - 2) Description of mixed materials to be collected by designated waste haulers and removed from the site.
 - c. The names and locations of mixed debris reuse and recycling facilities or sites.
 - d. The names and locations of trash disposal landfill facilities or sites.
 - e. Documentation that the facilities or sites are approved to receive the materials.
- B. Designated Manager responsible for instructing personnel, supervising, documenting and administer over meetings relevant to the Waste Management Plan.
- C. Monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.
 - 1. U.S. Green Building Council (USGBC):
 - 2. LEED Green Building Rating System for New Construction

1.7 RECORDS

- A. Maintain records to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and LEED Template.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. List of each material and quantity to be salvaged, recycled, reused.
- B. List of each material and quantity proposed to be taken to a landfill.
- C. Material tracking data: Receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices, net total costs or savings.

PART 3 - EXECUTION

3.1 COLLECTION

- A. Provide all necessary containers, bins and storage areas to facilitate effective waste management.
- B. Clearly identify containers, bins and storage areas so that recyclable materials are separated from trash and can be transported to respective recycling facility for processing.
- C. Hazardous wastes shall be separated, stored, disposed of according to local, state, federal regulations.

3.2 DISPOSAL

- A. Contractor shall be responsible for transporting and disposing of materials that cannot be delivered to a source-separated or mixed materials recycling facility to a transfer station or disposal facility that can accept the materials in accordance with state and federal regulations.
- B. Construction or demolition materials with no practical reuse or that cannot be salvaged or recycled shall be disposed of at a landfill or incinerator.

3.3 REPORT

- A. With each application for progress payment, submit a summary of construction and demolition debris diversion and disposal including beginning and ending dates of period covered.
- B. Quantify all materials diverted from landfill disposal through salvage or recycling during the period with the receiving parties, dates removed, transportation costs, weight tickets, manifests, invoices. Include the net total costs or savings for each salvaged or recycled material.

- C. Quantify all materials disposed of during the period with the receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices. Include the net total costs for each disposal.

END OF SECTION 017419

Page intentionally left blank.

SECTION 024100 - DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies demolition and removal of portions of buildings and utilities.

1.2 RELATED WORK

- A. Demolition and removal of roads, walks, curbs, and on-grade slabs outside buildings to be demolished: Section 312000, EARTH MOVING.
- B. Safety Requirements: GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- C. Disconnecting utility services prior to demolition: Section 010000, GENERAL REQUIREMENTS.
- D. Reserved items that are to remain the property of the Government: Section 010000, GENERAL REQUIREMENTS.
- E. Environmental Protection: Section 015719, TEMPORARY ENVIRONMENTAL CONTROLS.
- F. Construction Waste Management: Section 017419 CONSTRUCTION WASTE MANAGEMENT.

1.3 PROTECTION

- A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. Comply with requirements of GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations. Comply with requirements of Section 010000, GENERAL REQUIREMENTS, Article PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES AND IMPROVEMENTS.
- C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.

- D. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as ice, flooding, or pollution. Vacuum and dust the work area daily.
- F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
 - 1. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
 - 2. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Medical Center; any damaged items shall be repaired or replaced as approved by the Resident Engineer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have Resident Engineer's approval.
- H. The work shall comply with the requirements of Section 015719, TEMPORARY ENVIRONMENTAL CONTROLS.

1.4 UTILITY SERVICES

- A. Demolish and remove outside utility service lines shown to be removed.
- B. Remove abandoned outside utility lines that would interfere with installation of new utility lines and new construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 DEMOLITION

- A. Debris, including brick, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by him daily, off the Medical Center to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Resident Engineer. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.
- B. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Resident Engineer. When Utility lines are encountered that are not indicated on the drawings, the Resident Engineer shall be notified prior to further work in that area.

3.2 CLEAN-UP

On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to Resident Engineer. Clean-up shall include off the Medical Center disposal of all items and materials not required to remain property of the Government as well as all debris and rubbish resulting from demolition operations.

END OF SECTION 024100

Page intentionally left blank.

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies cast-in-place structural concrete and materials and mixes for other concrete.
- A. This section also includes architectural concrete finish for exterior face of grade level perimeter wall (west, north, east and south elevations).

Grade wall exterior finish:

Provide a wall finish/color that matches the exterior precast spandrel panels. Use a smooth-formed finish and/or abrasive blast finish or other methods as required. Use pigment mixed into concrete at batch plant. No surface applied coatings and stains allowed. Provide mockups as required by this Section.

1.2 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Precast Concrete Structure: Section 034133, PRECAST STRUCTURAL PRETENSIONED CONCRETE.
- C. Waterproofing treatment of slabs: Section 071916, SILANE WATER REPELLENTS.
- D. Sealants at structural joints: Section 079200, JOINT SEALANTS.
- E. Pavement Traffic and Warning Markings: Section 321723, PAVEMENT MARKINGS.
- F. Pile Foundations: Section 316316, AUGER CAST GROUT PILES.

1.3 TESTING AGENCY FOR CONCRETE MIX DESIGN

- A. Testing agency retained and reimbursed by the Contractor and approved by Resident Engineer.
- B. Testing agency maintaining active participation in Program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and

Technology. Accompany request for approval of testing agency with a copy of Report of Latest Inspection of Laboratory Facilities by CCRL.

- C. Testing agency shall furnish equipment and qualified technicians to establish proportions of ingredients for concrete mixes.

1.4 TOLERANCES

- A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is +0 mm (+0 inch) and -20 mm (-3/4 inch).
- B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 10, 13, and 16 (Nos. 3, 4, and 5) (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 mm (+0 inch) and -13 mm (-1/2 inch) where gross bar length is less than 3600 mm (12 feet), or +0 mm (+0 inch) and -20 mm (-3/4 inch) where gross bar length is 3600 mm (12 feet) or more.
- C. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +20 mm (+3/4 inch) and - 6 mm (-1/4 inch). Tolerance of thickness of beams more than 300 mm (12 inch) but less than 900 mm (3 feet) is +20 mm (+3/4 inch) and -10 mm (-3/8 inch).
- D. Slab Finishes: ACI 117, Section 4.5.6, F-number method in accordance with ASTM E1155, except as follows:
1. Test entire slab surface, including those areas within 600 mm (2 feet) of construction joints and vertical elements that project through slab surface.
 2. Maximum elevation change which may occur within 600 mm (2 feet) of any column or wall element is 6 mm (0.25 inches).
 3. Allow sample measurement lines that are perpendicular to construction joints to extend past joint into previous placement no further than 1500 mm (5 feet).

1.5 REGULATORY REQUIREMENTS

- A. ACI SP-66 – ACI Detailing Manual.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI 301 – Standard Specifications for Structural Concrete.

1.6 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Submittals and Resubmittals: Resident Engineer will review each of Contractor's shop drawings and/or submittal data the initial time and, should resubmittal be required, one additional time to verify that reasons for resubmittal have been addressed by Contractor and corrections made. Resubmittal changes/revisions/corrections shall be circled. Resident Engineer will review only circled items and will not be responsible for non-circled changes/revisions/corrections and additions. Should additional resubmittals be required, Contractor shall reimburse Owner for all costs incurred, including the cost of Engineer's services made necessary to review such additional resubmittals.
- C. Requests for Information:
 - 1. RFI process shall not be used for requesting substitutions. Procedures for substitutions are clearly specified elsewhere in the contract documents.
- D. Submit evidence of licensure in Michigan for professional engineer providing professional services as required for Contractor in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures.
 - 1. Contractor's responsibilities include formwork, shoring and re-shoring procedures, and other work described in Article "Contractors Professional Design Services", Article "Formwork", and Article "Shores and Re-Shores".
 - 2. Performance and design criteria are shown on the Drawings and in Article "Contractor's Professional Services – Performance and Design Criteria".
 - 3. Contractor's Professional Engineer shall furnish Owner a Certificate of Professional Liability Insurance in minimum amount of \$1,000,000 per claim.
- E. Shop Drawings: Reinforcing steel: Complete shop drawings
 - 1. Prepare placing drawings that detail fabrication, bending and placement of concrete reinforcement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hook spacing, and supports for concrete reinforcement. Comply with ACI SP-66, "ACI Detailing Manual." Include special reinforcement required for openings through concrete structures.
- F. Mill Test Reports:
 - 1. Reinforcing Steel.
 - 2. Cement.

G. Manufacturer's Certificates:

1. Abrasive aggregate.
2. Air-entraining admixture.
3. Chemical admixtures, including chloride ion content.
4. Waterproof paper for curing concrete.
5. Liquid membrane-forming compounds for curing concrete.
6. Non-shrinking grout.
7. Waterstops.
8. Expansion joint filler.
9. Adhesive binder.
10. Form materials and form release agents.
11. Steel reinforcement and accessories.
12. Fiber reinforcement.
13. Vapor Barriers.
14. Repair materials.
15. Submit certification that curing compound or evaporation reducer, if used, is compatible with sealer specified in Division 7 Section "Silane Water Repellents", and Traffic Coatings specified in Division 7 "Vehicular Traffic Coatings", and sealant specified in Division 7 Section "Joint Sealants."
16. Submit certification that curing compound or evaporation reducer is compatible with pavement marking specified in Division 32 Section "Pavement Markings."

H. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians and evidence of active participation in program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology and copy of report of latest CCRL, Inspection of Laboratory.

I. Submit concrete mixture proportions to Resident Engineer for each concrete mixture. Submit alternate mixture proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1. Provide mixture proportions not less than four weeks before placing concrete and not less than one week before pre-installation conference (pre-concrete meeting).
2. Proportion mixtures as defined in ACI 301 Section 4 header "Proportioning," Mixtures shall be proportioned by party other than Testing Agency responsible for testing Project concrete.
3. Use mixture proportions submission form at end of this Section for each concrete mixture. Any other mixture proportion submission form needs to identify submittal of all items listed in the specification submittal form and the following:

- a. Mixture Proportion Identification and use.
 - b. Method used for documentation of required average compressive strength, (ACI 301 Section 4 – Field test data or Trial mixtures).
 - c. Gradation of fine and coarse aggregates.
 - d. Proportions of all ingredients including all admixtures added either at time of batching or at job site.
 - e. Water/cementitious materials ratio.
 - g. Certification of the chloride content of admixtures.
 - h. Density (unit weight) of concrete, ASTM C 138.
 - i. Water soluble chloride ion content of concrete: ASTM C 1218.
 - j. Certificate of analysis of coal fly ash or processed ultra fine fly ash: Comply with ASTM C618, Class C or F.
- J. Testing Agency: Promptly report all field concrete test results to Resident Engineer, Contractor and Concrete Supplier. Include following information:
1. See Article "Quality Assurance."
 2. Density (unit weight) of concrete, ASTM C 138.
 3. Slump, ASTM C 143.
 4. Slump flow, ASTM C 1611 (for SCC).
 5. Concrete temperature at placement time. ASTM C 1064
 6. Air temperature at placement time.
 7. Strength determined in accordance with ASTM C 39.
- K. Contractor: Submit grout temperature limitations with grout submittal.
- L. Submit current certification of welders.
- M. Sample Panels and Mockups for cast-in-place concrete with **Architectural finish** (base wall at grade level perimeter): Before placing concrete, build mockups to verify selections made under sample panels and to demonstrate aesthetic effects and qualities of materials and execution. Manufacture mockups to comply with the following requirements, using materials indicated for the completed work:
1. Sample panel: Cast-in-place concrete contractor shall make 3-ft sq. samples for color and finish selection only. If rejected, another set of samples shall be made for review, until acceptable sample is made.
 2. After acceptance of finish sample, Cast-in-place concrete shall make a full height by 6-ft wide mockup of perimeter base wall at grade level designated "architectural concrete" or "architectural finish" on drawings. Mockup panel will be reviewed at site by resident engineer. If rejected, another set of panel shall be made for review, until acceptable mockup panel is made. If accepted, panel will be located on site and held there until completion and acceptance of project, when contractor shall remove it from site.

3. Manufacture mockups in the location and of the size indicated or, if not indicated, as directed by Resident Engineer.
4. Notify Resident Engineer seven (7) days in advance of dates and times when mockups will be constructed.
5. Obtain Resident Engineer's approval of mockups before starting fabrication.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
7. Demolish and remove mockups when directed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Conform to ACI 304. Store aggregate separately for each kind or grade, to prevent segregation of sizes and avoid inclusion of dirt and other materials.
- B. Deliver cement in original sealed containers bearing name of brand and manufacturer, and marked with net weight of contents. Store in suitable watertight building in which floor is raised at least 300 mm (1 foot) above ground. Store bulk cement and fly ash in separate suitable bins.
- C. Deliver other packaged materials for use in concrete in original sealed containers, plainly marked with manufacturer's name and brand, and protect from damage until used.
- D. Store all formwork and formwork materials clear of ground, protected, to preclude damage.
- E. Deliver reinforcement to Project site bundled, tagged and marked. Use metal clips indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.
- F. Store concrete reinforcement materials at site to prevent damage and accumulations of dirt or excessive rust.
- G. Avoid damaging coatings on epoxy coated reinforcement:
 1. Contact areas of handling and hoisting systems shall be padded or be made of nylon or other acceptable material.
 2. Use spreader bars to lift bundles of coated bars to prevent bar-to-bar abrasion.
 3. Pad bundling bands or fabricate of nylon or other acceptable material.
 4. Store coated bars on padded or wooden cribbing.
 5. Do not drag coated bars.
 6. After replacement, restrict traffic on coated bars to prevent damage.
 7. Repair damaged epoxy coatings according to ASTM D 3963.

- H. Concrete transported by truck mixer or agitator shall be completely discharged within one and one half-hours (one hour for hot weather concreting) after water has been added to cement or cement has been added to aggregate. Schedule deliveries to allow for delays due to weather, traffic, etc.

1.8 PRE-CONCRETE CONFERENCE

- A. General: At least 15 days prior to submittal of design mixes, conduct a meeting to review proposed methods of concrete construction to achieve the required results.
- B. Sample Agenda:
 - 1. Submittals.
 - 2. Coordination of work.
 - 3. Availability of material.
 - 4. Concrete mix design including admixtures.
 - 5. Methods of placing, finishing, and curing.
 - 6. Finish criteria required to obtain required flatness and levelness.
 - 7. Timing of floor finish measurements.
 - 8. Material inspection and testing.
 - 9. A summary of concrete procedures to protect fresh concrete from rain.
- C. Attendees: Include representatives of Contractor; subcontractors involved in supplying, conveying, placing, finishing, and curing concrete; admixture manufacturers; Resident Engineer; Consulting Engineer; Department of Veterans Affairs retained testing laboratories for concrete testing and finish verification.
- D. Minutes of the meeting: Contractor shall take minutes and type and distribute the minutes to attendees within five calendar days of the meeting.
 - 1. The minutes shall include a statement by the Concrete Contractor indicating that the proposed mixture proportions and placing/finishing/curing techniques can produce the concrete quality required by these specifications.

1.9 CONTRACTOR'S PROFESSIONAL SERVICES – PERFORMANCE AND DESIGN CRITERIA

- A. Provide professional services for temporary conditions during construction and portions of the Work required to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Specific requirements and criteria include, as a minimum, the following:

1. Design, erect, shore, brace, and maintain formwork, according to ACI 301 and ACI 347 to support vertical, lateral, static and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads. The contractor is responsible for layout and design, reviews, approvals, and inspections.
2. Design formwork, shoring, bracing, and other conditions for structural requirements and stability during construction until final structure is completed and accepted.
 - a. Comply with ACI 347.2 for design, installation, and removal of shoring and reshoring.
 - b. Superimposed loads to the concrete structure, slab-on-grade, and soil shall be less than the design loads as shown on Drawings.
 - c. Plan sequence of removal of shores and reshores to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excess stress or deflection.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualification: An experienced supplier who is experienced in manufacturing ready-mixed concrete products complying with ASTM C94 requirement for production facilities and equipment. Manufacturer shall also be certified according to the National Ready Mixed Concrete Association's Certifications of Ready Mixed Concrete Production Facilities.
- C. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 1. ACI 301, "Specifications for Structural Concrete."
 2. ACI 318, "Building Code Requirements for Structural Concrete and Commentary."
 3. ACI 117, "Standard Specifications for Tolerances for Concrete Construction and Materials."
 4. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."
- D. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in Michigan and who is experienced in providing professional engineering services of the kind indicated. See Article "Contractor's Professional Services Performance and Design Criteria".

- E. Welders and welding procedures shall conform to requirements of AWS D1.4. Except where shown Drawings, welding of reinforcing steel is prohibited unless accepted by Resident Engineer in writing.
- F. Submit steel producers certificates of mill analysis, tensile tests, and bend tests for reinforcing steel. Coordinate with welders and welding procedures.
- G. Inspection of concrete steel reinforcement is required in accordance with International Building Code of Michigan State Section 1704. Inspections shall be conducted by an inspection agency employed by Owner and approved by Resident Engineer. Inspector shall provide report in approved format to Owner with copy to Resident Engineer and Contractor. Inspection agency has authority to reject reinforcing not meeting Contract Documents. Inspections for all reinforcing steel for conformance to shop drawings and Contract Documents shall be completed prior to concrete placement.
- H. Epoxy coated reinforcement, ASTM A775 and A884:
 - 1. Coating applicator shall have quality control program to assure that coated reinforcement comply with requirements of Specifications.
 - 2. Submit proof of current certification for rebar coating plant from Concrete Reinforcing Steel Institute.
- I. Submit following information on Inspection of Reinforcement unless modified in writing by Resident Engineer.
 - 1. Project name and location.
 - 2. Contractor's name.
 - 3. Inspection Agency's name, address, and phone number.
 - 4. Date and time of inspection.
 - 5. Inspection Agency technician's name.
 - 6. Fabricator's name.
 - 7. Weather data:
 - a. Air Temperatures.
 - b. Weather.
 - c. Wind speed.
 - 8. Inspection location within structure.
 - 9. Reinforcement inspection data such as:
 - a. Bar size, spacing, cover, and grade.
 - b. Splices, bends, anchorages, welding.
 - c. Epoxy coating or galvanizing as required.
 - d. Support methods and construction sequencing.

10. Diary of general progress of Work.

J. Testing Agency Qualifications:

1. Independent agency, acceptable to authorities having jurisdiction, the Resident Engineer and acceptable to Engineer of Record, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
2. Testing laboratory shall submit documented proof of ability to perform required tests.
3. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 4, according to ACI CP-1 or an equivalent certification program.

K. Testing Agency is responsible for conducting, monitoring and reporting results of all tests required under this Section. Testing Agency shall immediately report test results showing properties that do not conform to Project Specification requirements to General Contractor's authorized on-site representative and to Owner's authorized on-site representative.

L. Submit following Field Test information for Project Concrete unless modified in writing by Resident Engineer:

1. Project name and location.
2. Contractor's name.
3. Testing Agency's name, address, and phone number.
4. Concrete supplier.
5. Date of report.
6. Testing Agency technician's name (sampling and testing).
7. Placement location within structure.
8. Time of batching.
9. Time of testing.
10. Elapsed time from batching at plant to discharge from truck at site.
11. Concrete mixture data (quantity and type):
 - a. cement
 - b. Fine aggregates.
 - c. Coarse aggregates.
 - d. Water.
 - e. Water-reducing admixture and high-range water-reducing admixture.
 - f. Other admixtures, including supplementary cementitious materials.
 - g. Supplementary cementitious materials.

12. Weather Data:

- a. Air temperatures.
- b. Weather

c. Wind Speed.

13. Field test data:

- a. Date, time and place of test.
- b. Slump.
- c. Air content.
- d. Concrete Temperature.
- e. Density (Unit weight).

14. Compressive test data:

- a. Cylinder number.
- b. Age of concrete when tested.
- c. Date and time of cylinder test.
- d. Curing time (field and lab).
- e. Cross-sectional area of cylinder.
- f. Compressive strength.
- g. Type of failure (at break).

M. Provide certification that curing compound conforms to requirements of ASTM C 1315.

N. All concrete flatwork finishers on Project shall hold current ACI Concrete Flatwork Finisher certification. Submit certification for each concrete flatwork finisher at Concrete Pre-construction Conference and obtain Resident Engineer's written acceptance.

O. Mockups for Flatwork: Before casting concrete, build mockups to verify selections made under sample submittals and to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

- 1. Build one acceptable test panels approximately 600 sq. ft. for flatwork in parking drive areas slab-on-grade in the location indicated or, if not indicated, submit a request for acceptance of the proposed location at the project site.
- 2. Stains, bugholes or other surface blemishes that deviate from the mockup will not be acceptable.
- 3. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
- 4. Obtain Resident Engineer's acceptance of mockups before casting concrete with specified finishes.
- 5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- P. Fly ash supplier shall make available qualified individual, experienced in placement of fly ash concrete, to aid Contractor. Qualification of supplier's representative shall be acceptable to Owner. Representative shall attend pre-construction meeting, and shall be present for all trial placements, initial startup and then as required by Owner.
- Q. Provide certification that curing compound and evaporation reducer are compatible with sealer and traffic topping specified in Division 7, and sealant specified in Division 7, Section "Joint Sealants".
- R. At all times during high-evaporation conditions, maintain adequate supply of evaporation reducer at site. Do not use evaporation reducer as finishing aid. See Part 3.
- S. Testing Agency: Identify those trucks of concrete supplier's which meet requirements of NRMCA Quality Control Manual. Permit only those trucks to deliver concrete to Project.

1.11 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Concrete Institute (ACI):
 - 117-06Tolerances for Concrete Construction and Materials
 - 211.1-02Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 - 211.2-04Selecting Proportions for Structural Lightweight Concrete
 - 214R-02.....Evaluation of Strength Test Results of Concrete
 - 301-05Structural Concrete
 - 304R-2000.....Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 305R-06.....Hot Weather Concreting
 - 306R-(2002)Cold Weather Concreting
 - 308R-(2001)Standard Practice for Curing Concrete
 - 309R-05.....Guide for Consolidation of Concrete
 - 31808Building Code Requirements for Reinforced Concrete and Commentary
 - 347R-04.....Guide to Formwork for Concrete
 - 362.1Guide for the Design of Durable Parking Structures
 - SP-66-04ACI Detailing Manual
- C. American National Standards Institute and American Hardboard Association (ANSI/AHA):

A135.4-2004.....Basic Hardboard

D. American Society for Testing and Materials (ASTM):

A82/A82M-07	Steel Wire, Plain, for Concrete Reinforcement
A185/185M-07	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A615/A615M-08	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A653/A653M-07	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
A706/A706M-06	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A767/A767M-05	Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A820-06.....	Steel Fibers for Fiber-Reinforced Concrete
A996/A996M-06	Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
C31/C31M-08	Making and Curing Concrete Test Specimens in the field
C33-07.....	Concrete Aggregates
C39/C39M-05	Compressive Strength of Cylindrical Concrete Specimens
C94/C94M-07	Ready-Mixed Concrete
C138.....	Standard Test Method for Unit Weight, Yield and Air Content of Concrete
C143/C143M-05	Slump of Hydraulic Cement Concrete
C150-07.....	Portland Cement
C171-07.....	Sheet Materials for Curing Concrete
C172-07.....	Sampling Freshly Mixed Concrete
C173-07.....	Air Content of Freshly Mixed Concrete by the Volumetric Method
C192/C192M-07	Making and Curing Concrete Test Specimens in the Laboratory
C231-08.....	Air Content of Freshly Mixed Concrete by the Pressure Method
C260-06.....	Air-Entraining Admixtures for Concrete
C309-07.....	Liquid Membrane-Forming Compounds for Curing Concrete
C311.....	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use as a Mineral Admixture in Portland Cement Concrete
C330-05.....	Lightweight Aggregates for Structural Concrete

C494/C494M-08	Chemical Admixtures for Concrete
C496-06.....	Splitting Tensile Strength of Cylindrical Concrete Specimens
C567-05.....	Density of Structural Lightweight Concrete
C618-08.....	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
C666/C666M-03	Resistance of Concrete to Rapid Freezing and Thawing
C881/C881M-02	Epoxy-Resin-Base Bonding Systems for Concrete
C989	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregate for Use in Construction and Criteria for Laboratory Evaluation
C1107/1107M-07.....	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
C1116.....	Standard Specification for Fiber-Reinforced Concrete and Shotcrete
C1315-08.....	Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
D6-95(R2006).....	Loss on Heating of Oil and Asphaltic Compounds
D297-93(R2006).....	Rubber Products-Chemical Analysis
D1751-04.....	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D4397-02.....	Polyethylene Sheeting for Construction, Industrial and Agricultural Applications
E96/E96M.....	Standard Test Methods for Water Vapor Transmission of Materials
E1155-96(R2008).....	Determining F_F Floor Flatness and F_L Floor Levelness Numbers
E1643	Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
E1745	Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
F1637 02	Standard Practice for Safe Walking Surfaces

E. American Welding Society (AWS):

D1.1	Structural Welding Code - Steel
D1.4-05.....	Structural Welding Code - Reinforcing Steel

F. Concrete Reinforcing Steel Institute (CRSI):

Manual of Standard Practice (MSP)

G. National Cooperative Highway Research Program (NCHRP):

Report On.....Concrete Sealers for the Protection of Bridge Structures

H. U. S. Department of Commerce Product Standard (PS):

PS 1.....Construction and Industrial Plywood
PS 20.....American Softwood Lumber

I. U. S. Army Corps of Engineers Handbook for Concrete and Cement:

CRD C513Rubber Waterstops
CRD C572Polyvinyl Chloride Waterstops

J. Prestressed Concrete Institute (PCI):

1. MNL 116, "Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products."
2. MNL 120, "Design Handbook Precast Prestressed Concrete."
3. MNL 129, "Parking Structures-Recommended Practice for Design and Construction."
4. MNL 135, "Tolerances for Precast and Prestressed Concrete Construction."
5. "Code of Standard Practice for Precast Concrete."

K. Contractor shall have following ACI publications at Project construction site:

1. ACI SP-15, "Field Reference Manual: Standard Specifications for Structural Concrete ACI 301 with selected ACI References."
2. ACI 302.1R, "Guide for Concrete Floor and Slab Construction."
3. ACI 305R, "Hot Weather Concreting."
4. ACI 306.1, "Cold Weather Concreting."

L. International Code Council (ICC):

1. IBC "International Building Code 2009".

PART 2 – PRODUCTS

2.1 FORMS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints. Medium-density overlay, Class 1, or better, mill-applied release agent and edge sealed, complying with DOC PS 1

- B. Plywood: PS-1 Exterior Grade B-B (concrete-form) 16 mm (5/8 inch), or 20 mm (3/4 inch) thick for unlined contact form. B-B High Density Concrete
- C. Form Lining:
 - 1. Medium Density Overlay: Class 1 or better, mill-release agent treated and edge sealed.
 - 2. Plywood: Grade B-B Exterior (concrete-form) not less than 6 mm (1/4 inch) thick.
 - 3. Plastic, fiberglass, or elastomeric capable of reproducing the desired pattern or texture.
- D. Form Coatings: Provide commercial formulation form-coating compounds with a maximum VOC of 350 grams/liter that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces, such as water-curing, curing compound, stains or paints.
- E. Chamfer strips: Wood, metal, PVC, or rubber strips. 0.75 inch by 0.75 inch minimum unless noted otherwise.
- F. Form Ties: Develop a minimum working strength of 13.35 kN (3000 pounds) when fully assembled. Ties shall be adjustable in length to permit tightening of forms and not have any lugs, cones, washers to act as spreader within form, nor leave a hole larger than 20 mm (3/4 inch) diameter, or a depression in exposed concrete surface, or leave metal closer than 40 mm (1 1/2 inches) to concrete surface. Wire ties not permitted. Cutting ties back from concrete face not permitted. Factory-fabricated, internally disconnecting or removable ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal. At architectural finish areas, form ties shall be uniformly spaced in aligning rows and columns as approved by resident engineer.
- G. Rustication Strips: Metal, rigid plastic, or dressed wood with sides beveled and back kerfed; nonstaining; in longest practicable lengths.

2.2 MATERIALS

- A. Ready Mixed Concrete: Obtain concrete from plant with current certification from at least one of the following:
 - 1. Concrete Materials Engineering Council.
 - 2. Michigan Department of Transportation.
 - 3. National Ready Mixed Concrete Association.

4. Prestressed Concrete Institute.
- B. Portland Cement: ASTM C150 Type I or II. Use one cement supplier throughout project.
- C. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.
1. Testing: ASTM C311.
 2. Percentage of fly ash in Mixture Proportion shall be by weight, not by volume. Water/cement ratio will be calculated as water/cementitious (total cement and fly ash) ratio.
 3. Prohibited: Fly ash in same mix with Type IP blended cement.
 4. If strength or air content varies from value specified by more than specified tolerances, Resident Engineer or designated representative shall reject that concrete.
 5. Submit all fly ash concrete Mixture Proportions per ACI 301.
- D. Slag – (Ground Granulated Blast-Furnace Slag - GG BFS):
1. ASTM C 989, Grade 100 or higher.
 2. Percentage of GGBF slag in Mixture Proportion shall be by weight, not by volume. Water-cement ratio shall be calculated as water-cementitious (total portland cement + GGBF slag) ratio.
 3. If strength or air content varies from value specified by more than specified tolerances, Resident Engineer or designated representative shall reject that concrete.
 4. Submit all GGBF slag concrete mixture proportions per ACI 301.
- E. Normal Weight Aggregates (ACI 301, Section 4 header “Aggregates”):
1. Normal weight concrete aggregates:
 - a. Coarse aggregate: Crushed and graded limestone or approved equivalent conforming to ASTM C33 except as noted here, minimum class designations as listed below:
 - 1) Below grade construction and below frost line: Class 1S.
 - 2) Walls not exposed to public view: Class 3S.
 - 3) Walls exposed to public view: Class 5S.
 - 4) Slabs on ground: Class 4S.
 - 5) All other concrete: Class 5S.
 - b. No deleterious materials such as chert or opaline.

- c. Fine aggregate: Natural or Manufactured sand conforming to ASTM C 33 and having preferred grading shown for normal weight aggregate in ACI 302.1R, Table 5.2.1.
 - d. Coarse Aggregate shall not contain crushed hydraulic-cement concrete.
 2. Coarse aggregate: Nominal maximum sizes indicated below, conforming to ASTM C 33, Table 2:
 - a. Footings/Foundations: Size number 57 or 357.
 - b. Toppings and washes less than 3 in. thick: Size number 7 or 67.
 - c. Slab on grade: Size number 57.
 - d. All other members: Size number 67.
 3. Chloride Ion Level: ASTM C 1218. Chloride ion content of cement, aggregates and all other ingredients: tested by laboratory making trial mixes.
 4. Maximum size of coarse aggregates not more than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourths of minimum clear spacing between reinforcing bars.
- F. Mixing Water: Fresh, clean, and potable.
- G. Admixtures:
1. Water Reducing Admixture: ASTM C494, Type A and not contain more chloride ions than are present in municipal drinking water.
 2. Water Reducing, Retarding Admixture: ASTM C494, Type D and not contain more chloride ions than are present in municipal drinking water.
 3. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or G, and not contain more chloride ions than are present in municipal drinking water.
 4. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. Admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory of at least one year duration using an acceptable accelerated corrosion test method such as that using electrical potential measures.
 5. Air Entraining Admixture: ASTM C260.
 6. Concrete supplier and manufacturer shall verify via trial mixes and certify compatibility (no effect on workability, strength, durability, entrained air content, etc.) of all ingredients in each Mixture. Use admixtures in strict accordance with manufacturer's recommendations.
 7. Prohibited Admixtures: Calcium chloride, thiocyanate or admixtures containing more than 0.05 percent chloride ions are not permitted.
 8. Certification: Written conformance to the requirements above and the chloride ion content of the admixture prior to mix design review.

- H. Vapor Barrier: Provide vapor barrier which conforms to ASTM E 1745, Class A. The membrane shall have a water-vapor transmission rate less than or equal to 0.008 gr./ft²/hr when tested, in accordance with ASTM E96. Vapor barrier shall be no less than 15 mils thick. The vapor barrier shall be placed over prepared base material where indicated below slabs on ground.
1. New ISO certified virgin resins, polyolefin based maximum.
- I. Reinforcing Steel: ASTM A615, or ASTM A996, deformed, grade as shown.
- J. Welded Wire Fabric: ASTM A185 fabricated from as-drawn steel wire into flat sheets (roll stock prohibited).
- K. Reinforcing Bars to be Welded: ASTM A706.
- L. Galvanized Reinforcing Bars: ASTM A767.
- M. Epoxy-Coated Fabricated Reinforcing Bars: ASTM A 934, and as follows:
1. Steel Reinforcement: ASTM A 615, Grade 60, deformed bars.
- N. Provide in Bid two additional tons of placed reinforcement bars or welded wire reinforcement for inclusion in Project as Resident Engineer directs. Return cost of unused portion to Owner at unit price stated on Bid Form. Submit to Resident Engineer breakdown of use each month.
- O. For mechanical tension splices of reinforcement:
1. All splices to develop 125 percent of specified yield strength of bars, or of smaller bar in transition splices.
- P. Compression splices: Mechanically coupled splices in accordance with ACI 318, Chapter 12.
- Q. Bar supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from all plastic of greater compressive strength than concrete, and as follows:
1. In manner acceptable to Resident Engineer solely, bar and welded wire reinforcement supports shall be color-coded to visually differentiate supports by height and shall be fabricated to resist overturning during construction operations.
 2. For slabs on ground, use all-plastic supports with sand plates or horizontal runners where base materials will not support chair legs. All supports shall

have sufficient surface area in contact with ground so that they shall not allow clearance loss when reinforcement installed or concrete placed.

3. For concrete surfaces exposed to view where bar supports contact forms, supports shall have minimal contact, shall not cause voids and shall not cause damage to surrounding concrete. Use all-plastic supports conforming to CRSI Class 1 protection requirements.
4. Chairs shall be sized and spaced to prevent cover loss during construction operations.

R. Epoxy Coating Materials for Reinforcement: ASTM A 775 and A 884:

1. Supplier shall be certified currently under CRSI Fusion Bonded Epoxy Coating Applicator Plant Certification Program.

S. Joint Filler:

1. Joint filler in slabs and curbs: Asphalt impregnated fiber board; as shown on Drawings. ASTM D 1751.
2. Joint filler used vertically to isolate walls from columns or other walls: White molded polystyrene beadboard type.
3. Joint cover used to bridge gap between columns and grade walls, retaining walls, or basement walls: Minimum width: Gap width plus 4 in. for gaps over 3 inches wide, protect cover with protection board sized to span gap satisfactorily.

T. Curing Materials:

1. Evaporation Reducer: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Curing Compound (VOC Compliant, less than 350 g/l): Comply with ASTM C 309, Type 1, Class A or B. Moisture loss shall be not more than 0.55 kg/m² when applied at 200 sq. ft. gal. Manufacturer's certification is required. Silicate based compounds prohibited.
 - a. With product submittal provide plan and procedures for removal of residual curing compound prior to application of sealers, coatings, stains, pavement markings and other finishes.
 - b. Provide a summary of testing to show adequate surface preparation for successful application of sealers, coatings, stains, pavement markings, and other finishes.

- U. Penetrating Sealer: For use on parking garage ramps and decks. High penetration silane sealer providing minimum 95 percent screening per National Cooperative Highway Research Program (NCHRP) No. 244 standards for chloride ion penetration resistance. Requires moist (non-membrane) curing of slab.
- V. Non-Shrink Grout:
 - 1. ASTM C1107, pre-mixed, produce a compressive strength of at least 18 MPa at three days and 35 MPa (5000 psi) at 28 days. Furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 1200 mm x 1200 mm (4 foot by 4 foot) base plate.
 - 2. Where high fluidity or increased placing time is required, furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent under an 450 mm x 900 mm (18 inch by 36 inch) base plate.

2.3 RELATED MATERIALS

- A. Bonding Additive: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
 - 1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
 - 2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
 - 3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- C. Reglets: Fabricate reglets of not less than 0.0217-inch- thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- D. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- E. Mechanical and chemical anchors shall be manufactured by Hilti Fastening Systems, Tulsa Oklahoma, ITW Ramset/Red Head, Wood Dale, IL, Simpson Anchor Systems, Columbus, OH, or accepted equivalent. Anchor bolt

composition shall be from one or more of carbon steel and stainless steel, lead, Zamac alloy, nylon, plastic, polypropylene, and jute fiber.

1. Strength of all anchors shall comply with ICC-ES-AC 58CR or ICC-ES AC308 and ACI 318-05 Appendix D.
2. Carbon steel anchors shall be either zinc plated in accordance with ASTM B 633, or hot-dipped galvanized in accordance with ASTM A-153-78. Provide mill test reports and manufacturer's quality control certification upon Resident Engineer's request.
3. Stainless steel anchors shall be manufactured from ASTM A304, or A663 stainless steel. Provide mill test reports and manufacturer's quality control certification upon Resident Engineer's request.
4. Plastic, lead, or Zamac alloy anchors shall not be used for overhead applications. Chemical anchors shall not be used to resist pullout forces in overhead and wall installations unless proper consideration is given to fire conditions. For chemical anchors, consult with manufacturer's engineer.
5. Safety Factors: Static loads 4:1 minimum. Static load safety factors shall be per manufacturer's published data. Critical load (vibratory, overhead, etc. or more) safety factors shall be 10:1 minimum. Chemical anchors are not permitted for critical loads and where resistance to direct sustained tension is required.
 - a. If necessary for purposes of determining tensile and/or shear capacity in questionable base material, testing shall be done prior to actual anchor installation. A maximum of five tension and/or shear tests shall be performed by manufacturer's engineer. Anchors shall be proof loaded in tension and/or shear to assure that working load capacity is within specified allow-able load limit as published by manufacturer.
6. Anchor spacing and edge distance per manufacturer's limits. Loading and cluster spacing shall be as established by minimum industry standards for anchors, except as follows: Anchor loading, cluster spacing and edge distances shall be as published in manufacturer's literature. Consult with manufacturer's engineer for specific requirements.
7. Anchor installation shall be as required by manufacturers written instructions.

F. Inserts and Coil Rods:

1. Yield strength: 65,000 psi minimum.
2. Galvanizing: Where indicated, electrodeposited zinc coating, ASTM B 633, Service condition 1, Type III.
3. Epoxy coating: Where indicated.
4. Details shown on drawings are based on Dayton/Richmond Concrete Accessories, Inc. products and their respective capacities. Other products may be used only if contractor submits calculations, sealed by professional engineer or structural engineer licensed in Michigan, substantiating strength

of connection with other product. Calculations are subject to Resident Engineer's acceptance before fabrication is to proceed.

- G. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Profile: Flat, dumbbell with center bulb.

- H. Slide Bearing System at Expansion Joints:

1. Provide slide bearing system as shown and detailed on Drawings:
 - a. Beam and double tee bearings shall be reinforced PTFE: 100 percent virgin tetrafluoroethylene polymer and ground glass fiber reinforcing aggregate, prebonded to stainless steel and/or preformed fabric (Section 034133 "Plant Precast Structural Concrete," Part 2 Article "Materials," paragraph "Bearing Pads") bearing pads.
 - b. Slab and plank bearings shall be ultrahigh molecular weight, high-density polyethylene resin.
2. Backing materials for reinforced PTFE slide bearing systems as shown on Drawings:
 - a. Galvanized steel.
 - b. Stainless steel.
 - c. Reinforced elastomer, having durometer hardness of 90 +/- 5 and meeting requirements of Article 2.10.3(L) of AASHTO Standard Specifications for Highway Bridges (1983).

2.4 CONCRETE MIXES

- A. Mix Designs: Proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318.
1. If trial mixes are used, make a set of at least 6 cylinders in accordance with ASTM C192 for test purposes from each trial mix; test three for compressive strength at 7 days and three at 28 days.
 2. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, fly ash, admixtures, weight of fine and coarse aggregate per m³ (cubic yard) measured dry rodded and damp loose, specific gravity, fineness modulus, percentage of moisture, air content, water-cement -fly ash ratio, and consistency of each cylinder in terms of slump.

3. Prepare a curve showing relationship between water-cement -fly ash ratio at 7-day and 28-day compressive strengths. Plot each curve using at least three specimens.
 4. If the field experience method is used, submit complete standard deviation analysis.
- B. Fly Ash Testing: Submit certificate verifying conformance with specifications initially with mix design and for each truck load of fly ash delivered from source. Notify Resident Engineer immediately when change in source is anticipated. Prior to beginning trial mixes submit to the Resident Engineer the following representative samples of material to be used, properly identified source and project description and number, type of testing (complete chemical and physical), suitably packaged for shipment, and addressed as specified. Allow 60 calendar days for test results after submittal of sample.
1. Fly ash - 2.25 kg (five pounds).
 2. Portland cement - 3.5 kg (8 pounds):
Address -Waterways Experiment Station (WES)
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
ATTN: Engineering Materials Group
- C. After approval of mixes no substitution in material or change in proportions of approval mixes may be made without additional tests and approval of Resident Engineer or as specified. Making and testing of preliminary test cylinders may be carried on pending approval of cement and fly ash, providing Contractor and manufacturer certify that ingredients used in making test cylinders are the same. Resident Engineer may allow Contractor to proceed with depositing concrete for certain portions of work, pending final approval of cement and fly ash and approval of design mix.
- D. Cement Factor: Maintain minimum cement factors in Table I regardless of compressive strength developed above minimums. Fly ash may be substituted for up to 20 percent of the minimum cement factor at option of Contractor, except fly ash, silica fume and other pozzalons may not be used in concrete designated as architectural concrete.

TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE

Concrete Strength		Non-Air-Entrained	Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement kg/m ³ (lbs/c. yd)	Max. Water Cement Ratio	Min. Cement kg/m ³ (lbs/c. yd)	Max. Water Cement Ratio
35 (5000) ^{1,3}	375 (630)	0.45	385 (650)	0.40

30 (4000) ^{1,3}	325 (550)	0.45	340 (570)	0.45
25 (3000) ^{1,3}	280 (470)	0.65	290 (490)	0.55

1. If trial mixes are used, the proposed mix design shall achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. For concrete strengths above 35 Mpa (5000 psi), the proposed mix design shall achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.
2. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.

E. Maximum Slump: Maximum slump, as determined by ASTM C143 with tolerances as established by ASTM C94, for concrete to be vibrated shall be as shown in Table II AND THE Structural General Notes.

TABLE II - MAXIMUM SLUMP, MM (INCHES)*

Type of Construction	Normal Weight Concrete
Reinforced Walls, Topping at Tees, Landings, Washes and Pour Strips	75mm (3 inches)
Wall Footings, Grade Beams, DP Caps, Slab-on-Grade	100 mm (4 inches)

* Slump may be increased by the use of the approved high-range water-reducing admixture (superplasticizer). Tolerances as established by ASTM C94. Concrete containing the high-range-water-reducing admixture may have a maximum slump of 225 mm (9 inches). The concrete shall arrive at the job site at a slump of 50 mm to 75 mm (2 inches to 3 inches). This should be verified, and then the high-range-water-reducing admixture added to increase the slump to the approved level.

F. Air-Entrainment: Air-entrainment of normal weight concrete shall conform with the Structural General Notes. Determine air content by either ASTM C173 or ASTM C231.

G. High early strength concrete, made with Type III cement or Type I cement plus non-corrosive accelerator, shall have a 7-day compressive strength equal to specified minimum 28-day compressive strength for concrete type specified made with standard Portland cement.

H. Concrete slabs placed at air temperatures below 10 degrees C (50 degrees Fahrenheit) use non-corrosive, non-chloride accelerator. Concrete required to be air entrained use approved air entraining admixture. Pumped concrete, synthetic

fiber concrete, architectural concrete, concrete required to be watertight, and concrete with a water/cement ratio below 0.50 use high-range water-reducing admixture (superplasticizer).

- I. Enforcing Strength Requirements: Test as specified in Section 01 45 29, TESTING LABORATORY SERVICES, during the progress of the work. Seven-day tests may be used as indicators of 28-day strength. Average of any three 28-day consecutive strength tests of laboratory-cured specimens representing each type of concrete shall be equal to or greater than specified strength. No single test shall be more than 3.5 MPa (500 psi) below specified strength. Interpret field test results in accordance with ACI 214. Should strengths shown by test specimens fall below required values, Resident Engineer may require any one or any combination of the following corrective actions, at no additional cost to the Government:
1. Require changes in mix proportions by selecting one of the other appropriate trial mixes or changing proportions, including cement content, of approved trial mix.
 2. Require additional curing and protection.
 3. If five consecutive tests fall below 95 percent of minimum values given in Table I or if test results are so low as to raise a question as to the safety of the structure, Resident Engineer may direct Contractor to take cores from portions of the structure. Use results from cores tested by the Contractor retained testing agency to analyze structure.
 4. If strength of core drilled specimens falls below 85 percent of minimum value given in General Notes, Resident Engineer may order load tests, made by Contractor retained testing agency, on portions of building so affected. Load tests in accordance with ACI 318 and criteria of acceptability of concrete under test as given therein.
 5. Concrete work, judged inadequate by structural analysis, by results of load test, or for any reason, shall be reinforced with additional construction or replaced, if directed by the Resident Engineer.
- J. Supplementary cementitious materials: Maximum weight of fly ash, natural pozzolans, silica fume, processed ultra fine fly ash or slag included in concrete shall not exceed percentages of total weight (see footnotes for ACI 301 Part 4 Table "Requirements for Concrete Exposed to Deicing Chemicals") of cementitious materials as follows:
1. Fly Ash or other pozzolans conforming to ASTM C 618: 25 percent.
 2. Slag conforming to ASTM C 989: 50 percent. (Note: Provide minimum 30 percent slag cement at architectural concrete at grade level perimeter wall)
 3. Total of fly ash or other pozzolans and slag: 50 percent.
- K. Chloride Ion Content of Mixture:

1. Water soluble chloride ion content of concrete shall not exceed 0.06 percent by weight of cement for pre-stressed concrete and 0.15 percent for reinforced concrete. (ACI 318 Chapter 4 Table 4.4.1 "Maximum Chloride Ion Content for Corrosion Protection of Reinforcement") Test to determine chloride ion content shall conform to ASTM C 1218.
2. Concrete chloride ion content shall be determined by Testing Agency prior to placement. Cast samples from current production of concrete mix proposed for superstructure.
3. Concrete not meeting the requirements of paragraph "Water soluble chloride ion content of concrete..." above, shall contain appropriate amount of calcium nitrite. Concrete supplier shall provide laboratory test results showing the amount of excess chloride ion content in the concrete mixture contributed by the aggregates. For each pound of chloride ion in excess of the amount allowed, mix shall contain calcium nitrite (30 percent, plus or minus 2 percent, solids content) on one-to-one basis (one gallon of calcium nitrite for one lb of excess chloride ion). Maximum of 1.5 lb of chloride ion per cubic yard may be offset in this manner.

L. Alkali content of mixture shall not exceed 5 lb/cu. yd.

M. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Consider using water-reducing admixture or high-range water-reducing admixture (Superplasticizers), OR admixtures that achieve self-consolidating concrete, as required, for placement, workability, finishing and when required, increased flowability.
2. Consider using water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use high range water-reducing admixture in pumped concrete, concrete for parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio of 0.45 or less. Use normal or mid-range water reducing admixture for concrete with water-cementitious materials ratio greater than 0.45.

N. Self-Consolidating Concrete:

1. Minimum flow of 24 in. to 28 in. or as required by the successful test placement. All self-consolidating concrete shall contain the specified high-range water-reducing admixture and viscosity-modifying admixture as required.
2. Measure slump flow using slump cone upright or inverted in accordance with ASTM C1611. Measured flow shall be greater than 24 inches and consistent with submitted mixture test parameters plus or minus 2 in.
3. Measure passing ability in accordance with ASTM C 1621/C 1621M. Use the slump cone in the same way as in the slump flow test. Difference in average slump flow between slump flow and passing ability tests shall not exceed 2 in.

4. Determine the static segregation (stability) in accordance with ASTM C 1610/C 1610M. Segregation factor of the mixture shall not be more than 15 percent.
- O. Resident Engineer's acceptance of mixture proportions shall not relieve Contractor from responsibility for any variation from requirements of Contract Documents unless Contractor has in writing called Resident Engineer's attention to each such variation at time of submission and Resident Engineer has given written approval of each such variation.
- P. Adjustment to Concrete Mixtures: Adjustments to mixture proportions may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Resident Engineer. Laboratory test data for revised mixture and strength results shall be submitted to and accepted by Resident Engineer before using in work.

2.5 BATCHING AND MIXING

- A. General: Concrete shall be "Ready-Mixed" and comply with ACI 318 and ASTM C94, except as specified. Batch mixing at the site is permitted. Mixing process and equipment must be approved by Resident Engineer. With each batch of concrete, furnish certified delivery tickets listing information in Paragraph 16.1 and 16.2 of ASTM C94. Maximum delivery temperature of concrete is 38°C (100 degrees Fahrenheit). Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
-1. degrees to 4.4 degrees C (30 degrees to 40 degrees F)	15.6 degrees C (60 degrees F.)
-17 degrees C to -1.1 degrees C (0 degrees to 30 degrees F.)	21 degrees C (70 degrees F.)

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.6 TOOLS

A. Slab Jointing

1. Concrete groovers: For tooled joints in concrete:
 - a. For concrete not exceeding 4 in. thickness, use groover with 1 in. deep v-cut bit, 0.5 in. surface width and 3/16 in. to 1/4 in. edge radius.

- b. For concrete exceeding 4 in. thickness, use groover with 1.5 in. deep v-cut bit, 0.5 in. surface width and 3/16 in. to 1/4 in. edge radius.
2. Saw Cut Joints:
 - a. Acceptable tool: "Soff-Cut Saw Model 310" or "Model G2000," Soff-Cut International, Corona, CA or approved equivalent.

PART 3 – EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads and in accordance with Article 1.9 "Contractor's Professional Services – Performance and Design Criteria".
 1. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
 2. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, Class A.
 3. Fabricate forms to result in cast-in-place architectural concrete that complies with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- B. General: Design in accordance with ACI 347 is the responsibility of the Contractor. The Contractor shall retain a registered Professional Engineer to design the formwork, shores, and reshores.
 1. Form boards and plywood forms may be reused for contact surfaces of exposed concrete only if thoroughly cleaned, patched, and repaired and Resident Engineer approves their reuse.
 2. Provide forms for concrete footings unless Resident Engineer determines forms are not necessary.
 3. Corrugated fiberboard forms: Place forms on a smooth firm bed, set tight, with no buckled cartons to prevent horizontal displacement, and in a dry condition when concrete is placed.
- C. Treating and Wetting: Treat or wet contact forms as follows:
 1. Coat plywood and board forms with non-staining form sealer. In hot weather, cool forms by wetting with cool water just before concrete is placed.
 2. Clean and coat removable metal forms with light form oil before reinforcement is placed. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.

3. Use sealer on reused plywood forms as specified for new material.
- D. Size and Spacing of Studs: Size and space studs, wales and other framing members for wall forms so as not to exceed safe working stress of kind of lumber used nor to develop deflection greater than $1/270$ of free span of member.
- E. Unlined Forms: Use plywood forms to obtain a smooth finish for concrete surfaces. Tightly butt edges of sheets to prevent leakage. Back up all vertical joints solidly and nail edges of adjacent sheets to same stud with 6d box nails spaced not over 150 mm (6 inches) apart.
- F. Lined Forms: May be used in lieu of unlined plywood forms. Back up form lining solidly with square edge board lumber securely nailed to studs with all edges in close contact to prevent bulging of lining. No joints in lining and backing may coincide. Nail abutted edges of sheets to same backing board. Nail lining at not over 200 mm (8 inches) on center along edges and with at least one nail to each square foot of surface area; nails to be 3d blued shingle or similar nails with thin flatheads.
- G. Wall Form Ties: Locate wall form ties in symmetrically level horizontal rows at each line of wales and in plumb vertical tiers. Space ties to maintain true, plumb surfaces. Provide one row of ties within 150 mm (6 inches) above each construction joint. Space through-ties adjacent to horizontal and vertical construction joints not over 450 mm (18 inches) on center.
1. Tighten row of ties at bottom of form just before placing concrete and, if necessary, during placing of concrete to prevent seepage of concrete and to obtain a clean line. Ties to be entirely removed shall be loosened 24 hours after concrete is placed and shall be pulled from least important face when removed.
 2. Coat surfaces of all metal that is to be removed with paraffin, cup grease or a suitable compound to facilitate removal.
 3. Fill all form tie voids with concrete patching material to match architectural finish.
- H. Inserts, Sleeves, and Similar Items: Flashing reglets, steel strips, masonry ties, anchors, wood blocks, nailing strips, grounds, inserts, wire hangers, sleeves, drains, guard angles, forms for floor hinge boxes, inserts or bond blocks for elevator guide rails and supports, and other items specified as furnished under this and other sections of specifications and required to be in their final position at time concrete is placed shall be properly located, accurately positioned, and built into construction, and maintained securely in place.

1. Locate inserts or hanger wires for furred and suspended ceilings only in bottom of concrete joists, or similar concrete member of overhead concrete joist construction.
2. Install sleeves, inserts and similar items for mechanical services in accordance with drawings prepared specially for mechanical services. Contractor is responsible for accuracy and completeness of drawings and shall coordinate requirements for mechanical services and equipment.
3. Do not install sleeves in beams, joists or columns except where shown or permitted by Resident Engineer. Install sleeves in beams, joists, or columns that are not shown, but are permitted by the Resident Engineer, and require no structural changes, at no additional cost to the Government.
4. Minimum clear distance of embedded items such as conduit and pipe is at least three times diameter of conduit or pipe, except at stub-ups and other similar locations.
5. Provide recesses and blockouts in floor slabs for door closers and other hardware as necessary in accordance with manufacturer's instructions.

J. Construction Tolerances:

1. Set and maintain concrete formwork to assure erection of completed work within tolerances specified and to accommodate installation of other rough and finish materials. Accomplish remedial work necessary for correcting excessive tolerances. Erected work that exceeds specified tolerance limits shall be remedied or removed and replaced, at no additional cost to the Government.
2. Permissible surface irregularities for various classes of materials are defined as "finishes" in specification sections covering individual materials. They are to be distinguished from tolerances specified which are applicable to surface irregularities of structural elements.

K. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117, except as modified below:

1. Pier Caps:

- a. Variation of center from specified plan location: 0.5 in.
- b. Variation of bearing surface from specified location: Plus or minus 0.5 in.
- c. Variation from specified dimensions in plan: Plus 2 in. minus 0 in.
- d. Variation decrease from specified thickness: 0.5 in.

2. Footings:

- a. Footings other than those to receive masonry construction: Variation of bearing surface from specified elevation: Plus or minus 0.5 in.
- b. Footings to Receive Masonry Construction:

- 1) Variation of center from specified location in plan: Plus or minus 0.25 in. in any 10 ft but not to exceed plus or minus 0.5 in.
 - 2) Variation of bearing surfaces for specified elevation: Plus or minus 0.25 in. in any 10 ft but not to exceed plus or minus 0.5 in.
3. Piers, Columns, Walls, Beams, and Slabs:
- a. Variation in cross-sectional dimensions of piers, beams and columns and in thickness of walls and slabs: 12 in. or less: Plus 0.375 in., minus 0.25 in. Greater than 12 in.: Plus 0.5 in., minus 0.375 in.
 - b. Variation in elevation from specified elevation for piers, columns and walls: Plus or minus 0.5 in.
4. Permissible variations from plumb and designated building lines for portions of buildings more than 100 feet above ground: height/1000.
5. Anchor bolts: concrete contractor shall place anchor bolts within tolerances stated under heading "Anchor Bolts and Bearing Plates" of PCI "Code of Standard Practice for Precast Concrete."
- L. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Install keyways, reglets, recesses, and the like, for easy removal.
 2. Kerf wood inserts for easy removal.
 3. Do not use rust-stained steel form-facing material.
- M. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- N. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- O. Chamfer exterior corners and edges of permanently exposed concrete.
- P. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

- Q. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- R. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- S. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 PLACING REINFORCEMENT

- A. General: Details of concrete reinforcement in accordance with ACI 318 and ACI 315, unless otherwise shown.
- B. Placing: Place reinforcement conforming to CRSI DA4 and CRSI's "Manual of Standard Practice," unless otherwise shown.
 - 1. Place reinforcing bars accurately and tie securely at intersections and splices with 1.6 mm (16 gauge) black annealed wire. Use Epoxy-Coated Tie Wire with Epoxy-Coated Reinforcing. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces. Secure reinforcing bars against displacement during the placing of concrete by spacers, chairs, or other similar supports. Portions of supports, spacers, and chairs in contact with formwork shall be made of plastic in areas that will be exposed when building is occupied. Type, number, and spacing of supports conform to ACI 315. Where concrete slabs are placed on ground, use concrete blocks or other non-corrodible material of proper height, for support of reinforcement. Use of brick or stone supports will not be permitted.
 - 2. Install welded wire reinforcement in longest practicable lengths on continuous bar supports spaced at 2 ft. o.c., maximum. Lap edges and ends of adjoining sheets per ACI 318 and as follows:
 - a. Lap welded wire fabric at least 1-1/2 mesh panels plus end extension of wires not less than 300 mm (12 inches) in structural slabs.
 - b. Lap welded wire fabric at least 1/2 mesh panels plus end extension of wires not less than 150 mm (6 inches) in slabs on grade.
 - 3. Splice column steel at no points other than at footings and floor levels unless otherwise shown.
 - 4. Repair cut and damaged Epoxy-Coating with Epoxy Repair Coating according to ASTM D 3963
- C. Spacing: Minimum clear distances between parallel bars, except in columns and multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 25 mm (1 inch) or 1-1/3 times maximum size of coarse aggregate.

- D. Splicing: Splices of reinforcement made only as required or shown or specified. Accomplish splicing as follows:
1. Lap splices: Do not use lap splices for bars larger than Number 36 (Number 11). Minimum lengths of lap as shown.
 2. Welded splices: Splicing by butt-welding of reinforcement permitted providing the weld develops in tension at least 125 percent of the yield strength (f_y) for the bars. Welding conform to the requirements of AWS D1.4. Welded reinforcing steel conform to the chemical analysis requirements of AWS D1.4.
 - a. Submit test reports indicating the chemical analysis to establish weldability of reinforcing steel.
 - b. Submit a field quality control procedure to insure proper inspection, materials and welding procedure for welded splices.
 - c. Department of Veterans Affairs retained testing agency shall test a minimum of three splices, for compliance, locations selected by Resident Engineer.
 3. Mechanical Splices: Develop in tension and compression at least 125 percent of the yield strength (f_y) of the bars. Stresses of transition splices between two reinforcing bar sizes based on area of smaller bar. Provide mechanical splices at locations indicated. Use approved exothermic, tapered threaded coupling, or swaged and threaded sleeve. Exposed threads and swaging in the field not permitted.
 - a. Initial qualification: In the presence of Resident Engineer, make three test mechanical splices of each bar size proposed to be spliced. Department of Veterans Affairs retained testing laboratory will perform load test.
 - b. During installation: Furnish, at no additional cost to the Government, one companion (sister) splice for every 50 splices for load testing. Department of Veterans Affairs retained testing laboratory will perform the load test.
- E. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by Resident Engineer.
- F. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce bond.
- G. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise shown.

3.3 CONSTRUCTION JOINTS

- A. Unless otherwise shown, location of construction joints to limit individual placement shall not exceed 24,000 mm (80 feet) in any horizontal direction, except slabs on grade which shall have construction joints shown. Allow 48 hours to elapse between pouring adjacent sections unless this requirement is waived by Resident Engineer.
- B. Construction, control and isolation joints are located and detailed on Drawings:
 - 1. Tool joints at time of finishing. Tool: Part 2 Article "Tools."
 - 2. Saw Cut Joints:
 - a. Cut joint as soon as concrete will support weight of operator and saw without deforming.
 - b. Joint shall be 1 in. deep for concrete thickness of 4 in. or less. Joint shall be 1.5 in. deep for concrete exceeding 4 in. thickness. Do not cut reinforcement.
 - c. Extend joint to adjacent vertical surface within 30 minutes of cutting.
 - d. Retool or grind saw cut joint before installing sealant to provide equivalent dimensions, shape, and volume as joint obtained by tooled joint. Surface width shall be 0.5 in. with 3/16 in. to 1/4 in. edge radius.
 - e. All joints subject to acceptance by sealant installer. Rework rejected joints until acceptable to sealant installer.
 - 3. Isolation joints: Interrupt structural continuity resulting from bond, reinforcement or keyway.
 - 4. Construction and control joints in walls: Space joints at 20 ft on center unless smaller spacing is shown on Drawings.
 - 5. Construction or control joints in floor slabs on ground: Maximum slab area controlled by jointing 400 sq ft. Space joints at 18 ft on center maximum unless different spacing is shown on Drawings.
 - 6. Coordinate configuration of tooled joints with control joint sealants.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated. Do not continue reinforcement through sides of strip placements.
- D. Use bonding grout, containing the specified bonding admixture, on existing concrete surfaces that will be joined with fresh concrete.
- E. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated unless detailed otherwise.
 - 1. Joint filler and sealant materials are specified in Division 7 Sections of these Specifications.

- F. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown.
 - 1. Tool contraction joints.
 - 2. If joint pattern not shown, provide joints not exceeding 18 ft in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
- G. Joint sealant material is specified in Division 7 Sections.
- H. Flexible Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.
- I. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place. Install in longest lengths practicable.

3.4 EXPANSION JOINTS

- A. Clean expansion joint surfaces before installing premolded filler and placing adjacent concrete.
- B. Install polyvinyl chloride or rubber water seals, as shown in accordance with manufacturer's instructions, to form continuous watertight seal.

3.5 PLACING CONCRETE

- A. Preparation:
 - 1. Remove hardened concrete, wood chips, shavings and other debris from forms.
 - 2. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
 - 3. Have forms and reinforcement inspected and approved by Resident Engineer before depositing concrete.
 - 4. Provide runways for wheeling equipment to convey concrete to point of deposit. Keep equipment on runways which are not supported by or bear on reinforcement.

- B. Bonding: Before depositing new concrete on or against concrete which has been set, thoroughly roughen and clean existing surfaces of laitance, foreign matter, and loose particles.
1. Preparing surface for applied topping:
 - a. Remove laitance, mortar, oil, grease, paint, or other foreign material by sand blasting. Clean with vacuum type equipment to remove sand and other loose material.
 - b. Broom clean and keep base slab wet for at least four hours before topping is applied.
 - c. Use a thin coat of one part Portland cement, 1.5 parts fine sand, bonding admixture; and water at a 50: 50 ratio and mix to achieve the consistency of thick paint. Apply to a damp base slab by scrubbing with a stiff fiber brush. New concrete shall be placed while the bonding grout is still tacky.
- C. Conveying Concrete: Convey concrete from mixer to final place of deposit by a method which will prevent segregation. Method of conveying concrete subject to approval of Resident Engineer.
- D. Placing: For special requirements see Paragraphs, HOT WEATHER and COLD WEATHER.
1. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Resident Engineer.
 - a. Do not add water to concrete after adding high-range water-reducing admixtures to mix.
 2. Do not place concrete when weather conditions prevent proper placement and consolidation, or when concrete has attained its initial set, or has contained its water or cement content more than 1 1/2 hours.
 3. Deposit concrete in forms as near as practicable in its final position. Prevent splashing of forms or reinforcement with concrete in advance of placing concrete.
 4. Do not drop concrete freely more than 3000 mm (10 feet) for concrete containing the high-range water-reducing admixture (superplasticizer) or 1500 mm (5 feet) for conventional concrete. Where greater drops are required, use a tremie or flexible spout (canvas elephant trunk), attached to a suitable hopper.
 5. Discharge contents of tremies or flexible spouts in horizontal layers not exceeding 500 mm (20 inches) in thickness, and space tremies such as to provide a minimum of lateral movement of concrete.
 6. Continuously place concrete until an entire unit between construction joints is placed. Rate and method of placing concrete shall be such that no concrete between construction joints will be deposited upon or against partly set

- concrete, after its initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
- a. Maintain reinforcement in position on chairs during concrete placement.
 - b. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - c. Slope surfaces uniformly to drains where required.
 - d. Begin initial floating using highway bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
7. On bottom of members with severe congestion of reinforcement, deposit 25 mm (1 inch) layer of flowing concrete containing the specified high-range water-reducing admixture (superplasticizer). Successive concrete lifts may be a continuation of this concrete or concrete with a conventional slump.
- E. Consolidation: Conform to ACI 309. Immediately after depositing, spade concrete next to forms, work around reinforcement and into angles of forms, tamp lightly by hand, and compact with mechanical vibrator applied directly into concrete at approximately 450 mm (18 inch) intervals. Mechanical vibrator shall be power driven, hand operated type with minimum frequency of 5000 cycles per minute having an intensity sufficient to cause flow or settlement of concrete into place. Vibrate concrete to produce thorough compaction, complete embedment of reinforcement and concrete of uniform and maximum density without segregation of mix. Do not transport concrete in forms by vibration.
1. Use of form vibration shall be approved only when concrete sections are too thin or too inaccessible for use of internal vibration.
 2. Carry on vibration continuously with placing of concrete. Do not insert vibrator into concrete that has begun to set.

3.6 HOT WEATHER

- A. Follow the recommendations of ACI 305 or as specified to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete. Methods proposed for cooling materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by Resident Engineer.
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 COLD WEATHER

- A. Follow the recommendations of ACI 306 or as specified to prevent freezing of concrete and to permit concrete to gain strength properly. Use only the specified non-corrosive, non-chloride accelerator. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions. Methods proposed for heating materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by Resident Engineer.
 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3.8 PROTECTION AND CURING

- A. Conform to ACI 308: Initial curing shall immediately follow the finishing operation. Protect exposed surfaces of concrete from premature drying, wash by rain and running water, wind, mechanical injury, and excessively hot or cold temperatures. Keep concrete not covered with membrane or other curing material continuously wet for at least 7 days after placing, except wet curing period for high-early-strength concrete shall be not less than 3 days. Keep wood forms continuously wet to prevent moisture loss until forms are removed. Cure exposed concrete surfaces as described below. Other curing methods may be used if approved by Resident Engineer.
 1. Liquid curing and sealing compounds: Apply by power-driven spray or roller in accordance with the manufacturer's instructions. Apply immediately after finishing. Maximum coverage 10m²/L (400 square feet per gallon) on steel troweled surfaces and 7.5m²/L (300 square feet per gallon) on floated or broomed surfaces for the curing/sealing compound.
 2. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with tape.

3. Paper: Utilize widest practical width paper and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic or glue.
- B. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- C. Evaporation Reducer: Apply evaporation reducer to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft./h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing. Do not finish immediately after evaporation reducer applied. Wait until after (green, if Confilm used – pink, if Eucobar used) film disappears.
- D. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Tepid (within 20 deg F of concrete temperature) water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Curing Compound: After Moisture or Moisture-Retaining-Cover Curing, apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Apply two separate coats with first allowed to become tacky before applying second. Direction of second application shall be at right angles to direction of first.

- b. Curing compound prohibited when concrete has specified water-cementitious materials ratio less than or equal to 0.40 or air temperature above 80 deg F. Use moist cure instead.
- E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Tepid (within 20 deg F of concrete temperature) water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
 - 3. Curing Compound: Where permitted, apply uniformly in continuous operation by power spray or roller immediately after final finishing and the absence of surface moisture, according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Apply two separate coats with first allowed to become tacky before applying second. Direction of second application shall be at right angles to direction of first.
 - b. Curing compound prohibited when concrete has specified water-cementitious ratio less than or equal to 0.40 or air temperature above 80 deg F. Use moist cure instead.

3.9 REMOVAL OF FORMS

- A. Remove in a manner to assure complete safety of structure after the following conditions have been met.
 - 1. Where structure as a whole is supported on shores, forms for beams and girder sides, columns, and similar vertical structural members may be removed after cumulative curing at not less than 50 degrees F. for 24 hours, provided concrete has hardened sufficiently to prevent surface damage and curing is continued without any lapse in time as specified for exposed surfaces.
 - 2. Take particular care in removing forms of architectural exposed concrete to insure surfaces are not marred or gouged, and that corners and arises are true, sharp and unbroken.
- B. Control Test: Use to determine if the concrete has attained sufficient strength and curing to permit removal of supporting forms. Cylinders required for control tests taken in accordance with ASTM C172, molded in accordance with ASTM C31, and tested in accordance with ASTM C39. Control cylinders cured and protected in the same manner as the structure they represent. Supporting forms or shoring not removed until strength of control test cylinders have attained at least 70 percent of minimum 28-day compressive strength specified. Exercise care to assure that newly unsupported portions of structure are not subjected to heavy construction or material loading.
- C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Resident Engineer.

3.10 SHORES AND RESHORES

- A. Reshoring: Reshoring is required if superimposed load plus dead load of the floor exceeds the capacity of the floor at the time of loading.
- B. Comply with ACI 347.2, ACI 318 and ACI 301, for design, installation, and removal of shoring and reshoring and in accordance with Article 1.5 "Contractor's Professional Services – Performance and Design Criteria" at no additional cost to the Government.
 - 1. Do not remove shoring until measurement of slab tolerances is completed.
- C. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be

excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

- D. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.11 CONCRETE SURFACE PREPARATION

- A. Metal Removal: Unnecessary metal items cut back flush with face of concrete members.
- B. Patching: Maintain curing and start patching as soon as forms are removed. Do not apply curing compounds to concrete surfaces requiring patching until patching is completed. Use cement mortar for patching of same composition as that used in concrete. Use white or gray Portland cement as necessary to obtain finish color matching surrounding concrete. Thoroughly clean areas to be patched. Fill form tie holes which extend entirely through walls from unexposed face by means of a pressure gun or other suitable device to force mortar through wall. Wipe excess mortar off exposed face with a cloth.
- C. Upon removal of forms, clean vertical concrete surface that is to receive bonded applied cementitious application with wire brushes or by sand blasting to remove unset material, laitance, and loose particles to expose aggregates to provide a clean, firm, granular surface for bond of applied finish.
- D. Defective Concrete: Repair and patch defective areas when approved by Resident Engineer. Remove and replace concrete that cannot be repaired and patched to Resident Engineer's approval.
- E. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing. Use this repair procedure only with Resident Engineer's approval.
- F. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2-inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with specified bonding agent. Fill and compact with specified patching mortar before specified

- bonding agent has dried. Fill form-tie voids with specified patching mortar or cone plugs secured in place with specified bonding agent.
2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area on mockup, or if none, at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Resident Engineer.
- G. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, pop-outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of $\frac{1}{4}$ inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least $\frac{3}{4}$ -inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 6. Repair single holes 1 inch or less in diameter with patching mortar. Cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
 7. Repair isolated random cracks that have little movement and single holes not over 1 in. in diameter in accordance with procedures and materials specified

- in Division 7 Section "Joint Sealants." Receive Resident Engineer's written acceptance of methods and materials selected prior to application.
- a. Repair isolated random horizontal cracks less than 0.01 in. wide, using silane sealer product specified in Division 7 "Silane Water Repellants".
 - b. Repair isolated random horizontal cracks 0.01 in. to less than 0.03 in. wide, using methylemethacrylate product specified in Division 7 "Waterproofing System – part 2 Heading "Materials, High Molecular Weight Methylemethacrylate."
 - c. Repair isolated random horizontal cracks 0.03 in. to 0.06 in. wide: route and seal with specified sealant product in Division 7 "Waterproofing System – part 2 Heading "Materials, Concrete Control And Construction Joint Sealant System."
 - d. Repair isolated random vertical cracks more than 0.01 in. wide, using epoxy injection product specified in part 2 heading "Related Materials" of this section.
- H. Perform structural repairs of concrete, subject to Resident Engineer's approval, using epoxy adhesive and patching mortar.
- I. Repair materials and installation not specified above may be used, subject to Resident Engineer's approval.

3.12 CONCRETE FINISHES

A. Vertical and Overhead Surface Finishes:

1. Unfinished areas: Vertical and overhead concrete surfaces exposed in pipe basements, elevator and dumbwaiter shafts, pipe spaces, pipe trenches, above suspended ceilings, manholes, and other unfinished areas will not require additional finishing.
 - a. Rough Form Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding limits for class of surface specified.
 - b. Provide class C finish as described in ACI 347, for surfaces permanently concealed from public view, unless otherwise noted in the Contract Documents. Class C permits gradual or abrupt irregularities of 1/2 inch.
2. Interior and exterior exposed areas to be painted: Remove fins, burrs and similar projections on surfaces flush, and smooth by mechanical means approved by Resident Engineer, and by rubbing lightly with a fine abrasive stone or hone. Use ample water during rubbing without working up a lather of mortar or changing texture of concrete.

- a. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding limits for class of surface specified.
 - b. Provide Class A finish as described in ACI 347 for surfaces permanently exposed to public view. Class A permits gradual or abrupt irregularities of 1/8 inch.
 - c. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
3. Interior and exterior exposed areas finished: Give a grout finish of uniform color and smooth finish treated as follows:
 - a. After concrete has hardened and laitance, fins and burrs removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone stone.
 - b. Apply grout composed of one part of Portland cement, one part fine sand, smaller than a 600 μ m (No. 30) sieve. Work grout into surface of concrete with cork floats or fiber brushes until all pits, and honeycombs are filled.
 - c. After grout has hardened slightly, but while still plastic, scrape grout off with a sponge rubber float and, about 1 hour later, rub concrete vigorously with burlap to remove any excess grout remaining on surfaces.
 - d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish of area in same day. Make limits of finished areas at natural breaks in wall surface. Leave no grout on concrete surface overnight.
4. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
6. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects.
7. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
 - a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

8. EXPOSED-AGGREGATE FINISHES

- a. Abrasive-Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa). Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.
 - i. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample or mockup.
 - ii. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample or mockup.
 - iii. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample or mockup, as follows:
 1. Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant reveal.
 2. Light: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch (1.5 mm).
 3. Medium: Generally expose coarse aggregate; with slight reveal, a maximum of 1/4 inch (6 mm).
 4. Heavy: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter; with reveal range of 1/4 to 1/2 inch (6 to 13 mm).

B. Slab Finishes:

1. Monitoring and Adjustment: Provide continuous cycle of placement, measurement, evaluation and adjustment of procedures to produce slabs within specified tolerances. Monitor elevations of precast concrete structure in key locations before and after concrete placement to establish typical deflection patterns for the concrete structure. Provide information to Resident Engineer and floor consultant for evaluation and recommendations for subsequent placements.
2. Set perimeter forms to serve as screed using either optical or laser instruments. For slabs on grade, wet screeds may be used to establish initial grade during strike-off, unless Resident Engineer determines that the method is proving insufficient to meet required finish tolerances and directs use of rigid screed guides. Where wet screeds are allowed, they shall be placed using grade stakes set by optical or laser instruments. Use rigid screed guides, as opposed to wet screeds, to control strike-off elevation for all types

- of elevated (non slab-on-grade) slabs. Divide bays into halves or thirds by hard screeds. Adjust as necessary where monitoring of previous placements indicates it is needed.
3. Place slabs monolithically. Once slab placement commences, complete finishing operations within same day. Slope finished slab to floor drains where they occur, whether shown or not.
 4. Use straightedges specifically made for screeding, such as hollow magnesium straightedges or power strike-offs. Do not use pieces of dimensioned lumber. Strike off and screed slab to a true surface at required elevations. Use optical or laser instruments to check concrete finished surface grade after strike-off. Repeat strike-off as necessary. Complete screeding before any excess moisture or bleeding water is present on surface. Do not sprinkle dry cement on the surface.
 5. Immediately following screeding, and before any bleed water appears, use a 3000 mm (10 foot) wide highway straightedge in a cutting and filling operation to achieve surface flatness. Do not use bull floats or darbys, except that darbying may be allowed for narrow slabs and restricted spaces.
 6. Wait until water sheen disappears and surface stiffens before proceeding further. Do not perform subsequent operations until concrete will sustain foot pressure with maximum of 6 mm (1/4 inch) indentation.
 7. Steel Trowel Finish: Concrete surfaces to receive resilient floor covering or carpet, monolithic floor slabs to be exposed to view in finished work, future floor roof slabs, applied toppings, and other interior surfaces for which no other finish is indicated. Steel trowel immediately following floating. During final troweling, tilt steel trowel at a slight angle and exert heavy pressure to compact cement paste and form a dense, smooth surface. Finished surface shall be smooth, free of trowel marks, and uniform in texture and appearance.
 8. Broom Finish: Finish exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after surfaces have been floated. Brush in a direction transverse to main traffic. Match texture approved by Resident Engineer from sample panel.
 9. Flatwork in Parking and Drive Areas (BROOM Finish, ACI 301, Section 5 header "Broom or Belt Finish":
 - a. Bullfloat immediately after screeding. Complete before any excess moisture or bleed water is present on surface (ACI 302.1R, Article 8.3.3).
 - b. After excess moisture or bleed water has disappeared and concrete has stiffened sufficiently to allow operation, give slab surfaces coarse transverse scored texture by drawing broom across surface. Texture shall be as accepted by Resident Engineer from sample panels.
 - c. Finish tolerance: ACI 301, Paragraph 5.3.4.2 and ACI 117, paragraph 4.5.7: The gap at any point between the straightedge and the floor (and between the high spots) shall not exceed 0.5 in. In addition, floor surface shall not vary more than plus or minus 0.75 in. from elevation noted on Drawings anywhere on floor surface.

- d. Before installation of flatwork and after submittal, review, and approval of concrete mixture proportions, Contractor shall fabricate two acceptable test panels simulating finishing techniques and final appearance to be expected and used on Project. Test panels shall be minimum of 20 ft. by 30 ft. in area and shall be reinforced and cast to thickness of typical parking and drive area wearing surface in Project. (Maximum thickness of test panels need not exceed 6 in.) Test panels shall be cast from concrete supplied by similar concrete batch, both immediately after addition of superplasticizer or water-reducing admixture, and at maximum allowed time for use of admixture-treated concrete in accordance with Specifications. Intent of test panels is to simulate both high and low workability mixes, with approximate slump at time of casting of test panels to be 6 in. and 3 in., respectively. Contractor shall finish panels following requirements of paragraphs above, and shall adjust finishing techniques to duplicate appearance of concrete surface of each panel. Finished panels (one or both) may be rejected by Resident Engineer, in which case Contractor shall repeat procedure on rejected panel(s) until Resident Engineer acceptance is obtained. Accepted test panels shall be cured in accordance with Specifications and may be incorporated into Project. Accepted test panels shall serve as basis for acceptance/rejection of final finished surfaces of all flatwork.
 - e. Finish all concrete slabs to proper elevations to ensure that all surface moisture will drain freely to floor drains, and that no puddle areas exist. Contractor shall bear cost of any corrections to provide for positive drainage.
10. Flatwork in Stair towers and enclosed, Finished Areas (Float Finish, ACI 301, Paragraph 5.3.4.2.b):
- a. Give slab floated finish. Texture shall be as accepted by Resident Engineer from sample panels.
 - b. Finishing tolerance ACI 301, Section 5 header "Measuring Tolerances for Slabs" and ACI 117, paragraph 4.5.7: The gap at any point between the straightedge and the floor (and between the high spots) shall not exceed 5/16 in. In addition, floor surface shall not vary more than plus or minus 1/4 in. from elevation noted on Drawings anywhere on floor surface.
11. Flatwork in Stair towers and Parking Garage floor subject to pedestrian traffic:
- a. Concrete surfaces at all walking areas subject to pedestrian traffic shall provide a smooth, slip resistant walking surface for pedestrians with these minimum requirements:
 - 1) Shall provide walking surfaces in accordance with ASTM – F 1637 Standard Practice for Safe Walking Surfaces and the "Uniform Federal Accessibilities Standards" (UFAS) and ICC A117.1.

- 2) Adjoining walkway surfaces shall be flush and meet the following minimum requirements:
 - a) Changes in level of less than 1/4-inch in height may be without edge treatment as shown in UFAS Figure 7(c) and on the Drawings.
 - b) Changes in Level between 1/4-inch and 1/2-inch in height shall be beveled with a slope no greater than 1:2 as shown in UFAS Figure 7(d) and on the Drawings.
 - c) Changes in level greater than 1/2-inch in height are not permitted unless they can be transitioned by means of a ramp with minimum requirements shown on the Drawings.
 - d) Openings in floor or ground surfaces shall not allow passage of a sphere more than 1/2-inch diameter except as allowed for elevators and platform lifts as shown in UFAS Figure 8(g) and 8(h) and on the Drawings.
- 3) Walkway surfaces shall provide a slip resistant surface.
 - a) Concrete surfaces shall be troweled and finished to provide a slip resistant finish.
 - b) Contractor shall provide sample area with slip resistant surface finish.
 - c) Static coefficient of friction for walking surfaces shall be measured on a dry surface by the NBS – Brungraber machine using a silastic sensor shoe and shall be 0.6 or larger for a level surface and 0.8 or larger for ramps.

12. Measurements

- a. Department of Veterans Affairs retained testing laboratory will take measurements as directed by Resident Engineer, to verify compliance with finish requirements. Measurements will occur within 72 hours after completion of concrete placement (weekends and holidays excluded). Make measurements before shores or forms are removed to insure the "as-built" levelness is accurately assessed. Profile data for above characteristics may be collected using a laser level or any Type II apparatus (ASTM E1155, "profileograph" or "dipstick"). Contractor's surveyor shall establish reference elevations to be used by Department of Veterans Affairs retained testing laboratory.

13. Remedial Measures for Rejected Slabs: Correct rejected slab areas by grinding, planing, surface repair with underlayment compound or repair topping, retopping, or removal and replacement of entire rejected slab areas, as directed by Resident Engineer, until a slab finish constructed within specified tolerances is accepted.

3.13 SURFACE TREATMENTS

- A. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms. Broadcast aggregate uniformly over concrete surface at rate of application of 8% per 1/10th m² (7.5 percent per square foot) of area. Trowel concrete surface to smooth dense finish. After curing, rub treated surface with abrasive brick and water to slightly expose abrasive aggregate.

3.14 RETAINING WALLS

- A. Expansion and contraction joints, waterstops, weep holes, reinforcement and railing sleeves installed and constructed as shown.
- B. Exposed surfaces finished to match adjacent concrete surfaces, new or existing.
- C. Place porous backfill as shown.

3.15 PRECAST CONCRETE ITEMS

- A. Precast concrete items, not specified elsewhere. Cast using 25 MPa (3000 psi) air-entrained concrete to shapes and dimensions shown. Finish to match corresponding adjacent concrete surfaces. Reinforce with steel for safe handling and erection.

3.16 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still workable and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.17 FIELD QUALITY CONTROL

- A. Owner will employ a testing laboratory to perform tests and to submit test reports.
- B. Sample concrete in accordance with ASTM C 172.
- C. Temperature:
 - 1. Test temperature of concrete in accordance with ASTM C 1064/C 1064M and ACI 301 each time cylinders are taken or as directed by the Resident Engineer.
- D. Slump Test:
 - 1. Conduct one slump test in accordance with ASTM C 143/C 143M per truck load of ready-mixed concrete delivered to Project at truck for superstructure concrete.
 - 2. Conduct slump test in accordance with ASTM C143/C 143M and ACI 301 for foundation concrete.
 - 3. When high-range water-reducing admixture (superplasticizer) is used, initial slump must be verified by Testing Agency.
- E. Air Content:
 - 1. General Contractor: Coordinate all parties involved to produce conforming concrete.
 - 2. Sample freshly-mixed concrete at point of final placement in accordance with ASTM C 172 and conduct one air content test in accordance with ASTM C 231 or ASTM C 173 for each truck of ready-mix, air entrained concrete delivered to Project.
 - 3. Sample fresh concrete immediately following placement and screeding and conduct air content tests in accordance with ASTM C 231 or ASTM C 173 at rate of one for every 10 truck loads of ready-mix, air-entrained concrete delivered to Project. For small or half-loads, obtain Resident Engineer's acceptance of procedure 2 weeks before situation arises.
- F. Concrete Compressive Strength:
 - 1. Mold test cylinders in accordance with ASTM C 31 and test in accordance with ASTM C 31 as follows:
 - a. Take minimum of six cylinders for each 100 cu yd or fraction thereof, of each Mixture of concrete placed in any one day.

- b. Additional cylinders shall be taken under conditions of cold weather concreting per Part 3 Heading "Protection and Curing."
 - c. At Contractor's option and cost, cylinders may be taken to verify concrete strength prior to form removal.
 - d. Testing Agency: Provide and maintain site cure box for cylinders.
 2. Cover specimens properly, immediately after finishing. Protect outside surfaces of cardboard molds, if used, from contact with sources of water for first 24 hours after molding.
 3. Cure test cylinders per ASTM C 31 as follows:
 - a. To verify compressive strength prior to form removal or for additional test cylinders required due to cold weather concreting conditions:
 - 1) Store test specimens on structure as near to point of sampling as possible and protect from elements in same manner as that given to portion of structure as specimen represents.
 - 2) Transport to test laboratory no more than 4 hours before testing. Remove molds from specimens immediately before testing.
 - b. To verify 28-day compressive strength:
 - 1) During first 24 hours after molding, store test specimens under conditions that maintain temperature immediately adjacent to specimens in range of 60 to 80 degrees F. and prevent loss of moisture from specimens.
 - 2) Remove test specimens from molds at end of 20 +/- 4 hours and store in moist condition at 73.4 +/- 3 degrees F. until moment of test. Laboratory moist rooms shall meet requirements of ASTM C 511.
 4. Compression test for non-prestressed concrete:
 - a. Test 2 cylinders at 7 days.
 - b. Test 2 cylinders at 28 days.
 - c. Test 2 cylinders at 56 days for concrete strength requirement of 6000 psi or greater, otherwise hold 2 cylinders in reserve for use as Resident Engineer directs.
 5. Unless notified by Resident Engineer, reserve cylinders may be discarded without being tested after 56 days.
- G. Report all nonconforming test results to Resident Engineer and others on distribution lists via fax or email. Follow up with colored paper copies to flag the non-conformances.

- H. Monthly, submit a graph showing distribution of compressive strength test results and air content test results.

3.18 EVALUATION AND ACCEPTANCE OF CONCRETE

- A. Concrete Compression test will be evaluated by Resident Engineer in accordance with ACI 301. If number of tests conducted is inadequate for evaluation of concrete or test results for any type of concrete fail to meet specified strength requirements, core tests may be required as directed by Resident Engineer. Air content and parameters of air-void system shall meet requirements of this Section.
- B. Core tests, when required, in accordance with ASTM C42 and ACI 301.
- C. Should tested hardened concrete meet Specifications, Owner will pay for coring and testing of hardened concrete. Should tested hardened concrete not meet Specifications or should concrete have to be tested because Contractor did not conform to Project specifications, Contractor shall pay for coring and testing of hardened concrete and for any corrective action required for unaccepted concrete.

3.19 ACCEPTANCE OF STRUCTURE

- A. Acceptance of completed concrete Work will be according to provisions of ACI 301.
- B. "RAPIDLOAD" testing is acceptable, by Structural Preservation Systems, Baltimore, MD.

END OF SECTION 033000

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

II. GENERAL INFORMATION:	
Project:	City:
General Contractor:	
Concrete Supplier:	
Mixture Identification No.:	Concrete Grade:
Use (Describe) ¹ :	

¹ example: Footings, interior flatwork, floor slabs, topping, columns, etc.

II. MIXTURE PROPORTIONING DATA:		
Proportioning Based on (Check only one):		
Standard Deviation Analysis: _____ (see section VIII)		
or Trial Mix Test Data: _____ (see Section IX)		
Mixture	Density: _____ pcf;	Air: _____ % specified
Characteristics: (see Mixtures in Drawings General Notes)	Slump _____ in. before superplasticizer	Slump _____ in. after superplasticizer Or for SCC: Spread ____ in.
	Strength: _____ psi (28 day);	

W A L K E R A C C E P T A N C E S T A M P

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

III. MATERIALS:		
Aggregates: (size; type; source; gradation report; specification)		
Coarse:		
Fine:		
Other Materials:	<u>Type</u>	<u>Product-Manufacturer</u> <u>(Source)</u>
Cement:		
Flyash, slag, or other pozzolan:		
Silica Fume		
Processed Ultra Fine Fly Ash		
HRM		
Air Entraining Agent:		
Water Reducer		
High Range Water Reducer (HRWR / superplasticizer)		
Non-Corrosive Accelerator		
Retarder		
Fibers		
Other(s):		

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

IV. <u>MIX PROPORTIONS</u> ⁽²⁾		
	WEIGHT (lbs.) (per yd ³)	ABSOLUTE VOL. (cu. ft.) (per yd ³)
Cement:		
Fine Aggregate: ⁽³⁾		
Coarse Aggregate: ⁽³⁾		
Flyash, slag, or other pozzolan:		
Silica Fume		
Processes Ultra Fine Fly Ash		
HRM		
Water: ⁽⁴⁾ (gals. & lbs)		
Entrained Air: (oz.)		
Fibers:		
(Other) _____:		

TOTALS:		
NOTES: ⁽²⁾ Mix proportions indicated shall be based on data used in section VII or IX. ⁽³⁾ Based on saturated surface dry weights of aggregates. ⁽⁴⁾ Includes ALL WATER, including added water and free water contained on aggregates.		

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

V. RATIOS		VI. SPECIFIC GRAVITIES	
Water ⁽¹⁾	lb	Fine Aggregate:	
=	=		
Cementitious Material ⁽²⁾	lb	Coarse Aggregate:	
Fine Agg.	lb		
=	=		
Total Agg.	lb		
NOTES: ⁽¹⁾ Includes ALL water, including added water and free water contained on aggregates. ⁽²⁾ Cementitious materials include cement, fly ash, slag, silica fume, HRM, Processed Ultra Fine Fly Ash or other pozzolan.			

VII. <u>ADMIXTURES</u>			
Air Entraining Agent (A.E.A.):	___ oz.	per yd ³	___ oz. per 100# cement
Superplasticizer	___ oz.	per yd ³	___ oz. per 100# cement
Water Reducer	___ oz.	per yd ³	___ oz. per 100# cement
Non-corrosive Accelerator	___ oz.	per yd ³	___ oz. per 100# cement
Retarder	___ oz.	per yd ³	___ oz. per 100# cement
Other	___ oz.	per yd ³	___ oz. per 100# cement
Lithium Nitrate	___ gal.	per yd ³	

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

VIII. <u>STANDARD DEVIATION ANALYSIS:</u>		<u>Yes</u>	<u>N/A</u>
(Complete this section only if Mixture was developed using standard deviation analysis of previous project test results. If other method was used, check "N/A".)			
<u>Number of Tests Evaluated:</u>		<u>Standard Deviation:</u>	
<u>(One test is average of two cylinder breaks)</u>		<u>(Single Group)</u>	
<u>Attach copy of test data considered:</u>		<u>Standard Deviation:</u>	
		<u>(Two Groups)</u>	
Required average compressive strength: $f'_{cr} = f'_c + \underline{\hspace{2cm}}$ psi			
<p>NOTE:</p> <p>Mixture shall be proportioned in accordance with ACI 301 section 4.2.3 to achieve average compressive strength f'_{cr} equal to or greater than the larger of one of the following equations:</p> <p>(4.-3) $f'_{cr} = f'_c + 1.34ks$ [s= calculated standard deviation]</p> <p>or</p> <p>(4-4) $f'_{cr} = f'_c + 2.33ks - 500$</p> <p>or</p> <p>(4-5) $f'_{cr} = 0.9f'_c + 2.33ks$ (for $f'_c > 5,000$ psi)</p> <p>(Refer to ACI 301 for required average when data are not available to establish standard deviation. For post-tensioning projects, see also special requirements for strength required to apply initial post-tensioning.)</p>			
MIXTURE CHARACTERISTICS (As shown on drawings)			
Slump = <u> </u> in.		Air Content = <u> </u> %	
Unit Wet Wt. = <u> </u> pcf		Unit Dry Wt. = <u> </u> pcf	
MIXTURE CHARACTERISTICS (Based on proportioning data)			
Initial Slump = <u> </u> in.		Final Slump <u> </u> in.	
Unit Wet Wt.= <u> </u> pcf.		Unit Dry Wt. = <u> </u> pcf.	
Air Content = <u> </u> %			

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

IX. <u>TRIAL MIXTURE TEST DATA:</u>		<u>Yes</u>	<u>N/A</u>
(Complete this section only if Mixture Proportion is based on data from trial test mixture(s) batched by testing agency or Contractor. If other method was used, check "N/A".)			
<u>Age</u> (days)	<u>Mix #1</u> (comp. str.)	<u>Mix #2</u> (comp. str.)	<u>Mix #3</u> (comp. str.)
<u>7</u>			
<u>7</u>			
<u>28</u>			
<u>28</u>			
<u>28</u>			
<u>28</u> day average compressive strength, psi			
<p>NOTE:</p> <p>Mixture shall be proportioned in accordance with ACI 301 section 4.2.3 to achieve average compressive strength f'_{cr} equal to or greater than the larger of one of the following equations:</p> <p>(Less than 3000) $f'_{cr} = f'_c + 1000$</p> <p>or</p> <p>(3000 to 5000) $f'_{cr} = f'_c + 1200$</p> <p>or</p> <p>(Over 5000) $f'_{cr} = f'_c + 700$</p> <p>For post-tensioning projects, see also special requirements for strength required to apply initial post-tensioning.</p>			
MIXTURE CHARACTERISTICS (as shown on drawings)			
Slump = _____ in.		Air Content = _____ %	
Unit Wet Wt. = _____ pcf		Unit Dry Wt. = _____ pcf	
MIXTURE CHARACTERISTICS (Based on proportioning data)			
Initial Slump = _____ in.		Final Slump _____ in.	
Unit Wet Wt.= _____ pcf.		Unit Dry Wt. = _____ pcf.	
Air Content = _____ %			

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

X. OTHER REQUIRED TESTS		
Water Soluble Chloride Ion Content of mix:	_____%(by weight of cement)	ASTM C 1218
Hardened Air Content (per ASTM C457):		
Air content: ____%	Air void spacing ____in. Factor	Specific surface: ____in ² /in ³
Chloride Ion Content of Concrete Mixture: ASTM C 1218		
Shrinkage (Length Change, Average) per ASTM C157:		
____% @ 4 days	____% @ 7 days	____% @ 14 days
____% @ 21 days	____% @ 28 days	

CONCRETE MIXTURE PROPORTIONS SUBMITTAL FORM

Mixture #

Project Name:

XI. <u>Remarks:</u>
Ready Mix Concrete Supplier Information
Name:
Address:
Phone Number:
Date:
Main Plant Location:
Miles from Project Site:
Secondary or Backup Plant Location:
Miles from Project Site:

My signature below certifies that I have read, understood, and will comply with the requirements of this Section.

Signature_____

Typed or Printed Name

REQUIRED ATTACHMENTS	
	Coarse aggregate grading report
	Fine aggregate grading report
	Concrete compressive strength data used for calculation of required average strength and for calculation of standard deviation
	Chloride ion data and related calculations
	Admixture compatibility certification letter
	Shrinkage information per ASTM C157
	ASTM C 457

Page intentionally left blank.

SECTION 034133 - PRECAST STRUCTURAL PRE-TENSIONED CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies precast prestressed concrete construction including design not shown, fabrication, erection, and other related items including bearing pads and anchorage.
- B. Precast prestressed concrete includes double tees, beams and spandrels, columns, light wall panels, shear wall panels, ordinary wall panels and Precast Concrete with architectural finishes (Spandrels/beams). In addition to the requirements of this Section, all precast spandrel units with architectural finish shall comply with PCI MNL 117 and PCI MNL 135-00 "Tolerances for Precast Prestressed Concrete Construction".
- C. System described here is intended to perform in ACI 362.1R-97 zone III environment without long-term corrosion or other distress.
- D. Design structural reinforcement required to resist handling and erection stresses.
- E. See Drawings for:
 - 1. Precast concrete member load requirements.
 - 2. Minimum entrained air.
 - 3. Minimum compressive strength.
 - 4. Maximum water cementitious materials ratio.
- F. All precast concrete pieces require design by precast concrete manufacturer, unless noted otherwise on Drawings.

1.2 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Concrete: Section 033000, CAST-IN-PLACE CONCRETE.
- C. Sealants and Caulking: Section 079200, JOINT SEALANTS.
- D. Vehicular Traffic Topping: Section 071816, Vehicular Traffic Coatings.
- E. Repair of abraded galvanized and painted surfaces: Section 099100, PAINTING.
- F. Sealers: Section 071916, SILANE WATER REPELLANTS.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Precast concrete manufacturing plant shall be certified by Prestressed Concrete Institute, Plant Certification Program and is designated a PCI-Certified plant for Group C, Commercial (Structural) – Category CA3 or CA4, prior to start of production, and participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group A, Category A1--Architectural Cladding and Load Bearing Units.
- B. In lieu of above qualification, contractor shall meet and pay for following requirements:
 - 1. Retain an independent testing or consulting firm approved by Resident Engineer.
 - 2. This firm shall inspect precast plant at two-week intervals during production and issue a report, certified by a registered Professional Engineer verifying that materials, methods, products and quality control meet all requirements of specifications and drawings. When report indicates to the contrary, Resident Engineer may reject any or all products produced during period of noncompliance with above requirements.
- C. Precast concrete work shall be performed by firms that have demonstrated capability, subject to approval, to produce and erect type of work specified. Fabricator shall have sufficient production capacity to produce required units without delaying the work.
- D. Precast concrete manufacturer shall have on staff or shall retain a qualified registered Professional Structural Engineer to certify precast concrete conforms in all aspects to requirements of ACI 318.
- E. Erector Qualifications: Regularly engaged for at least 3 years in erection of precast structural concrete similar to requirements of this project shall be fully qualified in Category A (Architectural Systems) and Structure Category S2 by Precast/Prestressed Concrete Institute prior to beginning work.
- F. Requirements of Regulatory Agencies: Local codes plus applicable specifications, standards and codes are a part of these specifications.
- G. Design Standards: Comply With ACI 318 and The Design Recommendations Of PCI MNL 120, "PCI Design Handbook--Precast And Prestressed Concrete."
- H. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and camber and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete

Products." For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for precast units with architectural finish, comply with PCI MNL 117.

1. The precast concrete fabricator shall identify and coordinate specific project tolerance requirements and interfacing tolerances associated with other materials or systems which interface with the precast.
 2. Elemental and erection tolerances for group ca – commercial products with an architectural finish shall comply with PCI MNL 135-00 "Tolerances For Precast Prestressed Concrete Construction".
- I. Product options: drawings indicate size, profiles, and dimensional requirements of precast concrete units and are based on the specific types of units indicated. Other fabricators' precast concrete units complying with requirements may be considered. Refer to division 01 section "product substitutions procedures."
- J. Welding: qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"; and AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- K. Walking surfaces: walking areas subject to pedestrian traffic shall provide a smooth, slip resistant walking surface for pedestrians with these minimum requirements:
1. Shall provide walking surfaces in accordance with ASTM – F 1637 Standard Practice for Safe Walking Surfaces.
 2. Shall be designed to comply with "Americans with Disabilities Act (ADA), and Accessibility Guidelines (ADAAG)" and ICC A117.1. Americans with disabilities accessibility guidelines for buildings and facilities, as published by U.S. Architectural & Transportation Barriers Compliance Board, 1331 F Street, N.W., Suite 1000, Washington, DC 20004-1111. 1-800-872-2253.
 3. Adjoining walkway surfaces shall be flush and meet the following minimum requirements:
 - a. Changes in level of less than 1/4-inch in height may be without edge treatment as shown in ADA figure 303.2 and on the drawings.
 - b. Changes in level between 1/4-inch and 1/2-inch in height shall be beveled with a slope no greater than 1:2 as shown in ADA figure 303.3 and on the drawings.
 - c. Changes in level greater than 1/2-inch in height are not permitted unless they can be transitioned by means of a ramp as shown on drawings.
 - d. Openings in floor or ground surfaces shall not allow passage of a sphere more than 1/2-inch diameter except as allowed for elevators and platform lifts as shown in ADA figure 302.3 and on the drawings.
 4. Walkway surfaces shall provide a slip resistant surface.

- a. Concrete surfaces shall be troweled and finished to provide a slip resistant finish.
 - b. Contractor shall provide sample area with slip resistant surface.
 - c. Static coefficient of friction for walking surfaces shall be measured on a dry surface by the NBS – Brungraber Machine using a silastic sensor shoe and shall be 0.6 or larger for a level surface and 0.8 or larger for ramps.
- L. Sample Panels and Mockups for Precast concrete units with Architectural finish (Spandrels/beams): Before installing precast concrete units, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Manufacture mockups to comply with the following requirements, using materials indicated for the completed work:
1. Manufacture mockups in the location and of the size indicated or, if not indicated, as directed by Resident Engineer.
 2. Sample panel: Precast concrete fabricator shall make 3-ft sq. samples for color and finish selection only. If rejected, another set of samples shall be made for review, until acceptable sample is made.
 3. After acceptance of finish sample, precast concrete fabricator shall make two (2) full height by 6-ft wide sample panels of exterior beam/spandrel(s) designated "architectural precast concrete" on drawings. Sample panel will be reviewed at precast plant by Resident Engineer. If rejected, another set of sample panels shall be made for review, until acceptable sample is made. If accepted, sample panel shall be held at plant until production is complete, then shipped to site (if required) and held there until completion and acceptance of project, when contractor shall remove it from site.
 3. Notify Resident Engineer seven (7) days in advance of dates and times when mockups will be constructed.
 4. Obtain Resident Engineer's approval of mockups before starting fabrication.
 5. At precaster's plant, maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 6. In presence of Architect, damage part of an Exposed-Face Surface for each finish, color and texture, and demonstrate materials and techniques proposed for repair of surface blemishes to match adjacent undamaged surfaces.
 7. Demolish and remove mockups when directed.
 8. Full size mockups (if required) may become part of the completed work if undisturbed at time of substantial completion.

M. Concrete Testing:

1. Perform and pay for compression tests for all precast concrete work with in-house Quality Control personnel. Testing is subject to observation by Testing

- Agency hired by Owner. Use certificated test equipment. Unless otherwise specified, conform with PCI MNL 116.
2. Precast Structural Concrete Testing: Sample, test and report concrete in accordance with PCI MNL 116, with following exceptions:
 - a. Testing of concrete PCI MNL 116 section 6.2 shall comply with requirements of ACI 318 – 2009, Chapter 5 – Concrete Quality, Mixing and Placing.
 - b. Required concrete testing shall be performed by qualified technicians. Technicians in charge of sampling concrete; testing for slump, unit weight, yield, air content, temperature; and making an curing test specimens shall be certified in accordance with the requirements of ACI Concrete Field Testing Technician-Grade 1 Certification Program, or the requirements of ASTM C 1077, or PCI-PQPC Level I, II, or III; or an equivalent program.
 - c. Precast supplier shall conduct production testing and monitor testing reports and records to ensure consistency with suppliers reported data and compliance with project requirements.
 - d. Precast supplier shall identify non-compliant testing and no-compliant testing reports shall be promptly distributed to the owner, engineer, registered design professional responsible for the design, contractor, and appropriate subcontractors, appropriate suppliers.
 - 1) Distribute reports to allow timely identification of either compliance or the need for corrective action.
 - 2) Evaluation and acceptance of concrete shall comply with ACI 318 – 08 section 5.6.
 - 3) Evaluation and acceptance of non-compliant tests for concrete entrained air content below specified limit will be accepted if one of the following conditions are met.
 - a) ASTM C 457: Three concrete specimens tested in accordance with ASTM C 457 meet the following hardened air void parameters; air void spacing factor of 0.0080 in. maximum and specific surface (surface area of air voids) shall be 600 in² per cu in. of air-void volume, or greater.
 - b) ASTM C 457: Three concrete specimens tested shall meet air void parameters of approved concrete mixture submittal from Part 1.
 - c) ASTM C 666, Test Procedure A: Test three concrete specimens removed from structure. Concrete specimens tested shall have durability characteristics similar to that reported in approved concrete mixture submittal from Part 1.
 - N. Precaster shall provide casting schedule to Resident Engineer with first shop drawings submittal. Precaster shall notify Resident Engineer 48 hours in advance of casting of each piece type (tees, spandrel beams, inverted tee beams, columns, wall panels, or other pieces) so that Resident Engineer may

review reinforcement fabrication at precaster's plant before casting. Resident Engineer may request notification for specific piece marks.

- O. Inspection of steel reinforcement is required in accordance with IBC Building Code, 2009. Inspections shall be conducted by an inspection agency employed by Owner and by Resident Engineer. Inspector shall provide report in format to Owner with copy to Resident Engineer and Contractor. Inspection agency has authority to reject reinforcing not meeting Contract Documents. Inspections for all reinforcing steel for conformance to shop drawings and Contract Documents shall be completed prior to concrete pouring.

- P. Preinstallation Conference: Conduct conference at Project site.

1.4 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Shop Drawings:

1. Erection Drawings:

- a. Plans and/or elevations locating and defining material furnished by manufacturer.
- b. Sections and details showing connections, cast-in items and their relation to structure.
- c. Description of all loose, cast-in and field hardware.
- d. Field installed anchor location drawings.
- e. Erection sequences and handling requirements.
- f. Dead, live and other applicable loads used in design.

2. Production drawings:

- a. Instead of submitting shop drawings for all piece marks, precaster shall submit shop drawings for typical pieces only along with reinforcing detail drawing for corresponding calculations.
- b. Elevation view of each member.
- c. Sections and details to indicate quantities and position of reinforcing steel, anchors, inserts, and essential embedded hardware.
- d. Lifting and erection inserts.
- e. Dimensions and finishes.
- f. Prestress for strand and concrete strengths.
- g. Estimated cambers.
- h. Method of transportation.

- C. Product Design Criteria:

1. Loadings for design:

- a. Initial handling and erection stresses.
 - b. Dead and live loads as specified on contract drawings.
 - c. Other loads specified for member where they are applicable.
 - d. Deflection of precast members shall be limited as follows:
 - 1) Vertical Live Load - $\text{Span}/360$
 - 2) Wind Load - $0.0025 \times \text{Floor to Floor Height}$
 - e. Design shall provide for thermal movements of completed structure.
 - f. Include calculated fire-resistance analysis. Provide 2 hour fire resistance rating.
 - g. Where used in design of double tees, submit current test results substantiating that minimum shear reinforcing per ACI 318-05, Section 11.5.6.2 is permitted to be waived. (This testing does not waive the minimum stem reinforcing specified for this project in specification article—Performance Requirements.)
2. Design calculations of products shall be performed by a registered Professional Engineer experienced in precast prestressed concrete design.
 3. Design shall be in accordance with applicable codes, ACI 318 and the PCI Design Handbook.
 4. Details for waterproof joints between precast members.

D. Mix Designs: Submit proposed concrete mix designs and appropriate test data as specified in Part 2 of this section.

E. Permissible Design Deviations:

1. Design connections according to the conceptual details shown in the contract documents.
2. Design deviations will be permitted only after Resident Engineer's written approval of manufacturer's proposed design supported by complete design calculations and drawings.
3. Design deviations shall provide an installation equivalent to basic intent without incurring additional cost to the Government.

F. Repair/Alteration documents: After submission of shop drawings any repairs, alterations, or modifications shall be submitted by the precaster for review. All repair/alteration documents shall bear the seal and signature of qualified registered Professional Engineer.

G. Samples of bearing pads.

- H. Welding Certificates: Copies of certificates for welding procedures and personnel.
- I. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineer/architects and owners, and other information specified.
- J. Material Certificates: Signed by Manufacturer that each of the following items conforms to requirements.
 - 1. Concrete materials.
 - 2. Reinforcing materials and prestressing tendons.
 - 3. Admixtures.
 - 4. Bearing pads.
- K. Proof of certification of precast concrete supplier's plant under Prestressed Concrete Institute plant certification program before award of contract.
- L. Letter of Qualification, furnished by Precast/Prestressed Concrete Institute confirming that erector is fully qualified in Structure Category S2.
- M. Proof of precast erector qualification under PCI Field Qualification Program.
- N. Proof of precast erector's superintendent's qualification as Certified Field Auditor.
- O. Submittals and Resubmittals: Resident Engineer will review each of Contractor's shop drawings and/or submittal data the initial time and, should resubmittal be required, one additional time to verify that reasons for resubmittal have been addressed by Contractor and corrections made. Resubmittal changes/revisions/corrections shall be circled. Resident Engineer will review only circled items and will not be responsible for non-circled changes/revisions/corrections and additions. Should additional resubmittals be required, Contractor shall reimburse Owner for all costs incurred, including the cost of Resident Engineer's services made necessary to review such additional resubmittals.
- P. Requests for Information
 - 1. RFI process shall not be used for requesting substitutions. Procedures for substitutions are clearly specified elsewhere in the contract documents.

1.5 PERFORMANCE REQUIREMENTS

- A. Parking structure contract drawings are based on performance type design for precast superstructure. An integral part of this project is preparation of final design drawings. Design calculations and shop drawings as required in accordance with this Section, and specifications necessary for fabrication and construction of all precast concrete pieces and required accessories in accordance with all code and engineering requirements.
- B. Design Drawings and Specifications: Precast supplier shall employ qualified registered professional Engineer/Architect, licensed in Michigan to perform such design and acceptable to Resident Engineer. Such design shall meet criteria established in these documents. This professional (hereinafter referred to as Designer) shall prepare and seal final structural design drawings, design calculations, shop drawings, and specifications (hereinafter referred to as Design Documents) submitted to Resident Engineer for review. Designer shall be responsible for structural design for Project and will be required to submit design calculations and shop drawings to Resident Engineer for review prior to any fabrication and construction for Project. For those pieces for which Designer has design responsibility, Designer shall also prepare and seal drawings and calculations for submittal to proper governing authorities as required.
- C. Submission of Final Design Documents: Precast supplier shall submit final Design Documents to Resident Engineer for review in ample time to allow such review before proceeding with any fabrication or construction. These Design Documents, prepared and sealed by Designer, may be submitted in "stages" to allow for phased construction. These Design Documents shall be completed in every detail necessary for fabrication and construction of Project, complying with design intent and requirements of Contract Documents. See Division 01 Section "Shop Drawings, Product Data and Samples" for Shop Drawings. These shop drawings shall neither be prepared nor be submitted to Resident Engineer for review until after design drawings, design calculations, and specifications have been accepted by Resident Engineer. Upon review, Resident Engineer's written remark "No Exception Taken" shall mean that item, design drawings, calculation, or specification has been accepted for the design intent.
- D. Designer's Insurance and Certificate: Designer will be required to furnish Owner a Certificate of Professional Liability Insurance in minimum amount of \$2,000,000 per claim. All Design Documents prepared by Designer shall be certified (bear seal and signature of Designer registered in Michigan before they are submitted for review).
- E. Minimum Durability Design Requirements:
 - 1. Double tee flange connectors and anchorages: Stainless steel alloy A304 or alloy 201-LN.

2. Galvanize entire assembly of all connection hardware (excluding tee to tee connectors) and end bearing plate assemblies. Touch up galvanizing with Z.R.C. after field welds are made.
 - a. Take all necessary precautions to prevent embrittlement of hot-dip galvanized assemblies. (Refer to ASTM A143 and A767).
3. Provide extra reinforcing around all openings, including door openings: 2 #5 bars all 4 sides of each opening and extend 2 ft beyond corners or opening. Add 2 #5 bars 4 ft long as diagonal bars at each corner.
4. Coil Rods: Provide 0.75 in. diameter by 2 ft 6 in. minimum coil rods and inserts at following locations as minimum unless other method(s) accepted in writing by Engineer:
 - a. Typical Exterior Columns: Minimum of 2 per column into topping pour, 1 in each column face parallel to spandrel.
 - b. Corner Columns: Minimum of 2 per column into topping pour, 1 in each interior column face.
 - c. Exterior Spandrels: Minimum of 1 at each double tee stem in load bearing spandrels and minimum of 1 every 4 ft on center for non-loading bearing spandrels into topping pour.
 - d. "Light Wall": Minimum of 1 at each double tee stem into topping pour.
5. Diaphragm Reinforcing: Cast-in-place concrete topping contractor to provide minimum of 3 #5 continuous bars at perimeter of all floor diaphragms cast into topping pour unless alternate reinforcing shown on Drawing.

F. General Design Criteria:

1. Unless noted otherwise, all design shall be in accordance with governing codes, standards and references listed in Drawing General Notes and in this Section.
2. Maximum self-weights (using normal weight concrete for all pieces) and minimum concrete strengths shall be per sections shown, Drawing General Notes and as noted herein.
3. Pieces shall be designed considering all vertical loads, lateral loads due to wind, seismic, temperature differentials, shrinkage, shortening, and effects due to prestressing.
4. All pieces shall have fire ratings as specified in Drawing General Notes.
5. Ultimate design capacity of inserts, coil rods, and coil bolts in tension shall not be greater than 90% of yield capacity of weakest piece.
6. Minimum concrete cover of reinforcement, prestressing strands, etc. shall be based on ACI 318, Sections 7.7.2 a, and 7.7.3, a and b.
7. Water/cement ratio for all pieces shall be ≤ 0.40 .
8. See heading "Precast System Design Criteria" for additional piece design criteria.

G. Precast System Design Criteria:

1. Double Tees:

- a. Design shall include type, number, and location of strands, flange reinforcement, shear reinforcement, cast-in-place concrete topping reinforcement, end bearing plate and confinement reinforcement. Prestress in accordance with provisions of this Specification and referenced standards, codes, etc. Entire assembly of end bearing plates shall be hot dipped galvanized.
- b. Design flanges to support design dead load and either uniform (design) live load or 3000 lb concentrated wheel live load acting on area $4\frac{1}{2}" \times 4\frac{1}{2}"$ (located to produce maximum stress condition), whichever provides greater stresses.
- c. Where permitted by Governing Code, live loads may be reduced. Double tees may be designed as Class T or Class C according to ACI 318, Sections 18.3 and 18.4.
- d. Live load deflections shall meet requirements of ACI 318 Table 9.5 (b). Total dead load plus live load deflection, including long term effects, shall not adversely affect drainage.
- e. As determined by project conditions, design as "restrained" or "unrestrained" pieces for purposes of fire rating requirements. Use ASTM E119, Appendix X3 and Table X3.1 to determine restraint conditions. Minimum cover of reinforcement, prestressing strands, etc., and other fire rating design criteria shall be based on this premise.
- f. Surface to receive topping shall be rough to allow proper bond per ACI 318, Section 17.5
- g. Flange connections shall be stainless steel alloy A304 or 201-LN "Vector Connector" by JVI, Inc., or accepted equal.
- h. Shear reinforcement consisting of stem mesh shall be provided 5'-0" minimum in each stem at each end but not less than required by design.

2. Beams: Exterior and Interior "L," Inverted Tee, Exterior and Interior Pocketed, and Spandrel (Non-Load Bearing):

- a. Design shall include type, number, and location of longitudinal reinforcement, shear and torsion reinforcement, end bearing plates and confinement reinforcement, connection requirements, and ledge reinforcement. Ledge reinforcement shall be designed per PCI Design Handbook, current Edition, Section 4.5. Continuity shall be maintained between both faces of reinforcement at ends of pieces. Inverted tee beams and L-beams may be designed as composite sections, but overhanging flanges shall not be considered as part of the effective section.
- b. Bumper loads shall be as noted in Drawing General Notes.

- c. Where permitted by Governing Code, live loads may be reduced. Prestressed beams may be designed as Class T or Class C according to ACI 318, Sections 18.3 and 18.4 except beams exposed to weather, such as spandrel beams, shall be designed as Class U.
 - d. Live load deflections shall meet requirements of ACI 318 Table 9.5 (b). Total dead load plus live load deflection, including long term effects, shall not adversely affect drainage.
 - e. Torsion design shall be per PCI Design Handbook, current Edition, Section 4.4 and ACI 318.
 - f. Skew ends of beams as required for sloping bays.
3. Columns:
- a. Design shall include number and location of vertical reinforcement, vertical reinforcement splices, shear reinforcement, concrete haunch design, including bearing plates and anchor bolts at foundation. Where pieces are prestressed, minimum ties shall be provided per ACI 318, Section 7.10.5, not Chapter 18.
 - b. Pockets shall be sloped as required for beam bearings.
 - c. All columns shall be continuous full height. Splice locations, if required, shall be acceptable to Resident Engineer.
4. Connections:
- a. Connections shown on Contract Drawings are minimum and are intended to establish standard of performance. Resident Engineer reserves right to accept or reject alternate details. Design as necessary to transfer gravity loads, lateral loads, torsion forces and forces due to volume change effects. Design shall meet or exceed PCI recommendations.
 - b. Use minimum additional load factor of 1.2 for design of **all** superstructure connections. Connections are any elements that mechanically tie separate members together. Column haunches, beam and tee end bearing plates, etc. are considered part of member design and not subject to the additional load factor. Restraint developed by friction between bearing pads and connection pieces shall not be considered to contribute to connection. Positive connections shall be made by welds, bolts, or cast-in-place reinforcement. Design in accordance with "PCI Design Handbook – Precast Prestressed Concrete," Sixth Edition.
 - c. Bearing pads shall be provided by precast subcontractor as shown on Contract Drawings. Refer to Part 2 "Bearing Materials" for additional information.
 - d. Beam to column bearing pads shall not extend under beam ledge unless ledge is designed for bearing or recessed to prevent bearing.
 - e. Design column and wall base plates and shims so that base plate grouting is not needed prior to erection of pieces supported by column or wall.

- f. Provide continuous reinforcing bars, as shown on the drawings or two #4 bars minimum, immediately above and below inserts resisting bumper loading.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling:

1. Lift and support precast concrete members during manufacturing, stockpiling, transporting and erection operations only at lifting or supporting points, or both, as shown on contract and shop drawings, and with approved lifting devices. Lifting devices shall have a minimum safety factor of 4. Exterior lifting hardware shall have a minimum safety factor of 5.
2. Transportation, site handling, and erection shall be performed with acceptable equipment and methods, and by qualified personnel.

B. Storage:

1. Store all units off ground.
2. Place stored units so that identification marks are discernible.
3. Separate stacked members by battens across full width of each bearing point.
4. Stack so that lifting devices are accessible and undamaged.
5. Do not use upper members of stacked tier as storage area for shorter member or heavy equipment.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. American Society for Testing and Materials (ASTM):

A36/A36M-04	Standard Specifications for Carbon Structural Steel
A82-02.....	Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement
A123/A123M-04	Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M-04	Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A185-02.....	Standard Specifications for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
A307-04.....	Standard Specifications for Carbon Steel Bolts and Studs
A325 Rev.B-04	Standard Specifications for Structural Bolts, Steel, Heat Treated

A416/A416M-02	Standard Specifications for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A615/A615M Rev.B-04.....	Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A706/A706M Rev.B-04.....	Standard Specifications for Low-Allow Steel Deformed and Plain Bars for Concrete Reinforcement
A767/A767M-05	Standard Specifications for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A775/A775M Rev.A-04.....	Standard Specifications for Epoxy-Coated Reinforcing Steel Bars
C33-03.....	Standard Specifications for Concrete Aggregates
C88-99.....	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C150-04.....	Standard Specifications for Portland Cement
C260-01.....	Standard Specifications for Air-Entraining Admixtures for Concrete
C330-04.....	Standard Specifications for Lightweight Aggregates for Structural Concrete
C494/C494M-04	Standard Specification for Chemical Admixtures for Concrete

C. American Concrete Institute (ACI):

117/117R-02.....	Standard Specifications for Tolerances for Concrete Construction and Materials
318/318R-05.....	Building Code Requirements for Reinforced Concrete

D. American Association of State Highway and Transportation Officials (AASHTO):

HB-17-02	Standard Specifications for Highway Bridges Fourteenth Edition
----------------	---

E. Prestressed Concrete Institute (PCI):

MNL-120-85	PCI Design Handbook - Precast and Prestressed Concrete
MNL-116S-99	Manual for Quality Controls for Plants and Production of Precast and Prestressed Concrete Products
MNL 117	Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
MNL-127-85	Recommended Practice for Erection of Precast Concrete
MNL-135.....	Tolerance Manual for Precast and Prestressed Concrete Construction

F. American Welding Society (AWS):

D1.1/D1.1M-04Structural Welding Code - Steel
D1.4.98Structural Welding Code - Reinforcing Steel

G. Military Specifications (MIL. SPEC.):

MIL-C882E-89Cloth, Duck, Cotton or Cotton-Polyester Blend
Synthetic Rubber, Impregnated, and Laminated, Oil
Resistant

H. U.S. Army Corps of Engineers:

CRD-C-621-93-97Specifications for Non-Shrink Grout

1.9 PRODUCT WARRANTY

A. Provide warranty similar to sample below.

B. Sample:

- a. Manufacturer warrants what all materials furnished have been manufactured in accordance with the specifications for this project. Manufacturer further warrants that if erection of said material is to be performed by those subject to this control and direction, work will be completed in accordance with the same specifications.
- b. In no event shall manufacturer be held responsible for any damages, liability or costs of any kind or nature occasioned by or arising out of the actions or omissions of others, or for work, including design, done by others; or for material manufactured, supplied or installed by others; or for inadequate construction of foundations, bearing walls, or other units to which materials furnished by the precast manufacturer are attached or affixed.
- c. Period of this warranty shall be 3 years beginning at date of beneficial occupancy. Should any defect [other than hairline cracks: defined as not more than 0.006 in. wide] be discovered after acceptance and occupancy of Project, which can be directly attributed to defect in product material or workmanship not evident at time of initial occupancy, then precast manufacturer shall, upon written notice, correct defects or replace products without expense to Owner, Resident Engineer or General Contractor. In sole judgment of Resident Engineer, any defects resulting from issues outlined in paragraph above, or resulting from normal wear and tear, product color changes or improper maintenance procedures are not considered responsibility of precast manufacturer.

1.10 REPAIR WARRANTY

- A. Furnish Owner with written total responsibility guarantee that repairs will be free of defects, water penetration and deterioration related to repair design, workmanship or material deficiency.
- B. Warranty period shall be 3 years commencing with date of acceptance of repair.
- C. Perform any repair under this warranty at no cost to Owner.
- D. Before construction, provide Resident Engineer with sample of final warranty. Guarantee shall be provided by precaster.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I or III.
- B. Aggregates: ASTM C33, Coarse and Fine.
 - 1. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S.
 - a. Face-Mix Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining.
 - b. Fine Aggregates: Selected, natural or manufactured sand as required to match sample panels.
- C. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant..
- D. Air-entraining Admixture: ASTM C260.
- E. Chemical Admixtures: ASTM C494.
- F. Mixing Water: Fresh, clean, and potable.
- G. Reinforcing Steel: ASTM A615M, Grade 400 MPa (ASTM A615, Grade 60), deformed.
- H. Weldable Reinforcing Steel: ASTM A706M, Grade 400 MPa, (ASTM A706 Grade 60).
- I. Galvanized Reinforcing Steel: ASTM A767M, Grade 400 MPa, (ASTM A767, Grade 60) Class II, hot-dipped galvanized after fabrication and bending.
- J. Epoxy Coated Reinforcing Steel: ASTM A775M, Grade 400 MPa, (ASTM A775, Grade 60).

- K. Anchor Bolts: ASTM A307, low-carbon steel bolts, regular hexagon nuts and carbon steel washers, galvanized.
- L. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon bolts, and hardened washers complying with ASTM A325, galvanized.
- M. Welded Wire Fabric: ASTM A185.
- N. Wire Reinforcement: ASTM A82.
- O. Prestressing Steel: ASTM A416, Grade 250K or 270K, uncoated, 7-wire, stress-relieved strand.
- P. Anchors and Inserts: ASTM A36 structural steel plates and shapes, ASTM A153 or ASTM A123 hot dipped galvanized finish.
- Q. Non-metallic Shrinkage-Resistant Grout: Proprietary pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with CRD-C-621. Minimum cube strength of 62 MPa (9000 psi) at 28 days when placed at flowable consistency.
- R. Welded Studs: AWS D1.1.
- S. Welded Rebar: AWS D1.4.
- T. Caulking and Sealants: Specified under Section 07 92 00, JOINT SEALANTS.
- U. Accessories: Provide clips, hangers, and other accessories required for installation of project units and for support of subsequent construction or finishes.
- V. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is non-reactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes.
- W. Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123, after fabrication, and ASTM A 153, as applicable.
 - 1. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20: "ZRC Cold Galvanizing Compound," ZRC Worldwide, Marshfield, MA 02050, or approved equivalent.

- X. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply lead and chromate-free, rust-inhibitive primer, complying with performance requirements in FS TT-P-664 according to SSPC-PA 1.

2.2 STAINLESS-STEEL CONNECTION MATERIALS

- A. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
- B. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.
- C. Stainless-Steel Headed Studs: ASTM A 276.
- D. Electrodes for Welding Type 304 stainless-steel: E 308.
- E. Flange-to-flange field connection plates: ASTM A666, Type 304, or 201-LN of grade suitable for application.

2.3 BEARING PADS

- A. Provide bearing pads for precast structural concrete units as follows:
 - 1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 70 ± Shore A durometer, minimum tensile strength 2,250 psi per ASTM D 412.
 - 2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer.
 - 3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer.
 - 4. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to mild-steel plate, of type required for in-service stress.
 - 5. High-Density Plastic: Multimer, nonleaching, plastic strip.
- B. Beams: Horizontal bearing pads.
 - 1. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer, unless noted otherwise on Drawings.
- C. Double Tee Stems: Horizontal bearing pads:

1. Engineered Random Oriented, Fiber-Reinforced Elastomeric Pads: Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer.
- D. Engineered random oriented fiber reinforced bearing pads with properties tested to be orthotropic in pad plane may be substituted for beam bearing pads where shown on Drawings, and if accepted in writing by Engineer.
- E. Joints between precast pieces: Non-load bearing vertical spacers only:
1. Fiber impregnated elastomeric bearing pads.
 2. Durometer hardness 80 minimum.
- F. Solid precast plank: Bearing strips: "Korolath," Koro Corp., Hudson, MA or approved equivalent.
- G. Shims for bearing pads:
1. Galvanized or epoxy-coated ASTM A 36 steel. Do not stack steel shims more than 3 high. Tack weld multiple shims together on at least 2 faces or corners. Touch up galvanizing or epoxy coating damaged by welding. See Section "Cast-in-Place Concrete" for materials.
 2. High-Density Plastic: A maximum of 1 plastic shim and a maximum of ½" in thickness may be used to adjust for field tolerances. Precaster shall submit certification of bearing capacity of plastic shim materials for approval prior to installation.
- H. Slide Bearing Systems at Expansion Joints:
1. Provide slide bearing systems as shown and detailed on Drawings:
 - a. Beam and double tee bearings shall be reinforced PTFE: 100% virgin tetrafluoroethylene polymer and ground glass fiber reinforcing aggregate, prebonded to stainless steel and/or preformed fabric (see paragraph "Bearing Pads" under heading "Connection Materials" above) bearing pads.
 - b. Slab and plank bearing shall be ultrahigh molecular weight, high-density polyethylene resin.
 2. Backing material for reinforced PTFE slide bearing systems as shown on Drawings:
 - a. Galvanized steel.
 - b. Stainless steel.

- c. Reinforced elastomer, having durometer hardness of 90 plus or minus 5 and meeting requirements of Article 2.10.3(L) of AASHTO Standard Specifications for Highway Bridges (1983).

2.4 CONCRETE MIXTURES

- A. Prepare concrete mixture proportions for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
 - 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. A qualified independent testing agency may be engaged by Fabricator for preparing and reporting proposed mixture proportions for the laboratory trial mix basis.
- C. Requirements for concrete mixture proportions are shown on Drawings:
 - 1. Compressive strength
 - 2. Slump
 - 3. Water-cementitious materials ratio
 - 4. Air content
- D. Cementitious Materials: For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 318 requirements.
- E. Supplementary Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - 1. Fly Ash or other pozzolans conforming to ASTM C 618: 25 percent.
 - 2. Slag conforming to ASTM C 989: 50 percent.
 - 3. Total of fly ash or other pozzolans and slag: 50 percent. Within the total, Fly ash or pozzolans not exceeding 25 percent.
- F. Air Entrainment:
 - 1. See General Notes on Drawings for total average air content (percent by volume).
 - 2. Average air content shall exceed value stated in General Notes on Drawings.
 - 3. Permissible variation for any one test result from specified average total air content: plus or minus 1.5 percent
 - 4. Hardened concrete shall have an air void spacing factor of 0.0080 in. maximum. Specific surface (surface area of air voids) shall be 600 in² per cu in. of air-void volume, or greater. Concrete mixes not meeting these values as determined by ASTM C 457 may require adjustments unless accepted in writing by Engineer. Refer to Part 1 Article "Submittals."

G. Chloride Ion Content of Mixture:

1. Water soluble chloride ion content of mix (including all constituents) shall not exceed 0.06% chloride ions by weight of cement for prestressed concrete and 0.15% for reinforced concrete. Test to determine chloride ion content shall conform to ASTM C 1218.
2. Concrete chloride ion content shall be determined by Testing Agency prior to placement. Cast samples from current production of concrete mix proposed for superstructure.
3. Concrete not meeting the requirements of paragraph "Water soluble chloride ion content of mix..." above, shall contain appropriate amount of calcium nitrite. Concrete supplier shall provide laboratory test results showing the amount of excess chloride ion content in the concrete mixture contributed by the aggregates. For each pound of chloride ion in excess of the amount allowed, mix shall contain calcium nitrite (30%, +/- 2%, solids content) on one-to-one basis (one gallon of calcium nitrite for one lb of excess chloride ion). Maximum of 1.5 lb of chloride ion per cubic yard may be offset in this manner.

H. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use high range water-reducing admixture in pumped concrete, concrete for parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio of 0.45 or less. Use normal or mid-range ASTM Type A water reducing admixture for concrete with water-cementitious materials ratio greater than 0.45.
 4. Use Corrosion-Inhibiting, Admixture in concrete mixes for double tees, beams, stairs and landing slabs at a rate of 3 gal/cubic yard of concrete.
- I. When concrete mixture contains calcium nitrite admixture, (or other ionic salts that affect the chloride permeability test), perform rapid chloride permeability test for submitted mixture and for control sample. Control sample shall be same mixture proportions and water-cement ratio as submitted mixture, except calcium nitrite admixture shall not be used.
- J. Engineer's acceptance of mixture shall not relieve precast concrete fabricator from responsibility for any variation from requirements of Contract Documents unless precast concrete fabricator has in writing called Engineer's attention to each such variation at time of submission and Engineer has given written approval of each such variation.

- K. Adjustment to Concrete Mixtures: Mixture proportion adjustments may be requested by precast concrete fabricator when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised mixture proportions and strength results must be submitted to and accepted by Engineer before using in work.

2.5 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application.
- C. Epoxy Grout: ASTM C 881, 2-component epoxy resin, of type, grade, and class to suit requirements.
- D. Backer rod for grouted and sealed joints: Division 07 section, "Joint Sealants."

2.6 FABRICATION

- A. Fabrication Procedures: PCI MNL-116. PCI MNL 117 for members with architectural finishes.
- B. Fabrication Tolerances:
1. PCI MNL-116. ACI 117 for reinforcing steel placement.
 2. PCI MNL-135 for Precast Concrete with Architectural Finishes noted on drawings.
- C. Finishes:
1. Color, texture and finish of all Exterior Precast (bottom and exterior face) shall match adjacent precast exterior spandrel/beam panels on the existing East Parking Structure.
 2. Standard Underside: Resulting from casting against approved forms using good industry practice in cleaning of forms, design of concrete mix, placing and curing. Small surface holes caused by air bubbles, normal color variations, normal form joint marks, and minor chips and spalls will be tolerated, but no major or unsightly imperfections, honeycomb, or other defects will be permitted.
 3. Standard Top: Result of vibrating screed and additional hand finishing at projections. Normal color variations, minor indentations, minor chips and

- spalls will be permitted. No major imperfections, honeycomb, or defects will be permitted.
4. Exposed Vertical Ends: Strands shall be recessed and the ends of member will receive sacked finish.
- D. Precast Concrete Finishes: Provide finishes in accordance with MNL-116, and MNL-117 for units with architectural finish as follows:
1. Formed surfaces: Fill air pockets and holes over 0.25 in. in diameter with sand-cement paste and grind smooth all form offsets or fins over 0.125 in.
 2. Columns, unformed surfaces: face toward inside of parking structure.
 3. Precast concrete surfaces that will provide a pedestrian walking surface shall conform to Article "Quality Assurance, paragraph "Walking Surfaces"
 4. Spandrel beams: Provide finishes in accordance with MNL 117 and as follows:
 - a. Interior face: steel trowel finish, or textured finish per accepted sample.
 - b. Ends and top, smooth dense surface standard finish.
 - c. Color, texture and finish of all Exterior Precast (bottom and exterior face) shall match adjacent precast exterior spandrel/beam panels on the existing East Parking Structure.
5. Double tees:
- a. Tee areas with cast-in-place concrete topping: Top surface shall be transverse raked to 0.25 in. depth minimum to insure bond of topping.
 - b. Tee areas without cast-in-place concrete topping: Top surface shall have medium broom finish in longitudinal direction. All sides, ends and bottom: Smooth dense standard finish.
 - c. Top surfaces that provide pedestrian a pedestrian walking surface shall conform to Article "Quality Assurance", paragraph "Walking Surfaces".
 - d. Top surface of block outs for pour strips: Transverse raked to 0.25 in. depth minimum to insure bond of topping.
 - e. Depressor holes: Filled with non-shrink, non-staining grout.
6. Wall panels:
- a. Shear walls, interior faces: steel trowel finish.
- E. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing, complying with CRSI recommendations. For exposed-to-view concrete surfaces, shear legs of supports are in contact with forms, provide supports with legs that are plastic protected or stainless steel protected.

- F. Use epoxy coated reinforcing whenever concrete cover is less than 50 mm (2 inches) for top surfaces exposed to deicing salts, brackish water or salt spray, such as in parking garage decks.
- G. Openings: Primarily on thin sections, factory fabricate those openings 250 mm (10 inches) round or square or larger as shown on drawings. Locate and field drill or cut other openings where no contact is made with prestressing or reinforcing steel after precast prestressed products have been erected. Opening shall be approved by Resident Engineer before drilling or cutting.
- H. Patching: Patching will be acceptable providing structural adequacy of product and appearance are not impaired.
- I. Defective Work: Precast concrete units which do not conform to specified requirements, including strength, tolerances, and finishes, shall be removed and replaced with precast concrete units that meet the requirements of this section. Contractor is also responsible for cost of corrections to other work affected by or resulting from corrections to precast concrete work.
- J. Fasteners: Cast in galvanized hardware such structural inserts, bolts and plates as required by drawings.
- K. For protection against corrosion, coat exposed ends of prestressing strands in all prestressed pieces with Sonneborn "Hydrocide 600, 700, or 700B," or accepted equivalent.
- L. Locate lift loops and erection inserts so as not to be visible in completed construction. Provide all lift loops and erection inserts with 1.5 in. minimum concrete or grout cover in completed construction. Any lift loops or erection inserts that must be located in areas that will be exposed to public view in completed construction or are in elevator shafts shall be recessed and patched with:
 - 1. Minimum of 1.5 in. drypack, latex modified concrete grout to match surrounding concrete.
 - 2. Minimum of 1.5 in. sealant (see Division 07 Section "Joint Sealants," color to match surrounding concrete.
 - 3. Mechanically fastened plastic covers, color to match surrounding concrete(vertical surfaces only).
- M. Mark each piece of precast concrete for identification and date of casting recorded. Marks shall not be visible after erection and completion of Work.
- N. Comply with requirements in PCI MNL 117 for measuring, mixing, transporting, and placing concrete. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 117.

- O. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

2.7 SOURCE QUALITY CONTROL

- A. Owner may employ an independent testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.
 - 1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
- B. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements, and PCI MNL 117 for precast concrete with architectural finishes.
- C. Strength of precast concrete units will be considered deficient if units fail to comply with PCI MNL 116 requirements, and PCI MNL 117 for precast concrete with architectural finishes, including the following:
 - 1. Units fail to comply with compressive-strength test requirements.
 - 2. Units fail to comply with entrained air content test requirements.
 - 3. Reinforcement and prestressed tendons of units do not comply with fabrication requirements.
 - 4. Concrete curing and protection of units against extremes in temperature fail to comply with requirements.
 - 5. Units are damaged during handling and erecting.
- D. Testing: If there is evidence that the strength of precast concrete units may be deficient or may not comply with PCI MNL 116 requirements, and PCI MNL 117 for precast concrete with architectural finishes. Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.
 - 1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Resident Engineer.
 - 2. Cores will be tested, after immersion in water, in a wet condition per ACI 301 if units will be wet under service conditions.
 - 3. Cores will be tested in an air-dry condition per ACI 301 if units will be dry under service conditions.
 - 4. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-

- day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength.
5. Test results will be made in writing on the same day that tests are performed, with copies to Resident Engineer, Contractor, and precast concrete fabricator. Test reports will include the following:
 - a. Project identification name and number.
 - b. Date when tests were performed.
 - c. Name of precast concrete fabricator.
 - d. Name of concrete testing agency.
 - e. Identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength; type of break; compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
 - E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
 - F. Dimensional Tolerances: Units with dimensions smaller or larger than required and not complying with tolerance limits may be subject to additional testing.
 1. Precast concrete units with dimensions larger than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to comply with construction conditions.
 - G. Precaster's Quality Control inspector shall inspect all pieces immediately after pieces have received final finish.
 - H. Pieces shall be inspected and defects numbered on back of control tags attached to the back of each piece according to the following system:
 1. Foreign material in face.
 2. Bug holes.
 3. Rough or chipped edges.
 4. Cold joints.
 5. Form Lines.
 6. Cornice details.
 7. Uniformity of finish.
 8. Uniformity of retarder.
 9. Finish at retarder surround.
 10. Finish on return surfaces.

- I. Precaster's finishers shall correct defects in precaster's plant or yard. As defects corrected, finishers shall write an "f" next to the corresponding defect number on the back of the piece control tag.
- J. As pieces loaded for shipment, precaster's Quality Control inspector shall reinspect pieces to verify completion of corrections and place an "x" after the letter "f" for each item verified and initial the piece for final approval. Pieces with uncorrected defects shall not be shipped.
- K. Defective Work: Precast concrete units that do not comply with requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 ERECTION

- A. Site Access: Provide suitable access to building, proper drainage, and firm, level bearing for hauling and erection equipment to operate under their own power.
- B. Examinations: Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Preparation:
 - 1. Provide true, level surfaces on field placed bearing walls and other field placed supporting members.
 - 2. Place and accurately align anchor bolts, plates or dowels in column foundations, grade beams and other field placed support members.
 - 3. Shoring required for composite beams and slab shall have a minimum load factor of 1.5 times (dead load plus construction loads).
- D. Installation: Installation of precast prestressed concrete shall be performed by the fabricator or a competent erector in accordance with PCI MNL-127. Lift members with suitable lifting devices at points provided by manufacturer. Temporary shoring and bracing, when necessary, shall comply with manufacturer's recommendations.
- E. Bearing Pads: Install bearing pads as precast concrete units are being erected. Set pads on true, level, and uniform bearing surfaces and maintain in correct position until precast concrete units are placed.
- F. Alignment: Align and level precast members as required by the approved shop drawings. Level out variations between adjacent members by jacking, loading, or

any other feasible method as recommended by the manufacturer and acceptable to Resident Engineer. Individual pieces are considered plumb, level, and aligned if the error does not exceed 1:500 excluding structural deformation caused by loads.

G. Erection Tolerances: Install precast concrete units level, plumb, square, and true, and in alignment without exceeding the recommended erection tolerances of PCI MNL 127, "Recommended Practice for Erection of Precast Concrete" and PCI MNL 135, "Tolerance Manual for Precast Prestressed Concrete Construction."

1. Structure shall be brought within tolerances and tolerances for deviation from plumb shall be checked by General Contractor-employed Michigan Registered Surveyor before placement of any cast-in-place concrete on superstructure.
2. Variations between adjacent slab members shall comply with the requirements for walking surfaces in article "Field Quality Control"

H. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints as follows:

1. Provide forms or other method to retain grout in place until hard enough to support itself. Where required, pack spaces with non-shrink, dry-pack grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.

3.2 FIELD WELDING

A. Field welding is to be done by qualified welders using equipment and materials compatible to base material in accordance with AWS D1.1 and AWS D1.4.

1. Protect precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
2. Repair damaged metal surfaces by cleaning and applying a coat of galvanized repair paint to galvanized surfaces.
3. Repair damaged metal surfaces by cleaning and re-priming damaged painted surfaces.

B. Field coat with galvanized paint specified under Section 09 91 00, PAINTING all welded connections.

3.3 ATTACHMENTS

Do not use powder-actuated or air-driven fasteners or drill the precast units for surface attachment of accessory items unless otherwise accepted by the precast manufacturer.

3.4 FIELD QUALITY CONTROL

- A. As pieces arrive at jobsite, General Contractor's Quality Control inspector shall check the production control tag for each piece to verify that the piece is complete and correct.
- B. Any defective Work that cannot be repaired to satisfaction of Resident Engineer, whether found at site or at shop at any time before completion and acceptance of Project, will be rejected regardless of previous reviews and shall be remade or reconstructed to satisfaction of Resident Engineer. However, finishes accepted at shop will not be rejected at site.
- C. Improperly located bearing pads or those of incorrect material will not be accepted by Resident Engineer and shall be relocated or modified at expense of Contractor, no matter when rejected.
- D. Performance Requirements:
 - 1. Conduct inspections, perform testing, and make repairs or replace unsatisfactory precast pieces as required.
 - 2. Limitations as to amount of patching which will be permitted is subject to acceptance of Resident Engineer.
 - 3. In-place precast pieces may be rejected for any 1 of following:
 - a. Exceeding specified installation tolerances.
 - b. Damaged during construction operations.
 - c. Exposed-to-view surfaces which develop surface finish deficiencies.
 - d. Other defects as listed in PCI MNL-116 and PCI MNL-117.
 - 4. Walking Surfaces: walking areas subject to pedestrian traffic shall be slip resistant to meet minimum requirements in the specification Article "Quality Assurance".
 - 5. Repair isolated random cracks that have little movement and single holes not over 1 in. in diameter in accordance with manufacturer's requirements. As a minimum manufacturer requirements shall be submitted for record and address the procedures and materials specified in Division 07. Receive Resident Engineer's written acceptance of materials selected prior to application.
 - a. Repair isolated random horizontal cracks less than 0.01 in. wide, using silane sealer product specified in Section 07.
 - b. Repair isolated random horizontal cracks 0.01 in. to less than 0.03 in. wide, using methylmethacrylate product specified in Section 07.

- c. Repair isolated random horizontal cracks 0.03 in. to 0.06 in. wide: route and seal with specified control joint sealant product in Section 07.
 - d. Repair isolated random vertical cracks more than 0.01 in. wide, using epoxy injection product approved.
- 6. Repairs and repaired pieces shall be subject to 5 yr warranty provided by precaster. See Part 1 heading "Repair Warranty."
- 7. Repairs and repaired pieces shall have documented design. See Part 1 heading "Submittals."
- E. Welds and high-strength bolt connections are subject to inspection and testing by Testing Agency. As minimum, following testing shall be performed:
 - 1. Welds: Visually inspect all welds.
 - a. Double tee flange-to-flange connections: Test 5% of welds, if at discretion of Inspector, visual inspection inconclusive.
 - b. All other welds: Test 25% of all field fillet welds and 5% of all shop welds.
 - c. Testing: Penetrating dye or magnetic particle at Inspector discretion.
 - d. One spot test per partial penetration weld using magnetic or ultrasonic testing.
 - 2. Bolted Connections: Visual inspection of all connections. Check proper torque with calibrated torque wrench at minimum of 2 bolts of every connection.
- F. Testing Agency has authority to reject materials, welds, and connections not meeting Specifications.

3.5 CLEANING

- A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.
 - 1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.
 - 3. At completion of Work or at such times as directed by Resident Engineer, remove all rejected and surplus material, rubbish or apparatus from premises and deliver Work to Resident Engineer's satisfaction.

3.6 INSPECTION AND ACCEPTANCE

Final inspection and acceptance of erected precast prestressed concrete shall be made by Resident Engineer to verify conformance with drawings and specifications.

END OF SECTION 034133

Page intentionally left blank.

SECTION 040523 - MASONRY PROCEDURES AND ACCESSORIES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Installation Procedures of all types of masonry units specified elsewhere.
- B. Installation Requirements of misc. masonry accessories specified in Divs. 4 & 7, and other material specified in other Divisions of these specifications.
- C. Coordination between masonry and other equipment which may be installed in the masonry, or require masonry openings.
- D. Horizontal wire reinforcing or adjustable wire reinforcing as required by individual details/conditions.
- E. Masonry veneer reinforcement systems.
- F. Steel bar reinforcing.
- G. Anchors, ties, dowels and other miscellaneous metal accessories.
- H. Weeps, Through-wall Flashings, and Counter Flashings.
- I. Miscellaneous Accessories.
- J. Cleaners.
- K. Mortar bedding.
- L. Grout for filling masonry cores and setting beds.
- M. Solid Grouting under all Through-wall Flashings.
- N. Control and Expansion Joints.
- O. Leveling Beds for Non-Specific Structural Applications.
- P. Water-repellant coating for unpainted CMU exposed to weather.
- Q. Refer to Section 042000 Unit Masonry for Mortar materials.

1.02 GENERAL REQUIREMENTS

- A. Coordinate with all special shapes and different kinds of masonry that shall be installed in this Project.

- B. Coordinate with the Mechanical and Electrical trade Contractors for equipment that may need masonry openings, mounting or other consideration that may affect the masonry installation.
- C. Coordinate with the structural Documents for lintels and beams over proposed masonry openings to determine if steel or masonry lintels are required.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 042000 - Unit Masonry.
- B. Section 047200 - Cast Stone
- C. Division 5 - Metals
- D. Section 076000 – Flashing and Sheet Metal.
- E. Section 079200 - Joint Sealants.

1.04 REFERENCE STANDARDS

- A. ASTM C-5 - Quicklime for Structural Purposes.
- B. ASTM C-91 - Masonry Cement.
- C. ASTM C 94 - Ready-mix Concrete
- D. ASTM C-144 - Aggregate for Masonry Mortar.
- E. ASTM C-150 - Portland Cement.
- F. ASTM C-207 - Hydrated Lime for Masonry Purposes.
- G. ASTM C-270 - Mortar for Unit Masonry.
- H. ASTM C 404 - Aggregates for Masonry Grout
- I. ASTM C-476 - Mortar and Grout for Reinforced Masonry.
- J. ASTM C 1329 - Standard Specification for Mortar Cement.
- K. ACI 530/ASCE 5/TMS 402 - Building Code Requirements for Masonry Structures.
- L. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures.
- M. NCMA TR-88 - Hot and Cold Weather Masonry Construction Manual.

1.05 QUALITY ASSURANCE

- A. Refer to Brick Industry Association – Technical Notes for additional information, procedures standards for the installation of brick veneer masonry units and the proper detailing of masonry systems.**
- B. Temporary Bracing: Comply with Mason Contractors Association of America's Standard Practice for Bracing Masonry Walls Under Construction, and Masonry Wall Bracing Design Handbook, published by the Masonry Contractors Association of America.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature and certification for all masonry accessories demonstrating compliance with specified requirements.
- B. Submit manufacturer's instructions.
- C. Shop Drawings: Submit shop drawings for all masonry reinforcing bars.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Requirements: Comply with recommendations of IMIAWC (CW).
- B. Hot Weather Requirements: Comply with IMIAWC (HW)

1.08 INCONSISTENCIES

- A. In the case that a discrepancy exists between two or more stated or implied characteristics of any product, assembly, technique, and application, etc., between any one or more Sections of this Project Manual, any one or more Paragraphs of this Specification, or between the Drawings and Specifications, the Contractor's Bid amount shall reflect the most costly version or combination of the requirement(s).

PART 2 - PRODUCTS

2.01 STEEL BAR REINFORCING

- A. Standards: Reinforcing shall conform to ASTM A-615, Grade 60 for deformed bars for masonry construction.
- B. See Section 042000 – Concrete Unit Masonry for Concrete Masonry Unit reinforcing.

2.02 WIRE GAUGE REINFORCING

- A. Standards:

1. Reinforcing shall conform to ASTM A 82 for uncoated wire and with ASTM A 153, Class B-2 (1.5 oz. per sq. ft. of wire surface) for zinc coating (galvanized) applied after prefabrication into units.

- a. Applications requiring hot-dipped galvanizing: masonry exposed to weather or in contact with earth.

B. Single-wythe Design:

1. Ladder Type with cross rods spaced not more than 16" o.c. for single wythe wall reinforcement.
2. Provide products which account for one (1) rod for each face shell of concrete masonry.
3. Prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10'.

- C. Flexible Anchors:** Flexible anchors are required for connecting masonry to structural framework and other masonry. Ladder and z-type ties will not be acceptable due to non-standard brick size. Provide 2-piece anchors which permit vertical or horizontal differential movement between wall and framework parallel to, but resist tension and compression forces perpendicular to, plane of wall.

1. Wire size: 0.1875 diameter

- D. Width - Size:** Two inches less than nominal thickness of wall.

- E. Rod Size:** Deformed longitudinal side rods 9 gauge (3/16" – heavy) and cross rods to be 9 gauge wires unless noted otherwise.

- F. Cross Rods:** Cross rods which serve as metal tie in exterior cavity and other multi-wythe walls shall be galvanized and drip crimped.

- G. Corners and Tee Sections:** Prefabricated of material and design similar to main reinforcement.

2.03 ANCHOR AND TIE SYSTEMS

- A. Masonry to Cast-in-Place Concrete and Precast Concrete and Masonry to Masonry:** Provide 2-piece anchors consisting of cast-in-place dovetail slot and 9 ga. triangular wire-tie with vertical movement, size to extend to within 3/4" of face of masonry veneer.

1. Provide anchors vertically at 16" centers and horizontally at 24" centers for brick, 32" centers for block, and within 12" of any corner for either material.
2. Adjustable veneer anchor, masonry to concrete – equal to Hohmann and Barnard #305 with #315 Flexible Dovetail Brick Tie.
3. Hot dip galvanized for all applications.

- 4. Deliver dovetail slot materials to Cast-in-Place Concrete and Precast Concrete Fabricators for inclusion in their work. Sequence deliveries to maintain the Project Schedule. Coordinate with the General Contractor.**

2.04 MASONRY SYSTEM FLASHINGS

A. Thru-wall Flashing and Counter-Flashing:

1. Bituthene Sheet Flashing (rubberized asphalt), as thru-wall flashing: Flexible sheet flashing especially formulated from modified bituthene flexible and waterproof in concealed masonry applications, black in color and of thickness indicated below:
 - a. Thickness: 40 mils
 - b. Material: Cold-applied self-adhesive sheet of rubberized asphalt integrally bonded to an 8 mil, high-density, cross-laminated polyethylene film.
 - c. **Mechanically fasten thru-wall flashing to substrate with a termination bar approved by the flashing manufacturer.**

B. Provide Adhesives, Primers, and Seam Tapes for Flexible Membrane Flashings as required by the manufacturer.

C. Whether or not it is shown on the Drawings, provide Solid Grout under all through-wall Flashings to provide consistent support of and drainage from Flashing to weeps.

2.05 ACCESSORIES

A. Reinforcement Retaining Clip: extruded rigid polyvinyl chloride (PVC), with one retaining ridge to secure 9 gauge wire, and three retaining ridges to secure 3/16" diameter wire, grooved base for improved mortar bond.

B. Compressible Filler: Filler strips conforming to ASTM D 1056, Class 2A1, 25% oversized in thickness. Width shall match the masonry wythe minus 1/2 inch.

C. Preformed Control Joint Gasket: ASTM D 2000, BC810, Designation M2AA-805, or complying with ASTM D 2287, Type PVC-654-4, formed with shear key to fit into sash block ends.

D. Joint Reinforcement Wire:

1. Wire size: 3/16", galvanized wire.
2. Length: 10 feet minimum continuous piece length.

E. Weep hole material:

1. Provide opening at head joints spaced 24" o.c. for Brick installations and 32" o.c. (2-1/2" high) for CMU. Provide weeps in the first course above embedded flashings. And as follows:

- a. Form weeps by keeping head joints free and clear of mortar.
- b. Brick vents, cotton wicks and plastic tube weeps are not acceptable.

F. Bond Breaker Strips: Asphalt-saturated organic roofing felt per ASTM D 226, Type I.

G. Control joints:

1. Extruded PVC compound with 80 durometer hardness conforming to ASTM D 2240. Control joints shall occur at 30 feet intervals (max.), and singularly at each exterior masonry corner. Refer to details for additional information or spacing requirements.
2. Additional Control Joint details may be allowed per the Structural Documents. The Contractor has the option of any method shown.

H. Grout Stop:

1. Non-corrosive 1/4" square polypropylene monofilament screening, in widths to match material, allowing proper bonding while preventing grout from falling through block cores.

I. Cavity Drainage Material:

1. Clean, sharp Mason's sand.
2. **Pea pebble fill is not an acceptable Cavity Drainage Material.**

2.06 WATER-REPELLANT ADMIXTURES

- A. For all Cementitious Masonry Units exposed to the weather in finished construction AND NOT SCHEDULED TO BE PAINTED, provide a field-applied clear 40% silane sealer.
- B. For all Cast Stone Masonry Mortar, provide an integral liquid polymeric admixture for combining with mortar mix, which cross links and becomes permanently locked into mortar to provide resistance to water penetration per ASTM E 514-74, without reducing flexural and compressive strength of mortar when tested per ASTM C 1072 and ASTM C 780.

2.07 MASONRY CLEANING

- A. Pressure washing shall not exceed 300 psi and care shall be taken to proceed only at acute angles to the masonry if this method is used. Use a 25 – 50 degree fan-tip for all pressure spraying.

B. Concrete Block Masonry Cleaning:

1. **Job mixed or pre-prepared chemical cleaners containing acid are prohibited.**
2. Clean exposed concrete masonry surfaces by dry brushing at end of each day's work and after final pointing to remove mortar spots, stains and droppings. Masonry surfaces to be exposed, either painted or unpainted shall be thoroughly cleaned. Leave surfaces free mortar and other stains
3. On completion of pointing and re-pointing of all interior and exterior block work, clean thoroughly with "SureKlean 600", "Craft Klean", or similar prepared detergent only as expressly recommended by masonry unit manufacturer. Mix and apply in strict accordance with manufacturer's instructions. Test cleaning agent on 20 sq. ft. sample wall area in an inconspicuous area before beginning overall cleaning. Apply cleaner using fiber brushes and non-metallic scrappers, then rinse wall thoroughly with clean water.
4. All cleaning shall be done prior to installation of stone surfaces, finished floors, wall mounted light fixtures, door hardware, aluminum doors and frames, landscaping, or other items. Protect any such installed items from damage due to cleaning operations.

C. Brick Cleaning: 1/2 cup trisodium phosphate and 1/2 cup laundry detergent dissolved in one gallon of warm water.

1. Pre-soak masonry prior to using detergent to minimize absorption of detergent agent.
2. Protect all windows, doors and trim with plastic sheeting.
3. Protect all cast-in-place concrete and stone work as required by the manufacturer from and detergents and from run-off of cleaning procedure.
4. Refer to the Brick Industry Association Technical Notes for requirements of special cleaning methods.
5. Manufactured Cleaners:
 - a. Every attempt shall be made to clean brick with warm water, mild detergent (as noted above) and brush scrubbing. Use commercial agents only when less aggressive methods fail, with the following conditions:
 - 1) **Where acid-based Manufactured cleaners are used, clean brick prior to installation of adjacent stone surfaces, without exception.**
 - 2) **Where acid-based Manufactured cleaners are used, clean brick prior to installation of adjacent landscaping, without exception.**
 - b. Consult brick manufacturer for proper cleaners based on the texture, density and color of the particular brick.
 - c. Submit the manufacturer's recommendations with the Cut-Sheets and MSDS for the brick cleaner as submittals to the Architect for review.

2.08 DISPOSAL OF WASH WATER

- A. Disposal of Wash Water: Utilize one of the following two procedures to handle wash water generated from detergent or chemical cleaning.
- B. Contractor may obtain approval from the Michigan Department of Natural Resources & Environment (MDNRE) for their company to discharge to ground by “authorization by notification” as a mobile power washer. NOTE: Discharge to ground means discharge to grassy an/or soil areas capable of water infiltration. Discharge to ground cannot be utilized during frozen ground conditions, as water discharge will freeze and/or run off into storm drains. If operations will occur during winter or frozen conditions – the wash water must be collected and sampled to determine proper disposal, as identified in item 2 below. Please note that discharge to ground has a volume per acre per month limit that must be followed.
- C. Collect wash water and sample to determine proper disposal method.
- D. Contact the appropriate stakeholder for information on discharge to ground and for disposal of collected wastewater. Please allow adequate lead time for sampling, analysis and disposal coordination.
- E. Do not allow runoff from cleaning activities that is discharged to ground to leave the site. Protect storm drains and catch basins.

PART 3 - EXECUTION

3.01 JOB CONDITIONS

- A. Cold Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit masonry damaged by frost or freezing conditions. Comply with the following requirements:
 - 1. Cold Weather Construction: When the ambient temperature is within the limits indicated, use the following requirements:
 - a. 40 to 30 Deg. F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 Deg. F.
 - b. 32 to 25 Deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 Deg. F. Heat grout materials to produce grout temperatures between 40 and 120 Deg. F. Maintain mortar and grout above freezing until used in masonry.
 - c. 25 to 20 Deg. F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 Deg. F. Heat grout materials to produce grout temperatures between 40 and 120 Deg. F. Maintain mortar

- and grout above freezing until used in masonry. Heat masonry units to 40 Deg. F if grouting. Use heat on both sides of walls under construction.
- d. 20 Deg F and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 Deg. F. Heat grout materials to produce grout temperatures between 40 and 120 Deg. F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 Deg. F. Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 32 Deg F within the enclosures.
2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection:
- a. 40 to 25 Deg. F: Cover masonry with a weather resistant membrane for 48 hrs after construction.
 - b. 25 to 20 Deg. F: Cover masonry with insulating blankets or provide enclosure and heat for 48 hrs after construction to prevent freezing. Install wind breaks when wind velocity exceeds 15 mi./h.
 - c. 20 Deg F and Below: Provide enclosure and heat to maintain temperature above 32 Deg. F within the enclosure for 48 hrs after construction.
- B. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 Deg F. and above.

3.02 INSTALLATION – GENERAL

- A. Wetting Clay Brick: Wet brick made from clay or shale which has ASTM C 67 initial rates of absorption (suction) of more than 30 grams per 30 sq. in. per minute. Use wetting methods which ensure each clay masonry unit being nearly saturated but surface dry when laid.
- B. Do not wet concrete masonry units.
- C. Cleaning Reinforcing: Before placing, remove loose rust, ice and other coating from reinforcing.
- D. Thickness: Build cavity and composite walls, floors and other masonry construction to the full thickness show. Build single-wythe walls to the actual thickness of the masonry units, using the nominal thickness of the material.
- E. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.

- F. Cut masonry units using motor-driven saws. Use dry cutting saws to cut concrete masonry units.
- G. Matching Existing Masonry Work: Match coursing, bonding, color and texture of new masonry work with existing. Tooth masonry infill into existing masonry coursing.
- H. **Bond Break: Provide a continuous bond breaker strip in all mortar joints between clay masonry and concrete masonry.**
- I. Sealer: Apply two (2) coats of sealer complying with requirements of the manufacturer.
 - 1. At all exposed exterior Decorative Concrete Masonry Units unless otherwise indicated.
 - 2. At all exposed exterior Regular Concrete Masonry Units unless otherwise indicated.
 - 3. At all exposed interior Regular Concrete Masonry Units that are not scheduled to be otherwise painted.

3.03 CONSTRUCTION TOLERANCES

- A. Variations from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed $\frac{1}{4}$ " in 10', or $\frac{3}{8}$ " in a story height not to exceed 20'. For exterior corners, expansion joints, control joints and other conspicuous lines do not exceed $\frac{1}{4}$ " in any story or 20' maximum.
- B. Variations from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed $\frac{1}{4}$ " in any bay or 20' maximum.
- C. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed $\frac{1}{2}$ " in any bay or 20' maximum.
- D. Variations in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus $\frac{1}{4}$ " nor plus $\frac{1}{2}$ ".
- E. Variation in Mortar-Joint Thickness: Do not vary from bed-joint thickness indicated by more than plus or minus 3.2 mm (0.125 inc.), with a maximum thickness limited to 12.7 mm (0.5 in). Do not vary bed-joint thickness from bed-joint thickness of adjacent course by more than 3.2 mm (0.125 inc.). Do not vary from head-joint thickness indicated by more than plus or minus 3.2 mm (0.125 in.). Do not vary head-joint thickness from adjacent head-joint thickness by more than 3.2 mm (0.125 inc.). Do not vary from collar-joint thickness indicated by more than minus 6.4 mm (0.25 in.) or plus 9.5 mm (0.375 in.).

3.04 MIXING OF MORTAR

- A. Mixing of mortar (and grout) shall be done in a mechanical batch mixer, in which all cementitious material shall be mixed for at least 5 minutes with the maximum amount of water. Hand mixing for small jobs is not permitted without the Architect's permission.
- B. Mortar shall be used within 2 hours after mixing when air temperature is 80°F, or higher, and within 3-1/2 hours when air temperature is less than 80°F. Retempering during this time to replace water lost by evaporation will be allowed.
- C. Maintain sand uniformly damp immediately before the mixing process.
- D. Mix mortar ingredients in accordance with ASTM C 270.

3.05 GROUTING

- A. Grout Placement – normal lift; subject to the Contract Documents and Masonry Institute's recommendations:
 - 1. Place grout within 1-1/2 hours from mixing and prior to initial set of grout.
 - 2. Do not exceed the grout pour heights of ACI 530.1/ASCE 6/TMS 602.
 - 3. Place grout in lifts not exceeding 5 feet high.
 - a. If there is a significant delay, stop grout minimum of 1-1/2 inches below the top of masonry to form a shear key with the next lift.
 - 4. Consolidate grout at time of placement for pours of 12 inches or less by mechanical vibration or puddling.
 - 5. Consolidate grout at time of placement for pours exceeding 12 inches by mechanical vibration and reconsolidate by mechanical vibration while grout is still plastic.
 - 6. Solidly fill cells below lintel or beam bearing minimum of 24 inches high.
 - 7. Bond Beams and Masonry Lintels:
 - a. Allow masonry lintels to attain sufficient strength to support loads imposed during construction before removing temporary supports.
 - 8. Alternatively, place masonry units and grout using construction procedures employed in the accepted grout demonstration panel.
 - 9. Whether or not it is shown on the Drawings, provide Solid Grout under all through-wall Flashings to provide consistent support of and drainage from Flashing to weeps.
- B. Low-lifting Grouting:
 - 1. Limit height of pours to 12".
 - 2. Limit height of masonry to 16" above each pour.

3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.

C. High-Lift Grouting:

1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
2. Brick: Limit pours to maximum 12' in height and 25' horizontally.
3. Hollow Masonry: Limit lifts to maximum 4' and pours to maximum height of 24'.
4. Place grout for spanning elements in single, continuous pour.

3.06 LAYING MASONRY WALLS

- A. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2". Do not use units with less than nominal 4" horizontal face dimensions at corners or jambs.
- B. Stopping and Resuming Work: Rack back ½ unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly and remove loose masonry units and mortar prior to laying fresh masonry.
- C. Built-in Work: As the Work progresses, build-in items specified under this and other sections of these specification. Fill in solidly with masonry around built-in items.
 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
 2. Where build-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
 3. Fill cores in hollow concrete masonry units with grout 3 courses (24") under bearing plated, beams, lintels, posts and similar items.
- D. Masonry walls indicated to extend to the roof deck shall terminate 1" below the underside if the deck - typical.
 1. Maintain fire-rated separations required by filling resulting space with a firestop joint assembly suitable for permanent placement – as required to maintain rating.
 2. Coordinate with Architectural Details for masonry termination at decks above, or at a minimum:

- a. Provide a continuous 16 ga. track to receive masonry when running perpendicular to deck flutes.
- b. Where masonry wall is parallel to deck flutes, provide a supplemental 12 ga. plate to link flutes and provide attachment for metal track.

3.07 MORTAR BEDDING AND JOINTING

- A. Spread mortar using the 'beveling' technique described in BIA 21C-78 to keep cavities free of mortar droppings and to assist in filling 3-hole brick cores.**
- B. Lay solid brick size masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
- C. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footing and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.
- D. Maintain joints widths shown, except for minor variations required to maintain bond alignment. If not indicated – all joints shall be 3/8".
- E. Tool exposed joints slightly concave for brick and slightly concave for block including scored joint using a jointer larger than joint thickness, unless otherwise noted.
- F. Raked, struck, or similar joints are not acceptable.**
- G. Provide full head joints on brick masonry.
- H. Do not pound corners or jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.
- I. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes
 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Wet joint surfaces thoroughly before applying mortar.
- J. For all conditions receiving a vapor/air barrier membrane application all masonry joints shall be struck flush with full mortar bed.

3.08 STRUCTURAL BONDING OF MULTI-WYTHER MASONRY

- A. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
 - 1. Provide individual metal ties at not more than 24" OC vertically.
 - 2. Provide continuity with horizontal joint reinforcement using prefabricated "T" units.

3.09 CAVITY WALLS CONDITIONS

- A. **All Brick Veneer Masonry conditions on the Project shall be consider to be Cavity Wall Conditions unless specifically noted otherwise.**
- B. Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity flush.
- C. Tie exterior wythe to back-up with brick ties and/or continuous horizontal joint reinforcing, installed in mortar joints at not more than 16" OC vertically.
- D. Provide weep holes (2-1/2" high open head joints), through-wall flashing, and counter-flashing in brick veneer wythe located immediately above lintels, relieving angles, brick ledges, and flashings, and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior, spaced 24" OC horizontally, unless otherwise indicated.
- E. Provide 10" depth of cavity drainage material located immediately above all lintels, flashings and ledges.

3.10 HORIZONTAL JOINT REINFORCEMENT

- A. General: Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcing a minimum of 6".
- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Reinforce walls with continuous horizontal joint reinforcing unless specifically noted to be omitted.

3.11 ANCHORING MASONRY WORK

- A. General: Provide anchor devices of type specified.
 - 1. Anchor masonry to structural members where masonry abuts or faces structural members.

3.12 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Place Reinforcement: Comply with requirements in Michigan Building Code.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in Michigan Building Code for cleanouts and for grout placement, including minimum grout space and maximum pour height
 - 2. Limit height of vertical grout pours to not more than 60".

3.13 FLASHING OF MASONRY WORK

- A. Install flashings in compliance with BIA and NCMA recommendations for project-specific conditions.
- B. Install flashings in compliance with manufacturer's instructions except where overridden by BIA or NCMA recommendations.
- C. Provide concealed flashing in masonry work at or above shelf angles, lintels, brick ledges, relieving angles, and other obstructions to the downward flow of water in the cavity so as to divert such water to the exterior.
- D. Prepare masonry surfaces to be smooth and free from projections which could puncture flashing.
- E. Do not allow any penetrations in flashings.
- F. Place through-wall flashing on sloping bed of mortar and cover with mortar.
- G. Seal penetrations in flashing with mastic before covering with mortar.
- H. Extend Thru-wall flashings to ½" behind exterior face of wall and turn up a minimum of 4" on cavity substrate. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up 4". At heads and sills turn up ends not less than 4" to form a pan/end dam.

- I. Extend flashing the full length of all obstructions to the downward flow of water in the cavity and minimum of 4" beyond the masonry opening on each end. Form flashing into dams at side terminations.
- J. **Mechanically fasten thru-wall flashing to substrate with a termination bar approved by the flashing Manufacturer.**
- K. Fabricate through-wall metal flashings embedded in masonry with ribs formed in sawtooth pattern at 3-inch intervals along length of flashing to provide a 3-way integral mortar bond and weep hole drainage as indicated.
- L. Interlock and joints of deformed metal flashings by over-lapping deformation not less than 1-1/2" and seal lap with elastic sealant.
- M. Coordinate weeps with flashings and structural elements.
- N. Install reglets and nailers for flashing and other related work where shown to be built into masonry work.
- O. Provide flashing at all locations indicated or at the lowest elevation in a masonry wall still above grade.
- P. Counter-Flashings:
 - 1. Extend flashings to outside face of masonry and terminate with a hemmed edge. Project no more than 1/2' from finished face of masonry.
 - 2. Install weeps immediately on top of flashing.
 - 3. For flexible membrane flashing, form end dams at horizontal terminations of flashings.
 - 4. Lap flexible membrane joints a minimum of 6 inches and seal with compatible material.

3.14 REPAIR AND POINTING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or gout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings and adjacent work to provide a neat, uniform appearance, prepared for application of sealants.

3.15 INSTALLATION OF REINFORCING

- A. If not otherwise indicated on the Drawings, install wire gauge masonry reinforcing in horizontal joints of concrete block walls at a spacing of not more than 16 inches apart vertically to coincide with brick and block coursing.
- B. Install wire gauge reinforcing so that it is completely embedded in mortar or grout. Joints with wire gauge reinforcing shall be provided in accordance with ACI-530 (latest edition). Where continuous wire gauge reinforcing is called for, lap reinforcing 12" min. and install corner and intersection assemblies to provide complete reinforcement of the horizontal masonry joint at that elevation. Tie corner-reinforcing units to straight wall units.
- C. Lap reinforcing bars in accordance with ACI-530 (latest edition), a minimum of 48 bar diameters and not less than 24" where spliced. Separate lapping bars by at least one bar diameter or 1" (whichever is greater), or wire together. Lap horizontal joint reinforcing 24" where spliced. Use preformed corners and sections.
- D. Unless otherwise indicated on Drawings, place reinforcing bars so that they have a minimum clearance of 1/4" from adjacent masonry and meet all spacing requirements of ACI-530 (latest edition). Use corner bars for continuous horizontal reinforcing at corners. Dowel vertical reinforcing from footing to match vertical reinforcing size and location.
- E. Secure rigid insulation in place with rigid insulation retainer at each masonry wall tie connector location on horizontal joint reinforcement.

3.16 INSTALLATION OF ANCHOR AND TIE SYSTEMS

- A. Install metal ties with maximum spacing of 16" on center vertically, and 24" on center horizontally for brick and 32" on center horizontally for block, unless noted otherwise.
- B. Provide additional ties within 12" of all masonry openings.
- C. Extend reinforcement a minimum of 8" past masonry jamb openings, and 1 course above each opening.

3.17 CONTROL AND EXPANSION JOINTS

- A. Provide vertical and horizontal expansion, control and isolation joints in brick veneer and CMU masonry as shown on the Drawings and/or as recommended by the Masonry Institute. Typical vertical control joints shall not exceed 24 feet on center.
- B. Provide a bond-break between masonry and other material to allow horizontal, differential expansion/contraction between materials. This bond-break shall be as part of the flashing/weep system or a 15# felt under the mortar bed.

- C. Coordinate all vertical control joints with adjacent openings/lintel bearings to provide a single joint satisfying both concerns of corners and openings.
- D. Construct expansion and/or control (movement) joints as indicated on the Drawings. Terminate horizontal reinforcing on both sides of the movement joint. Reinforcement for bond beams may be continuous or discontinuous depending upon indicated structural requirements.
- E. Isolate masonry construction from structural framing with control joints.
- F. Leave exposed faces of joints ready for caulking.

END OF SECTION 040523

SECTION 042000 - UNIT MASONRY

PART 1 – GENERAL

1.1 DESCRIPTION

This section specifies requirements for construction of masonry unit walls.

1.2 RELATED WORK

- A. Steel lintels and shelf angles: Section 055000, METAL FABRICATIONS
- B. Section 040523 MASONRY PROCEDURES AND ACCESSORIES
- C. Sealants and sealant installation: Section 079200, JOINT SEALANTS.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- B. Samples and Mockups:
 - 1. Face brick, sample panel, 200 mm by 400 mm (8 inches by 16 inches), showing full color range and texture of bricks, bond, and proposed mortar joints. Mockup: Prior to installing unit masonry, construct sample wall panels to verify selections to demonstrate aesthetic effects as well as other qualities of materials and execution. Build mockups to comply with the requirements, using materials indicated for final unit of Work.
 - 2. Concrete masonry units, when exposed in finish work.
 - 3. Anchors, and ties, one each and joint reinforcing 1200 mm (48 inches) long.
- C. Shop Drawings:
 - 1. Special masonry shapes.
 - 2. Concrete masonry units for typical window and door openings, and, for special conditions as affected by structural conditions.
 - 3. Shop Drawings: Submit shop drawings for fabrication, bending, and placement of reinforcing bars. Comply with ACI 315. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcement for unit masonry work.
- D. Certificates:

1. Certificates signed by manufacturer, including name and address of contractor, project location, and the quantity, and date or dates of shipment of delivery to which certificate applies.
2. Indicating that the following items meet specification requirements:
 - a. Face brick.
 - b. Solid and load-bearing concrete masonry units
3. Testing laboratories facilities and qualifications of its principals and key personnel to perform tests specified.

E. Preconstruction Testing:

1. Employ and pay a qualified independent testing agency to perform the following preconstruction testing to establish compliance of proposed materials and construction with specified requirements.
 - a. Concrete Masonry Unit Test: For each different concrete masonry unit indicated, test units for strength, absorption, and moisture content per ASTM C 140.
 - b. Prism Test: For each type of wall construction indicated, test masonry prisms per ASTM E 447, Method B.
 - c. Test mortar properties per test methods of ASTM C 270.
 - d. Evaluate mortar composition and properties per ASTM C 780.
 - e. Test grout compressive strength per ASTM C 1019.

F. Manufacturer's Literature and Data:

1. Anchors, ties, and reinforcement.
2. Shear keys.
3. Reinforcing bars.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following installed compressive strengths ($f'm$) at 28 days.
1. For Concrete Unit Masonry: As follows, based on net area:
 - a. $f'm = 2000$ psi.

1.5 DELIVERY, STORAGE, AND HANDING

- A. Store masonry units on elevated platforms, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes,

contaminants, corrosion, and other causes. If units become wet, do not install until they are in an air-dried condition.

- B. Store cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 WARRANTY

- A. Warrant exterior masonry walls against moisture leaks and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be three years.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):

A951-06.....	Steel Wire for Masonry Joint Reinforcement.
A615/A615M-07	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
A675/A675M-03	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical PropertiesC34-03 Structural Clay Load-Bearing Wall Tile
C55-06.....	Concrete Building Brick
C90-06.....	Load-Bearing Concrete Masonry Units
C62-05.....	Building Brick (Solid Masonry Units Made From Clay or Shale)
C216-07.....	Facing Brick (Solid Masonry Units Made From Clay or Shale)
C476-02.....	Standard Specification for Grout for Masonry
D1056-07.....	Flexible Cellular Materials - Sponge or Expanded Rubber
D3574-05.....	Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams
F1667-05	Fasteners: Nails, Spikes and Staples

C. Masonry Industry Council:

All Weather Masonry Construction Manual, 2000.

D. American Welding Society (AWS):

D1.4-05 Structural Welding Code – Reinforcing Steel.

E. Federal Specifications (FS):

FF-S-107C-00.....Screws, Tapping and Drive

F. Brick Industry Association - Technical Notes on Brick Construction (BIA):

11-1986Guide Specifications for Brick Masonry, Part I

11A-1988Guide Specifications for Brick Masonry, Part II

11B-1988Guide Specifications for Brick Masonry, Part III
Execution

11C-1998.....Guide Specification for Brick Masonry Engineered
Brick Masonry, Part IV

11D-1988.....Guide Specifications for Brick Masonry Engineered
Brick Masonry, Part IV continued

G. Masonry Standards Joint Committee; Specifications for Masonry Structures (ACI 530.1-05/ASCE 6-05/TMS 602-99) (MSJC).

PART 2 - PRODUCTS

2.1 BRICK

- A. Face Brick to match size, shape, configuration, color, texture, finish, variation and overall appearance of the existing brick veneer on the East Parking Structure. For reference, the existing brick on the East Parking Structure is defined below:

1. Manufacturer: Yankee Hill Brick Company (or approved equal)
2. Brick: LMD Red Range
3. Size: VASPC1 (3 5/8 x 2 3/8 x 7 5/8) PLEASE NOTE THE SPECIAL HEIGHT AT 2 3/8"
4. Texture: Smooth ASTM-C216 Grade SW Type FBS
5. Mortar Color: refer to Mortar Materials below
6. Distributor: Brick Tech Architectural / Robert Weeks / 248-548-0777

- B. Brick veneer shall meet the specifications of ASTM C-216, sizes and types as indicated on Drawings, and the following:

1. Brick shall be tested in accordance with Standard Methods of Testing Brick, ASTM C67-07a, for compliance with ASTM C-216-07a and ASTM C-652.
2. Compressive Strength: minimum 12,900 PSI, 89.00 Mpa.
3. Absorption: Average Saturation Coefficient 0.86.
4. Efflorescence: Average "Not Effloresced".
5. Deviation from specified Length, Width, and/or Height: 0.02" maximum.
6. Grade: SW, no exceptions.
7. Type: FBS
8. Coring: All brick shall be cored in a 3-core pattern except as follows: In locations where top or bottom of brick units will be exposed to weather or view in completed construction, provide non-cored units.
9. Waivered Brick: Brick waived under C-216 is not acceptable.

2.2 CONCRETE MASONRY UNITS

A. Hollow and Solid Load-Bearing Concrete Masonry Units: ASTM C90.

1. Unit Weight: Normal weight.
2. Fire rated units for fire rated partitions.
3. Sizes: Modular.
4. For molded faces used as a finished surface, use concrete masonry units with uniform fine to medium surface texture unless specified otherwise.

2.3 MORTAR MATERIALS

A. Portland Cement: ASTM C-150, Type I - Normal, except Type III may be used for cold weather. Provide natural color or white cement as required to produce required mortar colors noted below.

B. Hydrated Lime: ASTM C-207, Type S.

C. Quicklime: ASTM C-5, non-hydraulic type.

D. Water: Potable, clean and free from injurious amounts of oil, alkali, acids, organic materials.

E. Mortar Aggregate: Natural, or as manufactured sand, meeting ASTM C-144.

F. Grout Aggregate: ASTM C-404.

G. Mortar Color:

1. Mortar Color at Exterior Brick Veneer: BTA #J547, to match existing
2. Mortar Color Pigment: High purity, chemically inert, unfading, alkali-fast mineral oxides, finely ground and especially prepared for mortar.

- a. Mineral oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar. Do not add pigments to colored cement products.
 - b. Pigments shall not exceed 10 percent of Portland cement by weight.
 - c. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
 - d. Pigments shall meet ASTM C979.
- H. Admixtures: Avoid use of accelerants and admixtures (other than colorants) if possible. All Admixtures shall be submitted and authorized by the Architect prior to application.
1. Accelerating Admixture: Non-chloride type of use in cold weather.
 2. Moisture-Resistant Admixture: Water repellent compound designed to reduce capillarity.
 3. Use of calcium chloride as an additive is not acceptable.
- I. Bonding Agent: Multi-Purpose, Acrylic Latex type. Use per manufacturer's instruction, and only as required for field conditions.

END OF SECTION 042000

Page intentionally left blank.

SECTION 047200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies manufactured concrete units to simulate a natural stone.
- B. Installation of cast stone units.

1.2 RELATED WORK

- A. Setting and pointing mortar: Section 040523, MASONRY PROCEDURES AND ACCESSORIES.
- B. Joint sealant and application: Section 079200, JOINT SEALANTS.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples:
 - 1. Cast stone, sample panel, size 100 by 300 by 300 mm (4 by 12 by 12 inches) each color and finish.
 - 2. Show finish on two 100 mm (4-inch) edges and 300 by 300 mm (12 by 12 inch) surface.
- C. Shop Drawings:
 - 1. Cast stone showing exposed faces, profiles, cross sections, anchorage, reinforcing, jointing and sizes.
 - 2. Setting drawings with setting mark.
- D. Certificates: Test results indicating that the cast stone meets specification requirements and proof of plant certification.
- E. Submit manufacturers test results of cast stone previously made by manufacturer.
- F. Laboratory Data: Description of testing laboratories facilities and qualifications of its principals and key personnel.
- G. List of jobs furnished by the manufacturer, which were similar in scope and at least three (3) years of age.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store cast stone under waterproof covers on planking clear of ground.
- B. Protect from handling, dirt, stain, and water damage.
- C. Mark production units with the identification marks as shown on the shop drawings.
- D. Package units and protect them from staining or damage during shipping and storage.
- E. Provide an itemized list of product to support the bill of lading.

1.5 WARRANTY

- A. Warranty exterior masonry walls against moisture leaks, any defects and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be two years.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by the basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
- B. Cast Stone Institute Technical Manual and Cast Stone Institute standard specifications.
- C. American Society for Testing and Materials (ASTM):

A167-99 (2004)	Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A185-07	Steel, Welded Wire Fabric, Plain for Concrete
A615/A615M-08	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C33-07	Concrete Aggregates
C150-07	Portland Cement
C503-08	Marble Dimension Stone (Exterior)
C568-08	Limestone Dimension Stone
C615-03	Granite Dimension Stone
C616-08	Quartz-Based Dimension Stone
C979-05	Pigments for Integrally Colored Concrete
C1194-06	Compressive Strength of Architectural Cast Stone
C1195-03	Absorption of Architectural Cast Stone
C1364-07	Architectural Cast Stone.
D2244-07	Calculation of Color Differences from Instrumentally Measured Color Coordinates.

1.7 QUALITY ASSURANCE

A. The Manufacturer:

1. Must have three (3) years minimum continuous operating experience and have facilities for manufacturing cast stone as described herein. Manufacturer shall have sufficient plant facilities to produce the shapes, quantities and size of cast stone required in accordance with the project schedule.
2. Must be a member of the Cast Stone Institute.
3. Must have a certified plant (certification by the Cast Stone Institute).

B. Stone setter: Must have three (3) years experience setting cast or natural building stone.

C. Testing: One (1) sample from production units may be selected at random from the field for each 500 cubic feet (14 m³) delivered to the job:

1. Three (3) field cut cube specimens from each of these sample shall have an average minimum compressive strength of not less than 85% with no single specimen testing less than 75% of design strength as specified.
2. Three (3) field cut cube specimens from each of these samples shall have an average maximum cold-water absorption of 6%.
3. Field specimens shall be tested in accordance with ASTM C 1194 and C 1195.
4. Manufacturer shall submit a written list of projects similar and at least three (3) years of age, along with owner, architect and contractor references.

1.8 MANUFACTURING TOLERANCES

- A. Cross section dimensions shall not deviate by more than + 1/8 in. (3 mm) from approved dimension.
- B. Length of units shall not deviate by more than length /360 or + 1/8 in. (3mm), whichever is greater, not to exceed + 1/4 in (6 mm). Maximum length of any unit shall not exceed 15 times the average thickness of such unit unless otherwise agreed by the manufacturer.
- C. Warp bow or twist of units shall not exceed length/360 or + 1/8 in. (3 mm), whichever is greater.
- D. Location of dowel holes, anchor slots, flashing grooves, false joints and similar features – On formed sides of unit, 1/8 in (3 mm), on unformed sides of unit, 3/8 in (9 mm) maximum deviation.

1.9 MOCK-UP

- A. Provide full size unit(s) for use in construction of sample wall. The mock-up becomes the standard of workmanship for the project.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CAST STONE

- A. Comply with ASTM C 1364
- B. Physical properties: Provide the following:
 - 1. Compressive Strength – ASTM C 1194: 6,500 psi (45 Mpa) minimum for products at 28 days.
 - 2. Absorption – ASTM C 1195: 6% maximum by the cold water method, or 10% maximum by the boiling method for products as 28 days.
 - 3. Air Content – ASTM C173 or C231, for wet cast product shall be 4-8% for units exposed to freeze-thaw environments. Air entrainment is not required for vibrant dry tamp (VDT) products.
 - 4. Freeze thaw - ASTM C 1364L The cumulative percent weight loss (CPWL) shall be less than 5% after 300 cycles of freezing and thawing.
 - 5. Linear Shrinkage - ASTM C 426L Shrinkage shall not exceed 0.065%.
- C. Job site testing – One (1) sample from production units may be selected at random from the field for each 500 cubic feet (14m³) delivered to the job site:
 - 1. Three (3) field cut cube specimens from each of these samples shall have an average minimum compressive strength of not less than 85% with no single specimen testing less than 75% of design strength as allowed by ACI 318.
 - 2. Three (3) field cut cube specimens from each of these samples shall have an average maximum cold-water absorption of 6%.
 - 3. Field specimens shall be tested in accordance with ASTM C 1194 and C 1195.

2.2 RAW MATERIALS

- A. Portland cement – Type I or Type III, white and/or grey, ASTM C 150.
- B. Coarse aggregates – Granite, quartz or limestone, ASTM C 33, except for gradation, and are optional for the vibrant dry tamp (VDT) casting method.
- C. Fine aggregates – Manufactured or natural sands, ASTM C 33, except for gradation.
- D. Colors – Inorganic iron oxide pigments, ASTM C 979 except that carbon black pigments shall not be used.
- E. Admixtures- Comply with the following:

1. ASTM C 260 for air-entraining admixtures.
2. ASTM C 494/C 495 M Types A-G for water reducing, retarding, accelerating and high range admixtures.
3. Other admixtures: integral water repellents and other chemicals, for which no ASTM Standard exists, shall be previously established as suitable for use in concrete by proven field performance or through laboratory testing.
4. ASTM C 618 mineral admixtures of dark and variable colors shall not be used in surfaces intended to be exposed to view.
5. ASTM C 989 granulated blast furnace slag may be used to improve physical properties. Tests are required to verify these features.

F. Water – Potable

G. Reinforcing bars:

1. ASTM A 615/A 615M. Grade 40 or 60 steel galvanized or epoxy coated when cover is less than 1.5 in. (37 mm).
2. Welded Wire Fabric: ASTM A 185 where applicable for wet cast units.

H. All anchors, dowels and other anchoring devices and shims shall be standard building stone anchors commercially available in a non-corrosive material such as zinc plated, galvanized steel, brass, or stainless steel Type 302 or 304.

2.3 COLOR AND FINISH AND CONFIGURATION

- A. Color, texture, reveals and finish shall match existing belt course limestone units on the adjacent existing East Parking Structure. Length of units shall match existing.
- B. All surfaces intended to be exposed to view shall have a fine-grained texture similar to natural stone, with no air voids in excess of 1/32 in. (0.8 mm) and the density of such voids shall be less than 3 occurrences per any 1 in² (25mm²) and not obvious under direct daylight illumination at a 5 ft. (1.5m) distance.
- C. Units shall exhibit a texture approximately equal to the approved sample when viewed under direct daylight illumination at a 10 ft (3m) distance.
- D. ASTM D 2244 permissible variation in color between units of comparable age subjected to similar weathering exposure.
 1. Total color difference – not greater than 6 units.
 2. Total hue difference-not greater than 2 units.

2.4 REINFORCING

- A. Reinforce the units as required by the drawings and for safe handling and structural stress.
 1. Minimum reinforcing shall be 0.25 percent of the cross section area.

- B. Reinforcement shall be non-corrosive where faces exposed to weather are covered with less than 1.5in. (38 mm) of concrete material. All reinforcement shall have minimum coverage of twice the diameter of the bars.
- C. Minor chipping resulting from shipment and delivery shall not be grounds for rejection. Minor chips shall not be obvious under direct daylight illumination from a 20-ft (6m) distance.
- D. The occurrence of crazing or efflorescence shall not constitute a cause for rejection.
- E. Remove cement film, if required, from exposed surface prior to packaging for shipment.

2.5 CURING

- A. Cure units in a warm curing chamber 1000 F (537.8 C) at 95 percent relative humidity for approximately 12hours, or cure in a 95 percent moist environment at a minimum 700F (371.1 C) for 16 hours after casting. Additional yard curing at 95 percent relative humidity shall be 350-degree-days (i.e. 7 days @ 500F (260.0 C) or 5 days @ 700F (371.1 C) prior to shipping. Form cured units shall be protected from moisture evaporation with curing blankets or curing compounds after casting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Installing contractor shall check cast stone materials for fit and finish prior to installation. Do not set unacceptable units.

3.2 SETTING TOLERANCES

- A. Comply with Cast Stone InstituteSM Technical Manual.
- B. Set stones 1/8 in. (3 mm) or less, within the plane of adjacent units.
- C. Joints, plus – 1/6 in. (1.5 mm), minus – 1/8 in. (3 mm).

3.3 JOINTING

- A. Joint size:
 - 1. At stone/brick joints 3/8 in. (9.5 cm).
 - 2. At stone/stone joints in vertical position 1/4 in. (6 mm) (3/8 in. (9.5 mm) optional).
 - 3. Stone/stone joint exposed on top 3/8 in. (.5 mm).
- B. Joint Materials:

1. Mortar, Type N, ASTM C 270.
2. Use a full bed of mortar at all bed joints.
3. Flush vertical joints full with mortar.
4. Leave all joints with exposed tops or under relieving angles open for sealant.
5. Leave head joints in coping and projecting components open for sealant.

B. Location of joints:

1. As shown on shop drawings.
2. At control and expansion joints unless otherwise shown.

3.4 SETTING

- A. Drench units with clean water prior to setting.
- B. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.
- C. Set units in full bed of mortar, unless otherwise detailed.
- D. Rake mortar joints 3/4 in. (18 mm) in. for pointing.
- E. Remove excess mortar from unit faces immediately after setting.
- F. Tuck point unit joints to a slight concave profile.

3.5 JOINT PROTECTION

- A. Comply with requirements of Section 07 92 00, JOINT SEALANTS.
- B. Prime ends of units, insert properly sized backing rod and install required sealant.

3.6 REPAIR AND CLEANING

- A. Repair chips with touchup materials furnished by manufacturer.
- B. Saturate units to be cleaned prior to applying an approved masonry cleaner.
- C. Consult with manufacturer for appropriate cleaners.

3.7 INSPECTION AND ACCEPTANCE

- A. Inspect finished installation according to Bulletin #36 published by the Cast Stone Institute.

END OF SECTION 047200

Page intentionally left blank.

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

This section specifies structural steel shown and classified by Section 2, Code of Standard Practice for Steel Buildings and Bridges.

1.2 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Painting: Section 099100, PAINTING.
- C. Steel Decking: Section 053100, STEEL DECKING.

1.3 QUALITY ASSURANCE

- A. Fabricator and erector shall maintain a program of quality assurance in conformance with Section 8, Code of Standard Practice for Steel Buildings and Bridges. Work shall be fabricated in an AISC certified fabrication plant.
- B. Before authorizing the commencement of steel erection, the controlling contractor shall ensure that the steel erector is provided with the written notification required by 29 CFR 1926.752. Provide copy of this notification to the Resident Engineer.

1.4 TOLERANCES

Fabrication tolerances for structural steel shall be held within limits established by ASTM A6, by Section 7, Code of Standard Practice for Buildings and Bridges, and by Standard Mill Practice - General Information (AISC ASD Manual, Ninth Edition, Page 1-145

1.5 DESIGN

- A. Connections: Design and detail all connections for each member size, steel grade and connection type to resist the loads and reactions indicated on the drawings or specified herein. Use details consistent with the details shown on the Drawings, supplementing where necessary. The details shown on the Drawings are conceptual and do not indicate the required weld sizes or number of bolts unless specifically noted. Use rational engineering design and standard practice in detailing, accounting for all loads and eccentricities in both the connection and the members. Promptly notify the Resident Engineer of any location where the

connection design criteria is not clearly indicated. The design of all connections is subject to the review and acceptance of the Resident Engineer. Submit structural calculations prepared and sealed by a qualified engineer registered in the state where the project is located. Submit calculations for review before preparation of detail drawings.

1.6 REGULATORY REQUIREMENTS

- A. AISC: Specification for Structural Steel Buildings - Allowable Stress Design, or LRFD Specification for Structural Steel Building.
- B. AISC: Code of Standard Practice for Steel Buildings and Bridges.

1.7 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguished between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size and length of bolts, distinguish between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
- D. Certificates:
 - 1. Structural steel.
 - 2. Steel for all connections.
 - 3. Welding materials.
 - 4. Shop coat primer paint.
- E. Test Reports:
 - 1. Welders' qualifying tests.
- F. Design Calculations and Drawings:
 - 1. Connection calculations, if required, signed and sealed by licensed professional engineer in the State of Michigan.

1.8 DELIVER, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other support and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.9 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.10 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Institute of Steel Construction (AISC):
 - 1. Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design (Ninth Edition, 1989)
 - 2. Load and Resistance Factor Design Specification for Structural Steel Buildings (Second Edition, 1995)
 - 3. Code of Standard Practice for Steel Buildings and Bridges (March 2000).
- C. American National Standards Institute (ANSI):
 - B18.22.1-98.....Plain Washers
 - B18.22M-00.....Metric Plain Washers
- D. American Society for Testing and Materials (ASTM):
 - A6/A6M-02Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
 - A36/A36M-01Standard Specification for Carbon Structural Steel
 - A53/A53M-01Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

A123/A123M-02	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A242/A242M-01	Standard Specification for High-Strength Low-Alloy Structural Steel
A283/A283M-00	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
A307-00.....	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
A325-02.....	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A490-02.....	Standard Specification for Heat-Treated Steel Structural Bolts 150 ksi Minimum Tensile Strength
A500-01.....	Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A501-01.....	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
A572/A572M-01	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
A992/A992M-02	Standard Specification for Structural Steel Shapes

E. American Welding Society (AWS):

D1.1-02.....Structural Welding Code-Steel

F. Research Council on Structural Connections (RCSC) of the Engineering Foundation:

Specification for Structural Joints Using ASTM A325 or A490 Bolts

G. Military Specifications (Mil. Spec.):

MIL-P-21035.....Paint, High Zinc Dust Content, Galvanizing, Repair

H. Occupational Safety and Health Administration (OSHA):

29 CFR Part 1926-2001Safety Standards for Steel Erection

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel: ASTM A36, A992.

B. Structural Tubing: ASTM A500, Grade B.

C. Steel Pipe: ASTM A53, Grade B.

D. Bolts, Nuts and Washers:

1. High-strength bolts, including nuts and washers: ASTM A325.
2. Bolts and nuts, other than high-strength: ASTM A307, Grade A.
3. Plain washers, other than those in contact with high-strength bolt heads and nuts: ANSI Standard B18.22.1.

E. Zinc Coating: ASTM A123.

F. Galvanizing Repair Paint: Mil. Spec. MIL-P-21035.

G. Primer: Fabricator's standard lead and chromate-free, non-asphaltic, rust-inhibiting primer, unless noted otherwise.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 CONNECTIONS (SHOP AND FIELD)

- A. Welding: Welding in accordance with AWS D1.1. Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.1 to perform type of work required.
- B. High-Strength Bolts: High-strength bolts tightened to a bolt tension not less than proof load given in Specification for Structural Joints Using ASTM A325 or A490 Bolts. Tightening done with properly calibrated wrenches, by turn-of-nut method or by use of direct tension indicators (bolts or washers). Tighten bolts in connections identified as slip-critical using Direct Tension Indicators or the turn-of-the-nut method. Twist-off torque bolts are not an acceptable alternate fastener for slip critical connections.

3.2 FABRICATION

Fabrication in accordance with Chapter M, Specification for Steel Buildings - Allowable Stress Design and Plastic Design or Load and Resistance Factor Design.

3.3 SHOP PAINTING

- A. General: Shop paint steel with primer in accordance with Section 6, Code of Standard Practice for Steel Buildings and Bridges.
- B. Shop paint for steel surfaces is specified in Section 099100, PAINTING.
- C. Do not apply paint to following:
 - 1. Surfaces within 50 mm (2 inches) of joints to be welded in field.
 - 2. Surfaces which will be encased in concrete.
 - 3. Surfaces which will receive sprayed on fireproofing.
 - 4. Top flange of members which will have shear connector studs applied.
- D. Structural steel in the interstitial space that does not receive sprayed on fireproofing shall be painted with primer in accordance with general requirement of shop painting.
- E. Zinc Coated (Hot Dip Galvanized) per ASTM A123 (after fabrication): Touch-up after erection: Clean and wire brush any abraded and other spots worn through zinc coating, including threaded portions of bolts and welds and touch-up with galvanizing repair paint.

3.4 ERECTION

- A. General: Erection in accordance with Section 7, Code of Standard Practice for Steel Buildings and Bridges.
- B. Temporary Supports: Temporary support of structural steel frames during erection in accordance with Section 7, Code of Standard Practice for Steel Buildings and Bridges.

3.5 FIELD PAINTING

- A. After erection, touch-up steel surfaces specified to be shop painted. After welding is completed, clean and prime areas not painted due to field welding.
- B. Finish painting of steel surfaces is specified in Section 099100, PAINTING.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspection agency to inspect field welds and bolted connections.
- B. Bolted Connections: Shop-bolted will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:

- a. Liquid Penetrant Inspection: ASTM E 165.
- b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
- c. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
- d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 051200

Page intentionally left blank.

SECTION 053100 - STEEL DECKING

PART 1 – GENERAL

1.1 DESCRIPTION

This section specifies material and services required for installation of steel decking as shown and specified.

1.2 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Finish Painting: Section 099100, PAINTING.

1.3 DESIGN REQUIREMENTS

- A. Design steel decking in accordance with AISI publication, "Specification for the Design of Cold-formed Steel Structural Members" except as otherwise shown or specified.
- B. Design all elements with the latest published version of applicable codes.

1.4 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings: Shop and erection drawings showing decking unit layout, connections to supporting members, and similar information necessary for completing installation as shown and specified, including supplementary framing, sump pans, ridge and valley plates, cant strips, cut openings, special jointing or other accessories. Show welding, side lap, closure, deck reinforcing and closure reinforcing details. Show openings required for work of other trades, including openings not shown on structural drawings. Indicate where temporary shoring is required to satisfy design criteria.
- C. Manufacturer's Literature and Data: Showing steel decking section properties and specifying structural characteristics.
- D. Certification: For each type and gauge of metal deck supporting concrete slab or fill, furnish certification of the specified fire ratings. Certify that the units supplied are U.L. listed as a "Steel Floor and Form Unit".

- E. Insurance Certification: Assist the Government in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

- B. American Society for Testing and Materials (ASTM):

A36/A36M-08	Standard Specification for Carbon Structural Steel
A611-97	Standard Specification for Structural Steel (SS), Sheet, Carbon, Cold-Rolled
A653/A653M-08	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process
C423-08	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

- C. American Institute of Steel Construction (AISC):

1. Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design (ninth Edition, 1989)
2. Load and Resistance Factor Design Specification for Structural Steel Buildings (Latest Edition)

- D. American Iron and Steel Institute (AISI):

1. Specification and Commentary for the Design of Cold-Formed Steel Structural Members

- E. American Welding Society (AWS):

D1.3-08	Structural Welding Code - Sheet Steel
---------------	---------------------------------------

- F. Factory Mutual (FM Global):

1. Loss Prevention Data Sheet 1-28: Wind Loads to Roof Systems and Roof Deck Securement
2. Factory Mutual Research Approval Guide (2002)

- G. Military Specifications (Mil. Spec.)

MIL-P-21035B	Paint, High Zinc Dust Content, Galvanizing Repair
--------------------	---

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel Decking: Provide 3DR or 3N, 20 gage. ASTM A653, Structural Quality.
- B. Galvanizing: ASTM A653,
- C. Galvanizing Repair Paint: Mil. Spec. MIL-P-21035B.
- D. Primer for Shop Painted Sheets: Manufacturer's standard primer (2 coats). When finish painting of steel decking is specified in Section 099100, PAINTING primer coating shall be compatible with specified finish painting.
- E. Miscellaneous Steel Shapes: ASTM A36.
- F. Welding Electrode: E60XX minimum.
- G. Sheet Metal Accessories: ASTM A653, galvanized, unless noted otherwise. Provide accessories of every kind required to complete the installation of metal decking in the system shown. Finish sheet metal items to match deck such as the following items:
 - 1. Metal Cover Plates: For end-abutting deck units, to close gaps at changes in deck direction, columns, walls and openings. Same quality as deck units but not less than 1.3 mm (18 gauge) sheet steel.
 - 2. Continuous Sheet Metal Edging: At openings, concrete slab edges and roof deck edges. Same quality as deck units but not less than 1.3 mm (18 gauge) steel. Side and end closures supporting concrete and their attachment to supporting steel shall be designed by the manufacturer to safely support the wet weight of concrete and construction loads. The deflection of cantilever closures shall be limited to 3 mm (1/8 inch) maximum.
 - 3. Metal Closure Strips: For openings between decking and other construction, of not less than 1.3 mm (18 gauge) sheet steel of the same quality as the deck units. Form to the configuration required to provide tight-fitting closures at open ends of flutes and sides of decking.
 - 4. Ridge and Valley Plates: Provide 1.3 mm (18 gauge), minimum 100 mm (4 inch) wide ridge and valley plates where roof slope exceeds 40 mm per meter (1/2 inch per foot).
 - 5. Cant Strips: Provide bent metal 45 degree leg cant strips where indicated on the Drawings. Fabricate cant strips from 1 mm (20 gauge) metal with a minimum 125 mm (5 inch) face width.
 - 6. Seat Angles for Deck: Provide where a beam does not frame into a column.
 - 7. Sump Pans for Roof Drains: Fabricated from single piece of minimum 1.9 mm (14 gauge) galvanized sheet steel with level bottoms and sloping sides to

direct water flow to drain, unless otherwise shown. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than 75 mm (3 inches) wide. Recess pans not less than 38 mm (1 1/2 inches) below roof deck surface, unless otherwise shown or required by deck configuration. Holes for drains will be cut in the field.

2.2 REQUIREMENTS

- A. Provide steel decking of the type, depth, gauge, and section properties as shown.
- B. Metal Roof Deck: Single pan fluted units with flat horizontal top surfaces utilized to act as a permanent support for all superimposed loads. Comply with the depth and minimum gage requirements as shown on the Contract Documents.
 - 1. Finish: Galvanized G-60.
 - 2. Deep Rib (Type N) deck.
- C. Do not use steel deck for hanging supports for any type or kind of building components including suspended ceilings, electrical light fixtures, plumbing, heating, or air conditioning pipes or ducts or electrical conduits.
- D. Steel decking units used for interstitial levels shall include an integral system.
 - 1. System to provide a simple point of attachment for light duty hanger devices.
 - 2. System to allow for flexibility for attaching hangers for support of suspended ceilings, electrical, plumbing, heating, or air conditioning items, weight not to exceed 50 kg/m² (10 psf).
 - 3. System shall provide for a minimum spacing pattern of 300 mm (12 inches) on centers longitudinally and 600 mm (24 inches) on centers transversely.
 - 4. Maximum load suspended from any hanger is 23 kg (50 pounds).
 - 5. System consisting of fold-down type hanger tabs or lip hanger is acceptable.

PART 3 - EXECUTION

3.1 ERECTION

- A. Do not start installation of metal decking until corresponding steel framework has been plumbed, aligned and completed and until temporary shoring, where required, has been installed. Remove any oil, dirt, paint, ice, water and rust from steel surfaces to which metal decking will be welded.
- B. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.

- C. Do not use floor deck units for storage or working platforms until permanently secured. Do not overload deck units once placed. Replace any deck units that become damaged after erection and prior to casting concrete at no cost to the Government.
- D. Place steel decking units at right angles to supporting members. End laps of sheets of roof deck shall be a minimum of 50 mm (2 inches) and shall occur over supports.
- E. Fastening Deck Units:
1. Fasten floor deck units to steel supporting members by not less than 16 mm (5/8 inch) diameter puddle welds or elongated welds of equal strength, spaced not more than 305 mm (12 inches) o.c. with a minimum of two welds per unit at each support. Where two units abut, fasten each unit individually to the supporting steel framework.
 2. Tack weld or use self-tapping No. 8 or larger machine screws at 915 mm (3 feet) o.c. for fastening end closures. Only use welds to attach longitudinal end closures.
 3. Weld side laps of adjacent floor deck units that span more than 1524 mm (5 feet). Fasten at midspan or 915 mm (3 feet) o.c., whichever is smaller.
 4. Fasten roof deck units to steel supporting members by not less than 16 mm (5/8 inch) diameter puddle welds or elongated welds of equal strength, spaced not more than 305 mm (12 inches) o.c. at every support, and at closer spacing where required for lateral force resistance by diaphragm action. Attach split or partial panels to the structure in every valley. In addition, secure deck to each supporting member in ribs where side laps occur. Power driven fasteners may be used in lieu of welding for roof deck if strength equivalent to the welding specified above is provided. Submit test data and design calculations verifying equivalent design strength.
 5. Mechanically fasten side laps of adjacent roof deck units with spans greater than 1524 mm (5 feet) between supports, at intervals not exceeding 915 mm (3 feet) o.c., or midspan, whichever is closer, using self-tapping No. 8 or larger machine screws.
 6. Provide any additional fastening necessary to comply with the requirements of Underwriters Laboratories and/or Factory Mutual to achieve the required ratings.
 7. Uplift Loading: Install and anchor roof deck units to resist gross uplift loading of 2.1 kPa (45 psf) at eave overhang and 1.4 kPa (30 psf) for other roof areas.
- F. Cutting and Fitting:
1. Cut all metal deck units to proper length in the shop prior to shipping.

2. Field cutting by the metal deck erector is restricted to bevel cuts, notching to fit around columns and similar items, and cutting openings that are located and dimensioned on the Structural Drawings.
3. Other penetrations shown on the approved metal deck shop drawings but not shown on the Structural Drawings are to be located, cut and reinforced by the trade requiring the opening.
4. Make all cuts neat and trim using a metal saw, drill or punchout device; cutting with torches is expressly prohibited.
5. Do not make any cuts in the metal deck that are not shown on the approved metal deck drawings. If an additional opening not shown on the approved shop drawings is required, submit a sketch, to scale, locating the required new opening and any other openings and supports in the immediate area. Do not cut the opening until the sketch has been reviewed and accepted by the Resident Engineer. Provide any additional reinforcing or framing required for the opening at no cost to the Government. Failure to comply with these requirements is cause for rejection of the work and removal and replacement of the affected metal deck.
6. Reinforcement at Openings: Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work shown.

3.2 WELDING

Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.3.

3.3 FIELD REPAIR

1. Areas scarred during erection.
2. Welds to be thoroughly cleaned and touched-up. Touch-up paint for zinc-coated units shall be zinc rich galvanizing repair paint.

END OF SECTION 053100

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies items and assemblies fabricated from structural steel shapes, aluminum tubing, and other materials as shown and specified.
- B. Items specified.
 - 1. Support for Wall and Ceiling Mounted Items:
 - 2. Frames
 - 3. Loose Lintels
 - 4. Railing
 - 5. Wire Mesh Panels
 - 6. Aluminum Guardrails

1.2 RELATED WORK

- A. Section 033000: CAST-IN-PLACE CONCRETE (ANGLES).
- B. Section 034133: PRECAST STRUCTURAL CONCRETE
- C. Section 042000: UNIT MASONRY
- D. Joint Sealants: Section 079200: JOINT SEALANTS
- E. Prime and finish painting: Section 099100, PAINTING.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
 - 1. Each item specified, showing complete detail, location in the project, material and size of components, method of joining various components and assemblies, finish, and location, size and type of anchors.
 - 2. Mark items requiring field assembly for erection identification and furnish erection drawings and instructions.
 - 3. Provide templates and rough-in measurements as required.
- C. Manufacturer's Certificates:

- ## 1.4 QUALITY ASSURANCE

- ## 1.5 APPLICABLE PUBLICATIONS

- | | |
|----------------------|--|
| A36/A36M-05 | Structural Steel, plates, shapes and bars |
| A48-03 | Gray Iron Castings |
| A53-06 | Pipe, Steel, Black and Hot-Dipped, Zinc-Coated
Welded and Seamless |
| A123-02 | Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
Products |
| A167-99(R2004) | Stainless and Heat-Resisting Chromium-Nickel Steel
Plate, Sheet and Strip |
| A269-07 | Seamless and Welded Austenitic Stainless Steel
Tubing for General Service |

A307-07	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A312/A312M-06	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
A500	Steel Tubing (Cold Formed)
A653/A653M-07	Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
B221-06	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
C1107-07	Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
F436-07	Hardened Steel Washers
F468-06	Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
F593-02	Stainless Steel Bolts, Hex Cap Screws, and Studs
F1667-05	Driven Fasteners: Nails, Spikes and Staples

D. American Welding Society (AWS):

D1.1-04	Structural Welding Code Steel
D1.2-03	Structural Welding Code Aluminum
D1.3-98	Structural Welding Code Sheet Steel

E. National Association of Architectural Metal Manufacturers (NAAMM)

AMP521-01	Pipe Railing Manual
AMP 500-505-1988	Metal Finishes Manual
MBG 531-00	Metal Bar Grating Manual

F. Structural Steel Painting Council (SSPC):

SP 1-05	No. 1, Solvent Cleaning
SP 2-05	No. 2, Hand Tool Cleaning
SP 3-05	No. 3, Power Tool Cleaning

G. Federal Specifications (Fed. Spec):

RR-T-650E	Treads, Metallic and Nonmetallic, Nonskid
-----------------	---

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

- A. In addition to the dead loads, design fabrications to support the following live loads unless otherwise specified.

- B. Railings and Handrails: 900 N (200 pounds) in any direction at any point.
- C. Wire Mesh Panels: 900 N (200 pounds) in any direction at any point.

2.2 MATERIALS

- A. Structural Steel: ASTM A36.
- B. Stainless Steel: ASTM A167, Type 302 or 304.
- C. Aluminum, Extruded: ASTM B221, Alloy 6063-T5 unless otherwise specified. For structural shapes use alloy 6061-T6 and alloy 6061-T4511.
- D. Steel Pipe: ASTM A53.
 - 1. Galvanized for exterior locations.
 - 2. Type S, Grade A unless specified otherwise.
 - 3. NPS (inside diameter) as shown.
- E. Steel Tubing: ASTM A500 (Cold Formed)
 - 1. Galvanized for exterior locations.
- F. Primer Paint: As specified in Section 099100, PAINTING.
- G. Stainless Steel Pipe: ASTM A269, type 304.
- H. Grout: ASTM C1107, pourable type.

2.3 HARDWARE

- A. Rough Hardware:
 - 1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated, or zinc-coated by electro-galvanizing process. Galvanized G-90 where specified.
 - 2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.
- B. Fasteners:
 - 1. Bolts with Nuts:
 - a. ASME B18.2.2.
 - b. ASTM A307 for 415 MPa (60,000 psi) tensile strength bolts.
 - c. ASTM F468 for nonferrous bolts.

- d. ASTM F593 for stainless steel.
- 2. Screws: ASME B18.6.1.
- 3. Washers: ASTM F436, type to suit material and anchorage.
- 4. Nails: ASTM F1667, Type I, style 6 or 14 for finish work.

2.4 FABRICATION GENERAL

A. Material

- 1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.
- 2. Use material free of defects which could affect the appearance or service ability of the finished product.

B. Size:

- 1. Size and thickness of members as shown.
- 2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

C. Connections

- 1. Except as otherwise specified, connections may be made by welding, shop-riveting or bolting.
- 2. Field riveting will not be approved.
- 3. Design size, number and placement of fasteners, to develop a joint strength of not less than the design value.
- 4. Holes, for rivets and bolts: Accurately punched or drilled and burrs removed.
- 5. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.
- 6. Use Rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
- 7. Use stainless steel connectors for removable members machine screws or bolts.

D. Fasteners and Anchors

- 1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.
- 2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members

or causing failure of the anchor or fastener, and suit the sequence of installation.

3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
4. Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self drilling and tapping screws or bolts.

E. Workmanship

1. General:

- a. Fabricate items to design shown.
- b. Furnish members in longest lengths commercially available within the limits shown and specified.
- c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
- d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.
- e. Provide openings, cut-outs, and tapped holes for attachment and clearances required for work of other trades.
- f. Prepare members for the installation and fitting of hardware.
- g. Cut openings in gratings and floor plates for the passage of ducts, sumps, pipes, conduits and similar items. Provide reinforcement to support cut edges.
- h. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.

2. Welding:

- a. Weld in accordance with AWS.
- b. Welds shall show good fusion, be free from cracks and porosity and accomplish secure and rigid joints in proper alignment.
- c. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.
- d. Finish welded joints to match finish of adjacent surface.

3. Joining:

- a. Miter or butt members at corners.
- b. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.

4. Anchors:

- a. Where metal fabrications are shown to be preset in concrete, weld 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 150 mm (6 inches) long with 25 mm (one inch) hooked end, to back of member at 600 mm (2 feet) on center, unless otherwise shown.
- b. Where metal fabrications are shown to be built into masonry use 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 250 mm (10 inches) long with 50 mm (2 inch) hooked end, welded to back of member at 600 mm (2 feet) on center, unless otherwise shown.

5. Cutting and Fitting:

- a. Accurately cut, machine and fit joints, corners, copes, and miters.
- b. Fit removable members to be easily removed.
- c. Design and construct field connections in the most practical place for appearance and ease of installation.
- d. Fit pieces together as required.
- e. Fabricate connections for ease of assembly and disassembly without use of special tools.
- f. Joints firm when assembled.
- g. Conceal joining, fitting and welding on exposed work as far as practical.
- h. Do not show rivets and screws prominently on the exposed face.
- i. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.

F. Finish:

1. Finish exposed surfaces in accordance with NAAMM Metal Finishes Manual.
2. Aluminum: NAAMM AMP 501. **Finish to match existing.**
 - a. Mill finish, AA-M10, as fabricated, use unless specified otherwise.
 - b. Clear anodic coating, AA-C22A41, chemically etched medium matte, with Architectural Class 1, 0.7 mils or thicker.
 - c. Colored anodic coating, AA-C22A42, chemically etched medium matte with Architectural Class 1, 0.7 mils or thicker.
 - d. Painted: AA-C22R10.
3. Steel and Iron: NAAMM AMP 504.
 - a. Zinc coated (Galvanized): ASTM A123, G90 unless noted otherwise.
 - b. Surfaces exposed in the finished work:
 - 1) Finish smooth rough surfaces and remove projections.

- 2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.

c. Shop Prime Painting:

1) Surfaces of Ferrous metal:

- a) Items not specified to have other coatings.
- b) Galvanized surfaces specified to have prime paint.
- c) Remove all loose mill scale, rust, and paint, by hand or power tool cleaning as defined in SSPC-SP2 and SP3.
- d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP1.
- e) After cleaning and finishing apply one coat of primer as specified in Section 099100, PAINTING.

4. Stainless Steel: NAAMM AMP-504 Finish No. 4.

G. Protection:

1. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal, using zinc rich paint on hot-dip zinc coat items and zinc dust primer on all other zinc coated items.

2.5 LOOSE LINTELS

- A. Furnish lintels of sizes shown. Where size of lintels is not shown, provide the sizes specified.
- B. Fabricate lintels with not less than 150 mm (6 inch) bearing at each end for nonbearing masonry walls, and 200 mm (8 inch) bearing at each end for bearing walls.
- C. Provide one angle lintel for each 100 mm (4 inches) of masonry thickness as follows except as otherwise specified or shown.
 1. Openings 750 mm to 1800 mm (2-1/2 feet to 6 feet) - 100 x 90 x 8 mm (4 x 3-1/2 x 5/16 inch).
 2. Openings 1800 mm to 3000 mm (6 feet to 10 feet) - 150 x 90 x 9 mm (6 x 3-1/2 x 3/8 inch).
- D. For 150 mm (6 inch) thick masonry openings 750 mm to 3000 mm (2-1/2 feet to 10 feet) use one angle 150 x 90 x 9 mm (6 x 3-1/2 x 3/8 inch).
- E. Provide bearing plates for lintels where shown.

- F. Weld or bolt upstanding legs of double angle lintels together with 19 mm (3/4 inch bolts) spaced at 300 mm (12 inches) on centers.
- G. Insert spreaders at bolt points to separate the angles for insertion of metal windows, louver, and other anchorage.
- H. Where shown or specified, punch upstanding legs of single lintels to suit size and spacing of anchor bolts.
- I. Elevator Entrance:
 - 1. Fabricate lintel from plate bent to channel shape, and provide a minimum of 100 mm (4 inch) bearing each end.
 - 2. Cut away the front leg of the channel at each end to allow for concealment behind elevator hoistway entrance frame.

2.6 ALUMINUM RAILINGS

- A. In addition to the dead load, design railing assembly to support live load specified.
- B. Fabrication General:
 - 1. Alloy and temper recommended by aluminum producer or finisher for use and finish indicated, with not less than the strength and durability of alloy and temper designated below:
 - a. Extruded Bar and Tube: ASTM B 221, 6063-T5/T52.
 - b. Extruded Structural Pipe and Tube: ASTM B 429, 6063-T5/T52.
 - c. Drawn Seamless Tube: ASTM B 483, 6063-T832.
 - d. Plate and Sheet: ASTM B 209, 6061-T6.
 - c. Die and Hand Forgings: ASTM B 247, 6061-T6.
 - e. Castings: ASTM B 26, 356-T6.
 - 2. Provide continuous shop-welded joints, dressed smooth and flush.
 - 3. Exposed threads will not be approved.
 - 4. Exterior Post Anchors.
 - a. Fabricate aluminum tube or pipe sleeve inserts with closed ends or plates as shown.
 - b. Coordinate location of reinforcement.
 - 5. Corrosion protection: Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.
 - 6. Close all tube/pipe ends.

7. Grout/Anchoring Cement: Non-shrink nonmetallic grout: CE CRD-C621 or erosion-resistant anchoring cement; non-staining, non-corrosive, nongaseous, recommended by manufacturer for types of applications indicated.
8. Provide an epoxy filler around all tube sections inserted into sleeve-inserts in exterior applications
9. Connect all handrail and guard systems with butt-welding or with welded, internal connectors.
10. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
11. Field welding: comply with AWS Code for appearance and quality of welds.

2.7 WIRE MESH PANELS

- A. Fabricate panel frame of ASTM A36 structural steel shapes as shown, with continuous welded joints, dressed smooth and flush.
- B. Fabricate clip angles using ASTM A36 steel shaped as shown on drawings. Provide clip angles, and setting drawings to installing contractor.
- C. Fabricate wire mesh fabric and fasten to panel frame using welded connections at each wire.
 1. Wire mesh fabric shall be 4" x 4" square weave, lock crimp weave construction, 1/4 inch diameter wire, 3-3/4 inch opening, plain cold rolled steel.
- D. Finish for wire mesh panels (mesh, frame and anchor clips): Hot dip galvanized (G-90) after fabrication and assembly of panel is complete. (Do not prime paint; hot dip galvanized coating is final finish for wire mesh panels).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set work accurately, in alignment and where shown, plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Items set into concrete or masonry.
 1. Provide temporary bracing for such items until concrete or masonry is set.
 2. Place in accordance with setting drawings and instructions.

3. Build strap anchors, into masonry as work progresses.
- C. Set frames of gratings, covers, corner guards, trap doors and similar items flush with finish floor or wall surface and, where applicable, flush with side of opening, except where otherwise noted in construction drawings.
- D. Field weld in accordance with AWS.
 1. Design and finish as specified for shop welding.
 2. Use continuous weld unless specified otherwise.
- E. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.
- F. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.
- G. Isolate aluminum from dissimilar metals and from contact with concrete and masonry materials as required to prevent electrolysis and corrosion.
- H. Secure escutcheon plate with set screw.

3.2 INSTALLATION OF SUPPORTS

- A. Anchorage to structure.
 1. Secure angles or channels and clips to overhead structural steel by continuous welding unless bolting is shown.
 2. Secure supports to concrete inserts by bolting or continuous welding as shown.
 3. Secure supports to mid height of concrete beams when inserts do not exist with expansion bolts and to slabs, with expansion bolts. unless shown otherwise.

3.3 STEEL LINTELS

- A. Use lintel sizes and combinations shown or specified.
- B. Install lintels with longest leg upstanding, except for openings in 150 mm (6 inch) masonry walls install lintels with longest leg horizontal.
- C. Install lintels to have not less than 150 mm (6 inch) bearing at each end for nonbearing walls, and 200 mm (8 inch) bearing at each end for bearing walls.

3.4 ALUMINUM RAILINGS

A. Aluminum Posts and Railing Supports:

1. At Precast Concrete Spandrel Panels: Install aluminum sleeves in concrete formwork for exterior railing installed. Coordinate location of reinforcement.
2. At Cast-In-Place concrete: drill holes in post-formed concrete of sufficient size to accommodate sleeve. Coordinate location of reinforcement.
3. Set post in sleeve and pour grout to surface. Apply beveled bead of urethane sealant at perimeter of post as specified in Section 079200, JOINT SEALANTS on exterior posts.

B. Erection Tolerances:

1. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
2. Maximum Offset From True Alignment: 1/4 inch.
3. Maximum Out-of-Position: 1/4 inch.

3.5 WIRE MESH PANELS

- A. Level and plumb wire mesh panels and locate within precast concrete panel openings as indicated on Drawings.
- B. Secure framed wire mesh panels to precast concrete panels with expansion bolts through angle clips as shown on Drawings.
- C. Touch up hot dip galvanized finish at abraded areas as required.

3.6 CLEAN AND ADJUSTING

- A. Adjust movable parts including hardware to operate as designed without binding or deformation of the members centered in the opening or frame and, where applicable, contact surfaces fit tight and even without forcing or warping the components.
- B. Clean after installation exposed prefinished and plated items and items fabricated from stainless steel, aluminum and copper alloys, as recommended by the metal manufacture and protected from damage until completion of the project.

END OF SECTION 055000

SECTION 060700 - PRESSURE-TREATED WOOD PRODUCTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Preservative treatment of lumber and plywood as a pressure-treatment
- B. Fire-retardant treatment of lumber and plywood as a pressure-treatment
- C. Wood that shall be pressure-treated for preservative or fire-retardants as noted in the Documents and/or required by Code and typically for:
 - 1. Wood in contact with concrete
 - 2. Wood exposed to the weather
 - 3. Wood in roof coping and flashing installations
 - 4. As required in an assembly as noted in the Documents

1.02 RELATED SECTIONS

- A. Section 061000 - Rough Carpentry
- B. Division 7 – Roofing Systems

1.03 REFERENCES

- A. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron And Steel Hardware; 1998.
- B. AWPA C20 - Structural Lumber -- Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 1999
- C. AWPA C27 - Plywood -- Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 1999
- D. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials; 1998
- E. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 1996.

1.04 SUBMITTALS

- A. Preservative Treatment Certification: Treating plant's certification of compliance with specified standards, process employed, and preservative retention values
- B. Fire-Retardant Treatment Certification: Treating plant's certification of

compliance with specified requirements

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect wood products against moisture and dimensional changes, in accordance with instructions from treating plant.

1.06 WARRANTY

- A. Fire-Retardant Treated Wood: Provide manufacturer's standard 20-year limited warranty.
- B. Preservative-Treated Wood: Provide manufacturer's standard lifetime warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide preservative wood treatment that does not contain arsenic, chromium or other preservatives classified as hazardous by the Environmental Protection Agency.
 - 1. Preserve Pressure Treated Lumber: Arsenic and Chromium free pressure treated wood produced in accordance with ACQ Preserve Standard ACQ - 94 and the appropriate AWPAs (AWPA C1, AWPAs C2, AWPAs C4, AWPAs C5, AWPAs C9, AWPAs C14, AWPAs C15, AWPAs C16, AWPAs C17, AWPAs C22, AWPAs P5).
 - 2. Wood or wood products that are treated with CCA (Copper Chromium Arsenide) or other pressure treatments that are toxic or hazardous are prohibited.
 - 3. Substitutions: See Section 01600 - Product Requirements.
 - 4. Provide wood treatment by or under license from Chemical Specialties, Inc., One Woodlawn Green, Suite 250, 200 E. Woodlawn Road, Charlotte, NC 28217. ASD. Tel: (800) 421-8661.
- B. Provide fire-retardant treated wood, where required, as pressure impregnated lumber and plywood with chemicals complying with AWPAs C20 and C27, respectively. Identify with appropriate classification marking of UL, US Testing, Timber Products Inspection, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

2.02 MATERIALS

- A. Dimension Lumber: As specified in Section 061000.
- B. Structural Plywood: As specified in Section 061000.

- C. Fasteners: For treated wood and where wood is in ground contact, subject to high relative humidity, or exposed to weather, provide steel fasteners with hot-dip zinc coating per ASTM A 153/A 153M.
- D. Hot dipped galvanized or stainless steel fasteners and fittings are recommended. Anti-corrosion coatings applied to fasteners and fittings in contact with treated wood will enhance long term performance. Direct contact of Preserve treated wood with aluminum fasteners is not recommended. A list of approved fastener systems is available from your Preserve supplier.

2.03 PRESSURE TREATMENT OF WOOD

A. Preservative Treatment:

- 1. Treatment: ACQ(R) Preserve(R)
 - a. Use 0.25 lb/cu ft retention for above ground use.
 - b. Use 0.40 lb/cu ft retention for ground contact use.
 - c. Use 0.60 lb/cu ft retention for in-ground use.
- 2. Kiln dry after treatment to 19 percent maximum moisture content for lumber and 15 percent for plywood.
- 3. Treat wood to 'above ground use' in the following locations:
 - a. In contact with roofing, flashing, or waterproofing.
 - b. In contact with masonry or concrete.
 - c. Within 18 inches (450 mm) of grade.
 - d. Exposed to weather
 - e. Other locations indicated.

B. Fire-Retardant Treatment:

- 1. Lumber: Comply with AWPAC20.
- 2. Plywood: Comply with AWPAC27, Type A.
- 3. Surface Burning Characteristics: UL FRS rating; flame spread and smoke developed ratings of 25 or less in a test of 30 minutes' duration in accordance with ASTM E 84, NFPA 255, or UL 723. This shall meet a Class A rating.
- 4. Treatment: No halogens, sulfates, chlorides, ammonium phosphate, oils, or solvents. Smoke Toxicity: no more than that of untreated wood.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Framing and Sheathing: Comply with installation requirements in Section 061000.
- B. Fire-Retardant Treated Wood: End cuts and drilling are permitted. Do not rip or

mill lumber or plywood after fire-retardant treatment.

- C. Apply field treatment complying with AWPAC M4 to cut surfaces of preservative treated lumber and plywood.

3.02 SCHEDULE

- A. All wood in exterior applications used as blocking or furring shall be pressure-treated with a preservative – typically.
- B. All wood in contact with concrete shall be pressure-treated with a preservative – typically.
- C. All wood in contact with the earth or below grade shall be pressure-treated with a preservative – typically.
- D. All wood or blocking within a fire-rated assembly shall be pressure-treated with a fire-retardant – typically.

END OF SECTION 060700

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Framing with dimensional lumber
- B. Sheathing of roof
- C. Roof curbs, cant and perimeter nailers
- D. Preservative and fire-retardant treatments required for this material – see Section 060700 – Pressure-Treated Wood Products.

1.02 RELATED SECTIONS

- A. Section 033000 – Concrete Work
- B. Section 040523 – Masonry Procedures and Accessories
- C. Section 060700 – Pressure-Treated Wood Products

1.03 REFERENCES

- A. AHA (American Hardboard Association) A135.4 - Basic Hardboard
- B. ALSC (American Lumber Standards Committee) - Softwood Lumber Standards.
- C. ANSI A208.1 Mat-Formed Wood Particleboard
- D. APA (American Plywood Association)
- E. AWPA (American Wood Preservers Association) C1 - All Timber Products - Preservative Treatment by Pressure Process
- F. AWPA (American Wood Preservers Association) C20 - Structural Lumber Fire Retardant Treatment by Pressure Process
- G. NFPA (National Forest Products Association)
- H. RIS (Redwood Inspection Service)
- I. SPIB (Southern Pine Inspection Bureau)
- J. WCLIB (West Coast Lumber Inspection Bureau)
- K. WWPA (Western Wood Products Association)

1.04 QUALITY ASSURANCE

- A. Lumber Standard: Comply with PS 20.
- B. Plywood Standard: Comply with PS 1.
- C. Identification: Factory-mark each piece of lumber and plywood with type, grade, mill and grading agency.

1.05 SUBMITTALS FOR REVIEW

- A. Product Data: Provide technical data on insulated sheathing, wood preservative materials, fire-retardant materials and application instructions.
- B. Perform Work in accordance with the following agencies:
 - 1. Lumber Grading Agency: Certified by ALSC.
 - 2. Plywood Grading Agency: Certified by APA.
- C. In lieu of grade stamping exposed to view lumber and plywood, submit manufacturer's certificate certifying that products meet or exceed specified requirements.

PART 2 – PRODUCTS

2.01 LUMBER MATERIALS

- A. Lumber, General:
 - 1. Nominal sizes are indicated, except as shown be detail dimensions. Provide dressed lumber, S4S, with 19% maximum moisture content and time of dressing.
 - 2. Comply with PS 20 "American Lumber Standard" and with applicable grading rules; factory-mark with grade, species, moisture content at time of surfacing, and mill; dressed lumber, S4S, unless otherwise indicated.
- B. Framing Lumber (2" through 4" thick):
 - 1. Concealed Dimension Lumber: As follows:
 - a. Species: Any wood species listed by PS 20.
 - b. Moisture Content: S-DRY, KD 19 or MC 19 (19 percent maximum moisture content).
 - c. Grade: No. 2 or standard grade
 - 2. For light framing (less than 6" wide), provide Construction Grade, any species, 19 percent maximum moisture content.

C. Concealed blocking and framing in exterior wall and roof assemblies:

1. SPF species, No. 2 and Btr. grade, 19 percent maximum moisture content.
2. .40#/ cu. ft. pressure-preservative treated
3. Fire-resistant treatment as required to match assembly ratings and as required

2.02 SHEATHING MATERIALS

A. Plywood roof sheathing materials:

1. Comply with PS1 "U.S. Product standard for Construction and Industrial Plywood" for plywood construction panels and, for products not manufactured under PS1 provision with APA PRP-108
2. Exterior type, CDX plywood APA Rated Sheathing, $\frac{3}{4}$ " thick tongue and groove edges, 48 x 96 inch sized sheets, Exposure Durability 1 unsanded, association stamped.

B. Identify each plywood panel with appropriate APA trademark.

2.03 MISCELLANEOUS MATERIALS

A. Fasteners and Anchorages:

1. Provide size and type recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices.
2. Provide fasteners with a hot-dip zinc coating (ASTM A153) for treated lumber and where wood is in ground contact, subjected to high relative humidity, or exposed to weather.
3. Toggle bolt type for anchorage to hollow masonry
4. Expansion shield and lag bolt type for anchorage to solid masonry or concrete.
5. Bolt or ballistic fastener for anchorages to steel

B. Die Stamped Connectors: 16 ga. thick, hot dipped galvanized steel.

C. Sill Gasket on Top of Foundation Wall: 1/4 inch thick, plate width, closed cell foam from continuous rolls.

D. Termite Shield: Galvanized sheet steel, 1/16 inch

E. Building Paper:

1. Asphalt saturated felt, non-perforated, ASTM D 226.

2.04 PRESSURE-TREATMENT

- A. Coordinate all pressure-treatment with Section 060700 – Pressure-Treated Wood Products for additional requirements. In general:
- B. Preservative Treatment: Obtain preservative-treated lumber complying with AWWA Standard C2. Mark each treated item with AWPB or SPIB Quality Mark Requirements. Coat surfaces cut after treatment to comply with AWWA M4.
 - 1. Above-Ground Wood Treatment: Pressure-treat with waterborne preservatives to a minimum retention of 0.40 pcf. Treat wood items indicated and in contact with roofing, flashing, waterproofing, masonry, concrete, and within 18 inches of grade. Kiln-dry interior dimension lumber and construction panels after treatment to 19 and 15 percent maximum moisture content, respectively.
- C. Fire-Retardant Treatment: Comply with AWWA C20 for lumber, AWWA C27 for plywood; Interior Type A for protected items, Exterior Type for items exposed to weather.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Set carpentry work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
 - 2. Securely attach carpentry work to substrate by anchoring and fastening as required by recognized standards. Countersink nail heads on exposed carpentry work and fill holes. Use finishing nails for finish work. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.
 - 3. Place full width continuous sill flashings under framed walls on cementitious foundations. Lap flashing joint 4 inches
 - 4. Place sill gasket directly on sill flashing, cementitious foundation. Puncture gasket clean and fit tight to protruding foundation anchor bolts.
- B. Wood Framing, General:
 - 1. Provide framing members of sizes and on spacings shown on the drawings, and frame openings to comply with recommendations of "Manual for House Framing" of National Forest Products Association. Do not splice structural members between supports.
 - 2. Anchor and nail to comply with "Recommended Nailing Schedule" of "Manual for House Framing" and other recommendations of N.F.P.A. and other recommendations of N.F.P.A.

3. Double members at openings over 24 inches wide. Space short studs over and under opening to stud spacing.
4. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists. Frame rigidly into joists.

C. Installation of Plywood:

1. Comply with recommendations of the American Plywood Association (APA).
2. Install sheathing as recommended by APA for spacing of supports or types of substrates involved in the work. Provide thickness shown or verify as required for spans and load applications.

3.02 WOOD BLOCKING, NAILERS AND GROUNDS

- A. Provide wherever shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached.
- B. Attach to substrates as required to support applied loading.
- C. Countersink bolts and nuts flush with surfaces, unless otherwise indicated.
- D. Build into masonry during installation of masonry and anchor to form work before concrete placement.
- E. Provide permanent grounds of dressed, preservative treated lumber not less than 1-1/2" wide and of thickness required to bring face of ground to exact thickness of finish material mounting. Shim as required to bring to perfect plumb or level.

3.03 SHEATHING

- A. Secure roof sheathing with longer edge perpendicular to framing members and with ends staggered and sheet ends over bearing.
- B. Use sheathing clips between sheets between roof framing members. Provide solid edge blocking between sheets. Fully engage tongue and groove edges.
- C. Place plywood or structural-use panel sheathing at building corners for a horizontal distance of 96 inches, or provide sheet steel corner bracing.
- D. Place building paper horizontally over wall sheathing; weather lap edges and ends.
- E. Install plywood to two-span continuous.

3.04 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.

- B. Brush apply two coats of preservative treatment on wood in contact with cementitious materials, roofing and related metal flashings and other locations where moisture exposure is possible. Treat site sawn cuts.
- C. Allow preservative to dry prior to erecting members.

3.05 COORDINATION

- A. For all materials noted herein – coordinate with the Documents for system requirements for widths, thicknesses, material characteristic and pressure-treated properties.
- B. Documents and Drawing Details shall override all specifications noted herein for specific material requirements.

END OF SECTION - 061000

SECTION 071816 - VEHICULAR TRAFFIC COATINGS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Single installer shall be responsible for providing complete sealant and waterproofing system designed to minimize occurrence of common sealant, waterproofing, and concrete deterioration problems. All measures called for in these Specifications will be rigorously enforced.
- B. This section specifies a fluid applied, waterproofing, traffic bearing elastomeric membrane with integral wearing surface, where surface to which membrane is to be applied is over occupied spaces as noted on the drawings (i.e., Storage Rooms, Electrical Rooms, Elevator Control Room). Membrane is also required over all Cast-in-Place Concrete wash areas as noted on the drawings. Materials shall be compatible with materials or related work which they come into contact.

1.2 RELATED WORK

- A. Division 03, Section 033000, CAST-IN-PLACE CONCRETE.
- B. Division 03, Section 034133, PRECAST STRUCTURAL PRETENSIONED CONCRETE.
- C. Division 9, Section, PAVEMENT MARKINGS.

1.3 TEST AREA

- A. Before start of general application, apply the elastomeric coating as specified in a representative test area. The area shall be approximately 9 m² (100 square feet). The area to be covered by the coating shall include all site conditions such as flashings bases, corners and projections through the coating. Location of test area shall be determined by the Resident Engineer, and after approval, shall serve as an example for the remaining work.

1.4 QUALITY ASSURANCE

- A. Testing Agency: Independent testing laboratory employed by Owner and acceptable to Resident Engineer.
- B. Manufacturer: Review concrete finish specification and confirm in writing to Resident Engineer and General Contractor that finishes as specified are acceptable for system to be installed. Send to Resident Engineer and General

Contractor 1 month before placement of any concrete which will receive traffic topping.

- C. Testing Agency employ wet mil gauge to periodically monitor thickness during application. See Submittals paragraph Traffic Topping, Quality Control Procedures, Quality Control Plan.
- D. Manufacturer: Provide qualified representative on site for duration of Work.
- E. Use trial sections under Installation/Application paragraph Traffic Topping, "Install 1 trial section..." to determine adequacy of pre-application surface cleaning. Obtain Owner, Resident Engineer and manufacturer acceptance of cleaning before proceeding with topping application.
- F. Determine overall topping system mil thickness:
 - 1. Contractor shall provide 6 in. by 6 in. bond breaker (topping coupon) on concrete surface for each 25,000 sq ft, or fraction thereof, of topping to be placed as directed by Resident Engineer and manufacturer. Dimensionally locate coupon for easy removal.
 - 2. Contractor shall assist Testing Agency in removing topping coupons from concrete surface at completion of manufacturer-specified cure period. Contractor shall repair coupon area per topping manufacturer's instructions.
 - 3. Testing Agency shall determine dry mil thickness of completed Traffic Topping System, including bond breaker. Take 9 readings (minimum), 3 by 3 pattern at 2 in. on center. No reading shall be taken closer than 1 in. from coupon edge. Report individual readings and overall topping system average to Resident Engineer. Readings shall be made with micrometer or optical comparator.
- G. Pre-installation Conference: Meet at project site well in advance of time scheduled for Work to proceed to review requirements for Work and conditions that could interfere with successful topping performance. Require every party concerned with topping Work, or required to coordinate with it or protect it thereafter, to attend. Include manufacturer's technical representative and warranty officer.
- H. Traffic Topping shall satisfy the current National Volatile Organic Compound (VOC) Emission Standards for Architectural Coatings.

1.5 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Manufacturers Literature and Data: Each material, indicating compliance with specification requirements.
- C. Section "Vehicular Traffic Coatings" contractor's experience record for past 3 years.
 - 1. Experience shall include verification of 3 years experience with submitted system.
 - 2. Information shall be included with bid submission.
- D. Superintendent qualifications.
 - 1. List Superintendent's specific training/qualification.
- E. Evidence of applicator's being certified by manufacturer. Evidence shall include complete copy of manufacturer's licensing/certification document, spelling out repair responsibility for warranty claims.
- F. Reviewed Shop Drawings distributed to all others whose Work is related.
- G. Manufacturer shall submit a resume with a minimum of 5 independently verified projects completed within the last 2 years with submitted system, to include:
 - 1. Name and location of project.
 - 2. Type of system applied.
 - 3. On-Site contact with phone number.
- H. Certification that products and installation comply with applicable federal, state of Michigan, and local EPA, OSHA and VOC requirements regarding health and safety hazards.
- I. Two copies each of manufacturer's technical representative's log for each visit.
- J. Signed statement from this Section applicator certifying that applicator has read, understood, and shall comply with all requirements of this Section.
- K. Submit 3 copies of System Maintenance Manual.
- L. Five copies of Snow Removing Guidelines for areas covered by guarantees.
- M. Written computations to Resident Engineer of material quantities (by components) to be applied to concrete surface at least 60 days before application of traffic topping.
- N. Proposed method of preparation of concrete surface.

- O. Proposed method and details for treatment of cracks and other defects on concrete surface.
- P. Product samples: Each finish color on 100 by 200 mm (4 by 8 inch) Stepped Sample showing each component for each duty grade to be applied.
- Q. Quality Control Procedures: System manufacturer shall submit written quality control plan to Resident Engineer for acceptance one month prior to construction for application procedures which specifically address following:
 - 1. Surface preparation acceptance criteria.
 - 2. Crack detailing recommendations.
 - 3. Method of application of coats.
 - 4. Primer type and application rate.
 - 5. For all coats, wet mils required to obtain specified dry thickness. System dry mil thickness excluding aggregate.
 - 6. Number and type of coats.
 - 7. Quality control plan for assured specified uniform membrane thickness that utilizes grid system of sufficiently small size to designate coverage area of not more than 5 gallons at specified thickness. In addition, employ wet mil gauge to continuously monitor thickness during application. Average specified wet mil thickness shall be maintained within grid during application with minimum thickness of not less than 80% of average acceptable thickness. Immediately apply more material to any area not maintaining these standards.
 - 8. Type, gradation and aggregate loading required within each coat.
 - 9. Maximum and minimum allowable times between coats.
 - 10. Temperature, humidity and other weather constraints. Specify substrate moisture testing criteria.
 - 11. Final cure time before resumption of parking and/or paint striping.
 - 12. Any other special instructions required to ensure proper installation.
 - 13. Quality Service Requirements:
 - a. Show evidence of nationwide vendor and licensed/approved applicator network. List of names, addresses and phone numbers, with copies of certification/approval agreement with each, satisfies requirement. Licensing/certification agreement shall include following information:
 - 1) Applicator's financial responsibility for warranty burden under agreement terms.
 - 2) Manufacturer's financial responsibility for warranty burden under agreement terms.
 - 3) Process for dispute settlement between manufacturer and applicator in case of system failures where cause is not evident or cannot be assigned.
 - 4) Authorized signatures for both Applicator Company and Manufacturer.
 - 5) Commencement date of agreement and expiration date (if applicable).

- b. Provide copies of manufacturing statistical process control charts for current month.
 - c. Provide copy of field application quality control procedures.
 - d. Show evidence of minimum 10 projects completed by applicator over previous 3 years using submitted system.
14. Flash point of each component 200o F. maximum.
15. Static coefficient of friction shall meet minimum requirements of Americans with Disabilities Act (ADA).
16. Provide certificate stating materials have been tested and listed for UL 790 Class "A" rated materials/system by UL for traffic topping application specified on project. Containers shall bear UL labels.
17. Written certification from traffic topping manufacturer confirming compatibility with existing underlying coatings and/or substrate.
18. Written acceptance by traffic topping manufacturer of existing coatings and/or substrate for application of new traffic topping system.

1.6 WARRANTY

- A. Warranty surfaces, where elastomeric coating has been applied, against leaks and other failures, over and above normal wear and failure of substrate, and subject to the terms of the "Warranty of Construction", FAR clause 52.246-21, except that the warranty period is three years.
- B. System Manufacturer: The warranty shall provide that system will be free of defects, water penetration and chemical damage related to system design, workmanship or material deficiency, consisting of:
 - 1. Any adhesive or cohesive failures.
 - 2. Spalling surfaces.
 - 3. Weathering.
 - 4. Abrasion or tear failure resulting from normal traffic use.
 - 5. Failure to bridge cracks less than 0.0625 in. or cracks existing at time of traffic topping installation on double tees only.
- C. If material surface shows any of defects listed above, supply labor and material to repair all defective areas and to repaint all damaged line stripes.
- D. Perform any repair under this warranty at no cost to Owner.
- E. With submittal, provide Resident Engineer with sample of final warranty including the following: length of warranty, change in value of warranty – if any- based on length of remaining warranty period, transferability of warranty, responsibilities of each party, notification procedures, dispute resolution procedures, and limitations of liability for direct and consequential damages.

- F. With submittal, provide Resident Engineer with sample of Manufacturer's Licensing/Certification Agreement, detailing joint responsibilities of manufacturer and applicator with regard to warranty claim resolution.
- G. Snowplows, vandalism, abnormal abrasive maintenance equipment, and studded snow tires are not normal traffic use and are exempted from Warranty.

1.7 DELIVERY AND STORAGE

- A. Delivery materials to the site in original sealed containers, clearly marked with manufacturer's name and brand, and type of material.
- B. Store materials in weather tight and dry storage facility. Protect from damage from handling, weather and construction operations before, during and after installation. Store materials at temperatures and under conditions recommended by the manufacturer.

1.8 PROJECT CONDITIONS

- A. Proceed work only when existing and forecast weather and temperature of concrete substrate will permit work in accordance with Manufacturers Recommendations.

1.9 SAFETY REQUIREMENTS

- A. Keep products away from heat, sparks and flame. Do not permit use of spark producing equipment during application of flammable products or where explosive fumes are present.

1.10 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - C794-06 Adhesion in Peel of Elastomeric Joint Sealants
 - D412-06 Vulcanized Rubber and Thermoplastic Elastomers-Tension
 - D2240-05 Rubber Property Durometer Hardness
 - E96-05 Water Vapor Transmission of Materials

PART 2 – PRODUCTS

2.1 PRIMER

- A. Type required by the elastomeric coating manufacturer.

2.2 ELASTOMERIC BASE AND TOP COAT

- A. Elastomeric base and top coat materials shall meet or exceed the following requirements:

Property	Test Method	Base Coat	Top Coat
Tensile Strength	ASTM D412	300 pounds per square inch	2000 pounds per square inch
Elongation	ASTM D412	350 percent	200 percent
Hardness, Shore A	ASTM D2240	25	75
Peel Strength (on concrete)	ASTM C794	30 pounds, 100 percent cohesion	100 percent cohesion to base coat
Permeability	ASTM E96	12 metric perms	0.06 metric perms

- B. Provide complete traffic topping system with all components specified for new, heavy-duty applications, including all waterproofing and wearing courses.
- C. Provide ultraviolet screening for all traffic topping placed on this project.
- D. Finish top coat shall be colored grey, unless noted otherwise.

2.3 AGGREGATE

- A. Thoroughly washed, clean, medium grained sharp indigenous stone granules, graded between 1mm and 4mm in size, and having a hardness of 6.5 or greater on the Moh's scale.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect surfaces to receive Work and report immediately in writing to Resident Engineer any deficiencies in surface which render it unsuitable for proper execution of Work.
- B. Coordinate and verify that related Work meets following requirements:
1. Concrete surfaces are finished as acceptable for system to be installed.
 2. Curing compounds used on concrete surfaces are compatible with Work to be installed.
 3. Concrete surfaces have completed proper curing period for system selected.
 4. Joint Sealants are compatible with traffic toppings.

- C. Acid etching: Prohibited.
- D. All openings to occupied space shall be sealed to prevent cleaning materials, solvents and fumes from infiltration. All protective measures and/or ventilating systems required to prevent infiltration are incidental to this Work.

3.2 PREPARATION

- A. General Contractor: Correct unsatisfactory conditions in manner acceptable to traffic topping installer before installation. All high points, ridges, and other defects shall be corrected as acceptable to Resident Engineer prior to installation of traffic topping.
- B. Remove all laitance and surface contaminants, including oil, grease and dirt by shotblasting. Prepare by sandblasting all surfaces inaccessible to shotblast equipment.
- C. Before applying materials, apply system to small area to assure that it will adhere to substrate and joint sealants and dry properly and to evaluate appearance.
- D. A primer coat is required for all systems. No exception.
- E. All cracks on concrete surface shall be prepared in accordance with manufacturer's recommendations.
- F. Mask off adjoining surfaces not to receive traffic topping and mask off drains to prevent spillage and migration of liquid materials outside membrane area. Provide neat/straight lines at termination of traffic topping.

3.3 APPLICATION

- A. Prime all surfaces to receive elastomeric waterproofing materials as recommended by the products manufacturer.
- B. Where horizontal surfaces intersect vertical surfaces provide a sealant type fillet as recommended by the manufacturers.
- C. Apply elastomeric base coat at a rate that will ensure a dry film thickness of not less than 25 mils.
- D. Apply elastomeric intermediate coat at a rate that will ensure a dry film thickness of not less than 15 mil.
- E. Uniformly disperse aggregate topping in intermediate coat at the rate of 1.5 to 2.4 Kg per m² (30 to 50 lbs/100 sq. ft.); inter bond and vulcanize granules within the fluid elastomeric topping in accordance with manufacturer's instructions.

- F. Apply elastomeric top coat at a rate which will ensure a dry film thickness of 12 mils for the top coat and a total combined dry film thickness for the base, intermediate and top coats of not less than 52 mils.
- G. Uniformly disperse aggregate topping in top coat at the rate of 0.5 Kg per m² (10 lbs/100 sq. ft.); inter bond and vulcanize granules within the fluid elastomeric topping in accordance with manufacturer's instructions.
- H. Complete the base to a uniform established line as shown.

3.4 INSTALLATION

- A. Do all Work in strict accordance with manufacturer's written instructions and specifications including, but not limited to, moisture content of substrate, atmospheric conditions (including relative humidity and temperature), coverages, mil thicknesses and texture, and as shown on Drawings.
- B. Manufacturer's technical representative, acceptable to Resident Engineer, shall be on site during surface preparation and installation.
- C. Cease material installation under adverse weather conditions, or when temperatures are outside manufacturer's recommended limitations for installation, or when temperature of work area or substrate are below 40°F.
- D. Refer to Submittals paragraph Traffic Topping, "Quality Control Procedures..." and Quality Assurance paragraph Traffic Topping.
- E. Installation shall include all of following steps:
 - 1. Surface Preparation – to prepare concrete for system application.
 - 2. Crack Detail – for crack bridging.
 - 3. Primer Coat – To insure proper adhesion of membrane to substrate.
 - 4. Base Coat – to provide crack spanning in conjunction with Crack Detail noted above.
 - 5. Aggregate Coat – to hold aggregate in system, providing skid and wear close up resistance.
 - 6. Aggregate – Correct size, shape, hardness and amount necessary to insure proper skid and wear resistance.
 - 7. Top Coat – to lock aggregate into place, provide a maintainable surface and provide resistance to ponding water, UV degradation, color loss and chemical intrusion.
- F. Do not apply traffic topping material until concrete has been air dried at temperatures at or above 40° F. for at least 30 days after curing period specified.

- G. Install 1 trial section of topping system for each duty grade specified. Do not proceed with further topping application until trial sections accepted in writing by Resident Engineer. Remove and replace rejected trial sections with acceptable application. Trial section shall also be tested for:
1. Wet mil thickness application per manufacturer's literature and Submittals paragraph Traffic Topping, "Quality Control Procedures..."
 2. Adhesion to concrete substrate per manufacturer's printed test data.
 3. Overall dry mil thickness per Quality Assurance paragraph Traffic Topping.
- H. All adjacent vertical surfaces shall be coated with traffic topping minimum of 4 in. above coated horizontal surface.
- I. Complete all Work under this Section before painting line stripes.

3.5 CLEANING

- A. Remove smears of elastomeric material from other work.

3.6 PROTECTION

- A. Protect the finished coating from traffic until the coating cures.

END OF SECTION 071816

SECTION 071916 - SILANE WATER REPELLENTS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Single installer shall be responsible for providing complete sealant and waterproofing system designed to minimize occurrence of common sealant, waterproofing, and concrete deterioration problems. All measures called for in these Specifications will be rigorously enforced.
- B. This Section includes Concrete Sealer on these surfaces:
 - 1. All top supported concrete floors, except where traffic topping is provided.
 - 2. Concrete stair treads and landings (all levels).
 - 3. All areas of slab-on-grade within Parking Structure Footprint.
- C. Materials shall be compatible with materials or related Work with which they come into contact, and with materials covered by this Section.

1.2 RELATED WORK

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.
- B. Division 03, Section 033000, CAST-IN-PLACE CONCRETE.
- C. Division 03, Section 034133, PRECAST STRUCTURAL PRETENSIONED CONCRETE.
- D. Section 321723, PAVEMENT MARKINGS.

1.3 QUALITY ASSURANCE

- A. Testing Agency: Independent Testing Laboratory employed by Owner and acceptable to Resident Engineer.
- B. Manufacturer: Sealer shall be compatible with all materials to which it would be applied.
- C. Sealer shall be applied to Project at same rate used to pass NCHRP 244 test. However, Section "Silane Water Repellents" Installation/Application paragraph "Install 3 trial sections..." must also be met. If both requirements cannot be met simultaneously with single application rate, sealer will be rejected.

- D. Testing Agency shall take a) 1 core from each trial section referenced under Section "Silane Water Repellents" Installation/Application paragraph "Install 3 trial sections...", and b) 3 additional cores as directed by Resident Engineer after sealer application to test for sealer effectiveness in accordance with ASTM D6489-99 "Determining Water Absorption of Hardened Concrete Treated with a Water Repellent Coating". Concrete core samples shall be taken 14 days after application of sealer. Report water absorption through top and bottom surfaces of core. Sealer effectiveness as determined by comparison of water absorption through sealed top surface and core bottom surface shall be at least 85 percent.
- E. Sealer shall satisfy the current National Volatile Organic Compound (VOC) Emission Standards for Architectural Coatings.

1.4 SUBMITTALS

- A. Make submittals in accordance with requirements of Division 01 and as specified in this Section.
- B. Section "Silane Water Repellents" contractor's experience record for past 3 years.
 - 1. Experience shall include verification of 3 years experience with submitted system.
- C. Superintendent qualifications.
 - 1. List Superintendent's specific training/qualification.
- D. Evidence of applicator's being certified by manufacturer. Evidence shall include complete copy of manufacturer's licensing/certification document, spelling out repair responsibility for warranty claims.
 - 1. Provide a complete copy of licensing/certification document for each system manufacturer to Resident Engineer that confirms system installer is a licensed/certified applicator for the manufacturer and is legally licensed to perform work in the state of Michigan.
 - 2. Licensing/certification agreement must provide following information:
 - a. Applicator's financial responsibility for warranty burden under agreement terms.
 - b. Manufacturer's financial responsibility for warranty burden under agreement terms.
 - c. Process for dispute settlement between manufacturer and applicator in case of system failures where cause is not evident or cannot be assigned.
 - d. Officers' signatures for both Applicator Company and Manufacturer.

- e. Commencement date of agreement and expiration date (if applicable).
 - 3. All Work under Section "Silane Water Repellents" shall be performed by organizations which have successfully performed at least 3 verifiable years of installations similar to those involved in this Contract, and minimum 10 projects with submitted system. In addition, system installer shall submit listing of 5 or more prior installations in climate and size similar to that for this Project.
 - 4. Final selection of Section "Silane Water Repellents" installer shall be subject to acceptance of Resident Engineer. Resident Engineer retains right to reject any installer.
 - 5. All Section "Silane Water Repellents" Work shall be under immediate control of person experienced in this type Work. Exercise close check and rigid control of all operations as necessary for full compliance with all requirements. Contractor's superintendent assigned to Project shall have supervised 5 prior projects of similar magnitude and design, and shall be present during all operations. Superintendent shall be acceptable to Resident Engineer. Resident Engineer retains right to remove superintendent from project if superintendent fails to ensure full compliance with Specification.
- E. Reviewed Shop Drawings distributed to all others whose Work is related.
- F. Manufacturer shall submit a resume with a minimum of 5 independently verified projects completed within the last 2 years with submitted system, to include:
- 1. Name and location of project.
 - 2. Type of system applied.
 - 3. On-Site contact with phone number.
- G. Certification that products and installation comply with applicable federal, state of New York , and local EPA, OSHA and VOC requirements regarding health and safety hazards.
- H. Two copies each of manufacturer's technical representative's log for each visit.
- I. Signed statement from this Section applicator certifying that applicator has read, understood, and shall comply with all requirements of this Section.
- J. Submit 3 copies of System Maintenance Manual.
- K. Written computations to Resident Engineer of material quantities to be applied to concrete surfaces at least 60 calendar days before sealer application.
- L. Proposals for alternate application methods to Resident Engineer at least 60 calendar days before sealer application.

M. Supplier shall furnish application rate at which following tests were passed:

1. NCHRP 244 tests:

- a. Four Inch Cube Series II (incorporating 5 days of air drying prior to coating test cubes): Upper limits of average weight gain and net chloride content at completion of cube test series shall be limited to 16% of weight gain and 14% of net chloride gain of untreated control cubes.
2. ASTM C672 test (non-air entrained concrete): Acceptable scaling rating shall be "zero plus."
3. All laboratory testing specified shall be performed with manufacturer's product. Test results based on utilization of substitute sealer formulations are not acceptable.

N. Quality Service Requirements:

1. Show evidence of nationwide vendor and certified/approved applicator network. List of names, addresses and phone numbers, with copies of certification/approval agreement with each, satisfies requirement.
2. Provide copies of manufacturing statistical process control charts for current month.

1.5 PROJECT CONDITIONS

A. Weather and Substrate Conditions for Sealers: Do not proceed with application (except with written recommendation of manufacturer) under any of the following conditions:

1. Ambient temperature is less than 40° F.
2. Substrate surfaces have cured for less than 1 month.
3. Rain or temperatures below 40° F predicted for a period of 24 hours.
4. Earlier than 24 hours after surfaces became wet.
5. Substrate is frozen or surface temperature is less than 40° F.
6. Windy condition such that repellent may be blown to vegetation or substrates not intended.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials to site in original, unopened containers, bearing following information:

1. Name of product.
2. Name of manufacturer.
3. Date of preparation.

- 4. Lot or batch number.
- B. Store materials under cover and protect from weather. Replace packages or materials showing any signs of damage with new material at no additional cost to Owner.
- C. At no time shall weight of stored material being placed on slab area exceed total design load of slab area.

1.7 WARRANTY

- A. Warranty surfaces, where silane water repellent has been applied, against leaks and other failures, over and above normal wear and failure of substrate, and subject to the terms of the "Warranty of Construction", FAR clause 52.246-21, except that the warranty period is two years.
- B. If material surface shows any defects, supply labor and material to repair all defective areas and to repaint all damaged line stripes.
- C. Perform any repair under this warranty at no cost to Owner.
- D. With submittal, provide Resident Engineer with sample of final warranty including the following: length of warranty, change in value of warranty – if any- based on length of remaining warranty period, transferability of warranty, responsibilities of each party, notification procedures, dispute resolution procedures, and limitations of liability for direct and consequential damages.
- E. With submittal, provide Resident Engineer with sample of Manufacturer's Licensing/Certification Agreement, detailing joint responsibilities of manufacturer and applicator with regard to warranty claim resolution.

1.8 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C642, "Test for Specific Gravity, Absorption and Voids in Hardened Concrete."
 - 2. ASTM D6489-99, "Determining the Water Absorption of Hardened Concrete Treated with a Water Repellent Coating."

PART 2 - PRODUCTS

2.1 MATERIALS, CONCRETE SEALER

- A. Acceptable concrete sealers are listed below. Minimum application rate in sq ft per gal (sf/g) is listed for each product type. Submit 1 product from Class Silane (40%, Low VOC) and include in Base Bid. Submit 1 product each from Class Silane (40%, water based) and Class Silane (90% - 100%) and submit as Add Alternates. Sealers shall be compatible with all other materials in this Section and related work.

1. Class Silane (40%, Low VOC): 125 sf/g.
2. Class Silane (40%+, water based): 125 – 150 sf/g.
3. Class Silane (90-100%): 200 sf/g.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect surfaces to receive Work and report immediately in writing to Resident Engineer any deficiencies in surface which render it unsuitable for proper execution of Work.
- B. Coordinate and verify that related Work meets following requirements:
 1. Concrete surfaces are finished as acceptable for system to be installed.
 2. Curing compounds used on concrete surfaces are compatible with Work to be installed.
 3. Concrete surfaces have completed proper curing period for system selected.
 4. Joint Sealants are compatible with sealers.
- C. Acid etching: Prohibited.
- D. All openings to occupied space shall be sealed to prevent cleaning materials, solvents and fumes from infiltration. All protective measures and/or ventilating systems required to prevent infiltration are incidental to this Work.

3.2 PREPARATION, CONCRETE SEALER

- A. All control joint and expansion joint Work shall be complete and accepted by Resident Engineer before beginning concrete sealer surface preparation and application.
- B. Repair or replace all sealant materials damaged by surface preparation operations.
- C. Clean all surfaces to be sealed as acceptable to sealer manufacturer before sealer application by means of medium/high pressure water blasting or scrubbing with brooms and cleaning solution. Cleaning method and materials shall be sufficient to allow absorption criteria stated in Quality Assurance, paragraph Concrete Sealer, "Testing Agency shall take..." to be met. See Installation/ Application paragraph Concrete Sealer, "Install 3 trial sections..." also.
- D. Equipment used during floor slab cleaning shall not exceed height limitation of facility and shall not exceed 3,000 lb axle load or vehicle gross weight of 6,000 lb.

- E. Mask off adjoining surfaces not to receive sealer and mask off drains to prevent spillage and migration of liquid materials outside sealer area. Provide neat/straight lines at termination of sealer.

3.3 INSTALLATION/APPLICATION, GENERAL

- A. Do all Work in strict accordance with manufacturer's written instructions and specifications including, but not limited to, moisture content of substrate, atmospheric conditions (including relative humidity and temperature), coverages, mil thicknesses and texture, and as shown on Drawings.
- B. Manufacturer's technical representative, acceptable to Resident Engineer, shall be on site during surface preparation and installation.
- C. Cease material installation under adverse weather conditions, or when temperatures are outside manufacturer's recommended limitations for installation, or when temperature of work area or substrate are below 40°F.
- D. Submit manufacturer's recommended application rates in writing before start of sealer application. Quality Assurance paragraph Concrete Sealer, "Testing Agency shall take..." states minimum rate.
- E. All concrete to be treated shall be cured above 50° F. for at least 14 days before applying sealer.
- F. All concrete to be treated shall be air dried for at least 72 hours (following surface wetting) at temperatures above 50° F. immediately before applying protective sealer system.
- G. Ambient and concrete temperatures shall be 50° F. or higher during application of protective sealer, but temperature, humidity and wind velocity shall be within manufacturer-specified limits to prevent solvent flash-off.
- H. Install 3 trial sections of sealer to verify treated surface is not glazing as result of sealer application. If application of sealer causes glazing at trial section, Contractor shall contact sealer manufacturer to obtain written recommendations for solving problem. Contractor shall not proceed with sealer application following trial section applications until directed to do so in writing by Resident Engineer.
- I. Clean all surfaces affected by sealer material overspray and repair all damage caused by sealer material overspray to adjacent construction or property at no cost to Owner.

- J. Unsatisfactory test results reported under Quality Assurance paragraph Concrete Sealer, "Testing Agency shall take..." shall be grounds for rejection of sealer and sealer application or sealer reapplication at no additional cost to Owner.

3.4 CLEANING

- A. Clean off excess material and material smears adjacent to joints as work progresses using methods and materials approved by manufacturers.

END OF SECTION 071916

SECTION 076000 - FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Formed sheet metal work for flashing and insulated expansion joint covers are specified in this section.

1.2 RELATED WORK

- A. Section 034133, PRECAST STRUCTURAL PRETENSIONED CONCRETE
- B. Section 042000, UNIT MASONRY
- C. Sealant compound and installation: Section 079200, JOINT SEALANTS.
- D. Paint materials and application: Section 099100, PAINTING.
- E. Flashing of Floor Drains.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
 - 1. Flashings
 - 2. Gravel Stop-Fascia
- C. Manufacturer's Literature and Data:
 - 1. Two-piece counterflashing
 - 2. Nonreinforced, elastomeric sheeting
- D. Certificates: Stating that aluminum has been given - specified finish & thickness of anodizing.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below for a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

B209-07Aluminum and Aluminum-Alloy Sheet and Plate
D4586-07Asphalt Roof Cement, Asbestos Free

C. American National Standards Institute/Single Ply Roofing Institute (ANSI/SPRI):

ES-1-2003Wind Design Standard for Edge Systems Used with
Low Slope Roofing Systems

D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

Architectural Sheet Metal Manual (2003 Edition).

E. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-505-88Metal Finishes Manual

F. American Architectural Manufacturers Association (AAMA):

605-98Voluntary Specification for High Performance Organic
Coatings on Architectural Extrusions Panels

G. Federal Specification (Fed. Spec):

A-A-1925AShield, Expansion; (Nail Anchors)

H. International Building Code (IBC):

2007 Edition

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Sheet: ASTM B209, alloy 3003-H14. Except alloy used for color anodized aluminum shall be as required to produce specified color. Alloy required to produce specified color shall have the same structural properties as alloy 3003-H14.
- B. Rosin Paper: Fed-Spec. UU-B-790, Type I, Grade D, Style 1b, Rosin-sized sheathing paper, weighing approximately 3 Kg/10 m²(6 lbs/100 sf).
- C. Bituminous Paint: ASTM D1187, Type I.

D. Fasteners:

1. Nails:

- a. Minimum diameter for aluminum nails 3 mm (0.105 inch).
- b. Minimum diameter for stainless steel nails: 2 mm (0.095 inch) and annular threaded.
- c. Length to provide not less than 22 mm (7/8 inch) penetration into anchorage.

2. Rivets: Not less than 3 mm (1/8 inch) diameter.

3. Expansion Shields: Fed Spec A-A-1925A.

E. Sealant: As specified in Section 07 92 00, JOINT SEALANTS for exterior locations.

F. Roof Cement: ASTM D4586.

2.2 SHEET METAL THICKNESS

A. Except as otherwise shown or specified use thickness or weight of sheet metal as follows:

B. Thickness of aluminum or galvanized steel is specified with each item.

2.3 FABRICATION, GENERAL

A. Jointing:

1. Joints shall conform to following requirements:

- a. Flat-lock joints shall finish not less than 19 mm (3/4 inch) wide.
- b. Lap joints subject to stress shall finish not less than 25 mm (one inch) wide and shall be soldered and riveted.
- c. Unsoldered lap joints shall finish not less than 100 mm (4 inches) wide.

2. Flat and lap joints shall be made in direction of flow.

B. Expansion and Contraction Joints:

1. Fabricate in accordance with the Architectural Sheet Metal Manual recommendations for expansion and contraction of sheet metal work in continuous runs.
2. Space joints as shown or as specified.
3. Space expansion and contraction joints for aluminum at intervals not exceeding 5400 mm (18 feet), except do not exceed 3000 mm (10 feet) for gravel stops and fascia-cant systems.

4. Fabricate slip-type or loose locked joints and fill with sealant unless otherwise specified.
5. Fabricate joint covers of same thickness material as sheet metal served.

C. Cleats:

1. Fabricate cleats to secure flashings and sheet metal work over 300 mm (12 inches) wide and where specified.
2. Provide cleats for maximum spacing of 300 mm (12 inch) centers unless specified otherwise.
3. Form cleats of same metal and weights or thickness as the sheet metal being installed unless specified otherwise.
4. Fabricate cleats from 50 mm (2 inch) wide strip. Form end with not less than 19 mm (3/4 inch) wide loose lock to item for anchorage. Form other end of length to receive nails free of item to be anchored and end edge to be folded over and cover nail heads.

D. Edge Strips or Continuous Cleats:

1. Fabricate continuous edge strips where shown and specified to secure loose edges of the sheet metal work.
2. Except as otherwise specified, fabricate edge strips or minimum 1.25 mm (0.050 inch) thick aluminum.
3. Use material compatible with sheet metal to be secured by the edge strip.
4. Fabricate in 3000 mm (10 feet) maximum lengths with not less than 19 mm (3/4 inch) loose lock into metal secured by edge strip.
5. Fabricate Strips for fascia anchorage to extend below the supporting wood construction to form a drip and to allow the flashing to be hooked over the lower edge at least 19 mm (3/4-inch).
6. Fabricate anchor edge maximum width of 75 mm (3 inches) or of sufficient width to provide adequate bearing area to insure a rigid installation using 1.6 mm (0.0625 inch) thick aluminum.

E. Drips:

1. Form drips at lower edge of sheet metal counter-flashings (cap flashings), fascias, gravel stops, wall copings, by folding edge back 13 mm (1/2 inch) and bending out 45 degrees from vertical to carry water away from the wall.
2. Form drip to provide hook to engage cleat or edge strip for fastening for not less than 19 mm (3/4 inch) loose lock where shown.

F. Edges:

1. Edges of flashings concealed in masonry joints opposite drain side shall be turned up 6 mm (1/4 inch) to form dam, unless otherwise specified or shown otherwise.

2. Finish exposed edges of flashing with a 6 mm (1/4 inch) hem formed by folding edge of flashing back on itself when not hooked to edge strip or cleat. Use 6 mm (1/4 inch) minimum penetration beyond wall face with drip for through-wall flashing exposed edge.
3. All metal roof edges shall meet requirements of IBC 2003.

G. Metal Options:

1. Where options are permitted for different metals use only one metal throughout.

2.4 FINISH

- A. Use same finish on adjacent metal or components and exposed metal surfaces unless specified or shown otherwise.
- B. In accordance with NAAMM Metal Finishes Manual, unless otherwise specified.
- C. Finish exposed metal surfaces as follows, unless specified otherwise:
 1. Aluminum:
 - a. Clear Finish: AA-C22A41 medium matte, clear anodic coating, Class 1 Architectural, 18 mm (0.7 mils) thick.

2.5 CONDUCTORS (DOWNSPOUTS)

- A. Fabricate conductors and scuppers of not less than 0.025 thick stainless steel in sections approximately 3000 mm (10 feet) long with 19 mm (3/4 inch) wide flat locked seams.
- B. Fabricate open face channel shape with hemmed longitudinal edges.
- C. Fabricate elbows by mitering, riveting, and soldering. Lap upper section to the inside of the lower piece.
- D. Fabricate conductor brackets or hangers of same material as conductor, 2 mm (1/16 inch) thick by 25 mm (one inch) minimum width. Form to support conductors 25 mm (one inch) from wall surface in accordance with Architectural Sheet Metal Manual Plate 34, Design C for rectangular.
- E. Conductor Heads:
 1. Fabricate of same material as conductor.

2. Fabricate conductor heads to not less than 250 mm (10 inch) wide by 200 mm (8 inch) deep by 200 mm (8 inches) from front to back.
3. Form front and side edges channel shape not less than 13 mm (1/2 inch) wide flanges with edge hemmed.
4. Slope bottom to sleeve to conductor or downspout at not less than 60 degree angle.
5. Extend wall edge not less than 25 mm (one inch) above front edge.
- 6. SOLDER JOINTS FOR WATER TIGHT ASSEMBLY.**
- 7. FABRICATE OUTLET TUBE OR SLEEVE AT BOTTOM NOT LESS THAN 50 MM (2 INCHES) LONG TO INSERT INTO CONDUCTOR.**

2.6 SPLASHPANS

- A. Fabricate of 0.4 mm (0.015 inch) thick stainless steel.

2.7 REGLETS

- A. Fabricate reglets of one of the following materials:
 1. Stainless steel, not less than 0.3 mm (0.012 inch) thick.
- B. Fill open-type reglets with fiberboard or other suitable separator, to prevent crushing of the slot during installation.
- C. Bend edges of reglets for setting into concrete to an angle of not less than 45 degrees, and make wide enough to provide firm anchorage in the concrete.
- D. Fabricate reglets for building into horizontal masonry mortar joints not less than 19 mm (3/4 inch) deep, nor more than 25 mm (one inch) deep.
- E. Fabricate mitered corners, fittings, and special shapes as may be required by details.
- F. Reglets for concrete may be formed to receive flashing and have a 10 mm (3/8 inch), 45 degree snap lock.

2.8 SCUPPERS

- A. Fabricate scuppers with minimum of 100 mm (4 inch) wide flange.
- B. Provide flange at top on through wall scupper to extend to top of base flashing.
- C. Fabricate exterior wall side to project not less than 13 mm (1/2 inch) beyond face of wall with drip at bottom outlet edge.
- D. Fabricate not less than 100 mm (4 inch) wide flange to lap behind gravel stop fascia.

- E. Fabricate exterior wall flange for through wall scupper not less than 25 mm (one inch) wide on top and sides with edges hemmed.
- F. Fabricate gravel stop bar of 25 mm x 25 mm (one by one inch) angle strip soldered to bottom of scupper.
- G. Fabricate scupper not less than 200 mm (8 inch) wide and not less than 125 mm (5 inch) high for through wall scupper.
- H. Solder joints watertight.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install flashing and sheet metal items as shown in Sheet Metal and Air Conditioning Contractors National Association, Inc., publication, ARCHITECTURAL SHEET METAL MANUAL, except as otherwise shown or specified.
2. Apply Sealant as specified in Section 079200, JOINT SEALANTS.
3. Apply sheet metal and other flashing material to surfaces which are smooth, sound, clean, dry and free from defects that might affect the application.
4. Remove projections which would puncture the materials and fill holes and depressions with material compatible with the substrate.
5. Coordinate with masonry work for the application of a skim coat of mortar to surfaces of unit masonry to receive flashing material before the application of flashing.
6. Confine direct nailing of sheet metal to strips 300 mm (12 inch) or less wide. Nail flashing along one edge only. Space nail not over 100 mm (4 inches) on center unless specified otherwise.
7. Install bolts, rivets, and screws where indicated, specified, or required in accordance with the SMACNA Sheet Metal Manual. Space rivets at 75 mm (3 inch) on centers in two rows in a staggered position. Use neoprene washers under fastener heads when fastener head is exposed.
8. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
9. Nail continuous cleats on 75 mm (3 inch) on centers in two rows in a staggered position.
10. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
11. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.

12. Where required to prevent galvanic action between dissimilar metal isolate the contact areas of dissimilar metal with sheet lead, waterproof building paper, or a coat of bituminous paint.
13. Isolate aluminum in contact with dissimilar metals others than stainless steel, white bronze or other metal compatible with aluminum by:
 - a. Paint dissimilar metal with a prime coat of zinc-chromate or other suitable primer, followed by two coats of aluminum paint.
 - b. Paint dissimilar metal with a coat of bituminous paint.
 - c. Apply an approved caulking material between aluminum and dissimilar metal.
14. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
15. Paint aluminum in contact with absorptive materials that may become repeatedly wet with two coats of bituminous paint or two coats of aluminum paint.

3.2 REGLETS

- A. Install reglets in a manner to provide a watertight installation.
- B. Locate reglets not less than 225 mm (9 inch) nor more than 400 mm (16 inch) above roofing, and not less than 125 mm (5 inch) nor more than 325 mm (13 inch) above cant strip.
- C. Butt and align end joints or each section of reglet and securely hold in position until concrete or mortar are hardened:
 1. Coordinate reglets for anchorage into concrete with formwork construction.
 2. Coordinate reglets for masonry to locate horizontally into mortar joints.

END OF SECTION 076000

SECTION 076100 - METAL ROOFING SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide and install a hidden fastener, metal roofing panel system – See Roof Panel Description for appearance of roof panel
- B. Attachment clips or channels, vinyl closure strips and other accessories
- C. Related flashings, closures, ice guards and accessory components – as required
- D. Furnish all accessories necessary for a complete and watertight installation.
- E. Gutters and Downspouts

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 051200 – Structural Steel: Structural steel building frame
- B. Section 060700 – Pressure-Treated Products
- C. Section 061000 – Rough Carpentry
- D. Section 079200 – Joint Sealants

1.03 REFERENCES

- A. American Iron & Steel Institute (AISI) Specification for the Design of Cold formed Steel Structural Members
- B. ASTM E-1592
- C. ASTM A-653 & ASTM A924 Steel Sheet, Zinc-Coated (Galvanized)
- D. ASTM A167 - Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip
- E. ASTM A446/A446 M - Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process, Structural (Physical) Quality
- F. ASTM A525/A525 M - Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process, General Requirements
- G. ASTM A606 - Steel Sheet and Strip, Hot Rolled and Cold Rolled, High Strength, Low Alloy, with Improved Corrosion Resistance

- H. ASTM A755/A755 M - Steel Sheet, Metallic Coated by the Hot Dip Process and Prepainted by the Coil Coating Process For Exterior Exposed Building Products
- I. ASTM A792/A792 M - Steel Sheet, Aluminum-Zinc Alloy Coated by the Hot Dip Process, Structural (Physical) Quality
- J. ASTM B370 Specification for Copper Sheet and Strip for Building Construction
- K. ASTM B209/B209 M - Aluminum and Aluminum Alloy Sheet and Plate
- L. ASTM C665 - Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

1.04 SYSTEM DESCRIPTION

- A. System: Preformed and prefinished metal roofing system of standing seam profile noted.
 - 1. Standing seam profile – 16" nominal spacing
 - 2. Clip-on batten
- B. Providing all misc. flashings and trim pieces for a complete and watertight installation.

1.05 PERFORMANCE REQUIREMENTS

- A. General: Provide complete sheet metal roofing system, including, as a minimum, custom-fabricated metal roof pans, cleats, clips, anchors and fasteners, sheet metal flashing and drainage components related to sheet metal roofing, fascia panels, trim, soffit panels, and accessories as indicated and as required for a weathertight installation.
- B. Thermal Movements: Provide sheet metal roofing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal roofing thermal movements. Base engineering calculation on surface temperatures of material defined below.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- C. Water Infiltration: Provide sheet metal roofing that does not allow water infiltration to buildings exterior envelope including soffit structure, with metal flashing and connections of sheet metal roofing lapped to allow moisture to run over and off the material.

1.06 DESIGN REQUIREMENTS

- A. The system shall meet Wind Uplift UL 90 and ASTM E-1592.
- B. Components: Design and size components to withstand dead and live loads caused by snow, positive and negative wind pressure acting normal to plane of roof as calculated in accordance with applicable codes.
- C. Maximum Allowable Deflection of Panel: $1/90$ of span.
- D. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; deflection of structural support framing.
- E. Slope: refer to construction documents for roof slope. Roofing materials, associated accessories, and fabrication must perform as directed in this specification under the indicated low-slope condition.

1.07 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum (3) three years experience.
- B. Installer: Company specializing in performing the work of this section with minimum (3) three years experience.
- C. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- D. Preliminary Roofing Conference: Before starting roof construction, conduct conference at Project site.

1.08 SUBMITTALS

- A. Provide complete literature of manufacturer's product along with detailed drawings of all connection conditions, material gauge, color selection chart, and performance criteria. Shop drawings to show details of weatherproofing at all edges and penetrations.
- B. Samples: Submit samples of roof panel illustrating finish color, sheen, and texture.
- C. Submit manufacturer's 20-year paint warranty covering finish fade, chalk and peel.

- D. Qualification Data: For Installer and fabricator.
- E. Provide a complete set of details noting: seams and dimensions, attachment methods, flashing and termination, roof penetrations, expansion, connections to adjoining work.

1.09 WARRANTY

- A. Special Installer's Warranty: Roofing Installer's warranty, on warranty form at end of this Section, signed by Roofing Installer, in which Roofing Installer agrees to repair or replace components of custom-fabricated sheet metal roofing that fail in materials or workmanship within specified warranty period.**

- 1. Failures include the following:

- a. Structural failures
- b. Loose parts
- c. Wrinkling or buckling
- d. Failure to remain weathertight, including uncontrolled water leakage,
- e. Deterioration of metals, metal finishes, and other materials beyond normal weathering, including non-uniformity of color or finish Galvanic action between sheet metal roofing and dissimilar materials.

- 2. Warranty Period for Roof Performance: Three years from date of Substantial Completion

- B. Paint finish shall have a twenty (20) year guarantee against cracking, peeling and fade (not to exceed 5 N.B.S. units).
- C. Galvalume material shall have a twenty (20) year guarantee against failure due to corrosion, rupture or perforation
- D. Correct defective Work within a (5) five-year period after Substantial Completion for degradation of panel finish including color fading caused by exposure to weather.
- E. Correct defective Work within a (5) five-year period after Substantial Completion water tightness, integrity of seals.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Peterson Aluminum Corporation
- B. Uni-Clad – A Firestone Building Product

- C. Berridge Manufacturing Company
- D. ATAS International, Inc.
- E. Architectural Building Components
- F. MBCI - Metal Building Components, Inc.
- G. ALTERNATE MANUFACTURERS:

1. Proprietary names and/or model numbers used to designate products or materials are not intended to imply that products of named manufacturers are required to exclusion of equivalent products of other accepted manufacturers. Requests for approval of other products may be accepted in accordance with General Conditions.

2.02 ROOF PANEL DESCRIPTION

- A. Roofing shall be Snap-on Standing Seam, continuous panels appropriate for a low-slope condition as shown in construction documents. Seam spacing shall be nominal 16" on center with an approx. height of 2".
- B. Snap-on seams shall be nominally 2" in height and shall contain factory-applied Extruded Vinyl Weather Seal Insert to prevent siphoning of moisture through the standing seam.
- C. The roofing shall be a hidden fastener system, to allow for expansion and contraction of panel material. Concealed anchor clips shall be spaced as required to meet uplift loads (maximum of 24" on center).
- D. Finish shall be a two-coat Kynar 500 finish applied over prime coated steel panel – See below. Architect shall select color from complete color selection.
- E. All trim and flashing shall be fabricated by this manufacturer. Flashings shall be 18 gauge steel 0.040 finished to match roof panel.
- F. The roofing shall carry a full 20 year Warranty as a watertight roofing installation.

2.03 COMPONENTS

- A. Exterior Sheet: Minimum 24 gage thick pre-coated steel stock.
- B. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.
- C. Expansion Joints: Same material, thickness and finish as exterior sheets; manufacturer's standard brake formed.

- D. Trim, Closure Pieces, Caps, Flashings: Same material, thickness and finish as exterior sheets; brake formed to required profiles.
- E. Anchors: Galvanized steel

2.04 UNDERLAYMENT MATERIALS

- A. Self- Adhering, High-Temperature Sheet: 30 to 40 mils thick minimum, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer unless not recommended by manufacturer.
 - 1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970
 - 2. Low Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970
 - 3. Acceptable Products:
 - a. Dri-Start "HR" High Performance Roofing Underlayment
 - b. Grace, W. R. & Co.; Vycor Ultra
 - c. Henry Company; Perma-Seal PE
 - d. Alternate Manufacturers: Proprietary names and/or model numbers used to designate products or materials are not intended to imply that products of named manufacturers are required to the exclusion of equivalent products of other accepted manufacturers. Requests for approval of other products may be accepted in accordance with General Conditions.
- B. Felts: ASTM D 226, Type II (No. 43), asphalt-saturated organic felts without aggregate
- C. Slip Sheet: Building paper, minimum 5 lb/100 sq. ft., rosin sized.

2.05 EXTERIOR SHEET FINISH

- A. Substrate Material:
 - 1. Prefinished Metal shall be Hot-Dipped Galvanized - ASTM A446-85 Grade C G90 Coating A525-86 24 Gauge core steel or prefinished Galvalume - ASTM 792-86 AZ-55
- B. Exterior panel finish system over steel panel substrate noted above: Finish shall be factory-applied full strength Kynar 500 Fluoropolymer coating with a top side dry film thickness of 0.70 to 0.90 mil over 0.25 to 0.35 mil prime coat, to provide a total dry film thickness of 0.95 to 1.25 mil. Bottom side shall be coated with primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for adhesion, flexibility, and longevity as specified by the Kynar 500 finish supplier.

- C. Strippable film shall be applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed before installation.
- D. **Color as selected by the Architect from the Manufacturer's standard range of colors.**

2.06 ACCESSORIES

- A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; color to match.
- B. Vinyl Weatherseal Insert
- C. Sealants: Specified in Section 079200 Manufacturer's standard type suitable for use with installation of system
- D. Fasteners:
 - 1. Galvanized Steel with washers where required.
 - 2. Coordinate with particulars of the Panel System Description – and provide Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized; fastener cap same color as exterior panel. Exposed fasteners same finish as panel system.
- E. Field Touch up Paint: As recommended by panel manufacturer.
- F. Bituminous Paint: Asphalt base.
- G. Metal Gutters and Downspouts:
 - 1. Manufacturer formed gutter in uniform section lengths not exceeding 12 feet, with mitered and welded or soldered corner units, end caps, outlet tubes, and other accessories.
 - 2. Elevate back edge at least 1 inch above front gutter rim for proper drainage.
 - 3. Details and Accessories:
 - a. Furnish with flat-stock gutter straps and gutter support brackets and expansion joints and expansion-joint covers fabricated from same metal and finish as gutters.
 - b. Provide "K" style profile, 4" (6" industrial) high typical.
 - c. Fabricate gutter from 0.050 inch thick aluminum.
 - d. Provide continuous, removable leaf screen with metal frame.
 - e. Provide downspout in rectangular shape, closed-face with mitered elbows, manufactured of the same material and finish as the gutters.
 - 4. Acceptable Manufacturers:

- a. Architectural Products Co.
 - b. Petersen Aluminum
 - c. ATAS International, Inc.
 - d. Hickman
 - e. Alternate Manufacturers: Proprietary names and/or model numbers used to designate products or materials are not intended to imply that products of named manufacturers are required to the exclusion of equivalent products of other accepted manufacturers. Requests for approval of other products may be accepted in accordance with General Conditions.
5. Finish:
- a. Fluoropolymer Coating System: Manufacturer's standard two-coat thermocured system, composed of inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene resin by weight, complying with AAMA 605.2.
 - b. Color and Gloss: **As selected by the Architect from the Manufacturer's standard range of colors.**
6. Material: ASTM B221, 6063-T5 alloy and temper, or as recommended by manufacturer for use intended and as required for proper application of finish indicated.
7. Installation:
- a. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions.
 - b. Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts and accessories. Slope gutters 1/4 inch per foot minimum.
 - c. Install running lengths to allow controlled expansion of movement of metal components in relation not only to one another, but also to adjoining dissimilar materials.
 - d. Seal metal joints watertight.
 - e. Connect downspouts to downspout boots connected to storm sewer system. Seal connection watertight.
8. Cleaning and Protection
- a. Clean exposed surfaces according to manufacturer's written instructions. Touch-up damaged metal coatings.

2.07 EQUIPMENT

- A. Portable Roll-Forming Equipment: Manufacturer's standard UL-certified equipment capable of forming sheet metal roofing in profiles indicated.

2.08 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest practicable lengths.
- C. Form panels for batten seams.
- D. Fabricate corners in one continuous piece with minimum 18-inch returns.
- E. All exposed adjacent flashing shall be of the same material and finish as the roofing panels.
- F. All material panels/coils shall receive "tension leveling" during fabrication to minimize the effects of 'oil-canning' apparent in the finished installation.
- G. Hem all exposed edges of flashing on underside, 1/2 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that building framing members are ready to receive panel system. Coordinate with Manufacturer for allowable substrates and tolerances and report any non-conformance to the Architect.
- B. Report all unacceptable conditions to the Architect. Beginning work constitutes acceptance of conditions.

3.02 FABRICATION

- A. General: fabricate sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions (pan width and seam height), geometry, metal thickness, and other characteristics of installation indicated. Fabricate sheet metal roofing and accessories at the shop to greatest extent possible.
 - 1. Batten-Seam Roofing: Form batten-seam pans of width as indicated on the drawings, with sides turned up as indicated with 1/2-inch flange turned toward center of pan.
- B. Install sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work. Form exposed sheet metal work to fit substrates without excessive oil canning, buckling, and tool marks, true to line and levels indicated, and with exposed edges folded back to form hems.

1. Lay out sheet metal roofing so cross seams, when required, are made in direction of flow with higher pans overlapping lower pans. Stagger cross seams.
 2. Fold and cleat eaves and transverse seams in the shop.
 3. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements shown and as required for leak proof construction.
- C. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant (concealed within joints).
- D. Sealant Joints: Where movable, non-expansion-type joints are indicated or required to produce weathertight seams, form metal to provide for proper installation of elastomeric sealant, in compliance with SMACNA standards.
- E. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturers of dissimilar metals or by fabricator.
- F. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams: Fabricate nonmoving seams in accessories with flat-lock seams. Pre-tin edges to be seamed, form seam, and solder.
 3. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

3.03 INSTALLATION - UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment; wrinkle free, on roof sheathing under sheet metal roofing. Comply with

temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply underlayment in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses and where indicated below. Overlap side edges not less than 3-1/2 inches. Install single sheet of underlayment into gutter trough down length of gutter. Lap seams perpendicular to direction of gutter flow. Roll laps with roller. Cover underlayment within 14 days.

1. Apply underlayment a minimum of 30" up roof surface from line of outside face of the exterior wall,
 2. over all surfaces of gutter trough in singular width,
 3. on top and front face of eave projections,
 4. 36" in from the all gable edges, down all valleys, hips and ridges,
 5. on roof surface 24" out and 1" minimum up wall where roof adjoins any vertical walls.
- B. Felt Underlayment: Install felt underlayment and building-paper slip sheet on roof sheathing under sheet metal roofing. Use adhesive for temporary anchorage. Apply at locations indicated on Drawings, in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
- C. Apply slip sheet over underlayment before installing sheet metal roofing.
- D. Install flashings to cover underlayment to comply with requirements specified in Division 7 Section "Sheet Metal Flashing and Trim."

3.04 INSTALLATION - PANELS

- A. General: Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement. Install fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.
1. Field cutting of sheet metal roofing by torch is not permitted.
 2. Loose fasten gutter end of batten seam sheet metal roofing and allow transverse seam, adjacent to ridge, free movement due to thermal expansion and contraction. Rigidly attach ridge pan at ridge allowing expansion at adjacent transverse seam. Pre-drill roofing panels.
 3. Flash and seal sheet metal roofing with weather closures at rakes, and at perimeter of all openings. Refer to details of individual conditions in the construction documents, ,
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Locate roofing splices over, but not attached to, structural supports. Stagger roofing splices and end laps to avoid a four-panel lap splice condition.

6. Lap metal flashing over sheet metal roofing to allow moisture to run over and off the material.
- B. Fasteners: Use fasteners of sizes that will not penetrate completely through substrate.
 1. Fasten roofing to structural supports; aligned, level, and plumb. Use concealed fasteners unless otherwise approved by Architect/Engineer.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by fabricator of sheet metal roofing or manufacturers of dissimilar metals.
- D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- E. Install sealants for preformed roofing panels between any accessory and any adjoining surface.

3.05 TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet perpendicular too slope on batten roofing and flat seamed roofing. Locate battens and seams as indicated on the drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- B. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.
- C. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.06 PROTECTION - CLEANING

- A. Protect installed roofing panels and trim from damage caused by adjacent construction until completion of installation.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films, if any, as sheet metal roofing is installed. On completion of sheet metal roofing installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

- E. Remove site cuttings from finish surfaces.
- F. Clean and wash pre-finished surfaces with mild soap and water; rinse with clean water.

END OF SECTION 076100 SPECIFICATIONS
ROOF WARRANTY TO FOLLOW -

This Warranty shall be completed by the appropriate Contractor and submitted to the Architect during the Shop Drawing submittal process.

ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ (insert name) of _____ (Insert address), herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
1. Owner: _____ (*Insert name of Owner*)
 2. Address: _____ (Insert address)
 3. Building: _____ (Insert information)
 4. Address: _____ (Insert address)
 5. Area of Work: _____ (Insert information)
 6. Acceptance Date: _____ (Insert date)
 7. Warranty Period: 3 years
 8. Expiration Date: _____ (Insert date)
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period.
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding <Insert wind speed> mph;
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and

- g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
 6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall, afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
 7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.
- E. IN WITNESS THEREOF, this instrument has been duly executed this _____
(Insert day) day of _____ (Insert month), _____ (Insert year).
1. Authorized Signature: _____ (insert signature)
 2. Name: _____ (Insert name)
 3. Title: _____ (Insert title)

Page intentionally left blank.

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Section covers all sealant materials and their application, wherever required for complete installation of building materials or systems.

1.2 RELATED WORK

- A. Masonry control and expansion joint: Section 042000, UNIT MASONRY.

1.3 QUALITY CONTROL

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results from a qualified testing agency based on testing current sealant formulations within a 12-month period.
- D. VOC: Acrylic latex and Silicon sealants shall have less than 50g/l VOC content.
- E. Mockups: Before installing joint sealants, apply elastomeric sealants at locations indicated on Drawings to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution:
 - 1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this section.

1.4 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's installation instructions for each product used.
- C. Cured samples of exposed sealants for each color where required to match adjacent material.

D. Manufacturer's Literature and Data:

1. Caulking compound
2. Primers
3. Sealing compound, each type, including compatibility when different sealants are in contact with each other.

1.5 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not proceed with installation of joint sealants under following conditions:
 - a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 °C (40 °F).
 - b. When joint substrates are wet.

B. Joint-Width Conditions:

1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions:

1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.6 DELIVERY, HANDLING, AND STORAGE

- A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.
- B. Carefully handle and store to prevent inclusion of foreign materials.
- C. Do not subject to sustained temperatures exceeding 5° C (40° F) or less than 32° C (90° F).

1.7 DEFINITIONS

- A. Definitions of terms in accordance with ASTM C717 and as specified.
- B. Back-up Rod: A type of sealant backing.
- C. Bond Breakers: A type of sealant backing.

- D. Filler: A sealant backing used behind a back-up rod.

1.8 WARRANTY

- A. Warranty exterior sealing against leaks, adhesion, and cohesive failure, and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be extended to two years.
- B. General Warranty: Special warranty specified in this Article shall not deprive Government of other rights Government may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

1.9 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
- | | |
|-----------------------|--|
| C509-06..... | Elastomeric Cellular Preformed Gasket and Sealing Material. |
| C612-04..... | Mineral Fiber Block and Board Thermal Insulation. |
| C717-07..... | Standard Terminology of Building Seals and Sealants. |
| C919-02..... | Use of Sealants in Acoustical Applications. |
| C920-05..... | Elastomeric Joint Sealants. |
| C1021-08..... | Laboratories Engaged in Testing of Building Sealants. |
| C1193-05..... | Standard Guide for Use of Joint Sealants. |
| C1330-02 (R2007)..... | Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants. |
| D1056-07..... | Specification for Flexible Cellular Materials—Sponge or Expanded Rubber. |
| E84-08..... | Surface Burning Characteristics of Building Materials. |
- C. Sealant, Waterproofing and Restoration Institute (SWRI). The Professionals' Guide

PART 2 - PRODUCTS

2.1 SEALANTS

- A. S-1:
1. ASTM C920, polyurethane.
 2. Type M.

3. Class 25.
4. Grade NS.
5. Shore A hardness of 20-40

B. S-2:

1. ASTM C920, polyurethane.
2. Type M.
3. Class 25.
4. Grade P.
5. Shore A hardness of 25-40.

C. S-6:

1. ASTM C920, silicone, neutral cure.
2. Type S.
3. Class: Joint movement range of plus 100 percent to minus 50 percent.
4. Grade NS.
5. Shore A hardness of 15-20.
6. Minimum elongation of 1200 percent.

2.3 COLOR

- A. Sealants used with exposed masonry shall match color of mortar joints.
- B. Sealants used with unpainted concrete shall match color of adjacent concrete.
- C. Color of sealants for other locations shall be light gray or aluminum, unless specified otherwise.

2.4 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 1. Type C: Closed-cell material with a surface skin.
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32° C (minus 26° F). Provide

products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 FILLER

- A. Mineral fiber board: ASTM C612, Class 1.
- B. Thickness same as joint width.
- C. Depth to fill void completely behind back-up rod.

2.6 PRIMER

- A. As recommended by manufacturer of caulking or sealant material.
- B. Stain free type.

2.7 CLEANERS-NON POURIOUS SURFACES

- A. Chemical cleaners acceptable to manufacturer of sealants and sealant backing material, free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.
- B. Coordinate for repair and resolution of unsound substrate materials.
- C. Inspect for uniform joint widths and that dimensions are within tolerance established by sealant manufacturer.

3.2 PREPARATIONS

- A. Prepare joints in accordance with manufacturer's instructions and SWRI.
- B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.
 - 1. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
 - 2. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - a. Metal.
 - b. Glass.
- C. Do not cut or damage joint edges.
- D. Apply masking tape to face of surfaces adjacent to joints before applying primers, caulking, or sealing compounds.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Apply primer to sides of joints wherever required by compound manufacturer's printed instructions.
 - 1. Apply primer prior to installation of back-up rod or bond breaker tape.
 - 2. Use brush or other approved means that will reach all parts of joints.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

3.3 BACKING INSTALLATION

- A. Install back-up material, to form joints enclosed on three sides as required for specified depth of sealant.
- B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.
- C. Cut fillers installed by others to proper depth for installation of back-up rod and sealants.
- D. Install back-up rod, without puncturing the material, to a uniform depth, within plus or minus 3 mm (1/8 inch) for sealant depths specified.
- E. Where space for back-up rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

3.4 SEALANT DEPTHS AND GEOMETRY

- A. At widths up to 6 mm (1/4 inch), sealant depth equal to width.
- B. At widths over 6 mm (1/4 inch), sealant depth 1/2 of width up to 13 mm (1/2 inch) maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

3.5 INSTALLATION

- A. General:
 - 1. Apply sealants and caulking only when ambient temperature is between 5° C and 38° C (40° and 100° F).
 - 2. Do not use sealant type listed by manufacture as not suitable for use in locations specified.
 - 3. Apply sealing compound in accordance with manufacturer's printed instructions.
 - 4. Avoid dropping or smearing compound on adjacent surfaces.
 - 5. Fill joints solidly with compound and finish compound smooth.
 - 6. Tool joints to concave surface unless shown or specified otherwise.
 - 7. Apply compounds with nozzle size to fit joint width.
 - 8. Test sealants for compatibility with each other and substrate. Use only compatible sealant.
- B. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise.

3.6 CLEANING

- A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by the caulking or sealant manufacturer.
- B. After filling and finishing joints, remove masking tape.
- C. Leave adjacent surfaces in a clean and unstained condition.

3.7 LOCATIONS

- A. Exterior Building Joints, Horizontal and Vertical:
 - 1. Metal to Metal: Type S-1, S-2
 - 2. Metal to Masonry or Precast Concrete: Type S-1
 - 3. Masonry to Masonry or Precast Concrete: Type S-1
 - 4. Precast Concrete to Precast Concrete: Type S-1
- B. Metal Reglets and Flashings:
 - 1. Flashings to Wall: Type S-6
 - 2. Metal to Metal: Type S-6

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies hollow metal steel doors, hollow metal steel frames and related components.
- B. Terms relating to steel doors and frames as defined in ANSI A123.1 and as specified.

1.2 RELATED WORK

- A. Door Hardware: Section 087100, DOOR HARDWARE.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.4 SHIPMENT

- A. Prior to shipment label each door and frame to show location, size, door swing and other pertinent information.
- B. Fasten temporary steel spreaders across the bottom of each door frame.

1.5 STORAGE AND HANDLING

- A. Store doors and frames at the site under cover.
- B. Protect from rust and damage during storage and erection until completion.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. Door and Hardware Institute (DHI):
 - A115 Series.....Steel Door and Frame Preparation for Hardware,
Series A115.1 through A115.17 (Dates Vary)

C. Steel Door Institute (SDI):

A250.8-03.....Standard Steel Doors and Frames

D. American Society for Testing and Materials (ASTM):

A568/568-M-07.....Steel, Sheet, Carbon, and High-Strength, Low-alloy,
Hot-Rolled and Cold-Rolled

A1008-08.....Steel, sheet, Cold-Rolled, Carbon, Structural, High
Strength Low Alloy and High Strength Low Alloy with
Improved Formability

D1621-04.....Compressive Properties of Rigid Cellular Plastics

E. The National Association Architectural Metal Manufacturers (NAAMM):

Metal Finishes Manual (1988 Edition)

F. Underwriters Laboratories, Inc. (UL):

Fire Resistance Directory

G. Intertek Testing Services (ITS):

Certifications Listings...Latest Edition

H. Factory Mutual System (FM):

Approval Guide

PART 2 - PRODUCTS

2.1 MATERIALS

A. Sheet Steel: ASTM A1008, cold-rolled for panels (face sheets) of doors.

B. Anchors, Fastenings and Accessories: Fastenings anchors, clips connecting members and sleeves from zinc coated steel.

C. Prime Paint: Paint that meets or exceeds the requirements of A250.8.

2.2 FABRICATION GENERAL

A. GENERAL:

1. Follow SDI A250.8 for fabrication of standard steel doors, except as specified otherwise. Doors to receive hardware specified in Section 087100, DOOR

HARDWARE. Tolerances as per SDI A250.8. Thickness, 44 mm (1-3/4 inches), unless otherwise shown.

2. Close top edge of exterior doors flush and seal to prevent water intrusion.
3. When vertical steel stiffeners are used for core construction, fill spaces between stiffeners with mineral fiber insulation.

B. Extra Heavy Duty Doors: SDI A250.8, Level 3, Model 2 of size and design shown. Core construction Types d or f, for interior doors, and Types b, c, e, or f, for exterior doors. Use for stairwell doors.

2.3 METAL FRAMES

A. General:

1. SDI A250.8, 1.3 mm (0.053 inch) thick sheet steel, types and styles as shown or scheduled.
2. Frames for exterior doors: Fabricate from 1.7 mm (0.067 inch) thick galvanized steel conforming to ASTM A525.
4. Knocked-down frames are not acceptable.

B. Reinforcement and Covers:

1. SDI A250.8 for, minimum thickness of steel reinforcement welded to back of frames.
2. Provide mortar guards securely fastened to back of hardware reinforcements.

C. Terminated Stops: SDI A250.8.

D. Glazed Openings within doors:

- a. Integral stop on exterior, corridor, or secure side of door.
- b. Design rabbet width and depth to receive glazing material or panel shown or specified.

E. Frame Anchors:

1. Floor anchors:
 - a. Where floor fills occur, provide extension type floor anchors to compensate for depth of fill.
 - b. At bottom of jamb use 1.3 mm (0.053 inch) thick steel clip angles welded to jamb and drilled to receive two 6 mm (1/4 inch) floor bolts. Use 50 mm x 50 mm (2 inch by 2 inch) 9 mm by (3/8 inch) clip angle for lead lined frames, drilled for 9 mm (3/8 inch) floor bolts.

- c. Where mullions occur, provide 2.3 mm (0.093 inch) thick steel channel anchors, drilled for two 6 mm (1/4 inch) floor bolts and frame anchor screws.
- d. Where sill sections occur, provide continuous 1 mm (0.042 inch) thick steel rough bucks drilled for 6 mm (1/4 inch) floor bolts and frame anchor screws. Space floor bolts at 50 mm (24 inches) on center.

2. Jamb anchors:

- a. Locate anchors on jambs near top and bottom of each frame, and at intermediate points not over 600 mm (24 inches) apart, except for fire rated frames space anchors as required by labeling authority.
- b. Form jamb anchors of not less than 1 mm (0.042 inch) thick steel unless otherwise specified.
- c. Anchors set in masonry: Use adjustable anchors designed for friction fit against the frame and for extension into the masonry not less than 250 mm (10 inches). Use one of following type:
 - 1) Wire loop type of 5 mm (3/16 inch) diameter wire.
 - 2) T-shape or strap and stirrup type of corrugated or perforated sheet steel.
- d. Anchors for frames set in prepared openings:
 - 1) Steel pipe spacers with 6 mm (1/4 inch) inside diameter welded to plate reinforcing at jamb stops or hat shaped formed strap spacers, 50 mm (2 inches) wide, welded to jamb near stop.
 - 2) Drill jamb stop and strap spacers for 6 mm (1/4 inch) flat head bolts to pass thru frame and spacers.
- e. Modify frame anchors to fit special frame and wall construction and provide special anchors where shown or required.

2.4 LOUVERS

A. General:

- 1. Sight proof type with stationary blades the full thickness of the door.
- 2. Provide insect screen.

B. Fabrication:

- 1. Fabricate louvers as complete units. Install in prepared cutouts in doors.

C. Screen frames:

1. Fabricate frame to hold wire fabric in a channel with a retaining bar anchor and to mount on surface of door with screws.
2. Finish: Clean anodized finish, 0.4 mils thick.

2.5 SHOP PAINTING

- A. SDI A250.8.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Plumb, align and brace frames securely until permanent anchors are set.
1. Use triangular bracing near each corner on both sides of frames with temporary wood spreaders at midpoint.
 2. Use wood spreaders at bottom of frame if the shipping spreader is removed.
 3. Protect frame from accidental abuse.
 4. Where construction will permit concealment, leave the shipping spreaders in place after installation, otherwise remove the spreaders after the frames are set and anchored.
 5. Remove wood spreaders and braces only after the walls are built and jamb anchors are secured.
- B. Floor Anchors:
1. Anchor the bottom of door frames to floor with two 6 mm (1/4 inch) diameter expansion bolts. Use 9 mm (3/8 inch) bolts on lead lined frames.
 2. Power actuated drive pins may be used to secure frame anchors to concrete floors.
- C. Jamb Anchors:
1. Anchors in masonry walls: Embed anchors in mortar. Fill space between frame and masonry wall with grout or mortar as walls are built.
 2. Coat frame back with a bituminous coating prior to lining of grout filling in masonry walls.
 3. Secure anchors to sides of studs with two fasteners through anchor tabs. Use steel drill screws to steel studs.
 4. Frames set in prepared openings of masonry or concrete: Expansion bolt to wall with 6 mm (1/4 inch) expansion bolts through spacers. Where subframes or rough bucks are used, 6 mm (1/4 inch) expansion bolts on 600 mm (24 inch) centers or power activated drive pins 600 mm (24 inches) on centers. Secure two piece frames to subframe or rough buck with machine screws on both faces.
- D. Install anchors for labeled fire rated doors to provide rating as required.

- E. Overhead Bracing (Lead Lined Frames): Where jamb extensions extend to structure above, anchor clip angles with not less than two, 9 mm (3/8 inch) expansion bolts or power actuated drive pins to concrete slab. Weld to steel overhead members.

3.2 INSTALLATION OF DOORS AND APPLICATION OF HARDWARE

- A. Install doors and hardware as specified in Section 081113, HOLLOW METAL DOORS AND FRAMES.

END OF SECTION 081113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Door hardware and related items necessary for complete installation and operation of doors.

1.2 RELATED WORK

- A. Caulking: Section 079200 JOINT SEALANTS.
- B. Application of Hardware: Section 081113, HOLLOW METAL DOORS AND FRAMES.

1.3 GENERAL

- A. All hardware shall comply with UFAS, (Uniform Federal Accessible Standards) unless specified otherwise.
- B. Provide rated door hardware assemblies where required by most current version of the International Building Code (IBC).
- C. Hardware for application on metal doors and frames shall be made to standard templates. Furnish templates to the fabricator of these items in sufficient time so as not to delay the construction.
- D. The following items shall be of the same manufacturer, if possible, except as otherwise specified:
 - 1. Mortise locksets.
 - 2. Hinges for hollow metal and wood doors.
 - 3. Surface applied overhead door closers.
 - 4. Exit devices.
 - 5. Floor closers.

1.4 WARRANTY

- A. Warranty period shall be two years in lieu of one year for all items except as noted below:
 - 1. Locks, latchsets, and panic hardware: 5 years.
 - 2. Door closers and continuous hinges: 10 years.

1.5 MAINTENANCE MANUALS

- A. In accordance with Section 010000, GENERAL REQUIREMENTS Article titled "INSTRUCTIONS", furnish maintenance manuals and instructions on all door hardware.

1.6 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. Submit 6 copies of the schedule per Section 013323 plus 2 copies to the VAMC Locksmith (VISN Locksmith if the VAMC does not have a locksmith).
- B. Hardware Schedule: Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (if fire rated and listed)	ANSI/BHMA Finish Designation

- C. Samples and Manufacturers' Literature:

1. Samples: All hardware items (proposed for the project) that have not been previously approved by Builders Hardware Manufacturers Association shall be submitted for approval. Tag and mark all items with manufacturer's name, catalog number and project number.
2. Samples are not required for hardware listed in the specifications by manufacturer's catalog number, if the contractor proposes to use the manufacturer's product specified.

- D. Certificate of Compliance and Test Reports: Submit certificates that hardware conforms to the requirements specified herein. Certificates shall be accompanied by copies of reports as referenced. The testing shall have been conducted either in the manufacturer's plant and certified by an independent testing laboratory or conducted in an independent laboratory, within four years of submittal of reports for approval.

1.7 DELIVERY AND MARKING

- A. Deliver items of hardware to job site in their original containers, complete with necessary appurtenances including screws, keys, and instructions. Tag one of each different item of hardware and deliver to Resident Engineer for reference

purposes. Tag shall identify items by Project Specification number and manufacturer's catalog number. These items shall remain on file in Resident Engineer's office until all other similar items have been installed in project, at which time the Resident Engineer will deliver items on file to Contractor for installation in predetermined locations on the project.

1.8 INSTRUCTIONS

- A. Hardware Set Symbols on Drawings: Except for protective plates, door stops, mutes, thresholds and the like specified herein, hardware requirements for each door are indicated on drawings by symbols. Symbols for hardware sets consist of letters (e.g., "HW") followed by a number. Each number designates a set of hardware items applicable to a door type.
- B. Keying: All cylinders shall be keyed into existing Grand Master Key System. Provide removable core cylinders that are removable only with a special key or tool without disassembly of knob or lockset. Cylinders shall be 6 OR 7 pin type. Keying information shall be furnished at a later date by the Resident Engineer. Contractor shall verify with the station personnel, the location of key identification to be stamped on cylinders.

1.9 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. In text, hardware items are referred to by series, types, etc., listed in such specifications and standards, except as otherwise specified.
- B. American Society for Testing and Materials (ASTM):
 - E2180-07.....Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) In Polymeric or Hydrophobic Materials
- C. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
 - A156.1-06.....Butts and Hinges
 - A156.4-08.....Door Controls (Closers)
 - A156.6-05.....Architectural Door Trim
 - A156.13-05.....Mortise Locks and Latches Series 1000
 - A156.16-08.....Auxiliary Hardware
 - A156.18-06.....Materials and Finishes
 - A156.21-09.....Thresholds
 - A156.22-05.....Door Gasketing and Edge Seal Systems
 - A156.26-06.....Continuous Hinges

A156.28-07Master Keying Systems
A250.8-03Standard Steel Doors and Frames

D. National Fire Protection Association (NFPA):

80-10Fire Doors and Fire Windows
101-09Life Safety Code

E. Underwriters Laboratories, Inc. (UL):

Building Materials Directory (2008)

PART 2 - PRODUCTS

2.1 BUTT HINGES

A. ANSI A156.1. Provide only three-knuckle hinges, except five-knuckle where the required hinge type is not available in a three-knuckle version (e.g., some types of swing-clear hinges). The following types of butt hinges shall be used for the types of doors listed, except where otherwise specified:

1. Exterior Doors: Type A2112/A5112 for doors 900 mm (3 feet) wide or less and Type A2111/A5111 for doors over 900 mm (3 feet) wide. Hinges for exterior outswing doors shall have non-removable pins. Hinges for exterior fire-rated doors shall be of stainless steel material.

B. Provide quantity and size of hinges per door leaf as follows:

1. Doors 1210 mm (4 feet) to 2260 mm (7 feet 5 inches) high: 3 hinges minimum.
2. Doors up to 900 mm (3 feet) wide, standard weight: 114 mm x 114 mm (4-1/2 inches x 4-1/2 inches) hinges.

C. See Articles "MISCELLANEOUS HARDWARE" and "HARDWARE SETS" for pivots and hinges other than butts specified above and continuous hinges specified below.

2.2 DOOR CLOSING DEVICES

A. Closing devices shall be products of one manufacturer for each type specified.

2.3 OVERHEAD CLOSERS

A. Conform to ANSI A156.4, Grade 1.

B. Closers shall conform to the following:

1. The closer shall have minimum 50 percent adjustable closing force over minimum value for that closer and have adjustable hydraulic back check effective between 60 degrees and 85 degrees of door opening.
3. Material of closer body shall be forged or cast.
4. Arm and brackets for closers shall be steel, malleable iron or high strength ductile cast iron.
5. Where closers are exposed to the exterior or are mounted in rooms that experience high humidity, provide closer body and arm assembly of stainless steel material.
6. Closers shall have full size metal cover; plastic covers will not be accepted.
7. Closers shall have adjustable hydraulic back-check, separate valves for closing and latching speed, adjustable back-check positioning valve, and adjustable delayed action valve.
8. Provide closers with any accessories required for the mounting application, including drop plates, special soffit plates, spacers for heavy-duty parallel arm fifth screws, bull-nose or other regular arm brackets, longer or shorter arm assemblies, and special factory templating. Provide special arms, drop plates, and templating as needed to allow mounting at doors with overhead stops and/or holders.
9. Closer arms or backcheck valve shall not be used to stop the door from overswing, except in applications where a separate wall, floor, or overhead stop cannot be used.
10. Provide parallel arm closers with heavy duty rigid arm.
11. Where closers are to be installed on the push side of the door, provide parallel arm type except where conditions require use of top jamb arm.
12. Provide all surface closers with the same body attachment screw pattern for ease of replacement and maintenance.
13. All closers shall have a 1 ½" (38mm) minimum piston diameter.

2.4 LOCKS AND LATCHES

- A. Conform to ANSI A156.2. Locks and latches for doors 45 mm (1-3/4 inch) thick or over shall have beveled fronts. Lock cylinders shall have not less than six or seven pins. Cylinders for all locksets shall be removable core type. Cylinders shall be furnished with construction removable cores and construction master keys. Construct all cores so that they will be interchangeable into the core housings of all mortise locks, rim locks, cylindrical locks, and any other type lock included in the Great Grand Master Key System. Disassembly of lever or lockset shall not be required to remove core from lockset. All locksets or latches on double doors with fire label shall have latch bolt with 19 mm (3/4 inch) throw, unless shorter throw allowed by the door manufacturer's fire label. Provide temporary keying device or construction core of allow opening and closing during construction and prior to the installation of final cores.
- B. In addition to above requirements, locks and latches shall comply with following requirements:

1. Mortise Lock and Latch Sets: Conform to ANSI/BHMA A156.13. Mortise locksets shall be series 1000, minimum Grade 2. All locksets and latchsets shall have lever handles fabricated from cast stainless steel. Provide sectional (lever x rose) lever design as designated. No substitute lever material shall be accepted. All locks and latchsets shall be furnished with 122.55 mm (4-7/8-inch) curved lip strike and wrought box. At outswing pairs with overlapping astragals, provide flat lip strip with 21mm (7/8-inch) lip-to-center dimension. Lock function F02 shall be furnished with emergency tools/keys for emergency entrance. Furnish armored fronts for all mortise locks.

2.5 KEYS

- A. Stamp all keys with change number and key set symbol. Furnish keys in quantities as follows:

Locks/Keys	Quantity
Cylinder locks	2 keys each
Cylinder lock change key blanks	25 each different key way
Master-keyed sets	6 keys each
Grand Master sets	6 keys each
Great Grand Master set	5 keys
Control key	2 keys

2.6 KICK PLATES

- A. Conform to ANSI Standard A156.6.
- B. Provide protective plates as specified below:
 1. Kick plates, metal, Type J100 series.
 2. Provide kick plates where specified. Kick plates shall be 254 mm (10 inches) high. Both kick and mop plates shall be minimum 1.27 mm (0.050 inches) thick. Provide kick and mop plates beveled on all 4 edges (B4E). On push side of doors where jamb stop extends to floor, make kick plates 38 mm (1-1/2 inches) less than width of door, except pairs of metal doors which shall have plates 25 mm (1 inch) less than width of each door. Extend all other kick and mop plates to within 6 mm (1/4 inch) of each edge of doors. Kick and mop plates shall butt astragals. For jamb stop requirements, see specification sections pertaining to door frames.

2.7 EXIT DEVICES

- A. Conform to ANSI Standard A156.3. Exit devices shall be Grade 1; type and function are specified in hardware sets. Trim shall have cast satin stainless steel

lever handles of design similar to locksets, unless otherwise specified. Provide key cylinders for keyed operating trim and, where specified, cylinder dogging.

- B. At non-rated openings with panic hardware, provide panic hardware with key cylinder dogging feature.

2.8 FLUSH BOLTS

- A. Conform to ANSI A156.3. Dimension of flush bolts shall conform to ANSI A115. Flush bolts shall automatically latch and unlatch. Furnish dustproof strikes conforming to ANSI A156.16 for bottom flushbolt. Face plates for dustproof strike shall be rectangular and not less than 38 mm by 90 mm (1-1/2 by 3-1/2 inches).

2.9 FINISHES

- A. Exposed surfaces of hardware shall have ANSI A156.18, finishes as specified below. Finishes on all hinges, pivots, closers, thresholds, etc., shall be as specified below under "Miscellaneous Finishes." For field painting (final coat) of ferrous hardware, see Section 099100, PAINTING.
- B. 630: All surfaces on exterior and interior of buildings, except where other finishes are specified.
- C. Miscellaneous Finishes:
1. Hinges --exterior doors: 630.
 2. Hinges --interior doors: 630.
 3. Door Closers: Factory applied paint finish. Dull or Satin Aluminum color.
 4. Thresholds: Mill finish aluminum.
 5. Other primed steel hardware: 600.

2.10 BASE METALS

- A. Apply specified U.S. Standard finishes on different base metals as following:

Finish	Base Metal
630	Stainless steel

PART 3 - EXECUTION

3.1 HARDWARE HEIGHTS

- A. For new buildings locate hardware on doors at heights specified below, with all hand-operated hardware centered within 864 mm (34 inches) to 1200 mm (48 inches), unless otherwise noted:
- B. Hardware Heights from Finished Floor:

1. Exit devices centerline of strike (where applicable) 1024 mm (40-5/16 inches).
2. Locksets and latch sets centerline of strike 1024 mm (40-5/16 inches).
3. Deadlocks centerline of strike 1219 mm (48 inches).
4. Hospital arm pull 1168 mm (46 inches) to centerline of bottom supporting bracket.
5. Centerline of door pulls to be 1016 mm (40 inches).
6. Push plates and push-pull shall be 1270 mm (50 inches) to top of plate.
7. Push-pull latch to be 1024 mm (40-5/16 inches) to centerline of strike.
8. Locate other hardware at standard commercial heights. Locate push and pull plates to prevent conflict with other hardware.

3.2 INSTALLATION

- A. Closer devices, including those with hold-open features, shall be equipped and mounted to provide maximum door opening permitted by building construction or equipment. Closers shall be mounted on side of door inside rooms.

- B. Hinge Size Requirements:

Door Thickness	Door Width	Hinge Height
45 mm (1-3/4 inch)	900 mm (3 feet) and less	113 mm (4-1/2 inches)

- C. Hinge leaves shall be sufficiently wide to allow doors to swing clear of door frame trim and surrounding conditions.

- D. Hinges Required Per Door:

Doors over 1500 mm (5 ft) high and not over 2280 mm (7 ft 6 in) high	3 butts
--	---------

- E. Fastenings: Suitable size and type and shall harmonize with hardware as to material and finish. Provide machine screws and lead expansion shields to secure hardware to concrete, ceramic or quarry floor tile, or solid masonry. Fiber or rawl plugs and adhesives are not permitted. All fastenings exposed to weather shall be of nonferrous metal.
- F. After locks have been installed; show in presence of Resident Engineer that keys operate their respective locks in accordance with keying requirements. (All keys, Master Key level and above shall be sent Registered Mail to the Medical Center Director along with the bitting list. Also a copy of the invoice shall be sent to the Resident Engineer for his records.) Installation of locks which do not meet specified keying requirements shall be considered sufficient justification for rejection and replacement of all locks installed on project.

3.3 FINAL INSPECTION

- A. Installer to provide letter to VA Resident/Project Engineer that upon completion, installer has visited the Project and has accomplished the following:
1. Re-adjust hardware.
 2. Evaluate maintenance procedures and recommend changes or additions, and instruct VA personnel.
 3. Identify items that have deteriorated or failed.
 4. Submit written report identifying problems.

3.4 DEMONSTRATION

- A. Demonstrate efficacy of mechanical hardware and electrical, and electronic hardware systems, including adjustment and maintenance procedures, to satisfaction of Resident/Project Engineer and VA Locksmith.

3.5 HARDWARE SETS

- A. Following sets of hardware correspond to hardware symbols shown on drawings. Only those hardware sets that are shown on drawings will be required. Disregard hardware sets listed in specifications but not shown on drawings.

		<u>HW-1</u>	
Door # 101			
6	Hinges	A5111	BB1199 x 4.5" x 4.5" x NRP 630
1	Lockset	F07	3880-IC x SEC x WTS 630
1	Core	By Owner	
1	Closer	C02021	5100 689
1	Gasket	R0W154	726S CHAR
2	Flushbolts	L14251	282D 626
1	DP Strike	L04021	280X 626
2	Kickplate	J102	194S-10" 630

END OF SECTION 087100

This page left blank intentionally.

SECTION 099100 - PAINTING

PART 1-GENERAL

1.1 DESCRIPTION

- A. Section specifies field painting.
- B. Section specifies prime coats which may be applied in shop under other sections.
- C. Painting includes shellacs, stains, varnishes, coatings specified, markers and identity markings.

1.2 RELATED WORK

- A. Shop prime painting of steel and ferrous metals: Division 05 - METALS, Division 22 - PLUMBING, and Division 26 - ELECTRICAL.
- B. Concrete pavement marking: Section 321723, PAVEMENT MARKINGS.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:

Before work is started, or sample panels are prepared, submit manufacturer's literature, the current Master Painters Institute (MPI) "Approved Product List" indicating brand label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI "Approved Product List" where applicable is acceptable.

- C. Sample Panels:

1. After painters' materials have been approved and before work is started submit sample panels showing each type of finish and color specified.
2. Panels to show color: Composition board, 100 by 250 by 3 mm (4 inch by 10 inch by 1/8 inch).
3. Attach labels to panel stating the following:

- a. Federal Specification Number or manufacturers name and product number of paints used.
 - b. Product type and color.
 - c. Name of project.
 4. Strips showing not less than 50 mm (2 inch) wide strips of undercoats and 100 mm (4 inch) wide strip of finish coat.
- D. Sample of identity markers if used.
- E. Manufacturers' Certificates indicating compliance with specified requirements:
1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.

1.4 DELIVERY AND STORAGE

- A. Deliver materials to site in manufacturer's sealed container marked to show following:
1. Name of manufacturer.
 2. Product type.
 3. Batch number.
 4. Instructions for use.
 5. Safety precautions.
- B. In addition to manufacturer's label, provide a label legibly printed as following:
1. Federal Specification Number, where applicable, and name of material.
 2. Surface upon which material is to be applied.
 3. If paint or other coating, state coat types; prime, body or finish.
- C. Maintain space for storage, and handling of painting materials and equipment in a neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.
- D. Store materials at site at least 24 hours before using, at a temperature between 18 and 30 degrees C (65 and 85 degrees F).

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. American Conference of Governmental Industrial Hygienists (ACGIH):

ACGIH TLV-BKLT-2008Threshold Limit Values (TLV) for Chemical Substances
and Physical Agents and Biological Exposure Indices
(BEIs)

ACGIH TLV-DOC-2008Documentation of Threshold Limit Values and Biological
Exposure Indices, (Seventh Edition)

C. American National Standards Institute (ANSI):

A13.1-07Scheme for the Identification of Piping Systems

D. Federal Specifications (Fed Spec):

TT-P-1411A.....Paint, Copolymer-Resin, Cementitious (For
Waterproofing Concrete and Masonry Walls) (CEP)

E. Master Painters Institute (MPI):

No. 54-07Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)

No. 77-07Epoxy Cold Cured, Gloss (EC)

H. Steel Structures Painting Council (SSPC):

SSPC SP 1-04 (R2004).....Solvent Cleaning

SSPC SP 2-04 (R2004).....Hand Tool Cleaning

SSPC SP 3-04 (R2004).....Power Tool Cleaning

PART 2 - PRODUCTS

2.1 MATERIALS

A. Identity markers options:

1. Pressure sensitive vinyl markers.
2. Snap-on coil plastic markers.

B. Interior/Exterior Latex Block Filler: MPI 4.

C. Interior Alkyd, Semi-Gloss (AK): MPI 47.

D. Interior Latex Primer Sealer: MPI 50.

E. Universal Metal Primer: MPI 76.

F. Rust-Inhibitive Primer (Water Based): MPI 107.

G. Interior Latex, MPI Gloss Level 3 (LE) (Egg-Shell): MPI 52.

H. Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE): MPI 54.

I. Fast Cure Epoxy: MPI 108.

J. Acrylic Polyurethane: MPE 212.

2.2 PAINT PROPERTIES

- A. Use ready-mixed (including colors), except two component epoxies, polyurethanes, polyesters, paints having metallic powders packaged separately and paints requiring specified additives.
- B. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

2.3 REGULATORY REQUIREMENTS/QUALITY ASSURANCE

- A. Paint materials shall conform to the restrictions of the local Environmental and Toxic Control jurisdiction.
 - 1. Volatile Organic Compounds (VOC): VOC content of paint materials shall not exceed 10g/l for interior latex paints/primers and 50g/l for exterior latex paints and primers.
 - 2. Lead-Base Paint:
 - a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
 - b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
 - 3. Asbestos: Materials shall not contain asbestos.
 - 4. Chromate, Cadmium, Mercury, and Silica: Materials shall not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.
 - 5. Human Carcinogens: Materials shall not contain any of the ACGIH-BKLT and ACGIH-DOC confirmed or suspected human carcinogens.
 - 6. Use high performance acrylic paints in place of alkyd paints, where possible.
 - 7. VOC content for solvent-based paints shall not exceed 250g/l and shall not be formulated with more than one percent aromatic hydro carbons by weight.

PART 3 - EXECUTION

3.1 JOB CONDITIONS

- A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.
 - 1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
 - 2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each days work.
- B. Atmospheric and Surface Conditions:
 - 1. Do not apply coating when air or substrate conditions are:
 - a. Less than 3 degrees C (5 degrees F) above dew point.
 - b. Below 10 degrees C (50 degrees F) or over 35 degrees C (95 degrees F), unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.
 - 2. Maintain interior temperatures until paint dries hard.
 - 3. Do no exterior painting when it is windy and dusty.
 - 4. Do not paint in direct sunlight or on surfaces that the sun will soon warm.
 - 5. Apply only on clean, dry and frost free surfaces except as follows:

3.2 SURFACE PREPARATION

- A. Method of surface preparation is optional, provided results of finish painting produce solid even color and texture specified with no overlays.
- B. General:
 - 1. Remove prefinished items not to be painted such as escutcheon plates, hardware, trim, and similar items for reinstallation after paint is dried.
 - 2. Remove items for reinstallation and complete painting of such items and adjacent areas when item or adjacent surface is not accessible or finish is different.
 - 3. See other sections of specifications for specified surface conditions and prime coat.
 - 4. Clean surfaces for painting with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used.
- C. Ferrous Metals:

1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter in accordance with SSPC-SP 1 (Solvent Cleaning).
2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 (Hand Tool Cleaning) and SSPC-SP 3 (Power Tool Cleaning). Exception: where high temperature aluminum paint is used, prepare surface in accordance with paint manufacturer's instructions.
3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with TT-F-322D (Filler, Two-Component Type, For Dents, Small Holes and Blow-Holes). Finish flush with adjacent surfaces.
 - a. This includes flat head countersunk screws used for permanent anchors.
 - b. Do not fill screws of item intended for removal.
4. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
5. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.

D. Zinc-Coated (Galvanized) Metal, Surfaces Specified Painted:

1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion in accordance with SSPC-SP 1 (Solvent Cleaning).
2. Spot coat abraded and damaged areas of zinc-coating which expose base metal on hot-dip zinc-coated items with MPI 18 (Organic Zinc Rich Coating). Prime or spot prime with MPI 134 (Waterborne Galvanized Primer) or MPI 135 (Non- Cementitious Galvanized Primer) depending on finish coat compatibility.

3.3 PAINT PREPARATION

- A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.
- B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.
- C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.
- D. Mix two component and two part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.

- E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

3.4 APPLICATION

- A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.
- B. Unless otherwise specified, apply paint in three coats; prime, body, and finish. When two coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.
- C. Apply each coat evenly and cover substrate completely.
- D. Allow not less than 48 hours between applications of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by Resident Engineer.
- E. Finish surfaces to show solid even color, free from runs, lumps, brushmarks, laps, holidays, or other defects.
- F. Apply by brush, roller or spray, except as otherwise specified.

3.5 PRIME PAINTING

- A. After surface preparation prime surfaces before application of body and finish coats, except as otherwise specified.
- B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.
- C. Additional field applied prime coats over shop or factory applied prime coats are not required except for exterior exposed steel apply an additional prime coat.
- D. Metals:
 - 1. Steel and iron: MPI 76 (Universal Metal Primer); MPI 107 (Rust-Inhibitive Primer - Interior).

3.6 EXTERIOR FINISHES

- A. Apply following finish coats where specified.

B. Steel and Ferrous Metal:

1. Intermediate coat of MPI 108 (Fast Cure Epoxy).
2. Top Coat of MPI 212 (Acrylic Polyurethane).

3.7 INTERIOR FINISHES

A. Apply following finish coats over prime coats in spaces or on surfaces specified.

1. Ferrous Metal, Galvanized Metal, and Other Metals Scheduled:

- a. Intermediate coat of MPI 108 (Fast Cure Epoxy).
- b. Top Coat of MPI 313 (Acrylic Polyurethane).

3.8 PAINT COLOR

A. Color and gloss of finish coats to be specified.

B. Coat Colors:

1. Color of priming coat: Lighter than body coat.
2. Color of body coat: Lighter than finish coat.
3. Color prime and body coats to not show through the finish coat and to mask surface imperfections or contrasts.

3.10 MECHANICAL AND ELECTRICAL WORK FIELD PAINTING SCHEDULE

- A. Field painting of mechanical and electrical consists of cleaning, touching-up abraded shop prime coats, and applying prime, body and finish coats to materials and equipment if not factory finished in space scheduled to be finished.
- B. Paint various systems specified in Division 22 - PLUMBING, and Division 26 - ELECTRICAL.
- C. Paint after tests have been completed.
- D. Omit prime coat from factory prime-coated items.
- E. Finish painting of mechanical and electrical equipment is not required when located in interstitial spaces, above suspended ceilings, in concealed areas such as pipe and electric closets, pipe basements, pipe tunnels, trenches, attics, roof spaces, shafts and furred spaces except on electrical conduit containing feeders 600 volts or more.
- F. Omit field painting of items specified in paragraph, Building and Structural WORK NOT PAINTED.

G. Apply paint systems on properly prepared and primed surface as follows:

1. Interior Locations:

a. Apply two coats of MPI 47 (Interior Alkyd, Semi-Gloss (AK)) to following items:

- 1) Metal under 94 degrees C (200 degrees F) of items such as bare piping, fittings, hangers and supports.
- 2) Equipment and systems such as hinged covers and frames for control cabinets and boxes, electric conduits and panel boards.

3.11 BUILDING AND STRUCTURAL WORK FIELD PAINTING

A. Painting and finishing of interior and exterior work except as specified under paragraph 3.11 B.

1. Painting of disturbed, damaged and repaired or patched surfaces when entire space is not scheduled for complete repainting or refinishing.
2. Painting of ferrous metal and galvanized metal.
3. Identity painting and safety painting.

B. Building and Structural Work not Painted:

1. Finished surfaces:

- a. Hardware except ferrous metal.
- b. Anodized aluminum, stainless steel, chromium plating, copper, and brass, except as otherwise specified.
- c. Signs, fixtures, and other similar items integrally finished.

2. Concealed surfaces:

- a. Inside walls or other spaces behind access doors.
- b. Surfaces equipment.

3. Labels:

- a. Code required label, such as Underwriters Laboratories Inc., Inchcape Testing Services, Inc., or Factory Mutual Research Corporation.
- b. Identification plates, instruction plates, performance rating, and nomenclature.

4. Galvanized metal:

- a. Except where specifically specified to be painted.

3.12 PROTECTION CLEAN UP, AND TOUCH-UP

- A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.
- B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.
- C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

END OF SECTION 099100

APPENDIX

Coordinate the following abbreviations used in Section 099100, PAINTING, with other Sections. Use the same abbreviation and terms consistently.

Paint or coating	Abbreviation
Acrylic Emulsion	AE (MPI 10 – flat/MPI 11 – semigloss/MPI 119 - gloss)
Exterior Latex	EL(MPI 10 / 11 / 119)
Exterior Oil	EO (MPI 9 – gloss/MPI 8 – flat/MPI 94 – semigloss)
Latex Emulsion	LE (MPI 53, flat/MPI 52, eggshell/MPI 54, semigloss/MPI 114, gloss Level 6)
Latex Gloss	LG (MPI 114)
Latex Semigloss	SG (MPI 141)
Latex Low Luster	LL (MPI 139)

END OF APPENDIX

Page intentionally left blank.

SECTION 101400 - SIGNAGE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies code required signs.
- B. This section also specifies exterior information signs, and traffic clearance signs.
- C. This section includes the following types of signs:
 - 1. Reflective regulatory signs (R-Signs).
 - 2. Pedestrian panel signs (PP-Signs).
 - 3. Vandal-resistant signs (V-Signs).

1.2 RELATED WORK

- A. Section 099100 "Painting" for painting by others of surfaces to which signs specified herein may be applied. Painting of signs is included in this Section.
- B. Division 26 Section "Electrical" for labels, tags, and nameplates for electrical equipment.
- C. Section 265100 "Interior Lighting" for illuminated exit signs.

1.3 MANUFACTURER'S QUALIFICATIONS

- A. Sign manufacturer shall provide evidence that they regularly and presently manufacturers signs similar to those specified in this section as one of their principal products.
- B. Qualifications: Manufacturers: Sign manufacturer shall have completed a minimum of 3 projects in last 3 years with similar materials and methods of manufacture as required for this project.
- C. Where warranties are required, manufacturer and/or installers shall be authorized by the entity providing the warranty.
- D. All completed signs shall be free from defects in materials and workmanship and effectively present specified message under both day and night viewing conditions. Sign faces shall be reasonably smooth, shall exhibit uniform color and brightness over entire background surface and shall not appear mottled, streaked, or stained when viewed either in ordinary daylight or incidental beams of automobile headlamps.

- E. Regulatory Requirements: Comply with Americans with Disabilities Act (ADA) and state and local codes as adopted by authorities having jurisdiction. Signs affected, may include, but not be limited to:
 - 1. Illuminated Exit Signs: Refer to Division 26.
- F. Single Source Responsibility: For each separate required type of sign as defined herein, obtain signs from a single firm specializing in this type of work so that there will be undivided responsibility for such work.
- G. Design Criteria: Drawings indicate sizes, profiles, and dimensional requirements of signs. Other signs with deviations from indicated dimensions and profiles may be considered, provided deviations do not change design concept. Burden of proof of equality is on proposer.
- H. Coordinate sign placement with structural configuration and lighting location. Before sign installation, arrange meeting with VACOTR and lighting installer at site to review sign placement. Additional compensation not allowed for relocating signs after installation if relocation required due to conflicts with lighting or structure.
- I. Provide written 3 year full replacement warranty to Owner that all signage will be free of defects due to workmanship and materials such as fading, peeling, delamination, and installation. With no additional cost to Owner, repair all defects that develop during warranty period and all damage to other Work due to such defects. NOTE: Additional warranties apply to specific sign types and products, as specified herein.

1.4 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting and mounting. Where sizes of signs may be affected by dimensions of surfaces on which they are installed, verify dimensions by field measurement. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

1.5 COORDINATION

- A. For signs to be supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for said devices. Furnish templates for installation.

1.6 SUBMITTALS

- A. Submit in accordance with Section 013300, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- B. Samples: Sign panels and frames, with letters and symbols, each type. Submit 2 sets. One set of samples will be retained by VACOTR, other returned to Contractor.
 - 1. Sign Panel, 200 mm x 250 mm (8 inches x 10 inches), with letters.
 - 2. Color samples of each color, 150 mm x 150 mm (6 inches x 6 inches. Show anticipated range of color and texture.
 - 3. Sample of typeface, arrow and symbols in a typical full size layout.
- C. Manufacturer's Literature:
 - 1. Showing the methods and procedures proposed for the concealed anchorage of the signage system to each surface type.
 - 2. Manufacturer's printed specifications, anchorage details, installation and maintenance instructions.
- D. Samples: Sign location plan, showing location, type and total number of signs required.
- E. Shop Drawings: Scaled for manufacture and fabrication of sign types. Identify materials, show joints, welds, anchorage, accessory items, mounting and finishes.
 - 1. Provide message list for each sign required, including large-scale details of wording, artwork as shown on drawings, and layout of lettering.
 - 2. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as a unit of Work in other Sections.
- F. Maintenance Data: For signage cleaning and maintenance requirements to be included in maintenance manual.

1.7 DELIVERY AND STORAGE

- A. Deliver materials to job in manufacturer's original sealed containers with brand name marked thereon. Protect materials from damage.
- B. Package to prevent damage or deterioration during shipment, handling, storage and installation. Maintain protective covering in place and in good repair until removal is necessary.
- C. Deliver signs only when the site and mounting services are ready for installation work to proceed.

- D. Store products in dry condition inside enclosed facilities.

1.8 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- B. American Society for Testing and Materials (ASTM):

B209-07Aluminum and Aluminum-Alloy Sheet and Plate
B221-06Aluminum and Aluminum-Alloy Extruded Bars, Rods,
Wire, Shapes, and tubes.

- C. Federal Specifications (Fed Spec):

MIL-PRF-8184FPlastic Sheet, Acrylic, Modified.
MIL-P-46144CPlastic Sheet, Polycarbonate

1.9 MINIMUM SIGN REQUIREMENTS

- A. Signs:

1. Type Styles: As shown. Characters shall have a width-to-height ratio between 3:5 and 1:1. Characters shall have a stroke width-to-height ratio of between 1:5 and 1:10.
2. Character Height: minimum 75 mm (3 in) high for overhead signs. As shown, for directional signs.
3. Mounting Location and Height: As shown.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Signs of type, size and design shown on the drawings and as specified.
- B. Signs complete with lettering, framing and related components for a complete installation.
- C. Provide graphics items as completed units produced by a single manufacturer, including necessary mounting accessories, fittings and fastenings.
- D. Do not scale drawings for dimensions. Contractor to verify and be responsible for all dimensions and conditions shown by these drawings. VACOTR to be notified of any discrepancy in drawing, in field directions or conditions, and/or of any changes required for all such construction details.

- E. The Sign Contractor, by commencing work of this section, assumes overall responsibility, as part of his warranty of work, to assure that assemblies, components and parts shown or required within the work of the section, comply with the Contract Documents. The Contractor shall further warrant: That all components, specified or required to satisfactorily complete the installation are compatible with each other and with conditions of installations.

2.2 PRODUCTS

- A. Aluminum:
 - 1. Sheet and Plate: ASTM B209.
 - 2. Extrusions and Tubing: ASTM B221.
- B. Cast Acrylic Sheet: MIL-PRF-8184F; Type II, class 1, Water white non-glare optically clear. Matt finish water white clear acrylic shall not be acceptable.
- C. Polycarbonate: MIL-P-46144C; Type I, class 1.
- D. Vinyl: 0.1 mm thick machine cut, having a pressure sensitive adhesive and integral colors.
- E. Steel: See Section 051200, STRUCTURAL STEEL FRAMING.

2.3 SIGN STANDARDS

- A. Topography:
 - 1. Type Style: Helvetica Medium or Frutiger LT 55 Roman. Initial caps or all caps as indicated in Sign Message Schedule.
 - 2. All text, and symbols to be provided in size, colors, typefaces and letter spacing shown. Text shall be a true, clean, accurate reproduction of typeface(s) shown. Text shown in drawings are for layout purposes only; final text for signs is listed in Sign Message Schedule.
- B. Project Colors and Finishes: See Sign Schedule and VA Signage Design Guide.

2.4 FABRICATION

- A. Design components to allow for expansion and contraction for a minimum material temperature range of 56 °C (100 °F), without causing buckling, excessive opening of joints or over stressing of adhesives, welds and fasteners.
- B. Form work to required shapes and sizes, with true curve lines and angles. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners whenever and wherever possible.

- C. Shop fabricate so far as practicable. Joints fastened flush to conceal reinforcement, or welded where thickness or section permits.
- D. Contact surfaces of connected members be true. Assembled so joints will be tight and practically unnoticeable, without use of filling compound.
- E. Signs shall have fine, even texture and be flat and sound. Lines and miters sharp, arises unbroken, profiles accurate and ornament true to pattern. Plane surfaces be smooth flat and without oil-canning, free of rack and twist. Maximum variation from plane of surface plus or minus 0.3 mm (0.015 inches). Restore texture to filed or cut areas.
- F. Level or straighten wrought work. Members shall have sharp lines and angles and smooth surfaces.
- G. Extruded members to be free from extrusion marks. Square turns and corners sharp, curves true.
- H. Drill holes for bolts and screws. Conceal fastenings where possible. Exposed ends and edges mill smooth, with corners slightly rounded. Form joints exposed to weather to exclude water.
- I. Finish hollow signs with matching material on all faces, tops, bottoms and ends. Edge joints tightly mitered to give appearance of solid material.
- J. All painted surfaces properly primed. Finish coating of paint to have complete coverage with no light or thin applications allowing substrate or primer to show. Finished surface smooth, free of scratches, gouges, drips, bubbles, thickness variations, foreign matter and other imperfections.
- K. Movable parts, including hardware, are be cleaned and adjusted to operate as designed without binding or deformation of members. Doors and covers centered in opening or frame. All contact surfaces fit tight and even without forcing or warping components.
- L. Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
- M. No signs are to be manufactured until final sign message schedule and location review has been completed by the VACOTR and forwarded to contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Protect products against damage during field handling and installation. Protect adjacent existing and newly placed construction, landscaping and finishes as necessary to prevent damage during installation. Paint and touch up any exposed fasteners and connecting hardware to match color and finish of surrounding surface.
- B. Mount signs in proper alignment, level and plumb according to the sign location plan and the dimensions given on elevation and sign location drawings. Where otherwise not dimensioned, signs shall be installed where best suited to provide a consistent appearance throughout the project. When exact position, angle, height or location is in doubt, contact VACOTR for clarification.
- C. Contractor shall be responsible for all signs that are damaged, lost or stolen while materials are on the job site and up until the completion and final acceptance of the job.
- D. Remove or correct signs or installation work VACOTR determines as unsafe or as an unsafe condition.
- E. At completion of sign installation, clean exposed sign surfaces. Clean and repair any adjoining surfaces and landscaping that became soiled or damaged as a result of installation of signs.
- F. Contractor will be responsible for verifying that behind each sign location there are no utility lines that will be affected by installation of signs. Any damage during installation of signs to utilities will be the sole responsibility of the Contractor to correct and repair.
- G. Furnish inserts and anchoring devices which must be set in concrete or other material for installation of signs. Provide setting drawings, templates, instructions and directions for installation of anchorage devices which may involve other trades.

END OF SECTION 101400

Page intentionally left blank.

SECTION 104413 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section covers surface mounted fire extinguisher cabinets.

1.2 RELATED WORK

- A. Field Painting: Section 099100, PAINTING.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data: Fire extinguisher cabinet including installation instructions.

1.4 APPLICATION PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Testing and Materials (ASTM):
 - D4802-02.....Poly (Methyl Methacrylate) Acrylic Plastic Sheet

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHER CABINET

- A. Surface mounted type with flat trim of size and design shown suitable for exterior use.

2.2 FABRICATION

- A. Form body of cabinet from 0.9 mm (0.0359 inch) thick sheet steel.
- B. Fabricate door and trim from 1.2 mm (0.0478 inch) thick sheet steel with all face joints fully welded and ground smooth.

1. Glaze doors with 6 mm (1/4 inch) thick ASTM D4802, clear acrylic sheet, Category B-1, Finish 1.
2. Design doors to open 180 degrees.
3. Provide continuous hinge, pull handle, and adjustable roller catch.

2.3 FINISH

- A. Finish interior of cabinet body with baked-on semigloss white enamel.
- B. Finish door, frame with manufacturer's standard baked-on prime coat and finish with baked-on semigloss white enamel.

PART 3 - EXECUTION

- A. Install fire extinguisher cabinets where located on Drawings and secure in accordance with manufacturer's instructions.
- B. Install cabinet so that bottom of cabinet is 975 mm (39 inches) above finished floor where practical.

END OF SECTION 104413

SECTION 210511 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 21.
- B. Definitions:
 - 1. Exposed: Piping and equipment exposed to view in finished rooms.
 - 2. Option or optional: Contractor's choice of an alternate material or method.

1.2 RELATED WORK

- A. Section 010000, GENERAL REQUIREMENTS.
- B. Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Excavation and Backfill: Section 312000, EARTH MOVING.
- D. Concrete and Grout: Section 033000, CAST-IN-PLACE CONCRETE.
- E. Building Components for Attachment of Hangers: Section 053100, STEEL DECKING.
- F. Section 055000, METAL FABRICATIONS.
- G. Flashing for Wall and Roof Penetrations: Section 076000, FLASHING AND SHEET METAL.
- H. Section 079200, JOINT SEALANTS.
- I. Section 099100, PAINTING.
- J. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

1.3 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
 - 2. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 - 3. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 - 4. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

5. Asbestos products or equipment or materials containing asbestos shall not be used.
- B. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- C. Supports for standpipe shall be in conformance with NFPA 14.

1.4 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
 1. Equipment and materials identification.
 2. Fire-stopping materials.
 3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
 4. Wall, floor, and ceiling plates.
- C. Coordination Drawings: Provide detailed layout drawings of all piping systems.
- D. Maintenance Data and Operating Instructions:
 1. Maintenance and operating manuals in accordance with Section 010000, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
 2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 099100, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 099100, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.

- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Valve Tags and Lists:
 - 1. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 - 2. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
 - 3. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

2.2 GALVANIZED REPAIR COMPOUND

Mil. Spec. DOD-P-21035B, paint form.

2.3 PIPE PENETRATIONS

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
 - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
 - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from this requirement must receive prior approval of Resident Engineer.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.

- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 079200, JOINT SEALANTS.

2.4 TOOLS AND LUBRICANTS

- A. Furnish, and turn over to the Resident Engineer, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: Hardwood or metal, permanently identified for in tended service and mounted, or located, where directed by the Resident Engineer.
- D. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.5 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate location of piping, sleeves, inserts, hangers, and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light

outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Protection and Cleaning:

1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly exposed materials and equipment.

C. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

D. Install gages, valves, and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

E. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 LUBRICATION

Field check and lubricate equipment requiring lubrication prior to initial operation.

3.3 STARTUP AND TEMPORARY OPERATION

Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 010000, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.4 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 010000, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Resident Engineer.

- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.5 INSTRUCTIONS TO VA PERSONNEL

Provide in accordance with Article, INSTRUCTIONS, of Section 010000, GENERAL REQUIREMENTS.

END OF SECTION 210511

SECTION 211200 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 DESCRIPTION

Fire-suppression manual dry standpipes.

1.2 SCOPE OF WORK

- A. Design, installation and testing shall be in accordance with NFPA 14 except for specified exceptions.
- B. Design, materials, equipment and installation, inspection and testing of a complete and ready for operation fire-suppression manual dry standpipe system as required by NFPA 14.
- C. Modification of the existing standpipe system as indicated on the drawings and as further required by these specifications.
- D. Painting of exposed piping and supports to match surrounding background in stairways and red in unfinished areas.

1.3 RELATED WORK

- A. Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Section 099100, PAINTING.
- C. Section 210511 COMMON WORK RESULTS FOR FIRE SUPPRESSION for general mechanical requirements and items, which are common to more than one section.

1.4 QUALITY ASSURANCE

- A. Designer's Qualifications: Design work and shop drawings shall be prepared by a licensed engineer practicing in the field of Fire Protection Engineering.
- B. Installer Reliability: The installer shall possess a valid State of Michigan contractor's license. The installer shall provide documentation of having successfully completed three projects of similar size and scope.
- C. Materials and Equipment: All equipment and devices shall be of a make and type listed by UL and approved by FM, or other nationally recognized testing laboratory for the specific purpose for which it is used. All materials, devices, and equipment shall be approved by the VA.
- D. Testing: Materials and Testing Certificate as per NFPA 14. Provide certificates for all parts of the system.

1.5 DESIGN CRITERIA

- A. The design, materials, equipment, installation, and testing of the system shall be in accordance with NFPA 14 the latest edition.
- B. For hydraulic calculations, calculated demand shall not fall less than 10 percent below the water supply curve.
- C. Water Supply: Base water supply on a fire pumper truck being able to provide 1250 gpm at 150 psig at the fire department connection.
- D. Size standpipes to provide 100 psig) at the most remote connections.
- E. Provide seismic protection for all new and existing systems as required by NFPA 14. Also comply with Section 210511, Common Work Results for Fire Suppression for allowable seismic design.

1.6 SUBMITTALS

- A. Submit as one package in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Prepare detailed working drawings that are stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering. As Government review is for technical adequacy only, the installer remains responsible for correcting any conflicts with other trades and building construction that arise during installation. Partial submittals will not be accepted. Material submittals shall be approved prior to the purchase or delivery to the job site. Suitably bind submittals in notebooks or binders and provide index referencing the appropriate specification section. Submittals shall include the following:
 - 1. Certificates:
 - a. Installer's qualifications and documentation of previous work.
 - b. Materials and Testing certificates as specified.
 - 2. Drawings: Submit detailed 1:100 (1/8 inch) scale (minimum) working drawings conforming to NFPA 14. Include a site plan showing the fire hydrant nearest the fire department connection.
 - 3. Manufacturers Literature and Data Sheets: All pertinent literature and data for the materials and equipment proposed for the project. Include listing information and installation instructions in data sheets. Clearly identify the item to be used.
 - a. For backflow preventers, provide flow test curves from UL, FM, or the Foundation for Hydraulic Research and Cross-Connection Control to verify pressure loss calculations.
 - b. Provide for materials and equipment proposed for use on the system. Include listing information and installation instructions in data sheets. Where data sheet describes items in addition to that item being submitted, clearly identify proposed item on the sheet.
 - 4. Calculation Sheets: Submit hydraulic calculations in accordance with NFPA 14.

5. Final Document Submittals: Provide as-built drawings, testing and maintenance instructions in accordance with the requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Submittals shall include, but not be limited to, the following:
 - a. One complete set of reproducible as-built drawings showing the installed system with the specific interconnections between the waterflow switch or pressure switch and the fire alarm equipment. One copy of final CADD drawing files shall be provided on diskettes that are compatible with the VAMC CADD system.
 - b. Four sets of complete, simple, understandable, step-by-step, testing instructions giving recommended and required testing frequency of all equipment, methods for testing all equipment, and a complete trouble shooting manual. Provide maintenance instructions on replacing any components of the system including internal parts, periodic cleaning and adjustment of the equipment and components with information as to the address and telephone number of both the manufacturer and the local supplier of each item.
 - c. Certificates shall document all parts of the installation.
 1. Installer's qualifications and documentation of previous work.
 2. Materials and Testing certificates as specified.
 - d. Instruction Manual: Provide one copy of the instruction manual covering the system in a flexible protective cover and mount in an accessible location adjacent to the riser.

PART 2 PRODUCTS

2.1 STANDPIPE SYSTEM

- A. All components are to be UL listed and FM approved.
- B. Pipe: Pipe shall be designed to withstand a system working pressure of not less than 200 psi.
 1. Above ground: Schedule 40, Galvanized inside and out with threaded joints:
 - a. ASTM A53, Grade A, "Welded & Seamless Steel Pipe".
 - b. ASTM A795, "Spec. for Black & Hot-Dipped Zinc Coated (Galvanized) Welded & Seamless Steel Pipe for Fire Protection Use".
 2. Underground: Ductile-Iron with mechanical joints:
 - a. AWWA C151, "Ductile-Iron Pipe for Water or Other Liquids" (cement lined & bitumastic coated).
- C. Fittings: ANSI B16.4, 250 psi hot dipped galvanized malleable or cast-iron screwed.
- D. Hose Valves: 300 psi 2.5 in. (63.5mm) size complete with adapters, cap and chain, and local city Fire Department standard hose threads. Similar to Elkhart U-25-2.5.

- E. Siamese Fittings: Inlet fittings with internal clappers, hose caps and chains as noted on Drawings. Hose threads according to local city Fire Department standards.
- F. Check Valves: 200 psi iron body, bronze mounted, synthetic rubber disc, bolted cap, flanged ends with ball drip.
- G. Drain Valve: 200 psi, bronzed globe, integral seats, renewable seat with threaded ends.
- H. Provide base threads for fittings complying with standards of local Fire Department.
- I. Standpipe isolation valves shall be indicating type OS & Y gate valves with solid wedge disc and flanged ends.
- J. Provide a 0 to 300 psi 3.5 inch diameter pressure gauge at the top of each standpipe riser.
- K. Double Check Detector Assembly, 8 in. Shall meet AWWA and USC Foundation for Cross Control and Hydraulic Research Requirements.
- L. Water Flow Detector: Grinnell No. VSR-F.
- M. Vertical Indicator Posts: Grinnell No. F750 with tamper switch.
- N. All clamps, rods and other supporting material shall be hot dipped galvanized or stainless steel.

PART 3 - EXECUTION

3.1 STANDPIPE SYSTEM PIPING INSTALLATION

- O. Install and test in accordance with NFPA 14:
 - 1. Provide standpipes and hose valves at locations as shown on Drawings. Hose valves shall have a sign marked, "MANUAL DRY STANDPIPE FOR FIRE DEPARTMENT USE ONLY".
 - 2. On riser at each parking level, provide 2.5 in. (63.5 mm) hose valve with 2.5 in. (63.5 mm) to 1.5 in. (38 mm) adapter, cap and chain.
 - 3. Provide isolation valves at base of each standpipe, with a sign marked, "RISER ISOLATION CONTROL VALVE".
 - 4. Provide other valves as noted on Drawings.
 - 5. At Siamese inlet connection provide permanent, brass base plate marked, "STANDPIPE".
 - 6. Paint above ground portions of standpipe system.
 - 7. All clamps, rods and other supporting material shall be hot dipped galvanized or stainless steel.
 - 8. All piping shall be adequately pitched to drain all sections of pipe.
 - 9. Provide minimum hand clearance between valves and wall and columns to allow operation of valve.

10. Any pipe that is cut, scratched or threaded shall be coated with a zinc rich coating (ZRC or approved equivalent) at these locations.

3.2 INSPECTION AND TEST

- A. Flushing: Flush newly installed systems prior to performing hydrostatic tests in order to remove any debris which may have been left as well as ensuring piping is unobstructed.
- B. Hydrostatic Testing: Hydrostatically test the system including the fire department connections, as specified in NFPA 14, NFPA-25 and NFPA 13 latest edition, in the presence of the Authority Having Jurisdiction or his designated representative.
- C. Final Inspection and Testing: Test the system in accordance with NFPA 14, NFPA 25 and NFPA 13 latest editions after all necessary corrections have been accomplished. Advise the Authority Having Jurisdiction who will then schedule the final inspection and test. Furnish all instruments, labor and materials required for the tests and provide the services of the installation foreman or other competent representative of the installer to perform the tests. Correct any deficiencies found and retest the system. Include the operation of all features of the systems under normal conditions in the test.

3.3 INSTRUCTIONS

Furnish the services of a competent instructor for not less than two hours for instructing personnel in the operation and maintenance of the system, on the dates requested by the COTR/Resident Engineer.

3.3 WARRANTY

- A. All work performed and materials and equipment furnished under this contract shall be free from defects for a period of one year from date of acceptance by the government.
- B. All new piping and equipment incorporated into the new system shall be hydrostatically tested and warranted as new.

END OF SECTION 211200

Page intentionally left blank.

SECTION 220511 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section shall apply to all sections of Division 22.
- B. Definitions:
 - 1. Exposed: Piping and equipment exposed to view in finished rooms.
 - 2. Option or optional: Contractor's choice of an alternate material or method.

1.2 RELATED WORK

- A. Section 010000, GENERAL REQUIREMENTS.
- B. Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 312000, EARTH MOVING: Excavation and Backfill.
- D. Section 033000, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- E. Section 053100, STEEL DECKING, Building Components for Attachment of Hangers.
- F. Section 055000, METAL FABRICATIONS.
- G. Section 076000, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- H. Section 079200, JOINT SEALANTS.
- I. Section 09 91 00, PAINTING.
- J. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

1.3 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. Unless otherwise noted.
 - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 - 3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 5. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
 6. Asbestos products or equipment or materials containing asbestos shall not be used.
- B. Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
 2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
 3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
 4. All welds shall be stamped according to the provisions of the American Welding Society.
- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the RE/COTR for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the RE/COTR at least two weeks prior to commencing installation of any item.
 2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.
- E. Plumbing Systems: IPC, International Plumbing Code.

1.4 SUBMITTALS

- A. Submittals shall be submitted in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 220511, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

- D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- F. Upon request by Government, lists of previous installations for selected items of equipment shall be provided. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.
- G. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
 - 1. Equipment and materials identification.
 - 2. Fire stopping materials.
 - 3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
 - 4. Wall, floor, and ceiling plates.
- H. Coordination Drawings: In accordance with GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION. Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment or piping until layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.
 - 1. Mechanical equipment rooms.
 - 2. Interstitial space.
 - 3. Hangers, inserts, supports, and bracing.
 - 4. Pipe sleeves.
 - 5. Equipment penetrations of floors, walls, ceilings, or roofs.
- I. Maintenance Data and Operating Instructions:
 - 1. Maintenance and operating manuals in accordance with Section 010000, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
 - 2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.
 - 3. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the RE/COTR. Such replacement shall be at no additional cost to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC), latest edition. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices such as: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators

shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.

- C. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
 - 1. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by RE/COTR where working area space is limited.
 - 2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
 - 3. Waterproof membrane shall not be penetrated.
- F. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Protection and Cleaning:
 - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
 - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, shall be used for all pad or floor mounted equipment. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

- J. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation K. Work in Existing Building:
 - 1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 010000, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
- K. Inaccessible Equipment:
 - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
 - 2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Para. 3.1 shall apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.3 RIGGING

- A. Openings in building structures shall be planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.
- C. All openings in the building shall be closed when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.

- E. Contractor shall check all clearances, weight limitations and shall provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to RE/COTR for evaluation prior to actual work.

3.4 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Resident Engineer.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work shall be provided.
- D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC), latest edition, and these specifications.
- E. Overhead Supports:
 - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
 - 3. Tubing and capillary systems shall be supported in channel troughs.
- F. Floor Supports:
 - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
 - 2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
 - 3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular

space between sleeves and bolts with a grout material to permit alignment and realignment.

3.5 LUBRICATION

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be delivered to RE/COTR in unopened containers that are properly identified as to application.
- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

3.6 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 099100, PAINTING.
- B. In addition, the following special conditions apply:
 - 1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
 - 2. The following Material And Equipment shall NOT be painted:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gages and thermometers.
 - j. Glass.
 - k. Name plates.
 - 3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint obtained from manufacturer or computer matched.

4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

3.7 IDENTIFICATION SIGNS

- A. Laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance shall be placed on factory built equipment.
- C. Pipe Identification: Refer to Section 099100, PAINTING.

3.8 STARTUP AND TEMPORARY OPERATION

- A. Start up of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 010000, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.9 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, all required tests shall be performed as specified in Section 010000, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Resident Engineer.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.

3.10 OPERATION AND MAINTENANCE MANUALS

- A. Provide four bound copies. The Operations and maintenance manuals shall be delivered to RE/COTR not less than 30 calendar days prior to completion of a phase or final inspection.
- B. All new and temporary equipment and all elements of each assembly shall be included.
- C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- D. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- E. Lubrication instructions, type and quantity of lubricant shall be included.
- F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- G. Set points of all interlock devices shall be listed.
- H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.
- I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- J. Emergency procedures.

3.11 INSTRUCTIONS TO VA PERSONNEL

Instructions shall be provided in accordance with Article, INSTRUCTIONS, of Section 010000, GENERAL REQUIREMENTS.

END OF SECTION 220511

SECTION 221100 – FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. In accordance with Contract Documents, furnish all labor equipment, and materials to install domestic water, and storm sewer plumbing facility.
- B. This Section includes plumbing piping systems as indicated on the Drawings. Systems include the following:
 - 1. Potable domestic water system.
- C. Related Sections: Following Sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Common Work Results for Plumbing".

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, except where indicated otherwise:
 - 1. Water Distribution Systems, Below Ground: 150 psig.
 - 2. Water Distribution Systems, Above Ground: 125 psig.

1.4 SUBMITTALS

- A. General: Submit the information specified in the submittals Section of "Basic Mechanical Requirements" in accordance with Conditions of Contract and Division 01 Specifications Section.
- B. See requirements of Division 01 Section, "Submittal Procedures," Part 1 heading, "Submittal Procedures," for limits to resubmittals.

- C. See requirements of Division 01 Section, "Submittal Procedures," Part 2 heading, "Requests for Information," for RFI constraints.

PART 2 - PRODUCTS

2.1 GENERAL

- A. See Division 22 Section "Common Work Results for Plumbing" for acceptable products and manufacturers.

2.2 MATERIALS

- A. General:

- 1. Provide new materials of the best grade and quality.

- B. Pipe:

- 1. Water

- a. Copper

- 1) Above Ground - Type L hard drawn copper: ASTM B88.
 - 2) Underground - Type K hard drawn copper: ASTM B88.

- C. Fittings and Joints:

- 1. Make all connections between steel or iron pipe and copper pipe with approved insulating coupling.
 - 2. Nipples: Same material as pipe on which they are used. Avoid use of close nipples if possible.
 - 3. Fittings for copper water piping: Forged copper fittings sweat soldered using lead-free solder. Do not use cast copper.
 - 4. Adapters for unions and valves: Solder to IPS.

- D. Valves:

- 1. Globe valves: Provide bronze or iron bodies, with brass rings and renewable composition discs equivalent to Crane No. 1, 351, or 1310.
 - 2. Check valves: Provide swing type, with bronze bodies, equivalent to Crane No. 37, 372, or 1342.
 - 3. Gate valves 3 in. and smaller: Provide bronze or iron body gate valves, with non-rising stem with wedge disc, equivalent to Crane No. 440. Elsewhere, provide iron body gate valves, equivalent to Crane No. 460.
 - 4. Angle valves 3 in. and smaller: Provide bronze body, RS Class 125, threaded. Two (2) in. and larger: Provide cast iron body, OS & Y, Flanged.

5. Approved manufacturers of valves furnished and installed are Crane, Lunkenheimer, Powell, or approved equivalent.
 6. Provide gate and globe valves of type permitting repacking while valve is under pressure.
 7. Packing shall be fiberglass graphite composition with Inconel were insert or approved equivalent.
 8. Furnish and install valve TAGS for each valve provided under Contract. Tags may be of following:
 - a. Two (2) in. x 1.5 in. rectangular anodized aluminum tags, 0.0625 in. thick with 0.375 in. thick stamped letters.
- E. Clamps, rods and all support material and hardware shall be hot dipped galvanized or stainless steel.

2.3 REDUCED PRESSURE BACKFLOW PREVENTERS

- A. General: ASSE Standard, backflow preventers, of size indicated for maximum flow rate indicated and maximum pressure loss indicated.
1. Working Pressure: 150 psig minimum except where indicated otherwise.
 2. 2 in. and Smaller: Bronze body with threaded ends.
 3. Interior Components: Corrosion-resistant materials.
 4. Strainer on inlet.

2.4 WALL FAUCETS

- A. Provide valves/faucets as noted on plans.
1. $\frac{3}{4}$ " Woodford Model 24C or approved equivalent. Brass finish with loose tee handle and vacuum breaker backflow preventer.
 2. 1 $\frac{1}{2}$ " – Potter Roemer 4060 with 1 $\frac{1}{2}$ " to $\frac{3}{4}$ " reducer and Woodford 34HD vacuum breaker.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Domestic Water System:
1. Furnish and install complete system of water supply piping. All water piping shall be Type K copper pipe below grade and Type L copper pipe above grade. Arrange for water service with local utility company and civil engineer. Provide water meter connection and extend service from water

- meter installed by local utility company. All charges of utility company for service, water meter, and related Work shall be paid by this contractor.
2. Water supply shall be connected to each fixture requiring water. All water supply piping shall be pitched to relieve air.
 3. Provide water hammer arrester at terminals of all water supply risers and pipes of ample capacity to prevent water hammer.
 4. All branches shall be valved so that any supply line may be controlled.
 5. Wall faucets shall be provided and installed where located on Drawings.
 6. System shall be flushed, chlorinated for 24 hrs, and tested.

3.2 ADJUSTING

- A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.3 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures related to startup and servicing of interceptors.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or when work stops.

END OF SECTION 221100

SECTION 221400 - FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

This section describes the requirements for storm drainage systems, including piping and all necessary accessories as designated in this section.

1.2 RELATED WORK

- A. Section 099100, PAINTING: Preparation and finish painting and identification of piping systems.
- B. Section 220511, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.

1.3 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Piping.
 - 2. Roof Drains.
 - 3. Cleanouts.
 - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.

PART 2 - PRODUCTS

2.1 SUBMITTALS

- A. General:
 - 1. Provide new materials of the best grade and quality.
- B. Pipe:
 - 1. Drainage:
 - a. Cast iron: (Storm drainage 15" and smaller)

- 1) Buried underground inside and to point 5 ft outside building: Service weight bell and spigot type, ASTM A74.
- 2) Above ground: Cast iron: "No Hub", ASTM A888.

C. Fittings and Joints:

1. Nipples: Same material as pipe on which they are used. Avoid use of close nipples if possible.
2. Fittings for cast-iron soil pipe: correspond to pipe in material, ASTM A74.
3. Joints in buried cast-iron pipe: Approved rubber gaskets.
4. Fittings for copper drainage piping: Cast copper fittings, ASA B16.23. Sweat solder joints with lead-free solder.

D. Floor and Trench Drains: heavy duty cast-iron with coated, heavy duty, vandal-proof grate and sediment buckets. Size, connection type and additional requirements are as specified on Drawings.

E. Backwater Valves: Coated cast iron backwater valve, plastic ball float, elastomer seat, bronze cage and threaded or spigot outlet connection. Size, connection type and additional requirements are as specified on Drawings.

F. Cleanouts:

1. In conductor risers: Coated cast iron cleanout tee with hub and spigot connections and coated cast iron plug with internal gasket seal for installation in unfinished areas. Where finished appearance in wall installation is required, use in conjunction with access cover or box:
 - a. Acceptable manufacturers:
 - 1) Smith 4510 Series.
 - 2) Wade W-8560 Series.
 - 3) Zurn Z-1400 Series.
 - 4) Alternate Manufacturers: Proprietary names and/or model numbers used to designate products or materials are not intended to imply that products of named manufacturers are required to the exclusion of equivalent products of other accepted manufacturers. Requests for approval of other products may be accepted in accordance with General Conditions.
2. In floors in structure: Coated cast iron, adjustable housing, floor cleanout, spigot or no-hub connection with internal gasketed cleanout plug and adjustable housing with heavy duty, secured (vandalproof) scoriated round cast iron tractor cover for heavy traffic for installation flush with finished floor:

- a. Acceptable manufacturers:
 - 1) Smith 4240 Series.
 - 2) Wade W-6000-Z and W-7000-Z Series.
 - 3) Zurn Z-1420-25.
 - 4) Alternate Manufacturers: Proprietary names and/or model numbers used to designate products or materials are not intended to imply that products of named manufacturers are required to the exclusion of equivalent products of other accepted manufacturers. Requests for approval of other products may be accepted in accordance with General Conditions.
- 3. In floors and walls in finished areas: Provide with flush brass ring and covers, chrome plates, screwed to plug and set level and flush with floor or wall.
- G. Expansion Joints for Rain Water Collectors: Vertical expansion joint, coated cast iron body and packing gland and silicone bronze sleeve with preformed neoprene packing gasket:
 - 1. Acceptable manufacturers:
 - a. Smith 1710 Series.
 - b. Wade W-3900 Series.
 - c. Zurn Z-190.
 - d. Alternate Manufacturers: Proprietary names and/or model numbers used to designate products or materials are not intended to imply that products of named manufacturers are required to the exclusion of equivalent products of other accepted manufacturers. Requests for approval of other products may be accepted in accordance with General Conditions.
- H. Clamps, rods and all support material and hardware shall be hot dipped galvanized or stainless steel.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. The pipe installation shall comply with the requirements of the International code and these specifications.
- B. Branch piping shall be installed from the piping system and connect to all drains and outlets.

- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings to allow for ceiling panel removal.
- F. Unless otherwise stated on the documents, minimum horizontal slope shall be one inch for every 1.22 m (4 feet) of pipe length.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for storm drainage piping shall be made using appropriate branches, bends and long sweep bends. Long turn double wye branch and 1/8 bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried storm drainage piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"

3.2 JOINT CONSTRUCTION

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hubless, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.

3.3 SPECIALTY PIPE FITTINGS

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.

- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES:

- A. Support piping in building on standard clevis type (MSS SP-69, No. 1) hangers with adjustable rods.
- B. Properly support all piping installed on suitable pipe hangers and supports. Permanent hangers, supports, and anchors shall be fabricated from durable materials, hot dipped galvanized or stainless steel, suitable for service conditions in accordance with details on Drawings.
- C. Base required strength of all supporting equipment on combined weight of piping filled with water, plus any insulating covering.
- D. Install hangers for horizontal piping with the following minimum rod sizes:

<u>Nominal Pipe Size</u>	<u>Minimum Rod Size</u>
0.75 in. to 2 in. pipe	0.375 in.
2.5 in. to 3.5 in. pipe	0.5 in.
4 in. to 5 in. pipe	0.625 in.
6 in. pipe	0.75 in.
8 in. to 12 in. pipe	0.875 in.

- E. Provide and install anchors in piping system to fix direction of expansion and contraction. Fabricate and assemble anchors to secure desired points of piping in relatively fixed positions. Hangers shall permit line to take up expansion and contraction freely in opposite directions away from anchored point and shall be so arranged as to be structurally suitable for particular location, line, and loading conditions in question.
- F. Use stainless steel expansion anchors to anchor pipe hanger and supports where insters have been improperly located, or where necessary to support piping from existing concrete construction. Expansion anchor locations must have approval of Engineer/Architect before installation. Coordinate location with structural.
- G. Support parallel pipe lines at same level on approved trapeze or saddle type hangers.
- H. Use steel rods to attach ring or trapeze hangers to building structure. Space hangers at sufficiently close intervals to support piping and its contents, 12 ft on center maximum for threaded pipes.

- I. Support copper piping with copper clevis hangers, or clevis hanger with copper supporting loop.
- J. Provide sheet metal collar at each pipe hanger for insulated pipe with vapor barrier.
- K. Any support hardware or material that is cut, scratched, or threaded shall be coated with zinc rich coating (ZRC or equivalent) at these locations.

3.4 TESTS:

- A. Storm sewer system shall be tested either in its entirety or in sections.
- B. Storm Water Drain tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
 - 1. If entire system is tested with water, tightly close all openings in pipes except the highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
 - 2. For an air test, an air pressure of 35 kPa (5 psi) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the test.
 - 3. Final Tests: Either one of the following tests may be used.
 - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
 - b. Peppermint Test: Introduce .06 liters (2 ounces) of peppermint into each line or stack.

END OF SECTION 221400

SECTION 260511 - REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, cable, switchboards, switchgear, panelboards, motor control centers, and other items and arrangements for the specified items are shown on drawings.
- C. Electrical service entrance equipment (arrangements for temporary and permanent connections to the utility's system) shall conform to the utility's requirements. Coordinate fuses, circuit breakers and relays with the utility's system, and obtain utility approval for sizes and settings of these devices.
- D. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

- A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 TEST STANDARDS

- A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:
 - 1. Listed; Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets

- appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
 3. Certified; equipment or product which:
 - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
 - c. Bears a label, tag, or other record of certification.
 4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

- A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- B. Product Qualification:
 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
 2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

1.5 APPLICABLE PUBLICATIONS

Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

1.6 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 1. Components of an assembled unit need not be products of the same manufacturer.

2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 3. Components shall be compatible with each other and with the total assembly for the intended service.
 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
 2. Four copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
 3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.7 EQUIPMENT REQUIREMENTS

Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS and Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.8 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
 2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
 3. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
 4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

5. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.9 WORK PERFORMANCE

- A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by contract.
- B. Job site safety and worker safety is the responsibility of the contractor.
- C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
 1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
 2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
 3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the Resident Engineer and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
 4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Resident Engineer.
- D. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 010000, GENERAL REQUIREMENTS.
- E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 010000, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interferences.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working spaces shall not be less than specified in the NEC for all voltages specified.
- C. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
2. "Conveniently accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.11 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. Nameplates for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Nameplates for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 1/2 inch [12mm] high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.

1.12 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 1. Mark the submittals, "SUBMITTED UNDER SECTION _____".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. Submit each section separately.
- E. The submittals shall include the following:

1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
2. Elementary and interconnection wiring diagrams for communication and signal systems, control systems and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
3. Parts list which shall include those replacement parts recommended by the equipment manufacturer.

F. Manuals: Submit in accordance with Section 010000, GENERAL REQUIREMENTS.

1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation instructions.
 - e. Safety precautions for operation and maintenance.
 - f. Diagrams and illustrations.
 - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers and replacement frequencies.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

1.13 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.14 ACCEPTANCE CHECKS AND TESTS

The contractor shall furnish the instruments, materials and labor for field tests.

1.15 TRAINING

- A. Training shall be provided in accordance with Article 1.25, INSTRUCTIONS, of Section 010000, GENERAL REQUIREMENTS.
- B. Training shall be provided for the particular equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the contractor and approved by the Resident Engineer at least 30 calendar days prior to the planned training.

END OF SECTION 260511

Page intentionally left blank.

SECTION 260521 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)

PART 1 – GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of the low voltage power and lighting wiring.

1.2 RELATED WORK

- A. Excavation and backfill for cables that are installed in conduit: Section 312000, EARTH MOVING.
- B. General electrical requirements that are common to more than one section in Division 26: Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- C. Conduits for cables and wiring: Section 260533, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

1.3 SUBMITTALS

- A. In accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
 - 1. Manufacturer's Literature and Data: Showing each cable type and rating.
 - 2. Certificates: Two weeks prior to final inspection, deliver to the Resident Engineer four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

PART 2 - PRODUCTS

2.1 CABLE AND WIRE (POWER AND LIGHTING)

- A. Cable and Wire shall be in accordance with Fed. Spec. A-A-59544, except as hereinafter specified.
- B. Single Conductor:
 - 1. Shall be annealed copper.
 - 2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.
 - 3. Shall be minimum size No. 10 AWG, except where smaller sizes are specified.
- C. Insulation:

1. THW, XHHW, or dual rated THHN-THWN shall be in accordance with UL 44, and 83.

D. Color Code:

1. Secondary service, feeder and branch circuit conductors shall be color coded as follows:

208/120 volt	Phase	480/277 volt
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

- a. The lighting circuit "switch legs" and 3-way switch "traveling wires" shall have color coding unique and distinct (i.e. pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Field coordinate for a final color coding with the Resident Engineer.
2. Use solid color compound or solid color coating for No. 10 AWG branch circuit conductors and neutral sizes.
3. Phase conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
 - a. Solid color compound or solid color coating.
 - b. Stripes, bands, or hash marks of color specified above.
 - c. Color as specified using 19 mm (3/4 inch) wide tape. Apply tape in half overlapping turns for a minimum of 75 mm (three inches) for terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
5. Color code for isolated power system wiring shall be in accordance with the NEC.

2.2 SPLICES AND JOINTS

- A. In accordance with UL 486A, C, D, E and NEC.

B. Branch circuits:

1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped wires.

3. The number, size, and combination of conductors, as listed on the manufacturers packaging shall be strictly complied with.

C. Feeder Circuits:

1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material.
2. Field installed compression connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements or compression indents per wire.
3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulate with not less than that of the conductor level that is being joined.
4. Plastic electrical insulating tape: ASTM D2304 shall apply, flame retardant, cold and weather resistant.

2.3 CONTROL WIRING

- A. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring, except the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

2.4 WIRE LUBRICATING COMPOUND

- A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.
- B. Shall not be used on wire for isolated type electrical power systems.

2.5 WARNING TAPE

- A. The tape shall be standard, 76 mm (3 inch) wide, 4-Mil polyethylene detectable type.
- B.
- C. The tape shall be red with black letters indicating "CAUTION BURIED ELECTRIC LINE BELOW".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with the NEC, and as specified.
- B. Install all wiring in raceway systems.
- C. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes, or handholes.

- D. Wires of different systems (i.e. 120V, 277V) shall not be installed in the same conduit or junction box system.
- E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
- F. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.
- G. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.
- H. Wire Pulling:
 - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
 - 2. Use ropes made of nonmetallic material for pulling feeders.
 - 3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Resident Engineer.
 - 4. Pull in multiple cables together in a single conduit.
- I. The wires shall be derated in accordance with NEC Article 310. Neutral wires, under conditions defined by the NEC, shall be considered current-carrying conductors.

3.2 SPLICE INSTALLATION

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

3.3 CONTROL AND SIGNAL WIRING INSTALLATION

- A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.
- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.
- C. Where separate power supply circuits are not shown, connect the systems to the nearest panelboards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.
- D. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.
- E. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

3.4 CONTROL AND SIGNAL SYSTEM IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.5 FEEDER IDENTIFICATION

- A. In each interior pulbox and junction box, install metal tags on each circuit cables and wires to clearly designate their circuit identification and voltage.
- B. In each manhole and handhole, provide tags of the embossed brass type, showing the cable type and voltage rating. Attach the tags to the cables with slip-free plastic cable lacing units.

3.6 DIRECT BURIAL CABLE INSTALLATION

- A. Tops of the cables:
 - 1. Below the finished grade: Minimum 600 mm (24 inches) unless greater depth is shown.
 - 2. Below road and other pavement surfaces: In conduit as specified, minimum 750 mm (30 inches) unless greater depth is shown.
 - 3. Do not install them under railroad tracks.
- B. Under road and paved surfaces: Install cables in concrete encased galvanized steel rigid conduits. Size as shown on plans, but not less than 50 mm (two inch) trade size with bushings at each end of each conduit run. Provide size/quantity of conduits required to accommodate cables plus one spare.
- C. Work with extreme care near existing ducts, conduits, cables and other utilities to prevent any damage.
- D. Cut the trenches neatly and uniformly:
 - 1. Excavating and backfilling is specified in Section 312000, EARTH MOVING.
 - 2. Place a 75 mm (3 inch) layer of sand in the trenches before installing the cables.
 - 3. Place a 75 mm (three inch) layer of sand over the installed cables.
 - 4. Install continuous horizontal, 25 mm by 200 mm (1 inch by 8 inch) preservative impregnated wood planking 75 mm (three inches) above the cables before backfilling.
- E. Provide horizontal slack in the cables for contraction during cold weather.

- F. Install the cables in continuous lengths. Splices within cable runs will not be accepted.
- G. Connections and terminations shall be submersible type designed for the cables being installed.
- H. Warning tape shall be continuously placed 300 mm (12 inches) above the buried cables.

3.7 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for the new installation. Only wiring that conforms to the specifications and applicable codes may be reused. If existing wiring does not meet these requirements, existing wiring may not be reused and new wires shall be installed.

3.8 FIELD TESTING

- A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances.
- B. Tests shall be performed by megger and conductors shall test free from short-circuits and grounds.
- C. Test conductor phase-to-phase and phase-to-ground.
- D. The Contractor shall furnish the instruments, materials, and labor for these tests.

END OF SECTION 260521

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies general grounding and bonding requirements of electrical equipment operations and to provide a low impedance path for possible ground fault currents.
- B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

- A. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 260521, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.
- C. Section 264100, FACILITY LIGHTNING PROTECTION: Requirements for a lightning protection system.

1.3 SUBMITTALS

- A. Submit in accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:

1. Certification that the materials and installation is in accordance with the drawings and specifications.
2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.
- C. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

2.2 GROUND RODS

- A. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- B. Quantity of rods shall be as required to obtain the specified ground resistance.

2.3 SPLICES AND TERMINATION COMPONENTS

Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.4 GROUND CONNECTIONS

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
 1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
 3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

2.5 EQUIPMENT RACK AND CABINET GROUND BARS

Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x 3/4 inch).

2.6 GROUND TERMINAL BLOCKS

At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

PART 3 - EXECUTION

3.1 GENERAL

- A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
- B. System Grounding:
 - 1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 - 2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.3 SECONDARY EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.

2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.
- D. Switchgear and Switchboards:
1. Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
 2. For service entrance equipment, connect the grounding electrode conductor to the ground bus.
 3. Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.
- E. Transformers:
1. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment.
- F. Conduit Systems:
1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
 3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.
- G. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
- H. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
- I. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

- J. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.
- K. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- L. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.
- M. Panelboard Bonding: The equipment grounding terminal buses of the normal and essential branch circuit panelboards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than 16 mm² (10 AWG). These conductors shall be installed in rigid metal conduit.

3.4 CORROSION INHIBITORS

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.5 CONDUCTIVE PIPING

- A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.6 LIGHTNING PROTECTION SYSTEM

Bond the lightning protection system to the electrical grounding electrode system.

3.7 ELECTRICAL ROOM GROUNDING

Building Earth Ground Busbars: Provide ground busbar hardware at each electrical room and connect to pigtail extensions of the building grounding ring.

3.8 WIREWAY GROUNDING

- A. Ground and Bond Metallic Wireway Systems as follows:
 - 1. Bond the metallic structures of wireway to provide 100 percent electrical continuity throughout the wireway system by connecting a 16 mm² (6 AWG) bonding jumper at all intermediate metallic enclosures and across all section junctions.
 - 2. Install insulated 16 mm² (6 AWG) bonding jumpers between the wireway system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 16 meters (50 feet).

3. Use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.
4. Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 meters.

3.9 GROUND RESISTANCE

- A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.
- B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Services at power company interface points shall comply with the power company ground resistance requirements.
- D. Below-grade connections shall be visually inspected by the Resident Engineer prior to backfilling. The Contractor shall notify the Resident Engineer 24 hours before the connections are ready for inspection.

3.10 GROUND ROD INSTALLATION

- A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.
- B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.
- C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION 260526

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
- B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

- A. Bedding of conduits: Section 312000, EARTH MOVING.
- B. Fabrications for the deflection of water away from the building envelope at penetrations: Section 076000, FLASHING AND SHEET METAL.
- C. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building: Section 079200, JOINT SEALANTS.
- D. Identification and painting of conduit and other devices: Section 099100, PAINTING.
- E. General electrical requirements and items that is common to more than one section of Division 26: Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- F. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

1.3 SUBMITTALS

In accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

- A. Shop Drawings:
 - 1. Size and location of main feeders;
 - 2. Size and location of panels and pull boxes
 - 3. Layout of required conduit penetrations through structural elements.
 - 4. The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Certification: Prior to final inspection, deliver to the Resident Engineer four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 13 mm (3/4 inch) unless otherwise shown. Where permitted by the NEC, 13 mm (3/4 inch) flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
 - 1. Exposed: 100% pure, polyvinylchloride (PVC) rigid, Schedule 80 with cemented couplings in accordance with NEMA TC-6.
 - 2. Embedded and Underground: 100% pure, polyvinyl chloride (PVC) rigid, Schedule 40 with cemented couplings in accordance with NEMA TC-6.
 - 3. In surface mounted PVC conduit runs longer than 7ft 6 inches between hard points and at building expansion joints provide PVC surface mounted expansion fittings with stainless steel fasteners that allow pipe to move longitudinally with temperature related movement but restrains it from other movement.
- C. Encasement for Underground Conduit
 - 1. Underground outside of structure and entire service entrance feed: Concrete, 3 in. separation and 3 in. encasement or as indicated on Drawings. Provide warning tape 6 in. below surface and 12 in. above encasement.
- D. Electrical Boxes and Fittings:
 - 1. Outlet, device, pull and junction boxes, conduit bodies and fittings shall be sized per NEC Article 370. All conduit connections shall be threaded.
 - 2. Surface boxes and covers:
 - a. Weatherproof PVC box and cover unless fixture is attached to box.
 - b. Weatherproof hot dip galvanized cast metal or malleable iron with threaded fittings if a fixture is attached directly to the box.
 - 3. Boxes for other areas and uses: Gasketed screw cover boxes, 14 or 12 gage, G-90 grade galvanized bodies, 12 or 10 gage G-90 grade galvanized steel covers. NEMA 3R GSC with threaded hubs.
 - 4. Boxes embedded in walls: Concrete type.
- E. Wireways: Equip with hinged covers, except where removable covers are shown.

- F. Warning Tape: Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters, and imprinted with "CAUTION BURIED ELECTRIC LINE BELOW".

PART 3 - EXECUTION

3.1 PENETRATIONS

- A. Cutting or Holes:
 - 1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Resident Engineer prior to drilling through structural sections.
 - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Resident Engineer as required by limited working space.
- B. Fire Stop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 078400, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 079200, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

- A. In accordance with UL, NEC, as shown, and as hereinafter specified.
- B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where specifically "accepted" by NEC Article 517.
- C. Install conduit as follows:
 - 1. In complete runs before pulling in cables or wires.
 - 2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
 - 3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
 - 4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
 - 5. Mechanically and electrically continuous.
 - 6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
 - 7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.

8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
10. Flashing of penetrations of the roof membrane is specified in Section 076000, FLASHING AND SHEET METAL.
11. Do not use aluminum conduits in wet locations.
12. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

D. Conduit Bends:

1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets, and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:

1. Install conduit with wiring, including homeruns, as shown.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Resident Engineer.

3.3 WET OR DAMP LOCATIONS

- A. Unless otherwise shown, use conduits of rigid steel.
- B. Provide sealing fittings, to prevent passage of water vapor.

3.4 SEAL TIGHT FLEXIBLE CONDUIT

- A. Use seal tight flexible conduit in lengths not greater than 2 ft to connect motors, transformers, and for whips connecting trunnion mounted fixtures to junction boxes. Do not install flexible conduit at other locations without written approval of Engineer.

3.6 CONDUIT SUPPORTS, INSTALLATION

- A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.
- B. Securely fasten exposed conduits to ceiling or walls with 1 hole PVC straps (Carlson E978 series or equivalent) that will allow for conduit expansion on contraction. Provide support and expansion fittings per NEC 352 using 80 degree F. temperature change. Provide expansion fittings at all locations conduit crosses expansion joint. Provide spacers or extensions as required to achieve proper mounting heights. Using blockouts or other structural members as a source of support is prohibited. (Maximum distance between supports for 3/4" and 1" conduit is three feet and a conduit expansion fitting will be required in all PVC conduit runs that are longer than 7 feet 6 inches between junction

boxes or other securely mounted points. The parts of the expansion joints and straps that need to slide cannot be painted.)

- C. Provide supports, foundations, stands, platforms, anchor bolts, and other necessary material required to install electrical equipment and systems. When anchor bolts for lighting poles, or other fasteners, are embedded in structure as it is being erected, provide templates and coordinate installation. Anchor bolts and baseplates shall be hot-dip galvanized in accordance with ASTM A153. Bond 1 anchor bolt to structural rebar.
- D. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.17 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.
 - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.
- C. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 600 mm (24 inch), center-to-center lateral spacing shall be maintained between boxes.)
- D. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 100 mm (4 inches) square by 55 mm (2-1/8 inches) deep, with device covers for the wall material and thickness involved.
- E. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
- F. On all Branch Circuit junction box covers, identify the circuits with black marker.

END OF SECTION 260533

Page intentionally left blank.

SECTION 260541 - UNDERGROUND ELECTRICAL CONSTRUCTION

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of manholes, handholes and ducts to form a complete underground raceway system.
- B. “Duct” and “conduit”, and “rigid metal conduit” and “rigid steel conduit” are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

- A. Section 312000, EARTH MOVING: Trenching, backfill and compaction.
- B. Section 055000, METAL FABRICATIONS: Ladders.
- C. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.
- D. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- E. Section 260533, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings and boxes for raceway systems.
- F. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 SUBMITTALS

- A. Submit in accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
- C. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
 - 1. Certification that the materials are in accordance with the drawings and specifications.
 - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

PART 2 - PRODUCTS

2.2 GROUNDING

- A. Rods: Per Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS and UL 467
- B. Ground Wire: Stranded bare copper 16 mm² (6 AWG) minimum.

2.3 WARNING TAPE:

Standard 4-mil polyethylene 76 mm (3 inch) wide tape, detectable type, red with black letters, imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW".

2.4 PULL ROPE:

Plastic with 890N (200 pound) minimum tensile strength.

PART 3 - EXECUTION

3.1 TRENCHING

- A. Refer to Section 312000, EARTH MOVING for trenching back-filling, and compaction.
- B. Cut the trenches neatly and uniformly.
- C. For Concrete Encased Ducts:
 - 1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 1200 mm (4 foot) intervals to establish the grade and route of the duct bank.
 - 2. Pitch the trenches uniformly towards manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts towards buildings wherever possible.
 - 3. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.
 - 4. After the concrete encased duct has sufficiently cured, the trench shall be backfilled to grade with earth, with appropriate warning tape attached.

3.3 DUCT INSTALLATION

- A. General Requirements:
 - 1. Ducts shall be in accordance with the NEC and IEEE C2, as shown on the drawings, and as specified.
 - 2. Slope ducts to drain towards manholes and handholes, and away from building and equipment entrances. Pitch not less than 100 mm (4 inches) in 30 M (100 feet).
 - 3. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be PVC-coated galvanized rigid steel, and shall extend a minimum of 1500 mm (5 feet) outside of building foundation.

4. Stub-ups, sweeps, and risers to equipment mounted on outdoor concrete slabs shall be PVC-coated galvanized rigid steel, and shall extend a minimum of 1500 mm (5 feet) away from edge of slab.
5. Install insulated grounding bushings on the terminations.
6. PVC-coated rigid steel conduits shall be coupled to the ducts with suitable adapters, and the whole encased with 75 mm (3 inches) of concrete.
7. PVC coated rigid steel conduit turns of direction for all duct lines shall have minimum 1200 mm (4 feet) radius in the horizontal and vertical directions. PVC conduit sweeps for all duct lines shall have a minimum 12000 mm (40 feet) radius in the horizontal and 1200 mm (4 feet) in the vertical directions. Where a 12000 mm (40 feet) radius is not possible, horizontal turns of direction shall be rigid steel.
8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 75 mm (3 inches) above bottom of trench during the concrete pour. Spacer spacing shall not exceed 1500 mm (5 feet).
9. Duct lines shall be installed no less than 300 mm (12 inches) from other utility systems, such as water, sewer, and chilled water.
10. Clearances between individual ducts:
 - a. For like services, not less than 75 mm (3 inches).
 - b. For power and signal services, not less than 150 mm (6 inches).
 - c. Provide plastic spacers to maintain clearances.
 - d. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires shall not act as substitute for spacers.
11. Duct lines shall terminate at window openings in manhole walls as shown on the drawings. All ducts shall be fitted with end bells.
12. Couple the ducts with proper couplings. Stagger couplings in rows and layers to insure maximum strength and rigidity of the duct bank.
13. Keep ducts clean of earth, sand, or gravel during construction, and seal with tapered plugs upon completion of each portion of the work.

B. Concrete Encased Ducts and Conduits:

1. Install concrete encased ducts for medium and high voltage systems, low voltage systems, and signal systems unless otherwise shown on the drawings.
2. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts shall be uniform in size and material throughout the installation.
3. Tops of concrete-encased ducts shall be:
 - a. Not less than 600 mm (24 inches) and not less than shown on the drawings, below finished grade.
 - b. Not less than 750 mm (30 inches) and not less than shown on the drawings, below roads and other paved surfaces.
 - c. Conduits crossing under grade slab construction joints shall be installed a minimum of 1200 mm (4 feet) below slab.
4. Extend the concrete envelope encasing the ducts not less than 75 mm (3 inches) beyond the outside walls of the outer ducts and conduits.

5. Within 3000 mm (10 feet) of building, manhole and handhole wall penetrations, install reinforcing steel bars at the top and bottom of each concrete envelope to provide protection against vertical shearing.
6. Install reinforcing steel bars at the top and bottom of each concrete envelope of all ducts underneath roadways and parking areas.
7. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, handholes, ducts, conduits, and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to insure smooth durable transitions.
8. Conduit joints in concrete may be placed side by side horizontally but shall be staggered at least 150 mm (6 inches) vertically.
9. For medium voltage duct bank installations, a grounding conductor shall be extend along all electrical duct banks including stubs through each electrical distribution system manhole and to each transformer and switching-station installation.
10. Duct Bank Markers:
 - a. Duct bank markers, where required, shall be located at the ends of duct banks except at manholes or handholes at approximately every 60 meter (200 feet) along the duct run and at each change in direction of the duct run. Markers shall be placed 600 mm (2 feet) to the right of the duct bank, facing the longitudinal axis of the run in the direction of the electrical load.
The letter "D" with two arrows shall be impressed or cast on top of the marker. One arrow shall be located below the letter and shall point toward the ducts. Second arrow shall be located adjacent to the letter and shall point in a direction parallel to the ducts. The letter and arrow adjacent to it shall each be approximately 75 mm (2-inches) long. The letter and arrows shall be V-shaped, and shall have a width of stroke at least 6 mm ($\frac{1}{4}$ inch) at the top and a depth of 6 mm ($\frac{1}{4}$ inch).
 - c. In paved areas, the top of the duct markers shall be flush with the finished surface of the paving.
 - d. Where the duct bank changes direction, the arrow located adjacent to the letter shall be cast or impressed with an angle in the arrow the same as the angular change of the duct bank.

C. Direct Burial Duct and Conduits:

1. Install direct burial ducts and conduits only where shown on the drawings. Provide direct burial ducts only for low voltage systems.
2. Join and terminate ducts and conduits with fittings recommended by conduit manufacturer.
3. Direct burial ducts and conduits are prohibited under railroad tracks.
4. Tops of ducts and conduits shall be:
 - a. Not less than 600 mm (24 inches) and not less than shown on the drawings, below finished grade.
 - b. Not less than 750 mm (30 inches) and not less than shown on the drawings, below roads and other paved surfaces.
5. Do not kink the ducts or conduits.

- D. Concrete-Encased and Direct Burial Duct and Conduit Identification: Place continuous strip of warning tape approximately 300 mm (12 inches) above ducts or conduits before backfilling trenches. Warning tape shall be preprinted with proper identification.
- E. Spare Ducts and Conduits: Where spare ducts are shown, they shall have a nylon pull rope installed. They shall be capped at each end and labeled as to location of the other end.
- F. Duct and Conduit Cleaning:
 - 1. Upon completion of the duct bank installation or installation of direct buried ducts, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 3600 mm (12 inches) long, and shall have a diameter not less than 13 mm (1/2 inch) less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than the diameter of the duct.
 - 2. Mandrel pulls shall be witnessed by the Resident Engineer.
- G. Duct and Conduit Sealing: Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.
- J. Connections to Existing Ducts: Where connections to existing duct banks are indicated, excavate around the duct banks as necessary. Cut off the duct banks and remove loose concrete from the conduits before installing new concrete-encased ducts. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks.
- K. Partially Completed Duct Banks: During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 600 mm (2 feet) back into the envelope and a minimum of 600 mm (2 feet) beyond the end of the envelope. Provide one No. 4 bar in each corner, 75 mm (3 inches) from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 300 mm (1 foot) apart. Restrain reinforcing assembly from moving during pouring of concrete.

END OF SECTION 260541

Page intentionally left blank.

SECTION 260923 - LIGHTING CONTROLS

PART 1 – GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of the lighting controls.

1.2 RELATED WORK

- A. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- B. Section 260521, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 262726, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product Data: For each type of lighting control, submit the following information.
 - 1. Manufacturer's catalog data.
 - 2. Wiring schematic and connection diagram.
 - 3. Installation details.
- C. Manuals:
 - 1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
 - 2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Resident Engineer.
- D. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:
 - a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Photoelectric Relays: Conform to UL 773A, "Nonindustrial Photoelectric Switches for Lighting Control". Relays are solid state, with dry contacts for relay or contactor control, and have time delay to prevent false operation. Units shall have a weather tight housing, resistant to high temperatures and equipped with a sun glare shield and ice prevention. Photoelectric controls shall operate when natural light falls below design level. Units are adjustable for turn-on/turn-off levels. Set to turn on at 5 footcandles and off at 15 footcandles unless noted otherwise. Provide surge protection for top tier photoelectric control feed to LCP panel.

2.2 LIGHTING CONTROL PANEL ENCLOSURE

- A. Size NEMA 12 panel with hinged cover to allow for future addition of 3 control switches. Provide control switches, 120 volt L.E.D. pilot lights, terminal blocks as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.
- B. Aim outdoor photocell switch according to manufacturer's recommendations.
- C. Aiming for wall-mounted and ceiling-mounted motion sensor switches shall be per manufacturer's recommendations.
- D. Locate light level sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the scheduled light level at the typical work plane for that area.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations.
- B. Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.

- C. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placements.

3.3 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting control devices are in good operating condition and properly performing the intended function.

END OF SECTION 260923

Page intentionally left blank.

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of wiring devices.

1.2 RELATED WORK

- A. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 260533, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlets boxes.
- C. Section 260521, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting details, construction materials, grade and termination information.
- C. Manuals: Two weeks prior to final inspection, deliver four copies of the following to the Resident Engineer: Technical data sheets and information for ordering replacement units.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., and conform to NEMA WD 6.
 - 1. All receptacles are to be ground fault interrupter duplex receptacles: Shall be an integral unit, suitable for mounting in a standard outlet box.
 - a. Ground fault interrupter shall consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or – 1 milliamp) on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.
 - b. Ground Fault Interrupter Duplex Receptacles (not hospital-grade) shall be the same as ground fault interrupter hospital-grade receptacles except for the “hospital-grade” listing.
- B. Receptacles; 20, 30 and 50 ampere, 250 volts: Shall be complete with appropriate cord grip plug. Devices shall meet UL 231.
- C. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.

2.2 TOGGLE SWITCHES

- A. Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.
 - 1. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
 - 2. Ratings:
 - a. 120 volt circuits: 20 amperes at 120-277 volts AC.
 - b. 277 volt circuits: 20 amperes at 120-277 volts AC.

2.3 WALL PLATES

- A. Wall plates for switches and receptacles shall be type 302 stainless steel in finished areas and weatherproof type cast metal in other areas. Oversize plates are not acceptable.
- B. Standard NEMA design, so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD 6.
- C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.
- B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.
- C. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
- D. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.
- E. Install wall switches 48 inches [1200mm] above floor, OFF position down.
- F. Install convenience receptacles 18 inches [450mm] above floor, and 6 inches [152mm] above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.
- G. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.
- H. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
- I. Test GFCI devices for tripping values specified in UL 1436 and UL 943.

END OF SECTION 262726

Page intentionally left blank.

SECTION 264100 - FACILITY LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing and installation of a complete master labeled lightning protection system, complying with NFPA 780, UL 96 and UL 96A.

1.2 RELATED WORK

- A. Section 076000, FLASHING AND SHEET METAL: penetrations through the roof.
- B. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- C. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground faults.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Isometric and plan views showing layout and connections to the required metal surfaces.
 - 2. Show the methods of mounting the system to the adjacent construction.
- C. Qualifications: Submit proof that the installer of the lightning protection system is a certified Lightning Protection Institute (LPI) installer, and has had suitable and adequate experience installing other lightning protection systems, and is capable of installing the system as recommended by the manufacturer of the equipment.
- D. Certification: Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:
 - 1. Certification that the lightning protection system has been properly installed and tested.
 - 2. Certification that the lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Attach master labels to each item by its manufacturer as evidence that the materials have been manufactured in conformance with the UL Standards for master label lightning protection materials.
- B. In addition to conformance to UL 96, the component material requirements are as follows:
 - 1. Conductors: Electrical grade copper. Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, Class II, or Class II modified materials as applicable.
 - 2. Air terminals: Solid copper, 18 inches long, not less than 3/8 inch [9mm] diameter, with sharp nickel-plated points.
 - 3. Ground rods: Copper clad steel, not less than 1/2 inch [13mm] diameter by 8 feet [2400mm] long. Rods made of copper-clad steel shall conform to UL 467 and galvanized ferrous rods shall conform to IEEE C135.30.
 - 4. Ground plates: Solid copper, not less than 1/16 inch [2mm] thick.
 - 5. Tubing: Stiff copper or brass.
- C. Anchors and fasteners: Bolt type which are most suitable for the specific anchor and fastener installations. Clamp-type connectors for splicing conductors shall conform to UL 96, class as applicable, and, Class 2, style and size as required for the installation. Clamp-type connectors shall only be used for the connection of the roof conductor to the air terminal and to the guttering. All other connections, bonds, and splices shall be done by exothermic welds or by high compression fittings. The exothermic welds and high compression fittings shall be listed for the purpose. The high compression fittings shall be the type which require a hydraulically operated mechanism to apply a minimum of 10,000 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the conductors as inconspicuously as practical and with the proper bends.
- B. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.
- C. Use the exothermic welding type connections that form solid metal joints in the main vertical and horizontal conductors, and for connections that are not exposed in the finish work.
- D. Protect copper conductors with stiff copper or brass tubing, which enclose the conductors from the top to the bottom of the tubing, between one foot [300mm] below and seven feet [2100mm] above the finished grade. The conductor shall be bonded to the top and bottom of the tubing.

- E. Sheath copper conductors, which pass over cast stone, cut stone, architectural concrete and masonry surfaces, with not less than a 1/16 inch [2mm] thickness of lead to prevent staining of the exterior finish surfaces.
- F. For the earth connections, install ground rods and ground plates, and the conductor connections to them and the main water pipes in the presence of the Resident Engineer. For the conductors located outside of the building or stack, install the conductors not less than two feet [600mm] below the finished grade.
- G. Connect lightning protection cables to all metallic projections, equipment, and components above the top level as indicated on the drawings.
- H. Connect exterior metal surfaces, located within three feet [900mm] of the lightning protection system conductors, to the lightning protection system conductors to prevent flashovers.
- I. Maintain horizontal or downward coursing of main conductor and insure that all bends have at least an 8-inch radius and do not exceed 90 degrees.
- J. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Install air terminal bases, cable holders and other roof-system supporting means without piercing roof metal.
- K. On construction utilizing post tensioning systems to secure precast concrete sections, the post tension rods shall not be used as a path for lightning to ground. Down conductors shall be provided on structures using post tensioning systems. Down conductors shall have sufficient separation from post tension rods to prevent side-flashing. Post tension rods shall be bonded to the lightning protection and grounding systems only at the base of the structure; this bonding shall be performed in strict accordance with the recommendations of the post tension rod manufacturer, and shall be done by, or in the presence of, a representative of the manufacturer.
- L. Grounding: Test the ground resistance to earth by standard methods and conform to the ground resistance requirements specified in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- M. Where shown, use the structural steel framework or reinforcing steel as the main conductor:
 - 1. Weld or bond the non-electrically-continuous sections together and make them electrically continuous.
 - 2. Verify the electrical continuity by measuring the ground resistances to earth at the ground level, at the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings.
 - 3. Connect the air terminals together with an exterior conductor connected to the structural steel framework at not more than 60 foot [18m] intervals.
 - 4. Install ground connections to earth at not more than 60 foot [18m] intervals around the perimeter of the building.

5. Weld or braze bonding plates, not less than 8 inches [200mm] square, to cleaned sections of the steel and connect the conductors to the plates.
 6. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to UL Publication No. 96A.
- N. When the lightning protection systems have been installed, have the systems inspected by a UL representative. Obtain and install a UL numbered master label for each of the lightning protection systems at the location directed by the UL representative and the Resident Engineer.

END OF SECTION 264100

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of the interior lighting systems.

1.2 RELATED WORK

- A. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.
- B. Section 260521, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 262726, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product Data: For each type of lighting fixture (luminaire) designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of fixture designation, submit the following information.
 - 1. Material and construction details include information on housing, optics system and lens/diffuser.
 - 2. Physical dimensions and description.
 - 3. Wiring schematic and connection diagram.
 - 4. Installation details.
 - 5. Energy efficiency data.
 - 6. Photometric data based on laboratory tests complying with IESNA Lighting Measurements, testing and calculation guides.
 - 7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours) and color temperature (degrees Kelvin).
 - 8. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts and total harmonic distortion (THD).

C. Manuals:

1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Resident Engineer.

D. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:
 - a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES (LUMINAIRES)

- A. Shall be in accordance with NFPA 70 and UL 1598, as shown on drawings, and as specified.
- B. Sheet Metal:
 1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved) and parallel to each other as designed.
 2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.
 3. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
 4. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, latches shall function easily by finger action without the use of tools.
- C. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.
- D. Lamp Sockets:
 1. Fluorescent: Lampholder contacts shall be the biting edge type or phosphorous-bronze with silver flash contact surface type and shall conform to the applicable requirements of UL 542. Lamp holders for bi-pin lamps shall be of the telescoping compression type, or of the single slot entry type requiring a one-quarter turn of the lamp after insertion.
- E. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or

fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

F. Metal Finishes:

1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.

G. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

H. Light Transmitting Components for Fluorescent Fixtures:

1. Shall be 100 percent virgin acrylic.
 2. Flat lens panels shall have not less than 1/8 inch [3.2mm] of average thickness. The average thickness shall be determined by adding the maximum thickness to the minimum unpenetrated thickness and dividing the sum by 2.
 3. Unless otherwise specified, lenses, diffusers and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking.
- I. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballast integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures (not the lamp). Fixtures shall be designed for lamps as specified.

2.2 BALLASTS

- A. Linear Fluorescent Lamp Ballasts: 277V electronic instant-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:
1. Automatic lamp starting after lamp replacement.
 2. Sound Rating: Class A.
 3. Total Harmonic Distortion Rating: 10 percent or less.
 4. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 5. Operating Frequency: 20 kHz or higher.
 6. Lamp Current Crest Factor: 1.7 or less.
 7. Ballast Factor: 0.98-1.02
 8. Power Factor: 0.98 or higher.
 9. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.

2.3 LAMPS

A. Linear and U-shaped T5 and T8 Fluorescent Lamps:

1. Instant-start lamps shall comply with ANSI C78.3.
2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
3. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature of 4100°K, a Color Rendering Index (CRI) of greater than 70, average rated life of 24,000 hours, and be suitable for use with dimming ballasts, unless otherwise indicated. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.

2.5 EXIT LIGHT FIXTURES

A. Exit light fixtures shall meet applicable requirements of NFPA 101 and UL 924.

B. Housing and Canopy:

1. Shall be made of die-cast aluminum.
2. Optional steel housing shall be a minimum 20 gauge thick or equivalent strength aluminum.
3. Steel housing shall have baked enamel over corrosion resistant, matte black or ivory white primer.

C. Door frame shall be cast or extruded aluminum, and hinged with latch.

D. Finish shall be satin or fine-grain brushed aluminum.

E. There shall be no radioactive material used in the fixtures.

F. Fixtures:

1. Maximum fixture wattage shall be 1 watt or less.
2. Inscription panels shall be cast or stamped aluminum a minimum of 0.090 inch [2.25mm] thick, stenciled with 6 inch [150mm] high letters, baked with red color stable plastic or fiberglass. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass. The LED shall be rated minimum 25 years life.
3. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
4. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.

G. Voltages: Refer to Lighting Fixture Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.
- B. Align, mount and level the lighting fixtures uniformly.
 - 1. Surface mounted lighting fixtures:
 - a. Fixtures shall be installed as detailed on the drawings.
- C. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.
- D. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- E. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless a lesser period is specifically recommended by lamp manufacturer. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage. Replace any lamps and ballasts which fail during burn-in.
- F. At completion of project, relamp/reballast fixtures which have failed lamps/ballasts. Clean fixtures, lenses, diffusers and louvers that have accumulated dust/dirt/fingerprints during construction. Replace damaged lenses, diffusers and louvers with new.
- G. Dispose of lamps per requirements of Section 017419, CONSTRUCTION WASTE MANAGEMENT.

END OF SECTION 265100

Page intentionally left blank.

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of exterior luminaries, controls, poles and supports.

1.2 RELATED WORK

- A. Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 260533, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings, and boxes for raceway systems.
- C. Section 260521, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage power and lighting wiring.
- D. Section 260541, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground handholes and conduits.
- E. Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 SUBMITTALS

- A. Submit in accordance with Section 260511, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting, details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, poles, luminaries, lamps and controls.
- C. Manuals: Two weeks prior to final inspection, submit four copies of operating and maintenance manuals to the Resident Engineer. Include technical data sheets, wiring and connection diagrams, and information for ordering replacement parts.
- D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
 - 1. Certification that the materials are in accordance with the drawings and specifications.

2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 DELIVERY, STORAGE, AND HANDLING

Steel Poles: Do not store poles on ground. Store poles so they are at least 305 mm (one foot) above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall be in accordance with NEC, UL, ANSI, and as shown on the drawings and specified.

2.2 POLES

A. General:

1. Poles shall be square steel, as shown on the drawings, and as specified. Finish shall be as specified on the drawings.
2. The pole and arm assembly shall be designed for wind loading of 161 km/hr (100 miles per hour), with an additional 30 percent gust factor, supporting luminaire(s) having the effective projected areas indicated. The effective projected area of the pole shall be applied at the height of the pole base as shown on the drawings.
3. Poles shall be anchor-bolt type designed for use with underground supply conductors. Poles shall have oval-shaped handhole having a minimum clear opening of 65 by 125 mm (2.5 by 5 inches). Handhole cover shall be secured by stainless steel captive screws.
4. Provide a steel-grounding stud opposite hand hole openings.
5. Provide a base cover matching the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts.
6. Hardware: All necessary hardware shall be 300 series stainless steel.

B. Types:

1. Steel: Provide steel poles having with a minimum yield/strength of 48,000 psi and hot-dipped galvanized factory finish. Galvanized steel poles shall comply with ASTM A123 and A153. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 36,000 psi.

2.3 LUMINAIRES

- A. UL 1598 and NEMA C136.17. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, and safe for cleaning and relamping.
- B. Pre-wire internal components to terminal strips at the factory.

- C. Bracket mounted luminaries shall have leveling provisions and clamp type adjustable slip-fitters with locking screws.
- D. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.
- E. IESNA Cutoff Category: cutoff

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lighting in accordance with the NEC, as shown on the drawings, and in accordance with manufacturer's recommendations.
- B. Steel Poles:
 - 1. Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad 90 degrees at the bottom end. Provide galvanized nuts, washers, and ornamental covers for anchor bolts. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.
 - 2. After the poles have been installed, shimmed and plumbed, grout the spaces between the pole bases and the concrete base with non-shrink concrete grout material. Provide a plastic or copper tube, of not less than 9 mm (3/8-inch) inside diameter, through the grout tight to the top of the concrete base for moisture weeping.

3.2 GROUNDING

Ground noncurrent-carrying parts of equipment including metal poles, luminaries, mounting arms, brackets, and metallic enclosures as specified in Section 260526, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable and listed for this purpose.

END OF SECTION 265600

Page intentionally left blank.

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 – GENERAL

1.1 DESCRIPTION

Provide and install pan-tilt-zoom (PTZ) cameras and fixed cameras as shown on Drawings and fully integrate with the existing Video Surveillance System in the East Parking Structure, which is identified as the Closed Circuit Television System hereinafter referred to as the CCTV System as specified in this section. This work shall be performance design based according to the requirements of this specification.

The Contractor shall visit the site and verify existing conditions and equipment to develop appropriate design, equipment, installation and integration of the proposed cameras (as shown on drawings) to the existing CCTV system.

1.2 RELATED WORK

- A. For Warranty of Construction see GENERAL CONDITIONS.
- B. For General Requirements, Section 010000, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

- A. The Contractor shall be responsible for providing, installing, and the operation of the CCTV System as described in this specification. The Contractor shall also provide certification as required.
- B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.
- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

- A. Submit below items in conjunction with Master Specification Sections 013323, Shop Drawings, Product Data, and Samples.
- B. Provide certificates of compliance with Section 1.3, Quality Assurance.
- C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.
- D. Pre-installation design and as-built packages shall include:
 - 1. Index Sheet that shall:

- a. Define each page of the design package to include facility name, building name, floor, and sheet number.
 - b. Provide a list of all security abbreviations and symbols.
 - c. Reference all general notes that are utilized within the design package.
 - d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
 - 1) Outline all general and job specific work required within the design package.
 - 2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
 - a. Include a title block as defined above.
 - b. Define the drawings scale in both standard and metric measurements.
 - c. Provide device identification and location.
 - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements.
 - e. Identify all pull box and conduit locations, sizes, and fill capacities.
 - f. Address all general and drawing specific notes for a particular drawing sheet.
3. A riser drawing for each applicable security subsystem shall:
 - a. Indicate the sequence of operation.
 - b. Relationship of integrated components on one diagram.
 - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
 - d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
4. A system drawing for each applicable security system shall:
 - a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
 - b. Provide full detail of all system components wiring from point-to-point.
 - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
 - d. Show device locations that correspond to the floor plans.
 - e. All general and drawing specific notes shall be included with the system drawings.
5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
 - a. Device ID.
 - b. Device Location (e.g. site, building, floor, room number, location, and description).
 - c. Mounting type (e.g. flush, wall, surface, etc.).

- d. Power supply or circuit breaker and power panel number.
 - e. In addition, for the CCTV Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.
- 6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
 - 1. 35 percent
 - 2. 65 percent
 - 3. 90 percent
 - 4. 100 percent
- F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 calendar days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.
- G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the VA General Requirements, Section 010000, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):
 - 330 Electrical Performance Standards for CCTV Cameras
 - 375A..... Electrical Performance Standards for CCTV Monitors
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - C62.41..... IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
 - 802.3af Power over Ethernet Standard
- D. National Electrical Contractors Association (NECA):
 - 303-2005 Installing Closed Circuit Television (CCTV) Systems
- E. National Fire Protection Association (NFPA):
 - 70-05 Article 780-National Electrical Code
- F. Federal Information Processing Standard (FIPS):
 - 140-2 Security Requirements for Cryptographic Modules

- G. Underwriters Laboratories, Inc. (UL):
983-06 Standard for Surveillance Camera Units
3044-01 Standard for Surveillance Closed Circuit Television
Equipment

1.6 WARRANTY OF CONSTRUCTION.

Warrant CCTV System work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.

PART 2 – PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All equipment associated within the CCTV System shall be UL 3004 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
- B. All equipment shall operate on a 120 alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification.
- C. The system shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.
- D. All equipment and materials for the system will be compatible to ensure correct operation.

2.2 EQUIPMENT ITEMS

- A. CCTV system shall meet following requirements:
- B. All Cameras will be EIA 330 and UL 983 compliant as well as:
 - 1. Will be charge coupled device (CCD) cameras and shall conform to National Television System Committee (NTSC) formatting.
 - 2. Fixed cameras shall be color and the primary choice for monitoring following the activities described below. Pan/Tilt/Zoom (P/T/Z) cameras shall be color and are to be utilized to compliment the fixed cameras.
 - 3. Shall be powered by either 12 volts direct current (VDC) or 24 VAC. Power supplies shall be Class 2 and UL compliant.
 - 4. Shall be rated for continuous operation under the following environmental conditions:
 - a. Ambient temperatures of minus 10 degrees C (14 degrees F) to 55 degrees C (131 degrees F) utilizing equipment that will provide automatic heating and cooling.
 - b. Humidity, wind gusts, ice loading, and seismic conditions specified or encountered for locations where CCTV cameras will be utilized.

5. Will be home run to and interfaced with the existing monitoring and recording device via the existing controlling device such as a matrix switcher or network server located in the existing East Parking Structure electrical room and security office.
6. Shall be programmed to digitally flip from color to black and white at dusk and vise versa at dawn.
7. Will be fitted with auto-iris lenses to ensure the image is maintained in low light.
8. Lightning protection shall be IEEE C62.41 compliant and provided for all cameras. Either surge protectors or a lightning grid may be utilized. Ensure all lightning protection equipment is compliant with Article 780 of the National Electrical Code (NEC). The use of Fuses and Circuit Breakers as a means of lightning protection shall not be allowed.
9. A video encoder shall be used to convert the signal from National Television System(s) Committee (NTSC) to Moving Picture Experts Group (MPEG) format, as needed to make compatible with existing system.
10. Fixed Color Cameras Technical Characteristics:

Imaging Device	1/3-inch interline transfer CCD
Picture Elements	NTSC 510 (H) x 492 (V)
Scanning System	NTSC 525 lines, 21 interlace
Synchronization System	AC line lock/internal
Horizontal Resolution	330 TV lines
Iris Control	Selectable on/off
Electronic Shutter Range	NTSC 1/60-1/100,000 second
Auto Iris Lens Type	DC/video drive (auto sensing)
Minimum Illumination	0.6 lux
Signal to Noise Ratio	>50 dB
Automatic Gain Control	On/off switchable
Backlight Compensation	On/off switchable
Auto White Balance	On/off switchable
Video Output	1 Vp-p, 75 ohms
Power Consumption	Less than 5 watts
Video Connector	BNC
Lens Mount	C/CS mount (adjustable)

11. P/T/Z Cameras Technical Characteristics:

Effective Pixels	768 (H) x 494 (V)
Scanning Area	1/4-type CCD
Synchronization	Internal/Line-lock/Multiplexed Vertical Drive (VD2)
Video Output	1.0 v[p-p] NTSC composite/75 ohm
H. Resolution	570-line at B/W, or 480-line at color imaging
Signal-to-noise Ratio	50dB (AGC off, weight on)
Super Dynamic II	64 times (36dB) (selectable on/off)
Minimum Illumination	0.06 lx (0.006 fc) at B/W, 1 lx(0.1 fc)
Zoom Speed	Approx. 2.1s (TELE/WIDE) in sequence mode
Focus Speed	Approx. 2s (FAR/NEAR) in sequence mode
Iris	Automatic (Open/Close is

	possible)/manual
Maximum Aperture Ratio	1:1.6 (Wide) ~ 3.0 (Tele)
Focal Length	3.79 ~ 83.4 mm
Angular Field of View	H 2.6° ~ 51.7° V 2.0° ~ 39.9°
Electronic Shutter	1/60 (off), 1/100, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/10,000 s
Zoom Ratio	Optical 22x w/10x electronic zoom
Iris Range	F1.6 ~ 64, Close
Panning Range	360° endless
Panning Speed	Manual: Approx. 0.1°/s ~ 120°/s 16 steps
Tilting Range	0 ~ 90° (Digital Flip off), 0 ~180° (Digital Flip on)
Tilting Speed	Manual: Approx. 0.1°/s ~ 120°/s. 16 steps
Pan/Tilt	Manual/Sequential position/Auto Pan
Controls	Pan/Tilt, Lens, 64 Preset Positions, Home Position
Video Connector	BNC
Controller I/F	Multiplex-coaxial

C. Lenses: Shall be utilized in a manner that provides maximum coverage of the area being monitored by the camera. The lenses shall:

1. Be 1/3" to fit CCD fixed camera.
2. Be all glass with coated optics.
3. Have mounts that are compatible with the camera selected.
4. Be packaged and supplied with the camera.
5. Have a maximum f-stop of f/1.3 for fixed lenses, and a maximum f-stop of f/1.6 for variable focus lenses.
6. Be equipped with an auto-iris mechanism.
7. Have sufficient circle of illumination to cover the image sensor evenly.
8. Not be used on a camera with an image format larger than the lens is designed to cover.
9. Be provided with pre-set capability.

D. Two types of lenses shall be utilized for both interior and exterior fixed cameras:

1. Manual Variable Focus
2. Auto Iris Fixed

E. Manual Variable Focus:

1. Shall be utilized in large areas that are being monitored by the camera. Examples of this are perimeter fence lines, vehicle entry points, parking areas, etc.
2. Shall allow for setting virtually any angle of field, which maximizes surveillance effects.
3. Technical Characteristics:

Image format	1/3 inch
Focal length	5–50mm
Iris range	F1.4 to close

Focus range	1m (3.3 ft)
Back focus distance	10.05 mm (0.4 in)
Angle view Wide (1/3 in)	53.4 x 40.1
Angle view Tele (1/3 in)	5.3 x 4.1
Iris control	manual
Focus ctrl	manual
Zoom ctrl	manual

F. Auto Iris Fixed

1. Shall be utilized in areas where a small specific point of reference is to be monitored. Examples of this are doorways, elevators, cashier booths, etc.
2. To determine the exact size of the fixed lens required, complete a focal length calculation using either a focal length calculator or a focal length chart provided by the product manufacturer.
3. Technical Characteristics:

Image format	1/3 inch	1/3 inch	1/3 inch
Focal length	2.8 mm	4 mm	8 mm
Iris range	F1.2 – 200	F1.2 – 200	F1.2 - 200
Min. Object	0.3 m (1 ft)	0.3 m (1 ft)	0.3 m (1 ft)
Lens mount	CS-mount	CS-mount	CS-mount
Angle of view	94 X 72	64 X 49	33 x 25
Focus control	Manual	Manual	manual

G. Camera Housings and Mounts:

1. This section pertains to all interior and exterior housings, domes, and applicable wall, ceiling, corner, pole, and rooftop mounts associated with the housing. Housings and mounts shall be specified in accordance to the type of cameras used.
2. All cameras and lenses shall be enclosed in a tamper resistant housing. Any additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
3. The camera and lens contained inside the housing shall be installed on a camera mount. All additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
4. Shall be manufactured in a manner that are capable of supporting a maximum of three (3) cameras with housings, and meet environmental requirements for the geographical area the camera support equipment is being installed on or within.
5. Environmentally Sealed
 - a. Shall:
 - 1) Be designed in manner that it provides a condensation free environment for correct camera operation.
 - 2) Operate in a 100 percent condensing humidity atmosphere.
 - 3) Be constructed in a manner that:

- a) Has a fill valve to allow for the introduction of nitrogen into the housing to eliminate existing atmospheric air and pressurize the housing to create moisture free conditions.
 - b) Has an overpressure valve to prevent damage to the housing in the event of over pressurization.
 - c) Is equipped with a humidity indicator that is visible to the eye to ensure correct atmospheric conditions at all times.
 - d) The leak rate of the housing is not to be greater than 13.8kPa or 2 pounds per square inch at sea level within a 90 day period.
 - e) It shall contain camera mounts or supports as needed to allow for correct positioning of the camera and lens.
 - f) The housing and sunshield are to be white in color.
- b. All electrical and signal cables required for correct operations shall be supplied in a hardened carrier system from the controller to the camera.
 - c. The mounting bracket shall be adjustable to allow for the housing weight of the camera and the housing unit it is placed in.
 - d. Accessibility to the camera and mounts shall be taken into consideration for maintenance and service purposes.

6. Exterior Domes

- a. The dome shall be a pendant mount, pole mount, ceiling mount, surface mount, or corner mounted equipment.
- b. The lower portion of the dome that provides camera viewing shall be made of black opaque acrylic and shall have a light attenuation factor of no more than 1 f-stop.
- c. The housing shall be equipped with integral pan/tilt capabilities complete with wiring, wiring harness, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to fully provide a fully functional pan/tilt dome.
- d. The pan/tilt mechanism shall be:
 - 1) Constructed of heavy duty bearings and hardened steel gears.
 - 2) Permanently lubricated to ensure smooth and consistent movement of all parts throughout the life of the product.
 - 3) Equipped with motors that are thermally or impedance protected against overload damage.
- e. Pan movements shall be 360 degrees and tilt movement shall not be less than +/- 90 degrees.
- f. Pan speed shall be a minimum of 10 degrees per second.
- g. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity.

7. Exterior Wall Mounts

- a. Shall have an adjustable head for mounting the camera.
- b. Shall be constructed of aluminum, stainless steel, or steel with a corrosion-resistant finish.

- c. The head shall be adjustable for not less than plus and minus 90 degrees of pan, and not less than plus and minus 45 degrees of tilt. If the bracket is to be used in conjunction with a pan/tilt, the bracket shall be supplied without the adjustable mounting head, and shall have a bolt-hole pattern to match the pan/tilt base.
- d. Shall be installed at a height that allows for maximum coverage of the area being monitored.

H. Controlling Equipment

1. Cameras shall be compatible with all existing controlling equipment. Contractor shall perform all programming, connections and interface to provide fully operational system.
2. Shall be utilized to call up, operate, and program all cameras associated CCTV System components. Will have the ability to operate the cameras locally and remotely. A matrix switcher or a network server shall be utilized as the CCTV System controller.
3. The controller shall be able to fit into a standard 19" (47.5 cm) equipment rack.

I. Wires and Cables

1. Shall meet or exceed the manufactures recommendation for power and signal.
2. Will be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
3. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will contained in either EMT or RGS conduit.
4. All conduit, pull boxes, and junction boxes shall be clearly marked with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
5. Conduit fills shall not exceed 50 percent unless otherwise documented.
6. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
7. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area
8. High voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
9. For all equipment that is carrying digital data between the Access Control System and Database Management or at a remote monitoring station, shall not be less than 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.
10. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within three (3) ft. (one (1) m.) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:

- a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and peak current of 60 amperes.
 - b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and peak current of 500 amperes.
11. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. Fuses and relays shall not be used as a means of surge protection.
12. Coaxial Cables
- a. All video signal cables for the CCTV System, with exception to the PoE cameras, shall be a coaxial cable and have a characteristic impedance of 75 ohms plus or minus 3 ohms.
 - b. For runs up to 750 feet use of an RG-59/U is required. The RG-59/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 23 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
 - c. For runs between 750 feet and 1250 feet, RG-6/U is required. RG-6/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 18 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
 - d. For runs of 1250 to 2750 feet, RG-11/U is required. RG-11/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 14 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
 - e. All runs greater than 2750 feet will be substituted with a fiber optic cable. If using fiber optics as a signal carrier then the following equipment will be utilized:
 - 1) Multimode fiber optic cable a minimum size of 62 microns
 - 2) Video transmitter, installed at the camera that utilizes 12 VDC or 24 VAC for power.
 - 3) Video receiver, installed at the switcher.
 - f. RG-59/U Technical Characteristics

AWG	22
Stranding	7x29
Conductor Diameter	.031 in.
Conductor Material	BCC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.145 in.
Outer Shield Type	Braid/Braid
Outer Jacket Material	PVC
Overall Nominal Diameter	.242 in.
UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.094 µH/ft
Nom. Capacitance	Conductor to Shield 17.0 pF/ft
Nom. Velocity of Propagation	80 %
Nom. Delay	1.3 ns/ft

Nom. Conductor Resistance @ 20°C	DC	12.2 Ohms/1000 ft
Nom. Outer Shield Resistance @ 20°C	DC	2.4 Ohms/1000 ft
Max. Operating Voltage		UL 300 V RMS

g. RG-6/U Technical Characteristics:

AWG	18
Stranding	7x27
Conductor Diameter	.040 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.180 in.
Outer Shield Material	Trade Name Duofoil
Outer Shield Type	Tape/Braid
Outer Shield %Coverage	100 %
Outer Jacket Material	PVC
Overall Nominal Diameter	.274 in.
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.106 μ H/ft
Nom. Capacitance	Conductor to Shield 16.2 pF/ft
Nom. Velocity of Propagation	82 %
Nom. Delay	1.24 ns/ft
Nom. Conductor Resistance	DC 6.4 Ohms/1000 ft
Nominal Outer Shield Resistance @ 20°C	DC 2.8 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

h. RG-11/U Technical Characteristics:

AWG	15
Stranding	19x27
Conductor Diameter	.064 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.312 in.
Inner Shield Type	Braid
Inner Shield Material	BC - Bare Copper
Inner Shield %Coverage	95 %
Inner Jacket Material	PE – Polyethylene
Inner Jacket Diameter	.391 in.
Outer Shield Type	Braid
Outer Shield Material	BC - Bare Copper
Outer Shield %Coverage	95 %
Outer Jacket Material	Trade Name Belflex
Outer Jacket Material	PVC Blend

Overall Nominal Diameter	.520 in.
Operating Temperature Range	-35°C To +75°C
Non-UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.097 μ H/ft
Nom. Capacitance	Conductor to Shield 17.3 pF/ft
Nom. Velocity of Propagation	78 %
Nom. Delay	1.30 ns/ft
Nom. Conductor DC Resistance	3.1 Ohms/1000 ft
Nom. Inner Shield DC Resistance	1.8 Ohms/1000 ft
Nom. Outer Shield DC Resistance	1.4 Ohms/1000 ft
Max. Operating Voltage Non-UL	300 V RMS

13. Signal Cables:

- a. Signal wiring for PoE cameras depends on the distance the camera is being installed from either a hub or the server.
- b. If the camera is up to 300 ft from a hub or the server, then use a shielded UTP category 5 (CAT-V) cable with standard RJ-45 connector at each end. The cable must comply with the Power over Ethernet, IEEE802.3af, Standard.
- c. If the camera is over 300 ft from a hub or server then utilize a multimode fiber optic cable with a minimum size of 62 microns.
- d. Provide a separate cable for power.
- e. CAT-5 Technical Characteristics:

Number of Pairs	4
Total Number of Conductors	8
AWG	24
Stranding	Solid
Conductor Material	BC - Bare Copper
Insulation Material	PO – Polyolefin
Overall Nominal Diameter	.230 in.
IEC Specification	11801 Category 5
TIA/EIA Specification	568-B.2 Category 5e
Max. Capacitance Unbalance	(pF/100 m) 150 pF/100 m
Nom. Velocity of Propagation	70 %
Max. Delay	(ns/100 m) 538 @ 100MHz
Max. Delay Skew	(ns/100m) 45 ns/100 m
Max. Conductor DC Resistance	9.38 Ohms/100
Max. DCR Unbalance @ 20°C	3 %
Max. Operating Voltage	UL 300 V RMS

- f. Fiber Optic Cables Technical Characteristics:

Fiber Type	62.5 Micron
Number of Fibers	4
Core Diameter	2.5 +/- 2.5 microns

Core Non-Circularity	5% Maximum
Clad Diameter	125 +/- 2 microns
Clad Non-Circularity	1% Maximum
Core-clad Offset	1.5 Microns Maximum
Primary Coating Material	Acrylate
Primary Coating Diameter	245 +/- 10 microns
Secondary Coating Material	Engineering Thermoplastic
Secondary Coating Diameter	900 +/- 50 microns
Strength Member Material	Aramid Yarn
Outer Jacket Material	PVC
Outer Jacket Color	Orange
Overall Diameter	.200 in.
Numerical Aperture	.275
Maximum Gigabit Ethernet	300 meters
Maximum Gigabit Ethernet	550 meters

14. Power Cables

- a. Will be sized accordingly and shall comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket. Low voltage cables will be a minimum of 18 AWG, stranded and non-conductive polyvinylchloride (PVC) jacket.
- b. Will be utilized for all components of the CCTV System that require either a 110 VAC 60 Hz or 220 VAC 50 Hz input. Each feed will be connected to a dedicated circuit breaker at a power panel that is primarily for the security system.
- c. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.
- d. Shall be rated for either 110 or 220 VAC, 50 or 60 Hz, and shall comply with VA Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- e. Low Voltage Power Cables
 - 1) Shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.
 - 2) Cable size shall determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.

PART 3

3.1 INSTALLATION

- A. System installation shall be in accordance with NECA 303, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.
- B. Components shall be configured with appropriate "service points" to pinpoint system trouble in less than 30 minutes.

- C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- D. The CCTV System will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a complete network.
- E. A complete CCTV System shall be comprised of, but not limited to, the following components:
 - 1. Cameras
 - 2. Lenses
 - 3. Video Display Equipment
 - 4. Camera Housings and Mounts
 - 5. Integration with existing Controlling Equipment
 - 6. Integration with existing Recording Devices
 - 7. Wiring and Cables
- F. The Contractor shall visit the site and verify existing conditions and equipment to develop appropriate design, equipment, installation and integration of the proposed additional cameras (as shown on drawings) to the existing CCTV system. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.
- G. Existing Equipment
 - 1. The Contractor shall connect to and utilize existing video equipment, video and control signal transmission lines, and devices for proper integration of the additional cameras. Video equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.
 - 2. The Contractor shall perform a field survey, including testing and inspection of all existing video equipment and signal lines intended to be incorporated into the CCTV System, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
 - 3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
 - 4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or incorrect installation of equipment.

5. The Contracting Officer shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacture numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.
- H. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.
- I. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.
- J. Interconnection of Console Video Equipment: The Contractor shall connect signal paths between video equipment as specified by the OEM. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.
- K. Cameras:
1. Connect power and signal lines to the camera.
 2. Set cameras with fixed iris lenses to the f-stop to give full video level.
 3. Aim camera to give field of view as needed to cover the alarm zone.
 4. Aim fixed mounted cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun.
 5. Focus the lens to give a sharp picture (to include checking for day and night focus and image quality) over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected. Dome cameras shall have all preset positions defined and installed.
- L. Camera Housings, Mounts, and Poles:
1. Install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site.
 2. Provide a foundation for each camera pole as specified and shown.
 3. Provide a ground rod for each camera pole and connect the camera pole to the ground rod as specified in Division 26 of the VA Master Specification and the VA Electrical Manual 730.

4. Provide electrical and signal transmission cabling to the mount location via a hardened carrier system from the Access Control System and Database Management to the device.
5. Connect signal lines and AC power to the housing interfaces.
6. Connect pole wiring harness to camera.

M. System Start-Up

1. The Contractor shall not apply power to the CCTV System until the following items have been completed:
 - a. CCTV System equipment items and have been set up in accordance with manufacturer's instructions.
 - b. A visual inspection of the CCTV System has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 - c. System wiring has been tested and verified as correctly connected as indicated.
 - d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
 - e. Power supplies to be connected to the CCTV System have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

N. Supplemental Contractor Quality Control

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed CCTV System; and are approved by the Contracting Officer.
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

3.2 TESTING AND TRAINING

All testing and training shall be compliant with the VA General Requirements, Section 010000, GENERAL REQUIREMENTS.

END OF SECTION 282300

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork such as:
1. Site preparation.
 2. Excavation.
 3. Underpinning.
 4. Filling and backfilling.
 5. Grading.
 6. Soil Disposal.
 7. Clean Up.

1.2 DEFINITIONS

- A. Unsuitable Materials:
1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by AASHTO T 180.
 2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proofrolling, or similar methods.
 3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from reference borings and design requirements, excavate to acceptable strata subject to Resident Engineer's approval.
- B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.
- C. Trench Earthwork: Trenchwork required for utility lines.
- D. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.

- E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D2922.
- F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term "fill" means fill or backfill as appropriate.
- G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
- H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the Resident Engineer. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
- I. Authorized additional excavation: Removal of additional material authorized by the Resident Engineer based on the determination by the Government's soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
- K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- N. Bedding course: Layer placed over the excavated sub-grade in a trench before laying pipe. Bedding course shall extend up to the springline of the pipe.
- O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.
- P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include items like vehicles, equipment,

appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.

- R. Contaminated soils: Soil that contains contaminants as defined and determined by the Resident Engineer or the Government's testing agency.

1.3 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 010000, GENERAL REQUIREMENTS.
- C. Subsurface Investigation: Section 010000, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

1.4 CLASSIFICATION OF EXCAVATION

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.
- B. Rock Excavation:
1. Trenches and Pits: Removal and disposal of solid, homogenous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be excavated with a late-model, track-mounted hydraulic excavator; equipped with a 1050 mm (42 inch) wide, short-tip-radius rock bucket; rated at not less than 103 kW (138 hp) flywheel power with bucket-curling force of not less than 125 kN (28,090 lbf) and stick-crowd force of not less than 84.5 kN (19,000 lbf); measured according to SAE J-1179. Trenches in excess of 3000 mm (10 feet) wide and pits in excess of 9000 mm (30 feet) in either length or width are classified as open excavation.
 2. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be dislodged and excavated with a late-model, track-mounted loader; rated at not less than 157 kW (210 hp) flywheel power and developing a minimum of 216 kN (48,510 lbf) breakout force; measured according to SAE J-732.
 3. Other types of materials classified as rock are unstratified masses, conglomerated deposits and boulders of rock material exceeding 0.76 m³ (1 cubic yard) for open excavation, or 0.57 m³ (3/4 cubic yard) for footing and trench excavation that cannot be removed by rock excavating equipment equivalent to the above in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.

4. Definitions of rock and guidelines for equipment are presented for general information purposes only. The Contractor is expected to use the information presented in the Geotechnical Engineering Report to evaluate the extent and competency of the rock and to determine both quantity estimations and removal equipment and efforts.

1.5 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION

- A. Measurement: Cross section and measure uncovered and separated materials, and compute quantities by Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 010000, GENERAL REQUIREMENTS. Do not measure quantities beyond the following limits:
 1. 600 mm (24 inches) from outside face of concrete work for which forms are required, except for footings.
 2. 300 mm (12 inches) from outside of perimeter of formed footings.
 3. 150 mm (6 inches) below bottom of pipe and not more than pipe diameter plus 600 mm (24 inches) in width for pipe trenches.
 4. From outside dimensions of concrete work for which no forms are required (trenches, conduits, and similar items not requiring forms).

1.6 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Rock Excavation Report:
 1. Certification of rock quantities excavated.
 2. Excavation method.
 3. Labor.
 4. Equipment.
 5. Land Surveyor's or Civil Engineer's name and official registration stamp.
 6. Plot plan showing elevation.
- C. Furnish to Resident Engineer:
 1. Contactor shall furnish resumes with all personnel involved in the project including Project Manager, Superintendent, and on-site Engineer. Project Manager and Superintendent should have at least 3 years of experience on projects of similar size.
 2. Soil samples.
 - a. Classification in accordance with ASTM D2487 for each on-site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.

- b. Laboratory compaction curve in accordance with AASHTO T 180 for each on site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
- c. Test reports for compliance with ASTM D 2940 requirements for subbase material.
- d. Pre-excavation photographs and videotape in the vicinity of the existing structures to document existing site features, including surfaces finishes, cracks, or other structural blemishes that might be misconstrued as damage caused by earthwork operations.
- e. The Contractor shall submit a scale plan daily that defines the location, limits, and depths of the area excavated.

1.7 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. American Association of State Highway and Transportation Officials (AASHTO):

T99-01(2004).....	Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop
T180-01(2004).....	Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop

C. American Society for Testing and Materials (ASTM):

D448-03a.....	Standard Classification for Sizes of Aggregate for Road and Bridge Construction
D698-00ae1.....	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft ³ (600 kN m/m ³))
D1556-00.....	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D1557-02e1.....	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2700 kN m/m ³))
D2167-94 (2001)	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2487-06.....	Standard Classification of Soil for Engineering Purposes (Unified Soil Classification System)
D2922-05.....	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D2940-03.....	Standard Specifications for Graded Aggregate Material for Bases or Subbases for Highways or Airports

D. Society of Automotive Engineers (SAE):

J732-92Specification Definitions - Loaders
J1179-02Hydraulic Excavator and Backhoe Digging Forces

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
- B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups; free of rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a minimum dry density of 1760 kg/m³ (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.
- C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75-µm (No. 200) sieve, per ASTM D2940;.
- D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75-µm (No. 200) sieve.
- E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.
- F. Granular Fill:
 - 1. Under concrete slab, crushed stone or gravel graded from 25 mm (1 inch) to 4.75 mm (No. 4), per ASTM D 2940.
 - 2. Bedding for sanitary and storm sewer pipe, crushed stone or gravel graded from 13 mm (1/2 inch) to 4.75 mm (No 4), per ASTM D 2940.

PART 3 - EXECUTION

3.1 SITE PREPARATION

- A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from parking area and areas near existing eastern parking structure
- B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.
- C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by Resident Engineer. Remove materials from area near eastern parking structure.
- D. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by Resident Engineer. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m³ (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on station. Remove foreign materials larger than 50 mm (2 inches) in any dimension from topsoil used in final grading. Topsoil work, such as stripping, stockpiling, and similar topsoil work shall not, under any circumstances, be carried out when soil is wet so that the composition of the soil will be destroyed.
- E. Concrete Slabs and Paving: Score deeply or saw cut to insure a neat, straight cut, sections of existing concrete slabs and paving to be removed where excavation or trenching occurs. Extend pavement section to be removed a minimum of 300 mm (12 inches) on each side of widest part of trench excavation and insure final score lines are approximately parallel unless otherwise indicated. Remove material from area near eastern parking structure.
- F. Lines and Grades: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 010000, GENERAL REQUIREMENTS, shall establish lines and grades.
 - 1. Grades shall conform to elevations indicated on plans within the tolerances herein specified. Generally grades shall be established to provide a smooth surface, free from irregular surface changes. Grading shall comply with

- compaction requirements and grade cross sections, lines, and elevations indicated. Where spot grades are indicated the grade shall be established based on interpolation of the elevations between the spot grades while maintaining appropriate transition at structures and paving and uninterrupted drainage flow into inlets.
2. Locations of existing and proposed elevations indicated on plans, except spot elevations are from a site survey that measured spot elevations and subsequently generated existing contours and spot elevations. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Contractor is responsible to notify Resident Engineer of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify Resident Engineer of any differences between existing or constructed grades, as compared to those shown on the plans.
 3. Subsequent to establishment of lines and grades, Contractor will be responsible for any additional cut and/or fill required to ensure that site is graded to conform to elevations indicated on plans.
 4. Finish grading as specified on drawings.
- G. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations.

3.2 EXCAVATION

- A. Shoring, Sheet piling and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the Resident Engineer, banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities.
1. Design of the temporary support of excavation system is the responsibility of the Contractor.
 2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the Resident Engineer.
 3. Extend shoring and bracing to a minimum of 1500 mm (5 feet) below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
 4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall underpin the existing foundation, per Section 3.3 under disturbed foundations, as directed by Resident Engineer, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by Resident Engineer.

- B. Excavation Drainage: Operate pumping equipment and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from Resident Engineer.
- C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the Resident Engineer.
- D. Proofrolling:
 - 1. After rough grade has been established in cut areas and prior to placement of fill in fill areas under building and pavements, proofroll exposed subgrade with a fully loaded dump truck to check for pockets of soft material.
 - 2. Proofrolling shall consist of at least two complete passes with one pass being in a direction perpendicular to preceding one. Remove any areas that deflect, rut, or pump excessively during proofrolling, or that fail to consolidate after successive passes to suitable soils and replaced with compacted fill. Maintain subgrade until succeeding operation has been accomplished.
- E. Building Earthwork:
 - 1. Excavation shall be accomplished as required by drawings and specifications.
 - 2. Excavate foundation excavations to solid undisturbed subgrade.
 - 3. Remove loose or soft materials to a solid bottom.
 - 4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
 - 5. Do not tamp earth for backfilling in footing bottoms, except as specified.
 - 6. Slope grades to direct water away from excavations and to prevent ponding.
- F. Trench Earthwork:
 - 1. Utility trenches (except sanitary and storm sewer):
 - a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
 - b. Grade bottom of trenches with bell holes scooped out to provide a uniform bearing.
 - c. Support piping on undisturbed earth unless a mechanical support is shown.
 - d. Length of open trench in advance of piping laying shall not be greater than is authorized by Resident Engineer.

2. Sanitary and storm sewer trenches:

- a. Trench width below a point 150 mm (6 inches) above top of pipe shall be 600 mm (24 inches) maximum for pipe up to and including 300 mm (12 inches) diameter, and four-thirds diameter of pipe plus 200 mm (8 inches) for pipe larger than 300 mm (12 inches). Width of trench above that level shall be as necessary for sheeting and bracing and proper performance of the work.
- b. Bed bottom quadrant of pipe on undisturbed soil or granular fill.
 - 1) Undisturbed: Bell holes shall be no larger than necessary for jointing. Backfill up to a point 300 mm (12 inches) above top of pipe shall be clean earth placed and tamped by hand.
 - 2) Granular Fill: Depth of fill shall be a minimum of 75 mm (3 inches) plus one sixth of pipe diameter below pipe to 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
- c. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
- d. Use granular fill for bedding where rock or rocky materials are excavated.

G. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by drawings and specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm (1 inch). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements, and for inspections. Remove subgrade materials that are determined by Resident Engineer as unsuitable, and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the contractor shall obtain samples of the material, under the direction of the Resident Engineer, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. When unsuitable material is encountered and removed, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on volume in cut section only.

1. Site Grading:

- a. Provide a smooth transition between adjacent existing grades and new grades.
- b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

- c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed. Finish subgrades to required elevations within the following tolerances:
 - 1) Lawn or Unpaved Areas: Plus or minus 25 mm (1 inch).
 - 2) Walks: Plus or minus 25 mm (1 inch).
 - 3) Pavements: Plus or minus 13 mm (1/2 inch).
- d. Grading Inside Building Lines: Finish subgrade to a tolerance of 13 mm (1/2 inch) when tested with a 3000 mm (10 foot) straightedge.

3.3 UNDERPINNING

- A. Design of the underpinning system is the responsibility of the Contractor and is subject to review and approval by the Resident Engineer. Underpinning of existing building foundations, as indicated on structural drawings, or where excavation undermines existing foundations, shall be accomplished in the following manner:
 - 1. Make general excavation for new construction, where new foundations are to be below existing foundations, to elevation of new foundations (or sized stone subbase), maintaining a 45 degree sloped berm.
 - 2. For underpinning pits, underpin existing wall foundations by excavating 1200 mm (4 feet) wide pits to depth shown on drawings skipping 3 sections at any one time so as to maintain support for wall at all times.
 - 3. Underpin intervening sections one at a time; no adjacent sections shall be underpinned until concrete in adjacent sections shall have reached 20 MPa (2500 psi) strength and have been dry packed with non-shrink grout to obtain positive bearing. Sheet and brace underpinning pits if soil will not stand on a vertical cut during this operation, or as required for safety of workmen. Repack any voids behind sheeting to prevent sloughing which could cause settlement of existing foundations. Contractor performing this portion of work shall have been prequalified by Resident Engineer as having previously performed successfully this type of work or will demonstrate his capability for successfully performing this work. It shall be sole responsibility of the Contractor to guard against objectionable movement or settlement and to preserve integrity of existing structures.
 - 4. The tip elevation of the underpinning pits shall be a minimum of 900 mm (3 feet) below the adjacent excavation elevation.
 - 5. Subgrades at the tip of the underpinning pit shall be clean, dry, and free of debris and shall be observed by the Resident Engineer prior to concrete placement.
 - 6. Concrete shall not be free fall greater than 3000 mm (10 feet) into the pit.

3.4 FILLING AND BACKFILLING

- A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Borrow will be supplied at no additional cost to the Government. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, foundation drainage, and pipes coming in contact with backfill have been installed and work inspected and approved by Resident Engineer.
- B. Placing: Place materials in horizontal layers not exceeding 200 mm (8 inches) in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4 inches) in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen, or contain frost.
- C. Compaction: Compact with approved tamping rollers, sheepfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without prior approval of Resident Engineer. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Compact soil to not less than the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:
 - 1. Fills, Embankments, and Backfill
 - a. Under proposed structures, building slabs, steps, and paved areas, scarify and recompact top 300 mm (12 inches) of existing subgrade and each layer of backfill or fill material in accordance with AASHTO T180.
 - b. Curbs, curbs and gutters, AASHTO T180.
 - c. Under Sidewalks, scarify and recompact top 150 mm (6 inches) below subgrade and compact each layer of backfill or fill material in accordance with AASHTO T180.
 - d. Landscaped areas, top 400 mm (16 inches), AASHTO T180.
 - e. Landscaped areas, below 400 mm (16 inches) of finished grade, AASHTO T180.
 - 2. Natural Ground (Cut or Existing)

- a. Under building slabs, steps and paved areas, top 150 mm (6 inches), AASHTO T180.
- b. Curbs, curbs and gutters, top 150 mm (6 inches), AASHTO T180.
- c. Under sidewalks, top 150 mm (6 inches), AASHTO T180.

3.5 GRADING

- A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
- B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside building away from building walls for a minimum distance of 1800 mm (6 feet).
- D. Finish grade earth floors in pipe basements as shown to a level, uniform slope and leave clean.
- E. Finished grade shall be at least 150 mm (6 inches) below bottom line of window or other building wall openings unless greater depth is shown.
- F. Place crushed stone or gravel fill under concrete slabs on grade, tamped, and leveled. Thickness of fill shall be 150 mm (6 inches) unless otherwise shown.
- G. Finish subgrade in a condition acceptable to Resident Engineer at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.
- H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off property.
- B. Place excess excavated materials suitable for fill and/or backfill on site where directed.
- C. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

- D. Segregate all excavated contaminated soil designated by the Resident Engineer from all other excavated soils, and stockpile on site on two 0.15 mm (6 mil) polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Dispose of excavated contaminated material in accordance with State and Local requirements.

3.7 CLEAN UP

Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Property.

END OF SECTION 312000

SECTION 316316 - AUGER CAST GROUT PILES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies excavation and concrete required for construction of auger-placed concrete piles.

1.2 DEFINITION

Auger-placed concrete pile (ACP): Pile formed by rotation of a continuous flight hollow-shaft pile augured into the ground to the indicated depth. Grout is injected through auger shaft as auger is being withdrawn in such a way as to exert removing pressure on withdrawing earth-filled auger as well as lateral pressure on soil surrounding hole.

1.3 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Concrete: Section 033000, CAST-IN-PLACE CONCRETE.
- C. Subsurface investigation: Section 010000, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

1.4 CONTRACT BASIS

- A. Contract price for ACP's will be based upon total length of piles shown on the Contract Documents. Length of piles will be measured as shown.
 - 1. Adjustment of contract price shall be based upon total length of piles placed, and not on length of individual piles placed. When total length of completed piles is greater or less than length shown, contract price adjustment will be made in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
 - 2. Contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable when artificial materials that are not shown are encountered.

1.5 CONTRACTOR QUALIFICATIONS

- A. Approval by Contracting Officer is required of service of proposed Contractor and will be based upon submission by Contractor of certification that:

1. Contractor has technical qualifications, experience, trained personnel and facilities to install auger placed concrete piles as specified. Approval will not be given, however, where an experience record is one of unsatisfactory performance.
2. Contractor has installed ACP's on three installations similar and equivalent to this project for 3 years. Submit list of installations.

1.6 TOLERANCES

Install piling with a maximum variation of 75 mm (3 inches) of center of any pile from the location shown. Piles shall not be out of plumb more than 2 percent. (Checked by using a hand level prior to the start of drilling).

1.7 DESIGN MODIFICATIONS

- A. Where piles are installed exceeding specified tolerances for plumb or location, the foundation design will be analyzed by the Resident Engineer. Costs for analysis, redesign, and remediation shall be responsibility of Contractor.
- B. Additional piles and pile cap modifications necessitated by redesign shall be furnished and installed, at no additional cost to the Government.

1.8 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Certification to Examination of Site and Records: Before proceeding with the Work, submit copy of certification in acceptable form signed by the Contractor, stating that careful examination has been made of the site, existing structures, and records of utility lines, test boring records, soil samples, and subsurface exploration reports by the Owner's Geotechnical Engineer, Drawings, and Specifications.
- C. Shop Drawings and Miscellaneous Submittals:
 1. Description of pile drilling equipment.
 2. Description of grout pump and pressure gage calibration reports.
 3. Pile Installation Recorder (PIR) calibration reports.
 4. Complete description of method for ACP pile installation with a pile layout plan referenced to the structural plans, including a numbering system capable of identifying each individual pile, pile sizes, including pile length and tip elevations, reinforcing steel, and waterproofing details. In addition, furnish a detailed description of construction procedures, including steel shells, if used, and auguring methods.

5. Steel Reinforcement Shop Drawings: Comply with ACI 315. Furnish shop drawings prepared by a Professional Engineer licensed in the state of installation that include placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 - a. Prior to fabrication: Indicate steel grades, sizes, bending details, protective coatings, spacing, placement and supports.
 - b. Supplementary Product Literature: Furnish manufacturer's literature describing general properties of each product to be used in the Work.
 - c. Certifications: Furnish manufacturer's certified reports of mill tests for reinforcing steel and anchorage devices, including physical and chemical analysis.
6. Pile Installation records for all ACP's.

D. Reports:

1. Installation of each pile
2. Pile location and plumbness
3. Total quantity of grout placed
4. Load Test

E. Product Data: Submit copies of manufacturers' specifications for the following products, including copies of laboratory test reports and other data as may be required to show compliance with these specifications.

1. Fly Ash or Ground Granulated Blast Furnace Slag: ASTM C618, Class C or F and ASTM C989, Grade 100 or 120, respectively.
2. Plasticizing admixture: ASTM C1017/C1017M, Type II.
3. Grout Fluidifier: ASTM C937
4. Aggregate sieve analysis: ASTM C33.
5. Aggregate sodium sulfate soundness tests: ASTM C88.
6. Portland cement: ASTM C150, Type I, Test Piles Type III.
7. Reinforcing Steel: ASTM A615/A615M, Grade 60

F. Certificates: Contractor's qualifications as specified: Experienced specialty piling subcontractor having a minimum of 3 years successful experience installing Work of same type required for this project, and evidence of satisfactory completion of at least ten ACP installations comparable in scope of the Work and subsurface conditions. Employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used in the Work.

G. Contractor's Concrete Testing: Submit 3 copies of the laboratory testing reports to the Resident Engineer, the owner's Geotechnical Consultant, and other pertinent parties.

1. Submit report and certification of aggregate.
2. Laboratory Test Reports: Submit for evaluation grout materials and mix designs.

H. Pile Load Testing:

1. A schedule and sequencing plan for pile testing and installation.
2. Pile Installation Recorder (PIR) details.
3. Pile Installation Recorder (PIR) reports.
4. Pile Load Test Work Plan:
 - a. At least two weeks before commencing pile load testing work, the Contractor shall submit a pile load test work plan describing the equipment, apparatus, procedures, and schedule for testing ACP's in accordance with ASTM D1143 and as specified herein, to verify the design pile capacity. The work plan shall also include the proposed instrumentation of the test pile indicating depth, location, and details of the pile.
 - b. As part of the Pile Load Test Work Plan, submit shop drawings and other information describing the loading and test monitoring arrangement for pile load tests, including the following:
 - 1) Structural design of the test load support/reaction frame.
 - 2) Details of equipment and apparatus to be used for the monitoring load and pile movements.
 - 3) Data on testing and measuring equipment including required jack, load cell and/or gauge calibrations.
 - 4) Sample field data recording sheets or examples of automated data acquisition records proposed for recording load test data.

I. Independent Testing and Inspection Agency: The Contractor shall retain an Independent Testing and Inspection Agency (Agency) to document, monitor, and observe load test, probe pile, test pile, and production pile work. This Agency shall submit field reports and test results required by Section 3.2 for pile load tests, pile installations, and grout testing and inspection. They shall submit a pile installation report for each pile no later than three days after the installation is complete.

J. Welding Certificates.

K. Qualification Data: For Installer, Land Surveyor, and Testing and Inspection Agency.

- L. Upon completion of ACP installations, the Contractor shall submit five copies of drawings indicating actual in-place pile locations. The Contractor shall pay for all surveying costs. Drawings must be submitted prior to beginning any pile cap or mat installation. One electronic copy of the drawings shall be submitted in AutoCAD DWG format on CD-ROM.
- M. Record drawings at Project closeout according to Division 01 Section "Closeout Procedures."

1.9 QUALITY CONTROL

- A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. A Quality Control Program shall be submitted by the Contractor at least two weeks prior to the commencement of work. The implementation of a Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide work in accordance with the Contract Documents, applicable codes, regulations, and Governing Authorities.
- C. Contractor's Independent Testing and Inspection Agency (Agency): The Contractor shall retain at his own expense, the services of a qualified Independent Testing and Inspection Agency, licensed in the state of the project, to provide testing and inspection services during the installation of all foundation piling involved in this Work. This firm shall also provide consultation services to the Contractor if problems are encountered during the execution of the Work. The Agency shall be primarily concerned with the testing and construction methods which will result in finished foundation piling of the required quality and strength. The Agency shall also be concerned with preventing settlement and/or damage to surrounding structures, roads, utilities, embankments, both within the property lines and on adjoining properties during the construction.
- D. The Agency shall be experienced in the testing and installation of ACP foundations. It shall have been involved in at least 8 different ACP projects in the last 3 years, and shall have experience in recommending, testing, and specifying ACP's for similar subsurface conditions.
- E. Survey Work: The Contractor shall engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for ACP's. The surveyor shall record actual measurements of each ACP's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
- F. Contractor's Grout Mix Designer: The Contractor shall employ, at his own expense, a testing laboratory to design grout mixes, conduct tests and submit reports for the design mixes. The Grout Mix Designer shall be qualified according to ASTM C1077 and ASTM E329 to perform material evaluation tests and to design concrete mixes, as documented according to ASTM E548.

G. Welding Standards: Qualify procedures and personnel according to the following:

1. AWS D1.1
2. AWS D1.4

H. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

1.10 QUALITY ASSURANCE

- A. The Owner shall retain the services of a Geotechnical Consultant (Consultant) to provide general observation of all pile operations and to provide technical advice to the Owner with regard to pile operations and performance.
- B. The Consultant shall have been involved in at least 8 different ACP projects in the last 3 years, and shall have experience in recommending, testing, and specifying ACP's for similar subsurface conditions.

1.11 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. American Society for Testing and Materials (ASTM):

A615/A615M-06a.....	Standard Specification for Deformed and Plain Carbon-Steel Bar for Concrete Reinforcement
C33-03.....	Standard Specification for Concrete Aggregates
C88-05.....	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C109/C109M-05	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-in. or [50 mm] Cube Specimens)
C150-05.....	Standard Specification for Portland Cement
C404-06.....	Standard Specification for Aggregates for Masonry Grout
C618-05.....	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C937-02.....	Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete
C942-99 (2004)	Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
C989-05.....	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C1017/C1017M-03	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

- C1077-06.....Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
- D1143-81(1994)e1Standard Test Method for Piles Under Static Axial Compressive Load
- E329-05be1Standard Specification for Agencies Engaged in Construction Inspections and/or Testing
- E548-94.....Standard Guide for General Criteria Used for Evaluating Laboratory Competence

C. American Concrete Institute (ACI):

- C33-03.....Standard Specification for Concrete Aggregates
- 315-99Manual of Standard Practice for Detailing Reinforced Concrete Structures

D. American Welding Society (AWS):

- D1.1 (2006).....Structural Welding Code – Steel
- D1.4 (2005).....Structural Welding Code – Reinforcing Steel

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I, Test piles Type III.
- B. Grout Fluidifier: ASTM C937.
- C. Plasticizing admixture: ASTM C1017/C1017M, Type II
- D. Ash or Ground Granulated Blast Furnace Slag: ASTM C618, Class C or F and ASTM C989, Grade 100 or 120, respectively.
- E. Water: Fresh, clean, and potable.
- F. Aggregate: ASTM C404, Size No. 1 or Size No. 2.
- G. Reinforcing Steel: ASTM A615, Grade 60.
- H. Fine Aggregate: ASTM C33.
- I. Except for probe pile, pile load test and test pile purposes, no pile materials shall be ordered or delivered to the job site until the required load tests have been made and are acceptable to the Resident Engineer. Materials ordered or delivered to the project site prior to verification of the assumed pile length, will be at the Contractor's risk.

- J. After pile lengths are verified by the pile load test program, deliver materials to the project site in such quantities and at such times to assure the continuity of pile augering operations to the project schedule.
- K. Clearly mark pile leads in 300 mm (1 foot) increments.

2.2 MIXES

- A. Concrete: The grout used shall consist of a mixture of portland cement, sand, fluidifier, and water so proportioned and mixed to be pumped and to fill all voids in the foundation material. Mixture shall be proportioned to provide a minimum compressive strength of 27.6 Mpa (4000 psi) at 28 days.
- B. Mix Design: Testing Laboratory, retained by Contractor, shall design a mix to produce concrete as specified and perform tests as required. Certified test reports (duplicate) shall be submitted. Reports shall include proportions of design mix.
- C. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval from the Resident Engineer of proposed changes to concrete-mix design.
- D. Improper Mix: Immediately notify the Concrete Testing Laboratory and the Resident Engineer if at any time during construction the accepted mix design proves to be unsatisfactory for any reason. The Contractor's Concrete Mix Designer shall modify the design, subject to the review of the Resident Engineer, until a satisfactory mix is obtained.

2.3 EQUIPMENT

- A. Augering Equipment:
 - 1. Equipment shall consist of a continuous-flight, hollow-shaft auger which shall be rotated into the ground to the required pile depth as established by the pile load tests. Advance the auger at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the required depth. The hole in the bottom of the auger shall be closed with a suitable plug while being advanced into the ground. The plug shall be removed by grout or with a reinforcing bar. At the start of pumping grout, raise the auger from 150 to 300 mm (6 to 12 inches) and after the grout pressure builds sufficiently, redrill the auger to the previously established tip elevation. Cement grout shall then be injected through the auger shaft as the auger is being withdrawn, in such a way as to exert removing pressure on the withdrawing earth filled auger flights as well as lateral pressure on the soil surrounding the grout-filled pile hole. Grout pumping pressures shall be measured and shall be maintained high enough at all times to offset hydrostatic and lateral earth pressures. The

- auger shall rotate in a positive direction and shall be withdrawn in a steady continuous motion.
2. The auger flighting shall be continuous from the auger head to the top of auger without gaps or other breaks. The auger flighting shall be uniform in diameter throughout its length and shall be the diameter specified for the piles less a maximum of 3 percent.
 3. The hole through which the high-strength grout is pumped during the placement of the pile shall be located at the bottom of the auger head below the bar containing the cutting teeth.
 4. Augers over 12000 mm (40 feet) in length shall contain a middle guide.
 5. The piling leads should be prevented from rotating by a stabilizing arm or by firmly placing the bottom of the leads into the ground or by some other acceptable means. Leads shall be marked at 300 mm (1 foot) intervals to facilitate measurement of auger penetration.

B. Mixing and Pumping Equipment:

1. Only approved pumping and mixing equipment shall be used in the preparation and handling of the grout. A screen to remove over-size particles shall be placed at the pump inlet. All oil or other rust inhibitor shall be removed from mixing drums and grout pumps. All materials shall be such as to produce a homogeneous grout of the desired consistency.
 - a. The grout pump shall be a positive displacement piston type pump capable of developing displacing pressures at the pump not less than 2.5 Mpa (350 psi). The grout pump shall be provided with a pressure gauge in clear view of the equipment operator. The grout pump shall be calibrated at the beginning of the work to determine the volume of grout pumped per stroke. A positive method of counting grout pump strokes shall be provided by the Pile Contractor. Such methods may include digital or mechanical stroke counters or other acceptable methods.

C. Pile Installation Recorder (PIR):

1. The Contractor shall provide a PIR for ACP's for use by the Agency and the Consultant during pile installation. The PIR shall be used for each piling rig. The PIR shall record appropriate information during both the augering phase and during the grouting phase of the installation to assure minimum grout volume pumped per unit depth increment, and shall print results immediately upon completion of each pile.

PART 3 - EXECUTION

3.1 GENERAL

- A. Survey: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 010000, GENERAL REQUIREMENTS, shall establish lines and levels and stake pile locations.

- B. Before installing piles adjacent to any existing utilities, the Contractor shall notify the utility owner to ensure that protective Work will be coordinated and performed in accordance with the requirements of the utility owner. If any existing service lines, utilities and utility structures to remain in service are uncovered or encountered during these operations, protect, from damage and provide support if necessary.
- C. Should uncharted or incorrectly charted piping or other utilities be encountered during piling operations, immediately notify the Resident Engineer and the utility owner. Cooperate with the utility owner in keeping their respective services, utilities and facilities in operation.
- D. After all ACP's are in place, the Surveyor shall make a field survey of completed piles and shall submit a drawing to the Resident Engineer showing the plumbness of the piles and the actual pile locations with respect to planned pile locations.
- E. Pile Record: Submit complete and accurate record of all auger-placed piles to the Resident Engineer. Record shall indicate the pile location, diameter, length, elevation of bottom and top of pile, and the quantity of grout used in each pile. Any unusual conditions encountered during pile installation shall also be noted.
- F. Completion Certificate: The Contractor shall provide a written statement, stamped by a Professional Engineer registered in the State of the Work, verifying that the piles were installed per the Contract Documents, and that any piles not installed per the Contract Documents were installed in such a manner that they will not have an negative impact on the proposed structure.

3.2 ALLOWABLE LOAD ON PILES

A. Probe Piles:

- 1. A minimum of ten probe piles shall be installed prior to the installation of the production piles in manner utilizing identical equipment, methods, and materials for all piling.
- 2. probe piles shall be used by the Contractor to refine the operations of the equipment and shall not be installed at production pile locations.
- 3. The location of the probe piles shall be submitted to the Resident Engineer prior to their installation. If, in the opinion of Resident Engineer, the probe pile locations shown are not representative of the area, alternate locations will be provided by Resident Engineer.
- 4. Reaction piles for the load test pile may be used as probe piles.

B. Load test piles:

- 1. Load tests will be performed on a minimum of 2 probe piles. The data from the load test will be used to verify pile design load.

2. Contractor shall conduct load tests in accordance with ASTM D1143 Quick Load Test procedure. These tests will be conducted at no additional cost to the Government. No additional piles shall be installed until test reports of test piles are received and approved by Resident Engineer.
3. Additional load tests or an increase in production pile length may be required if the test pile fails the load test.

3.3 INSTALLATION

- A. The length and drilling criteria of production piles will be determined by the Resident Engineer from the installation of the probe piles, reaction piles, test piles, and the pile load tests. The installation shall be performed in an orderly sequence.
- B. Advance the auger at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the required depth or refusal criteria.
- C. Auger refusal is defined as a rate of auger penetration of less than 300 mm (1 foot) per minute of drilling.
- D. The hole in the bottom of the auger shall be closed while being advanced into the ground with a suitable plug. The plug shall be removed by grout pressure or with the reinforcing bar.
- E. Place continuous center reinforcing through the hollow-stemmed auger prior to placement of grout. Tie top of reinforcing in place after removal of auger. Use bar spacers to center reinforcing bars.
- F. At the start of pumping grout, raise the auger from 150 to 300 mm (6 to 12 inches) and after the grout pressure builds up sufficiently, redrill the auger to the previously established tip elevation.
- G. Maintain at least 3000 mm (10 feet) of grout on the auger flighting above the injection point during raising of the auger. Positive rotation of the auger shall be maintained throughout placement of the grout. Rate of grout injection and rate of auger withdrawal from the soil shall be coordinated as to maintain at all times the minimum grout head and a positive pressure on the gauges. The total volume of grout shall be at least 115 percent of the theoretical volume for each pile, except, after grout is flowing at the ground surface from the auger flighting, the rate of grout injection and auger withdrawal shall be coordinated so that there is a constant grout flow at the surface. If pumping of grout is interrupted for any reason, the Contractor shall reinsert the auger at least 1500 mm (5 feet) into the pile and regrout.
- H. Minimum volume of grout placed in hole shall be at least the nominal volume plus 15 percent of hole. Volume of grout per linear meter (linear foot) of pile shall be

not less than volume of grout per meter (volume of grout per foot) of the load test pile. Make volume measurements in the presence of Resident Engineer.

- I. Auger hoisting equipment shall be provided that will enable the auger to be rotated while being withdrawn smoothly and steadily.
- J. The spoil that accumulates around the auger during injection of the grout shall be promptly cleared away upon completion of the installation.
- K. Provide OSHA protective caps on all projecting reinforcement.
- L. Materials shall be accurately measured by volume or by weight as they are fed to the mixer. Order of placing the materials in mixer shall be as follows: (1) water, (2) fluidifier, and (3) other solids in order of increasing particle size. Provide grout injection equipment with a pressure gage in clear view of the equipment operator. A second pressure gauge shall be located near auger rig where it can be observed. Rate of injection and rate of auger withdrawal from soil shall be so coordinated as to maintain at all times a positive pressure on gage which will indicate existence of a removing pressure on bottom of auger flight. Magnitude of this pressure and performance of other augering and grouting procedures, such as rate of augering, rate of grout injection, and control of grout return around the auger flight, are dependent on soil conditions, and equipment capability shall be at option of Contractor, subject to approval of Resident Engineer. Equipment for pumping grout shall be positive displacement pump capable of developing a pressure at pump not less than 2.5 MPa (350 psi). Pump shall be calibrated by an approved method to verify accuracy of indicated discharge. Remove oil or other rust inhibitors from mixing drums and pumps. Auger hoisting equipment shall be capable of withdrawing auger smoothly and at a constant rate. If the auger jumps upward during withdrawal, it shall be reinserted, and rate of withdrawal decreased to prevent further jumping.
- M. Locate piles as shown unless otherwise directed by Resident Engineer. Do not place piles closer than 1524 mm (5 feet) edge to edge until grout in adjacent piles has set for 24 hours. In locations where there are no concrete slabs or other means of distributing load of the equipment placing piles, the equipment shall be kept at least 3000 mm (10 feet) away from pile location, or upper 3000 mm (10 feet) of pile shall be cased.
- N. Where pile top is near surface or above bottom of excavation, place metal sleeves of proper diameter around pile top.
- O. Cut off the tops of piles, square with pile axis and at the elevations indicated by removing fresh grout from the top of the pile or by cutting off hardened grout down to final cutoff point at any time after initial set has occurred. Where the pile cut-off is near the surface or above the bottom of the excavation, sleeves or casing of the proper diameter and at least 457 mm (18 inches) in length shall be

placed around the pile tops. (Special conditions may require metal sleeves of additional length).

- P. Redrill the pile to the original depth at no additional cost to the Owner if any of the following occurs:
1. The design pile reinforcement cannot be placed manually in the top of any pile following completion of grouting.
 2. The trap door at the bottom discharge outlet fails to open completely, effectively creating a side discharge condition.
 3. Loss of grout head occurs for any reason during pile installation.
 4. There is more than a twenty-minute delay during the grouting of any individual pile.
 5. There is a drop in grout level after completion of the pile, which exceeds the average for the remainder of the pile installations by more than 600 mm (2 feet).
- Q. The Contractor shall install additional piles at no additional cost for damaged, misaligned and/or mislocated piles. Contractor shall also be responsible for costs of concrete and reinforcing for required modifications to pile caps/grade beams due to damaged piles and/or misaligned or mislocated piles.
- R. If the grout level in any completed pile drops, the pile shall be rejected and replaced.
- S. No pile shall be loaded until the grout has attained full design strength.

3.4 OBSTRUCTIONS

- A. The advancement of the augers through naturally occurring materials such as cobbles, boulders and rock ledges, as outlined in the Geotechnical Report, is the responsibility of the Contractor. The Contractor is responsible for providing the necessary means and methods of advancing the augers through this material. The length of short piles terminated due to such foreseeable material will not be included in the total length of pile for payment at the unit price. Additional adjacent piles, as required by the Resident Engineer, will also not be included in the total length of piles for payment.
- B. In the event that unforeseen non-augerable material is encountered, such as cobbles, boulders, rock ledge, metal timbers or debris which causes the rate of penetration to be reduced to less than 300 mm (1 foot) per minute above the desired tip elevation, or causes the pile to drift from its location, then the pile shall be completed to the depth of the non-augerable material in accordance with these specifications. The length of such short piles shall be included in the total length of pile for payment at the unit price. If required by the Resident Engineer, additional adjacent piles shall be placed and the length of these additional piles shall also be included in the total length of piles for payment.

3.5 QUALITY CONTROL AND ASSURANCE

- A. The Contractor shall retain the services of a qualified Independent Testing and Inspection Agency (Agency), licensed in the state of the project, to provide Quality Control through testing and inspection services during the installation of all foundation piling involved in this Work.
- B. The Owner shall employ a Geotechnical Consultant (Consultant) to provide Quality Assurance through general observation and consultation of all pile operations.
- C. The Contractor and their Agency shall cooperate with the Consultant and the Resident Engineer in the performance of the Work. The presence of Consultant shall in no way relieve the Contractor of his obligation to perform the pile installation in accordance with the Contract Documents and these Specifications.
- D. Grout Mix: The grout mix shall be tested by making a minimum of six, 50 mm (2 inches) cubes for each day during which piles are placed. A set of six cubes shall consist of two cubes to be tested at seven days, and two cubes to be tested at 28 days and two cubes held in reserve. Test cubes shall be cured and tested in accordance with ASTM C109/C109M. Cube specimens may be restrained from expansion as described in ASTM C942.
- E. Pile Acceptance: The Agency shall immediately notify the Consultant and the Resident Engineer if any pile is not in conformance with these Specifications. The volume of grout placed in each pile shall be a minimum of 115% of theoretical volume of the pile. The amount of grout placed in each 1500 mm (5 feet) increments of the pile shall be checked continuously during installation. The cost of removing and replacing Auger Cast Piles, which are not in conformance, shall be borne by the Pile Contractor.
- F. Reports: The Agency shall maintain an installation record of each pile. The record shall note the project name and number, name of Contractors, pile location, design pile capacity, pile tip elevation, pile top elevation, depth of auger advancement, (total and continuous) quantity of grout placed, reinforcing steel placement, and any unusual occurrences during the pile installation. The grout quantity shall be determined by recording grout pump displacement or by other acceptable means. The Consultant shall also maintain a daily report, which summarizes all work performed by the Contractor.

3.6 CORRECTIONS OF DEFICIENCIES

- A. The contractor shall notify the Resident Engineer in writing, of the failure of a pile to meet any requirement of the Section. Such written notification shall include all information required for the evaluation of remedial measures, including all information required for redesign.

- B. Based on the survey provided, if a pile fails to comply with the location or tolerance requirements of 1.6, or the design load requirements noted on the Contract Documents, the Resident Engineer will calculate the load capacity requirements of that pile or, if in a pile group, each pile in that pile group, based on the actual, "as-driven" locations and inclinations. If the calculation indicates that the loading on that pile or, if in a pile group, on any pile in that pile group, exceeds the design load, then the Contractor shall perform such remedial work as the Resident Engineer in his sole discretion may require including furnishing and installing additional piles at locations approved by the Resident Engineer and modifying concrete or reinforcement steel. These corrective measures shall be performed solely at the Contractor's expense.
- C. If a pile fails to comply with the requirements of this Section and the Resident Engineer of record determines that modification to concrete or reinforcement steel, or the driving of additional piles is necessary, the Engineer of record will perform all required reanalysis, redesign and detailing.
- D. The Contractor, at his option and at any time that he determines that a pile will not satisfy the requirements of this Section for a reason other than encountering an unforeseen underground obstruction, may, subject to the provisions of this specification, abandon such pile and replace it with a new pile or piles rather than await direction or approval from the Resident Engineer. However, the Contractor, in exercising this option, assumes the risk that such replacement pile or piles will be acceptable to the Engineer.
- E. Abandoned piles shall be cut off 300 mm (1 foot) below the elevation of the bottom of the pile cap or mat as shown on the Contract Drawings and will not be paid for.

3.7 CLEAN UP

- A. All debris from excavation of objectionable material, removal of obstructions, and any material not to remain as part of the construction are to be removed and disposed of by the subcontractor in a legal manner at no additional cost to the Owner.
- B. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner, which would obstruct the easy access of equipment and personnel.

END OF SECTION 316316

Page intentionally left blank.

SECTION 316326 - DRILLED CAISSONS

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies excavation and concrete required for construction of foundation caissons.

1.2 DEFINITIONS

Satisfactory Bearing Material: Weathered limestone unit and is assumed to occur at bottom of caisson elevations shown.

1.3 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Earth excavation: Section 312000, EARTH MOVING.
- C. Concrete, including materials and mixes: Section 033000, CAST-IN-PLACE CONCRETE.

1.4 CONTRACT BASIS

- A. Contract price for caissons will be based upon total length for each type of caisson shown. Length of caissons will be measured from bottom elevation to top elevation of the caisson. The diameter of the caisson is defined as the minimum diameter of the shaft.
 - 1. Adjustment of contract price shall be based upon total length of each type of caisson placed and not on the length of individual caissons. When the total length of each type of completed caisson is greater or less than the length shown due to unsuitable soils or design modifications by the Resident Engineer, contract price adjustment will be made in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
 - 2. Contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable, when artificial materials that are not shown are encountered.

1.5 CLASSIFICATION OF EXCAVATION

- A. Soil/Weathered Rock Excavation:
Soil or weathered rock that can be reasonably excavated with the rock auger, i.e. rock auger advancement greater than 150 mm (6 inches) per 15 minutes (see rock auger refusal, 1.5.C-2, below)
- B. Sloping Weathered Rock Excavation:
Excavation of soil/weathered rock that can typically be excavated with the rock auger, except when the steeply sloping orientation of the stratum causes the rock auger to run askew.
- C. Rock Excavation:
 - 1. Excavation of material that meets the rock auger refusal criteria and requires the rock core barrel or other hard rock excavation techniques for removal.
 - 2. Rock auger refusal is defined as a penetration rate of less than 150 mm (6 inches) in 15 minutes, while operating a caisson drilling rig, rated with a torque capacity of at least 110 kN-meters (1,000,000 inch-pounds), applying a continuous down pressure of at least 220 kN (50,000 pounds), equipped with a rock auger that contains conical carbide-tipped ("Kennemetal") teeth.
- D. Nominal Soil or Weathered Rock Seams:
Nominal soil or weathered rock seams below rock auger refusal will be excavated and considered as rock for rock excavation quantities. A nominal soil or weathered rock seam is one which is less than 600 mm (2 feet) thick. Where soil or weathered rock seams or voids of 600 mm (2 feet) or greater are excavated within a mixed rock/soil or rock/weathered rock profile, excavation is classified as soil/weathered rock excavation until rock auger refusal is again established.

1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION

- A. Measurement: Excavation type in units of length shall be considered to change at the upper contact with a different excavation type as defined by section 1.5.
- B. Payment: Contract unit rates per length of each type of caisson shall be provided for each excavation condition type noted above in Section 1.5. Contract price and time will be adjusted for overruns or underruns in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
- C. Payment for Differing Site Conditions: No payment will be made for any rock excavation beyond caisson limits unless additional excavation is directed by the Resident Engineer. When rock excavation, as classified, is encountered, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

1.7 TOLERANCES

Install caissons with not more than the lesser of $1/24^{\text{th}}$ of caisson shaft diameter or 75 mm (3 inches) from design center location. Caissons shall not be out of plumb more than 25 mm (1 inch) in 3000 mm (10 feet) for the full depth.

1.8 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Before beginning work, submit a detailed location plan and description of the proposed method of caisson installation, all of which shall be subject to the review and approval of the Resident Engineer.
- C. Shop Drawings shall comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Furnish shop drawings prepared by a Professional Engineer licensed in the State of the project for the detailing, fabricating, bending, and placing of concrete reinforcement.
- D. Submit a detailed plan showing load test arrangement, location, and Contractor's qualifications and results for review and approval by the Resident Engineer.
- E. Reports:
 - 1. Caisson record: Data as specified.
 - 2. Rock excavation: Data as specified.
 - 3. Soil Testing Agency Reports shall be issued showing material type and allowable bearing capacity at bottom of shaft within 24 hours after testing or observing each caisson.
 - 4. Certified, "Caisson Field Record" for each caisson recording actual elevation of bottom, elevation of rock (if applicable), final centerline location of top, variation of shaft from plumb, bell dimension (if applicable), result of all tests and observations performed, material type and actual allowable bearing capacity of bottom, depth of socket into rock, levelness of bottom, seepage of water, still water level (if allowed to flood), elevation (top and bottom) of lining left in place, variation of shaft diameter (from those shown), and evidence of seams, voids or channels below bottom.

1.9 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A36/A36M-05 Standard Specification for Carbon Structural Steel
 - A283/A283M-03 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
 - A615/A615M-06a Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - A929/A929M-01 Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

A996/A996M-06a	Standard Specification for Rail-Steel and Axle-Steel Deformed and Bars for Concrete Reinforcement
C33-03	Standard Specification for Concrete Aggregates
C94/C94M-05	Standard Specification for Ready-Mixed Concrete
C150-05	Standard Specification for Portland Cement
C494/C494M-05a	Standard Specification for Chemical Admixtures for Concrete
C618-05	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C989-05	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C1017/C1017M-03	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

C. American Concrete Institute (ACI):

211.1-91 (2002)	Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
301-05	Specifications for Structural Concrete
315-99	Manual of Standard Practice for Detailing Reinforced Concrete Structures

D. . American Welding Society (AWS):

D1.1 (2006)	Structural Welding Code – Steel
-------------------	---------------------------------

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel Reinforcement: ASTM A 615/A 615M, or 996, Grade 60, deformed.
- B. Portland Cement: ASTM C 150, Type I or II.
- C. Fly Ash/Slag:
 - 1. Fly Ash Admixture: ASTM C 618, Class C or F.
 - 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- D. Normal-Weight Aggregate: ASTM C 33, uniformly graded, 19 mm (3/4-inch) maximum aggregate size.
- E. Water: Potable, complying with ASTM C 94/C 94M requirements.
- F. Admixtures: Certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494, Type A.
 2. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 3. High-Range, Water-Reducing Admixture: ASTM C 494, Type G.
 4. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
- G. Steel Casings: All casing shall meet ASTM A 283, Grade C; or ASTM A 36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1, or ASTM A 929/A 929M, steel sheet, zinc coated corrugated steel. The Contractor shall design shells to withstand drilling forces and earth pressures and reinforce the bottom cutting edge as required for proper drilling and sealing of the shells into the rock. The cutting edge shall be capable of coring through at least 3000 mm (10 ft) of broken or solid rock. A minimum of 2% out of roundness of the diameter shall be considered in the design of the shell. All seams shall be welded and watertight
- H. Concrete Mix: Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases. Use a qualified testing agency for preparing and reporting proposed mix designs for laboratory trial mix basis. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): 27.6 MPa (54000 psi).
 2. Minimum Slump: Capable of maintaining a slump of 125 mm (5 inches) plus or minus 25 mm (1 inch).
 3. Do not air entrain concrete for caissons.
 4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
 5. Concrete-mix design adjustments may be considered if characteristics of materials, project conditions, weather, test results, or other circumstances warrant. Resubmission and approval of proposed changes to concrete-mix proportions is the responsibility of the Contractor.
- I. Concrete Mixing: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information. Do not add water to concrete mix after mixing, unless a procedure per ACI 301 is submitted to and approved by the Resident Engineer. Maintain concrete temperature less than 32 degree Celsius (90 degree Fahrenheit).

PART 3 - EXECUTION

3.1 GENERAL

- A. Size: Minimum sizes and types of caissons are shown. Proposal to use caissons of sizes and types different from those shown may be accepted if submitted in writing to Resident Engineer for approval and provided the following conditions are met:
1. Least dimension of caisson is equal to or greater than least dimension shown.
 2. If volume of caisson as constructed is greater than that shown, bearing area at base is increased so that additional weight is distributed to bearing material at no more than 2,873 kPa (60 ksf).
 3. Entire caisson receives full lateral support from surrounding material.

- B. Changes: Requests for change in size or type of caisson from those shown shall be accompanied by calculations and other documentation necessary to show that proposed changes will meet load requirements. Do not proceed with changes before receiving written approval from Contracting Officer.
- C. Temporary Steel Casings: Install casings for protection of workers and inspection personnel, for prevention of cave-ins or displacement of earth walls, and for retention of ground water.
- D. Defective Casings: Do not install buckled, distorted or otherwise damaged casings. Replace casings damaged or disturbed during construction, casings that are not mud-tight or otherwise not in accordance with drawings or specifications, at no additional cost to the Government.
- E. Survey: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 010000, GENERAL REQUIREMENTS, shall establish lines and levels and stake caisson locations.

3.2 EXCAVATION

- A. Excavation and construction methods shall result in minimum disturbance of surrounding material and full lateral support of caissons by surrounding material.
- B. Remove boulders and rock in caissons such as rock seams underlain with soil seams, sloping rock or rock otherwise unsatisfactory for bearing.
- C. If materials with satisfactory bearing strength occur at elevations higher or lower than those shown, place bottom of caissons at higher or lower elevations, subject to approval of Resident Engineer.
- D. Excavate caissons to dimensions and required bearing strata or elevations shown on contract drawings. Maintain sidewall stability during drilling. Excavate holes for closely spaced caissons, and those occurring in fragile strata, only after adjacent holes are filled with concrete and allowed to set. The excavation shall be accomplished by hand or machine excavation as required. Caisson drilling equipment shall have the minimum torque capacity and downward force capacity for the contract site conditions. Bottoms of caissons shall be cleaned of loose or soft materials and leveled. If bottoms are sloping rock, excavate to a level plane or step with maximum step height less than 1/4 the width or diameter of the bearing area. All material removed from the caisson holes shall be removed from the ground around the casing before concrete placement is started and shall be disposed of by the Contractor off site in areas submitted to and approved by the Engineer.
- E. Excavations for utilities, support of excavations, or other purposes shall be kept a minimum distance of two shaft diameters away from the outer edge of the caisson.

3.3 PLACING CONCRETE

- A. Before placing concrete, the tip of the caisson shall be observed and approved by a qualified testing agency registered and licensed in the state. The testing agency shall be

retained by the Contractor and approved by the Resident Engineer. The shaft shall be inspected, cleared of mud, water, loose material and debris.

- B. Place concrete using a down pipe to direct flow of concrete. Except in presence of water, concrete may fall freely up to a maximum height of 9.14 meters (30 feet) provided the concrete does not hit the sides of the caisson. Use tremie pipe or pump if distance is greater than 9.14 meters (30 feet).
- C. Withdraw casings, as concrete is deposited, maintaining top surface of concrete constantly at least 1800 mm (6 feet) above lower end of casings. Place concrete to form a monolithic cylindrical shaft having full lateral support from surrounding undisturbed materials. Strike finished top surface of concrete to true plane at required elevation.
- D. Concrete placement in each caisson shall be one continuous operation. If placing operation has to be stopped, leave surface approximately level. If concrete has hardened, clean surface and slush with a 1 to 1 cement-sand grout before placing operation is resumed. Concrete pours shall not begin within one hour of darkness. In the event that this type of continuous sequential operation cannot be performed, the Contractor shall submit for approval by the Resident Engineer a method of securing the open excavation. The Contractor shall not leave excavations open overnight without receiving prior written approval from the Resident Engineer.
- E. When water is present, control water level to within 50 mm (2 inches) of bottom of the caisson by pumping. If impossible or impractical to control water, secure written permission from Resident Engineer to place concrete through water by means of a watertight tremie.
 - 1. When placing concrete under water, discharge end of tremie shall be submerged in fresh concrete and shaft of tremie maintained full of concrete to point above water level.
 - 2. Increase cement content of concrete required to be placed in water by one sack per cubic yard of concrete.

3.4 CAISSON RECORD

- A. For each caisson placed and before superstructure framing is placed, submit to Resident Engineer for approval a certified report recording following information prepared by Registered Professional Land Surveyor or Registered Civil Engineer.
- B. Caisson number, length, and bearing material.
- C. Location.
- D. Concrete and steel reinforcement properties.
- E. Plumbness.
- F. Dates:
 - 1. Excavation completed.
 - 2. Concrete placed.

G. Diameters:

1. Top of shaft.
2. Bottom of shaft.
3. Bell.

H. Elevations:

1. Top of ground.
2. Top of concrete.
3. Top of rock.
4. Bottom of caisson.

3.5 CLEAN UP:

- A. All debris from excavation of objectionable material, removal of obstructions, and any material not to remain as part of the construction are to be removed and disposed of by the Contractor in a legal manner at no additional cost to the Owner.
- B. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner, which would obstruct the easy access of equipment and personnel.

END OF SECTION 316326

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.2 RELATED WORK

- A. Laboratory and field testing requirements: Section 014529, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Paragraph 3.3 and Section 312000, EARTH MOVING.
- C. Pavement Markings: Section 321723, PAVEMENT MARKINGS.

1.3 INSPECTION OF PLANT AND EQUIPMENT

The Resident Engineer shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

1.4 ALIGNMENT AND GRADE CONTROL

The Contractor's Registered Professional Land Surveyor shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the Drawings.

1.5 SUBMITTALS

- A. In accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
- B. Data and Test Reports:
 - 1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other tests required by State Highway Department.
 - 2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by State Highway Department.
 - 3. Job-mix formula.

C. Certifications:

1. Asphalt prime and tack coat material certificate of conformance to State Highway Department requirements.
2. Asphalt cement certificate of conformance to State Highway Department requirements.
3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the Michigan Department of Transportation Specification.

D. One copy of Michigan Department of Transportation Specifications.

E. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Aggregate base, Asphaltic base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State Highway Material Specifications, including amendments, addenda and errata. Where the term "Engineer" or "Commission" is referenced in the State Highway Specifications, it shall mean the VA Resident Engineer or VA Contracting Officer.

2.2 AGGREGATES

- A. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.
- B. Base aggregate maximum size:
1. Base course 10" MDOT 21AA Crushed Limestone compacted to 95% maximum density. Place in two lifts.
- C. Asphaltic base course:
1. 4" No. 700, 20C Bituminous base course. Place 2 – 2" lifts.

2.3 ASPHALTS

- A. Comply with provisions of Asphalt Institute Specification SS2:
1. Asphalt cement: Penetration grade 50/60
 2. Prime coat: Cut-back type, grade MC-250
 3. Tack coat: Uniformly emulsified, grade SS-1H
- B. 1 ½" No. 1300T, 20AAA Bituminous wearing course.

2.4 SEALER

- A. Provide a sealer consisting of suitable fibrated chemical type asphalt base binders and fillers having a container consistency suitable for troweling after thorough stirring, and containing no clay or other deleterious substance.
- B. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

PART 3 - EXECUTION

3.1 GENERAL

The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the State Highway Specifications for the type of material specified.

3.2 MIXING ASPHALTIC CONCRETE MATERIALS

- A. Provide hot plant-mixed asphaltic concrete paving materials.
 - 1. Temperature leaving the plant: 143 degrees C (290 degrees F) minimum, 160 degrees C (320 degrees F) maximum.
 - 2. Temperature at time of placing: 138 degrees C (280 degrees F) minimum.

3.3 SUBGRADE

- A. Shape to line and grade and compact with self-propelled rollers.
- B. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.
- C. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.
- D. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.
- E. Proof-roll the subgrade with maximum 45 tonne (50 ton) gross weight dump truck as directed by VA Resident Engineer or VA Contracting Officer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

3.4 BASE COURSES

- A. Subbase (when required)
 - 1. Spread and compact to the thickness shown on the drawings.

2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
3. After completion of the subbase rolling there shall be no hauling over the subbase other than the delivery of material for the top course.

B. Base

1. Spread and compact to the thickness shown on the drawings.
2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.

C. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0mm (0.0") to plus 12.7mm (0.5").

D. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 5mm in 3m (3/16 inch in ten feet).

E. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

3.5 PLACEMENT OF ASPHALTIC CONCRETE PAVING

A. Remove all loose materials from the compacted base.

B. Apply the specified prime coat, and tack coat where required, and allow to dry in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.

C. Receipt of asphaltic concrete materials:

1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 130 degrees C (280 degrees F).
2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (50 degrees F), not during fog, rain, or other unsuitable conditions.

D. Spreading:

1. Spread material in a manner that requires the least handling.
2. Where thickness of finished paving will be 76mm (3") or less, spread in one layer.

E. Rolling:

1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown on the drawings.
2. Roll in at least two directions until no roller marks are visible.
3. Finished paving smoothness tolerance:
 - a. No depressions which will retain standing water.
 - b. No deviation greater than 3mm in 1.8m (1/8" in six feet).

3.6 APPLICATION OF SEAL COAT

- A. Prepare the surfaces, mix the seal coat material, and apply in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.
- B. Apply one coat of the specified sealer.
- C. Achieve a finished surface seal which, when dry and thoroughly set, is smooth, tough, resilient, of uniform black color, and free from coarse textured areas, lap marks, ridges, and other surface irregularities.

3.7 PROTECTION

Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

3.8 FINAL CLEAN-UP

Remove all debris, rubbish, and excess material from the work area.

END OF SECTION 321216

Page intentionally left blank.

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 DESCRIPTION

This work shall consist of furnishing and applying paint on pavement surfaces, in the form of traffic lanes, parking bays, areas restricted to handicapped persons, and other detail pavement markings, in accordance with the details as shown or as prescribed by the Resident Engineer. Conform to the Manual on Uniform Traffic Control Devices for Streets and Highways, published by the U.S. Department of Transportation, Federal Highway Administration, for details not shown.

1.2 SUBMITTALS

- A. In accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish Manufacturer's Certificates and Data certifying that the following materials conform to the requirements specified.
- B. Paint.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):

TT-P-1952D..... Paint, Traffic, and Airfield Marking, Waterborne (Type II)

PART 2 - PRODUCTS

2.1 PAINT

Paint for marking pavement (parking structure and zone marking) shall conform to MPI No. 97, color as shown. Paint shall be in containers of at least 18 L (5 gallons). A certificate shall accompany each batch of paint stating compliance with the applicable publication.

- A. Color of paint, unless noted otherwise on Contract Drawings, shall be yellow and shall match federal color chip No. 33538. Color shall have daylight directional reflectance (without glass beads) of not less than 50% (relative to magnesium oxide) when tested in accordance with Federal Test Method Standard 141, Method 6121.

- B. Paint color for blue accessible parking space pavement markings where already existing shall match federal color chip No. 35180. Color shall have daylight directional reflectance (without glass beads) of not less than 52% (relative to magnesium oxide) when tested in accordance with Federal Test Method Standard 141, Method 6121.

2.2 PAINT APPLICATOR

Apply all marking by approved mechanical equipment. The equipment shall provide constant agitation of paint and travel at controlled speeds. Synchronize one or more paint "guns" to automatically begin and cut off paint flow in the case of skip lines. The equipment shall have manual control to apply continuous lines of varying length and marking widths as shown. Provide pneumatic spray guns for hand application of paint in areas where a mobile paint applicator cannot be used. An experienced technician that is thoroughly familiar with equipment, materials, and marking layouts shall control all painting equipment and operations.

2.3 SANDBLASTING EQUIPMENT

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall furnish not less than 0.08 m³/s (150 cfm) of air at a pressure of not less than 625 kPa (90 psi) at each nozzle used.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Thoroughly clean all surfaces to be marked before application of paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by the Resident Engineer. Where oil or grease are present on old pavements to be marked, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint. Pavement marking shall follow as closely as practicable after the surface has been cleaned and dried, but do not begin any marking until the Resident Engineer has inspected the surface and gives permission to proceed. The Contractor shall establish control points for marking and provide templates to control paint application by type and color at necessary

intervals. The Contractor is responsible to preserve and apply marking in conformance with the established control points.

3.2 APPLICATION

Apply uniformly painted pavement marking of required color(s), length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces in conformance with the details as shown and established control points. The length and width of lines shall conform within a tolerance of plus or minus 75 mm (3 inches) and plus or minus 3 mm (1/8 inch), respectively, in the case of skip markings. The length of intervals shall not exceed the line length tolerance. Temperature of the surface to be painted and the atmosphere shall be above 10°C (50°F) and less than 35°C (95°F). Apply the paint at a wet film thickness of 0.4 mm (0.015 inch). Apply paint in one coat. At the direction of the Resident Engineer, markings showing light spots may receive additional coats. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent pick-up, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the marking, discontinue paint operations until cause of the slow drying is determined and corrected. Remove and replace marking that is applied at less than minimum material rates; deviates from true alignment; exceeds stipulated length and width tolerances; or shows light spots, smears, or other deficiencies or irregularities. Use carefully controlled sand blasting, approved grinding equipment, or other approved method to remove marking so that the surface to which the marking was applied will not be damaged.

3.3 PROTECTION

Conduct operations in such a manner that necessary traffic can move without hindrance. Protect the newly painted markings so that, insofar as possible, the tires of passing vehicles will not pick up paint. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic. Efface and replace damaged portions of markings at no additional cost to the Government.

3.4 DETAIL PAVEMENT MARKING

Use Detail Pavement Markings, exclusive of actual traffic lane marking, at exit and entrance areas at parking bays, and at such other locations as shown. Show the International Handicapped Symbol at indicated parking spaces. Color shall be as shown. Apply paint for the symbol using a suitable template that will provide a pavement marking with true, sharp edges and ends. Place detail pavement markings of the color(s), width(s) and length(s), and design pattern at the locations shown.

3.5 FINAL CLEAN-UP

Remove all debris, rubbish and excess material from the Station.

END OF SECTION 321723

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 – GENERAL

1.1 DESCRIPTION

This work consists of all labor, materials, and equipment necessary for furnishing and installing chain link fence, gates and accessories in conformance with the lines, grades, and details as shown.

1.2 RELATED WORK

A. Temporary Construction Fence: Section 010000, GENERAL REQUIREMENTS.

1.3 MANUFACTURER'S QUALIFICATIONS

Fence, gates, and accessories shall be products of manufacturers' regularly engaged in manufacturing items of type specified.

1.4 SUBMITTALS

A. In accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES, furnish the following:

1. Manufacturer's Literature and Data: Chain link fencing, gates and all accessories.
2. Manufacturer's Certificates: Zinc-coating complies with specifications.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

A121	Metallic Coated Carbon Steel Barbed Wire
A392-07	Zinc-Coated Steel Chain-Link Fence Fabric
A817-07	Metal-Coated Steel Wire for Chain-Link Fence Fabric and Marcellled Tension Wire
C94/C94M-07	Ready-Mixed Concrete
F567-07	Installation of Chain-Link Fence
F626-(R2003)	Fence Fittings
F900-05	Industrial and Commercial Swing Gates
F1083-08	Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

C. Federal Specifications (Fed. Spec.):

FF-P-110J.....Padlock, Changeable Combination

PART 2 - PRODUCTS

2.1 GENERAL

Materials shall conform to ASTM F1083 and ASTM A392 ferrous metals, zinc-coated; and detailed specifications forming the various parts thereto; and other requirements specified herein. Zinc-coat metal members (including fabric, gates, posts, rails, hardware and other ferrous metal items) after fabrication shall be reasonably free of excessive roughness, blisters and sal-ammoniac spots.

2.2 CHAIN-LINK FABRIC

ASTM A392 9 gauge wire woven in a 50 mm (2 inch) mesh. Top and bottom selva shall have twisted and barbed finish. Zinc-coating weight shall be 340 grams/m².

2.3 POST, FOR GATES AND FENCING

ASTM F1083, Grade SK-40A, round, zinc-coated steel. Dimensions and weights of posts shall conform to the tables in the ASTM Specification. Provide post braces and truss rods for each gate, corner, pull or end post. Provide truss rods with turnbuckles or other equivalent provisions for adjustment.

2.4 TOP RAIL AND BOTTOM RAIL

ASTM F1083, Grade SK-40A, round, zinc-coated steel. Dimensions and weights of posts shall conform to the tables in the ASTM Specification; fitted with suitable expansion sleeves and means for securing rail to each gate, corner, and end posts.

2.5 TOP AND BOTTOM TENSION WIRE

ASTM A817 and ASTM F626, zinc-coated, having minimum coating the same as the fence fabric.

2.6 ACCESSORIES

Accessories as necessary caps, rail and brace ends, wire ties or clips, braces and tension bands, tension bars, truss rods, and miscellaneous accessories conforming to ASTM F626

2.7 GATES

ASTM F900, type as shown. Gate framing, bracing, latches, and other hardware zinc-coating weight shall be the same as the FABRIC. Gate leaves more than 2400 mm (8 feet) wide shall have either intermediate members and diagonal truss rods, or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gates less than 2400 mm (8 feet) wide shall

have truss rods or intermediate braces. Attach gate fabric to the gate frame by method standard with the manufacturer, except that welding will not be permitted. Arrange latches for padlocking so that padlock will be accessible from both sides of the gate regardless of the latching arrangement. When required, extend each end member of gate frame sufficiently above the top member or provide three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

2.8 GATE HARDWARE

- A. Manufacturer's standard products, installed complete. The type of hinges shall allow gates to swing through 180 degrees, from closed to open position. Hang and secure gates in such a manner that, when locked, they cannot be lifted off hinges.

2.9 CONCRETE

ASTM C94/C94M, using 19 mm (3/4 inch) maximum-size aggregate, and having minimum compressive strength of 25 mPa (3000 psig) at 28 days. Non-shrinking grout shall consist of one part Portland cement to three parts clean, well-graded sand, non-shrinking grout additive and the minimum amount of water to produce a workable mix.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fence by properly trained crew, on previously prepared surfaces, to line and grade as shown. Install fence in accordance with ASTM F567 and with the manufacturer's printed installation instructions, except as modified herein or as shown. Maintain all equipment, tools, and machinery while on the project in sufficient quantities and capacities for proper installation of posts, chain links and accessories.

3.2 EXCAVATION

Excavation for concrete-embedded items shall be of the dimensions shown, except in bedrock. If bedrock is encountered before reaching the required depth, continue the excavation to the depth shown or 450 mm (18 inches) into the bedrock, whichever is less, and provide a minimum of 50 mm (2 inches) larger diameter than the outside diameter of the post. Clear loose material from post holes. Grade area around finished concrete footings as shown and dispose of excess earth as directed by the Resident Engineer.

3.3 POST SETTING

Install posts plumb and in alignment. Set post in concrete footings of dimensions as shown, except in bedrock. Thoroughly compact concrete so as it to be free of voids and finished in a slope or dome to divert water running down the post away from the footing. Straight runs between braced posts shall not exceed 150 m

(500 feet). Install posts in bedrock with a minimum of 25 mm (one inch) of non-shrinking grout around each post. Thoroughly work non-shrinking grout into the hole so as to be free of voids and finished in a slope or dome. Cure concrete and grout a minimum of 72 hours before any further work is done on the posts.

3.4 POST CAPS

Fit all exposed ends of post with caps. Provide caps that fit snugly and are weathertight. Where top rail is used, provide caps to accommodate the top rail. Install post caps as recommended by the manufacturer and as shown.

3.5 SUPPORTING ARMS

Design supporting arms, when required, to be weathertight. Where top rail is used, provide arms to accommodate the top rail. Install supporting arms as recommended by the manufacturer and as shown.

3.7 TOP RAILS AND BOTTOM RAILS

Install rails before installing chain link fabric. Provide suitable means for securing rail ends to terminal and intermediate post.

3.8 ACCESSORIES

Supply accessories (posts braces, tension bands, tension bars, truss rods, and miscellaneous accessories), as required and recommended by the manufacturer, to accommodate the installation of a complete fence, with fabric that is taut and attached properly to posts, rails, and tension wire.

3.9 GATES

Install gates plumb, level, and secure for full opening without interference. Set keepers, stops and other accessories into concrete as required by the manufacturer and as shown. Adjust hardware for smooth operation and lubricate where necessary.

3.10 REPAIR OF GALVANIZED SURFACES

Use galvanized repair compound, stick form, or other method, where galvanized surfaces need field or shop repair. Repair surfaces in accordance with the manufacturer's printed directions.

3.11 FINAL CLEAN-UP

Remove all debris, rubbish and excess material from the station.

END OF SECTION 323113

SECTION 331000 - WATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

Underground water distribution system complete, ready for operation, including all appurtenant structures, and connections to both new building service lines and to existing water supply.

1.2 RELATED WORK

- A. Maintenance of Existing Utilities: Section 010000, GENERAL REQUIREMENTS.
- B. Excavation, trench widths, pipe bedding, backfill, shoring, sheeting, bracing: Section 312000, EARTH MOVING.
- C. Concrete: Section 033000, CAST-IN-PLACE CONCRETE.
- D. Protection of materials and equipment: Section 220511, COMMON WORK RESULTS FOR PLUMBING.
- E. Fire protection system connection and supervisory switch for post indicator valve: Section 211200, FIRE-SUPPRESSION STANDPIPES.

1.3 DEFINITIONS

- A. Water Distribution: Pipelines and appurtenances which are part of the distribution system. The distribution system comprises the network of piping located throughout building areas and other areas of water use, including hydrants, valves, and other appurtenances used to supply water for domestic and fire-fighting/fire protection purposes.
- B. Water Service Line: Pipe line connecting building piping to water distribution lines.

1.4 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be product of one manufacturer.
 - 2. Nameplate: Nameplate bearing manufacturer's name or identifiable trademark securely affixed in a conspicuous place on equipment or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Water lines and the extension, and/or modifications to Public Utility systems.
- C. Comply with all rules and regulations of Federal, State, and Local Health Department having jurisdiction over the design, construction, and operation of potable water systems.
- D. All material surfaces in contact with potable water shall comply with NSF 61.

1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data (Submit all items as one package):

(Ductile Iron Pipe and Polyvinyl Chloride (PVC) shall be in accordance with AWWA C600 and C605 respectively; and shall be provided to Resident Engineer for approval.)

- 1. Piping.
- 2. Gaskets.
- 3. Valves.
- 4. Fire hydrants.
- 5. Street washer.
- 6. Meter.
- 7. Vaults, frames and covers.
- 8. Steps.
- 9. Post indicator.
- 10. Valve boxes.
- 11. Corporation and curb stops.
- 12. Curb stop boxes.
- 13. Joint restraint.
- 14. Disinfection products.
- 15. Link/sleeve seals.

- C. Testing Certifications:

- 1. Certification of Backflow Devices.
- 2. Hydrostatic Testing.
- 3. Certification of Disinfection, including free chlorine residuals, and bacteriological examinations.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI/ASME):

B16.1-98.....	Cast Iron Pipe Flanges and Flanged Fittings
B16.18.....	Cast Bronze Solder Joint Pressure Fittings
B16.26-88.....	Cast Copper Alloy Fittings for Flared Copper Tubes
B40.100-98.....	Pressure Gauges and Gauge Attachments

C. American Society for Testing and Materials (ASTM):

A123-97.....	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A148M-03.....	Standard Specifications for Steel Castings
A242-00.....	Standard Specifications for High Strength Low Alloy Structural Steel AASHTO No. M161
A307-02.....	Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
A536-04.....	Standard Specifications for Ductile Iron Castings
B61-02.....	Steam or Valve Bronze Castings
B62-02.....	Composition Bronze or Ounce Metal Castings
B88-02.....	Seamless Copper Water Tube
B828.....	Standard Practice: Soldering and Brazing Copper Tube and fittings
C32-04.....	Sewer and Manhole Brick (Made from Clay or Shale)
C139-03.....	Concrete Masonry Units for Construction of Catch Basins and Manholes
D1784-03.....	Standard Specifications for Rigid PVC Compounds and CPVC Compounds
D1869-00.....	Standard Specifications for Rubber Rings for Asbestos Cement Pipe
D2464-99.....	Standard Specifications for Threaded PVC Pipe Fittings, Schedule 80
D2467-02.....	Standard Specifications for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D3139-98.....	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
F477-02e1.....	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
C32-04.....	Standard Specifications for Sewer Manhole Brick

D. American Water Works Association (AWWA):

B300-04.....	Hypochlorites
B301-04.....	Liquid Chlorine
C104-04.....	Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water
C105-99.....	Polyethylene Encasement for Gray and Ductile C.I. Piping for Water and Other Liquids

- C110-03.....Ductile-Iron and Gray-Iron Fittings, 80 mm (3 Inches)
Through 1200 mm (48 Inches) for Water and Other
Liquids
- C111-01.....Rubber-Gasket Joints for Ductile-Iron and Gray-Iron
Pressure Pipe and Fittings
- C115-99.....Flanged Ductile-Iron and Gray-Iron Pipe with
Threaded Flanges
- C150-02.....American National Standard for Thickness Design of
Ductile Iron Pipe
- C151-96.....Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or
Sand-Lined Molds, for Water or Other Liquids
- C153-00.....Ductile-Iron Compact Fittings, 80 mm (3 inches)
Through 300 mm (12 Inches) for Water and Other
Liquids
- C500-02.....Gate Valves for Water and Sewerage Systems
- C502a-95.....Dry-Barrel Fire Hydrants
- C503-97.....Wet-Barrel Fire Hydrants
- C508-01.....Swing Check Valves for Waterworks Service, 2
Inches (50 mm) Through 24 Inches (600mm) NPS
- C509-01.....Resilient Seated Gate Valve for Water and Sewage
System
- C510-97.....Double Check Valve Back-Flow Prevention Assembly
- C511-97.....Reduced Pressure Principle Back-Flow Prevention
Assembly
- C550-01.....Protective Epoxy Interior Coatings for Valves and
Hydrants
- C600-01.....Installation for Ductile-Iron Water Mains and Their
Appurtenances
- C605-94.....Underground Installation of Polyvinyl Chloride (PVC)
Pressure Pipe and Fittings for Water
- C651-92.....Disinfecting Water Mains
- C800-01.....Underground Service Line Valves and Fittings
- C900-97.....Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches
Thru 12 Inches, for Water
- C905-97.....Polyvinyl Chloride (PVC) Pressure Pipe 14 Inches
Thru 36 Inches
- E. National Fire Protection Association (NFPA):
 - 24-95Installation of Private Fire Service Mains and Their
Appurtenances
 - 291-01Fire Flow Testing and Marking of Hydrants
 - 1141-98Fire Protection in Planned Building Groups
- F. NSF International:
 - 14-03Plastics Piping Components and Related Materials

61-02Drinking Water System Components-Health Effects
(Sections 1-9)

G. American Welding Society (AWS):

A5.8-04.....Braze Filler Metal

H. Foundation for Cross-Connection Control and Hydraulic Research-2005

I. Copper Development Association's Copper Tube Handbook-2005

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE AND FITTINGS

A. Ductile iron pipe, direct buried:

1. Provide ductile iron pipe conforming to the requirements of AWWA C151, Pressure Class 350 for Pipe 100 mm through 300 mm (4 inches through 12 inches) in diameter and 250, minimum for pipe larger than 300 mm (12 inches) in diameter, with standard thickness cement mortar lining interior, and interior asphaltic seal coat and exterior asphaltic coating, in accordance with AWWA and ANSI Standards.
2. Below Grade: Supply pipe in lengths not in excess of a nominal 6 m (20 feet) with rubber ring type push-on joints, mechanical joint or approved restrained joint. Provide flange joint pipe where shown on the drawings. Provide mechanical and restrained joint pipe with sufficient quantities of accessories as required for each joint.
3. When a polyethylene encasement over pipe, fittings, and valves is a requirement as indicated on the drawings, the material, installation and workmanship shall conform to applicable sections of AWWA C105. Make provisions to keep the polyethylene from direct exposure to sunlight prior to installation. Backfill following installation without delay to avoid exposure to sunlight.

B. Ductile Iron Pipe Above Grade or in Below Ground Concrete Pits:

1. Flanged ductile iron pipe, AWWA C115, with factory applied screwed long hub flanges except as otherwise specified hereinafter. Face and drill flanges after being screwed on the pipe, with flanges true to 90 degrees with the pipe axis and flush with end of pipe, ANSI B16.1, 850 kPa (125 psi) or 1725 kPa (250 psi) standard, for the purpose intended.
2. Wall Sleeve Castings: Size and types shown on the drawings and be hot dipped galvanized.
3. Pipe Thickness Class: Minimum of Class 53 as defined in AWWA C150 for all sizes of flanged pipe.

4. Rubber Ring Gaskets: Full face type, AWWA C111, 2 mm (1/16 inch) rubber ring gaskets and of approved composition suitable for the required service.
 5. Pipe and fittings exposed to view in the finished work are to be painted in accordance with Section 09 91 00, PAINTING. Pipe shall not receive the standard tar or asphalt coat on the outside surfaces but shall be shop primed on the outside with Rust Inhibitive Primer. Paint color shall match the wall color.
 6. Bolts and Nuts on Flanged Fittings: Grade B, ASTM A307. Low alloy, high strength steel in accordance with AWWA C111. Assemble stainless steel bolts and nuts using anti-seize compound to prevent galling.
- C. All Pipe Fittings: Ductile iron with a minimum pressure rating of 2400 kPa (350 psi). Fittings shall meet the requirements of ANSI and AWWA specifications as applicable. Rubber gasket joints shall conform to AWWA C111 for mechanical and push-on type joints. Ball joints shall conform to AWWA C151 with a separately cast ductile iron bell conforming to ASTM A148. Flanged fittings shall conform to AWWA C115 and be furnished flat faced and drilled to 850 kPa (125 psi) or 1725 kPa (250 psi) template in accordance with ANSI B16.1 with full faced gaskets.
- D. Provide cement mortar lining and bituminous seal coat on the inside of the pipe and fittings in accordance with AWWA C104. Provide standard asphaltic coating on the exterior.
- E. Provide a factory hydrostatic test of not less than 3.5 MPa (500 psi) for all pipe in accordance with AWWA C151.
- F. Provide non-detectable adhesive backed identification tape on top and sides of all buried ductile iron pipe, extended from joint to joint along the length of the pipe and have black lettering identifying the pipe service at no more than 300 mm (12 inch) intervals.

2.2 POLYVINYL CHLORIDE PIPE AND FITTINGS

- A. Class-Rated Polyvinyl Chloride (PVC) Pipe:
1. PVC pipe and accessories 100 mm to 356 mm (4 inches–14 inches) in diameter, AWWA C900 "Polyvinyl Chloride (PVC) Pressure Pipe", Class 200, DR 14, cast iron outside diameters, unless otherwise shown or specified.
 2. PVC pipe and accessories 400 mm (16 inches) or larger, AWWA C905, "Polyvinyl Chloride Water Transmission Pipe", Class 235, DR 18, cast iron outside diameters unless otherwise shown or specified. Pipe and accessories shall bear the NSF mark indicating pipe size, manufacturer's name, AWWA and/or ASTM Specification number, working pressure and production code. Pipe and couplings shall be made in accordance with ASTM D1784.
 3. PVC Pipe and Accessories Smaller than 100 mm (4 inches): Schedule 80, meeting the requirements of ASTM D-1785, Type 1, Grade 1. All exposed piping shall be CPVC meeting requirements of ASTM F441.

B. Joints:

1. Pipe 75 mm (3 inches) and Greater in Diameter: Push-on type with factory installed solid cross section elastomeric ring meeting the requirements of ASTM F-477.
2. Pipe Less Than 75 mm (3 inches) in Diameter: Threaded (ASTM D-2464) or solvent welded (ASTM 2467). Use Teflon tape or liquid Teflon thread lubricant approved for use on plastic on all threaded joints.

C. Fittings:

1. Class-Rated Pipe 75 mm (3 inches) in Diameter and Greater: Ductile iron with mechanical joints conforming to the requirements of AWWA C153.
2. For Schedule 80 Pipe less than 75 mm (3 inches) in Diameter: Threaded or solvent weld. Threaded PVC fittings shall conform to ASTM D2464. CPVC fittings shall conform to ASTM F437 for threaded fittings and ASTM F439 for solvent weld fittings.

2.3 COPPER PIPE AND TUBING

Copper Piping: ASTM B88, Type K, or Type L with flared fittings in accordance with AWWA C800, with sweat cast brass fittings per ANSI B16.18. Use brazing alloy, AWS A5.8, Classification BCuP.

2.4 VALVES

A. Asbestos packing is not allowed.

B. Gate:

1. 75 mm (3 inches) and Larger: Resilient seated, ductile iron body, bronze mounted, inclined seats, non-rising stem type turning counter-clockwise to open, 1375 kPa (200 pound) WOG. AWWA C509. The resilient seat shall be fastened to the gate with stainless steel fasteners or vulcanizing methods. The interior and exterior shall be coated with thermo-setting or fusion epoxy coating in accordance with AWWA C550.
2. Operator:
 - a. Underground: Except for use with post indicators, furnish valves with 50 mm (2 inch) nut for socket wrench operation. Post indicator shall comply with the requirements of NFPA 24 and shall be fully compatible with the valve provided.
 - b. Above Ground and in Pits: Hand wheels.

3. Joints: Ends of valves shall accommodate, or be adapted to, pipe installed.

C. Check: Swing.

1. Smaller than 100 mm (4 inches): Bronze body and bonnet, ASTM B61 or B62, 1375 kPa (200 pound) WOG.
2. 100 mm (4 inches) and Larger: Iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, 1375 kPa (200 pound) WOG. Check valves for fire lines shall conform to AWWA C508 and shall be epoxy coated and lined per AWWA C550.

D. Corporation stops and saddles shall conform to AWWA C800.

E. Curb Stop: Smaller than 75 mm (3 inches). Waterworks standard for Type "K" copper, single piece cast bronze body with tee top operated plug sealed with O-ring gaskets, 1375 kPa (200 pound) WOG per AWWA C800.

2.5 CURB STOP BOX

Cast iron extension box with screw or slide type adjustment and flared base. Box shall be adapted, without full extension, to depth of cover required over pipe at stop location. Cast the word "WATER" in cover and set cover flush with finished grade. Curb stop shut-off rod shall extend 600 mm (2 feet) above top of deepest stop box.

2.6 VALVE BOX

Cast iron extension box with screw or slide-type adjustment and flared base. Minimum thickness of metal shall be 5 mm (3/16 inch). Box shall be adapted, without full extension, to depth of cover required over pipe at valve location. Cast the word "WATER" in cover. Provide "T" handle socket wrenches of 16 mm (5/8 inch) round stock long enough to extend 600 mm (2 feet) above top of deepest valve box.

2.7 POST INDICATOR VALVE

A. Valve: Valve shall conform to the specifications listed in Section 2.4 for gate valves. The Post Indicator shall conform to NFPA 24, and shall be fully compatible with the valve and all the supervisory switches.

2.8 FIRE HYDRANTS

- A. Size of main valve opening of each hydrant shall be 125 mm (5 inches), minimum. Hose thread, size of fire apparatus connection, and shape, size and direction of rotation of operating head of hydrant shall be identical with present local fire department.
- B. Hydrant shall be type AWWA C502, heavy construction, of proper length to connect pipe without extra fittings, and shall be the traffic type with safety flange on barrel and safety couplings on the valve stem with the following features:
 1. Interior removable without digging up hydrant; can be packed under pressure; 150 mm (6 inch) bell connection; one steamer nozzle and two hose nozzles with nozzle caps securely chained to barrel; suitable drainage device; single

- rubber or leather-faced valve in base; nozzles, stuffing boxes, wedge nuts, seat rings, clamp plates, etc. Threaded joints or spindles shall be bronze. Upper and lower barrels shall be of equal diameters. Upper barrel shall be of sufficient length to permit setting hydrant with barrel flange not more than 50 mm (2 inches) above finished grade. All fire hydrants shall have 150 mm (6 inch) bottom connection.
2. Provide fire hydrants with a finish paint identical to the existing fire hydrants.

2.9 PIPE SLEEVES

Ductile iron or zinc coated steel.

2.10 BACKFLOW PREVENTER

- A. Potable Water and Irrigation Water Service: Reduced Pressure Principle Type AWWA C511, except pressure drop at rated flow shall not exceed 100 kPa (15 psi). Gate valves installed on the assembly shall be resilient seated valve conforming to AWWA C509.
- B. Fire Service: Double detector check valve. AWWA C510 and NFPA 14.
- C. In cold climate areas, backflow assemblies and devices shall be protected from freezing by a method acceptable to local jurisdiction.
- D. Backflow preventers shall be approved by the Foundation for Cross-Connection Control and Hydraulic Research per current edition of the Manual of Cross-Connection Control.
- E. Backflow preventer shall not be located in any area containing fumes that are toxic, poisonous or corrosive.
- F. Direct connections between potable water piping and sewer connected wastes shall not exist under any condition with or without backflow protection.
- G. Backflow preventer shall be accessed and have clearance for the required testing, maintenance and repair. Access and clearance shall require a minimum of one (1) foot (305 mm) between the lowest portion of the assembly and grade, floor or platform. Installations elevated more than five (5) feet (1524 mm) above the floor or grade shall be provided with a permanent platform capable of supporting a tester or maintenance person.

2.11 FLEXIBLE EXPANSION JOINTS: (PROVIDE FOR DOMESTIC AND FIRE SERVICE)

Ductile iron with ball joints rated for 1725 kPa (250 PSI) working pressure conforming to ANSI/AWWA A21.53/C153, capable of deflecting a minimum of 30 degrees and expanding simultaneously to the amount shown on the drawings. Flexible expansion joint shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be

lined with a minimum of 375 μm (15 mils) of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory holiday tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA A21.11/C110. Bolts and nuts high strength steel with synthetic gaskets that comply with AWWA C110.

2.12 DISINFECTION CHLORINE

- A. Liquid chlorine shall conform to AWWA B301 and AWWA C651.
- B. Sodium hypochlorite shall conform to AWWA B300 with 5 percent to 15 percent available chlorine.
- C. Calcium hypochlorite shall conform to AWWA B300 supplied in granular form or 5.g tablets, and shall contain 65 percent chlorine by weight.

2.13 WARNING TAPE

Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape, detectable type, blue with black letters, and imprinted with "CAUTION BURIED WATER LINE BELOW".

PART 3 - EXECUTION

3.1 BUILDING SERVICE LINES

Install water service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings to which such service is to be connected and make connections thereto. If building services have not been installed provide temporary caps.

3.2 REGRADING

Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

3.3 PIPE LAYING, GENERAL

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Resident Engineer.
- B. All pipe and fittings shall be subjected to a careful inspection just prior to being laid or installed. If any defective piping is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the Government. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.

- C. All buried piping shall be installed to the lines and grades as shown on the drawings. All underground piping shall slope uniformly between joints where elevations are shown.
- D. Contractor shall exercise extreme care when installing piping to shore up and protect from damage all existing underground water line and power lines, and all existing structures.
- E. Do not lay pipe on unstable material, in wet trench, or when trench or weather conditions are unsuitable.
- F. Do not lay pipe in same trench with other pipes or utilities unless shown otherwise on drawings.
- G. Hold pipe securely in place while joint is being made.
- H. Do not walk on pipes in trenches until covered by layers of earth well tamped in place to a depth of 300 mm (12 inches) over pipe.
- I. Full length of each section of pipe shall rest solidly upon pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipes on wood blocking.
- J. Tees, plugs, caps, bends and hydrants on pipe installed underground shall be anchored. See section 3.7 "PIPE SUPPORTS".
- K. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water and chemical, or mechanical injury. At completion of all work, thoroughly clean exposed materials and equipment.
- L. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by the manufacturer.
- M. Warning tape shall be continuously placed 300 mm (12 inches) above buried water pipes.

3.4 DUCTILE IRON PIPE

- A. Installing Pipe: Lay pipe in accordance with AWWA C600 with polyethylene encasement if required in accordance with AWWA C105. Provide a firm even bearing throughout the length of the pipe by tamping selected material at the sides of the pipe up to the spring line.
- B. All pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other approved means.
- C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Bevel cut ends of pipe to be

used with push-on bell to conform to the manufactured spigot end. Cement lining shall be undamaged.

D. Jointing Ductile-Iron Pipe:

1. Push-on joints shall be made in strict accordance with the manufacturer's instruction. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe is to be aligned with the bell of the pipe to which it is joined, and pushed home with approved means.
2. Mechanical Joints at Valves, Fittings: Install in strict accordance with AWWA C111. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gaskets with soapy water before tightening the bolts. Bolts shall be tightened to the specified torque.
3. Ball Joints: Install in strict accordance with the manufacturer's instructions. Where ball joint assemblies occur at the face of structures, the socket end shall be at the structure and ball end assembled to the socket.
4. Flanged joints shall be in accordance with AWWA C115. Flanged joints shall be fitted so that the contact faces bear uniformly on the gasket and then are made up with relatively uniform bolt stress.

3.5 PVC PIPE

- A. PVC piping shall be installed in strict accordance with the manufacturer's instructions and AWWA 605. Place selected material and thoroughly compacted to one foot above the top of the pipe and thereafter back filled as specified in Section 31 20 00, EARTH MOVING.
- B. Copper Tracer Wire: Copper tracer wire consisting of No. 14 AWG solid, single conductor, insulated copper wire shall be installed in the trench with all piping to permit location of the pipe with electronic detectors. The wire shall not be spiraled around the pipe nor taped to the pipe. Wire connections are to be made by stripping the insulation from the wire and soldering with rosin core solder. Solder joints shall be wrapped with rubber tape and electrical tape. At least every 300 m (1000 feet), provide a 2.3 kg (5 pound) magnesium anode attached to the main tracer wire by solder. The solder joint shall be wrapped with rubber tape and with electrical tape. An anode shall be attached at the end of each line.
- C. Magnetic markers may be used in lieu of copper tracer wire to aid in future pipe locating. Generally, install markers on 6 m (20 foot) centers. If pipe is in a congested piping area, install on 3 m (10 foot) centers. Prepare as-built drawing indicating exact location of magnetic markers.

3.6 COPPER PIPE

Copper piping shall be installed in accordance with the Copper Development Association's Copper Tube Handbook and manufacturer's recommendations.

Copper piping shall be bedded in 150 mm (6 inches) of sand and then back filled as specified in Section 312000, EARTH MOVING.

3.7 PIPE SUPPORTS

A. Supports:

1. All piping shall be properly and adequately supported. Hangers, supports, base elbows and tees, and concrete piers and pads shall be provided as indicated on the drawings. If the method of support is not indicated on the drawings, exposed piping shall be supported by hangers wherever the structure is suitable and adequate to carry the superimposed load. Supports shall be placed approximately 2.4 m (8 feet) on centers and at each fitting.
2. Hangers shall be heavy malleable iron of the adjustable swivel type, split ring type, or the adjustable-swivel, pipe-roll type for horizontal piping and adjustable, wrought iron, clamp type for vertical piping. Flat steel strap or chain hangers are not acceptable unless indicated on the drawings.
3. Hangers shall be attached to the structure, where possible, by beam clamps and approved concrete inserts set in the forms before concrete is poured. Where this method is impractical, anchor bolts with expanding lead shields, rawl drives, or malleable iron expansion shields will be permitted.
4. Where hangers cannot be used, the Contractor shall provide pipe saddle supports with pipe column and floor flange.

3.8 RESTRAINED JOINTS

- A. Sections of piping requiring restrained joints shall be constructed using pipe and fittings with restrained "locked-type" joints and the joints shall be capable of holding against withdrawal for line pressures 50 percent above the normal working pressure but not less than 1375 kPa (200 psi). The pipe and fittings shall be restrained push-on joints or restrained mechanical joints.
- B. The minimum number of restrained joints required for resisting force at fittings and changes in direction of pipe shall be determined from the length of retained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil. Restrained pipe length shall be as shown on the drawings.
- E. Ductile iron mechanical joint fittings shall be restrained with EBBA Iron Sales, Inc. Series 1200 Restrainer or approved equal. The restraining device shall be designed to fit standard mechanical joint bells with standard T head bolts conforming to AWWA C111 and AWWA C153. Glands shall be manufactured of ductile iron conforming to ASTM A536. Set screws shall be hardened ductile iron and require the same torque in all sizes. Steel set screws not permitted. These devices shall have the stated pressure rating with a minimum safety factor of 2:1. Glands shall be listed with Underwriters Laboratories and/or approved by Factory Mutual.

- F. Thrust blocks shall not be permitted.
- G. Where ductile iron pipe manufactured with restrained joints is utilized, all restrained joints shall be fully extended and engaged prior to back filling the trench and pressurizing the pipe.
- H. PVC pipe bell and spigot joints shall be restrained with the Uni-Flange Corp. Series 1350 Restrainer or approved equal. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A536. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy steel meeting the requirements of ASTM A242.
- I. Ductile iron mechanical joint fittings used with PVC pipe shall be restrained with UNI-Flange Corp. Series 1300 Restrainer, EBBA Iron, Inc, Series 2000PV Mechanical Joint Restrainer Gland, or approved equal. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A-536. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy steel meeting the requirements of ASTM A242.

3.9 PIPE SEPARATION

A. Horizontal Separation-Water Mains and Sewers:

- 1. Water mains shall be located at least 3 m (10 feet) horizontally from any proposed drain, storm sewer, sanitary or sewer service connection.
- 2. Water mains may be located closer than 3 m (10 feet) to a sewer line when:
 - a. Local conditions prevent a lateral separation of 3 m (10 feet); and
 - b. The water main invert is at least 450 mm (18 inches) above the crown of the sewer; and
 - c. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located one side of the sewer.
- 3. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of mechanical joint ductile iron pipe. Ductile iron pipe shall comply with the requirements listed in this specification section. The drain or sewer shall be pressure tested to the maximum expected surcharge head before back filling.

B. Vertical Separation-Water Mains and Sewers:

- 1. A water main shall be separated from a sewer so that its invert is a minimum of 450 mm (18 inches) above the crown of the drain or sewer whenever water mains cross storm sewers, sanitary sewers or sewer service connections. The vertical separation shall be maintained for that portion of the water main located within 10 feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.

2. Both the water main and sewer shall be constructed of slip-on or mechanical joint ductile iron pipe or PVC pipe equivalent to water main standards of construction when:
 - a. It is impossible to obtain the proper vertical separations described in (1) above; or
 - b. The water main passes under a sewer or drain.
3. A vertical separation of 450 mm (18 inches) between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking the water main.
4. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least 3 m (10 feet).

3.10 SETTING OF VALVES AND BOXES

- A. Provide a surface concrete pad 450 by 450 by 150 mm (18 by 18 by 6 inches) to protect valve box when valve is not located below pavement.
- B. Clean valve and curb stops interior before installation.
- C. Set valve and curb stop box cover flush with finished grade.
- D. Valves shall be installed plumb and level and in accordance with manufacturer's recommendations.

3.11 SETTING OF FIRE HYDRANTS

- A. Set center of each hydrant not less than 600 mm (2 feet) nor more than 1800 mm (6 feet) back of edge of road or face of curb. Fire apparatus connection shall face road with center of nozzle 450 mm (18 inches) above finished grade. Set barrel flange not more than 50 mm (2 inches) above finished grade.
- B. Set each hydrant on a slab of stone or concrete not less than 100 mm (4 inches) thick and 375 mm (15 inches) square. The service line to the hydrant, between the tee and the shoe of the hydrant, shall be fully restrained.
- C. Set bases in not less than 0.4 cubic meter (1/2 cubic yard) of crushed rock or gravel placed entirely below hydrant drainage device.
- D. Clean interiors of hydrants of all foreign matter before installation.

3.12 PIPE SLEEVES

Install where water lines pass through retaining walls, building foundations and floors. Seal with modular mechanical type link seal. Install piping so that no joint

occurs within a sleeve. Split sleeves may be installed where existing lines pass through new construction.

3.13 FLUSHING AND DISINFECTING

- A. Flush and disinfect new water lines in accordance with AWWA C651.
- B. Initial flushing shall obtain a minimum velocity in the main of 0.75 m/sec (2.5 feet per second) at 40 PSI residual pressure in water main. The duration of the flushing shall be adequate to remove all particles from the line.

Pipe Diameter		Flow Required to Produce 2.5 ft/sec(approx.) Velocity in Main		Number of Hydrant Outlets			
				Size of Tap. in. (mm)			
				1(25)	1 1/2(38)	2(51)	2 1/2-in (64 mm)
In	(mm)	gpm	(L/sec)	Number of taps on pipe			
4	(100)	100	(6.3)	1	--	--	1
6	(150)	200	(12.6)	--	1	--	1
8	(200)	400	(25.2)	--	2	1	1
10	(250)	600	(37.9)	--	3	2	1
12	(300)	900	(56.8)	--	--	3	2
16	(400)	1,600	(100.9)	--	--	4	2

The backflow preventers shall not be in place during the flushing.

- C. The Contractor shall be responsible to provide the water source for filling, flushing, and disinfecting the lines. Only potable water shall be used, and the Contractor shall provide all required temporary pumps, storage facilities required to complete the specified flushing, and disinfection operations.
- D. The Contractor shall be responsible for the disposal of all water used to flush and disinfect the system in accordance with all governing rules and regulations. The discharge water shall not be allowed to create a nuisance for activities occurring on or adjacent to the site.
- E. The bacteriological test specified in AWWA C651 shall be performed by a laboratory approved by the Department of Environmental Quality of the State. The cost of sampling, transportation, and testing shall be the responsibility of the Contractor.
- F. Re-disinfection and bacteriological testing of failed sections of the system shall be the sole responsibility of the Contractor.
- G. Before backflow preventers are installed, all upstream piping shall be thoroughly flushed.

3.14 HYDROSTATIC TESTING

- A. Hydrostatic testing of the system shall occur prior to disinfecting the system.
- B. After new system is installed, except for connections to existing system and building, backfill at least 300 mm (12 inches) above pipe barrel, leaving joints exposed. The depth of the backfill shall be adequate to prevent the horizontal and vertical movement of the pipe during testing.
- C. Prior to pressurizing the line, all joint restraints shall be completely installed and inspected.
- D. If the system is tested in sections, and at the temporary caps at connections to the existing system and buildings, the Contractor shall provide and install all required temporary thrust restraints required to safely conduct the test.
- E. The Contractor shall install corporation stops in the line as required to purge the air out of the system. At the completion of the test, all corporation stops shall be capped.
- F. The Contractor shall perform pressure and leakage tests for the new system for 2 hours to 1375 kPa (200 psi). Leakage shall not exceed the following requirements.
 - 1. Copper Tubing: No leaks.
 - 2. Ductile Iron Pipe: AWWA C600. Provide to Resident Engineer office.
 - 3. Polyvinyl Chloride (PVC) AWWA C605. Provide to Resident Engineer office.

3.15 BACKFLOW PREVENTOR TESTING

- A. All backflow preventers shall be tested and certified for proper operation prior to being placed in operation.
- B. Original copies of the certification shall be submitted to the Resident Engineer.

END OF SECTION 331000

Page intentionally left blank.

SECTION 333000 - SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

Outside, underground sanitary sewer system, complete, ready for operation, including all gravity flow lines manholes, cleanouts, frames, covers, structures, appurtenances, and connections to new building and structure, service lines, existing sanitary sewer lines, and existing sanitary structures, and all other incidentals.

1.2 RELATED WORK

- A. Maintenance of Existing Utilities: Section 010000, GENERAL REQUIREMENTS.
- B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 312000, EARTH MOVING.
- C. Concrete Work Reinforcing, Placement and Finishing; Section 033000, CAST-IN-PLACE CONCRETE.
- D. Fabrication of Steel Ladders: Section 055000, METAL FABRICATIONS.
- E. Protection of Materials and Equipment: Section 220511, COMMON WORK RESULTS FOR PLUMBING.

1.3 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 - 2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, including model number, securely affixed in a conspicuous place on equipment, or name or trademark, including model number cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Sanitary Sewer lines and the extension, and/or modifications to Public Utility Systems.

1.4 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data: Submit the following as one package:

1. Pipe, Fittings, and, Appurtenances.
2. Jointing Material.
3. Manhole and Structure Material.
4. Frames and Covers.
5. Steps and Ladders.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

A48/A48M-03	Gray Iron Castings
A536-84(2004)	Ductile Iron Castings
A615/A615M-06	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A625/A625M-03	Tin Mill Products, Black Plate, Single Reduced
A746-03	Ductile Iron Gravity Sewer Pipe
C12-06	Installing Vitrified Clay Pipe Lines
C76-05b/C76M-05b	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
C139-05	Concrete Masonry Units for Construction of Catch Basins and Manholes
C150-05	Portland Cement
C425-04	Compression Joints for Vitrified Clay Pipe and Fittings
C478-06a/C478M-06a	Precast Reinforced Concrete Manhole Sections
C700-05	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
C828-03	Low-Pressure Air Test of Vitrified Clay Pipe Lines
C857-95(2001)	Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
D698-00ae1	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
D2321-05	Underground Installation of Thermoplastic Pipes for Sewers and Other Gravity-Flow Applications
D2412-02	Determination of External Loading Characteristics of Plastic Pipe by Parallel- Plate Loading
D2992-01	Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
D3034-04a	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3212-96a (2003) e1	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

D3261-03.....	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
D3350-05.....	Polyethylene Plastics Pipe and Fittings Materials
D4101-05a.....	Polypropylene Injection and Extrusion Materials
F477-02e1	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F679-06	Poly (vinyl chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
F714-05	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F794-03	Poly (Vinyl Chloride)(PVC) Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
F894-05	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
F949-03	Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior and Fittings

C. American Water Works Association (AWWA):

C105/A21.5-05	Polyethylene Encasement for Ductile Iron Pipe Systems
C110/A21.10-03	Ductile-Iron and Gray-Iron Fittings for Water
C111/A21.11-00	Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings
C115-99.....	Flanged Ductile-Iron Pipe with Threaded Flanges
C116-03.....	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron Pipe and Gray Iron Fittings for Water Supply Service
C151-/A21.51-02	Ductile-Iron Pipe, Centrifugally Cast for Water
C153-00	Ductile-Iron Compact Fittings for Water Services
C508-01.....	Swing Check Valves for Waterworks, 2 inches (50 mm) Through 24 inches (600 mm) NPS
C509-01.....	Resilient Seated Gate Valves for Water-Supply Service
C515-01.....	Reduced-Wall, Resilient-Seated Gate Valves For Water Supply Service
C512-04.....	Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
C550-05.....	Protective Epoxy Interior Coatings for Valves and Hydrants
C600-05.....	Installation for Ductile-Iron Water Mains and Their Appurtenances
C605-94.....	Underground Installation of Polyvinyl (PVC) Pressure Pipe and Fittings for Water

- C900-97Polyvinyl Chloride (PVC) Pressure Pipe, 100 mm (4 inches) Through 300 mm (12 inches) for Water Distribution
- C905-97.....Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 350 mm through 1,200 mm (14 Inches through 48 Inches), for Water Transmission and Distribution
- C906-99.....Polyethylene (PE) Pressure Pipes and Fittings, 100 mm through 1575 mm (4 Inches through 63 Inches), for Water Distribution

D. American Association of State Highway and Transportation Officials (AASHTO):

- M198-05Joints for Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants

E. Uni-Bell PVC Pipe Association:

- Uni-B-6-98Recommended Practice Low Pressure Air Testing of Installed Sewer Pipe

PART 2 - PRODUCTS

2.1 PIPING

A. Gravity Flow Lines (Pipe and Fittings):

1. Vitrified Clay: Pipe and fittings shall conform to ASTM C700, extra strength, with gasketed bell and spigot end joints. Joints on the pipe and fitting shall conform to ASTM C425.
2. Polyvinyl Chloride (PVC):
 - a. Pipe and Fittings, 100 to 375 mm (4 to 15 inches) in diameter, shall conform to ASTM D3034, Type PSM, SDR 35 SDR 26. Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D3212. Gaskets shall conform to ASTM F477. Solvent welded joints shall not be permitted.
 - b. Pipe and fittings, 450 to 900 mm (18 to 36 inches) in diameter, shall be solid wall or have a corrugated or ribbed exterior profile and a smooth interior. Pipe shall conform to the following:
 - 1) Pipe and fittings shall conform to ASTM F949 corrugated sewer pipe with a smooth interior. The corrugated outer wall shall be fused to the smooth interwall at the corrugation valley. Pipe and fitting shall have a smooth bell, elastomeric joints conforming to ASTM D3212, and shall have a minimum pipe stiffness of 350 kPa (50 psi) at 5 percent deflection, when tested in accordance with ASTM D2412. Corrugation shall be perpendicular to the axis of the pipe to allow gaskets to be

- installed on field cut sections of pipe without the requirement for special fittings.
- 2) Ribbed wall PVC pipe and fittings shall conform to ASTM F794 ribbed sewer pipe with smooth interior pipe and fittings shall have a smooth bell, elastomeric joints conforming to ASTM D3212, and shall have a minimum pipe stiffness of 320 kPa (46 psi) when tested in accordance with ASTM D 2412, at 5 percent vertical deflection. Joints shall not leak at 7.6 m (25 feet) of head under 5 percent deflection.
 - 3) Solid wall pipe and fittings shall conform to ASTM F679, SDR 35 SDR 26 pipe and fittings shall gaskets conforming to ASTM F477, and shall be able to withstand a hydrostatic pressure of 345 kPa (50 psi).
3. Ductile Iron Pipe (DIP) for Sanitary Sewer: Shall conform to ASTM A746, thickness Class 51 unless otherwise shown or specified. Joints on pipe and fittings shall be push-on style and conform to AWWA C110 and AWWA C111, rated for 1.03 MPa (150 psi). Exterior coating shall be approximately 0.025 mm (1 mil) asphaltic coating as specified in ASTM A746. Interior lining shall be a catalyzed coal tar epoxy, having a minimum thickness of 0.60 mm (24 mils), a permeability rating of 0.13 perms, direct impact rating of 11.3 Nm (100 in-lbs), an abrasion resistance of 20 liters of sand per mil, and dielectric strength of 250 volts per mil. Pipe and fittings shall be polyethylene encased with 0.20 mm (8 mil) polyethylene sheeting per AWWA C105. Color of polyethylene encasement shall be green.
 4. High density polyethylene (HDPE) pipe and fittings 450 mm to 900 mm (18 inches to 36 inches) shall conform to ASTM F894. Pipe and fittings shall have a smooth interwall and profile exterior, and be as noted on the drawings. Joints shall be water tight elastomeric gaskets in accordance with ASTM D3212, or thermal welded joints.
- B. Gravity flow lines with secondary containment (pipe and fittings):
1. Piping systems conveying hazardous materials shall be constructed with a watertight primary (carrier) pipe completely enclosed within a watertight secondary (containment) pipe.
 2. Fiberglass Piping and Fittings: Shall be manufactured in accordance with ASTM D2992 using a filament-winding process. Joints shall be adhesive bonded straight or tapered spigot and bells. Taper angles shall not be greater than 0.5 degrees. The pipe and fittings shall have an integral epoxy resin-rich reinforced liner not less than 0.50 mm (0.020 inch) for carrier pipes, and not less than 0.25 mm (0.010 inch) for containment pipe.
 3. The carrier pipe shall be installed with manufactured spacers to maintain a minimum interstitial space of 19 mm (0.75 inch) between the carrier pipe and the containment pipe.
 4. The piping shall be equipped with adequate monitoring ports to detect the presence of fluids within the containment pipe and for the extraction of fluids from the containment pipe.

2.2 JOINTING MATERIAL

A. Gravity Flow Lines:

1. Vitrified Clay Pipe: Rubber gasket, ASTM C425.
2. Ductile Iron Pipe: Push-on or mechanical joints, AWWA C111, AWWA C110. Flange joints shall comply with AWWA C115. Flange joints shall only be used in vaults or above-grade.
3. Polyvinyl Chloride (PVC) Pipe (Gravity Use): Joints, ASTM D3212. Elastomeric gasket, ASTM F477.
4. High Density Polyethylene (HDPE) pipe and fitting joints, ASTM E-3212, elastomeric gaskets, ASTM F477.

B. Gravity Flow with Secondary Containment: Tapered or straight bell and spigot with adhesive bond. Completed joint shall be equal or greater than the pressure rating of the pipe.

C. Pressure (Force) Main:

1. All joints indicated on the drawings as being "restrained" shall be fully restrained and capable of restraining 50 percent above all loads acting on the joint, but not less than 1035 kPa (150 psi). Thrust blocks shall not be permitted.
2. Ductile iron pipe and fittings, mechanical or push-on, conforming to AWWA C110 and C111. Restrained joints shall meet the following requirements:
 - a. Push-on joints shall be restrained by a mechanical locking slot cast integrally in the bell of the pipe or fitting. The spigot shall have a retainer weldment or band. Locking segments, placed in the slots in the bell, shall form a mechanical restraint and prevent the opening of the joint.
 - b. Mechanical joint restraint shall be incorporated into the design of the follower gland. The restraining mechanism shall consist of individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The device shall be capable of full mechanical joint deflection during assembly and the flexibility of the joint shall be maintained after burial. The joint restraint ring and its wedging components shall be made of Grade 60-42-10 ductile iron conforming to ASTM A536. The wedges shall be ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell conforming to AWWA C111 and AWWA C153 of the latest revision. Torque limiting twist-off nuts shall be used to insure proper actuation of the restraining wedges. The gland shall be specifically designed for the type of pipe (DIP or PVC) connected to the fitting.

3. Polyvinyl Chloride (PVC) Pipe (Pressure Use):

- a. Push-on joints shall conform to AWWA C900, C905.
 - b. Push-on gaskets for pipe, ASTM F477.
 - c. Restrained joints shall comply with one of the following:
 - 1) Joints to mechanical ductile iron fittings shall comply with the requirements for ductile iron pipe, except the mechanical joint restraint gland shall be specifically designed for use with PVC pipe.
 - 2) Push-on bell and spigot joints shall be retained with retaining rings and thrust rods. The rings shall be ductile iron conforming to ASTM A536. The rings shall be split style with serrated inside face which grips the pipe when the halves of the ring is assembled together. The ring shall not bear directly on the back of the bell. The rods shall be of adequate size and number to resist all axial movement of the joint.
4. High Density Polyethylene (HDPE) pipe and fittings shall be fusion butt welded, flanged, or mechanical couplings as recommended by the manufacturer. Restrained joints shall be limited to fusion welded and flanged.

2.3 MANHOLES AND VAULTS

- A. Manholes and vaults shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. The manholes and vaults shall be in accordance with State Department of Transportation or State Roads Commission standard details, and the following:
1. Precast Concrete Segmental Blocks: Blocks shall conform to ASTM C139 and shall not be less than 150 mm (6 inches) thick for manholes to a depth of 3.6m (12 feet); not less than 200 mm (8 inches) thick for manholes deeper than 3.6m (12 feet) deep. Blocks shall be not less than 200 mm (8 inches) in length. Blocks shall be shaped so that joints seal and bond effectively with cement mortar. Parge structure interior and exterior with 15 mm (1/2 inch) of cement mortar applied with a trowel and finished to an even glazed surface.
 2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
 3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
 4. Flat top manhole tops shall be reinforced concrete as detailed on the drawings.

5. Vaults: Reinforced concrete, as indicated on the plans, or precast reinforced concrete. Concrete for precast sections shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C857.
6. Mortar:
 - a. Precast Concrete Segmental Block Structures: By volume, 1 part of Portland cement, 1/4 part lime hydrate, and 3 parts sand.
 - b. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21 L (5-1/2 gallons) per sack of cement.
7. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M198.
8. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words "sanitary sewer". The studs and the lettering shall be raised 8 mm (5/16 inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm (3/4 inch) vent holes and two lifting slots. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.
9. Manhole steps shall be polypropylene plastic coated on a No. 4 deformed rebar conforming to ASTM C478, Polypropylene shall conform to ASTM D4101. Steps shall be a minimum of 406 mm (16 inches) wide and project a minimum of 178 mm (7 inches) away from the wall. The top surface of the step shall have a studded non-slip surface. Steps shall be placed at 300 mm (12 inch) centers.
10. Ladders, brackets and hardware shall be constructed of welded aluminum, rails shall be 10 mm (3/8 inch) by 63 mm (2-1/2 inches) spaced a minimum of 400 mm (16 inches) apart. Rungs shall be 35 mm (1-3/8 inches) in diameter and have a non-slip surface. Standoffs shall offset the ladder 180 mm (7 inches) from the wall. The ladder assembly shall be rated for a minimum of 2200 N (500 pounds).

2.4 CONCRETE

Concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform with the provisions of Division 03 of these specifications.

2.5 REINFORCING STEEL

Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.6 CLEANOUT FRAMES AND COVERS

Frames and covers shall be gray iron casting conforming to ASTM C48. The frame and cover shall be rated for HS20-44 wheel loading, have a studded pattern on its cover, vent holes, and lifting slots. The cover shall fit firmly on the frame without movement when subject to vehicular traffic. The word "SEWER" shall be cast on the cover.

2.16 WARNING TAPE

Standard, .1mm (4Mil) polyethylene 76 mm (3 inch) wide tape detectable type, green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

PART 3 - EXECUTION

3.1 BUILDING SERVICE LINES

- A. Install sanitary sewer service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings where service is required and make connections. Coordinate the invert and location of the service line with the Contractor installing the building lines.
- B. Connections of service line to building piping shall be made after the new sanitary sewer system has been constructed, tested, and accepted for operation by the Resident Engineer. The Contractor shall install all temporary caps or plugs required for testing.
- C. When building services have not been installed at the time when the sanitary sewer system is complete, provide temporary plugs or caps at the ends of all service lines. Mark the location and depth of the service lines with continuous warning tape placed 300 mm (12 inches) above service lines.

3.2 ABANDONED MANHOLES STRUCTURES AND PIPING

- A. Manholes and Structures Outside of Building Areas: Remove frame and cover, cut and remove the top of an elevation of 600 mm (2 feet) below finished grade. Fill the remaining portion with compacted gravel or crushed rock or concrete.
- B. Manholes and Structures with Building Areas: Remove frame and cover and remove the entire structure and the base.
- C. Piping under and within 1500 mm (5 feet) of building areas shall be abandoned in place and completely filled with 21 MPa (3000 psi) concrete.

- D. Piping outside of building areas shall have all ends of the piping at the limit of the abandonment and within structures and manholes, plugged with concrete, and abandoned in-place.
- E. The Contractor shall comply with all OSHA confined space requirements while working within existing manholes and structures.
- F. When the limit of the abandonment terminates in an existing manhole to remain, the flow line in the bench of the manhole to the abandoned line shall be filled with concrete and shaped to maintain the flowline of the lines to remain.

3.3 REGRADING

- A. Raise or lower existing manholes and structures frames and covers, cleanout frames and covers and valve boxes in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Adjust the elevation of the cleanout pipe riser, and reinstall the cap or plug. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.
- C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

3.4 CONNECTIONS TO EXISTING VA OWNED MANHOLES

- A. During construction of new connections to existing manholes, it shall be the sole responsibility of the Contractor to maintain continued sanitary sewer service to all buildings and users upstream. The contractor shall provide, install, and maintain all pumping, conveyance system, dams, weirs, etc. required to maintain the continuous flow of sewage. All temporary measures required to meet this requirement shall be subject to the review of the Resident Engineer.
- B. Core existing structure, install pipe at the design invert. Install an elastomeric gasket around the pipe, and grout the interstitial space between the pipe and the core.
- C. The bench of the manhole shall be cleaned and reshaped to provide a smooth flowline for all pipes connected to the manhole.
- D. Connections and alterations to existing manholes shall be constructed so that finished work conforms as nearly as practicable to the applicable requirements

specified for new manholes, including concrete and masonry work, cutting and shaping.

3.6 PIPE SEPARATION

A. Horizontal Separation - Water Mains and Sewers:

1. Existing and proposed water mains shall be at least 3 meters (10 feet) horizontally from any proposed gravity flow and pressure (force main) sanitary sewer or sewer service connection.
2. Gravity flow mains and pressure (force) mains may be located closer than 3 meters (10 feet) but not closer than 1.8 m (6 feet) to a water main when:
 - a. Local conditions prevent a lateral separation of ten feet; and
 - b. The water main invert is at least 450 mm (18 inches) above the crown of the gravity sewer or 600 mm (24 inches) above the crown of the pressure (force) main; and
 - c. The water main is in a separate trench separated by undisturbed earth.
3. When it is impossible to meet (1) or (2) above, both the water main and sanitary sewer main shall be constructed of push-on or mechanical joint ductile iron pipe. The pipe for the sanitary sewer main shall comply with the specifications for pressure (force) mains, and the water main material shall comply with Section 33 10 00, WATER UTILITIES. The sewer shall be pressure tested as specified for pressure (force) mains before backfilling.

B. Vertical Separation - Water Mains and Sewers at Crossings:

1. Water mains shall be separated from sewer mains so that the invert of the water main is a minimum of 600 mm (24 inches) above the crown of gravity flow sewer or 1200 mm (48 inches) above the crown of pressure (force) mains. The vertical separation shall be maintained within 3 meters (10 feet) horizontally of the sewer and water crossing. When these vertical separations are met, no additional protection is required.
2. In no case shall pressure (force) sanitary main cross above, or within 600 mm (24 inches) of water lines.
3. When it is impossible to meet (1) above, the gravity flow sewer may be installed 450 mm (18 inches) above or 300 mm (12 inches) below the water main, provided that both the water main and sewer shall be constructed of push-on or mechanical ductile pipe. Pressure (Force) sewers may be installed 600 mm (24 inches) below the water line provided both the water line and sewer line are constructed of ductile iron pipe. The pipe for the sewer shall conform to the requirements for pressure sewers specified herein. Piping for the water main shall conform to Section 33 10 00, WATER UTILITIES.

4. The required vertical separation between the sewer and the water main shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer line is at least 3 meters (10 feet).

3.7 GENERAL PIPING INSTALLATION

- A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade. Pressure (force) mains shall have the bells facing the direction of flow.
- B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- G. Do not lay sewer pipe in same trench with another pipe or other utility. Sanitary sewers shall cross at least 600 mm (2 feet) below water lines.
- H. Do not walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 300 mm (12 inches) over the crown of the pipe.
- I. Warning tape shall be continuously placed 300 mm (12 inches) above sewer pipe
- J. Install gravity sewer line in accordance with the provisions of these specifications and the following standards:
 1. Ductile Iron Piping: AWWA C111 and C600.
 2. Vitrified Clay Piping: ASTM C12.
 3. Polyvinyl Chloride (PVC) Piping: ASTM D2321.
 4. High Density Polyethylene (HDPE) Piping: Comply with manufacturer's recommendations with gasketed joints.
- K. Gravity Flow Lines with Secondary Containment:

1. Install per manufacturer's recommendations. Install all pipe centering devices to maintain an interstitial space below the invert of the carrier pipe. Both the carrier and containment pipe shall be tested for leaks.

L. Installation of Pressure (Force) Mains:

1. Sections of piping listed on the drawings shall be fully restrained using approved joint restraint devices. Joint restraint devices shall be installed in accordance with the manufacturer's recommendations. For devices with twist of nuts, the twist of nuts shall be placed on top of the fitting for the Engineer's inspection. The Contractor shall torque test all bolts, set screws, identified by the Resident Engineer.
2. Thrust blocks shall not be permitted.
3. Install pressure (force) mains in accordance with the provisions of these specifications and the following standards:
 - a. Ductile Iron Piping: AWWA C111 and C600.
 - b. Polyvinyl Chloride (PVC) Piping: AWWA C605.
 - c. High Density Polyethylene (HDPE) Piping: Per manufacturer's recommendations.

3.8 MANHOLES AND VAULTS

A. General:

1. Circular Structures:

- a. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 15 mm (1/2 inch) or cement mortar applied with a trowel and finished to an even glazed surface.
- b. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top, shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
- c. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

2. Rectangular Structures:

- a. Reinforced concrete structures shall be installed in accordance with Division 03, CONCRETE.
- b. Precast concrete structures shall be placed on a 200 mm (8 inch) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on 200 mm (8 inches) thick aggregate base course compacted to a minimum of 95

percent of the maximum density as determined by ASTM D698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.

3. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.
4. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
 - a. Forming directly in concrete base of structure.
 - b. Building up with brick and mortar.
5. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (1-inch per foot) nor more than 1:6 (2 inches per foot). Bottom slab and benches shall be concrete.
6. The wall that support access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
7. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
8. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.9 SEWER AND MANHOLE SUPPORTS, CONCRETE CRADLES

Reinforced concrete as detailed on the drawings. The concrete shall not restrict access for future maintenance of the joints within the piping system.

3.10 CLEANOUTS

- A. 150 millimeters (6 inches) in diameter and consisting of a ductile iron 45 degree fitting on end of run, or combination Y fitting and 1/8 bend in the run with ductile iron pipe extension, water tight plug or cap and cast frame and cover flush with finished grade. Center-set cleanouts, located in unpaved areas, in a 300 by 300 by 150 mm (12 by 12 by 6 inches) thick concrete slab set flush with adjacent finished grade. Where cleanout is in force main, provide a blind flange top connection. The center of the flange shall be equipped with a 50 mm (2 inches) base valve to allow the pressure in the line to be relieved prior to removal of the blind flange. Frames and covers for pressure (force) mains shall be 600 mm (24 inches) in diameter.

- B. The top of the cleanout assembly shall be 50 mm (2 inches) below the bottom of the cover to prevent loads being transferred from the frame and cover to the piping.

3.11 INSPECTION OF SEWERS

Inspect and obtain the Resident Engineer's approval. Thoroughly flush out before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade. Lip at joints on the inside of gravity sewer lines are not acceptable.

3.12 TESTING OF SANITARY SEWERS

- A. Gravity Sewers and Manholes (Select one of the following):

1. Air Test: Vitrified Clay Pipe ASTM C828. PVC Pipe, Uni-Bell Uni-B-6. Clean and isolate the section of sewer line to be tested. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. The line shall be pressurized to 28 kPa (4 psi) and allowed to stabilize. After pressure stabilization, the pressure shall be dropped to 24 kPa (3.5 psi) greater than the average back-pressure of any groundwater above the sewer. The minimum test time shall be as specified in Uni-Bell Uni-B-6.
2. Exfiltration Test:
 - a. Subject pipe to hydrostatic pressure produced by head of water at depth of 900 mm (3 feet) above invert of sewer at upper manhole under test. In areas where ground water exists, head of water shall be 900 mm (3 feet) above existing water table. Maintain head of water for one hour for full absorption by pipe body before testing. During one hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 11 L (3.0 gallons) per hour per 30 m (100 feet).
 - b. If measurements indicate exfiltration is greater than maximum allowable leakage, take additional measurements until leaks are located. Repair and retest.
3. Infiltration Test: If ground water level is greater than 900 mm (3 feet) above invert of the upper manhole, infiltration tests are acceptable. Allowable leakage for this test will be the same as for the exfiltration test.

- B. Pressure (Force) Mains: Test at 690 kPa (100 psi) for two hours. Leakage shall be per the following:

$$L = J \cdot D \cdot \sqrt{P/4500}$$

Where:

L = Maximum Allowable Leakage in Gallons per Hour

J = Number of Joints in Test Area
D = Diameter of Pipe in Inches
P = Average Test Pressure (Psi)

- C. Testing of Fiberglass Sewage Holding Tanks: No leakage at 35 kPa (5 psi) air pressure test with 5:1 safety factor. Test by Contractor after installation.
- D. Testing of Concrete Wet Well: No leakage with the wet well completely filled with water for a duration of 4 hours.

END OF SECTION 333000

SECTION 334000 - STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies construction of outside, underground storm sewer systems. The storm sewer systems shall be complete and ready for operation, including all drainage structures, frames, grate and covers, connections to new buildings, structure service lines, existing storm sewer lines and existing drainage structures and all required incidentals.

1.2 RELATED WORK

- A. Maintenance of Existing Utilities: Section 010000, GENERAL REQUIREMENTS.
- B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 312000, EARTH MOVING.
- C. Concrete Work, Reinforcing, Placement and Finishing: Section 033000, CAST-IN-PLACE CONCRETE.
- D. Fabrication of Steel Ladders: Section 055000, METAL FABRICATIONS.
- E. Protection of Materials and Equipment: Section 220511, COMMON WORK RESULTS FOR PLUMBING.

1.3 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 - 2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to public storm sewer lines and the extension, and/or modifications to Public Utility systems.

1.4 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data: Submit the following as one package:
 - 1. Piping.

2. Jointing material.
3. Manhole, inlet and catch basin material.
4. Frames and covers.
5. Steps.
6. Resilient connectors and downspout boots.

C. One copy of State Department of Transportation standard details of MANHOLES, INLETS and catch basins.

D. One copy of State Department of Transportation specification.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

A48-03/A48M-03	Gray Iron Castings
A536-84(2004)	Ductile Iron Castings
A615-05/A615M-05	Deformed and Plain-Billet Steel Bars for Concrete Reinforcement
A655-04e1/A655M-04e1...	Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
A742-03/A742M-03	Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
A760-01a/A760M-01a	Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
A762-00/A762M-00	Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
A798-01/M798M-01	Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
A849-00	Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
A929-01/A929M-01	Steel Sheet, Metallic Coated by the Hot Dip Process for Corrugated Steel Pipe
C76-05a/C76M-05a	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
C139-03	Concrete Masonry Units for Construction of Catch Basins and Manholes
C150-04ae1	Portland Cement
C443-05/C443M-05	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C478-03a/C478M-03a	Precast Reinforced Concrete Manhole Sections
C506-05/C506M-05	Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe

C507-05a/C507M-05a.....	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
C655-04e1/C655M-04e1...	Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
C1433-04e1/C1433M-04e1	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers
C828-03.....	Low-Pressure Air Test of Vitrified Clay Pipe Lines
C857-95(2001)	Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
C923-02/C923M-02	Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Materials
C924-02/C924M-02	Testing Concrete Pipe Sewer Lines by Low Pressure Air Test Method
C1103-03/C1103M-03.....	Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
D698-00ae1.....	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
D1056-00.....	Flexible Cellular Materials-Sponge or Expanded Rubber
D2412-02.....	Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading
D2321-04e1.....	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications .
D3034-04a.....	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3212-96a(2003)e1	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D3350-04.....	Polyethylene Plastics Pipe and Fittings Materials
D4101-05a.....	Polypropylene Injection and Extrusion Materials
F477-02e1	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F679-03	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
F714-05	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F794-03	Poly (Vinyl Chloride)(PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
F894-98a	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
F949-03	Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior
F1417-92(2005).....	Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

NOTE: ASTM test methods shall be the current version as of the date of advertisement of the project.

C. American Association of State Highway and Transportation Officials (AASHTO):

HB17	Standard Specifications for Highway Bridges
M190-04	Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
M198-05	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
M294-04	Corrugated Polyethylene Pipe, 300-1500 mm (12 to 60 inches) Diameter

PART 2 - PRODUCTS

2.1 PIPING

A. Gravity Lines (Pipe and Appurtenances):

1. Concrete:

- a. Reinforced pipe, ASTM C76. Class IV. Joints shall be watertight flexible joints made with rubber-type gaskets conforming to ASTM C443.

2. Polyvinyl Chloride (PVC):

- a. Pipe and Fittings, Type PSM PVC Pipe, shall conform to ASTM D3034, Type PSM, SDR 35. Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D 3212. Gaskets shall conform to ASTM F 477. Solvent welded joints shall not be permitted.
- b. Pipe and fittings, smooth wall, corrugated or ribbed PVC, shall conform to the following:
 - 1) Pipe and fittings shall conform to ASTM F949 corrugated sewer pipe with a smooth interior. The corrugated outer wall shall be fused to the smooth interwall at the corrugation valley. Pipe and fitting shall have a smooth bell, elastomeric joints conforming to ASTM D 3212, and shall have a minimum pipe stiffness of 345 kPa (50 psi) at 5 percent deflection, when tested in accordance with ASTM D 2412. Corrugation shall be perpendicular to the axis of the pipe to allow gaskets to be installed on field cut sections of pipe without the requirement for special fittings.
 - 2) Ribbed wall PVC pipe and fittings shall conform to ASTM F794, Series 46. Ribbed sewer pipe with smooth interior pipe and fittings shall have a smooth bell, elastomeric joints conforming to ASTM D 3212, and shall have a minimum pipe stiffness of 320 kPa (46 psi) when tested in accordance with ASTM D 2412, at 5 percent vertical deflection. Joints shall not leak at 7.6 m (25 feet) of head under 5 percent deflection.
 - 3) Solid wall pipe and fittings shall conform to ASTM SDR 26 pipe and fittings shall gaskets conforming to ASTM F 477, and shall be able to withstand a hydrostatic pressure of 345 kPa (50 psi).

2.2 JOINTING MATERIAL

- A. Concrete Pipe: Rubber gasket ASTM C443.
- B. Polyvinyl Chloride (PVC) Pipe:
 - 1. PVC Plastic Pipe: Joints shall comply with ASTM D3212, Elastomeric Gaskets shall comply with ASTM F477 and as recommended by the manufacturer.
- C. PE Plastic Pipe:
 - 1. Smooth Wall PE Plastic Pipe: Pipe shall be joined using butt fusion as recommended by the manufacturer.
 - 2. Corrugated PE Plastic Pipe: Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F477. Soil tight joints shall conform to requirements in AASHTO HB-17, Division II, for soil tightness and shall be as recommended by the manufacturer.
 - 3. Profile Wall PE Plastic Pipe: Joints shall be gasket or thermal weld type with integral bell in accordance with ASTM F894.
- D. Corrugated Metal Pipe:
 - 1. Gaskets: Rubber gaskets, shall comply with ASTM D1056, Type 2 Rubber O-rings shall conform to ASTM C443.
 - 2. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of the band, and the size of the angles, bolts, rods and lugs as indicated, or where not indicated, as specified in the applicable standards or specifications for the pipe.

2.3 MANHOLES, INLETS AND CATCH BASINS

- A. Manholes, inlets and catch basins shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. Manholes, inlets and catch basins shall be in accordance with State Department of Transportation standard details, and the following VA requirements, in case of variance, VA requirements supersede:
 - 1. Precast Concrete Segmental Blocks: Blocks shall conform to ASTM C139 and shall not be less than 150 mm (6 inches) thick for manholes to a depth of 3.6 m (12 feet); not less than 200 mm (8 inches) thick for manholes deeper than 3.6 m (12 feet) deep. Blocks shall be not less than 200 mm (8 inches) in length. Blocks shall be shaped so that joints seal and bond effectively with cement mortar. Parge structure interior and exterior with 15 mm (1/2 inch) of cement mortar applied with a trowel and finished to an even glazed surface.
 - 2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm

- (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
 4. Flat top manhole tops shall be reinforced concrete as detailed on the drawings.
 5. Precast Catch Basins: Concrete for precast sections shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C-857.
 6. Mortar:
 - a. Precast Concrete Segmental Block Structures: By volume, 1 part of Portland cement, 1/4 part lime hydrate, and 3 parts sand.
 - b. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21L (5-1/2 gallons) per sack of cement.
 7. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M-198B.
 8. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words "storm sewer". The studs and the lettering shall be raised 8 mm (5/16 inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm (3/4 inch) vent holes and two lifting slots. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.
 9. Manhole steps shall be polypropylene plastic coated on a No. 4 deformed rebar conforming to ASTM C478, Polypropylene shall conform to ASTM D4101. Steps shall be a minimum of 250 mm (10 inches) wide and project a minimum of 125 mm (5 inches) away from the wall. The top surface of the step shall have a studded non-slip surface. Steps shall be placed at 300 mm (12 inch) centers.
 10. Ladders, brackets and hardware shall be constructed of welded aluminum, rails shall be 9 mm (3/8 inch) by 63 mm (2-1/2 inches) spaced a minimum of 400 mm (16 inches) apart. Rungs shall be 35 mm (1-3/8 inches) in diameter and have a non-slip surface. Standoffs shall offset the ladder 180 mm (7

- inches) from the wall. The ladder assembly shall be rated for a minimum of 2200 N (500 pounds).
- B. Prefabricated Corrugated Metal Manholes: Manholes shall be the type and design as indicated on the drawings and as recommended by the manufacturer.
 - C. Prefabricated Plastic Manholes and Drain Basins: Plastic manholes and drain basins shall be as indicated on the drawings.
 - D. Frame and Cover for Gratings: Frame and cover for gratings shall be cast gray iron conforming to ASTM A48; cast ductile iron conforming to ASTM A536 in accordance with State Department of Transportation standard details Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the drawings.

2.4 HEADWALLS

- A. Headwalls shall be cast-in-place concrete and in accordance with State Department of Transportation standard details. Concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform with the provisions of Division 03 of these specifications.

2.5 CONCRETE

Concrete shall be in accordance with State Department of Transportation standard specification. For concrete not specified in above standards, concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform to the provisions of Division 03 of these specifications.

2.6 REINFORCING STEEL

Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.7 FLARED END SECTIONS

Flared End Sections: Sections shall be of standard design fabricated from zinc-coated steel sheets conforming to requirements of ASTM A929.

2.8 WARNING TAPE

Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, purple with black letters, and imprinted with "CAUTION BURIED STORM SEWER BELOW".

PART 3 - EXECUTION

3.1 EXCAVATION FOR STORM DRAINS AND DRAINAGE STRUCTURES

Excavation of trenches and for appurtenances and backfilling for storm drains, shall be in accordance with the applicable portions of Section 31 20 00, EARTH MOVING.

3.2 PIPE BEDDING

The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Concrete pipe requirements are such that when no bedding class is specified, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform with the lowest one-fourth of the outside portion of circular pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material. Corrugated metal pipe bedding requirements shall conform to ASTM A798.

3.3 GENERAL PIPING INSTALLATION

- A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade.
- B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- G. Do not lay sewer pipe in same trench with another pipe or other utility.
- H. Do not walk on pipe in trenches until covered by layers of shading to a depth of 300 mm (12 inches) over the crown of the pipe.

- I. Install gravity sewer line in accordance with the provisions of these specifications and the following standards:
 1. Reinforced Concrete Pipe: Comply with manufacturer's recommendations with gasketed joints.
 2. Polyvinyl Chloride (PVC) Piping: ASTM D2321.
 3. High Density Polyethylene (HDPE) Piping: Comply with manufacturer's recommendations with gasketed joints.
- J. Warning tape shall be continuously placed 300 mm (12 inches) above storm sewer piping.

3.4 REGRADING

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.
- C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

3.5 MANHOLES, INLETS AND CATCH BASINS

- A. General:
 1. Circular Structures:
 - a. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 15 mm (1/2 inch) or cement mortar applied with a trowel and finished to an even glazed surface.
 - b. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
 - c. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

2. Rectangular Structures:

- a. Reinforced concrete structures shall be installed in accordance with Division 03, CONCRETE of these specifications.
 - b. Precast concrete structures shall be placed on a 200 mm (8 inch) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on a 200 mm (8 inches) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D 698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.
3. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.
4. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
- a. Forming directly in concrete base of structure.
 - b. Building up with brick and mortar.
5. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (25mm per 300mm, 1-inch per foot) nor more than 1:6 (50mm per 300mm, 2 inches per foot). Bottom slab and benches shall be concrete.
6. The wall that supports access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
7. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
8. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.7 INSPECTION OF SEWERS

Inspect and obtain the Resident Engineer's approval. Thoroughly flush out before inspection. Lamp between structures and show full bore indicating sewer is true to line and grade. Lip at joints on inside of sewer is prohibited.

3.8 TESTING OF STORM SEWERS

A. Gravity Sewers (Select one of the following):

1. Air Test: Concrete Pipes conform to ASTM C924, Plastic Pipes conform to ASTM F1417, all other pipe material conform to ASTM C828 or C924, after consulting with pipe manufacturer. Testing of individual joints shall conform to ASTM C1103.
2. Exfiltration Test:
 - a. Subject pipe to hydrostatic pressure produced by head of water at depth of 900 mm (3 feet) above invert of sewer at upper manhole under test. In areas where ground water exists, head of water shall be 900 mm (3 feet) above existing water table. Maintain head of water for one hour for full absorption by pipe body before testing. During 1 hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 11L (3.0 gallons) per hour per 30 m (100 feet).
 - b. If measurements indicate exfiltration is greater than maximum allowable leakage, take additional measurements until leaks are located. Repair and retest.

END OF SECTION 334000

Page intentionally left blank.

SECTION 334613 - FOUNDATION DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies foundation drainage system, including installation, backfill, and cleanout extensions.

1.2 SUBMITTALS

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples: For each type of filter fabric, pipe, and fitting indicated
- C. Product Data: Certifications from the manufacturers attesting that materials meet specification requirements.

1.3 RELATED WORK

- A. Materials testing and inspection during construction: Section 014529, TESTING LABORATORY SERVICES.
- B. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 010000, GENERAL REQUIREMENTS.
- C. Subsurface Investigation: Section 000860, SUBSURFACE SOILS REPORT.

1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred in the text by basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - HB17-02Standard Spec for Highway Bridges, Div II, Section 36.4.2.4, Joint Properties.
 - M6-03Fine Aggregate for Portland Cement Concrete
 - M86/M86M-06Concrete Sewer, Storm Drain, and Culvert Pipe
 - M288-06Geotextile Specification for Highway Applications
- C. American Society for Testing and Materials (ASTM):
 - D2321-05Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
 - D2729-03Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

D3034-06.....	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
F477-02e1	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F758-95(2000)	Standard Specification for Smooth-Wall Poly (Vinyl Chloride)(PVC)Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Perforated Drainage Pipe:

1. Perforated, PVC sewer pipe and fittings per ASTM D2729, in NPS 4 (DN 100) only. Joints shall be bell-and-spigot, loose type.

B. Cleanout Extension: ASTM A74, cast iron pipe or ASTM A746 ductile iron. Gravity Sewer pipes shall have a neoprene gasket joints and long sweep elbow fittings.

C. Drainage Conduit:

1. Pipe, fittings, and couplings shall be perforated and smooth PVC complying with ASTM D4216 and ASTM D2729.
2. Fittings shall be PVC with NPS 4 (DN 100) outlet connection.
3. Couplings shall be PVC.

D. Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:

E. Drainage Material:

1. Bedding: Crushed stone, 20 mm (3/4 inch) to No. 4 per ASTM D448.
2. Fill to 300 mm (1 foot) above pipe: Crushed stone, 20 mm (3/4 inch) to No. 4 per ASTM D448.

F. Concrete Sand: AASHTO M6.

PART 3 - EXECUTION

3.1 INSTALLATION

- #### **A. Laying:** Prior to installation of bedding materials or piping, examination of excavation and subgrades are to be observed by the Resident Engineer. Invert

elevation of drain pipe shall not be higher than top of lowest floor elevation nor lower than a 45 degree line projected from bottom of any adjacent footing. Lay drain lines and firmly bed in granular material a minimum of 75 mm (3 inches) below invert to top of pipe to true grades and alignment with bells facing upgrade, and to slope uniformly between elevations shown on foundation drainage drawings. Keep trenches dry until pipe is in place and granular material backfill is completed to 300 mm (1 foot) above top of pipe, unless otherwise noted.

1. Install gaskets, seals, sleeves, and couplings according to manufacturers written instructions and per the applicable standard:
 - a. PVC pipe installation shall be per ASTM D2321 and ASTM F758.
 - b. PE joint construction shall be per ASTM D2737 and AASHTO HB17, Division II, Section 26.4.2.4, "Joint Properties."
 - c. PVC joint construction shall be per ASTM D3034 with elastomeric seals gaskets per ASTM D2321.
 - d. Perforated PVC joint construction shall be per ASTM D2729, with loose bell and spigot joints.
 - e. Perforated concrete joint construction, including fittings and gaskets, shall be per ASTM C443/C443M.
 2. Lay perforated pipe with perforations down. Lay plain end pipe with closed joints held in place with two No. 9 spring steel wire clips at each joint or by standard clay collars.
 3. For foundation subdrainage, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 900 mm (3 feet), unless otherwise indicated.
 4. Install cleanout extensions where shown on the Contract Documents.
 5. Prior to backfilling, check drain lines to assure free flow. Remove obstructions and recheck lines until satisfactory.
- B. Backfilling: Place a minimum of 300 mm (12 inches) of granular material, hand tamped, extending in width a minimum of 600 mm (2 feet) from building wall. Then place a minimum of 150 mm (6 inches) of concrete sand, well tamped. Continue backfill with pit run sand and gravel with a maximum plasticity index of 6 to within 900 mm (3 feet) of finished grade in planting areas. Remainder of backfill shall be comparable to existing adjacent soils. In bituminous and concrete paving areas, backfill to the bottom of the base course with pervious material. Where foundation drain is within 600 mm (2 feet) of finished grade, one-half of fill shall be made with crushed stone.
- C. Filter fabric may be substituted for sand layer.
- D. Vertical drainage mat in conjunction with geotextile may be substituted for sand and drainage material.

- E. When drain lines are left open for connection to discharge line, the open ends shall be temporarily closed and their location marked with wooden stakes.

END OF SECTION 334613